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THURSDAY, JANUARY 7, 1886

THE RACES OF BRITAIN

The Races of Britain: a Contribution to the Anthropology of Western Europe. By John Beddoe, M.D., F.R.S., &c. (London: Trübner; Bristol: Arrowsmith. 1885.)

BELIEVING that after thirty years of labour his opportunities for observation are not likely to add much to his store of facts, or materially alter their significance in his own eyes, Dr. Beddoe has brought together his numerous contributions to the ethnology of the British Isles, and, with the addition of much new matter, has arrayed them before us in such a manner as to show his own conclusions, and to form "some small part of a solid platform" whereon future anthropologists, with antiquaries and philologists, may ultimately build a more complete and certain structure.

Dr. Beddoe's mode of procedure is to make extensive observations on the physical characters of the present inhabitants of our islands, and on those of the adjoining parts of the Continent which are the reputed cradles of the various elements of our race, and to compare the results with the records of history as far as they are available. The physical characters to which he attaches most importance are colour of hair and eyes, head-form, and stature, and of these he has collected a very large number of observations on a systematic plan, and hence the "numerical method" of studying anthropology which he first inaugurated in 1853, and which has since been largely followed by continental observers. Dr. Beddoe attaches most importance to colour, because he believes that "the colour of the hair is so much more permanent in races of men as to be fairly trustworthy evidence in matters of ethnical descent; and that nearly as much may be said for the colour of the eyes." With regard to head-form he complains of the great dearth of measurements of modern British skulls, the skulls in our museums being chiefly those of criminals, lunatics, and paupers, and therefore of little value; and he finds from personal experience that the accurate measurements of living heads are alike difficult to make and difficult to obtain. He supplies tables, however, of a considerable number of measurements of heads obtained by himself or his friends in different parts of the country. The statistics of stature and weight collected by Dr. Beddoe have been dealt with in a separate essay, and as they were incorporated with others of a similar kind collected by the Anthropometric Committee of the British Association, and published in their final report for 1883, they are, therefore, not republished in his present volume.

It is to his extensive observations on the colour of the hair and eyes that Dr. Beddoe chiefly trusts for his analysis of the racial distribution of our existing populations, and for the purpose of more convenient and definite comparison he adopts a formula which serves as an index of nigrescence." Having classified the colour of hair as red (R), fair (F), brown (B), dark (D), and black (N), "the gross index," he says, "is gotten by subtracting the number of red and fair-haired persons from that of the dark-haired, together with twice the black-haired. I double the black, in order to give its proper value to the greater tendency to melanosity shown thereby; while brown (which [illegible] though most persons pl[illegible] and approach more nea[illegible] the melanous variety:—

$$D + 2N$$

From the gross index, th[illegible] course easily obtained."

BOOK NO. 1062

Dr. Beddoe is quite alive to the want of uniformity in the manner of observing, to the different significance of the terms employed for the colours of hair and eyes, and to peculiarities in observers themselves, but as the data he makes use of were collected by himself, the personal equation of the observer and the terms employed are constant. He does not explain the principle on which his classification of colour of hair and eyes, is based, and it would seem to be the result of combinations which his very extensive observations have suggested as the most constant and consistent with each other and with other physical characters, as he claims for it a closer appositeness for defining racial distinctions than other schemes. It differs from the plans of Virchow, Vanderkindere, and Kollmann, and other continental anthropologists, and from that of the Anthropometric Committee, which is based on the simple anatomical arrangement of pigment in and on the surface of the iris, hair colour being deemed of secondary importance both from the difficulty of diagnosis and its greater changeableness with age.

Dr. Beddoe's account, extending over eleven chapters, of the prehistoric races, and the various conquests of the Romans, Anglo-Saxons, Danes, and Normans, and the fresh blood which they introduced into the country, is very fully and impartially rendered. The natives of South Britain at the time of the Roman conquest, according to Dr. Beddoe, "consisted mainly of several strata, unequally distributed, of Celtic-speaking people, who in race and physical type, however, partook more of the tall blond stock of Northern Europe than of the thick-set, broad-headed, dark stock which Broca has called Celts. . . . Some of these layers were Gaelic in speech, some Cymric: they were both superposed on a foundation principally composed of the long-headed dark races of the Mediterranean stock, possibly mingled with fragments of still more ancient races, Mongoliform or Allophylian. This foundation-layer was still very strong and coherent in Ireland and the north of Scotland, where the subsequent deposits were thinner, and in some parts partially or wholly absent . . . no Germans, recognisable as such by speech as well as by person, had as yet entered Britain."

Dr. Beddoe appears to hold a middle place between the writers who believe, on the one hand, in the extermination of the native races by the Anglo-Saxons, and on the other in their extensive survival in all parts of the country; while he attaches more importance to the new blood introduced by the Danes and Normans than is commonly admitted.

The portion of the work devoted to an analysis of the racial elements of the present inhabitants of the British Isles and adjoining countries of Western Europe consists

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of a very large number of tables showing the distribution of the colour of hair and eyes according to the "index of nigrescence," and to a less extent to the head-forms, from the author's personal observations; and of second series of colour of hair and eyes of military deserters illustrated by maps constructed on the plan of the Anthropometric Committee. There are also tables showing the relation between complexion and disease collected at the Bristol Infirmary; and numerous illustrations are given showing the physiognomy of males and females which the author believes to be typical of the various racial elements at present surviving among us.

Of the conclusions which Dr. Beddoe draws from all these observations it is impossible to give a summary here. He examines the whole country, district by district and county by county, from the Shetlands to Cornwall, and the reader must consult the work itself to see how far the author has succeeded in the task he has set himself, and to what extent he has prepared a solid platform for his successors in the same field of inquiry. It is most probable that Dr. Beddoe's conclusions, based as they are on a minute acquaintance with the history of the conquests and settlements of the country, and on a wide personal survey of the population in most stationary situations, will be accepted by anthropologists as the best results and the nearest approach to the truth which is attainable at the present day. On the other hand it is doubtful whether Dr. Beddoe's confidence in colour as a permanent racial character will bear the test of future inquiry, and whether his method will be accepted as sufficient when the questions of prepotency of stock, relative viability of dark and blond persons, and the influence of sexual selection have been more completely investigated. The Jews of Europe are isolated and preserved as a separate race by the sterility or low fertility of their mixed marriages, and the question of hybridism in the human race has received little attention from anthropologists. The function of reproduction is the most highly specialised and the most easily disturbed, and it is probable that the dying out of races is due more to this cause than to the "vices of civilisation" to which they are commonly attributed. American statistics show that the blond type is more subject to all the diseases, except one (chronic rheumatism), which disqualify men for military service, and this must obviously place blonds at a great disadvantage in the battle of life, while the popular saying, "a pair of black eyes is the delight of a pair of blue ones," shows that sexual selection does not allow them to escape from it. It is more than probable, therefore, from all these considerations, that the darker portion of our population is gaining on the blond, and this surmise is borne out by Dr. Beddoe's remark that the proportion of English and Scotch blood in Ireland is probably not less than a third, and that the Gaelic and Iberian races of the west, mostly dark-haired, are tending to swamp the blond Teutonic of England by a reflex migration—a fact not without significance to others than anthropologists at the present time.

The "Races of Britain" gives a very imperfect idea to those who are unacquainted with such inquiries, of the labour, time, and thought expended on its production, but anthropologists who know how to estimate such work at its full value will welcome it with great satisfaction as the most exhaustive account of the ethnology of our country which has appeared in recent years.

CHARLES ROBERTSON

OUR BOOK SHELF

Journal of the Royal Agricultural Society. Vol. xxi. Part II., Series II. (London: John Murray, 1885)

THE second part of the current number of this *Journal* opens with the second instalment of Mr. Fream's report upon Canadian agriculture. The climate, soil, and products of Eastern Canada, comprising the better-known States of Ontario, Quebec, and the maritime provinces are chiefly dealt with, whereas, in the first report, practical farming, and the almost untrodden regions of the north-west were particularly dealt with. The principal object of the report is to show the capabilities and rapid progress of Canada, and this is achieved by numerous statistics as to production and exports. In these provinces the fertility of the soil has been in a great degree exhausted and as a consequence mixed farming with the maintenance of live stock, and the use of improved processes, is taking the place of consecutive corn-growing. The growth of the dairy industry is a remarkable fact, and in the management of their cows and the manipulation of the products of the dairy, more attention is apparently paid to the teachings of science than is usual in the mother country. The exports of cheese have increased from 6,000,000 pounds per annum in 1870, to 76,000,000 pounds in 1884. The butter trade has long been stationary owing to the uncertain demand for Canadian butter. The Canadian cattle trade has also increased by leaps and bounds from a gross number of 6940 head in 1877, to 61,843 in 1884. The report is full of details of personal experience gained from many settlers in all parts of Old Canada. Names and addresses of the principal farmers, dairymen, and stock-breeders, are given with great frequency, and confer a special value on the report as a guide to intending settlers.

A large portion of the *Journal* is occupied with official reports of the Preston meeting of the Society (1885), including the report upon the prize farms in Lancashire. These last reports are less interesting than usual, as practical men, as the Lancashire farmers are excep tionally placed, and conduct their business upon sub urban principles of management. The sale of farm pro duce directly to the town consumer and the carry back of town manure is the marked feature. Rents appear to range particularly high for the present de pressed state of trade and agriculture, and are gene from fifty to sixty shillings per acre.

The customary reports of the Steward upon live st and implements, and short memoirs of the late B. T. B. Gibbs and Sir Watkin W. Wynn, close section. A summary of the Commission's Report Technical Education, 1884, and a reprint from the Re of the Pennsylvania State Board of Agriculture, occupy some fifty pages, the latter reviving M. Guér curious theory with regard to indications of mil properties in the peculiar distribution of hair on buttocks, known as the "escutcheon."

Among original articles indicating research, tho Miss E. Ormerod on the ox-warble and the w maggot, of Prof. Robertson upon rickets in sheep, Mr. Clement Stephenson upon abortion in cows r mentioned. Lastly, the number contains a contr from Rothamsted upon the valuation of manures, in which the results of past brought to bear upon the claims of outg compensation under recent Acts of Parli

m Paris to Pekin over Siberian Snows. By Victor
leignan. Edited, from the French, by William Conn.
London: W. Swan Sonnenschein and Co., 1885.)

mode in which this volume has been produced is rather
ous. In 1873 M. Meignan, who had already travelled
e regions around the Levant for pleasure, took it into
ead that, by way of contrast to these lands of the
he would like to see a land where snow and ice were
lominant, and accordingly he undertook to travel
n France to China through Siberia. He appears to
e had no object in the journey but the pleasure of
tion and of seeing new and strange objects. It was
dertaken in the winter, and the traveller naturally saw,
d was interested in, Moscow, Nijni-Novgorod, the
rals, and so travelled through Siberia by Omsk
Irkutsk. After a short stay in the latter place
pursued his journey through Kiachta, Urga, and
lgan to Pekin. Many travellers have done the
rney before and since; it is a long and tedious one,
d perhaps that is as much as can be said for it. Mr.
onn talks of crossing "the trackless Desert of Gobi"
n the way, but this is an abuse of language. The only
art of the Gobi passed is that between Urga and Kal-
gan, two considerable trading cities, between which cara-
vans, couriers, and travellers go daily along a high road
which is a very good one as roads go in Asia. But M.
Meignan, having done the journey, and being of a lively
and amusing turn, wrote an account of it some time after
his arrival in France. This account of a journey in 1873
Mr. Conn has "edited" in 1885; he has, he says, pro-
duced a modified version rather than a translation, the
modifications consisting in correcting the slipshod style
of the original, in producing "a more just co-ordination
of parts and subordination of minor details," and also in
expanding the original here and there. The volume,
withstanding this dual authorship, is pleasant reading,
h as a tolerably written account of a journey in Wales
cotland would be pleasant. There are not a few
s, especially as the traveller gets farther east, but
cannot seriously interfere with such enjoyment as
e derived from a perusal of the volume. As Mr.
has a taste for this species of literary work—having
ut shed another volume, an adaptation or translation
f a Japanese tale by a French writer, during the year—
we would suggest to him that he should select his originals
more carefully. A sterling popular work in French or
German might very easily prove a sterling popular work
n English; there can be little real use in reproducing
rumpery French books in English, except to add to the
ready enormous mass of similar indigenous literature in
gland.

LETTERS TO THE EDITOR

e Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

e Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Iridescent Clouds

n December 29 just passed, at 3.40 p.m., or shortly after
alst, and during the late frosty storm, there was a brilliant
n, ition of the iridescent clouds concerning which I wrote to
RE about a year ago. The tendency of many of these
clouds, or cloudlets, to rectilinear rhomboidal forms was
also their confinement in point of colour to blue,
r as red, and green—eschewing yellow, orange, and
N), "th while the sunset sky below them was, on the
geous panorama of all those yellow-*cum*-red
nu

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That so good an example of these iridescent cloudlets is not very frequent may be concluded from the number of letters which this occasion has already produced in the *Scotsman* newspaper here, and of which I send you six.

C. PIAZZI-SMYTH

15, Royal Terrace, Edinburgh, January 1

Peculiar Meteorological Phenomenon.—A somewhat rare phenomenon was observed at Burntisland, Falkirk, Laurencekirk, and many other parts of Scotland yesterday. A large number of miniature rainbows presented themselves in the sky, with the red, orange, yellow, and green colours distinctly discernible. They were not larger than the ordinary sun as it appears to the naked eye, and, after remaining visible for a considerable time, gradually faded away.

Fraserburgh, December 28, 1885

SIR,—To-day, at 3 p.m., a heavy snowstorm from the west-north-west was just clearing off here. Along the horizon, from west to south-west, lay a heavy bank of storm-cloud, hiding the sun. Above this, in same general direction, was a belt of clear sky. Above that, as the rack drifted off to south-east, there was disclosed a belt of light cirro-stratus cloud, in same general direction, about 30° from the sun, and evidently at very great height, for it kept the same general position nearly an hour, though with considerable variation of form. When first visible it was fringed on the side next the sun with bands of the most vivid and delicate prismatic colours—in series, blue end outside and red (prolonged into a splendid band of violet) inside. Detached portions, however, had the bands all round. The appearance continued in its first splendour only a few minutes, but less vividly for some time longer. It would be interesting to know whether the same appearance was seen at other places; and, if so, at what hour, and at what angle from the sun?

W. MACGILL, B.A.

Edinburgh, December 29, 1885

SIR,—I write to ask if any of your readers can give an explanation of a remarkable phenomenon which was visible in the western sky this afternoon. Just after sunset a few thin patches of cirrus clouds not far west of the zenith assumed a rich opal hue, while in others all the colours of the spectrum were beautifully displayed. The appearance of one of these clouds was exactly similar, in fact, to a completed, though, of course, miniature rainbow. This phenomenon continued for some time after the sun had set, and at times the colours could be seen to change rapidly. A cold frosty wind from the north-west was blowing at the time.

C. M.

Maxton, December 30, 1885

SIR,—With reference to the two letters on this subject in to-day's *Scotsman*, it may interest you to know that the cloud phenomenon in question was witnessed here twice yesterday. About 8 a.m. the sky was perfectly clear, and the crescent moon was shining in the south-west. As the radiance of the sun, as yet beneath the horizon, began to appear, several detached clouds, of a semi-transparent, filmy nature, suddenly came into view in the south-eastern sky, which had, a moment or two before, been without a single speck to dim it. These clouds, at first of an indefinable colour, quickly heightened in tone, and the prismatic colours became visible with gorgeous distinctness, increasing in intensity as the sun neared the horizon. The top band was of a peculiar blue, obviously different from the sky field. Beneath was a wave of rich rose-pink, next a cloudy-orange, with light streaks or "watermarks," then a rich mass of deep violet, fading lower into white. There were three large clouds, the upper and lower lines of which were quite level and perfectly parallel, though the edges to the east and west were sharp and ruggedly cut. In the case of one of these clouds the denser part was apparently rhomboidal, but on its eastern side, and connected with it, was an opalescent vapour filling up the space between what I may term the base and the hypothenuse of an angle of about 15°. The base of this incomplete triangle was equal in length to the base of the incomplete rhomboid. The lines were most clearly defined. There were a number of minute cloudlets, some the merest specks, but all showing the same colours that I have mentioned. They did not remain very long in this distinct state. As the sun rose above the horizon they became beautifully opalescent, and

their forms began to change in a wavy manner, and in a short time vanished as in ether from that part of the sky. The sun was now at a slight altitude, and when I turned round I saw to my astonishment similar clouds, though the colours were less distinct, in the north-west, where a few minutes previously none were to be seen. These did not last long, though during their short appearance their outlines were very distinct, there at the time being a heavy haze of reddish gray, changing to dusky carmine above the northern horizon. At this time a west wind was blowing with considerable force, but these clouds appeared to be high above the wind, as they were certainly not influenced by it. In mid-air there seemed to be a counter current, as light cirrus cloud-streaks drifted slowly across the zenith from the east. About 4 p.m. the same phenomenon occurred in the west and north-west, the clouds, if anything, being more beautiful than in the morning. They remained for a time after the sun had set. At 5 p.m. the thermometer registered 12° of frost. I trust I have succeeded in a partial way to convey some idea of sky effects so inexpressibly beautiful as to baffle description. I was informed last night that the previous Monday afternoon, as a party of noblemen and gentlemen were returning to Tynehead Station from a day's shooting on the Humbie Estate, in East Lothian, and while a terrific storm of wind and sleet prevailed, there was a sudden rift, through which the party saw a number of clouds of a similar nature to those I have attempted to describe. JOHN THOMSON

Maxton, Wednesday Afternoon

At 3 p.m. we have had a steady fall of snow for four hours. JOHN THOMSON

Wick, December 30, 1885

SIR,—Your correspondent "C. M." in to-day's paper exactly describes the phenomenon as it was seen here. The cirrus clouds were probably floating at a very high elevation in a stratum of air much below the freezing-point, and their structure thus having undergone some change, the sunlight became decomposed, causing the prismatic display. This theory may or may not be correct, but the end of the cirrus band farthest from the sun lost the colours first, and the end nearest the sun was the last on which a vestige remained after the sun had set. NEMO

Sunderland, December 30, 1885

SIR,—I have just read in to-day's *Scotsman* the letters of your correspondents in Fraserburgh and Edinburgh concerning the atmospheric or cloud phenomena of Monday, 28th. The appearance of the heavens here from 3.30 p.m. was most striking. The sun set in a rich water-glow, and the sky in the west being very free from obscuration, we could notice how the glow deepened as it ascended, until from 20° to 50° it presented a dark crimson or purple. Just above Venus—which was like a silver ball—there were seen some cirro-stratus clouds—bright and luminous—just like illuminations on a dark ground. They were stationary, and retained their shape for a very long time. At their western extremities were seen all the prismatic colours, as if they were encircled with rainbows. These colours were very distinct for half an hour, and then gradually disappeared; but still the clouds remained, and were seen at 5.20—almost in their original position—as bright electric clouds. I have observed the heavens for thirty years, but never saw so beautiful a cloud-display. I think the explanation is that the various strata of the atmosphere retain certain rays of light longer than usual when the sun's light falls at the oblique angle it has in December. These clouds evidently rested in a part of the atmosphere not affected by the disturbances nearer the earth.

D. PATTERSON, M.A.

ON going out at 4.12 p.m. to-day, I saw several remarkable clouds in the west part of the sky, somewhat similar to those described by Prof. Piazzi Smyth and several other correspondents in NATURE, vol. xxxi. pp. 148, 192, 264, 315, 338, 360. These clouds were collected in three groups, about south-west, west, and north-west respectively. Some of them were streaked, and the streaks and longer axes of all the clouds were directed approximately towards the spot where the sun had recently set. At the time when I first saw them, only one of these clouds showed prismatic colours, but I am informed by a friend that a little earlier, about 4 p.m., this was the case with several. As the other two sets showed colours and chang exhibited later on by those in the south-west, I propose describe the latter alone.

At 4.12 this group consisted of two large clouds and seve smaller ones, just above the planet Venus, the centre of group being at an altitude of about 30°. The uppermost cl was about 20° in length and 5° in breadth. Its longer axis directed towards, but slightly above, the point in the horizon wl the sun had just set. The west end of the cloud was round almost semicircular, and hazy near the edge. Then follow two or three fringes, also nearly semicircular, showing rather bri prismatic colours, the blue side of each fringe being towards t sun. The coloured fringes occupied about a third of the clou the rest of it was bright, with a slightly greenish tinge, as we also the other clouds of this group. The east end was draw out in striæ parallel to the longer axis of the cloud. Soon afte my first seeing them, the prismatic colours began to fade, an by 4.20 were no longer distinguishable, but the clouds then selves were still bright and noticeable. At 4.25 the cloud th had the prismatic fringes became very faint and had now slight rose-coloured tinge; the others had the same tinge colour, but remained bright. By this time the striæ at the eas end were drawn out in the direction of the length of the cloud, but became gradually fainter, and by 4.27 had disappeared; so that the cloud was now reduced to about half its original length, the remaining part having at the same time become broader, brighter, and of a deeper rose-colour. This colour, however, soon began to fade, and by 4.34 was nearly gone, though there was no apparent diminution of brightness. At 4.41 they were bright and of a grayish-white, almost steel-gray, colour, and continued so for some time. During all the time I watched them (about three-quarters of an hour) this group as a whole was nearly stationary, though the clouds themselves changed considerably in form and slightly in their relative positions. The sky was almost clear, but near the horizon there were some dark, heavy clouds, and at one time (4.25) several of these, driven by a strong wind, passed rapidly below the group above described, partly covering the lowermost. On going out again at 6.20 to watch them, I found that they had all disappeared. I may a that yesterday evening, soon after sunset, the western sky covered with a rosy flush, reminding one slightly of the wond ful sunsets of two years ago. CHARLES DAVIS

Sunderland, December 28, 1885

YESTERDAY morning (December 29), from about 8. 9 o'clock, a number of very brilliantly-coloured clouds were observed here by myself and others. The weather was cold and frosty, and the sky at the time was clear with the exception of a thick haze round the horizon; a few clouds were thinly distributed over the sky, and these were more or less coloured. The clouds in the south-east had colours rivalling those of the rainbow in intensity. The colours were also distributed in bands, though not in the same order as those of the rainbow. The clouds in the opposite quarter of the sky were smaller, an though unusually bright as regards luminosity the colours wer paler than on the other side of the sky. Each cloud also h one uniform tint, a pale green or blue or pink. The m brilliant clouds while fading assumed an appearance similar these others, some of the bands broadening out, while othe di-appeared. I saw a beautiful iridescent cloud here at t same hour one morning last December. At that time t phenomenon was generally observed throughout the country, is evident from the letters which appeared in NATURE (vol. xx pp. 148, 192, 264, &c.). JOHN STEVENSO

Broxburn, December 30, 1885

The Recent Star-Shower

MR. DENNING'S letter of December 12 makes me see that I did not put the point which was in my own mind with suffi cient clearness in my letters of December 7 and 8.

It was not to coincidences of star-showers with displays auroræ as to whose true auroral nature there appeared to no question, that I wished to draw attention, but to the that, among the instances to which I referred, of the cidence of such showers with *aurora-like phenomena*, ther two occasions, and those two occurrences of the same show which there was a notable absence of any magnetic disturb The coincidence of such disturbances with auroral displa

suppose, so thoroughly established that the notable absence of them on these occasions may fairly be taken to suggest a possibility that the phenomena were not truly auroral. If so, their coincidence with the star-shower becomes more noteworthy.

Rugby, January 5 J. B. HASLAM

A SPLENDID shower of meteors occurred on the night of November 27, 1885. Seen from Ava, near Mandalay, at 10 p.m. mean time of place, the point of emergence was near the zenith, and the shower radiated to each point of the horizon. The rate at that hour was 450 to 600 per minute, as near as I could judge lying on my back on the steamer's awning. It is probable, however, that I missed a great many. The point of emergence was at one-fifth the distance from γ Andromedæ (Almach) towards β Andromedæ (Mirach). The following night the shower was still plentiful, but I did not count them. The nights have been very clear and beautiful here.

December 1, 1885 ALFRED CARPENTER

Deposits of the Nile Delta

IN the abstract of the Report of the Committee of the Royal Society, on recent borings in the Nile Delta (NATURE, Dec. 10, 1885, p. 142), there is a reference to my "Notes on the Geology of the Nile Valley" (*Geological Magazine*, 1884), which calls for some explanation in the interests of Egyptian geology. When I saw a portion of the borings in Cairo, in the early part of 1884, the work had extended to a depth of only about 40 feet. At a depth of between 30 and 40 feet the boring-rod, after passing through continuous Nile mud, had entered into quicksand, consisting of polished and rounded grains of quartz and other hard rocks (desert sand), and the difficulties incident to this material had for the time arrested the operations. In connection with this and with the insufficiency of the funds on hand for overcoming the difficulties of the work, I wrote a letter at the time to the President of the Royal Society, strongly urging an additi nal grant, in order that greater depths might be reached.

I then believed, and still believe, that the quicksand marks the true base of the modern Delta alluvium, and corresponds with the similar sand which in certain parts of the Delta protrudes itself from beneath the fluviatile deposit. I did not, however, suppose that this sand rests directly on the rocky floor of the valley. On the contrary, as might be inferred from my short statement in the *Geological Magazine* (July 1884, p. 292 and footnote), I anticipated that below the sand would be found the Pleistocene clays, marls, sands, and concretionary limestones of the "Isthmian" formation seen at El Guisr on the Suez Canal, and the equivalents of which rise from under the alluvium in several places on the sides of the Nile Valley. These also constitute the lower strata of the borings reported by Figari Bey; and it appeared to me that in the colour and texture of the sediment mixed with the lower samples of the sand there were indications of the approach to these deposits.

Though I have not seen the borings between 40 and 80 feet, I still think that the question whether these are modern, or belong to the Pleistocene, remains to be disposed of, and will require comparison of the lower samples, if they can be separated from the mud and sand introduced from above, with the overlying deposit. This may have already been attended to, but if so, the fact is not stated in the published abstract. With reference to such comparisons I would ask particular attention to the chemical character and depth of the specimens containing calcareous concretions, which are characteristic of the Isthmian rather than of the Nilotic formation.

Of course I do not affirm that the modern deposit of the Delta is in no place thicker than 40 feet, on the contrary, on my view of the history of the district, there must be old buried channels of the Nile in which it is much thicker, but it should be possible to recognise these by the character of the material filling them.

The softness of the Nile water and the minutely arenaceous character of the Nile mud, as well as the connection of this with its fertility, have been remarked from the most ancient times, and the microscopic details given by Prof. Judd have done much to give precision to our views on these points. With respect however to the causes and geological significance of these phenomena, the conclusions stated in the abstract seem open to serious objections, suggested by the physical features of the area drained by the Nile, and the conditions under which the fluviatile deposits are laid down. As this subject is of some importance both with reference to the geology of Egypt and general geology, I would ask your permission to refer to it in a second short communication. J. WILLIAM DAWSON

McGill College, Montreal, December 24, 1885

The Discovery of the Source of the Mississippi

IT is a matter of little importance or interest in what spot is located the ultimate spring of the longest branch of even the greatest river. Especially is this the case with the Mississippi, where it may easily be an open question which of a dozen branches is the longest, when traced through its innumerable lakes and windings. By common consent, however, a certain branch of the Mississippi has been assumed as the river proper, and its head as Lake Itasca, in northern central Minnesota. The river was explored to this point, and the lake discovered in 1832 by Schoolcraft, who published a map of the lake, and of the river from this point downwards. He spent but one night on the lake, and did not explore its tributaries. Four years later Nicollet led an expedition to the head waters of this stream, reached Lake Itasca, and spent several days in making a thorough exploration of the country about it. In his narrative, published in 1841, he gives a full description of the tributaries to the lake which constituted, according to general acceptation, the extreme head waters of the river. The report is accompanied by a map, on which the geographic features described in the narrative are delineated, and which agrees in general with later and more accurate maps.

During the half century which has passed since the time of these explorers, settlement has crowded upon this region, railroads have been built in close proximity to it, and the country has been explored in every direction in the interest of the lumber industry. Furthermore, in 1876, the surveys of the General Land Office were extended over it. Lines were run at intervals of a mile over the whole region, and every lake and pond of any importance was mapped by traverse survey. In short, the country has long since ceased to be a *terra incognita*.

It is therefore with astonishment, not unmixed with a feeling akin to disgust, that we read in the daily papers, in certain magazines, and finally in the *Journal* of the Royal Geographical Society, an account of the alleged "discovery" of the source of the Mississippi, made by a Capt. Glazier, in the summer of 1881. It appears from his narrative, published in great fulness of detail in the *American Meteorological Journal*, September to December, 1884, that his expedition started at St. Paul and pushed its way manfully by rail and stage to the Leech Lake Indian agency. After obtaining at this place a full complement of men and material (except provisions) for a life in the wilderness, they started westward for Lake Itasca. They fortunately escaped all the perils of the journey, and arrived there on the third day safely. Coasting along the shore of the lake, they found a stream coming in at the head of the south-west arm, up which they journeyed, some two hundred yards, when they entered a second lake, which Capt. Glazier claims to be the ultimate source of the Mississippi, and to which, probably in virtue of his heroic achievement in being paddled to it, he claims the right to give his own name. The failure of provisions prevented him from making any further exploration or discovery, and the expedition returned to settlements.

It appears from the explorer's description and from the extremely incorrect map which accompanies his narrative—made, as he naively informs the reader, from information furnished by his Indian guide—that his so-called Glazier Lake is identical with a lake in Township 143 north, Range 36 west, which had been carefully mapped by traverse survey by the General Land Office in 1876, or five years prior to his "discovery." This lake, or pond, has an area of about half a square mile. On the Land Office plat it is called Elk Lake, and its connection with Lake Itasca is plainly indicated. By a mere inspection of this plat Capt. Glazier might have made his discovery, and thus have avoided all the hardships and labours of his perilous journey. Since his claim to the discovery of this lake must be considered as altogether baseless, his desire that his name shall be for ever associated with it as the source of the Mississippi River is preposterous, especially as he cannot be ignorant of the above facts. HENRY GANNETT

Washington, D.C.

Chætoderma

YOUR biological readers will probably be interested to learn that I dredged a specimen of *Chætoderma* last August off the

south end of the Isle of Man from a depth of about 20 fathoms. It is about 1·5 cm. in length, and differs somewhat in shape from both *Chatoderma nitidulum*, Lovén, and the new species (*C. militare*, Selenka) found during the *Challenger* Expedition. The calcareous spicules are also different from those of both the previously described species, but they seem to vary considerably in shape. The specimen—along with the other Vermes obtained during the various dredging expeditions carried on last summer by the members of the Liverpool Marine Biology Committee—has been placed in the hands of Mr. R. J. Harvey Gibson, M.A., for detailed examination, and will be described in the First Report upon the Fauna of Liverpool Bay, to be published shortly.

W. A. HERDMAN

University College, Liverpool, December 30, 1885

A Solar Halo

AT about noon on this day a fine halo with its mock suns was well seen at the Radcliffe Observatory. Measurements of the vertical radii of the first circle gave 22° 24′, whilst the angular distance between the true and mock suns was 22° 30′. The radius of the second circle was rather difficult to determine, but the mean of several measures gave 46° 40′. The inverted arcs at the vertices of the two circles were clearly seen. The zenith distance of the sun's centre was nearly 75° at the time of the observation.

E. J. STONE,
Radcliffe Observer

Radcliffe Observatory, Oxford, December 30, 1885

Ventilation

MR. FLETCHER's letter in your issue of December 17 (p. 153) illustrates the difficulties encountered by people who adopt patent ventilators and so-called systems of ventilation without considering the natural laws ruling the flow of currents of air.

The exit-shafts recommended by the writer of your article on the subject, as he himself confesses, may act as inlets, and generally do, if there is no other free inlet for air. This there seldom is in cold weather when the windows are closed, unless a hot-air grate on the Galton or other model is adopted. There is very little objection to running the exit-tube from the chandelier into the chimney flue, on the same principle as that of the chimney to each ventilator, now so much used.

I think the writer of your article hardly appreciates the difficulties to be encountered in ventilating an English house or assembly-room. Irrespective of the ignorance of the public generally on the subject, we are met by the fact that in most town houses it is very difficult to place a stove, with proper fresh-air inlet, in the entrance, where it may afford a supply of fresh warmed air to the house. As a rule the nearest flue is a very long way off. Again, fire-places being as a rule on inside walls in such houses, the flue to supply a hot-air grate (by far the best method of warming) has to be very long, and there is difficulty in arranging for its due cleansing.

Your correspondent speaks of expense being no object in the erection of public buildings. This is far from my experience. In the cases of churches, schools, and assembly-rooms, the question of ventilation is entirely bound up with that of heating, and in conversation with various makers of heating apparatus I have found their views quite unanimous on the peculiarities of building Committees on this subject. The lowest tender is as a rule accepted, and this never provides for ventilation. They are asked to heat only.

The real objection to ventilation in large rooms is the cost of the necessary heating apparatus. For instance, a large concert-room has recently been erected in this neighbourhood to seat 3800 persons, with a cubical content of 514,800 feet.

Now to warm this in the ordinary manner by hot-water pipes would require about 2600 feet of four-inch piping. But to supply a thousand feet of air per head, heated from 30° to 60° Fahr. would, according to the formula given in Hood's work, require no less than 10,600 feet, or more than four times the amount, while the space occupied by more than two miles of large piping would have to be taken into consideration.

No doubt the heating could be done more economically by steam coils or large stoves if care be taken not to over-heat the air.

Until ventilation is considered as necessary as drainage, and is paid for accordingly, and till failure on the part of architect and builder to secure it is visited with as severe penalties as failure in points of construction or design, I see no chance of improvement on the present state of chaos.

ERNEST H. JACOB

Leeds, December 22, 1885

Travellers' Snake-Stories

TRAVELLERS' "stories" are not expected to be quite matter-of-fact. One of the best of these jokes occurs in an article on "Travellers' Snake-Stories" in the December number of *Good Words*. Among the natural enemies of snakes the mongoose is thus described:—

"The mongoose, a bird known as the kingfisher of Australia, and secretary-bird of Africa, is well known in some of the West Indian Islands almost always to come off victorious in its encounters with the rattlesnake, and it has even been proposed to breed it specially for its extirpation."

From the use of the singular number in the above extract it is clear that only one animal is intended to be described, and that one is a *bird*. Next follows an interesting description in considerable detail (quoted from the *Standard* of January 22, 1883), of fights between the *Indian* mongoose and the Indian cobra in Lucknow, ending with the sentence:—

"He adds that these birds make affectionate pets," &c.

This is the best joke of all. It may be that the Australian kingfisher and African secretary-bird are locally called "mongoose" (this is not within the present writer's experience), but the *Indian* mongoose is a small animal, in shape very like a weasel or a ferret. It is impossible that the writer in the *Standard* (who is stated to have himself arranged the mongoose and cobra duels) could have described the mongoose as a *bird*. What does the man mean?

ALLAN CUNNINGHAM

Blackbird with White Feather

I NOTICE a letter from Mr. Murphy in your issue of December 24, 1885, about a blackbird with a white feather in its tail. Allow me to say that last month I saw a cock blackbird with a pure white tail; the rest of its plumage was natural. I saw it very distinctly, as it was flying away from me at the time, not more than ten yards off when I first noticed it, with its tail extended; I saw it again last week, within a few feet of the same place, this time running under a gate. My wife says she saw a similar bird, at the same spot, about a year ago.

THOMAS J. BUSK

Ford's Grove, Winchmore Hill, January 4

IT may interest your correspondent, Mr. J. J. Murphy, to know that for the last two years we have had a cock blackbird about our garden with a patch of pure white on each side of the head.

E. BROWN

Further Barton, Cirencester, January 3

DURING the frost of January 1880 I frequently noticed a hen blackbird with several white feathers on the head, breast, and back. It was quite tame, and came for food every day.

Hartford, Cheshire, December 30, 1885 E. K.

ON THE METHOD OF RECIPROCANTS AS CONTAINING AN EXHAUSTIVE THEORY OF THE SINGULARITIES OF CURVES[1]

IT is now two years and seven days since a message by the Atlantic cable containing the single word "elected" reached me in Baltimore informing me that I had been appointed Savilian Professor of Geometry in Oxford, so that for three weeks I was in the unique position of filling the post and drawing the pay of Professor of Mathematics in each of two Universities: one, the oldest and most renowned, the other—an infant Hercules—the most active and prolific in the world, and which realises what only existed as a dream in the mind of Bacon—the House of Solomon in the New Atlantis.

To Johns Hopkins, who endowed the latter, and in conjunction with it a great Hospital and Medical School between which he divided a vast fortune accumulated

[1] Inaugural Lecture of Prof. Sylvester, F.R.S., delivered before the University of Oxford, December 12, 1885.

during a lifetime of integrity and public usefulness, I might address the words familiarly applied to one dear to all Wykehamists :—

"Qui condis lævâ, qui condis collegia dextrâ,
Nemo tuarum unam vicit utraque manû."

The chair which I have the honour to occupy in this University is made illustrious by the names and labours of its munificent and enlightened founder, Sir Henry Saville; of Thomas Briggs, the second inventor of logarithms; of Dr. Wallis, who, like Leibnitz, drove three abreast to the temple of fame—being eminent as a theologian, and as a philologer, in addition to being illustrious as the discoverer of the theorem connected with the quadrature of the circle named after him, with which every schoolboy is supposed to be familiar, and as the author of the "Arithmetica Infinitorum," the precursor of Newton's "Fluxions"; of Edmund Halley, the trusted friend and counsellor of Newton, whose work marks an epoch in the history of astronomy, the reviver of the study of Greek geometry and discoverer of the proper motions of the so-called fixed stars; and by one in later times not unworthy to be mentioned in connection with these great names, my immediate predecessor, the mere allusion to whom will, I know, send a sympathetic thrill through the hearts of all here present, to whom he was no less endeared by his lovable nature than an object of admiration for his vast and varied intellectual requirements, whose untimely removal, at the very moment when his fame was beginning to culminate, cannot but be regarded as a loss, not only to his friends and to the University for which he laboured so strenuously, but to science and the whole world of letters.

As I have mentioned, the first to occupy this chair was that remarkable man Thomas Briggs, concerning whose relation to the great Napier of Merchiston, the fertile nursery of heroes of the pen and the sword, an anecdote, taken from the Life of Lilly, the astrologer, has lately fallen under my eyes, which, with your permission, I will venture to repeat :—

"I will acquaint you (says Lilly) with one memorable story related unto me by John Marr, an excellent mathematician and geometrician, whom I conceive you remember. He was servant to King James and Charles the First. At first, when the lord Napier, or Marchiston, made public his logarithms, Mr. Briggs, then reader of the astronomy lectures at Gresham College, in London, was so surprised with admiration of them, that he could have no quietness in himself until he had seen that noble person the lord Marchiston, whose only invention they were: he acquaints John Marr herewith, who went into Scotland before Mr. Briggs, purposely to be there when those two so learned persons should meet. Mr. Briggs appoints a certain day when to meet at Edinburgh; but failing thereof, the lord Napier was doubtful he would not come. It happened one day as John Marr and the lord Napier were speaking of Mr. Briggs: 'Ah John (said Marchiston), Mr. Briggs will not now come.' At the very moment one knocks at the gate; John Marr hastens down, and it proved Mr. Briggs to his great contentment. He brings Mr. Briggs up into my lord's chamber, where almost *one quarter of an hour was spent*, each beholding other almost with admiration *before one word was spoke*. At last Mr. Briggs began: 'My lord, I have undertaken this long journey purposely to see your person, and to know by what engine of wit or ingenuity you came first to think of this most excellent help into astronomy, viz. the logarithms: but, my lord, being by you found out, *I wonder nobody else found it out before*, when now known it is so easy.' He was nobly entertained by the lord Napier; and every summer after that, during the lord's being alive, this venerable man Mr. Briggs went purposely into Scotland to visit him."[1]

[1] A very similar story is told of the meeting of Leopardi and Niebuhr in Rome. What Briggs said of logarithms may be said almost in the same words of the subject of this lecture:—"This most excellent help to geometry which, being found out, one wonders nobody else found it out before; when, now known, it is so easy." I quite entered into Brigg's feelings at his interview with Napier when I recently paid a visit to Poincaré in his airy perch in the Rue Gay-Lussac in Paris (will our grandchildren live to see an Alexander Williamson Street in the north-west quarter of London, or an Arthur Cayley Court in Lincoln's Inn, where he once abode?) In the presence of that mighty reservoir of pent-up intellectual force my tongue at first refused its office, my eyes wandered, and it was not until I had taken some time (it may be two or three minutes) to peruse and absorb as it were the idea of his external youthful lineaments that I found myself in a condition to speak.

Some apology may be needed, and many valid reasons might be assigned, for the departure, in my case, from the usual course, which is that every professor on his appointment should deliver an inaugural lecture before commencing his regular work of teaching in the University. I hope that my remissness, in this respect, may be condoned if it shall eventually be recognised that I have waited, before addressing a public audience, until I felt prompted to do so by the spirit within me craving to find utterance, and by the consciousness of having something of real and more than ordinary weight to impart, so that those who are qualified by a moderate amount of mathematical culture to comprehend the drift of my discourse, may go away with the satisfactory feeling that their mental vision has been extended and their eyes opened, like my own, to the perception of a world of intellectual beauty, of whose existence they were previously unaware.

This is not the first occasion on which I have appeared before a general mathematical audience, as the messenger of good tidings, to announce some important discovery. In the year 1859 I gave a course of seven or eight lectures at King's College, London, at each of which I was honoured by the attendance of my lamented predecessor, on the subject of "The Partitions of Numbers and the Solution of Simultaneous Equations in Integers," in which it fell to my lot to show how the difficulties might be overcome which had previously baffled the efforts of mathematicians, and especially of one bearing no less venerable a name than that of Leonard Euler, and also laid the basis of a method which has since been carried out to a much greater extent in my "Constructive Theory of Partitions," published in the *American Journal of Mathematics*, in writing which I received much valuable co operation and material contributions from many of my own pupils in the Johns Hopkins University.[1] Several years later, in the same place, I delivered a lecture on the well-known theorem of Newton, which fills a chapter in the "Arithmetica Universalis," where it was stated without proof, and of which many celebrated mathematicians, including again the name of Euler, had sought for a proof in vain. In that lecture I supplied the missing demonstration, and owed my success, I believe, chiefly to merging the theorem to be proved, in one of greater scope and generality. In mathematical research, reversing the axiom of Euclid, and converting the proposition of Hesiod, it is a continual matter of experience, as I have found myself over and over again, that the whole is less than its part. On a later occasion, taking my stand on the wonderful discovery of Peaucellier, in which he had realised that exact parallel motion which James Watt had believed to be impossible, and exhausted himself in contrivances to find an imperfect substitute for, in the steam-engine, I think I may venture to say that I brought into being a new branch of mechanico-geometrical science, which has been, since then, carried to a much higher point by the brilliant inventions of Messrs. Kempe and Hart. I remember that my late lamented friend, the Lord Almoner's Reader of Arabic in this University, subsequently editor of the *Times*, Mr. Chenery, who was present on that occasion in an unofficial capacity, remarked to me after the lecture, which was delivered before a crowded auditory at the Royal Institution, that when they saw two suspended

[1] In one of those lectures, two hundred copies of the notes for which were printed off and distributed among my auditors, I founded and developed to a considerable extent the subject since rediscovered by M. Halphen under the name of the Theory of Aspects.

opposite Peaucellier cells, coupled toe-and-toe together, swing into motion, which would have been impossible had not the two connected moving points each described an accurate straight line, "the house rose at you." [The lecture merely illustrated experimentally two or three simple propositions of Euclid, Book III.].

The matter that I have to bring before your notice this afternoon is one far bigger and greater, and of infinitely more importance to the progress of mathematical science, than any of those to which I have just referred. No subject during the last thirty years has more occupied the minds of mathematicians, or lent itself to a greater variety of applications, than the great theory of Invariants. The theory I am about to expound, or whose birth I am about to announce, stands to this in the relation not of a younger sister, but of a brother, who, though of later birth, on the principle that the masculine is more worthy than the feminine, or at all events, according to the regulations of the Salic law, is entitled to take precedence over his elder sister, and exercise supreme sway over their united realms. Metaphor apart, I do not hesitate to say that this theory, *minor natu potestate major*, infinitely transcends in the extent of its subject-matter, and in the range of its applications, the allied theory to which it stands in so close a relation. The very same letters of the alphabet which may be employed in the two theories, in the one may be compared to the dried seeds in a botanical cabinet, in the other to buds on the living branch ready to burst out into blossom, flower, and fruit, and in their turn supply fresh seed for the maintenance of a continually self-perpetuating cycle of living forms In order that I may not be considered to have lost myself in the clouds in making such a statement, let me so far anticipate what I shall have to say on the meaning of Reciprocants and their relation to the ordinary Invariantive or Covariantive forms by taking an instance which happens to be common (or at least, by a slight geometrical adjustment, may be made so) to the two theories. I ask you to compare the form

$$a^2d - 3abc + 2b^3$$

as it is read in the light of the one and in that of the other. In the one case the a, b, c, d stand for the coefficients of a so-called Binary Quantic, and its evanescence serves to express some particular relation between three points lying in a right line. In the other case the letters are interpreted to mean the successive differential derivatives of the 2nd, 3rd, 4th, 5th orders of one Cartesian co-ordinate of a curve in respect to the other. The equation expressing this evanescence is capable of being integrated, and this integral will serve to denote a relation between the two co-ordinates which furnishes the necessary and sufficient condition in order that the point of the curve of any or no specified order (for it may be transcendental) to which the co-ordinates may refer, may admit of having, at the point where the condition is satisfied, a contact with a conic of a higher order than the common. In the one case the letters employed are dead and inert atoms; in the other they are germs instinct with motion, life, and energy.

A curious history is attached to the form which I have just cited, one of the simplest in the theory, of which the narrative may not be without interest to many of my hearers, even to those whose mathematical ambition is limited to taking a high place in the schools.

At pp. 19 and 20 of Boole's "Differential Equations" (edition of 1859) the author cites this form as the lefthand side of an equation which he calls the "Differential Equation of lines of the second order," and attributes it to Monge, adding the words, "But here our powers of geometrical interpretation fail, and results such as this can scarcely be otherwise useful than as a registry of integrable forms." In this vaticination, which was quite uncalled for, the eminent author, now unfortunately deceased, proved himself a false prophet, for the form referred to is among the first that attracts notice in crossing the threshold of the subject of Reciprocants, and is but one of a crowd of similar and much more complicated expressions, no less than it, susceptible of geometrical interpretation and of taking their place on the register of integrable forms. A friend, with whom I was in communication on the subject, and whom I see by my side, remarked to me, in reference to this passage:—"I cannot help comparing a certain passage in Boole to Ezekiel's valley of the dry bones: 'The valley was full of bones, and lo, they were very dry.' The answer to the question, 'Can these bones live?' is supplied by the advent of the glorious idea of the Reciprocants; and the grand invocation, 'Come from the four winds, O breath, and breathe upon these slain, that they may live,' may well be used here. That they will 'live and stand up upon their feet an exceeding great army' is what we may expect to happen." This, as you will presently see, is just what actually has happened.

Not knowing where to look in Monge for the implied reference, I wrote to an eminent geometer in Paris to give me the desired information; he replied that the thing could not be in Monge, for that M. Halphen, who had written more than one memoir on the subject of the differential equation of a conic, had made nowhere any allusion to Monge in connection with the subject. Hereupon, as I felt sure that a reference contained in repeated editions of a book in such general use as Boole's "Differential Equations" was not likely to be erroneous, I addressed myself to M. Halphen himself, and received from him a reply, from which I will read an extract:—

"En premier lieu, c'est une chose nouvelle pour moi que l'équation différentielle des coniques se trouve dans Boole, dont je ne connais pas l'ouvrage. Je vais, bien entendu, le consulter avec curiosité. Ce fait a échappé à tout le monde ici, et l'on a cru généralement que j'avais le premier donné cette équation. *Nil sub sole novi!* Il m'est naturellement impossible de vous dire où la même équation est enfouie parmi les œuvres de Monge. Pour moi, c'est dans *Le Journal de Math.* (1876), p. 375, que j'ai eu, je crois, la première occasion de développer cette équation sous la forme même que vous citez; et c'est quand je l'ai employée, l'année suivante, pour le problème *sur les lois de Képler* (*Comptes rendus*, 1877, t. lxxxiv. p. 939), que M. Bertrand l'a remarquée comme neuve. Ce qui vous intéresse plus, c'est de connaître la forme simplifiée sous laquelle j'ai donné plus tard cette équation dans le *Bulletin* de la Société Mathématique. C'est sous cette dernière forme que M. Jordan la donne dans son cours de l'École Polytechnique" (t. i. p. 53).

All my researches to obtain the passage in Monge referred to by Boole have been in vain.[1]

I will now proceed to endeavour to make clear to you what a Reciprocant means: the above form, which may be called the *Mongian*, would afford an example by which to illustrate the term; but I think it desirable to begin with a much easier one. Consider then the simple case of a single term, the second derivative of one variable, y, in respect to another, x. Every tyro in algebraical geometry knows that this, or rather the fact of its evanescence, serves to characterise one or more points in a curve which possess, so to say, a certain indelible and intrinsic character, or what is technically called a singularity; in this case an inflexion such as exists in a capital S, or Hogarth's line of beauty.

If we invert the two variables, exchanging, that is to say, one with the other, the fact of this indelibility draws with

[1] Search has been made in the collected works of Monge and in manuscripts of his own or Prony in the library of the Institute, but without effect. I have also made application to the Universal Information Society, who undertake to answer "every conceivable question," but nothing has so far come of it. Perhaps until the citation from Monge is verified it will be safer in future to refer to the so-called Mongian as the Boole-Mongian. It may be regarded as the starting-point of the Differential Invariant Theory, as the Schwarzian is of the deeper-lying and more comprehensive Reciprocant Theory.

it the consequence that in general these two reciprocal functions must vanish together, and as a fact each is the same as the other multiplied or divided by the third power of the first derivative of the one variable with respect to the other taken negatively. In this case we are dealing with a single derivative and its reciprocal. The question immediately presents itself whether there may not be a combination of derivatives possessing a similar property. We know that no *single* derivative except the second does.

Such a combination actually presents itself in a form hich occurs in the solution of Differential Equations of ne second order, the form

$$\frac{dy}{dx}\cdot\frac{d^3y}{dx^3}-\frac{3}{2}\left(\frac{d^2y}{dx^2}\right)^2,$$

hich, after the name of its discoverer, Schwarz, we may gree to call a Schwarzian (Cayley's "Schwarzian Deriva-ve"[1]). If in this expression the x and y be interchanged, s value, barring a factor consisting of a power of the st derivative, remains unaltered, or, to speak more rictly, merely undergoes a change of algebraical sign. Ve may now arrive at the generalised conception of an lgebraical function of the derivatives of one variable in respect to another, which, if we agree to pay no regard to the algebraical sign, or to any power of the first derivative that may appear as a factor, will remain unaltered when the dependent and independent variables are interchanged one with another; and we may agree to call any such unction a Reciprocant.

But here an important distinction arises—there are Reciprocants such as the one I first mentioned, $\frac{d^2y}{dx^2}$, or uch as the Mongian to which allusion has been made in he letter from M. Halphen, in which the second and igher differential derivatives alone appear, the first ifferential derivative not figuring in the expression. hese may be termed Pure Reciprocants. Thus I repeat $\frac{y}{x}$, and

$$9\left(\frac{d^2y}{dx^2}\right)^2\cdot\frac{d^5y}{dx^5}-45\frac{d^3y}{dx^3}\cdot\frac{d^2y}{dx^3}\cdot\frac{d^4y}{dx^4}+40\left(\frac{d^3y}{dx^3}\right)^3$$

pure reciprocants. Those from which the first ivative $\frac{dy}{dx}$ is not excluded may be called Mixed Re-procants. An example of such kind of Reciprocants is afforded by the Schwarzian above referred to. This distinction is one of great moment, for a little attention will serve to make it clear that every pure reciprocant expressed in terms of x and y marks an intrinsic feature or singularity in the curve, whatever its nature may be, of which x and y are the co-ordinates; for if in place of the variables (x, y) any two linear functions of these variables be substituted, a pure reciprocant, by virtue of its reciprocantive character, must remain unaltered save as to the mmaterial fact of its acquiring a factor containing nerely the constants of substitution.[2]

The consequence is that every pure reciprocant corresponds to, and indicates, some singularity or characteristic feature of a curve, and *vice versâ* every such singularity of a general nature and of a descriptive (although not necessarily of a projective) kind, points to a pure reciprocant.

Such is not the case with mixed reciprocants. They will not in general remain unaltered when linear substitutions are impressed upon the variables. Is it then necessary, it may be asked, to pay any attention to mixed reciprocants; or may they not be formally excluded at the very threshold of the inquiry? Were I disposed to put the answer to this question on mere personal grounds, I feel that I should be guilty of the blackest ingratitude, that I should be kicking down the ladder by which I have risen to my present commanding point of view, if I were to turn my back on these humble mixed reciprocants, to which I have reason to feel so deeply indebted; for it was the putting together of the two facts of the substantial permanence under linear substitutions impressed upon the variables of the Schwarzian form and the simpler one which marks the inflexions of a curve—it was, if I may so say, the collision in my mind of these two facts—that kindled the spark and fired the train which set my imagination in a blaze by the light of which the whole horizon of Reciprocants is now illumined.

But it is not necessary for me to defend the retention of mixed reciprocants on any such narrow ground of personal predilection. The whole body of Reciprocants, pure and mixed, form one complete system, a single garment without rent or seam, a complex whole in which all the parts are inextricably interwoven with each other. It is a living organism, the action of no part of which can be thoroughly understood if dissevered from connection with the rest.

It was in fact by combining and interweaving mixed reciprocants that I was led to the discovery of the pure binomial reciprocant, which comes immediately after the trivial monomial one,—the earliest with which I became acquainted, and of the existence of compeers to which I was for some time in doubt, and only became convinced of the fact after the discovery of the Partial Differential Equation, the master-key to this portion of the subject, which gives the means of producing them *ad libitum* and ascertaining all that exist of any prescribed type. Of this partial differential equation I shall have occasion hereafter to speak; but this is not all, for, as we shall presently see, mixed reciprocants are well worthy of study on their own account, and lead to conclusions of the highest moment, whether as regards their applications to geometry or to the theory of transcendental functions and of ordinary differential equations.

The singularities of curves, taking the word in its widest acceptation, may be divided into three classes: those which are independent of homographic deformation and which remain unaltered in any perspective picture of the curve; those which, having an express or tacit reference to the line at infinity, are not indelible under perspective projection, but using the word descriptive with some little latitude may, in so far as they only involve a reference to the line at infinity as a line, be said to be of a purely descriptive character; and, lastly, those which are neither projective nor purely descriptive, having relation to the points termed, in ordinary parlance, "circular points at infinity" [for which the proper name is "centres of infinitely distant pencils of rays," *i.e.* pencils, every ray of which is infinitely distant from every point external to it]. Such, for instance, would be the character of points of maximum or minimum curvature, which, as we shall see, indicate, or are indicated by, that particular class of Mixed to which I give the name of "Orthogonal Reciprocants." All purely descriptive singularities alike, whether pro-

[1] More strictly speaking this is Cayley's Schwarzian derivative cleared of fractions—it may well be called the Schwarzian (see my note on it in the *Mathematical Messenger* for September or October past). Prof. Greenhill in regard to the Schwarzian derivative proper writes me as follows:—

"I found the reference in a footnote to p. 74 of Klein's 'Vorlesungen über as Ikosaëder, &c.,' in which Klein thanks Schwarz for sending him the eference to a paper by Lagrange, 'Sur la construction des cartes géogra-hiques' in the *Nouveaux Mémoires de l'Académie de Berlin*, 1779. Com-are also Schwarz's paper in Bd. 75 of *Borchardt's Journal*, where further terary notices are collected together. Klein says further that in the Sächsischen Gesellschaft von Januar 1883,' he has considered the inner mean-ng (*innere bedeutung*) of the differential equation $\frac{\eta'''}{\eta'}-\frac{3}{2}\left(\frac{\eta''}{\eta'}\right)^2=f(\eta)$, here $\eta'=\frac{d\eta}{dx}$ . . . ."

There are two papers by Lagrange, one immediately following the other, Sur la construction des cartes géographiques," but I have not been able to iscover the Schwarzian derivative in either of them.

[2] The form as it stands shows that for y a linear function of x and y may e substituted; and the form *reciprocated* (by the interchange of x and y) shows that a similar substitution may be made for x. Hence arbitrary linear substitutions may be simultaneously impressed as x and y without inducing any change of form.

jective or non-projective, are indicated by pure reciprocants, and are subject to the same Partial Differential Equation; just as, in the Theory of Binary Quantics, Invariants, although under one aspect they may be regarded as a self-contained special class, admit of being and are most advantageously studied in connection with, and as forming a part of, the whole family of forms commonly known by the name of "semi-, or subinvariants," but which I find it conduce to much greater clearness of expression and avoidance of ambiguity or periphrasis to designate as Binariants.

The question may here be asked, How, then, are projective and non-projective pure reciprocants to be discriminated by their external characters?

I believe that I know the answer to this question, which is, that the former are subject to satisfy a second partial differential equation of a certain simple and familiar type, but this is a matter upon which it is not necessary for me to enter on the present occasion.[1] It is enough for our present purpose to remark that every projective pure reciprocant must, so to say, be in essence a masked ternary covariant. For instance, if we take the simplest of all such, viz. a, i.e. $\frac{d^2y}{dx^2}$, we have

$$\frac{d^2y}{dx^2}\cdot\left(\frac{d\phi}{dy}\right)^3 = \begin{vmatrix} \frac{d^2\phi}{dx^2} & \frac{d^2\phi}{dxdy} & \frac{d\phi}{dx} \\ \frac{d^2\phi}{dxdy} & \frac{d^2\phi}{dy^2} & \frac{d\phi}{dy} \\ \frac{d\phi}{dx} & \frac{d\phi}{dy} & \bullet \end{vmatrix}$$

which, for facility of reference, let me call M. Obviously we might instead of $a = 0$ substitute $M = 0$ to mark an inflexion. And now if we write Φ as the completed form of ϕ, when made homogeneous by the substitution of z for unity; and if we suppose it to be of n dimensions in x, y, z, and call its Hessian H, we shall obtain the syzygy

$$(n-1)^2\left(\frac{d\phi}{dy}\right)^3\cdot a + H + \left\{\frac{d^2\Phi}{dx^2}\cdot\frac{d^2\Phi}{dy^2} - \left(\frac{d^2\Phi}{dxdy}\right)^2\right\}\Phi = 0.$$

Hence the system $\Phi = 0$, $a = 0$, will be in effect the same as the system $\Phi = 0$, $H = 0$, and in this sense a may be said to carry H as it were in its bosom. And so in general every pure projective reciprocant may, in the language of insect transformation, be regarded as passing, so to say, first from the grub to the pupa or chrysalis, and from this again, divested of all superfluous integuments, to the butterfly or imago state.

Non-projective pure reciprocants undergo only one such change. There is no possibility of their ever emerging into the imago—their development being finally arrested at the chrysalis stage.

It would, I think, be an interesting and instructive task to obtain the imago or Hessianised transformation of the Mongian, but I am not aware that any one has yet done, or thought of doing, this.[2] It seems to me that by substituting Reciprocants in lieu of Ternary Covariants we are as it were stealing a dimension from space, inasmuch as Reciprocants, *i.e.* Ternary Covariants in their undeveloped state, are closely allied to, and march *pari passu* with, the familiar forms which appertain to merely binary quantics.

I will now proceed to bring before your notice the general partial differential equation which supplies the necessary and sufficient condition to which all pure reciprocants are subject.

It is highly convenient to denote the successive derivatives

$$\frac{dy}{dx^2}\ \frac{dy}{dx^3}\ \frac{dy}{dx^4}\ \ldots$$

by the simple letters $a, b, c, \ldots$

The first derivative $\frac{dy}{dx}$ plays so peculiar a part in this theory that it is necessary to denote it by a letter standing aloof from the rest, and I call it τ. This last letter, I need not say, does not make its appearance in any pure reciprocant. This being premised, I invite your attention to the equation in question, in which you will perceive the symbols of operation are separated from the object to be operated upon.

Writing $V = 3a^2\delta + 10ab\delta_c + (15ac + 10b^2)\delta_d + \ldots$ and calling any pure reciprocant R,

$$VR = 0$$

is the equation referred to.

I cannot undertake, within the brief limits of time allotted to this lecture, to explain how this operation, or, as it may be termed, this annihilator V is arrived at. The table of binomial coefficients, or rather half-series of binomial coefficients, shown in Chart 4, will enable you to see what is the law of the numerical coefficients of its several terms. Let the words *weight*, *degree*, *extent* (extent, you will remember, means the number of places by which the most remote letter in the form is separated from the first letter in the alphabet) of a pure reciprocant signify the same things as they would do if the letters $a, b, c, \ldots$ referred, according to the ordinary notation, to Binariants instead of to Reciprocants. The number of binariants linearly independent of each other whose weight, extent, and order are w, i, j is given by the partition formula $(w; i, j) - (w - 1; i, j)$ where in general $(w; i, j)$ means the number of ways of partitioning w into i or fewer parts none greater than j. It follows immediately from the mere form of V that the corresponding formula in the case of Reciprocants of a given type $w.i.j$ will be $(w; i, j) - (w - 1; i + 1, j)$ the augmentation of i in the second term of the formula being due to the fact that, whereas in the partial differential equation for Binariants it is the letters themselves which appear as coefficients, it is their quadratic functions of these in the case of Reciprocants. From the form of V we may also deduce a rigorous demonstration of the existence of Reciprocants strictly analogous to those with which you are familiar in the Binarian Theory, which are pictured in Chart 2, and are now usually designated as Protomorphs, as being the forms by the interweaving of which with one another (or rather by a sort of combined process of mixture and precipitation), all others, even the irreducible ones, are capable of being produced. The corresponding forms for Reciprocants you will see exhibited in the same table. Each series of Protomorphs may of course be indefinitely extended as more and more letters are introduced. In the table I have not thought it necessary to go beyond the letter g. You also know that besides Protomorphs there are other irreducible forms, the organic radicals, so to say, into which every compound form may be resolved, always limited in number, whatever the number of letters or primal elements we may be dealing with. The same thing happens to Reciprocants as you will notice in the comparative table in Chart 2. Without going into particulars, I will ask you to take from me upon faith the assurance that there is no single feature in the old familiar theory, whether it relates to Protomorphs, to Groundforms, to Perpetuants, to Factorial constitution, to Generating Functions, or whatever else sets its stamp upon the one, which is not counterfeited by and reproduced in the parallel theory.

[1] In Paris, from which I correct the proofs, I have succeeded in reducing this conjecture to a certainty and in establishing the marvellous fact that every Projective Reciprocant, or, which is the same thing, every Differential Invariant, is, at the same time, an Ordinary Subinvariant. Thus a differential invariant (or projective reciprocant) may be regarded as *a single personality clothed with two distinct natures*—that of a reciprocant and that of a subinvariant.

[2] M. Halphen informs me that this has been done by Cayley in the *Phil. Trans.* for 1865, and subsequently in a somewhat simplified form by Paluvin, *Comptes rendus*, 1874. But neither of these authors seems to have had the Boole-Mongian objectively before them, so that a slight supplemental computation is wanting to establish the equation between it and the function which either of them finds to vanish at a *scxtactic* point

So much—for time will not admit of more—concerning pure reciprocants.

Let me now say a few words *en passant* on Mixed Reciprocants.

Pure Reciprocants, we have seen, are the analogues of Invariants, or else of the leading terms [for that is what are Semi- or Subinvariants] of Covariantive expansions; each is subject to its own proper linear partial differential equation. Mixed Reciprocants are the exact analogues of the coefficients in such expansions other than those of the leading terms. Starting from the leading terms as the unit point, the coefficients of rank ω are subject to a partial differential equation of order ω; and just so, mixed reciprocants, if involving τ up to the power ω, are subject to a partial differential equation of that same order.

I have alluded to a peculiar class of mixed under the name of "Orthogonal Reciprocants." They are distinguished, as I have proved, by the beautiful property that, if differentiated with respect to τ, the result must be itself a Reciprocant. In Chart 1 you will see this illustrated in the case of a mixed reciprocant $(1+\tau^2)b - 3\tau a^2$, which serves to indicate the existence of points of maximum and minimum curvature. Its differential coefficient with respect to t is the oft-alluded-to Schwarzian, transliterated into the simpler notation. Proceeding in the inverse order—of Integration instead of Differentiation—I call your attention to a mixed reciprocant, of a very simple character, one which presents itself at the very outset of the theory, viz.—

$$\tau c - 5ab,$$

which, integrated in respect to t between proper limits, yields the elegant orthogonal reciprocant—

$$(\tau^2+1)c - 10a b\tau + 15a^3.$$

Expressed in the ordinary notation, this, equated to zero, takes the form—

$$\left\{\left(\frac{dy}{dx}\right)^2+1\right\}\left\{\frac{d^4y}{dx^4}-10\frac{dy}{dx}\cdot\frac{d^3y}{dx^3}\cdot\frac{d^2y}{dx^2}+15\left(\frac{d^2y}{dx^2}\right)^3\right\}=0.$$

Mr. Hammond has integrated this, treated as an ordinary differential equation, and has obtained the complete primitive expressed through the medium of two related Hyper-Elliptic Functions connecting the variables x and y (see Chart 3). It may possibly turn out to be the case that every mixed reciprocant is either itself an Orthogonal Reciprocant, or by integration, in respect to τ, leads to one.

It will of course be understood that, in interpreting equations obtained by equating to zero an Orthogonal Reciprocant, the variables must be regarded as representing not general but rectangular Cartesian co-ordinates.

Here seems to me to be the proper place for pointing out to what extent I have been anticipated by M. Halphen in the discovery of this new world of Algebraical Forms. When the subject first dawned upon my mind, about the end of October or the beginning of November last, I was not aware that it had been approached on any side by any one before me, and believed that I was digging into absolutely virgin soil. It was only when I received M. Halphen's letter, dated November 25, in relation to the Mongian business already referred to, accompanied by a presentation of his memoirs on Differential Invariants, that I became aware of there existing any link of connection between his work and my own. A Differential Invariant, in the sense in which the term is used by M. Halphen, is not what at first blush I supposed it to be, and as in my haste to repair what seemed to me an omission to be without loss of time supplied, I wrote to M. Hermite it was, in a letter which has been or is about to be inserted in the *Comptes rendus* of the Institute of France; it is not, I say, identical with what I have termed a general pure reciprocant, but only with that peculiar species of Pure Reciprocants to which I have in a preceding part of this lecture referred as corresponding and pointing to Projective Singularities. In his splendid labours in this field Halphen has had no occasion to construct or concern himself with that new universe of forms viewed as a whole, whether of Pure or Mixed Reciprocants, which it has been the avowed and principal object of this lecture to bring under your notice.

I anticipate deriving much valuable assistance in the vast explorations remaining to be made in my own subject from the new and luminous views of M. Halphen, and possibly he may derive some advantage in his turn from the larger outlook brought within the field of vision by my allied investigations.

Let me return for a moment to that simplest class of pure reciprocants which I have called protomorphs. Each of these will be found (as may be shown either by a direct process of elimination, or by integrating the equations obtained by equating them severally to zero, regarded as ordinary differential equations between x and y) each of these, I say, will be found to represent some simple kind of singularity at the point (x, y) of the curve to which these co-ordinates are supposed to refer. Thus, for instance, No. 1 marks a single point of inflexion; No. 2, points of closest contact with a common parabola; No. 3, what our Cayley has called sextactic points, referring to a general conic; No. 4, points of closest contact with a common cubical parabola; and so on. The first and third, it will be noticed, represent projective singularities, and as such, in M. Halphen's language, would take the name of Differential Invariants. The second and fourth, having reference to the line at infinity in the plane of the curve, are of a non-projective character, and as such would not appear in M. Halphen's system of Differential Invariants. It is an interesting fact that every simple parabola, meaning one whose equation can be brought under the form $y = x^{\frac{m}{n}}$, corresponds to a linear function of a square of the third, and the cube of the second protomorph, and consequently will in general be of the sixth degree. In the particular case of the cubical parabola, the numerical parameter of this equation is such that the highest powers of b cancel each other so that the form sinks one degree, and becomes represented by the *Quasi-Discriminant*, No. 4.

This simple instance will serve to illustrate the intimate connection which exists between the projective and non-projective reciprocants, and the advantage, not to say necessity, of regarding them as parts of one organic whole.

It would take me too far to do more than make the most cursory allusion to an extension of this theory similar to that which happens when in the ordinary theory of invariants we pass from the consideration of a single Quantic to that of two or more. There is no difficulty in finding the partial differential equation to double reciprocants which, as far as I have as yet pursued the investigation, appear to be functions of $a, b, c, \ldots$; $a', b', c', \ldots$; and of $(\tau - \tau')$.

The theory of double reciprocants will then include as a particular case the question of determining the singularities of paired points of two curves at which their tangents are parallel, and consequently the theory of common tangents to two curves and of bi-tangents to a single one.

I think I may venture to say that a general pure multiple reciprocant which marks off relative singularities, whether projective or non-projective, of a group of curves, is a function of the second and higher differential derivatives appertaining to the several curves of the group, and of the differences of the first derivatives, whereas in a mixed multiple reciprocant these last-named differences are replaced by the first derivatives themselves. As a particular case, when the group

dwindles to an individual and there is only one τ, this letter disappears altogether from the form, for there are no differences of a single quantity.

In the chart (marked No. 2) you will see the table of Protomorphs carried on as far as the letter g inclusive, and will not fail to notice what may be termed the higher organisation of Reciprocantive as compared with ordinary Invariantive Protomorphs; the degrees of the latter oscillate or librate between the numbers 2 and 3, whereas in the former the degree is variable according to a certain transcendental law dependent on the solution of a problem in the Partition of Numbers. Another interesting difference between general Invariants and general Pure Reciprocants consists in the fact that, whilst the number of the former ultimately (*i.e.* when the extent is indefinitely increased) becomes indefinitely great, that of the latter is determinate for any given degree even for an infinite number of letters.

In carrying on the table of protomorphs up to the letter h (see Chart 6) a new phenomenon presents itself, to which, however, there is a perfect parallel in the allied theory. An arbitrary constant enters into the form, its general value being a linear function of U and W (for which see Chart 6). But this is not all. If you examine the terms in both U and W (there are in all twelve such) you will find that these twelve do not comprise all of the same type to which they belong. There is a Thirteenth (a banished Judas), equally *a priori* entitled to admission to the group, but which does not make its appearance among them, viz. b^4d. I rather believe that a similar phenomenon of one or more terms, whose presence might be expected, but which do not appear, presents itself in the allied invariantive theory, but cannot speak with certainty as to this point, as the circumstance has not received, and possibly does not merit, any very particular attention.

Still, in the case before us, this unexpected absence of a member of the family, whose appearance might have been looked for, made an impression on my mind, and even went to the extent of acting on my emotions. I began to think of it as a sort of lost Pleiad in an Algebraical Constellation, and in the end, brooding over the subject, my feelings found vent, or sought relief, in a rhymed effusion, a *jeu de sottise*, which, not without some apprehension of appearing singular or extravagant, I will venture to rehearse. It will at least serve as an interlude, and give some relief to the strain upon your attention before I proceed to make my final remarks on the general theory.

TO A MISSING MEMBER

Of a Family Group of Terms in an Algebraical Formula

Lone and discarded one! divorced by fate,
Far from thy wished-for fellows—whither art flown?
Where lingerest thou in thy bereaved estate,
Like some lost star, or buried meteor stone?
Thou mindst me much of that presumptuous one
Who loth, aught less than greatest, to be great,
From Heaven's immensity fell headlong down
To live forlorn, self-centred, desolate:
Or who, new Heraklid, hard exile bore,
Now buoyed by hope, now stretched on rack of fear,
Till throned Astræa, wafting to his ear
Words of dim portent through the Atlantic roar,
Bade him "the sanctuary of the Muse revere
And strew with flame the dust of Isis' shore."

Having now refreshed ourselves and bathed the tips of our fingers in the Pierian spring, let us turn back for a few brief moments to a light banquet of the reason, and entertain ourselves as a sort of after-course with some general reflections arising naturally out of the previous matter of my discourse. It seems to me that the discovery of reciprocants must awaken a feeling of surprise akin to that which was felt when the galvanic current astonished the world previously accustomed only to the phenomena of machine or frictional electricity. The new theory is a ganglionic one: it stands in immediate and central relation to almost every branch of pure mathematics—to Invariants, to Differential Equations, ordinary and partial, to Elliptic and Transcendental Functions, to Partitions of Numbers, to the Calculus of Variations, and above all to Geometry (alike of figures and of complexes), upon whose inmost recesses it throws a new and wholly unexpected light. The geometrical singularities which the present portion of the theory professes to discuss are in fact the distinguishing *features* of curves; their *technical* name, if applied to the human countenance, would lead us to call a man's eyes, ears, nose, lips, and chin his singularities; but these singularities make up the character and expression, and serve to distinguish one individual from another. And so it is with the so-called singularities of curves.

Comparing the system of ground-forms which it supplies with those of the allied theory, it seems to me clear that some common method, some yet undiscovered, deep-lying, Algebraical principle remains to be discovered, which shall in each case alike serve to demonstrate the finite number of these forms (these organic radicals) for any specified number of letters. The road to it, I believe, lies in the Algebraical Deduction of ground-forms from the Protomorphs.[1] Gordan's method of demonstration, so difficult and so complicated, requiring the devotion of a whole University semester to master, is inapplicable to reciprocants, which, as far as we can at present see, do not lend themselves to symbolic treatment.

How greatly must we feel indebted to our Cayley, who while he was, to say at least, the joint founder of the symbolic method, set the first, and out of England little if at all followed, example of using as an engine that mightiest instrument of research ever yet invented by the mind of man—a Partial Differential Equation, to define and generate invariantive forms.

With the growth of our knowledge, and higher views now taken of invariantive forms, the old nomenclature has not altogether kept pace, and is in one or two points in need of a reform not difficult to indicate. I think that we ought to give a general name—I propose that of Binariants—to every rational integral form which is nullified by the general operator

$$\lambda ad_b + \mu bd_c + \nu cd_d + \dots$$

where $\lambda, \mu, \nu, \dots$ are arbitrary numbers.

This operator, I think, having regard to the way in which its segments link on to one another, may be called the Vermicular.

Binariants corresponding to unit values of $\lambda, \mu, \nu, \dots$ may be termed standard binariants. Those for which these numbers are the terms of the natural arithmetical series 1, 2, 3, . . . Invariantive binariants, which may be either complete or incomplete invariants; these latter are what are usually termed semi- or sub invariants. I may presently have to speak of a third class of binariants for which the arbitrary multipliers are the numbers 3, 8, 15, 24 . . . (the squares of the natural numbers each diminished by unity) which, if the theorem I have in view is supported by the event, will have to be termed Reciprocantive Binariants. But first let me call attention to what seems a breach of the asserted parallelism between the Invariantive and the Reciprocantive theories. In the former we have complete and incomplete invariants, but we have drawn no such distinction between one set of pure reciprocants and another. A parallel distinction does however exist.

If we use w, i, j to signify the weight, extent, and degree of an invariantive form, w is never less than the half product of ij; when equal to it the form is complete. In the case of reciprocants certain observed facts seem to indicate that there exists an analogous but less simple

[1] See the section on the Algebraical Deduction of the Ground-forms of the Quintic in my memoir on Subinvariants in the *American Journal of Mathematics*.

inequality. If this conjecture is verified it is not merely $\frac{ij}{2} - w$, but $\frac{ij}{2} - (j-2) - w$, which is never negative: and when this is zero, the form may be said to be complete.[1] There would then be thus complete forms in each of the two theories; in the earlier one they take a special name: this is the only difference.

We have spoken of Pure Reciprocants as being either projective or non-projective, but so far have abstained from particularising the external characters by which the former may be distinguished from the latter. I have good reason to suspect that the former are distinguished from the latter by being Binariants; that, in addition to being subject to annihilation by the operator V, they are also subject to annihilation by the Vermicular operator when made special by the use of the numerical multipliers 3, 8, 15 . . . above alluded to, or in other words (as previously mentioned incidentally) are subject to satisfy two simultaneous partial differential equations instead of only one.[2] Projective Reciprocants we have seen are disguised or masked Ternary Covariants—Covariants in the grub, the first undeveloped state. Now ternary covariants are capable, it may or may not be generally known, of satisfying 6 reducible to 2 simultaneous Partial Differential Equations, and at first sight it might be surmised that nothing would be gained by the substitution of the two new for the two old simultaneous partial differential equations. But the fact is not so, for the old partial differential equations are perfectly unmanageable, or at least have never, as far as I know, been handled by any one, for they have to do with a *triangular heap*, whereas the new ones are solely concerned with a *linear series* of co-efficients.

I have alluded to there being a particular form common to the two theories. In the one theory it is the Mongian alluded to in the correspondence, which has been read, with M. Halphen. In the other it is the source of the skew covariant to the cubic. If the latter be subjected to a sort of MacMahonic numerical adjustment, it becomes absolutely identical with the former. Let us imagine that before the invention of Reciprocants an Algebraist happened to have had both forms present to his mind, and had thought of some contrivance for lowering the coefficients of the Mongian written out with the larger coefficients, and had thus stumbled upon this striking fact. It could not have failed to vehemently arouse his curiosity, and he would have set to work to discover, if possible, the cause of this coincidence. He would in all probability have addressed himself to the form which precedes the source alluded to in the natural order of genesis, and have applied a similar adjustment to the much simpler form, $ac - b^2$: having done so he would have tried to discover to what singularity it pointed—but his efforts to do so we know must have been fruitless, and he would have felt disposed to throw down his work in despair, for the intermediate ideas necessary to make out the parallelism would not have been present to his mind. So long as we confine ourselves to Differential Invariants, *i.e.* to projective pure reciprocants, we are like men walking on those elevated ridges, those more than Alpine summits, such as I am told[1] exist in Thibet, where it may be the labour of days for two men who can see and speak to each other to come together. Reciprocants supply the bridge to span the yawning ravine and to bring allied forms into direct proximity.

I have spoken of mixed reciprocants as being subject to satisfy not a linear partial differential equation, but one of a higher order dependent on the intensity, so to say, of its mixedness—the highest power, that is to say, of the first differential derivative which it contains, and it might therefore be supposed that these forms are much more difficult to be obtained than pure reciprocants. But the fact is just the reverse, for as I discovered in the very infancy of the inquiry, and have put on record in the September or October number of the *Mathematical Messenger*, mixed reciprocants may be evolved in unlimited profusion by the application of simple and explicit processes of multiplication and differentiation. From any reciprocant whatever, be it mixed or pure, new mixed ones may be educed infinitely infinite in number, inasmuch as at each stage of the process, arbitrary functions of the first differential derivative may be introduced.

The wonderful fertility of this method of generation excited warm interest on the part of one of the greatest of living mathematicians, the expression of which acted as a powerful incentive to me to continue the inquiry. They may be compared with the shower of December meteors shooting out in all directions and covering the heavens with their brilliant trains, all diverging from one or more fixed radiant-points, the radiant-point in the theory before us being the particular form selected to be operated upon.

The new doctrine which I have endeavoured thus imperfectly to adumbrate has taken its local rise in this University, where it has already attracted some votaries to its side, and will, I hope, eventually obtain the co-operation of many more. I have ventured with this view to announce it as the subject of a course of lectures during the ensuing term.

When I lately had the pleasure of attending the new Slade Professor's inaugural discourse, I heard him promise to make his pupils participators in his work by painting pictures in the presence of his class. I aspire to do more than this—not only to paint before the members of my class, but to induce them to take the palette and brush and contribute with their own hands to the work to be done upon the canvas. Such was the plan I followed at the Johns Hopkins University, during my connection with which I may have published scores of Mathematical articles and memoirs in the journals of America, England, France, and Germany, of which probably there was scarcely one which did not originate in the business of the class-room; in the composition of many or most of them I derived inestimable advantage from the suggestions or contributions of my auditors. It was frequently a chase, in which I started the fox, in which

[1] If this should turn out to be true, the "crude generating fraction" for reciprocants would be almost identical with that of in- and co-variants of the same extent j. The denominators would be absolutely identical; as regards the numerators, while that for invariantive forms is $1 - a^{-1}x^{-2}$ the numerator for reciprocants would be $1 - a^{-2}x^{-3}$. As I write abroad and from memory there is just a chance that the index of a here given may be erroneous.

[2] As already stated in a previous footnote this conjecture is fully confirmed, my own proof having been corroborated (if it needed corroboration) by another entirely different one invented by M. Halphen, who fully shares my own astonishment at the fact of there being forms (half-horse, half alligator) at once reciprocants and sub-invariants, and as such satisfying two simultaneous partial differential equations.

If instead of denoting the successive differential derivatives (starting from the second) $a, b, c, \ldots$ we call them $\frac{a}{1.2}, \frac{b}{1.2.3}, \frac{c}{1.2\,3\,4}, \ldots$ the two Annihilators will be

$$a\delta_b + 2b\delta_c + 3c\delta_d + 4d\delta_e + \ldots \text{ and}$$

$$4\frac{a^2}{2}\delta_b + 5ac\delta_c + 6\left(ad + bc\right)\delta_d + 7\left(ae + bd + \frac{c^2}{2}\right)\delta_e + \ldots$$

the latter being my new operator, the Reciprocator V, accommodated to the above-stated change of notation for the successive differential derivatives.

Hardly necessary is it for me to point out in explanation of the semi-sums $\frac{a^2}{2}, \frac{c^2}{2}, \ldots$ that we may write the MacMahonised V under the form

$$4a^2\delta_b + 5(ac + ca)\delta_c + 6(ac + bc)\delta_d + 7(ae + bd + c^2 + db + ea)\delta_e + \ldots$$

It is to be presumed that in addition to mixed reciprocants (the ocean into which flows the sea of pure reciprocants, as into that again empties itself the river of projective reciprocants) there may exist a theory of forms in which y as well as $\frac{dy}{dx}$ will appear, or, so to say, doubly mixed reciprocants, the most general of all, in which case we must speak of the content of these as the ocean and of the others as sea, river, and brook. Curious is it to reflect that in the theory which as it exists comprises Invariantives, Reciprocants, and Invariantive Reciprocants or Reciprocant Invariantives, the order of discovery was (1) Invariantives (Eisenstein, Boole, &c.); (2) Invariantive Reciprocants (Monge and Halphen); (3) Reciprocants (Schwarz, the author of this lecture).

[1] I think my informant was my friend Dr. Inglis, of the Athenæum Club, who some time ago undertook a journey in the Himalayas in the hopes of coming upon the traces of a lost religion which he thought he had reason to believe existed among mankind in the pre-Glacial period of the earth's history.

we all took a common interest, and in which it was a matter of eager emulation between my hearers and myself to try which could be first in at the death.

During the past period of my professorship here, imperfectly acquainted with the usages and needs of the University, I do not think that my labours have been directed so profitably as they might have been either as regards the prosecution of my own work or the good of my hearers: my attention has been distracted between theories waiting to be ushered into existence and providing for the daily bread of class-teaching. I hope that in future I may be able to bring these two objects into closer harmony and correlation, and think I shall best discharge my duty to the University by selecting for the material of my work in the class-room any subject on which my thoughts may, for the time being, happen to be concentrated, not too alien to, or remote from, that which I am appointed to teach; and thus, by example, give lessons in the difficult art of mathematical thinking and reasoning—how to follow out familiar suggestions of analogy till they broaden and deepen into a fertilising stream of thought—how to discover errors and to repair them, guided by faith in the existence and unity of that intellectual world which exists within us, and is at least as real as that with which we are environed.

The *American Mathematical Journal*, conducted under the auspices of the Johns Hopkins University, which has gained and retains a leading position among the most important of its class, whether measured by the value of its contents or the estimation in which it is held by the Mathematical world, bears as its motto—

πραγμάτων ἔλεγχος οὐ βλεπομένων.

I have the pleasure of seeing among my audience this day the most distinguished geometer of Holland, Prof. Schoute, who has done me the signal honour of coming over to England to be present at this lecture, who hospitably entertained me at Groningen (in a vacation visit which I recently paid to his country, the classic soil which has given birth to an Erasmus, a Grotius, a Boerhaave, a Spinoza, a Huyghens, and a Rembrandt), and who was kind enough, in proposing my health at a party where many of his colleagues were present, to say that he felt sure "that I should return to England cheered and invigorated, and would, ere long, light on some discovery which would excite the wonder of the Mathematical world."

I do not venture to affirm, nor to think, that this vaticination has been fulfilled in the terms in which it was uttered, but can most truly say that the discovery, which it has been my good fortune to be made the medium of revealing, has excited my own deepest feelings of ever-increasing wonder rising almost to awe, such as must have come over the revellers who saw the handwriting start out more and more plainly on the wall, or the *scienziati* crowding round the blurred palimpsest as they began to be able to decipher characters and piece together the sentences of the long lost and supposed irrecoverable *De Republicâ*.

When I was at Utrecht, on my way to Groningen, Mr. Grinwis, the Professor of Mathematics at that University, showed me an English book on "Differential Equations," which had just appeared, of which he spoke in high terms of praise, and said it contained over 800 examples. I wrote at once for the book to England, and on seeing it on my arrival, forgetting that it had been ordered, mistook it for a present from the author or publisher, and, what is unusual with me, read regularly into it, until I came to the section on Hyper-geometrical series, where the Schwarzian Derivative (so named by Cayley after Prof. Schwarz) is spoken of.

Perhaps I ought to blush to own that it was new to me, and my attention was riveted by the property it possesses, in common with the more simple form which points to inflexions on curves, of remaining substantially unaltered, of persisting as a factor at least of its altered self, when the variables which enter it are interchanged. Following out this indication, I at once asked myself the question, "ought there not to exist combinations of derivatives of *all* orders possessing this property of reciprocation?" That question was soon answered, and the universe of mixed reciprocants stood revealed before me. These mixed reciprocants, by simple processes of combination, led me to the discovery of the first pure reciprocant, $3b^2 - 5ac$: whereupon I again put the question to myself, "are there, or are there not, others of this form, and if so, what are they?"

In an unexpected manner the question was answered, and my curiosity gratified to the utmost by the discovery of the partial differential equation which is the central point of the theory, and at once discloses the parallelism between it and the familiar doctrine of Invariants. Two principal exponents of that doctrine, who have infused new blood into it, and given it a fresh point of departure—Capt. MacMahon and Mr. Hammond—I have the pleasure of seeing before me. Mr. Kempe, who is also present, has lately entered into and signally distinguished himself in the same field, availing himself in so doing of his profound insight into the subject of linkages, his interest in which I believe I may say received its first impulse from the lecture which he heard me deliver upon it at the Royal Institution in January 1874, on the very night when the Prime Minister for the time being sent round letters to his supporters announcing his intention to dissolve Parliament. Of the two events I have ever regarded the lecture as by far the more important to the permanent interests of society. He has lately applied ideas founded upon linkages to produce a most original and remarkable scheme for explaining the nature of the whole pure body of Mathematical truth, under whatever different forms it may be clothed, in a memoir which has been recommended to be printed in the *Transactions* of the Royal Society, and which, I think, cannot fail when published to excite the deepest interest alike in the Mathematical and the Philosophical worlds.[1]

I also feel greatly honoured by the presence of Prof. Greenhill, who will be known to many in this room from his remarkable contributions to the theory of Hydrodynamics and Vortex Motion, and who has sufficient candour and largeness of mind to be able to appreciate researches of a different character from those in which he has himself gained distinction.

I should not do justice to my feelings if I did not acknowledge my deep obligations to Mr. Hammond for the assistance which he has rendered me, not only in preparing this lecture which you have listened to with such exemplary patience, but in developing the theory; I am indebted to him for many valuable suggestions tending to enlarge its bounds, and believe have been saved, by my conversations with him, from falling into some serious errors of omission or oversight. Saving only our Cayley (who, though younger than myself, is my spiritual progenitor—who first opened my eyes and purged them of dross so that they could see and accept the higher mysteries of our common Mathematical faith), there is no one I can think of with whom I ever have conversed, from my intercourse with whom I have derived more benefit. It would be an immense gain to Science, and to the best interests of the University, if something could be done to bring such men as Mr. Hammond (and, let me add, Mr. Buckheim, who ought never to have been allowed to leave it) to come and live among us. I am sure that with their endeavours added to my own and those of that most able body of teachers and researchers with whom I have the good fortune to be associated—my brother Professors and the Tutorial Staff of the University—we

[1] In his memoir for the *Phil. Trans.* Mr. Kempe contends that any whatever mathematical proposition or research is capable of being represented by some sort of simple or compound linkage. One would like to know by what sort of linkage he would represent the substance of the memoir itself.

could create such a School of Mathematics as might go some way at least to revive the old scientific renown of Oxford, and to light such a candle in England as, with God's grace, should never be put out.[1]

TABLES OF SINGULARITIES AND FORMULÆ REFERRED TO IN THE PRECEDING LECTURE

CHART 1.

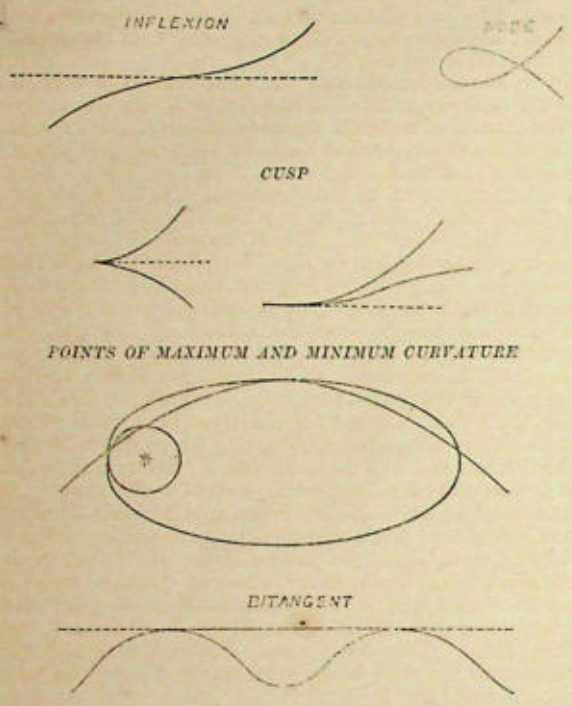


CHART 2.—PROTOMORPHS

Finariants	*Reciprocants*
a	a
$ac-b^2$	$3ac-5b^2$
$a^2d-3abc+2b^3$	$9a^2d-45abc+40b^3$
$ae-4bd+3c^2$	$5a^2e-35abd+7ac^2+35b^2c$
$a^2f+5abe+2acd+8b^2d-6bc^2$	$45a^3f-420a^2be-42a^2cd+1120ab^2d$ $-315abc^2-1120b^3c$
$ag-6bf+15ce-10d^2$	$a^2g-12abf-450ace+792b^2e$ $+588ad^2-2772bcd+1925c^3$

CHART 3.

No. 1. a
No. 2. $3ac-5b^2$
No. 3. $9a^2d-45abc+40b^3$
No. 4. $45a^3d^2-450a^2bc+192a^2c^3+400ab^2d+165ab^2c^2-400b^4c$

$$x=\int\frac{dt}{\sqrt{\kappa(1-15t^2+15t^4-t^6)+\lambda(3t-10t^3+3t^5)}}+\mu$$

$$y=\int\frac{tdt}{\sqrt{\kappa(1-15t^2+15t^4-t^6)+\lambda(3t-10t^3+3t^5)}}+\nu$$

$$V=3a^2\delta_b+10ab\delta_c+(15ac+10b^2)\delta_d+(21ad+35bc)\delta_e+(28ae+56bd+35c^2)\delta_f+\ldots$$

[1] I have purposely confined myself in my lecture to reciprocants, indicatives of properties of plane curves, but had in view to extend the theory to the case of higher dimensions in space leading to reciprocants involving the differential derivatives of any number of variables $y, z, \ldots$. M. Halphen, with whom I have had the great advantage of being in communication during my stay in Paris, has anticipated me in this part of my plan, and has found that the same method which I have used to obtain the Annihilator V applied to a system of variables leads to an Annihilator of very similar form to V, and at my request will publish his results in a forthcoming number of the *Comptes rendus*. Thus the dominion of reciprocants is already extended over the whole range of forms unlimited in their own number as well as in that of the variables which they contain

CHART 4.—COEFFICIENTS OF ANNIHILATOR V

1	4	3			
1	5	10			
1	6	15	10		
1	7	21	35		
1	8	28	56	35	
1	9	36	84	126	
1	10	45	120	210	126

CHART 5.—RECIPROCANT TRANSFORMATIONS

Grub	*Chrysalis*			*Imago*		
d^2y	$d^2\phi$	$d^2\phi$	$d\phi$	$d^2\Phi$	$d^2\Phi$	$d^2\Phi$
dx^2	dx^2	$dxdy$	dx	dx^2	$dxdy$	$dxdz$
	$d^2\phi$	$d^2\phi$	$d\phi$	$d^2\Phi$	$d^2\Phi$	$d^2\Phi$
	$dxdy$	dy^2	dy	$dxdy$	dy^2	$dydz$
	$d\phi$	$d\phi$	●	$d^2\Phi$	$d^2\Phi$	$d^2\Phi$
	dx	dy		$dxdz$	$dydz$	dz^2

(a) (M) (H)

$$(n-1)^2\left(\frac{d\phi}{dy}\right)^3 a+H+\left\{\frac{d^2\Phi}{dx^2}\cdot\frac{d^2\Phi}{dy^2}-\left(\frac{d^2\Phi}{dxdy}\right)^2\right\}\Phi=0.$$

$\frac{dy}{dx}\cdot\frac{d^3y}{dx^3}-\frac{3}{2}\left(\frac{d^2y}{dx^2}\right)^2$ is the Schwarzian, otherwise written $tb-\frac{3a^2}{2}$.

CHART 6.—THE H RECIPROCANTIVE PROTOMORPH

U	W	*The Vermicular Operator*
$65a^4i$	$120a^3cf$	$\lambda a\delta_b+\mu b\delta_c+\nu c\delta_d+\pi d\delta_e+\ldots$
$-975a^3hg$	$-200a^2b^2f$	
$-990a^3cf$	$-195a^2de$	*Examples*
$+6200a^2b^2f$	$-145a^2bce$	$a\delta_b+b\delta_c+c\delta_d+d\delta_e+\ldots$
$+4690a^2bce$	$+1000ab^3e$	$a\delta_b+2b\delta_c+3c\delta_d+4d\delta_e+\ldots$
$-1540ab^3e$	$+1365a^2bd^2$	$3a\delta_b+8b\delta_c+15c\delta_d+24d\delta_e+\ldots$
$-2730a^2bd^2$	$-777a^2c^2d$	
$+7161a^2c^2d$	$-22260abca$	
$+3080ab^2cd$	$+2485abc^3$	☞ bcd does not appear in either U or W.
$-24255abc^3$	$+105b^3c^2$	
$+25410b^3c^2$		

$H+\Lambda U+MW$

Λ and M are arbitrary numbers.

New College, Oxford, January 6

THE GEOLOGY OF MALAYSIA, SOUTHERN CHINA, &c.

THERE is a remarkable uniformity in the geology of a very large portion of Southern Asia and its dependent islands, especially from the Malay peninsula, as far east as the Philippines, and as far north as the Chinese continent. In the Malayan peninsula we have an elevated granitic axis. At the base of this there are Palæozoic schists and slates. Above these in a few places there are limestones in detached weathered masses. This limestone is often crystalline, white, blue, and black. In a few cases there are traces of stratification, but no fossils.

In a recent journey through Pahang I found precisely the same formations on the eastern side of the peninsula, with only this addition, that there is a belt of trachytic rocks of modern origin forming detached hills between the main range and the sea.

In Sumatra I learn that there are the same formations from the granite upwards. I cannot confirm this from personal observation, as I have travelled very little in the island. The mountain axis is far from the Straits of Malacca, and difficult of access. As far as I can judge from the geology of such large islands as Bilitou, Bintang, and Banca, the mountains are probably granitic and stanniferous.

Proceeding eastward and northerly, detached granite islands are met with. They are thickly strewn through the intermediate ocean. Those I have seen, such as the north and south Natunas, and other similar outliers, on voyages between Java, Singapore, Borneo, China, Cochin

China, and Siam, are all granitic, with a few Palæozoic slates and schists. To the eastward of the Malay peninsula a few limestone islands are seen, and they are similar in character to the calcareous rocks of the mainland.

It is perhaps needless to draw attention to the extraordinary number of these outliers. They do not show well on a map, as most of them are so very small, but those who travel in these regions can well understand why the early Arabian voyagers called this "the sea of the twelve thousand islands." Granite is the prevailing rock, but I have little doubt that modern trap-rocks form some of the islands. But there is no active volcano amongst them. The nearest point for such phenomena is said to be Formosa, but I think this doubtful. Yet, proceeding north from this large island, along the chain which connects it in an almost unbroken series through the Meiaco group, Liu Kiu and Linschoten Islands, to Japan, we find two active volcanoes (Naka Sima and Sawa Sima, the latter 3400 feet high), which seem to point to a line of disturbance, of which Formosa is a portion.

When we come to Borneo we find the first extensive development of stratified rocks. Though outliers of granite are met occasionally, it is evident that there is a great change in the geology of the coast. I shall confine my observations to what I saw. From Brunei northwards we meet with carbonaceous rocks, brown and yellow sandstones and shales with intercalated grits and conglomerates. The dip varies: sometimes slight, or nearly horizontal, showing but trifling disturbance in this part of the world. It seemed to me as if these carbonaceous rocks were of different ages. Those which line the Brunei River are much older-looking than those of Labuan. At Gaya, and again at Kudat, at the north extremity of Borneo, I saw brownish-yellow sandstones with shales and small seams of coal. The appearance of these beds reminded me much of the Mesozoic carbonaceous rocks of Queensland and New South Wales. At Sandakan or Elopura (North-East Borneo) the present capital of the North Borneo Settlement, there are high cliffs of red and yellow sandstone, which look older than anything I saw on the north or north-eastern coast. Over 600 feet are exposed in one cliff, with no signs of any carboniferous strata.

While at Sandakan I met the Governor's private secretary (Mr. D. D. Daly), who had just returned from a journey of exploration on the Kinebetungen River. He brought down many samples of good coal, besides tin and gold. Amongst the collection were some limestones very like the rocks I had seen in the Malay peninsula. These also form detached mountains. There are fine caves, I am informed, over 600 feet high, and in them are found some of the best kinds of edible birds' nests. Amid the fragments of limestone I recognised a Fenestella and a Stenopora. If this rock is of the same formation as the limestone outliers of the whole of Malaysia, then its age may be for the present considered as Palæozoic, and probably between Devonian and Carboniferous.

After visiting some islands of the Sooloo Archipelago (all volcanic) I went to the Philippines. At Luzon, Mindoro, and some of the larger members of the group, the rocks are principally volcanic. But it would be an error to regard them as exclusively so. There are some areas of stratified rocks with coral and other marine fossils, which are of probably Miocene and Pliocene age. In Mindanao there is gold. I obtained a few fossils from the Miocene beds of the latter island. They were all Foraminifera in a loose friable limestone, including *Orbulina universa*, D'Orb., *Globigerina biloba*, *triloba*, and *bulloides*, D'Orb., *Cristellaria italica*, D'Orb., *Pulvinulina Haueri*, D'Orb., *Rotlaia simplex*, D'Orb., and some others belonging to about twenty different genera. The same species are found in Luzon, and the beds are considered Eocene by Kusrer (see *Boletin de la Carta Geol. del. España*, vol. vii).

One of the most interesting portions of the Philippines is the Calamianes group, a small cluster of islands a short distance south and west of Mindoro. Here we find repeated the main geological features of the Malayan peninsula, with the addition of recent volcanic emanations. To the east of Busuanga (the largest of the group) is the Island of Coron, which presents to the sea a magnificent rampart of limestone cliffs and pinnacles from 600 to 1500 feet high. The aspect is grandly picturesque, but the character of the formation is unmistakably similar to the isolated limestone mountains in the Malayan Peninsula. The rocks are bluish-gray, with apparently a perpendicular stratification, with patches of brilliant colours, including red, yellow, pink, dark and light green, &c. The cliffs descend precipitously into about forty fathoms of water, but at the tidal line they are undermined by the action of the waves in a very cleanly-cut line. Occasionally one may see the natives (Visayas) lowering each other over these dizzy heights to gather the edible birds' nests which here also abound, and form the only valuable export from the islands. The outline of the island is magnificently rugged and irregular, weathered into needles and pinnacles of the most fantastic shape, in the recesses of which there is much pale green grass and patches of darker jungle. Caves are of course numerous. It was the birds'-nesting harvest at the time of my visit in March last.

The Island of Malagou, to the westward is similar to Culion, but it possesses the additional feature of a second line excavated by the waves about ten feet above the actual level. This seems to be the result of upheaval. Besides Malagou there are many small limestone islets, or mere pinnacles of grotesque shape. The seas are thus rendered peculiarly dangerous. The only port worthy of the name is Port Culion, with a town which is a mere cluster of Malay huts of bamboo and palm-leaves. The rocks are Palæozoic schists and quartzites. Thus we have a repetition of the formations as they occur in the Malayan Peninsula.

At Palawan and Mindanao the same formations are stated to occur. Of Mindanao there can be no doubt, but of Palawan little is known, and I have only seen the coast at a distance.

There is a continuance of the same geological features in South China, at least from those portions of the coast which I have seen between Macao and Swatow. At Hong Kong we have granite, ancient trap-rocks, felsites, and detached outliers of limestone exactly like the Palæozoic deposits all through the Eastern Archipelago. From the Canton River the same rocks have been seen by me together with well-marked Palæozoic fossils of carboniferous type (*Spirifer* especially).

I have never succeeded in getting away from the alluvial deposits of the great rivers of Cochin China. Just now the time could not be more unfavourable for any kind of exploration, but I believe the French are not neglecting the geology of the country.

Coal is extensively distributed in all the northern portions of the countries I have been describing. It is found in South China abundantly, Formosa, Tonquin, the Philippines, Japan, and Borneo, and I believe I have seen indications of a carbonaceous deposit in the Malay Peninsula.

Of the coals in South China little more is known than that they are abundant and of good quality. From the fossils I have seen they are probably of Palæozoic age. The Formosa coals are so bad that they have ceased to be worked or at least offered in the Hong Kong market. I know nothing of their age nor of the quality and age of the coals of Tonquin. The coals of the Philippines belong most probably to the Borneo older series. They are found on the south of Luzon and south of Zebu since 1827. More recently they have been found in the province of Albay (south-east of Manilla) and in Panay.

Samples from the latter mines were tried by the P. and O. Company with good results. The Japan coals are certainly Tertiary and most probably Miocene. Though brittle, they make such good steam coals that they are preferred to every other except Cardiff coal. Borneo is a mass of coal, and, as I believe, of very different ages. Those of Labuan were said to be Tertiary; those of Brunei look much older. But I question the Tertiary age of the Labuan beds.

The general character of the geology of the regions I have mentioned is (1) Granite rocks with older volcanic dykes; (2) Palæozoic schists and slates; (3) Limestones in detached outliers, probably of Carboniferous age; (4) Coal of various ages. There has been little upheaval, and that has revealed marine, Miocene, and Pliocene beds, with some few carbonaceous deposits.

J. E. TENISON-WOODS

Osaka, Japan, September 24, 1885

JOHN HUNTER'S HOUSE

EARL'S COURT HOUSE, once the residence of the illustrious John Hunter, has been made very properly the subject of a letter in the *Times* of Tuesday last, by Dr. Farquharson, M.P. The house, with which I have been familiar for the past twenty-two years, is well worth the attention of the curious which Dr. Farquharson begs for it. It differs, no doubt, somewhat from what it was in Hunter's time, but not so much, I think, as my friend supposes; for a drawing I have had made of it, when compared with another drawing taken not long after Hunter's death, and now in the possession of the Royal College of Surgeons, shows no very important change. The Lions' Den, of which I have also had a faithful copy taken, is still in good preservation, and Mrs. Hunter's boudoir retains all its original character, as she, the accomplished authoress of the well-known song,—

"My mother bids me bind my hair,"—

had it herself decorated. The copper in which the Irish giant was boiled down is in good order, and stands in an outhouse in the same place in which it stood when the giant, in piecemeal, found his way into it. In 1850 the late distinguished scholar, Dr. Robert Willis, of Barnes, took me to Kensington to see a man who remembered John Hunter. He was the son of Hunter's gardener, and was ten years of age at the time of Hunter's death in 1793. This man related some curious anecdotes of the great anatomist. One of these had reference to his presence of mind. One day as Hunter was entering his garden by the field at the back, still a field, one of the lions had got loose from its den. From the house the people called out to Hunter to get out of the way into a place of safety. Instead of this he took his handkerchief from his pocket, and marching boldly up to the lion, flipped it back into the den, and securely shut it in.

That Hunter conducted dissections in this place is clear from the remains that have been dug up in the garden. I examined a number of bones that were thus unearthed by the late occupier during some improvements which were going on about fifteen years ago. The bones showed some sections and re-sections of so curious and skilful a kind, that I asked and obtained permission to retain a few of them.

Upon the death of John Hunter, Earl's Court, held for a time by Mrs. Hunter, and by more than one future occupier, was turned into an asylum for ladies under restraint for lunacy, was held for many years as that by the Misses Bonney, and got the general name of "Miss Bonney's House" or Asylum. In 1864 it passed, still as an asylum, into the possession of my late friend Dr. Gardner Hill, who played so great a part as the practical pioneer of the system of the treatment of the insane without restraint. Dr. Hill continued to reside in the house till his death, by apoplexy, a few years ago, and his family have held it since his death up to the close of the past year, when they left it on the expiration of their lease. The fate of the house will almost certainly be its absorption, with its grounds, into a square or a series of streets, so that nothing will remain of it beyond the views which I and others who are given to antiquarian research may have taken of it, and at my instance Mr. Gardner has added several views to his magnificent collection of London. The memory of the place is thus secured for the future at least. But I agree with my learned brother Farquharson that the copper ought to go to the Hunterian Museum, to join the giant who is already so conspicuous and famous there.

BENJAMIN WARD RICHARDSON

NOTES

AN American Pasteur Institute has been incorporated in New York, its declared objects being the study and treatment of rabies and diseases susceptible of inoculation.

THE Rev. Thomas John Main, formerly Fellow of St. John's College, Cambridge, and a chaplain in the Royal Navy, died on the 28th ult. Mr. Main took his Bachelor's degree at St. John's College in 1838, as Senior Wrangler and first Smith's Prizeman, and proceeded M.A. in due course. He was for a period of thirty-four years Professor of Mathematics at the Royal Naval College at Portsmouth. Mr. Main was the author of various works on the marine steam-engine.

THE death is announced from St. Petersburg of Prof. Zakharow, of the University there, an eminent Orientalist. Nearly thirty years ago he went to China as a Russian missionary, and after General Ignatieff's Treaty of Pekin in 1860, he was employed, on account of his knowledge of Chinese and Manchu, in the work of delimiting the frontier created by that treaty. He then prepared a large map of this region, of which only one copy has been made, which is at present in the Russian Topographical Department. He also compiled a Manchu-Russian dictionary, published in 1875, and a Chinese-Manchu-Russian dictionary was almost completed at the time of his death. On his return to Europe he was appointed Professor of Manchu in the University of St. Petersburg, and in addition to his dictionaries compiled also a grammar of that language, which is now dying out in China, as the Manchus are a mere handful in the midst of the Chinese Empire, and are gradually losing their special tongue. Manchu is, however, still used at Chinese Court ceremonials, and in officially addressing the Emperor of China in person. M. Zakharow's great works have therefore a special value.

THE Association for the Improvement of Geometrical Teaching will hold its annual general meeting on Friday, January 15, at 11.30 a.m., at University College, Gower Street. At the afternoon meeting (2 p.m.) the President (R. B. Hayward, F.R.S.) will give an address on the Correlation of the Different Branches of Elementary Mathematics. A discussion will follow the reading of the address. Persons interested in the objects of the Association or in the subject of the address are cordially invited to attend.

THE Prince of Wales having expressed his desire that specimens of Australian fish might be exhibited in the Aquarium which will be opened in connection with the forthcoming Indian and Colonial Exhibition, the Trustees of the Melbourne Exhibition Building have given the matter their consideration, with a view of determining if specimens of therarer varieties could be sent from the Melbourne Aquarium. It has, however, been found that very great cost would be incurred in sending anything like an adequate supply of fish, and the project has therefore

been abandoned. It has been decided instead to forward for exhibition in the Victorian Court upwards of 100 water-colour drawings of the fishes of the colony, which have been executed to the order of the Trustees by a competent artist, and which, it is hoped, will be of interest to ichthyologists and others. It is also the intention of the Trustees to request the Government to assist them in the production of a descriptive work on Victorian fishes, the illustrations of which will be taken from these drawings. Prof. M'Coy has promised his assistance, and Mr. J. E. Sharrard, the Secretary to the Trustees, is already engaged in collecting materials for the work.

IT is announced that the seventh Congress of Orientalists will be held at Vienna in September next. The sittings will take place in the lecture-hall of the new University. It is hoped that the Archduke Rénier will act as honorary president.

AMONG the additional lectures announced at the Society of Arts are:—"The Experiments with Lighthouse Illuminants at the South Foreland," by E. Price Edwards; "Magnetism of Ships and the Mariner's Compass," by Mr. W. Bottomley, jun.; "Photography and the Spectroscope in their Application to Chemical Analysis," by Prof. W. N. Hartley; "The Scientific Development of the Coal-Tar Industry," by Prof. R. Meldola.

REPORTS reached London on Tuesday that a severe shock of earthquake was felt on Monday morning at 10.20, all along the route between Dartmouth and Kingsbridge, Devonshire, as well as at other places lying more inland. Just after leaving Dartmouth the driver of an omnibus which runs daily to and from Kingsbridge experienced an oscillation of the ground, which lasted some seconds. On arriving at Stoke Fleming a number of persons stated that they felt the shock. A house at Stokepenny is stated to have "rocked." In the "Green Dragon" public-house the shock caused a quantity of plaster to fall down from the ceilings. At Street the oscillation was similarly felt. At Blackawton the shock is reported to have been very conspicuously felt. It appears, however, to have been most severe at Torcross. The occupants of the "Fisherman's Arms" public-house, which stands on the beach, were so frightened that they rushed out of the place, thinking, as they said, that the building was going to fall. Mr. T. R. Vickary, of the Torcross Hotel, gives several particulars of the severity of the shock. It appears to have been felt by almost every one in the village. At Stoneham, Chillington, and Frogmore the oscillation was also experienced.

A SLIGHT shock of earthquake, lasting seven seconds, was felt in Venice at 11 o'clock on the night of the 29th ult. No damage was done.

THE volcano of Colima, on the Pacific coast of Mexico, exhibited a violent eruption on the 27th ult., which caused great alarm. The streams of lava completely covered the sides of the mountain. At the date of the last report flames were still darting from the crater, and clouds of smoke overhung the summit.

MR. BLANFORD'S theory of the winter rains of Northern India, based on a study of the meteorological registers, is as follows:—We have, he says, in the first instance, steady evaporation over an extensive moderately humid tract, at a comparatively low temperature, it is true, but in an atmosphere the stillness of which allows of the steady diffusion of the vapour to high levels, and the consequent formation of cloud. The slight disturbance of the baric equilibrium which follows (since the vertical decrease of temperature in a cloud-laden atmosphere is slower than in a clear atmosphere) is succeeded by a gentle indraught of warmer and more humid air from the south; for the Himalaya bars access to northerly winds. A vortex is then rapidly formed, accompanied with an increased cloud-formation, and speedily followed by precipitation, which takes the form of snow on the hills, and of rain over the river plains. The rainfall is invariably followed by a cool wind, and a wave of high barometric pressure from the west, which Mr. Blanford attributes to a drainage of cool heavy air from the valleys of the hills surrounding the Punjaub and the high lands of Beloochistan and Afghanistan—air cooled by precipitation on the mountains. If this theory be correct, the stillness of the atmosphere, combined with the presence of a moderate evaporation, must be accepted as the condition which primarily determines the formation of barometric minima and the winter rains of Northern India. As this stillness is due to the presence of lofty mountain-ranges in the north, it follows that, if the Himalayan chain were absent, these rains would probably cease, for any local evaporation in the Punjaub and the valley of the Ganges would be swept away by strong dry north-east winds blowing from the seat of high pressure, which in the winter months lies in Central Asia.

THE electric lighting of the French Opera House is almost complete. The number of incandescent lights is 3000.

M. JOUBERT, the director of the Trocadéro popular Observatory, has made arrangements with the several telegraphic stations in Paris, so that the public may be warned when the sky is deemed sufficiently clear for conducting observations and demonstrations.

MESSRS. SWAN SONNENSCHEIN AND CO. announce for early publication a Pocket Handbook to the Flora of the Alps, specially adapted for botanical tourists, and edited by Mr. A. W. Bennett.

ACCORDING to the Report for the past year of the Superintendent of the Royal Botanic Garden at Calcutta, further attempts to introduce into Bengal the kind of plantain (*Musa textilis*) from which Manilla hemp is derived have proved failures, owing to the low temperature of the cold weather; but the plant (*Sanseviera Zeylanica*) from which bow-string hemp is obtained grows very well. The Japan paper-mulberry, which has lately been introduced, has also been a success. Efforts are being made to introduce other plants of economic value, the principal being the coca plant, from which the important alkaloid cocaine is derived. The additions to the herbarium during the year appear to have been unusually large and comprehensive. As an example of the public utility of the Garden, it may be mentioned that 23,433 living plants were distributed to public institutions in India, while those sent abroad were proportionally numerous. In the same way 2,979 packets of seeds were sent out. The Report of the Lloyd Botanic Garden in Darjeeling is also included in the paper, which concludes with the usual statistical returns. We are glad to notice at the end a copy of a resolution conveying the thanks of the Lieutenant-Governor of Bengal to those concerned in administering the Gardens.

WE have received the numbers of the *Journal* of the Asiatic Society of Bengal (Science Section) for 1885, so far as they have been published. They contain in all eleven papers, some being continuations of papers previously published. Mr. Lionel de Nicéville contributes a fourth list of butterflies taken at Sikkim in October 1884, with notes. The number of species already recorded was 284, which is now raised to 313, or about twice the number of species found throughout the year in Calcutta; but even this number does not exhaust the region, for some valleys and the higher elevations were not explored. The same writer describes some new Indian *Rhopalocera*, and also a list of the butterflies of Calcutta and its neighbourhood, with notes on their habits, food-plants, &c. Mr. Atkinson publishes the second and third instalment of his notes on Indian

Rhynchota. Dr. Giles, the Surgeon-Naturalist to the Indian Marine Survey, writes on the structure and habits of *Cyrtophium calamicola*, a new tubicolous amphipod from the Bay of Bengal, a description of a new species of the amphipod genus *Melita* from the same place, and notes on Prothallus of *Padina pavonia*. These three form part of the Natural History Notes of the Indian Marine Survey steamer *Investigator*. Commander Alfred Carpenter, of the same steamer, under the title "The Swatch of no Ground," explains the presence in the deltaic banks ("the-Swatch") off the mouths of the Ganges and the Brahmaputra of channels of great depth. Mr. Hill, the Meteorological Reporter to the North-Western Provinces and Oudh, contributes observations on the solar thermometer at Lucknow, while last of all comes a paper from Japan. Dr. O. F. von Möllendorff (not to be confounded with his brother of recent Corean fame) writes on Japanese land- and freshwater-mollusks, a series of notes based chiefly on a collection made by Dr. John Anderson during the year 1884, and sent to the writer for classification.

We are glad to learn that Prof. Morse, Director of the Peabody Academy of Science, has in the press a work entitled "Japanese Homes and their Surroundings." Prof. Morse, it may be remembered, was Professor of Zoology in the University Tokio, and his prehistoric discoveries in Japan formed one of the earliest of the publications of that institution. The publishers of the work, which will contain numerous illustrations by the author, are Messrs. Ticknor and Co. of Boston.

At a meeting of the Seismological Society of Tokio held on November 18, 1885, in the University there, Prof. Shida described an instrument which he had designed to give an automatic record of earth-currents. The chief feature in it is an ingenious method of obtaining a record of the position of the coil or needle which indicated the current which might be passing through the instrument. This was accomplished by the needle, as it turned, making a series of almost frictionless electrical contacts between a series of metallic points and a film of liquid. The instrument has been practically worked, and is said to have yielded satisfactory records. A second paper by the same writer gave a history of all the facts with which we are acquainted respecting the phenomena of earth-currents. A considerable portion of the material embodied in the paper was derived from Prof. Shida's own observations on the lines and cables of this country. He made numerous references to instances where earth-currents of unusual magnitude had accompanied or preceded earthquakes. Many theories have been advanced to account for these phenomena, and it has been demonstrated by several investigations that they have a connection with the occurrence of sunspots. In the discussion which followed, Prof. Knott referred to the possibility of these disturbances being due to the inductive action of electrified bodies of air, while Prof. Milne added to the instances adduced by Prof. Shida of the simultaneous occurrence of earthquakes and earth-currents. Earthquakes occurring in America have, by the currents which had accompanied them, recorded themselves in Europe.

The Japanese do not appear to have lost any of their faith in the efficacy of vaccination for the small-pox. They have just enacted a very stringent law on the subject, for, besides ordinary vaccination in the first year of infancy, it provides for at least two subsequent re-vaccinations at intervals of from five to seven years, so that by the time a child has reached its fifteenth year it will have been vaccinated three times. Besides, during epidemics of small-pox, local authorities have power, when they deem it necessary, to order the vaccination of all the inhabitants of their districts, irrespective of the vaccinations required by the law.

We are informed that it is not the case that Dr. Sklarek has arranged to edit a new scientific journal to be published in Brunswick.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. T. W. Hall; a Sooty Mangabey (*Cercocebus fuliginosus* ♀) from West Africa, presented by Mr. T. Riseby Griffith; a Common Badger (*Meles taxus*), British, presented by Mr. Charles E. Russell; a Siamese Blue Pie (*Urocissa magnirostris*) from Siam, a Chinese Jay Thrush (*Garrulax chinensis*) from China, a Brazilian Hangnest (*Icterus jamaicai*) from Brazil, presented by Mr. Charles Clifton, F.Z.S.; an Alexandrine Parrakeet (*Palæornis alexandri*) from India, presented by Mr. C. Kerry Nicholls, F.Z.S.; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Miss Shackthwaite; a Larger Hill-Mynah (*Gracula intermedia*) from India, presented by Miss G. Lampard; a Greater Spotted Woodpecker (*Dendrocopus major*), British, presented by Mr. A. S. Hutchinson; a Scops Owl (*Scops giu*), British, presented by Mr. J. H. Leech, F.Z.S.; a Caracal (*Felis caracal*), a Puff Adder (*Vipera arietans*), three Horned Vipers (*Vipera cornuta*), an African Cobra (*Naia haje*), a Hyghian Snake (*Elaps hygiæ*), a Smooth-bellied Snake (*Homolosoma lutrix*), two Rhomb-marked Snakes (*Psammophylax rhombeatus*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; twelve Quails (*Coturnix communis*) from South Africa, presented by Capt. M. P. Webster; a Leopard (*Felis pardus*) from India, five Mauge's Dasyures (*Dasyurus maugei*), a White-backed Piping Crow (*Gymnorhina leuconota*) from Australia, deposited; a Virginian Opossum (*Didelphys virginiana*) from North America, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

Discovery of a New Nebula by Photography.—MM. Paul and Prosper Henry have recently announced the discovery by means of photography of a new nebula in the Pleiades. It was first photographed on November 16 last, and, though it was again photographed on December 8 and 9, MM. Henry have as yet been unable to detect it by direct telescopic observation. The nebula is about 3′ in extent, and "très-intense." It presents a well-marked spiral form, and seems just to escape Maia. Its position is as follows:—R.A. 3h. 38m. 57s., Decl. 24° 1′ N.

Gore's Nova Orionis.—M. C. Wolf, who has examined the spectrum of this star, finds that the impression of the presence of bright lines which a first glance produces is not confirmed when the spectrum is more carefully examined under a high dispersion. The spectrum is simply that of the well-known third type, viz. a continuous spectrum crossed by a succession of bands, which terminate towards the violet in a very dark and sharp edge, and which gradually shade away towards the red. M. Wolf further believes that he was able, in the moments of best definition, to resolve the dark bands into lines. The Nova therefore does not appear to resemble the so-called "temporary" stars, but to be simply a variable of the same class as Mira Ceti. Prof. Millosevich gives its exact position for 1885·0 as follows:—R.A. 5h. 48m. 59·59s., Decl. 20° 9′ 13″·2 N.; or 1m. 25·21s. *f* and 5′ 59″·14 *s* of χ Cygni. It is almost precisely due north of α Orionis, and distant from it 12° 46′ 20″.

The Astronomical Prizes of the Paris Academy of Sciences.—The Lalande Prize of the Académie des Sciences has been decreed to M. Thollon for his great map of the solar spectrum. This map, which has so far demanded four years of uninterrupted work, extends from *A* to *b*, and contains 3200 lines, 900 of which M. Thollon has been able to identify as of telluric origin. The Damoiseau Prize is reserved, no memoir having been offered for it. The subject proposed is the same as in former years: a revision of the theory of the satellites of Jupiter; a discussion of observations with special reference to the direct determination of the velocity of light; and lastly, the

construction of particular tables for each satellite. The Valz Prize has been awarded to Dr. Spörer for his researches on sun-spots,—his discovery of the striking relationship between the distribution of the spots in latitude and the epochs of their maxima and minima receiving especial notice.

FABRY'S COMET.—The following ephemeris from elements he has recently computed is given by Dr. S. Oppenheim in the *Astr. Nach.*, No. 2702 :—

Ephemeris for Berlin Midnight

1886	App. R.A. h. m. s.	App. Decl. ° ′ ″	Log. Δ	Log. r	Bright-ness.
Jan. 9 ...	23 36 33 ...	21 12 51 ...	0·2478 ...	0·2523 ...	1·40
11 ...	35 0 ...	20 38			
13 ...	33 35 ...	29 19 ...	0·2514 ...	0·2382 ...	1·47
15 ...	32 16 ...	38 54			
17 ..	31 4 ...	49 23 ...	0·2543 ...	0·2236 ...	1·55

BARNARD'S COMET.—Dr. J. von Hepperger has computed the following parabolic and elliptic elements for this comet :—

	Parabola		Ellipse
T	1886 May 6·2586	...	1886 May 4·5165
ω	118 57 9·9	...	121 41 24·9
Ω	67 42 52·2	...	68 37 19·7
i	87 24 30·0	...	82 51 6·2
log q	9·695574	...	9·665966
log a		...	1·336444
log e		...	9·990625

Error of the middle place (o − C).

$d\lambda = - 2''4$ $d\lambda = + 4''8$
$d\beta = - 3''9$ $d\beta = + 1''9$

The following ephemeris is by Dr. A. Krueger :—

Ephemeris for Berlin Midnight

1886	App. R.A. h. m. s.	App. Decl. ° ′	Log Δ	Log r
Jan. 9 ...	2 53 7 ...	+ 9 41·1 ...	0·3497 ...	0·2112
11 ...	49 7 ...	10 2·7		
13 ...	45 16 ...	10 24·8 ...	0·3383 ..	0·2131
15 ...	41 34 ...	10 47·3		
17 ...	38 2 ...	11 10·2 ...	0·3265 ...	0·2155

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 10-16

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 10

Sun rises, 8h. 5m. ; souths, 12h. 7m. 51·1s. ; sets, 16h. 11m. ; decl. on meridian, 21° 55′ S. : Sidereal Time at Sunset, 23h. 31m.

Moon (at First Quarter on Jan. 13) rises, 10h. 17m. ; souths, 15h. 56m. ; sets, 21h. 45m. ; decl. on meridian, 4° 41′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	6 25 ...	10 27 ..	14 29 ...	22 0 S.
Venus ...	9 41 ...	14 55 ...	20 9 ...	9 43 S.
Mars ...	21 53* ...	4 24 ...	10 55 ...	5 21 N.
Jupiter ...	23 7* ...	5 5 ...	11 3 ...	1 5 S.
Saturn ...	14 44 ...	22 54 ...	7 4* ...	22 35 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon

an.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
14 ...	B.A.C. 830	... 6	... 19 9	.. 20 11	... 75 343
16 ..	θ^1 Tauri ...	... 4½	... 15 56	... 16 58	... 66 244
16 ...	θ^2 Tauri ...	... 4½	... 15 58	... 16 56	... 45 264
16 ...	75 Tauri ...	... 6	... 16 33	near approach	155 —
16 ...	B.A.C. 1391	... 5	... 16 58	... 17 57	... 93 224
16 ...	80 Tauri ...	... 6	... 17 5	near approach	337 —
16 ...	81 Tauri ...	... 5¼	... 17 20	near approach	338 —
16 ...	85 Tauri ...	... 6	... 17 55	near approach	340 —
16 ...	Aldebaran	... 1	... 19 48	... 20 49	... 122 248

Phenomena of Jupiter's Satellites

Jan.	h.	m.		Jan.	h.	m.	
11 ...	4	4	II. ecl. disap.	14 ...	23	53	I. ecl. disap.
13 ...	1	29	II. tr. ing.	15 ...	3	16	I. occ. reap.
13 ...	4	15	II. tr. egr.	16 ...	0	25	I. tr. egr.
13 ...	5	24	I. ecl. disap.	16 ...	4	59	III. tr. ing.
14 ...	3	42	I. tr. ing.	16 ...	7	45	III. tr. egr.
14 ...	5	57	I. tr. egr.				

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich. Attention may be drawn to the Occultation occurring on the evening of January 16, and especially to that of Aldebaran.

Jan.	h	
10 ...	12 ...	Saturn in conjunction with μ Geminorum and less than 1′ north of that star.
13 ...	— ...	Venus at her point of greatest evening brilliancy.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2 ...	81 16 N. ...	Jan. 13,	0 24	*m*
Algol	3 0·8 ...	40 31 N. ...	,, 14,	2 22	*m*
			,, 16,	23 11	*m*
T Monocerotis ...	6 19·1 ...	7 9 N. ...	,, 15,	17 0	*m*
ζ Geminorum ...	6 57·4 ...	20 44 N. ...	,, 13,	2 30	*M*
U Monocerotis ...	7 25·4 ...	9 32 S. ...	,, 10,		*m*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 12,	17 47	*m*
			,, 15,	1 38	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 13,	1	
U Ophiuchi	17 10·8 ...	1 20 N. ...	,, 11,	1	
			,, 11,	21	
			and at intervals of	20	8
R Lyræ	18 51·9 ...	43 48 N. ...	Jan. 10,		*M*
η Aquilæ	19 46·7 ...	0 43 N. ...	,, 12,	5 0	*M*
δ Cephei	22 24·9 ...	57 30 N. ...	,, 12,	2 30	*m*
			,, 13,	17 0	*M*

M signifies maximum ; *m* minimum.

Meteor Showers

The cloudy weather generally prevailing at this season of the year greatly interferes with meteor-observation, but a number of fairly active radiants have been observed, the following amongst others :—From the constellation of the Lynx, R.A. 104°, Decl. 53° N. ; from Coma Beren, R.A. 181°, Decl. 35° N. ; from near χ Cygni, R.A. 295°, Decl. 53° N. Large meteors should be looked for on January 15, 16, and 17.

STANDARDS OF WHITE LIGHT[1]

THE experimental work of the Committee during the past year has not been extensive, as they had no funds at their disposal for experimental research, and they have been chiefly occupied with reviewing what has been done in the past and laying plans for future operations.

Lord Rayleigh has constructed an instrument which he calls a monochromatic telescope, by means of which the illuminated screens of a photometer may be examined, allowing light only of one definite colour to pass. It was hoped by Lord Rayleigh that experiment might show that, with some suitably-chosen colour, this instrument, used with any ordinary photometer, would, in comparing lights of different intensities and temperatures, give to each a candle-power which would be sufficiently accurate to represent for commercial purposes the intensity of the light. The Secretary has made some experiments at the Society of Arts, where he was kindly permitted to use the secondary batteries and glow-lamps ; but the results so far are not definite enough to justify their publication.

Mr. Vernon Harcourt has been engaged on an investigation on the barometrical correction to his pentane standard, and on another concerning the possibility of using lamp-shades as a protection from air-currents. His researches are communicated independently to the meeting.

Capt. Abney and Col. Festing have continued their observations on the intensity of radiations of different wave-lengths from incandescent carbon and platinum filaments at different

[1] Report of the Committee, consisting of Prof. G. Forbes, Capt. Abney, Dr. J. Hopkinson, Prof. W. G. Adams, Prof. G. C. Foster, Lord Rayleigh, Mr. Preece, Prof. Schuster, Prof. Dewar, Mr. A. Vernon Harcourt, and Prof. Ayrton, appointed for the purpose of reporting on Standards of White Light. Drawn up by Prof. G. Forbes (Secretary).

temperatures, which will go far to assist the Committee in their work.

Other isolated experiments have been made by members of the Committee, which will be published in due course.

Most of the members have examined the experiments of the Trinity Board at the South Foreland.

Existing Standards.—A consideration of existing standards convinces the Committee that the standard candle, as defined by Act of Parliament, is not in any sense of the word a standard. The French "bec Carcel" is also liable to variations; and with regard to the molten platinum standard of Violle, it seems that the difficulty of applying it is so great as to render its general adoption almost impossible.

With regard to the so-called standard candle, the spermaceti employed is not a definite chemical substance, and is mixed with other materials, and the constitution of the wick is not sufficiently well defined. Hence it is notorious that interested parties may prepare candles conforming to the definitions of the Act which shall favour either the producer or consumer to a serious extent. In view of these defects of the standard candle, it is a matter of great importance that a standard of light should be chosen which is more certain in its indications.

The Committee have looked into the merits of different proposed standards, and the majority feel satisfied that, for all the present commercial requirements, the pentane standard of Mr. Vernon Harcourt—since it has no wick and consumes a material of definite chemical composition—when properly defined, is an accurate and convenient standard, and gives more accurately than the so-called standard candle an illumination equal to that which was intended when the Act was framed.

Yet the Committee, while desiring to impress the Board of Trade and the public with these views, do not feel inclined at present to recommend the adoption of any standard for universal adoption until, further information on radiation having been obtained from experiment, they may learn whether or not it may be possible to propose an absolute standard, founded, like electrical and other standards, on fundamental units of measurement—a standard which, for these reasons, would be acceptable to all civilised nations. They are, however, inclined to look upon the pentane lamp as an accurate means of obtaining an illumination to replace the so-called standard candle.

Proposed Experimental Researches.—Radiation is measured as a rate of doing work, and consequently radiation might be measured in watts. The illumination (or luminous effect of radiation) depends partly upon the eye, and is a certain function of the total radiation. This function depends upon the wave-length of the radiation, or on the different wave-lengths of which the radiation, if it be compound, is composed. This function of the radiation perceived by the eye is partly subjective, and varies with radiations of different wave-lengths and with different eyes. Thus the illumination cannot, like the radiation, be expressed directly in absolute measurement. But the connection between the illumination and the radiation can be determined from a large number of experiments with a large number of eyes, so as to get the value of the function for the normal human eye. This function, however, is constant only for one source of light, or, it may be, for sources of light of the same temperature. It appears, then, that, in the first instance at least, a standard should be defined as being made of a definite material at a special temperature.

The energy required to produce a certain radiation in the case of a thin filament of carbon or platinum-iridium heated by the passage of an electric current can be easily measured by the ordinary electric methods, and the radiation may be measured by a thermopile or a bolometer, which itself can be standardised by measuring the radiation from a definite surface at 100° C., compared with the same at 0° C. The electric method measures the absorption of energy; the thermopile measures the total radiation. These two are identical if no energy is wasted in convection within the glass bulb of the lamp, by reflection and absorption of the glass, and by conduction from the terminals of the filament. Capt. Abney and Col. Festing have come to the conclusion that there is no sensible loss from these causes. The Committee propose to investigate this further. This constitutes a first research.

No research is necessary to prove that with a constant temperature of a given filament the luminosity is proportional to the radiation, because each of these depends only upon the amount of surface of the radiating filament. It will be necessary, however, to examine whether with different filaments it be possible to maintain them at such temperatures as shall make the illumination of each proportional to the radiation. This will be the case if spectrum curves, giving the intensity of radiation in terms of the wave-length when made out for the different sources of light, are of the same form. Thus a second research must be undertaken to discover whether the infinite number of spectrum radiation curves, which can be obtained from a carbon filament by varying the current, are identical in form when the filament is changed, but the material remains so far as possible of constant composition.

It will be an object for a later research to determine whether, when the radiation spectrum curve of any source of light has been mapped, a similar curve can be found among the infinite number of curves which can be obtained from a single filament.

The next step proposed is to examine a large number of carbon or of platinum-iridium filaments, and to find whether the radiation spectrum curve of different specimens of the same material is identical when the resistance is changed in all to x times the resistance at 0° C. If this law be true, a measurement of the resistance of the filament would be a convenient statement of the nature of the radiation curve. If, then, a number of filaments were thus tested to give the same radiation spectrum curve, their luminosities would in all cases be proportional to their radiations, or (if there be no loss in convection, conduction, absorption, and reflection) proportional to the electrical energies consumed.

Thus it might be hoped to establish a standard of white light, and to define it somewhat in the following manner:—*A unit of light is obtained from a straight carbon filament, in the direction at right angles to the middle of the filament, when the resistance of the filament is one-half of its resistance at 0° C., and when it consumes 10^9 C.G.S. units of electrical energy per second.*

Since Mr. Swan has taught us how to make carbon filaments of constant section by passing the material of which they are composed through a die, it is conceivable that another absolute standard should be possible—viz., a carbon filament of circular section, with a surface, say, 1-10th sq. cm., and consuming, say, 10^9 C.G.S. units of energy per second.

Whether such standards are possible or not depends upon the experiments of the Committee. The probability of success is sufficient to render these experiments desirable.

Proposed Later Experimental Researches.—Should these hopes be realised, and an absolute standard of white light thus obtained of a character which would commend it to the civilised world, it would then become an object of the Committee to find the ratio of luminosity when the radiation spectrum curve of the standard filament is varied by varying the current, and consequently the resistance of the filament.

Thus, by a large number of subjective experiments on human eyes, a multiplier would be found to express the illumination from the standard lamp, with each degree of resistance of the filament.

A research, previously hinted at, would then be undertaken—viz., to find whether the radiation spectrum curves of all sources of illumination agree with one or other of the curves of the standard filament. It is not improbable that this should be the case except for the high temperature of the electric arc.

Should this be found to be true, then photometry would be very accurate, and the process would be as follows:—*Adjust the standard filament until its radiation spectrum curve is similar to that of the light to be compared.* (This would probably be best done by observing the wave-length of the maximum radiation, or by observing equal altitudes on either side of the maximum, the instruments used being a spectroscope and a line thermopile or a bolometer.) The total radiation of each is then measured at equal distances by the thermopile. The resistance of the filament is measured, and its intensity in terms of the unit of white light obtained therefrom by the previous research. The luminosity of the compared source of light is then obtained directly.

The Committee desire to be reappointed, and to enable them to carry out the researches indicated they ask for a grant of 30*l*.

PHYSICS AT JOHNS HOPKINS[1]

THE large and well appointed laboratories recently erected by the Trustees of the Johns Hopkins University for the Chemical and Biological Departments have by contrast made

[1] From *Science* of December 18, 1885.

the more evident the needs of the Physical Department, which has been obliged to occupy temporarily parts of four different buildings. The Trustees, recognising this need, are now erecting a building for a physical laboratory. The new laboratory is to be a handsome building of red brick, trimmed with brown sandstone, and will occupy a fine site about a block from the other University buildings, on the corner of a quiet little street midway between the more important streets, which carry the bulk of the traffic of that region. It will therefore be as free from disturbance from the earth-vibrations as could be expected in a city.

The building will be 115 feet long by 70 feet broad, and will have four stories besides the basement. In the centre of the building, and below the basement, are several vaults for instruments requiring to be used at constant temperature, also a fireproof vault for storage. In these vaults will be placed Prof. Rowland's dividing-engine, by which the diffraction-gratings are ruled, and the Rogers-Bond comparator, which has recently become the property of the University. In the basement will be rooms for the mechanical workshop, for furnaces, and for piers for instruments requiring great stability. The first floor will include the main lecture-room, which will accommodate 150 persons, and rooms for investigations by advanced students in heat and electricity. The second floor will contain mathematical lecture-rooms, studies for instructors, and a room for the mathematical and physical library of the University.

The elementary laboratory will be on the third floor, which will also have rooms for more advanced work. The fourth floor will contain rooms for special work in light.

There will be a tower on the south-east corner of the building, which will have two rooms above the fourth floor. The upper of these will be provided with telescope and dome, and will be a convenient observatory when great steadiness in the instruments is not required. There will be power in the building for driving the machinery in the workshop and for running the dynamo-machines. A large section of the building is to be made entirely free from iron. The sash-weights will be of lead, and the gas-pipes of brass. Brackets will be attached to the walls, on which galvanometers and cathetometers may be placed. In order to avoid the inconvenience of having piers go up through the lower rooms, and yet to secure steadiness, beams have been introduced into the floors, which reach from one wall to the other between the regular floor-beams, and do not touch the floor at any point. If, now, a table is made to rest on two of these beams, by making holes in the floor over them to admit the legs of the table, it is entirely undisturbed by any one walking over the floor, except by such motion as is transmitted to the walls. There will also be a small vertical shaft in the wall of the tower, running from top to bottom, in which a mercurial manometer may be set up.

The vaults for constant temperature have been built with double walls, so that a current of air may be drawn between them whenever desirable to prevent dampness. It is expected that the laboratory will be ready by October next.

The photographic map of the spectrum upon which Prof. Rowland has expended so much hard work during the past three years, is nearly ready for publication. The map is issued in a series of seven plates, covering the region from wave-length 3100 to 5790. Each plate is 3 feet long and 1 foot wide, and contains two strips of the spectrum, except Plate No. 2, which contains three. Most of the plates are on a scale three times that of Angstrom's map, and in definition are more than equal to any map yet published, at least to wave-length 5325. The 1474 line is widely double, as also are b_3 and b_4, while E may be recognised as double by the expert. In the region of the H line these photographs show even more than Lockyer's map of that region. Negatives have also been prepared down to and including the B group, and they may be made ready for publication, one of which shows eleven lines between the D lines. A scale of wave-lengths is printed on each plate, and in no case does the error due to displacement of the scale amount to one part in 50,000. The wave lengths of over 200 lines have been determined to within one part in 500,000, and these serve as reference lines to correct any small error in the adjustment of the scale. The great value of such a map lies not only in the fact that it gives greater detail and is more exact than any other map in existence, but that it actually represents the real appearance of the spectrum in giving the relative intensities and shading of groups of lines, so that they are readily recognisable. The photographs were taken with a concave grating 6 inches in diameter, and having a radius of curvature of 21½ feet, and the photographs were taken when the plate was placed directly opposite the grating; both the sensitive plate and grating being perpendicular to a line joining their centres, and placed at a distance apart equal to the radius of curvature of the grating, the slit being on the circumference of the circle, whose diameter is the distance between the grating and plate. With this arrangement, the spectrum is photographed normal for wave-lengths without the intervention of any telescopes or lens systems; and a suitable scale of equal parts applied to such a photograph at once gives relative wave-lengths.

Few persons have any idea of the perseverance and patience required to bring such a task to a successful issue. More than a year was devoted to preliminary experiments designed to discover the best mode of preparing the plates for the particular regions to be photographed. Hundreds of preparations were tested to find their influence on the sensitised plate, and the whole literature of photography was ransacked, and every method tested to the utmost, before the work of taking the negatives could begin.

The Rogers-Bond comparator, which has been already referred to as having been purchased by the University lately, is one of two instruments that were constructed in 1881 by Pratt and Whitney of Hartford, Conn. The general plan and requirements were made out by Prof. W. A. Rogers of Cambridge, and the drawings and details were worked out by Mr. George M. Bond, then a student at Stevens Institute. The comparator was designed for making exact comparisons of standards of length. The other similar comparator is owned by the Pratt and Whitney Manufacturing Company, and is used by them in testing and constructing their standard gauges.

The instrument consists essentially of two microscope carriages, which slide on two parallel cylindrical steel ways between stops, which may be clamped at any point. A carriage entirely independent of the ways on which the microscopes slide supports the two bars to be compared, and is provided with means of accurate and rapid adjustment, by which the bars may be successively brought into position under the microscopes, and the lengths compared by the micrometers attached to the microscopes; or one microscope only need be used, and slid first against the stop at one end, and then against that at the other end. The instrument also affords great facility in determining fractions of a given length with any desired degree of precision. The instrument is one requiring the utmost skill in its construction, and it cost several thousand dollars to make it. A full account of this remarkable instrument is given in the *Proceedings* of the American Academy of Arts and Sciences for 1882–83. K.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Chancellor of St. Andrew's University (His Grace the Duke of Argyll) has given his sanction to a recent enactment of the University Court empowering the Senatus to admit to the Science Degrees of the University, students who may have received their education at University College, Dundee.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 17, 1885.—"A Preliminary Account of a Research into the Nature of the Venom of the Indian Cobra (*Naja tripudians*)." By R. Norris Wolfenden, M.D., Cantab. (from the Physiological Laboratory, University Coll., London). Communicated by E. A. Schäfer, F.R.S.

In this account the author refers only to cobra venom, the venom of *Naja tripudians*. The dried venom dissolved in water and filtered from accidental particles yields a solution, clear, and usually slightly acid. This solution contains a large amount of proteid. Boiling produces a copious coagulum, and after removal of all coagulum by frequent filtration there is still much proteid in the solution. A fresh solution of the venom is at once precipitated by neutral salts such as $MgSo_4$, NaCl, &c., and also by absolute alcohol.

The previous valuable labours of Sir Joseph Fayrer (*Proc. Roy. Soc.*, 1873, 1874, 1875, 1878), and Dr. Lauder Brunton and others, have dealt chiefly with the physiological side of the question, but have left the chemical nature of these snake venoms still undetermined.

Weir Mitchell and Reichert (*Med. News*, April 28, 1883; *Lancet*, July 21, 1883), working with the venoms of American snakes, have indicated in these venoms certain poisonous proteids, the nature of which, however, is not fully elucidated. Wall's ("Indian Snake Poisons," Allen and Co., 1883) experiments and conclusions lead to the same view. Blyth (*The Analyst*, vol. i.) attributed the venom to an acid ("cobric acid") of deadly power. Gautier asserted that he had separated ptomaines from Trigonocephalus and Naja venom. The author undertook this research with the object of determining whether the active venomous properties reside in the proteid constituents or some other non-proteid body or bodies. His work falls under the following heads:—

(1) The possibility of cobra-poisoning being due to "germs" or living organisms in the secretion.
(2) Its possible dependence upon an alkaloidal body.
(3) Its dependence upon some acid (cobric acid).
(4) Its dependence upon the proteids contained in it.
(5) The mode of action of these proteids.

With regard to the first proposition, the author finds nothing in cobra poison which will grow under cultivation methods favourable for such organisms. The symptoms of the poisoning are entirely unlike bacillary infection, and resemble more the effect of some rapidly-acting chemical poison. With regard to the presence of "alkaloids" in cobra venom, the author made three examinations of the dried venom by the Stass Otto method, but failed to find any trace of an alkaloid. He thus confirms the results of Prof. Wolcott Gibbs, who examined cobra poison for Dr. Weir Mitchell, in search of "ptomaines," but stated that he could find no trace of such bodies. In reference to the "cobric acid" said to have been obtained by Blyth from cobra venom, the author remarks that as it is said to be crystalline, it will presumably readily dialyse. Searching the dialysates for such a body, the author has failed to meet with it. Dialysates that retain any toxic power do so by virtue of the proteid which they contain, since cobra venom, or the dialysate of cobra venom, loses its poisonous properties with the removal of its proteids.

The fourth proposition—viz. that the toxic power of the venom is resident in the proteids, is the author's chief point, and on this subject he remarks as follows:—

The coagulum obtained by boiling the venom is harmless when injected into rats. The filtrate from the coagulum is toxic, though in less degree than the original solution. The author thinks this toxic power to be due to syntonin remaining in the solution. That it is due to proteid is shown by the fact that, with the removal of this proteid by acetate of lead, it is rendered harmless.

The dialysates of cobra venom which are toxic contain proteid, but lose their poisonous properties when this proteid is removed by boiling with ferric acetate.

The variable degree of toxic power of the dialysates is dependent on the length of time the dialysis has lasted, and thus upon the amount of proteid that has passed through the dialyser.

From what has been said as to the non-existence of any poisonous acid or alkaloid in cobra venom, and also the diminution of toxicity on boiling solutions of the venom, and complete removal of poisonous properties on completely freeing the boiled venom from such proteid as has escaped coagulation by heat, and further, as to the dependence of the toxicity of the dialysates on the proteid therein, there can be no further doubt that the toxic power of the venom is entirely due to its proteids, and that it completely loses all poisonous power on the removal of these bodies.

The formerly reputed power of permanganate of potash as an antidote is explained by the action of this body upon albumens, which it converts into oxyprotosulphonic and other allied acids (according to Brücke and Maly) and it fails as an antidote within the body because it oxidises all albumens indifferently, without any selective power for the cobra proteids.

The proteids contained in cobra venom are—

(1) Globulin, which is obtained by saturation and shaking with $MgSo_4$, and which is coagulated in its solutions at 75° C. It is extremely toxic, and kills by involving the respiratory system, producing speedy asphyxia.

(2) Serum albumen, present in the filtrate from the $MgSo_4$ precipitate, and which is brought down on further saturation and shaking with Na_2So_4. It coagulates between 70° and 80° C. There is very little of it present, and it probably acts in a poisonous manner by producing a general and ascending paralysis.

(3) Syntonin, which is left in the filtrate after boiling the venom, and is also partially precipitated by $MgSo_4$, along with the globulin, and also appears in the dialysates, from which it is entirely removed by boiling with ferric acetate, or lead acetate. It possesses poisonous properties, chiefly like the globulin.

It is possible that some specimens of cobra venom contain a little peptone, though it can only be in faint traces. The bodies which Weir Mitchell and Reichert have described as peptone in Crotalus and Mocassin venoms are probably albamoses. That they are precipitated by dilute acetic acid, NaCl, and liquor potassa indicates this character. The "globulin," which they have described as dissolved by heating instead of coagulating, is also possibly a body of this nature. The complete removal of all proteids from cobra poison by boiling with ferric acetate, except in some specimens the very faintest trace (as indicated by metatungstic acid), shows that when peptone is present it is only in the smallest traces, and it is not constantly found in cobra venom.

In conclusion, the author desires to express his thanks to the Indian executive for readily acceding to the request of Mr. Vincent Richards, a member of the last Snake Commission, to supply him with the dried venom. The amounts received have, however, been small, making the research not only slow, but very difficult.

Victoria (Philosophical) Institute, January 4.—A paper by Mr. Boscawen, on the Abramic Migration, and the light thrown thereon by recently discovered Assyrian Inscriptions was read.

PARIS

Academy of Sciences, December 28, 1885.—M. Jurien de la Gravière, Vice-President, in the chair.—Obituary notice of the late M. L. R. Tulasne and his botanical work, by M. P. Duchartre.—Note on the new star in Orion recently discovered at Lord Crawford's Observatory, Dun Echt, by M. C. Wolf. From a study of its spectrum, which belongs to Class III., section *a* of Vogel, this would appear to be, not a temporary star like τ Coronæ discovered in 1866, but a true star hitherto undetected.—On the movement of the molecules of the "solitary wave," by M. de Saint-Venant.—Researches on the functions of Wrisberg's nerve—complementary note, by M. Vulpian.—Researches on the real origin of the secreting nerves of Nuck's salivary gland, and of the labial salivary glands of the Dog, by M. Vulpian.—Observations on the structure of the vascular system in the genus Davallia, and particularly in *Davallia repens*, by M. A. Trécul.—On the respiration of plants outside the living organisms, in connection with M. Regnard's recent communication, by M. Ad. Chatin.—On a new theory of algebraic forms (continued), by Prof. Sylvester.—Report on M. Mestre's claim of priority of discovery in connection with MM. Napoli and Abdank-Abakanowicz's integraph, by the Commissioners, MM. Bertrand and Jordan. To a certain extent M. Mestre's claim is allowed; he appears entitled to the credit of the general idea of the apparatus, all the details of which must, however, be accredited to M. Napoli.—Letter on the proposed appointment of a special Commission to study the subsidence of the land along the coasts of the English Channel, by the Minister of Public Instruction.—On the relative frequency of the spots on the two hemispheres of the sun, by M. Spörer. Between the years 1880-82 the spots occurred most frequently in the northern hemisphere (56 per cent.), but from 1882-85 they were most frequent in the southern, being last year in the proportion of 69 to 30 per cent.—On a unique method of determining the constants of the altazimuth, and of M. Loewy's recently-invented meridian lunette "à grand champ," by M. Gruey.—Observations of Barnard's comet made at the Observatory of Bordeaux, by MM. G. Rayet, Doublet, and Flamme.—Observations of Fabry's comet made at the Observatory of Bordeaux, by MM. G. Rayet and Flamme.—Elements of Fabry's comet, by M. Gonnessiat.—Note on the secular diminution of the obliquity of the ecliptic, by M. F. Folie.—On the potential energy of two ellipsoids mutually attracting each other, by M. O. Callandreau.—On the doubly periodical functions of the third species, by M. Appell.—Note on the effects of the rheostatic machine of quantity (two illustrations), by M. Gaston Planté.—A new application of the principle determining the transmission of power to a distance by means of electricity, by M. Manceron.—Application of the numerical laws of the chemical equilibria to the dissociation of

the hydrate of chloride, by M. H. Le Chatelier. The principles here developed are directly applicable to all the hydrates of gaseous bodies, and to a large number of other compounds, such as the alkaline bi-carbonates, with which the author is at present occupied.—Action of some deoxidising agents on vanadic acids, by M. A. Ditté. It is shown that, when subjected at a high temperature to the action of hydrogen, sulphur, arsenic, phosphorus, and some other reducing agents, vanadic acid may, according to the circumstances, lose a greater or less quantity of oxygen.—Note on the preparation and physical properties of the pentafluoride of phosphorus, by M. H. Moissan.—Note on the combinations of the trichloride of gold with the tetrachlorides of sulphur and selenium, by M. L. Lindet.—Thermic researches on glyoxylic acid ($C_2H_4O_3$), by M. de Forcrand.—On the oxidation of sebacic acid, by M. H. Carette.—On a new means of testing the purity of volatile substances, by M. E. Duclaux.—On the normal character of the morbid process developed by tuberculous inoculations, by M. G. Colin.—Remarks on the character of the glycogen observed in the ciliated Infusoria, showing that it is in every respect analogous to that developed in the liver of higher organisms, by M. E. Maupas.—A physiological study of acetiphenone, by MM. A. Mairet and Combemale.—On the dialytic properties of the membrane of the cyst in *Verticella nebulifera* and other Infusoria, by M. F. Fabre.—Note on the polychete Annelidæ found on the French coast, district of Dinard, by M. de Saint-Joseph.—On the traces left by the Quaternary glaciers in the cave of Lombrives, Ariège Valley, by M. E. Trutat.—Remarks on the first sheets of the new geological map of France, prepared to a scale of 1 : 500,000, by MM. G. Vasseur and L. Carez. This work, which is to be completed during the course of the year 1886, will comprise altogether forty-eight sheets, of which fifteen have already been issued. These include the south coast of England, the greater part of Belgium, Luxemburg, the Rhine to Bonn and Frankfort, Alsace-Lorraine, the eastern and central parts of the Paris Basin, and the neighbourhood of Bordeaux.—Chief results of the systematic researches made in Sweden since the year 1873 on the upper atmospheric currents, by M. H. Hildebrandsson.—Note on the northern limit of the south-west monsoon in the Indian Ocean, by M. Venukoff. It appears from M. Prjevalsky's recent voyage to Northern Thibet that the limit of the south-western monsoon coincides approximately with the 37th parallel of latitude, and stretches west and east from about the head-waters of the Oxus and Tarim Rivers to the meridian of Lang-chew, capital of the province of Kan-su, in West China.—A reply to M. Bourquelot's recent note on interverted sugar, by M. E. Maumené.—Note on the guano of Alcatras, by MM. A. Herbelin and A. Andouard.—Reply to M. Cartailhac's objections on the human remains and pottery recently found in the cave of Nabrigas, by MM. Martel and de Launay. The authors deny the possibility of a post-Quaternary disturbance of the cave, and consequently maintain the conclusions already formulated on the significance of these discoveries.—The death was announced of M. Tulasne, Member of the Botanical Section, who died at Hyères on December 22, 1885.

VIENNA

Imperial Academy of Sciences, October 8, 1885.—On the establishment of a homogeneous magnetic field on the tangent galvanometer for measuring stronger currents, by G. A. Schilling.—On the blood-circulation of the ganglion-cell, by A. Adamkiewicz.—Determination of the orbit of the planet Ida (243), by N. Herz.—On the energy of the yeast-cell, by G. Czeczetka.—On a new method for the determination of phosphorus in pig-iron and steel, by W. Kalmann.—On Brooks's comet of September 2, 1885, by E. Weiss.—Astronomical researches on the eclipses noted by Hebrew writers : i. the Biblical eclipses, by E. Mahler.

October 15.—Contributions to our knowledge of sulphohydantoins, by R. Andreasch.—On the disposition of karyokinetic figures in the central nervous system and in the retina of adder-embryos, by L. Merk.—Researches on strychnine, by F. Loebisch and P. Schoop.

October 22.—On some applications of the principle of apolarity, by B. Igel.—Studies on quercetin and its derivatives, ii., by J. Herzig.—On some derivatives of phloroglucin, by the same.—On rhamnin and rhamnetin, by the same—Results of an embracing computation of the elements of all central and partial eclipses of the sun—8000—which have occurred in the period −1207 November 10 (Jul.) till +2161 November 17 (Greg.), and of all total eclipses of the moon—5200—in the period from −1206 April 21 (Jul.) till +2163 April 12 (Greg.), by Th. von Oppolzer.—On prophetic eclipses, by E. Mahler.

November 5.—On the fat of cochineal, by E. Raimann.—On *Tosoraphinia texta*, Rœm. sp., and on *Scytalia pertusa*, Reuss. sp., from the environs of Raudnitz (Bohemia), by J. Fahalka.—On Crocodilida from the Miocene of Styria, by A. Hofmann.—On the application of the gravity of a rolling body as a motive power, by J. Burgaritzki.—On a new mechanical principle of the force hitherto called gravitation, by W. Boss.—A preliminary note on the zodiacal light, by T. Unterweger.—Sketch of a theory of the moon, by Th. von Oppolzer.

STOCKHOLM

Academy of Sciences, December 9.—Remarques concernant un cas special du problème des trois corps, éclaircies par une première approximation pour les mouvements de la planète Hécube (108) sous l'influence du soleil et de Jupiter, by Dr. Paul Harzer.—On Scheffierite from Långbau and Pajsberg, by Dr. G. Flink.—Observations on the meteoric showers, November 27, 1885, by Prof. H. Hildebrand.—Sur la théorie des ensembles, by Prof. G. Cantor.—Remarks on this paper, by Dr. G. Enström.—New and imperfectly-known Isopoda, by Dr. C. Bovallius.—Systematic list of the family Asellida, by the same.—The laws of the atomic weights, by Dr. Y. R. Rydberg.—On double oxalates of platinum, by Herr H. G. Söderbaum.—On rocks composed of pyroxene and amphibole in Central and East Småland : (1) classification and description of the rocks, by F. Eichstädt ; (2) Myrmecological studies, by Herr G. A.—On pyramidal stones (Dreikanter) from the Cambrian formation of Sweden, by Prof. A. G. Nathorst.

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THURSDAY, JANUARY 14, 1886

THE VEGETABLE GARDEN

The Vegetable Garden. Illustrations, Descriptions, and Culture of the Garden Vegetables of Cold and Temperate Climates. By MM. Vilmorin-Andrieux, of Paris. English Edition. Published under the direction of W. Robinson, Editor of the *Garden*. 8vo, pp. 601. (London: Murray, 1886.)

THIS is an English edition of a book which under its original title of "Les Plantes Potagères" has been received with encomiums alike by gardeners and by men of science. Professedly addressed solely to practical gardeners, it is so conscientiously elaborated that it has become, and will remain, a standard book of reference for the naturalist. This is a great triumph for the author, M. Henry Vilmorin. The botanist would at first glance naturally be disposed to consider such a book as at best merely a descriptive trade catalogue of an eminent seed firm, and the biologist might perhaps look askance at the notion of deriving any information of value for purposes of pure science from its pages. But on further examination, it will be found that the merely trade element is ignored, and that the descriptions of the several plants treated of are so carefully drawn up that they will as far as they go meet the requirements of the naturalist.

These descriptions are founded, as we have personal reasons for knowing, not only on the observation of plants growing in the author's seed grounds near Paris, but also on the inspection and comparison of the same or allied forms in the market gardens of Europe generally. The experimental garden of our own Royal Horticultural Society at Chiswick has been utilised in this way, while even the smaller market gardens in the vicinity of Continental towns have not been left unvisited.

Those who have not previously attended to the matter will possibly experience a feeling of surprise at the large number of varieties here enumerated. They are familiar, perhaps, with broccolis and cauliflowers, though they would find it hard to distinguish between them. They might pick out savoys from cabbages, but for the most part they would roughly class such things as "greens," and not pursue the subject further.

While all vegetables are grown for food, subdivisions may be created among them in accordance with special requirements. There are, for instance, the supply of the markets, the exigencies of the exhibition table, the demands of private establishments, and, we might add, the demands resulting from the eager competition of commercial men. The rule of the survival of the fittest has to be applied with special modifications to each of these cases.

Quality is not so much an object of solicitude to the market grower as early or quick growth and abundant produce. The man who can send his produce to market earlier than his fellows has a distinct advantage, and thus it is that foreign competition is so serious an affair for the English grower. Not only from the Channel Islands but from the South of France and Algeria come immense quantities of salads, vegetables, and fruits to our markets. The smaller cost of labour and the high prices obtained balance the expense of the long transit. The home-grower, on the other hand, can continue the supply after the Continental sources have become exhausted, and thus in some cases late varieties are preferred by our growers. But in any case for market purposes on a large scale—for the supply of the general public—the crops must be large, and hence it is that a market gardener will grow what he knows to be "a good cropper" rather than a plant of better quality but which is less productive.

The exhibition tables at our flower and fruit shows, although they foster a good deal of fantastic extravagance, nevertheless effect much good by allowing of the exhibition of numerous varieties, so that the grower may see which is good and which less good, or which is specially suited to his conditions and requirements. They also stimulate the zeal of the growers and powerfully promote good cultivation. This must have been remarked by many at the exhibitions held by the Royal Horticultural Society for the last two years in connection with the "Health" and with the "Inventions" Exhibitions. Such displays render great services to cottagers and others by bringing under their notice new and improved varieties often just as easy to cultivate as those of inferior quality. On the other hand, the "prize system" too often leads to the devotion of an inordinate amount of attention to mere size and external appearance. The bigger and the more symmetrical the exhibit the better the chance of a prize. The huge roots seen at the cattle shows, for instance, are in their way marvels of culture, but their feeding value is considerably less in proportion to others of more moderate size and perhaps less shapely appearance. Water, rather than starch and sugar or nitrogenous compounds, is the predominant element in these overgrown products. When such vegetables as these get prizes the judges are to blame and the societies are doing their work badly.

In private establishments the case is different. While the supply must of course be adequate, the quality of the vegetables is a matter of greater consideration than the mere quantity.

The different requirements we have alluded to entail a corresponding variation in the amount and character of the supply. In addition differences of soil, climate, and other local conditions necessitate other variations. What is suitable for one place is not so for another. When these facts are considered, the wonder that there should be so many varieties will pass off. In most instances these plants have been in cultivation for centuries. They exhibit, some more, some less, the tendency to vary which is the common attribute of all creatures. Having secured a variation suitable for his purpose, whatever it may be, the object of the grower is to fix it and perpetuate it, and only those who have visited our great seed-farms know with what jealous care and with what labour this is effected. When, as is the case with the Brassicas, the facilities for intercrossing are great, the difficulty of preserving a pure stock is intensified.

For scientific purposes, for the purpose of ascertaining the nature and possible range of variation within limited periods, and either under the same or under different conditions, a visit to an experimental garden like that at Chiswick, or to one or other of the great commercial seed-farms, is most instructive.

M

This aspect of the matter is treated of in the original preface, but we regret to see that it has been omitted from the English version. This is an injury to the book from the point of view of science, and an injustice to the reader, who would value the opinion of so careful an observer as M. Henry Vilmorin. It must suffice here to say that although he recognises the "unstable and perpetually changing characters" of plants, especially when submitted to cultivation, this variation, vast as it is, does not, in his opinion, affect either the number or the position of "legitimate species." M. Vilmorin's natural qualifications and his exceptional opportunities, of course, entitle him to be heard with very great respect, but we suspect most English botanists and cultivators would arrive at different conclusions from the same premises.

Of the value of this book to practical men it is not necessary to speak here: it is because it offers so valuable a storehouse of carefully observed facts of value to the biologist that we have alluded at such length to a volume which might at first be thought to be of interest to gardeners only, but which, we may repeat, is eminently worthy the attention of all those interested in the vast questions connected with variation and inheritance.

There are many points on which we should have liked to have commented, but the exigencies of space forbid. We have only to add that the translation has been well done by Mr. W. Miller, that some practical details have been added to adapt the book for English use, and that a very copious index is provided.

MAXWELL T. MASTERS

PROFESSOR MARSHALL ON THE FROG

The Frog; an Introduction to Anatomy and Histology. By Prof. A. Milnes Marshall, M.D., D.Sc., M.A., F.R.S., Beyer Professor of Zoology in Owens College, Manchester. Second Edition. (Manchester: J. E. Cornish, 1885.)

THE teaching of biological science never received a greater impetus than that which took its origin in the establishment, fourteen years ago, of the laboratory at South Kensington, now associated with the Normal School of Science and Royal School of Mines; and the publication, some three years later, in connection therewith, of Huxley and Martin's "Elementary Biology," marks an epoch no less definite or important. The large number of teaching laboratories which have since been founded, wherever the English tongue is spoken and even on the Continent, have almost without exception been modelled directly or indirectly upon the Kensington plan. Practical directions for working have been issued in connection with most of them, compiled along the lines of Huxley and Martin, but specially adapted to the requirements of the individual schools. Of these, most are still alone used in the dissecting rooms for which they were written; some few have, however, been published separately, the volume before us being one of their number.

The author's name is a guarantee of the thoroughness of the work, and he has done well in taking such a prototype for a guide. We read in the preface that the book is a first instalment, to be followed by a second dealing with "types of the principal zoological groups;" as the ultimate success of the project will depend upon the selection of these types, and especially upon the evenness of balance maintained in dealing with them, we reserve full criticism until the completed work is before us.

The present edition is mainly noteworthy for the introduction of illustrations—fifteen in number. The original ones are for the most part somewhat rough, though accurate in detail, and they have the merit of representing the structures as they will meet the eye of the student. Fig. 10, however, would bear recutting, for if the bones are "represented black" why not the columella-auris; and continuity should certainly be shown between the brain and very sketchy labyrinth. The maxillo-palatine commissure—described (p. 84) in its proper place—should also find a representative in Fig. 13, and in connection with the renal-portal vein of Fig. 4 afferent renal branches might be advantageously introduced. The relation of the mesentery to the kidneys in Fig. 2 also needs looking into.

The text bears the mark of a writer in full sympathy with the difficulties which beset a beginner; more importance might, however, well be given to a consideration of those matters of symmetry, locality, and general utility which must be mastered before studying anatomy proper. The customary restrictions put upon at least the terms *anterior*, *posterior*, *lateral*, should be clearly set down in addition to those given on p. 13 and elsewhere, and the positions of the organs should be described accordingly. If this were so, the description of the liver given on p. 17 would, for example, be more accurately rendered than it is.

It would facilitate the demonstration of the bile ducts in so small an animal, if the student were directed to simply squeeze the gall-bladder after having opened up the intestine, instead of risking the insertion of a destructive bristle as advised on p. 20.

A special feature has been made of the histological section of the work, but, granting its thoroughness, we would fain see some of the frog's tissues retained for those supplemented from other animals, especially in the case of bone, where so highly instructive an example as that of the long bone is to hand. In describing the nerve fibre the nodes of Schmidt have been overlooked, but here our author is not alone; considering the years that have elapsed since their discovery, it is strange that they should only recently have found mention in our English text-books. Reflecting on the doubtful nature of the so-called non-medullated nerve-fibres, it is a pity that the ultimate ramifications of a medullated fibre in so out-of-the-way a place as the cornea should be made (p. 89) to do duty for them.

The book is neatly and carefully got up, but a future edition should not be published without an index. The description of the mesentery in relation (p. 18) to the alimentary canal, and those of the attachments of the corpus adiposum and testes (p. 17) might well be much modified; and the like is true of the statement that the skeleton gives (p. 45) "precision to the movements" of the body. The heading (p. 48), "peculiar vertebræ," is bad, and olfactory *sacs* reads on p. 49 "olfactory nerves," in error. A somewhat remarkable typographical error is the "mpanic cavity" of p. 98.

In conclusion, we would take exception to the references (pp. 28 and 74) to the suppressed aortic arches of the embryo and to the mode of development of the nervous axis, unless their introduction bears upon the lecture scheme adopted at the Victoria University. If so, well and good, but if not, we are of opinion that such supplemental statements should be inserted, in a book of this kind, as footnotes or their equivalents. It is sufficient that the beginner should realise that three pairs of aortic arches exist in the adult, alone under consideration.

OUR BOOK SHELF

Methods of Research in Microscopical Anatomy and Embryology. By C. O. Whitman, M.A., Ph.D. (Boston: S. E. Cassino and Co.; London: Trübner and Co. 1885.)

WITHIN the last few years a number of new methods have been suggested for use in microscopical, and more particularly embryological, research, and a glance at almost any one of the recent memoirs on these subjects will serve to show how much is due to the employment of new methods. It is, however, extremely important not to lose sight of the fact that complicated methods are exceedingly likely to produce false or misleading appearances. To carry on successfully any microscopical research it will probably be necessary to invent new methods or at any rate modify old ones to suit the exigencies of the case. To do this an acquaintance with the methods which have been used by previous observers is necessary, and in addition a clear idea of such general principles as it is possible to formulate with regard to the action of various classes of reagents upon various tissues.

A great number of the new methods have been described, and this often in a few words only, in special memoirs, so that they are often overlooked.

"Hitherto," says the author of the work before us, "most of our standard books of reference on methods have been rather complex in character, dealing with the microscope and technical methods as a whole." With regard to the introductory to the main subject, a reluctance on the part of their inventors to reveal what they thus make a sort of trade secret, "withholding it on the ground that others are not entitled to the advantages of your experience." Dr. Whitman in his present work has sifted the numerous methods which have been suggested, and has given histologists the benefit of his great practical experience in rejecting some while recommending others; he has also endeavoured to formulate as many general principles as possible, though of course there is more to be done in this respect, our knowledge being at present insufficient to generalise to any great extent.

We notice with regret a slight tendency in the work before us as well as certain histological schools to neglect almost entirely the older and simpler methods of cutting sections. Serial section-cutting is now such an important item in all morphological work that it is apt to be used to the exclusion of older methods, which give in many cases undoubtedly better histological results.

Dr. Whitman has also collected a large number of most important observations with regard to the best method, time, and place of obtaining material; these are of course very incomplete, but it is to be hoped that he will see his way towards continuing them, and that others will follow his excellent example.

Alternating Currents of Electricity. By Thomas H. Blakesley, M.A. "*Electrician* Series." (London: Published at the Office of the *Electrician*, 1885.)

THIS is a very unsatisfactory little book; indeed it is difficult to find anything favourable to say of it, except that it is concerned with a subject which is of considerable importance, and which might be treated in an interesting and instructive manner. It is a reprint of papers, originally published in the *Electrician*, on Alternating Currents of Electricity, and professes to deal with various problems connected with them by geometrical methods. But the methods are long and intricate, and the work is not well done:—carelessly written and printed in the beginning, the style remains unchanged. The errors in form are numerous, the figures are not good, and geometry and algebra are mixed up in formulas in the most puzzling and irritating way. We find commas between the factors of products (all through pp. 11, 12, 13), and diagrams in which the letters are illegible in several places. In one investigation covering three or four pages, we have the letter *C* used for capacity of a condenser, for electric current, for the sum of a series of cosines, and for designating points in the diagrams. In fact the whole book is full of confusion, and is a model of what mathematical writing ought not to be; while we cannot imagine that it will prove useful or even intelligible to the telegraph engineers for whose benefit we may suppose it was put together.

J. T. B.

Third Annual Report of the New York Agricultural Experiment Station, for the Year 1884. (Albany, N.Y.: Weed, Parsons, and Co.)

THIS Experiment Station was established by an Act of Legislature passed in 1880, and amended in 1881. The management is intrusted to a Board of Trustees, who appoint a director, horticulturist, botanist, chemist, stenographer, farmer, and assistants. Such an organisation must be considered as a step in advance beyond anything yet done in this country, being a direct action on the part of the Government to promote the exact knowledge of agriculture. This is the main object. Among desire to bring before the readers of NATURE technical instruction the many voices raised on behalf of those engaged in industrial pursuits, or of artisans and other artists, few are to be heard in favour of more promotion of exact agricultural knowledge. The Americans are wiser, and are establishing what they call "experiment stations" in various parts of their wide territory. A few of the objects of investigation at present occupying the attention of the staff of the New York Station may be enumerated as follows:—(1) Fertiliser analysis; (2) sample orchards containing single trees of each known variety; (3) soil temperatures at various depths; (4) digestibility of various foods; (5) germination of commercial seed; (6) a study of maize; (7) root-distribution by root-washings; (8) milk; (9) diseases of plants. These sections furnish material for 418 pages, abounding in tables of results of great practical value. The pains taken in thoroughly working out the conditions of milk-production in the case of two cows, "Meg" and "Gem," are evidence of great activity and zeal. The weight of the cows was taken daily from September 17 to November 12. The weight of food consumed, the accurate analysis of the food, the *daily* weight of solid and liquid excrements, the *daily* yield of milk, the *daily* analysis of the milk,—all this carefully and punctually recorded, and fixed in tables, is a work of great importance, not only as bearing directly upon dairying, but having likewise a physiological value. Such constant daily observations are not only essential, if the experiment is to be of any practical value, but must be beyond the efforts of practical farmers, who really ought not to undertake such investigations. But the value to the community at large when such experiments are conducted quietly and regularly by persons specially set apart and paid to carry them out cannot be overrated. They must not be attempted by ordinary dairymen in ordinary stalls, and with ordinary business appliances, but can only be carried out by trained hands, in specially constructed stalls and with special arrangements, all of which must

be carried out at a *loss*, which loss is the reason for an endowment. It is hard to say whether the perusal of such a Report as now lies before us impresses most with admiration for American activity or regret for English supineness.

JOHN WRIGHTSON

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscript. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Major Greely on Ice, &c.

IN the long and interesting address of Major Greely at the special meeting of the Royal Geographical Society, held ten days ago, with the object of hearing an account of some of his proceedings during his painfully memorable Arctic expedition, the traveller dwelt so largely upon the conditions of the ice on the open Polar sea, &c., that one was led to believe that he was talking *at* opinions—spoken or written—by some one adverse to his own; possibly those given by myself in the communication published in NATURE of December 10 last may have been meant. Should this be so, anything that Major Greely has said does not in the slightest degree affect the statements made by me in the above-mentioned letter.

Major Greely tells us that Hayes, as well as *Kane* (it should be *Morton*), saw "an open Polar basin." Payer, in as high or a higher latitude at Franz Josef Land, saw, at a much earlier date in spring than Hayes and Morton did, a larger pool of open water, with "myriads" of water-fowl, but did not think This was an "open Polar basin," or part of one.

confined to our Arctic seas. That great open Polar sea is already, if not wholly, firm root for at least thirty years [illegible] where it seems to have taken a spiritualistic origin, for Dr. Kane was a [illegible] should imagine,

With the fear of appearing tedious, I shall quote [illegible] spiritualism. perfect meaning, if not the exact words, of part of a letter which a distinguished spiritualist, Major ——, sent to me prior to one of my Arctic expeditions. In this letter I was told that Franklin was still alive (clear proof had been obtained that he had been dead some years before the date of a *part* of this letter), and was residing at 132 (?), St Peter Street, in a seaport town called Joppa, having a population of more than 100,000 persons, on one of the lands near the Pole!

There was a large population, the Government Republican, and a fine, healthy, and salubrious climate. "These *people were descendants of one of the lost tribes of Israel*"!

The postscript was curious, and written at a later date than the letter itself, immediately after the death of Dr. Kane, as follows:—"Have just had communication with the spirit of Dr. Kane, whose first visit after death was paid to Franklin in Joppa, where he was still alive and well, but praying to get home."

Major Greely seems to confound two forms of ice having very different origins—namely, the floeberg, of which I have already said enough elsewhere, and the freshwater-ice, which, he says, is derived from the ice-caps of far northern lands, a mass of which he saw, having very considerable extent and "a thickness of one-sixth of a mile! with a deep valley containing a number of boulders."

This great mass of ice, 880 feet thick, with valley and rounded stones, may have been readily formed on the shores of one of the high headlands—one of which is named as having an altitude of nearly 3000 feet—along the northern portions of which Lieut. Lockwood skirted during his sledge journey on the coast of Greenland.

True, I was never in these high latitudes, but a person may sometimes be permitted to reason from analogy, as I shall attempt to do.

In 1848 I saw on the northern shore of America, in lat. 68° 40', not far from the Coppermine River, a snowdrift against a cliff about 100 feet high, and in 1849 I and my party were detained at the same place for a good many days, during which we had ample time and opportunity to examine this snowdrift, nearly all of which was converted into ice that seemed permanent, except when parts broke off and floated away.

The slope of this snowdrift tapered towards the sea with so gentle a descent that our boat was easily hauled upon it to protect it from the ice-pack, and we with great facility carried our baggage up the ascent, and pitched our tent on the top of the cliff. A part of this snow-drift ice had broken off and drifted away, showing a very distinct stratified section, similar to that described by Dr. Moss and Major Greely.

The height of this section above sea-level was only, as far as I can remember, about 10 or 12 feet, for the water is shallow on this coast,[1] but, if Major Greely's measurements are correct, the

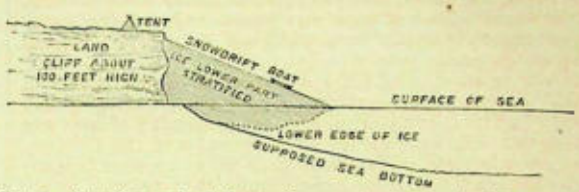


FIG. 1.—Actually seen by J. Rae in 1849, at a headland north of Coppermine River, lat. 68° 40'.

water close to the Greenland shore must be pretty deep—at least 100 fathoms—so as to float ice one-sixth of a mile thick.

My contention is that, if in latitude 69° a drift-bank of snow and ice is kept up from year to year against a cliff 100 feet high, the same thing may take place in latitude 82° to a far larger extent, where the shore is 2000 feet high, steep or precipitous, and the sea deep, so that masses of ice 800 or 900 feet thick may break off and float away.

That such great sloping snowdrifts do occur on the northern Greenland coast was proved by the difficulty met with by one of the officers of the English Expedition in travelling along them in 1876 with sledges, being forced to do so in many places by the rough ice outside, which stopped the way along the level floe.

As regards boulders, they are to be found of various sizes, more or less numerous, [illegible] everywhere on Arctic lands high above the present sea-level, and they might have been transported to the "valley" spoken of by Greely in other ways than [illegible] supposed by him. They may have been moved downwards [illegible] the alternate freezings and thaws of the snow slope of the valley to [illegible] storms and snowdrifts, then down the carried by one of those streams of [illegible] or they may have been tioned as running down over the snow-caps of [illegible] to that matfact, all that is wanted for this purpose would be two [illegible] In

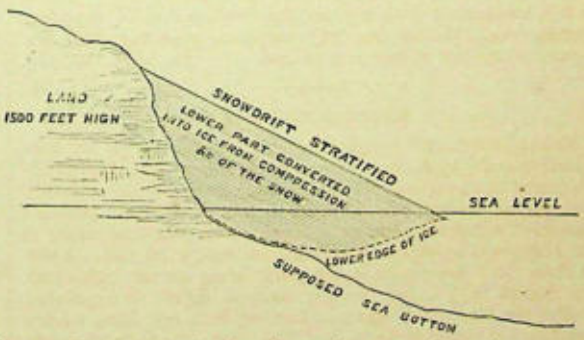


FIG. 2.—Supposed headland on the northern part of Greenland, about 1500 feet high. Greely says these headlands (or one of them) are nearly 3000 feet, having a northern or north-eastern aspect.

steep bluffs, with a deep narrow ravine between. The bluffs would give the thick masses of snow and ice-drift, and the ravine might form the bed of a stream carrying stones into the valley.

Neither Dr. Moss nor Major Greely, as far as I have noticed, have accounted for the very distinct stratification seen in the form of ice described. In all parts of Arctic America where I have been, a fall of snow is usually either accompanied or followed by a gale of wind more or less strong, chiefly from one

[1] In the very rough sketch sent, the water is made to appear much too deep; in fact, there is no pretence at correct proportion of heights and distances.—J. R.

direction, with thick snowdrift, which cuts away earth and sand in minute particles from the windward side of any hill or rising ground in its course, and these particles are carried along until they find a resting-place under the lee of some steep bank or cliff.

These foreign substances, when mixed with a great depth of snow, are not readily seen, but when the spring evaporation and thaws remove a great part of the snow, a stratum—more or less thin—of coloured matter, is visible on the surface, and this marks clearly the stratum or formation of one season. No doubt, sometimes, if there happen to be a minimum of snow-drift during the winter, followed by an unusually warm summer, all the winter deposit of snow may be removed, and the earthy deposit (naturally smaller than usual) will be added to that of the previous year.

It may be asked why I did not speak of these matters in Major Greely's presence at the meeting of the Geographical Society? This is easily explained: Major Greely's address was so long that little time was left for discussion, and this time was most properly given to the officers (four of whom were present) of the English Government Expedition of 1875-76, who, to my surprise and amusement, let the astute citizen of the United States have things pretty much his own way. In fact, one of these officers made matters rather worse than better by what he said.

JOHN RAE

4, Addison Gardens, Kensington, W., January 1

Hydrophobia—A Further Precaution

IT may be taken as an accepted fact that mongrels are more liable to rabies than well-bred dogs, both from the ill-treatment they commonly receive, and from the unnatural mingling of species that has led to their production. Statistics show that over 90 per cent. of mad dogs are retrievers, or animals so-called. In addition to these two points, it can be safely maintained that no kind of dog gives birth to so many mongrels as the retriever. Pointers, setters, terriers, and hounds will not readily breed from dogs of another class, but the reverse is true of the retriever, and the result is the production of a horrible progeny that ought to be immediately destroyed. Owners of a kennel of sporting dogs are constantly subjected to the annoyance of one of their true-bred retrievers having a litter of pups that only resemble retrievers in their coats. I would therefore suggest that the Retriever Stud Book should be kept by a Government official, and that all owners of retrievers should be obliged to send notice to him when a litter arrived; and that the police should be empowered to destroy any retriever whose owner was not provided with a certificate of registration. A few inspectors of litters could travel the country, and at a cost of a few hundreds a year prevent the development of countless mongrels—valueless for sporting purposes, hideous to look at, and sure promoters of canine madness.

H. M. TOMLIN

Rotation of Mars

PROF. BAKHUYZEN is right in regard to the number of days counted in error by Kaiser in comparing Hooke and Huyghens with recent observations. I wrote away from books, and with no means of determining whether Kaiser had made Hooke's observation a day too early or a day too late in comparing it with Huyghens's—which was what in reality he did. I saw that three days' correction would about bring matters right, and knew that in 1873 I *had* brought matters right; so concluded that was the way. But, being in London for a few days, I have looked up my paper of 1873, and find that the correction was obtained by omitting two days from Kaiser's count between Huyghens and himself, and adding one day to his count between Hooke and Huyghens.

I have not seen Prof. Bakhuyzen's paper, and the pressure of more serious business (life-duties) prevents me from giving time to such examination of it as I gave to Kaiser's in 1873. The results, however, were and are before me. It was natural I should infer that he had taken Kaiser's results as they stood. For, the comparison of either Hooke or Huyghens, using Kaiser's own dates and estimates (following him, in fact, in everything except his clerical errors in regard to the New Style date for Hooke's observations, and to the number of days in 1700 and 1800), gives no such results as Prof. Bakhuyzen has presented. Kaiser made the interval between November 1, 1862, 6h. 10·1m., and August 13, 1672, 12h. 10·3m. (at which epochs he found Mars to have been in the same position in regard to sidereal rotation), to be 69476d. 17h. 59·8m., and in this period, he said, Mars made 67,719 rotations: the resulting estimate of the rotation-period is 24h. 37m. 22·64s. In reality the interval was 69474d. 17h. 59·8m., and in this interval Mars made 67,717 rotations: the resulting estimate of the rotation-period is 24h. 37m. 22·71s. Again, using the observations of Hooke and Huyghens combined to give a mean, and the mean of the best observations between 1830 and 1870, we deduce the period 24h. 37m. 22·71s., which was, I find, the value I indicated as the most probable in 1873. Using observations up to those in 1884, I find for the period 24h. 37m. 22·703s. I find no noteworthy correction on using Maraldi's or W. Herschel's observations, with which, indeed, my inquiry began. I am satisfied the seconds are nearer 22·7 than 22·64.

RICHARD A. PROCTOR

A Meteor

AT 4.47 p.m. yesterday, whilst returning home with two friends, I saw a large meteor pass slowly downwards in an east-north-easterly direction. Unfortunately it was twilight and very cloudy at the time of the observation, and the "fireball," as one of my friends called it, was consequently shorn of much of its brilliancy. It was, however, distinctly visible behind a thin veil of cloud, and when seen for a couple of seconds in the open it seemed to have an apparent diameter about four times that of the planet Venus, which, with the crescent moon, were the only other conspicuous objects in the heavens at that time.

Brighton, January 10 W. AINSLIE HOLLIS

Meteorological Phenomena

I HAVE just received the inclosed notice of a meteorological phenomenon which you may consider of sufficient interest for publication in NATURE.

HENRY TOYNBEE

Meteorological Office, 116, Victoria Street, London, S.W., January 6

LEAVING the port of Kingston, Jamaica, at dusk on November 23, 1885, the night was fine and starlit overhead, but about 8 p.m. a heavy bank of cloud obscured the island, and all around the upper edges of this cloud-bank brilliant flashes of light were incessantly bursting forth, sometimes tinged with prismatic hues, while intermittently would shoot vertically upwards continuous darts of light displaying prismatic colours in which the complementary tints, crimson and green, orange and blue, predominated. Sometimes these darts of light were projected but a short distance above the cloud-bank, but at others they ascended to a considerable altitude, resembling rockets more than lightning. This state of matters continued until about 9.30 p.m., when all display of light ceased. As I have never seen such a phenomenon in any other part of the world, I have deemed it an unusual occurrence, and worthy of record.

R.M.S. *Moselle*, Southampton T. MACKENZIE

I SHALL be obliged if you will allow me to record in your columns the following account of some remarkable phenomena witnessed during a voyage from Sunderland to London, and I trust that if you are good enough to insert this letter, it may be the means of eliciting some explanation from yourself or your readers as to the causes producing such strange effects. Capt. Herring, of the s.s. *Fenton*, reports to me as follows:—

"We left Sunderland at 3 p.m. on the 7th inst. bound for London, wind west-south-west, with snow squalls and strong sea; towards midnight wind increased, and the squalls cyclonic. When between Flamborough Head and Scarborough, the vessel became enveloped with phosphorescence, the mast-heads exhibiting the curious phenomenon known by sailors as 'Composants' (*corpus sancti*), which in this instance were shaped like a top, about two feet at the widest part, resembling a bunch of mistletoe illuminated. The standing rigging and all protruding objects were in like manner illuminated, and the most extraordinary effect was produced when the mate, who was on the bridge with me at the time, raised his head above the canvas weather-sheeting; the whole of his hair, exposed, and beard were instantly illuminated, and in like manner his hands when elevated became phosphorescent on the outline of his mittens. When under cover of the sheeting there was no appearance of phosphorescence; it would therefore appear that the effect of the wind produced the phenomenon. The weather

towards morning moderated, and brilliant flashes of lightning were seen to the eastward." CHARLES WEST

Lloyd's, London, E.C., January 11

The Admiralty Manual on Terrestrial Magnetism

IN a recent number of NATURE you mention that the new edition of the Admiralty Manual on Terrestrial Magnetism is being edited by me. It gives me great pleasure to be able to inform those interested in this work that I have obtained the advice and assistance of Capt. Creak and Mr. Whipple as to the changes required in the description of the ship- and land-observations respectively. From the guidance of such able specialists I feel that the work will have a value that it could never have had from my unaided exertions.

GEO. FRAS. FITZGERALD

Trinity College, Dublin, January 6

Anchor Frosts

ON the night of Friday, January 8, there was an anchor frost in the Cherwell such as has not been known for twenty years, according to people who have lived at a mill on the river (Clifton Mill, near Aynho Station) for that period. In a mild form the phenomenon is fairly frequent there. The most marked effects are seen in comparatively still water.

Thus, in the mill-pond, where the current is stopped by the mill during the night, the whole stream becomes semi-viscous. Roots beneath the water, the brickwork at the sides of the mill-pond, &c., are seen to be coated with ice beneath the water as far down as can be seen, and between this ice and the surface ice-crystals form, not in a sheet or block, but interlaced loosely, like snow crystals in a drift. The mass thus formed blocks the channel, and it is said that water coming upon it from above will rise in level and flow over it, as over a solid obstruction. This I have not seen myself.

When the mill is started, at first the water will hardly flow past the wheel; but at length the crystals are forced to the surface, where they remain in floating masses, under which the water flows as usual.

The surface is not covered with a sheet of ice in these frosts.

In a broad, shallow ditch at right angles to the river, where the water is comparatively still, similar effects could be seen: the pebbles at the bottom coated with ice and the water filled with loose crystals. One consequence of the bottom ice forming on this occasion was that the floodgates were frozen down on the Friday evening, so that they could not be drawn up as usual, and the river overflowed during the night. In the morning, when they were at last raised, the water would hardly flow through, as already mentioned in the case of the water-wheel.

T. HANDS

Clifton Mill, near Aynho Station

Curious Phenomenon in Cephalonia

I BEG leave to forward to you an extract from a letter which I have recently received from a friend and former pupil who is at present an officer on board one of Her Majesty's ships in the Mediterranean. I have never seen any reference to the phenomenon which he describes. If you can insert the extract, perhaps it may evoke further information with regard to it. I would not forward the statement unless I had every confidence in the writer, so that I do not think he would be likely to be easily deceived or mistaken in his observations. He is a gentleman who took an excellent position in the Cambridge Mathematical Tripos.

E. LEDGER

Barham, January 7

"By the way, at Cephalonia there is a very remarkable phenomenon. The sea runs into the land in a strong stream, turning a water-wheel on the way, and disappears in the earth about a hundred yards from the entrance. Can you explain this? I believe no one has yet done so. No part of the island is below the level of the sea, nor is there any salt lake or spring in the island. I imagine this water must be converted into steam, which comes out either at Naples or Stromboli."

SIR F. J. O. EVANS

CAPTAIN SIR FREDERICK J. O. EVANS, R.N., K.C.B, F.R.S., late Hydrographer of the Admiralty, died at his residence, 21, Dawson Place, on December 20, 1885, in his seventy-first year.

This eminently scientific officer entered the Royal Navy in the year 1828, and served in H.M. ships *Rose* and *Winchester*, on the North American station, until 1833, when he was transferred to H.M. surveying-vessel *Thunder*, Commander Richard Owen, and was employed until 1836 in surveying operations in various parts of the West Indies.

It was in this ship, and under the guidance of her able Captain, that he imbibed those scientific tastes which formed his character later in life, and laid the foundation of a career of usefulness, uninterrupted to its close, and which has perhaps rarely found a parallel in the naval profession.

Mr. Evans subsequently served in the *Caledonia*, the flag-ship in the Mediterranean, the *Asia*, the *Rapid*, the *Rolla*, the *Dido*, and *Wolverene*, of which two latter ships he was acting master. He was confirmed in that rank in 1841, and was then appointed to H.M.S. *Fly*, Capt. F. P. Blackwood, fitting for special exploring and surveying service in Australia and New Guinea, where he was continuously employed until 1846. He took a very leading part in the examination of the Coral Sea, the Barrier Reefs of Australia, Torres Strait, and the neighbouring shores of New Guinea, regions then comparatively unknown. After a short period of surveying service on the home coasts, Evans was appointed to the *Acheron*, under the late Admiral Stokes, and was engaged until 1851 in exploring and surveying the coasts of the then young colony of New Zealand; in both these important enterprises he took a very conspicuous part, and gained for himself the reputation of a skilful and scientific surveying officer, second to none in the profession.

During the Russian war Evans was employed in the Baltic on special reconnoitring service, and was attached to various ships of the fleet, taking an active part in the operations against Bomarsund and among the Aland Isles, for which he was mentioned in gazetted despatches.

It may be truly said that for many years of his life Evans was a zealous contributor to magnetic science. He had already begun to make observations of the three magnetic elements whilst employed on hydrographic work in H.M. ships *Fly* and *Acheron* in the Australian Colonies and New Zealand, between the years 1842-1851; but it was not until 1855, when he became Superintendent of the Compass Department of the Royal Navy that he was able to devote himself entirely to the magnetism of iron ships, a subject which was then growing yearly in importance, from the increasing amount of iron used in fitting as well as construction even before iron plating had brought about an actual crisis.

Sagaciously foreseeing the important part the science of magnetism was destined to play in the Navy, then being revolutionised by the change from wood to iron, he devoted his whole energies to the study of the subject until he had made himself completely master of it.

In 1865 Capt. Evans was appointed Chief Assistant to the Hydrographer, retaining his position as head of the magnetic department; this post he continued to hold until the early part of 1874, when a vacancy occurring in the Hydrographership of the Admiralty he was selected to fill it, and continued to do so with equal ability and conscientiousness until within a little more than a year of his death.

From the time of his first appointment in 1855 as Chief of the Admiralty Compass Department until his death Capt. Evans (in happy co-operation during a great part of the time with that great mathematical genius Archibald Smith) devoted himself heart and soul to the solution of what was really a question of life and death to the British Navy, and indeed to seafaring people all over the world. The question was whether it was possible so to deal with the disturbing element of iron, then entering largely into the construction of ships of all kinds, as to prevent the time-honoured compass from becoming a useless toy, or

even a misleading guide. Now that the difficulty has been grappled with and conquered, we have half learned to forget the magnitude of the peril. But for the scientific and practical progress due to the labours of Capt. Evans and Archibald Smith we might almost with advantage have thrown all our compasses overboard. The attraction due partly to the inherent and partly to the induced magnetism of iron ships, and especially of plated ships, was so violent as to induce in some vessels, in certain positions, errors of two, three, or four points of compass indication. Something had been done to explain the causes of the mischief and to suggest palliatives. Famous old Flinders, at the beginning of the century, had spelt out the mystery so far as it was disclosed by the wooden ships of his time, but he had to deal with comparatively minute errors due to induction alone, and was never brought face to face with the stupendous difficulty which iron shipbuilding and iron ship-plating, afterwards created. The late Astronomer-Royal had done good and sound work in the earlier days of iron, but much more was needed to overcome the serious trouble which the newer types of mercantile and still more of naval vessels threatened to bring upon us.

It was at this critical epoch that Capt. Evans and Archibald Smith began to work together. Years of experimental labour and mathematical research went to the production of the "Admiralty Manual on Deviations of the Compass"—a book perhaps as perfect in its kind as a book could be. It is hard to do justice to the elegance of the mathematical handling, and, above all, to the happiness of the graphic methods which are found in the Manual, without seeming to indulge in extravagant laudation. An enthusiast in such matters once pronounced it a piece of lovely work, and one need not be an enthusiast to appreciate all that the epithet was meant to carry. Capt. Evans would have been the last to deny that the larger part of the purely theoretical investigation was due to his brilliant fellow-worker. Indeed his modesty often prompted him to claim less than his fair share of the credit due to both. The subject was one which called for the combination of practical sagacity and experience with refined scientific method—and if Archibald Smith was the stronger on the one side, Capt. Evans was his master on the other; nor was either of them without large powers, even in the special department of their joint labour in which he owned the supremacy of his friend. It was an undertaking which called for the united effort of just two such men as were fortunately brought together to do it, and the result has been a triumph to England and a blessing to the world which will preserve the memories of its authors as long as the ocean remains the highway of Englishmen and of the world.

The death of his old colleague did not abate the zeal of Capt. Evans, and few years passed since that time without some notable addition from the hands of the Hydrographer to our existing stock of experimental knowledge and scientific theory upon the subject which he had made his own. Much of his work will be found in the *Philosophical Transactions* of the Royal Society, and in 1870 he published an elementary manual supplementary to the Manual; both these works have been freely translated on the Continent, and are the acknowledged text-books in our own and foreign Navies to the present time.

The various steps of Evans's work may thus be stated:—

In 1858 a Chart of Curves of Equal Magnetic Declination, compiled by him for that epoch, was published by the Admiralty. This chart appeared most opportunely, for, with compass errors growing in amount and complexity, the mariner was by means of it enabled to ascertain in any part of the navigable world how far his compass deviated from the magnetic north.

In 1859 he read a paper on the magnetism of iron ships at the Royal United Service Institution. This was a valuable *résumé* of all that had been hitherto done in order to obtain a knowledge of the magnetism of iron ships and the treatment of their compasses. He also communicated some results of Archibald Smith's method of analysis as applied to the errors of the compass found in H.M. ships.

Evans's next paper consisted of a Report to the Hydrographer of the Admiralty on Compass Deviations in the Royal Navy. It treated of the magnetic character of the various iron ships in the Navy, and also of the *Great Eastern* steamship. The results of this paper were (1) to show the best direction for building an iron ship; (2) the best position for placing her compass; (3) the various sources of error affecting a compass under favourable conditions. This report was communicated to the Royal Society, and published in their *Transactions* in 1860.

In 1861 he read a paper of similar import before the Institute of Naval Architects.

Reference has already been made to his work on the *Great Eastern*, and an important result of it was the experimental investigation which he was led to make as to the cause of the abnormal errors of the compasses in that vessel, proceeding from the application of Airy's system of magnet and soft-iron correctors when long single-compass needles are used.

With Evans principally as an experimentalist and Archibald Smith as the mathematician, a valuable paper on the proper length and arrangement of the needles on a compass card, together with exact information as to the proper arrangement of magnet and soft-iron correctors with respect to it, was presented to the Royal Society in 1861, being the result of the joint work of those ardent investigators into the compass question in iron ships.

Commencing with this latter paper, we find Evans and Smith as we have said above, generally working together, and under their joint editorship there appeared in 1862 the first edition of the "Admiralty Manual for Deviations of the Compass." The introduction, however, of armour-plated ships soon rendered a new edition necessary, and in 1863 it was published. This work was again revised in 1869, and became the text-book of the world on the important question of the deviations of the compass in iron ships of whatever form, being translated into all the principal European languages.

In 1865 Evans and Smith produced another important paper on the "Magnetic Character of the Armour-plated Ships of the Royal Navy," which was published in the *Phil. Trans. Roy. Soc.* The novelty of the form of ships thus discussed as regards their magnetic character caused the results to be of more than usual interest, and showed with what degree of confidence compasses might be placed in positions where both helmsman and officer might have armour protection.

The practicability of determining the magnetic co-efficients without swinging, and also of ascertaining the heating error without inclining the ship, was also demonstrated, and has since been largely adopted in the Royal Navy.

In 1866 proposals were made by Mr. Evan Hopkins, C.E., to depolarise the iron hulls of ships by means of electro-magnets, and he was allowed by the Admiralty to experiment on the *Northumberland*, an armour-plated ship lying in the Victoria Docks. With the increasing difficulty of finding suitable positions for the compass, the prospect of being able to depolarise an iron ship was very attractive. In an able paper, however, read before the Royal Society in 1868, Evans showed that, so far from the hull of the *Northumberland* being depolarised, a portion of it was only temporarily, and therefore dangerously, polarised, and afterwards returned to its normal condition, thus preventing similar experiments being tried with other ships of the Navy.

It was only natural that a joint editor of the "Admir-

alty Manual for Deviations of the Compass," who knew the difficulties of that work for his fellow-seamen, should wish to present the subject, on which he had worked so long, in an elementary form more suitable to their every-day requirements. Evans therefore, in 1870, published his "Elementary Manual for Deviations of the Compass," a work which has been very well received by the nautical world, and has been translated into various European languages.

With the exception of some papers read at certain meetings of the British Association, and two lectures read at the Royal United Service Institution in 1865 and 1872, Evans subsequently relaxed his personal investigations into the magnetism of iron ships, and turned more to terrestrial magnetism.

Thus, in 1872, he contributed a paper to the Royal Society, on the magnetic declination in the British Islands, and compiled the magnetical instructions for the voyage of H.M.S. *Challenger*, being again assisted in this, and for the last time, by his old fellow-labourer, Archibald Smith.

Lastly, in 1878, Evans read an able and instructive lecture, on the magnetism of the earth, before the Geographical Society, showing the distribution and direction of the earth's magnetic force and the changes in its elements as then known.

Capt. Evans was elected a Fellow of the Royal Society in 1862. He sat for many years on its Council, and was more than once a Vice-President. He was also a Fellow of the Royal Astronomical and Geographical Societies; he served for many years as member of the Meteorological Committee of the Royal Society, and on the change in the constitution of that body became a member of its Council.

In recognition of his public services the Companionship of the Bath was conferred upon him in 1873, and in 1881 he was advanced to the Commandership of the same order.

Sir Frederick Evans's last public service after his retirement from the Admiralty in 1884 was as the British Delegate at the Congress of Washington for the establishment of a prime meridian and questions kindred to it.

JOHN MORRIS

PROFESSOR JOHN MORRIS died on Thursday, January 7, having been laid aside by illness for several months. Born at Homerton in 1810, he spent almost the whole of his life in or near London. For many years a pharmaceutical chemist at Kensington, he passed all his spare time in exploring the neighbourhood of the metropolis and in collecting from field and book the great store of geological knowledge which was one of his especial characteristics. But science claimed more and more of his time, and at last he abandoned business entirely. In 1855 he was appointed Professor of Geology at University College, London, which post he held till 1877, when he was succeeded by Prof. Bonney. In 1878 the honorary degree of M.A. was conferred upon him by the University of Cambridge.

Morris was elected a Fellow of the Geological Society in 1845, and, whilst in health, was a constant attendant at its meetings. He received the first Lyell Medal in 1876, and has four times received the Wollaston Donation Fund. In the Geologists' Association he has been an earnest worker, having been twice its President, and always one of the foremost leaders at its excursions.

The earliest publication by Prof. Morris was "Observations on the Strata near Woolwich," in the *Magazine of Natural History* for 1835. Most of his own descriptive papers refer to the south-east of England and in the Oolitic districts, but in association with others he has done important work elsewhere. His paper with Murchison, "On the Palæozoic and their Associated Rocks of the Thüringerwald and the Harz," read before the Geological Society in 1855, is still one of the best accounts of those districts in the English language. He was joint-author with Dr. Lycett of an important monograph for the Palæontographical Society on the Oolitic Mollusca.

Considering the enormous amount of information stored in Morris's mind, one is surprised that comparatively so little original work came from his pen, and especially that so few species of fossils except those of the Great Oolite bear his name as their author. For this, however, we may perhaps be thankful; he may have been equally well employed in reducing the number of those already in use. This he did to good purpose in his "Catalogue of British Fossils," the first edition of which was published in 1843, the second in 1854. From that date onwards he was engaged in collecting materials for a third edition, which unfortunately he did not complete. Every working geologist and palæontologist has made constant use of this book, and those who have used it most best know the vast amount of labour which its preparation entailed. It is not a mere list, compiled from various authors; but nearly every species has been critically examined and the synonymy carefully traced.

Fond of conversation, a ready and pleasing public speaker, Morris was always glad to impart his knowledge to others. This knowledge was varied and exact; minerals, rocks, and fossils were equally familiar to him, and he was well read in the wider questions of physical geology.

He was held in high regard by all who knew him; and those who gathered around his grave at Kensal Green came to pay the tribute of personal friendship not less than that of admiration for scientific worth.

DISTRIBUTION OF DRIVING-POWER IN LABORATORIES

A NOVEL arrangement has been adopted at the Physiological Laboratory at Cambridge, and at the Owens College, Manchester, for driving instruments in various rooms by means of a central motor. At the Brown Institution shafting has been used for the same purpose. This method is commonly used for driving machines which require a good deal of power, but it is not suitable for laboratories where the power is often required in many rooms, on different floors and some distance apart, thus causing great complication in the fittings. Again, when shafting is used, the instrument to be driven must be placed opposite a pulley on the shaft; in the arrangement about to be described, the instrument may be moved to any part of the tables, and the tables can be fixed in any part of the rooms.

We will now describe in detail the arrangement as applied in the Laboratory at Cambridge. The motor is an Otto gas-engine. It was found most convenient to place it in the cellar.

In Fig. 1 a pulley, B, fixed to a short length of shafting, is driven by a cord from the fly-wheel of the gas-engine, shown at A. The small pulleys at C are necessary to guide the cord in the required direction. This direction is vertical, hence no sag can compensate for changes of length due to stretching and the varying moisture of the atmosphere. The following arrangement was therefore adopted. Two grooves are turned in the pulley B, over which the cord passes twice, having between the first and second time passed under a pulley which supports a weight, W. Thus, the only effect of a change of length in the cord is to raise or lower the weight.

The short length of shafting driven in this manner by the pulley B is used to distribute the power to various rooms. A cord runs to each room, and forms a separate system, which can be stopped or started independently. This is done in the following manner. Fig. 2 shows a

side view of the shafting, to which a number of pulleys are fixed. One of these, E, drives a second pulley, F, which is supported by a frame turning about a pivot, G. The pulley F has three grooves in it. A short leather band passes round the centre groove and round the pulley E; thus, if the centres of the pulleys E and F are brought together, the leather band which receives its motion from E will slip round F without driving it; but on the other hand, if the centres are pulled apart, F will be driven. When the cord H is pulled, the centres are brought together, and when released, a weight, K, gives the necessary

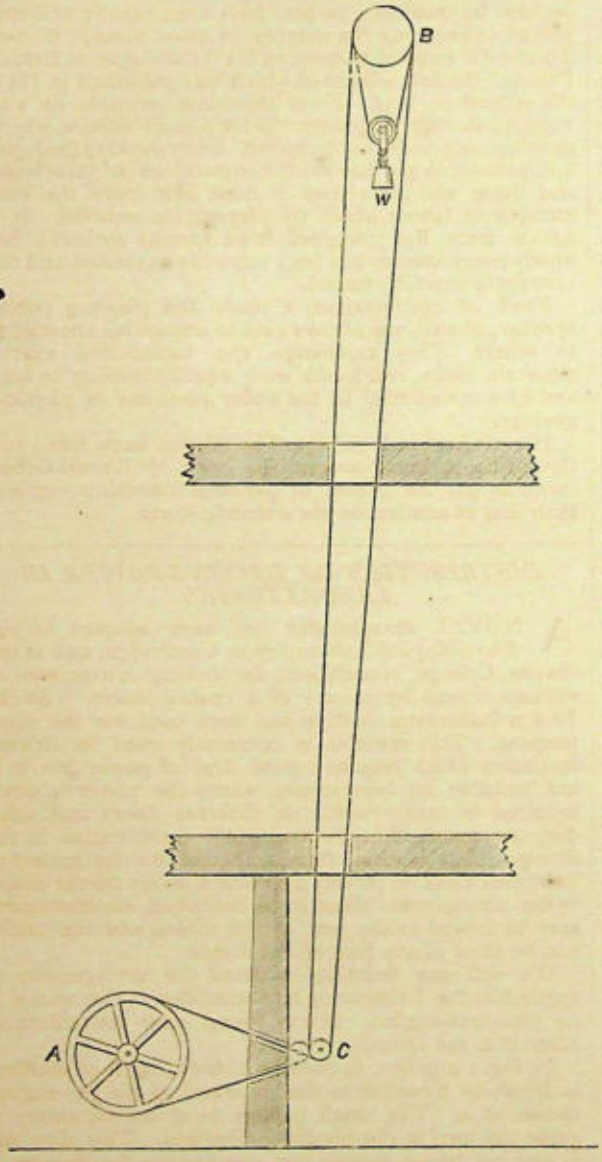


FIG. 1.

tension to the leather band. The endless cord L, which conveys power to one of the various rooms, is driven by the pulley F. This arrangement is something like that adopted for connecting the fly-wheel of the gas-engine with the shafting. The cord L first passes three-quarters of a turn round one of the grooves in the pulley F, under the pulley, M, which supports the weight K, and a quarter of a turn round the other groove of the pulley F. The cord then passes away in a horizontal direction, and is guided by pulleys round angles, either in a vertical or horizontal plane, to the rooms where the power is required. It is then guided in the same manner along the edge of each of the tables on which the instruments are to stand. The weight K, besides giving the necessary tension to the leather band, will take up all slack in the cord L. The cord runs near the ceiling, and is either led over pulleys and down to the tables in the rooms, or up through the ceiling to tables standing on the floor above.

The power is transmitted as follows to the instruments standing on the table from the cord running along its edge. Fig. 3 shows a piece of apparatus designed for this purpose, which has been called a driving-pulley. It is clamped to the edge of the table, and the cord is then made to pass round the pulley, P, as shown. This has the effect of raising the weight K, Fig. 2. The instruments are driven by a light cotton band passing round one of two grooves in a pulley fixed to the same spindle as the pulley P. The larger of the grooves is shown at Q, the smaller is not visible in the figure. The band is kept tight by means of a pulley and a weight, in the manner previously described; this arrangement also allows the

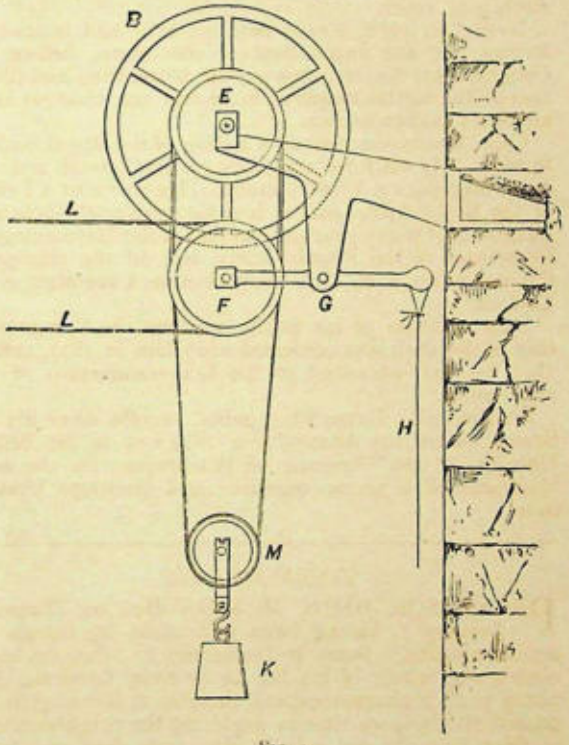


FIG. 2.

instrument to be moved to any distance from the driving pulley without altering the length of the band.

In the figure, the instrument being driven is shown at R. It is essential that it may be stopped without interfering with the cord which supplies power to the room. This is done in the following manner, which we believe is new. The handle T is fixed to a brass piece formed in the shape of a sector of a pulley, with an overhanging edge. It is arranged to turn about the bearing through which the spindle of the pulley Q passes, and can therefore rotate about the same axis as this pulley. The groove in the overhanging edge is in a line with the groove in the pulley. In the figure the cotton band is shown resting in this groove, and not in the groove of the pulley Q; now, if the sector is turned through half a revolution by the handle T, the cotton band will fall from it into the groove in the pulley Q. Thus the instrument is started; the reverse action not only throws it out of gear, but the friction of the cord running in the groove in the sector acts as a brake, and brings it quickly to rest. From the

foregoing description it is evident that, once moved, the sector is required to remain in that position until moved again; in fact, it must turn with a certain amount of stiffness. A short piece of cord lies in a groove cut in its edge as shown at S; as the cord is prevented from moving and kept in tension by an india-rubber band, its friction in the groove must be overcome when the sector is turned. The smaller of the two grooves on the pulley Q is not visible in the figure, neither is the arrangement shown for lifting the cotton band out of this groove. The instrument being driven is a rotating cylinder for recording any vertical movements in the ordinary manner. Five grooves of different sizes are cut in the pulley R, and, as there are two grooves in the pulley Q, ten different speeds are possible. The sizes of these pulleys are such that the ten speeds form a geometrical series in which two consecutive speeds are in the ratio of 100: 140.

The cotton band as well as the main driving-cord can be slipped off the driving-pulley without being cut; it can then at once be removed from the table. From this description it will be seen how the instruments may be driven, as before stated, whilst standing on any part of the table.

This method of distributing power is convenient for

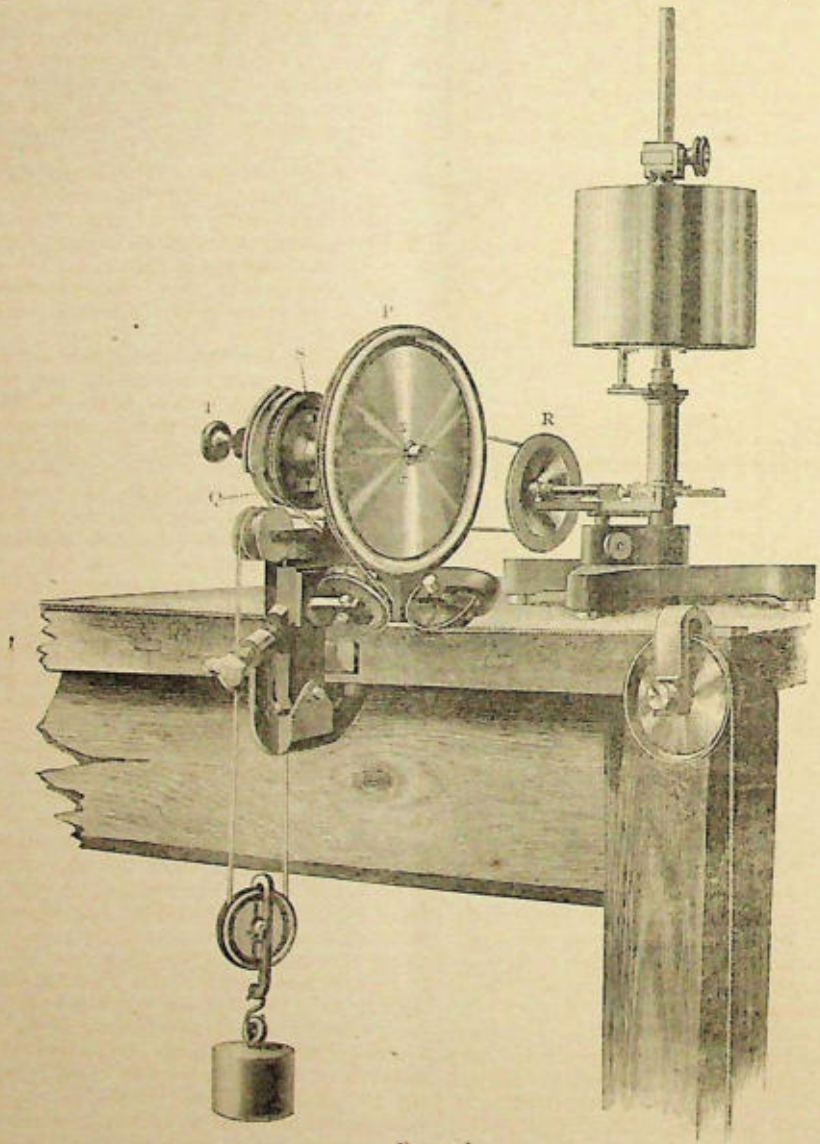


FIG. 3.

laboratories where a large amount of class-work is done, as it removes the necessity of supplying each student with a separate instrument containing clockwork. It is also most useful in original work for driving special pieces of apparatus which may often require more power than can be obtained by clockwork.

Cotton has been found to be the best material for the cords; it has the advantage of running almost silently, and is very durable. The pulleys that guide the cord from the shaft to the various rooms have been designed to run a long time without requiring oil, and with very little friction. The speed adopted is 10 feet per second; a small cord running at this speed can easily do all the work that is required.

A great variety of instruments are driven in the laboratory at Cambridge; among others we may mention a turning-lathe, also a small centrifugal machine which runs at about ninety turns per second, requiring a special driving-pulley.

The whole apparatus, both at Manchester and at Cambridge, has been designed and constructed by the Cambridge Scientific Instrument Company.

RADIANT LIGHT AND HEAT[1]

IV. (*Continued*)

Radiation and Absorption—Celestial Applications

THIS is perhaps the most suitable place for alluding to a method of obtaining a picture of the corona on ordinary occasions, recently introduced by Dr. Huggins, and which has already met with considerable success.

By using a suitable absorbing medium Huggins has been able so greatly to diminish the proportion between the terrestrial glare and the light from the corona, that a photographic image of the regions around the sun exhibits visible traces of an excess of action in certain places which are probably those occupied by the corona. Plates prepared in this manner were compared with those taken of the corona in Egypt during a total eclipse, and the comparison, made by several observers, appears to leave little doubt that the object photographed is really the corona. A development of this method would prove a great boon to solar inquiry.

Another result of the application of the spectroscope to the sun has been the determination of the rates of motion of the currents which take place in the solar atmosphere.

This is done by the method of displacement already mentioned, a motion of solar gas towards the eye pushing its spectral lines to the more refrangible side of their ordinary position, while a motion in the opposite direction has a contrary effect. In Fig. 20 we have a representation of the deviation of the F line in a spot spectrum.

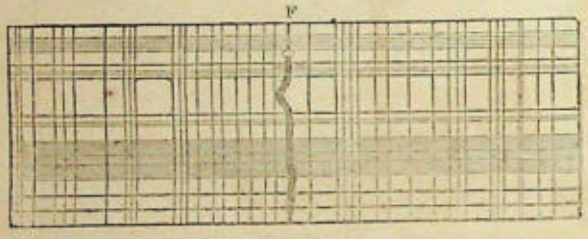


FIG. 20.

By this means prodigious solar velocities have been observed. In our earth when air moves at the rate of 100 miles an hour we count it a hurricane, but in the sun we find gaseous matter frequently moving at the rate of 100 miles a second.

It has likewise been observed that the velocities of solar motions are greatest on occasions of maximum sun spots, when there appears to be a general increase in the activity of all things belonging to our luminary.

It may therefore be said that all our observations combine in proving how extensive the solar atmosphere must be, and how enormous must be the velocities of its constituents, and more especially of the hydrogen, which enters largely into its composition.

We have thus two facts connected with our luminary which fill us with amazement. For we have, in the first place, his continued ability to radiate powerfully without cessation, or even apparent diminution, and we have, in the second, the astounding velocities of his atmospheric motions.

A little reflection will, however, serve to convince us that these two wonderful facts are intimately connected together and serve to explain each other, and that in truth the atmospheric motions are the very machinery which enables the sun to continue his radiation.

For let us inquire what is the essential condition of such continued radiation.

Clearly we must have some process by which there shall be a continuous and very rapid stream of fresh particles sent to the surface of the sun. These are there required to give out their light and heat, and then promptly to retire, being replaced by fresh particles from beneath, which again in their turn give out light and heat and then rapidly retire. It is necessary that there should be some powerful machinery of this kind, in virtue of which fresh recruits shall continually be carried to the front, while the exhausted battalions are promptly marched behind into the magazine.

Now such machinery is supplied in the vast and intense solar convection currents by means of which the cold matter from above is rapidly carried down, forming a sun spot, while the hot matter from beneath is rapidly carried upwards, forming a faculæ.

This ceaseless system of ascending and descending currents gives rise, no doubt, to the mottled appearance of our luminary, while in certain districts of the sun and on certain occasions the system is swelled out into gigantic proportions, and we have a large sun spot, with its accompanying faculæ. Nor is it difficult to understand why convection currents should be so powerful in the atmosphere of our luminary. The intensity of such currents will depend upon the following conditions:—

(1) On the intensity of the heat of the hot portions of the arrangement as compared to that of the cold.

(2) On the intensity of gravity.

(3) On the scale of the whole arrangement.

(4) On the presence of condensible substances in the atmosphere.

Now in the sun the heat of the hot particles is very great, while the space around the sun may be taken to represent something without heat. Again the intensity of gravity at the sun's surface is very great, being about twenty-eight times greater than that with which we are familiar on the earth.

In the third place, the scale of the whole arrangement is very great; and, lastly, we have without doubt the presence of condensible substances in the solar atmosphere. All these are powerful causes, and we must bear in mind that they have not merely to be added, but rather multiplied together. Can we therefore wonder that their joint effect is such as to raise the violence of solar storms into something like 60 or 100 miles per second?

These considerations may likewise, perhaps, serve to throw light on the question of solar variability. We have seen that sun spots have a period of eleven years, and that near the minimum of this period there are occasions when the sun is entirely without spots.

Now it is sufficiently obvious, and has likewise been proved experimentally, that a sun spot gives out less light and heat than the ordinary solar surface. On the other hand, the proportion which the spotted area bears to that of the whole disc is insignificant, so that, taking these two facts together, we should at first sight imagine that the sun ought to give us very slightly less light and heat on those occasions when there are most spots.

I think, however, that this direct action is probably inappreciable, and that sun spots are rather to be regarded as *symptoms* of a particular state of the sun, implying an increased activity of solar convection currents. Now, inasmuch as the outpouring of solar light and heat is kept up by means of these convection currents, we might therefore expect that on occasions when such currents are peculiarly powerful the sun should give out most light and heat. To use the words of the late Sir J. Herschel, the "*sun fot*" may on such occasions be boiling very rapidly.

On the whole, therefore, theory would lead us to infer that the sun will be found most powerful in its radiation on those occasions when it has most spots on its surface. It will, however, be noticed that this is merely a theoretical conclusion, and has to be supported by evidence which must of course be terrestrial. Have we, then, any terrestrial evidence that the sun is more powerful in its

[1] Continued from p. 38.

radiation at times of maximum than at times of minimum sun spot frequency?

In reply to this question, we must acknowledge that of direct evidence derived from the actinometer we have hardly any. Certain preliminary observations made by Mr. Hennessey at the headquarters of the Trigonometrical Survey in India may perhaps induce us to imagine that the sun may be most powerful on occasions of maximum sun spot frequency, but this is far from conclusive. We have, however, very strong indirect evidence in favour of this conclusion. This is derived partly from the facts of terrestrial magnetism and partly from those of terrestrial meteorology, that from the former being the stronger of the two. It is well known that the sun produces changes in the magnetism of the earth. It gives rise, for instance, to the solar-diurnal variation of the needle which is a systematic change; and it likewise produces magnetic storms, these words being employed to denote changes of a peculiarly abrupt and irregular kind. Now undoubtedly these both imply an energetic action of some kind on the part of the sun, and we have strong grounds for supposing that this energetic action is connected with the radiating power of our luminary. But both of these solar actions upon the magnetism of the earth are decidedly stronger in times of maximum than in times of minimum sun spot frequency.

Such electrical phenomena as the aurora borealis and the currents which take place in the crust of the earth are likewise peculiarly developed on the same occasions.

In Fig. 21 we have a diagram representing the connection between sun spot maxima, the maxima of declination range, and the frequency of the aurora borealis.

When we come to meteorology, the evidence before us is not so conclusive, although here also what we have tends, I think, in the same direction. Mr. Meldrum has shown that there are most cyclones in the Indian Ocean

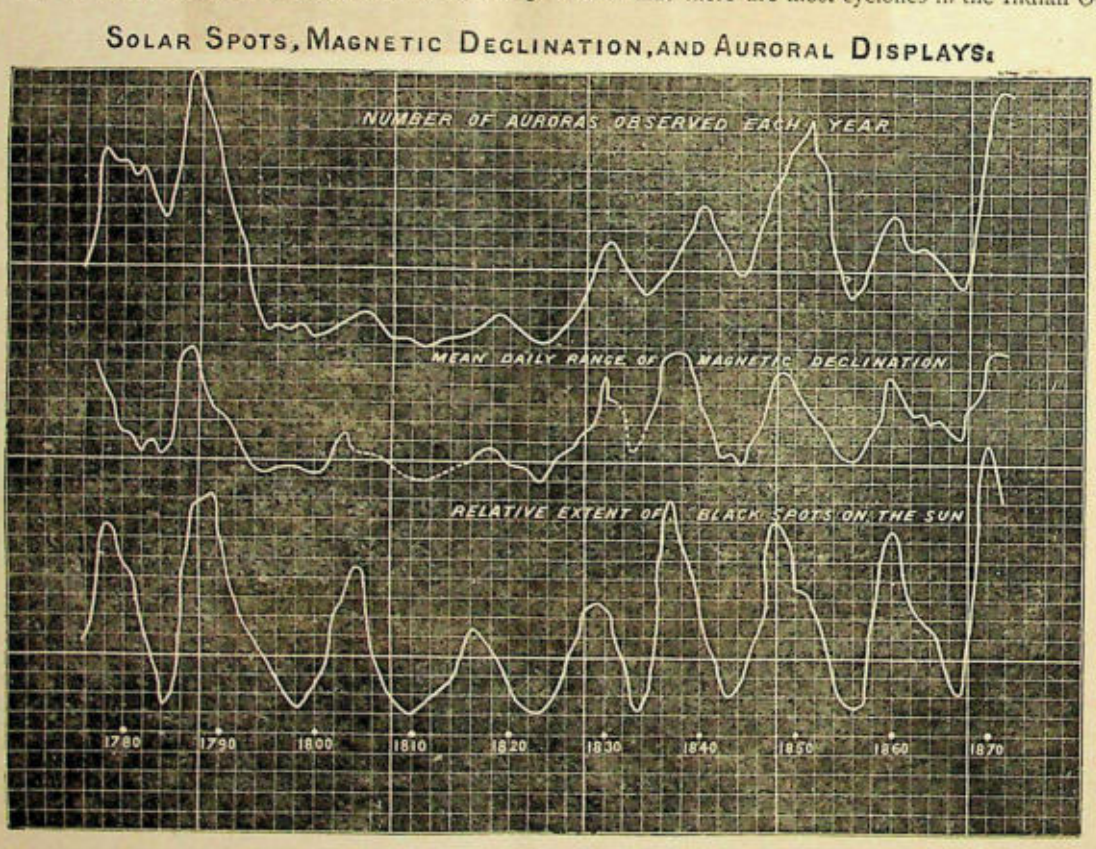


FIG. 21.

about times of maximum sun spots, and M. Pöey has proved the same thing with respect to West Indian hurricanes. On the whole, too, and in the majority of stations, the rainfall is greatest on the same occasions.

Again, let us take the barometric pressure of the air. Here a little reflection will convince us that the peculiar variations in the distribution of such pressure are really caused by the sun. For instance, we know that Western Siberia during the winter season has a pressure decidedly above the average, and we should therefore imagine that in years when the sun is peculiarly powerful the winter pressure in Siberia would prove to be particularly high. Now this is just the state of things which Mr. Blanford has found to correspond with years of maximum sun spot frequency, and thus the evidence is in favour of these being also years of maximum solar power. The Indian meteorologists have derived similar conclusions from the observations made in India. In fine, we may, with the balance of probability in our favour, adopt the conclusion deduced by Mr. Baxendell at a comparatively early period, who found that the forces which produce the movements of the atmosphere were apparently more energetic in years near maximum than in years near minimum sun spot frequency.

Let me now proceed to indicate the nature of the information which the spectroscope gives us regarding the planets and comets of our system. Since the moon and the various planets are illuminated by the sun, their spectra will necessarily be built upon that of the sun. As a matter of fact, this is found to be the case; but we ought to bear in mind that the solar rays that reach us from a planet must have penetrated some distance into the atmosphere of that planet. In doing so they will most probably have suffered spectral absorption, the

nature of which may thus suffice to throw light upon the constitution of the planet's atmosphere.

Working in this manner, Dr. Huggins has observed no trace of an atmosphere in the moon, but in the spectrum of Jupiter lines are seen which indicate the existence of an absorbing atmosphere. One band appears to correspond in spectral position with dark lines due to our earth's atmosphere; but another band is different from

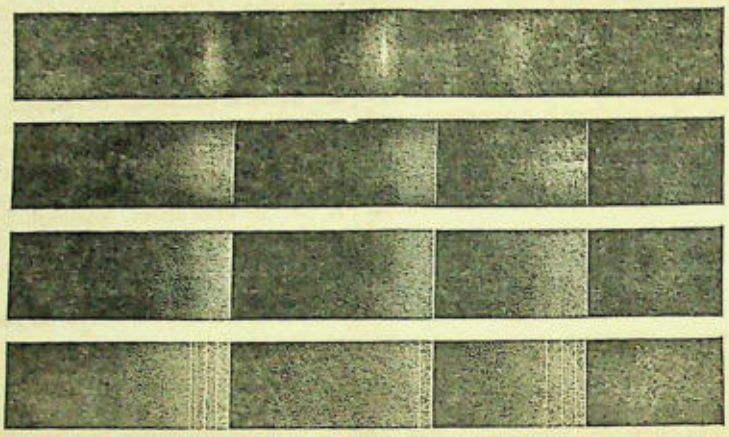


Fig. 22.—(1) Spectrum of Tiersen's comet; (2) Spectrum of Winnecke's comet; (3) Spectrum of carbon in olefiant gas; (4) Spectrum of carbon in olive oil (Huggins).

any line caused by our atmosphere, and indicates most probably the existence of some unknown constituent. Saturn has likewise a band common to the earth, so that aqueous vapour probably exists in the atmospheres of Jupiter and Saturn.

The spectrum of Mars indicates in like manner the

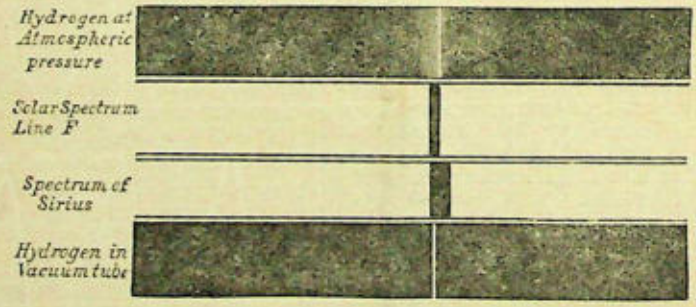


Fig. 23.

existence in the atmosphere of that planet of matter similar to that which occurs in the earth's atmosphere.

The absorption spectra of the far distant planets have likewise been examined.

Padre Secchi and M. Janssen agree with the conclusion that the vapour of water probably exists in certain planetary atmospheres.

In the absorption spectrum of our atmosphere Professor

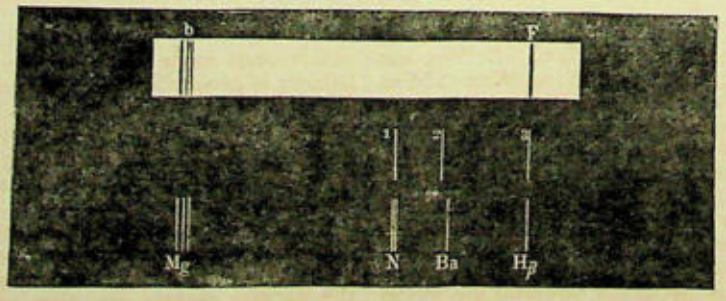


Fig. 24.—First, the solar spectrum; next, the spectrum of the nebulæ; 1, 2, 3 the lines observed. Below, the bright lines of magnesium, nitrogen, barium, and hydrogen.

Piazzi-Smyth has noticed a band which appears to be associated with the presence or possibility of rain, and which he has termed the rain-band. Strangely enough in the bright spectrum of the aurora borealis, which comes from our atmosphere, there is a line which we cannot identify with the spectrum of any known terrestrial substance.

Dr. Huggins has likewise studied the spectra given by

the brighter portions of comets, and has obtained for many of these bodies lines which resemble the spectrum of carbon, as taken in a hydrocarbon.

In Fig. 22 we have, first, the spectrum of Brorsen's comet; secondly, the spectrum of Winnecke's comet; thirdly, the spectrum of carbon in olefiant gas; fourthly, that of carbon in olive oil.

More recently the same observer has found other specimens of this class of bodies, which give spectra essentially different from the hydrocarbon type, and he remarks that as the meteors which come down to us differ greatly in chemical constitution, so it is not surprising that a similar difference should be found in comets which we know to be very closely allied to meteors.

Dr. Miller and Mr. Huggins were amongst the first to give us information regarding the spectra of stars. These bodies exhibit spectra very similar to that of the sun—that is to say, they give us an underlying continuous spectrum, intersected with dark lines. We have thus evidence of a similarity in physical constitution between our sun and these very distant bodies.

The position of the dark lines is the great object of interest in stellar spectra, and by the method already described the presence of various terrestrial elements has been detected in the stars.

In the most brilliant bluish-white stars, along with the presence of numerous fine lines, we have a comparatively small number of prominent absorption lines, the substances which these indicate as present being hydrogen, calcium, magnesium, and sodium. We shall return to this subject on a future occasion.

Miller and Huggins were so fortunate as to obtain the spectrum of a star which suddenly blazed out in May, 1866, and found in it the unmistakeable presence of bright hydrogen lines.

Such a star is probably to be regarded as exhibiting on an enormous scale the same phenomenon which is frequently seen in the outburst of hydrogen from the interior of our luminary. Indeed, we have sometimes bright lines of hydrogen in the spectrum of certain solar regions. Padre Secchi has also ascertained that several very small stars exhibit bright lines.

I need hardly say that in the case of the fixed stars where the disc is a mere point, we have no possibility of differentiating between various portions of it, or of ascertaining the velocities of its atmospheric motions by spectral displacement.

We have, however, the means of ascertaining by this method whether the star be approaching us or receding from us, and how rapidly it is doing so. Huggins has made many laborious and interesting observations of this nature, and has determined the relative motion to or from us of many stars—a result which could not possibly be ascertained without the spectroscope.

In Fig. 23 we have an indication of the proper motion of Sirius as seen by the displacement of the hydrogen line F in the spectrum of that star.

Before concluding this branch of my subject, let me briefly allude to the light thrown by spectrum analysis on the composition of certain of the nebulæ. On directing his stellar spectroscope to the planetary nebula in the constellation Draco on 20th August, 1864, Dr. Huggins found that its spectrum consisted of three bright lines on a dark background—in fine, that it was the spectrum of incandescent gas.

Of these three lines one is in all probability the hydrogen line H; another appears to coincide with one of the lines of nitrogen, while the third does not coincide with any known line.

Other nebulæ have since been found by Huggins to give us similar spectra.

Fig. 24 denotes the general spectrum given by the nebulæ.

It thus appears that we have already derived great information regarding the constitution of the heavenly bodies by means of spectrum analysis.

BALFOUR STEWART

(*To be continued.*)

NOTES

THE death is announced, in his seventy-first year, of Dr. John Christopher Draper, Professor of Chemistry in the Medical Department of the University of the City of New York. Dr. Draper was the eldest son of the eminent Prof. John W. Draper. His scientific papers, apart from those on the science of medicine, are devoted to chemical and physical subjects; and among the latter chiefly to optical phenomena. His last one, relating to dark lines in the solar spectrum, attracted some attention at the time, 1878-79.

THE death is announced of Mr. James Fergusson, F.R.S., on the 9th inst., at the age of seventy-eight years. Mr. Fergusson was well known by his writings on Indian architecture, and also by his magnificent work on "Tree and Serpent Worship in India."

THE deaths among French Academicians have been unusually numerous of late; we have to record this week that of M. de Saint-Venant, a member of the Section of Geometry.

THE Russian Academy of Science has elected Mr. David Gill, Astronomer-Royal at the Cape of Good Hope, a Corresponding Member.

SEVERAL French papers have published articles on the opportunity of celebrating the centenary of Arago's birth, this celebrated astronomer and physicist having been born at Estagel, a country town of the Department of the Pyrénées Orientales, on Feb. 26, 1786. As he was a Copley Medallist and a foreign member of the Royal Society of London, it is expected that this Society will be invited to send a delegate to take part in the proceedings. Arago was elected a member of the Paris Academy at the early age of twenty-three, after having achieved the measurement of the meridian arc from Dunkirk to Formentera, for determining the length of the metre. His predecessor was Jerome de Lalande. In 1830 he was elected Perpetual Secretary, and he continued to act as such during twenty-three years up to his death, which took place in 1853. His works have been edited by Barral, and fill seventeen large octavo volumes, of which four are devoted to "Astronomie Populaire."

IN a very excellent article in *Science* on "The Government and its Scientific Bureaus," we find some wholesome remarks on the conditions under which scientific work can be performed at its best. "Science cannot be carried forward by prescribing too definitely the tasks of scientific men. They may be bound by appointed days and hours; they may be told to perform specific duties,—and if only the maintenance of routine work is required, such regulations may secure fidelity and efficiency. But if knowledge is to be advanced, if better methods of work are to be discovered, if greater accuracy is desired, if unknown facts are to be ascertained and recorded and discussed, and, in short, if there is to be real progress, the methods of freedom are to be employed, not those of petty regulation. By this we mean that if the great undertakings which the Government has in charge, if especially its surveys of the coast and of the interior are to go forward, discretion must be given to the chiefs of bureaus, and they must be held to accountability for the aggregate success of their work. Honesty, economy, clear and accurate statement of accounts are, of course, to be demanded in every office: nobody questions this. But the determination of what shall be undertaken in a given year, to whom it shall be assigned, what allowances shall be made for instruments, books, and assistants,—these are questions which experience and judgment must decide. Somebody who has all the facts in mind must make

the determination, and he must not be too quickly condemned, because the immediate results of the investigations which he has undertaken are not yet apparent. The highest personal character should be found in every one who is called upon to direct the labours of a scientific corps; he should be faithful, watchful, careful that all the interests intrusted to him may be promoted; but he should be free within the limitations of his office to select his subordinates, determine their duties, and prescribe their methods. Only by such regulated freedom as this can the highest results be obtained. Discretion with responsibility, in all the higher work of science, will bring the best services from those whose moral attitude is what it should be: no others should be intrusted with the leadership."

From the "Washington Letter" of *Science* we learn that in the retiring address of the President of the Chemical Society there Prof. F. W. Clarke gave "an able and entertaining *résumé* of the growth of chemistry in Washington during the past twelve or fifteen years." The President concluded with a plea for the establishment of a national laboratory, which, in its dimensions and equipment, should be commensurate with the importance and dignity of the science. Arguments to show the economy in, and the necessity for, such an establishment were not lacking, [illegible] in number or force. Examples of duplication or useless repetition of work, multiplication of instruments and facilities with no increase in efficiency, and frittering away time and energy on work properly belonging elsewhere, were given with a convincing emphasis, which made it a little difficult, at the close of the address, to believe that there were two sides to the question.

The programme of the Congress of French Learned Societies for 1886 has been declared by a decree published by the Minister of Public Instruction. Amongst other subjects to be discussed by the fifth, or Natural Sciences Section, we find the following:—Study of the topographical distribution of the species inhabiting the French coasts; detailed study of the fluviatile fauna of France, indicating the species which are migratory and those which are permanent, and in the former case the dates of arrival and departure, noting also the time of laying the eggs, and the influence of the composition of the water; study of the migrations of birds, and of the periodical phenomena of vegetation, noting the coincidences of budding, flower, and maturity, with the appearance of the principal kinds of insects injurious to agriculture; the influence of winter temperatures on insects and their duration; study of honey- and wax-producing insects; a study, from an anthropological point of view, of the different populations which have occupied, in whole or part, a certain part of France since the most remote times; the course and duration of the great epidemics of the Middle Ages and of recent times; a comparison between the Tertiary vertebrates of the various French formations in view of the successive modifications which the types have undergone; a comparison of the Quaternary vertebrates with similar species of the present epoch; a comparison of the flora of the southern departments of France with that of Algiers; the Eucalyptus and its uses; the influence of the chain of the Cevennes in the propagation northwards of the Mediterranean species of plants and animals; a study of the general movements of sand in Asia and Africa, noting the region in which it is retreating and that in which it is advancing.

We lately commented on a suggestion made, on economical grounds, that Jamaica should diminish the amount spent on, and by consequence the usefulness of, the Colonial Botanic Gardens. We are pleased to notice that similar views do not prevail elsewhere in the West Indian Islands, for at a late meeting of the Legislative Council of Grenada, the Governor announced that it had been decided to establish a Botanic Garden on the island. The site, he said, was selected on Government land, and an annual grant of 300*l.* was placed on the estimates for the expense of preparing the ground and paying a superintendent, who has not yet been engaged. The sum appears small, but is really a considerable amount for an island which is small and far from wealthy.

Messrs. Wodderspoon and Co., Serle Street, Lincoln's Inn, are publishing in one sheet on paper for sixpence, an easy guide to the principal constellations and stars visible in Great Britain. We have first a map of the circumpolar stars, and another showing those north and south of the equator; the guiding lines, by which the stars can be easily found from the instructions carefully given, being printed in red ink. It is very clear that the author has embodied in this cheap chart the results of much labour for the teaching of people uninstructed in such matters. We learn, indeed, that many copies have already been given away among coastguardsmen, labourers, and others, who, after a little instruction, use them greedily, and delight in having them to refer to. This is distinctly a good work, and we trust that some of our readers will follow it up.

We hear that the reconstruction of the Naval Astronomical Observatory of Japan, which has been deferred for several years owing to the extraordinary outlay required, is to be commenced at once according to the plans originally prepared.

It is stated that M. Paul Bert, the French physiologist, has been appointed Resident in Annam, Tonquin, and Cambodia.

A complete set of observations of the new star in Orion discovered by Mr. J. E. Gore on December 13, 1885, was, *Science* states, obtained at Harvard College Observatory on December 16—the very evening on which the despatch was received from Lord Crawford—settling the non-identity of the star with D.M. + 20°, 1172, the star named in the despatch. A meridian circle observation by Prof. Rogers gave for the position of the *nova* R.A. 5h. 49m. 4·25s., Decl. + 20° 9′ 15″·6. Prof. Pickering's photometric measures made the magnitude 6·2, and the spectroscope showed the existence of bright bands. Two excellent photographs fixing the position of the star with reference to neighbouring stars were obtained, and one photograph of the spectrum. The indications are suggestive of the new star being a long-period variable, and there was a slight suspicion of a diminution in magnitude during the first six or seven hours it was under observation.

Mr. Wood-Mason has, it is stated, undertaken to prosecute a thorough inquiry into the silk-producing larvæ of India.

South-Eastern Roumelia was visited on the evening of the 8th and morning of the 9th inst. by earthquake shocks, some of which were of a violent character. At Philippopolis the movement is described as being in a south-south-easterly direction.

On December 29, 1885, there was an earthquake at Ismidt, in Asia Minor, not far from Constantinople. It took place at half-past one in the afternoon. The oscillations were slight, and passed from west to east.

An interesting discovery of bronze hatchets and other prehistoric warlike instruments has been made at Llanwitt Major, Glamorganshire. As a number of workmen were engaged in digging a foundation for a building, they discovered three spear-heads, six hatchet-like celts, and several other interesting relics, which were concealed under an ancient wall. Some bones were also found. A further search is being organised.

Some interest is being excited among geologists in Kent by the great depth to which a boring has been sunk at the Dover Guard Prison for a water supply. The boring, which is close to the sea, has now reached a depth of 1000 feet, being 700 feet below the sea-level.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mr. T. Risely Griffith; a Gray Ichneumon (*Herpestes griseus*) from India, presented by Capt. J. Cutting; a Gray Squirrel (*Sciurus cinereus*) from North America, presented by Mrs. Charles Neck; a Golden Eagle (*Aquila chrysaetos*), European, presented by Mr. H. V. Knox; a Bronze-winged Pigeon (*Phaps chalcoptera*) from Australia, presented by Mr. Augustus F. Spry; a —— Hang-nest (*Xanthosomus icterocephalus*) from Venezuela, a Song Thrush (*Turdus musicus*), British, deposited; a White-thighed Colobus (*Colobus vellerosus*), a Moustache Monkey (*Cercopithecus cephus*), a Ludio Monkey (*Cercopithecus ludio*) from West Africa, received in exchange.

OUR ASTRONOMICAL COLUMN

THE LEYDEN OBSERVATORY.—Prof. H. G. van de Sande Bakhuyzen has published his Report for the year ending September 15, 1885. The work to which the meridian circle was devoted during the year was the continuation of the observation of a selected list of fairly bright stars situated in the immediate neighbourhood of the Pole. It is expected that this series of observations will be finished off during the present winter. With the 7-inch refractor, nine observations of Wolf's comet were made. Between October 1884 and March 1885, a series of measures have been made with Airy's double-image micrometer attached to this equatorial, for the purpose of determining the systematic errors of the measures of the diameters of Mars and Uranus obtained in former years. For this purpose, Prof. Bakhuyzen has measured the diameters of artificial disks, formed by circular holes in a copper plate, made so as to resemble, both in size and brightness, the planets themselves. The results of these investigations will be published shortly. The reduction of the meridian observations, 1877-85, is in a forward state, some parts being nearly completed. This work is intrusted to Dr. E. F. van de Sande Bakhuyzen, the First Observer. Some progress has also been made in the reduction of the zone observations, 1874-76. Prof. Bakhuyzen himself has been chiefly occupied with his monograph on the rotation-period of Mars, now published. In March 1885 work was commenced in connection with the erection of the new 10½-inch objective, and the instrument is now ready for use. The mounting has been supplied by the Repsolds, and the object-glass by Alvan Clark and Sons. Its performance, so far as it has yet been tested, appears to be remarkably good, and does not compare unfavourably with that of other instruments of similar size. In Prof. Bakhuyzens' hands it will doubtless do good work.

FABRY'S COMET.—Dr. H. Oppenheim gives the following ephemeris for this comet for Berlin midnight:—

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Log r
Jan. 17	23 31 4	+21 53·4	0·2304	0·2025
19	23 29 58	22 5·3		
21	23 28 58	22 18·2	0·2316	0·1857
23	23 28 3	22 32·1		
25	23 27 14	22 46·9	0·2319	0·1682

BROOKS'S COMET.—The following elements and ephemeris have been computed for this comet by Dr. J. Palisa:—

T = 1885 Nov. 28·2136 Berlin M.T.

$\pi = 301\ 29\ 50$
$\Omega = 262\ 30\ 48$ Mean Eq. 1886·0.
$i = 42\ 31\ 27$
$\log q = 0{\cdot}04091$

Error of the middle place (O − C).

$d\lambda \cos\beta = +4''{\cdot}7 \qquad d\beta = 4''{\cdot}5$

Ephemeris for Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Log r	Brightness.
Jan. 14	21 5 25	+12 8·6	0·2921	0·1261	0·74
18	21 20 46	13 48·6	0·2989	0·1377	0·68
22	21 35 48	15 25·2	0·3064	0·1495	0·62
26	21 50 48	+16 57·4	0·3146	0·1614	0·57

The brightness on December 28 is taken as unity.

BARNARD'S COMET.—For Barnard's comet Dr. H. Oppenheim gives the following ephemeris, also for Berlin midnight:—

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Log r
Jan. 17	2 37 45	+11 14·7	0·2136	0·3193
19	2 34 22	11 38·4		
21	2 31 8	12 2·5	0·2173	0·3068
23	2 28 4	12 27·0		
25	2 25 9	12 51·8	0·2213	0·2937

GORE'S NOVA ORIONIS.—Dr. Copeland, examining the spectrum of this object at Lord Crawford's Observatory, Dun Echt, finds distinct evidence of a spectrum of bright bands superposed on a well-marked spectrum of the third type; these bright bands corresponding to those ordinarily seen in cometary spectra, and obtained in the spectrum of a coal-gas flame.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 17-23

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 17

Sun rises, 8h. 0m.; souths, 12h. 10m. 24·5s.; sets, 16h. 21m.; decl. on meridian, 20° 42′ S.: Sidereal Time at Sunset, 0h. 9m.

Moon (Full on January 20) rises, 13h. 53m.; souths, 21h. 44m.; sets, 5h. 39m.*; decl. on meridian, 18° 13′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 40	10 36	14 32	22 59 S.
Venus	9 12	14 39	20 6	7 14 S.
Mars	21 30*	4 0	10 30	5 9 N.
Jupiter	22 39*	4 38	10 37	1 6 S.
Saturn	14 15	22 25	6 35*	22 36 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon

Jan.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
17	117 Tauri	6	15 38	16 28	33 264
18	130 Tauri	6	0 54	1 59	124 310
18	26 Geminorum	5½	20 37	21 44	43 271
20	1 Cancri	6	2 3	2 49	61 338
22	37 Sextantis	6	19 16	20 7	33 224

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Jan.	18, 0	2 *m*
			,,	22, 23	41 *m*
Algol	3 0·8	40 31 N.	,,	19, 20	0 *m*
ζ Geminorum	6 57·4	20 44 N.	,,	18, 5	0 *m*
			,,	23, 7	30 *M*
S Cancri	8 37·4	19 27 N.	,,	19, 3	23 *m*
δ Libræ	14 54·9	8 4 S.	,,	19, 17	20 *m*
			,,	22, 1	11 *m*
U Coronæ	15 13·6	32 4 N.	,,	19, 23	6 *m*
U Ophiuchi	17 10·8	1 20 N.	,,	17, 18	41 *M*
			and at intervals of	20	8
β Lyræ	18 45·9	30 14 N.	Jan.	19, 19	0 *m*
η Aquilæ	19 46·7	0 43 N.	,,	17, 0	0 *m*
δ Cephei	22 24·9	57 50 N.	,,	19, 0	0 *M*
			,,	22, 19	0 *m*

M signifies maximum; *m* minimum.

MR. AITKEN ON DEW[1]

THE first point referred to in this paper is the source of the vapour that condenses to form dew. A short historical sketch is given of the successive theories from time to time advanced on this point, showing how in early times dew was supposed to descend from the heavens, and then afterwards it was suggested that it rose from the earth, while Dr. Wells, who has justly been considered the great master of this

[1] Abstract of Paper read before the Royal Society of Edinburgh on December 21, 1885, communicated by permission of the Council of the Society.

subject, thought it came neither from above nor from below, but was condensed out of the air near the surface of the earth. He combated Gersten's idea that it rose from the earth, and showed that all the phenomena observed by Gersten and others which were advanced to support this theory could be equally well explained according to the theory that it was simply formed from the vapour present at the time in the air, and which had risen from the ground during the day, and concluded that if any did rise from the ground during night, the quantity must be small, but, with great caution, he adds that "he was not acquainted with any means of determining the proportion of this part to the whole."

A few observations of the temperature of the ground near the surface and of the air over it, first raised doubts as to the correctness of the now generally-received opinion that dew is formed of vapour existing at the time in the air. These observations, made at night, showed the ground at a short distance below the surface to be always hotter than the air over it; and it was thought that so long as this excess is sufficient to keep the temperature of the surface of the ground above the dew-point of the air, it will, if moist, give off vapour; and it will be this rising vapour that will condense on the grass and form dew, and not the vapour that was previously present in the air.

The first question to be determined was whether vapour does, or does not, rise from the ground on dewy nights. One method tried of testing this point was by placing over the grass, in an inverted position, shallow trays made of thin metal and painted. These trays were put over the ground to be tested after sunset and examined at night, and also next morning. It was expected that, if vapour was rising from the ground during dewy nights, it would be trapped inside the trays. The result in all the experiments was that the inside was dewed every night, and the grass inside was wetter than that outside. On some nights there was no dew outside the trays, and on all nights the inside deposit was heavier than the outside one.

An analysis of the action of these trays is given, and it is concluded that they act very much the same as if the air was quite still. Under these conditions vapour will rise from the ground so long as the vapour-tension on the surface of the ground is higher than that at the top of the grass, and much of this rising vapour is, under ordinary conditions, carried away by the passing air, and mixed with a large amount of dryer air, whereas the vapour rising under the trays is not so diluted; and hence, though only cooled to the same amount as the air outside, it yields a heavier deposit of dew.

Another method of testing this point was employed, which consisted in weighing a small area of the exposed surface of the ground, as it was evident that if the soil gave off vapour during a dewy night, it must lose weight. A small turf about 6 inches (152 mm.) square, was cut out of the lawn and placed in a small shallow pan of about the same size. The pan with its turf, after being carefully weighed, was put out on the lawn in the place where the turf had been cut. It was exposed for some hours while dew was forming, and on these occasions it was always found to lose weight. It was thus evident that vapour was rising from the ground while dew was forming, and therefore the dew found on the grass was formed of part of the rising vapour, trapped or held back by coming into contact with the cold blades of grass.

The difference between these experiments in which the exposed bodies *lose* weight, and the well-known ones in which bodies are exposed to radiation, and the amount of dew formed is estimated by the *increase* in their weight, is pointed out. In the former case the bodies are in good heat-communication with the ground, whereas in the latter, little or no heat is received by conduction from the earth.

Another method employed for determining whether the conditions found in nature were favourable for dew rising from the ground on dewy nights, was by observations of the temperatures indicated by two thermometers, one placed on the surface of the grass, and the other under the surface, amongst the stems, but on the top of the soil. The difference in the readings of these two thermometers on dewy nights was found to be very considerable. From 10° to 18° F. was frequently observed. A minimum thermometer placed on, and another under, the grass, showed that during the whole night a considerable difference was always maintained. As a result of this difference of temperature, it is evident that vapour will rise from the hotter soil underneath, into the colder air above, and some of it will be trapped by coming into contact with the cold grass.

While the experiments were being conducted on grass land, parallel observations were made on bare soil. Over soil the inverted traps collected more dew inside them than those over grass. A small area of soil was spread over a shallow pan, and after being weighed was exposed at the place where the soil had been taken out, to see if bare soil as well as grass lost weight during dewy nights. The result was that on all nights on which the tests were made the soil lost weight, and lost very nearly the same amount as the grass land.

Another method employed of testing whether vapour is rising from bare soil, or is being condensed upon it, consisted in placing on the soil, and in good contact with it, small pieces of black mirror, or any substance having a surface that shows dewing easily. In this way a small area of the surface of the earth is converted into a hygroscope, and these test-surfaces tell us whether the ground is cooled to the dew-point or not. So long as they remain clear and undewed, the surface of the soil is hotter than the dew-point, and vapour is being given off, while if they get dewed, the soil will also be condensing vapour. On all nights observed, these test-surfaces kept clear, and showed the soil to be always giving off vapour.

All these different methods of testing point to the conclusion that during dewy nights, in this climate, vapour is constantly being given off from grass-land, and almost always from bare soil; that the tide of vapour almost always sets outwards from the earth, and but rarely ebbs, save after being condensed to cloud and rain, or on those rarer occasions on which, after the earth has got greatly cooled, a warm moist air blows over it. The results of some of the experiments are given, showing, from weighings, the amount of vapour lost by the soil at night, and also the heat lost by the surface soil.

It seems probable that when the radiation is strong, that soil, especially if it is loose and not in good heat-communication with the ground, will get cooled below the dew-point, and have vapour condensed upon it. On some occasions the soil certainly got wetter on the surface, but the question still remains, Whence the vapour? Came it from the air, or from the soil underneath? The latter seems the more probable source: the vapour rising from the hot soil underneath will be trapped by the cold surface-soil, in the same way as it is trapped by grass over grass-land. During frost, opportunities are afforded of studying this point in a satisfactory manner, as the trapped vapour keeps its place where it is condensed. On these occasions the under sides of the clods, at the surface of the soil, are found to be thickly covered with hoar-frost, while there is little on their upper or exposed surfaces, showing that the vapour condensed on the surface-soil has come from below.

The next division of the subject is on dew on roads. It is generally said that dew forms copiously on grass, while none is deposited on roads, because grass is a good radiator and cools quicker, and cools more, than the surface of a road. It is shown that the above statement is wrong, and that dew really does form abundantly on roads, and that the reason it has not been observed is that it has not been sought for at the correct place. We are not entitled to expect to find dew on the surface of roads as on the surface of grass, because stones are good conductors of heat, and, the vapour-tension being higher underneath than above the stones, the result is, the rising vapour gets condensed on the under sides of the stones. If a road is examined on a dewy night, and the gravel turned up, the under sides of the stones are found to be dripping wet.

Another reason why no dew forms on the surface of roads is that the stones, being fair conductors, and in heat-communication with the ground, the temperature of the surface of the road is, from observations taken on several occasions, higher than that of the surface of the grass alongside. The air in contact with the stones is, therefore, not cooled so much as that in contact with the grass.

For studying the formation of dew on roads, slates were found to be useful. One slate was placed over a gravelly part of the road, and another over a hard dry part. Examined on dewy nights the under sides of these slates were always found to be dripping wet, while their upper surfaces, and the ground all round, were quite dry.

The importance of the heat communicated from the ground is illustrated by a simple experiment with two slates or two iron weights, one of them being placed on the ground, either on grass or on bare soil, and the other elevated a few inches above the surface. The one resting on the ground, and in heat-communication with it, is found always to keep dry on dewy nights, whereas the elevated one gets dewed all over.

The effect of wind in preventing the formation of dew is referred to. It is shown that, in addition to the other ways

already known, wind hinders the formation of dew by preventing an accumulation of moist air near the surface of the ground.

An examination of the different forms of vegetation was made on dewy nights. It was soon evident that something else than radiation and condensation was at work to produce the varied appearances then seen on plants. Some kinds of plants were found to be wet, while others of a different kind, and growing close to them, were dry, and even on the same plant some branches were wet, whilst others were dry. The examination of the leaf of a broccoli plant showed better than any other that the wetting was not what we might expect if it were dew. The surface of the leaf was not wet all over, and the amount of deposit on any part had no relation to its exposure to radiation, or access to moist air; but the moisture was collected in little drops, placed at short distances apart, along the very edge of the leaf. Closer examination showed that the position of these drops had a close relation to the structure of the leaf; they were all placed at the points where the veins in the leaf came to the outer edge, at once suggesting that these veins were the channels through which the liquid had been expelled. An examination of grass revealed a similar condition of matters: the moisture was not equally distributed over the blade, but was in drops attached to the tips of some of the blades. These drops, seen on vegetation on dewy nights, are therefore not dew at all, but are an effect of the vitality of the plant.

It is pointed out that the excretion of drops of liquid by plants is no new discovery, as it has been long well known, and the experiments of Dr. Moll on this subject are referred to; but what seems strange is that the relation of it to dew does not seem to have been recognised.

Some experiments were made on this subject in its relation to dew. Leaves of plants that had been seen to be wet on dewy nights were experimented on. They were connected by means of an india-rubber tube with a head of water of about 1 metre, and the leaf surrounded with saturated air. All were found to exude a watery liquid after being subjected to pressure for some hours, and a broccoli leaf got studded all along its edge with drops, and presented exactly the same appearance it did on dewy nights. A stem of grass was also found to exude at the tips of one or two blades when pressure was applied.

The question as to whether these drops are really exuded by the plant, or are produced in some other way, is considered. The tip of a blade of grass was put under conditions in which it could not extract moisture from the surrounding air, and, as the drop grew as rapidly under these conditions as did those on the unprotected blades, it is concluded that these drops are really exuded by the plant. Grass was found to get "dewed" in air not quite saturated.

On many nights no true dew is formed, and nothing but these exuded drops appear on the grass; and on all nights when vegetation is active, these drops appear before the true dew, and if the radiation is strong enough and the supply of vapour sufficient, true dew makes its appearance, and now the plants get equally wet all over, in the same manner as dead matter. The difference between true dew on grass, and these exuded drops, can be detected at a glance. The drops are always exuded at a point near the tip of the blade, and form a drop of some size, while true dew is distributed all over the blade. The exuded liquid forms a large diamond-like drop, while the dew coats the blade with a pearly lustre.

Towards the end of the paper the radiating powers of different surfaces at night is considered, and after a reference to some early experiments on this subject, the paper proceeds to describe some experiments made with the radiation-thermometer described by the author in a previous paper. When working with this instrument it is placed in a situation having a clear view of the sky all round, and is fixed at the same height as the ordinary thermometer-screen, which is worked along with it, the difference between the thermometer in the screen and the radiation-thermometer being observed. This difference in clear nights amounts to from 7° to 10°. By means of the radiation-thermometer the radiating powers of different surfaces were observed. Black and white cloths were found to radiate equally well; soil and grass were also almost exactly equal to each other. Lamp-black was equal to whitening. Sulphur was about 2/3rds of black paint, and polished tin about 1/7th of black paint. Snow in the shade on a bright day was at midday 7° colder than the air, while a black surface at the same time was only 4° colder. This difference diminished as the sun got lower, and at night both radiated almost equally well. In the concluding pages of the paper some less important subjects are considered.

TELESCOPIC SEARCH FOR THE TRANS-NEPTUNIAN PLANET[1]

IN the twentieth volume of the *American Journal of Science*, at page 225, I gave a preliminary account of my search, theoretic and practical, for the trans-Neptunian planet. I say *the* trans-Neptunian planet, because I regard the evidence of its existence as well-founded, and further, because, since the time when I was engaged upon this search, nothing has in the least weakened my entire conviction as to its existence in about that part of the sky assigned; while, as is well known, the independent researches in cometary perturbations by Prof. Forbes conducted him to a result identical with my own,—a coincidence not to be lightly set aside as pure accident.

That five years have elapsed since this coincidence was remarked, and the planet is still unfound, is not sufficient assurance to me that its existence is merely fanciful. In so far as I am informed, this spot of the sky has received very little scrutiny with telescopes competent to such a search; and most observers finding nothing would, I suspect, prefer not to announce their ineffective search.

The time has now come when this search can be profitably undertaken by any observer having the rare combination of time, enthusiasm, and the necessary appliances. Strongly marked developments in astronomical photography have been effected since this optical search was conducted; and the capacity of the modern dry-plate for the registry of the light of very faint stars makes the application of this method the shortest and surest way of detecting any such object. Nor is this purely an opinion of my own. But the required apparatus would be costly; and the instrument, together with the services of an astronomer and a photographer, would, for the time being, be necessarily devoted exclusively to the work. While, however, the photographic search might have to be ended with a negative result, in so far as the trans-Neptunian planet is concerned, there would still remain the series of photographic maps of the region explored, and these would be of incalculable service in the astronomy of the future.

In the latter part of the paper alluded to above, I stated the speculative basis upon which I restricted the stellar region to be examined; also the fact that between November of 1877 and March of 1878 I was engaged in a telescopic scrutiny of this region, employing the twenty-six-inch refractor of the Naval Observatory. For the purposes contemplated I had no hesitation in adopting the method of search whereby I expected to detect the planet by the contrast of its disk and light with the appearance of an average star of about the thirteenth magnitude. A power of 600 diameters was often employed, but the field of view of this eye-piece was so restricted that a power of 400 diameters had to be used most of the time. I say, too, that, "after the first few nights, I was surprised at the readiness with which my eye detected any variation from the average appearance of a star of a given faint magnitude: as a consequence whereof my observing-book contains a large stock of memoranda of suspected objects. My general plan with these was to observe with a sufficient degree of accuracy the position of all suspected objects. On the succeeding night of observation they were re-observed; and, at an interval of several weeks thereafter, the observation was again verified." Subjoined to the original observations are printed these verifications in heavy-faced type.

In conducting the search, the plans were several times varied in slight detail,—generally because experience with the work enabled me to make improvements in method. Usually I prepared every few days a new zone-chart the region of over which I was about to search; and these charts, while containing memoranda of all the instrumental data which could be prepared beforehand, were likewise so adjusted with reference to the opposition-time of the planet as to avoid, if possible, its stationary point. The same thing, too, was kept in mind in selecting the times of subsequent observation. Notwithstanding this precaution, however, it would be well if some observer who has a large telescope should now re-examine the positions of these objects.

Researches in faint nebulæ and nebulous stars appearing likely to constitute a separate and interesting branch of the astronomy of the future, it has seemed to me that the astronomers engaged in this work may like to make a careful examination of some of the stars entered in my observing-book under the category of "suspected objects." The method I adopted of

[1] By David P. Todd, M.A., from the *Proceedings* of the American Academy of Arts and Sciences.

servation of these objects was by the determination of their absolute, but only of their relative, positions, ncy of the larger "finder" of the great telescope. rture of five inches, a power of thirty diameters, view of seventy-eight minutes of arc. Two sually drawn in the book for each of these showing the relation of adjacent objects in the and the other the configuration of the more jects in the field of view of the finder. Adjacent nder" diagrams are the settings,—to the nearest rc in declination, and of time in right ascension,—as the large finding-circles, divided in black and white. ield of vew of the finder is cross-ed by two pairs of hair-ines, making a square of about twelve minutes on a side by their intersection at the centre. The diagrams in all cases represent the objects as seen with an inverting eye-piece. As the adjustment of the finder was occasionally verified, as well as the readings of the large circles, there should be no trouble in identifying any of these objects, notwithstanding the fact that no estimates of absolute magnitude were recorded. The relative magnitudes, while intended to be only approximate, are still shown with sufficient accuracy for the purpose of the research, and the diagrams are, in general, faithful tracings from the original memoranda.

[Mr. Todd transcribes the observing-book entire.].

PRIME MERIDIAN TIME[1]

the first day of the month, the President of the United States, in his message at the opening of Congress, referred to the International Meridian Conference lately convened in Washington, in the following words:—"The Conference concluded its labours on November 1, having with substantial unanimity agreed upon the meridian of Greenwich as the starting point whence longitude is to be computed through 180° eastward and westward, and upon the adoption for all purposes for which it may be found convenient of a Universal Day, which shall begin at midnight on the initial meredian, and whose hours shall be counted from zero up to twenty-four."

The Canadian Institute is peculiarly interested in this announcement. No society, literary or scientific, has taken a more important part in the initiation of the movement to reform our Time-system, of which the success is, to some extent, indicated in the President's words. It therefore appears to me fit and proper that I should recall to your attention the various steps which from time to time have been taken, so that we may possess a record of the events which have led to the now almost general recognition of the necessity for a new notation.

Six years ago on several occasions the meetings of the Institute were engaged in discussing the subject of Time-reckoning and the selection of a Prime Meridian common to all nations. Papers were read and arguments were advanced, with the view of showing the necessity of establishing a cosmopolitan or universal time, by which the events of history might be more accurately recorded, and which would respond to the more precise demands of science, and generally satisfy the requirements of modern civilisation. The *Proceedings* of the Institute for January and February, 1879, give at considerable length the views submitted and the suggestions offered to meet the new conditions of life. While on the one hand it was argued that the introduction of a comprehensive scheme by which time could be universally reckoned was highly desirable, it was equally maintained that the determination of a common Prime Meridian for the world was the key to its success, and that the establishment of such a meridian, as a zero, recognised by all nations, was the first important step demanded.

These *Proceedings* were brought under the notice of His Excellency the Marquis of Lorne, then Governor-General of Canada. In the name of the Institute, they were submitted, in the form of a memorial, with the hope that His Excellency would see fit to lay them before the Imperial Government, that they would by these means obtain the attention of the several scientific bodies throughout Europe, and that some general systematic effort would be made in the right direction to secure the important objects sought to be attained.

Through the good offices of His Excellency, copies of the Canadian Institute *Proceedings* found their way to the British Admiralty, the Astronomer Royal, Greenwich, the Astronomer Royal for Scotland, Edinburgh, the Royal Society, the Royal Geographical Society, the Royal Astronomical Society, the Royal United Service Institute, and other societies of eminence and weight in the United Kingdom. Copies of the papers were likewise sent through the Imperial Government to the governments of the following countries, viz.:—

France,	Germany,
Italy,	Norway and Sweden,
The United States,	Russia,
Austria,	Belgium,
Brazil,	Denmark,
Japan,	The Netherlands,
Spain,	Portugal,
Switzerland,	Turkey,
Greece,	China.

In the year following, the American Metrological Society issued a Report of the Committee on Standard Time. The report bears the name of Mr. Cleveland Abbe, the Chairman of the Committee, and the date of May, 1879. It draws attention to many of the causes calling for the establishment of accurate time, and the attempts made since the establishment of the electro-magnetic telegraph to make the notation of time synchronous. While pointing out that this result had been obtained in Great Britain through the efforts of Prof. Airy, Mr. Cleveland Abbe gave a list of the various observatories on this continent which are in possession of the necessary apparatus and force proper to furnish astronomically accurate time by telegraph. Writing in February, 1880, while giving the resolution adopted by the society, recommending the adoption of accurate time by telegraph from an established astronomical observatory, Mr. Cleveland Abbe points out that the subject of accurate time has been taken up by the Horological Bureau of the Winchester Observatory of Yale College, and that the most perfect apparatus had been received for the purpose of distributing New York time with the highest degree of uniformity and accuracy.

Mr. Cleveland Abbe's own remarks on the subject are of high value. He forcibly points out the difficulties and inconveniences under which railway operations in America labour from the want of a proper system of time. To show this fact in greater force, he gives the 74 standards then followed. These several standards he proposed to set aside and replace by standards each differing one hour, or 15° of longitude.

While recommending this course, the report sets forth that the change could only be regarded as a step towards the absolute uniformity of all time-pieces, and the Society passed resolutions, that absolute uniformity of time is desirable; that the meridian six hours west of Greenwich should be adopted as the National Standard to be used in common on all railways and telegraphs, to be known as "Railroad and Telegraph Time;" that after July 4, 1880, such uniform Standard Time should be the legal standard for the whole country, and that the State and National Legislatures should be memorialised on the subject.

Mr. Cleveland Abbe in this report alluded to the previous *Proceedings* of the Canadian Institute.

The active sympathy of the Marquis of Lorne greatly aided the movement of Time-reform in its early stages. In 1879, in his official position as Governor-General, he had been the recipient of the papers published by the Canadian Institute, and had transmitted them to Great Britain, and through the Imperial Government to the several European centres. In 1880, it was learned that the Report to the American Metrological Society, above alluded to, would shortly be issued. Accordingly, advance copies were obtained from New York, and, together with additional papers issued by this Institute, they were transmitted by His Excellency to the following European Societies, and the special attention of their members was directed to the documents themselves:—

1. The Institut de France	Paris.
2. Société de Géographie	Paris.
3. Société Belge de Géographie	Brussels.
4. Königliche Preussische Akademie der Wissenschaften	Berlin.
5. Gesellschaft für Erdkunde	Berlin.
6. Kaiserliche Akademie der Wissenschaften	Vienna.
7. K. K. Geographische Gesellschaft . .	Vienna.
8. Nicolaievskaia Glavnaia Observatoria .	Pultowa.
9. Imper. Rousskae Geograficheskoe Obschestou	St. Petersburg.

[1] This paper, giving the early history of a movement which is now attracting such general attention, we extract from a recently received volume of *Transactions* of the Canadian Institute.

10. Imper. Akademia Nauk . . . . . St. Petersburg.
11. Société de Géographie . . . . . Geneva.

By this means attention was obtained for the subject in Europe, and when I submit evidence of the fact, I think you will agree with me, that no little of the success which has attended the movement is owing to our late Governor-General. We must all acknowledge how much we are indebted to him for the great personal interest he has always shown on the subject. We are certainly warranted in forming the opinion, that the dissemination of these papers, under such distinguished auspices, awakened attention to the arguments they contain, and prepared the way for the subsequent action taken at the International Geographical Congress at Venice, at the Geodetic Congress at Rome, and more recently at the Conference at Washington.

Mr. Wilhelm Förster, director of the Berlin Observatory, enters into the subject at length in a paper "Zur Beurtheilung Einiger Zeitfragen, insbesondere gegen die Einführung einer deutschen Normalzeit." [A Review of some considerations on Time, especially against the introduction of German National Uniform Time.]

Mr. Förster proceeds to say: The British Government is now transmitting, through its representatives, although at the same time it declares itself neutral, a proposition which has been published by a society of scientific men in Canada, which aims at the establishment of a cosmopolitan normal datum (Prime Meridian) and of Universal Time, and also the establishment of 24 meridians of an hour apart, by which local time will be absorbed. The first proposal Mr. Förster describes as an important sign of the times and evidently favours it.

He strongly protests against the establishment of a National German Time; but for railway business, and for such matters of communication as require precision, also for the form of expression of all scientific relations to time, Mr. Förster points out that a Universal Time common to the whole world is to be recommended.

Dr. G. von Boguslavski, in the *Verhandlungen der Gesellschaft für Erdkunde* (*Transactions of the Geographical Society of Berlin*), commends the new scheme as it has been put forth in the Canadian Institute papers, and foretells that it will be a matter of fact in a short time.

Col. Aden, Director of the Military School, Belgium, has two papers in the *Bulletin de la Société Belge de Géographie*. He supports the proposal to establish Universal Time, and expresses the opinion that longitude throughout the world should have a common notation, dating from one universally adopted Prime Meridian.

Col. Wauverman, President of the Geographical Society of Antwerp, in the *Bulletin* of that society, 1882, advocates the change, and with ability meets the arguments raised against it, showing them to be groundless and arising from a want of thoroughly understanding the question.

In Spain, the proposals have met with full support. All the papers issued by the Canadian Institute have been translated and published in a paper of 80 pages by the Revista General de Marina. The translator, Don Juan Pastorin, an officer of the Spanish navy, is warm in his commendation of the scheme, and takes a wise and comprehensive view of the whole question. The Spanish Government secured the advantage of this gentleman's services as delegate to the Washington Conference.

M. Otto Struve, the well known Astronomer and Director of the Imperial Observatory, Pultowa, reports on the papers transmitted by Lord Lorne to the Imperial Academy of Science, St. Petersburg. He gives his adherence to the establishment of Universal Time, based, as suggested, on a Prime Meridian common to the whole globe, and strongly advocates counting the hours in one series up to 24.

In England, the Royal Society considered favourably both the establishment of a Universal Time and the determination of a common Prime Meridian. While the present Astronomer Royal, Mr. Christie, takes a favourable view of the question, his predecessor, Sir G. B. Airy, reported unfavourably. The report of the Astronomer Royal for Scotland, Prof. Piazzi-Smith, is decidedly adverse. These documents have been transmitted to the Institute.

In Italy, the Italian Geographical Society has given its countenance to a work by Mr. Fernando Bosari, who, in a pamphlet of 68 pages, reviews the whole question at length, and lays down three principles: 1. The determination of a Zero-meridian; 2. The establishment of Cosmopolitan Time based upon it; 3. The notation of the hours from 1 [illegible] tinuous series.

The question of Universal Time and the selec[illegible] Meridian is discussed with ability in a paper [illegible] Thury, professor at the University of Geneva.

At the meeting of the Association for the R[illegible] cation of the Laws of Nations at Cologne, Pr[illegible] question of regulating time on the new systen[illegible] and resolutions moved.

In the same year (1881), the subject occupied th[illegible] the International Geographical Congress at Venice, [illegible] delegate from the Canadian Institute attended. Th[illegible] question was warmly discussed, and resolutions adopted. [illegible] appointment of an International Conference to meet at Wash[illegible] ington, specially to consider the question, was then suggested by the Canadian delegate, and warmly supported by gentlemen representing the government and scientific societies of United States. The President of the Congress communicated the resolutions to the Italian Government, and Prince Teano, behalf of the Italian Government, undertook to conduct official correspondence. Out of this appears to have sprung important discussion at the meeting of the International Geodet Association at Rome, in October, 1883, when the utility Universal Time was recognised, and a special International Conference for the establishment of a zero-meridian for longitude and time recommended.

Returning to this side of the Atlantic, the question of regul[illegible] time for railway, telegraph, and civil purposes generally, was sidered at the Convention of the American Society of Engineers, held at Montreal, June 15, 1881, and a committee men engaged in the management, and familiar with the economy of railways, appointed to examine the question. The committee has reported from time to time. They recognised that a proposition to reform the general time system of the country was a problem beset with difficulties, but it did not appear to them insolvable. It was felt, however, that the question affected so many interests that any change could only be effected by general concurrence.

To attain the end proposed by this society, the papers bearing on the question were printed, and a scheme modified on the *Proceedings* of the Canadian Institute was drawn up, under the title of "Cosmopolitan scheme for regulating time."

I may briefly recall the features of the scheme.

There should be one standard of absolute time, a Universal Day, based on the mean solar passage, at one particular meridian, the Prime or initial meridian for computing longitude. This Prime Meridian, together with the Universal Day, to be observed by all civilised nations.

There should be 24 secondary or hour-meridians established, 15 degrees of longitude apart, beginning with the Prime Meridian as zero.

To distinguish the Universal Day from local days, it should bear the title of "Cosmic Day."[1]

Cosmic Time is intended to be used to promote exactness in chronology, and to be employed in astronomy, navigation, meteorology and in synchronous observations throughout the world. To be employed in ocean telegraphy and generally in all operations non-local in character.

The several 24 meridians to be used as standards for local time around the globe. Applying the system to North America, the effect would be to reduce the standards to four or five, as suggested by the Metrological Society.

A circular, dated March 15, 1882, signed by Mr. John Bogart, the Secretary of the American Society of Civil Engineers, was forwarded to the leading men in railway direction, either as general managers, superintendents, or engineers, and to men of scientific attainments throughout the United States and Canada. The paper thus circulated contained 11 questions, and categorical replies were invited to them.

Replies were received and reported on at a Convention of the Society, held in Washington on May 15, 1882. The scheme submitted was generally and cordially approved.

An emphatic and unanimous opinion was expressed, that there should be established as early as possible a comprehensive system of Standard Time for North America.

[1] [NOTE.—I may remark, that the designation "Cosmic" was first suggested, independently, by two Canadian gentlemen widely separated, by Mr. R. G. Haliburton, then in Algiers, and by Mr. Thomas Hector, of Ottawa. The etymology commends the use of the word. It has been accepted by a number of societies and by many individuals as appropriate and applicable.]

Of those who replied to the queries, 95 per cent. favoured the idea that there should be a common agreement between the standards of time in all countries. That while we must primarily look to our own convenience on this continent, it is proper to aim at eventually attaining general uniformity among all nations.

Seventy-six per cent. were in favour of reducing the standards in North America so that they would differ only by intervals of one hour, and 92 per cent. were in favour of a notation of the hours of the day by a single series from 1 to 24, instead of in two divisions, each of 12 hours.

The character of the replies received indicated that a remarkable unanimity of opinion prevailed in every section of the continent heard from. The Convention accordingly resolved that an attempt should be made to obtain European concurrence to the selection of a Prime Meridian on which a time-system could be definitely based. But, failing to obtain this recognition, the people of the Western Continent should determine a zero-meridian for their own use and guidance.

It was thereupon resolved to petition the Congress of the United States to take the matter into consideration. The American Metrological Society about the same time adopted a similar proceeding. The consequences were that a joint-resolution of the House of Representatives and the Senate was passed, authorising the President of the United States to call an International Conference to fix on and recommend for universal adoption a common Prime Meridian to be used in the reckoning of longitude and in the regulation of time throughout the world.

On the meeting of the American Association for the Advancement of Science in Montreal, in July, 1882, the subject was brought forward, and all the documents were submitted and discussed. It was agreed that the Association should co-operate with other bodies in furtherance of the movement.

On two occasions the Royal Society of Canada has had its attention directed to the matter, and this body has assisted in furthering the determination of the problem by its co-operation and by correspondence with the Government.

While some delay took place in summoning the International Conference by the President, in consequence of diplomatic correspondence on the subject, the question was ripening on both sides of the Atlantic for concerted action. Indeed, a decision with respect to the regulation of local time was anticipated by the railway authorities in North America, who adopted the system of hour-standards which had been prominently brought forward as described.

On November 18 of last year (1883) the new system of regulating railway time on this continent came into operation. There had been several preliminary meetings of railway managers; the last meeting was a Convention held in Chicago the previous October, and it was then determined immediately to carry out the change.

Mr. W. F. Allen, the secretary of this Convention, who also took a prominent part in effecting the adoption of the change, has given a history of the events leading to it. Upon this gentleman mainly fell the labour of arranging details, and he executed the difficult duties assigned to him with consummate ability. In the words of the historian, the transition from the old to the new system "was put into effect without any appreciable jar, and without a single accident occurring." According to this authority the first newspaper to advocate some change was the *Railroad Gazette* for April 2, 1870, and it is claimed that as early as 1869 Prof. Charles F. Dowd, Principal of Temple Grove Ladies' Seminary, Saratoga Springs, proposed a system of meridians based on the meridian of Washington at intervals of one hour, by which railways should be operated, and that an expression of his views was placed in the hands of the President of the New York and Canada Railroad. The proposition appears to have attracted attention in the *Travellers' Official Guide* of 1872. In 1873 it was brought before the Railway Association of America, not now in existence. A committee was appointed to examine into its merits; they failed to recognise its necessity, and recommended that the question of National Standard Time for use on Railways be deferred till it more clearly appeared that the public interest called for it.

Mr. Dowd's efforts to introduce a National Standard Time to meet the difficulties which were being developed were at the time imperfectly appreciated. He, however, has had the satisfaction of seeing a scheme unanimously accepted, and put in operation, which in essential features does not materially differ from that which he advocated; and he himself attended at the meeting of the American Metrological Society, and took part in the proceedings when the details of the new time arrangements were officially narrated.

Prominent among those who have earnestly laboured to advance the movement of time-reform is the distinguished President of Columbia College, New York. Dr. Barnard has from the first taken the deepest interest in the question, and few men have done so much to bring it to a practical issue. In the proceedings of the American Metrological Society for 1881 will be found a paper prepared by Dr. Barnard in 1872, and presented to an association which has since assumed an international character, and is known as the Association for the Reform and Codification of the Laws of Nations. In this paper Dr. Barnard recommends the selection of Greenwich as the Prime Meridian for the world, and he submits the views he held at that early date, which at this hour are of peculiar interest. He points out that "it is becoming a matter of greater importance every day that there should be established some universal rule for defining the calendar day for all the world."

I have alluded to the valuable report of Prof. Cleveland Abbe, of the United States Signal Service, to the Metrological Society, and I cannot deny myself the pleasure of acknowledging the services of the gentlemen with whom I have been associated on the special committee on Standard Time of the American Society of Civil Engineers, Mr. Charles Paine, of New York; Mr. Theodore N. Ely, of Altoona, Pennsylvania; Mr. J. M. Toucey, of the Hudson River Railway; Prof. Hilgard, Coast Survey, Washington; Prof. T. Egleston, of Columbia College: General T. G. Ellis, of Hartford, now unfortunately deceased, and Mr. John Bogart, Secretary of the Society.

The American Society of Civil Engineers, since meeting in Montreal, in 1881, has made persistent and continuous efforts in the common interest to advance the movement of time-reform, having greatly aided in bringing about the important change carried into effect a year ago. This Society is now directing attention to a reform of scarcely less importance, the notation of the hours of the day. At the Buffalo convention in June 1884, this particular question received prominent consideration in the address of the President, as well as in the report of the special committee. Since that date a correspondence has taken place between the Secretary and the railway managers in the United States and Canada. Already replies have been received from the representatives of some 60,000 miles of railway, 98 per cent. of whom have given expression to their sympathy with the movement, to abandon the old practice of halving the day, designating the two sets of 12 hours by the abbreviations A.M. and P.M., and are prepared to adopt a simple notation of 1 to 24 in a single series. The great telegraph interests of the country are likewise in full sympathy with it. The President of the Western Union Telegraph Company, Dr. Norwin Green, states that their telegraphic traffic is equal to the transmission of 44,000,000 messages a year, and the general adoption of the 24 o'clock system (as it has been designated), would be cordially welcomed by telegraphers. It would reduce materially the risk of errors, and to the company over which he presides, he says it would save the transmission by telegraph of at least 150,000,000 letters annually.

The branch literature bearing on the two questions of Universal Time and the establishment of a Prime Meridian, has been enriched by a series of papers which have appeared during the past year in the *International Standard*, a magazine published in Cleveland, Ohio. These papers are by the following gentlemen connected with the International Institute:—Rev. H. G. Wood, of Sharon, Pennsylvania; Prof. C. Piazzi-Smyth, Astronomer Royal for Scotland; Prof. John N. Stockwell, Astronomer, Cleveland; Mr. Jacob M. Clark, C.E., New York; Mr. William H. Searle, Pennsylvania; the late Abbé F. Moigno, Canon of St. Denis, Paris; Commodore Wm. B. Whiting, U. S. Navy; Mr. Charles Latimer, C.E., Cleveland; and others.

It will be seen from what I have submitted, that the proceedings have neither been few nor without success, and that since this Institute published the first issue of papers on Time and Time-reckoning, the subject has received much attention on both sides of the Atlantic. Societies with kindred pursuits, men of recognised merit in the scientific world, have turned to its examination and aided in its development. Some few men have acted in concert. The labours of others have been independent. Some of these names I have been able to record, but I fear that I neglect to include many of eminence because they are not

known to me. It is this varied and widely diffused effort which has rendered possible the realisation of the practical results which I have the gratification to record, and all the members of this Society must equally join in the common satisfaction in the measure of success which has been achieved.

Six years back, when the subject was discussed in this hall, there were probably not a few who viewed the propositions then submitted as merely fanciful theories. Others, who did not refuse to recognise their bearing, entertained the feeling that many grave difficulties presented themselves to interfere with any successful attempt to reform or modify usages so ancient as the computation of time. But the Institute, as a body, was hopeful. The action taken by the Council to extend the field of discussion and awaken the attention of foreign communities, evinced confidence, and we may now ask, was this confidence justified? What are the facts to-day? Twelve months have passed since an important change in the notation of railway time was made with general approval throughout the length and breadth of North America; a revolution in the usages of 60,000,000 of people has been silently effected and with scarcely a trace that it has happened. That proceeding has been followed by events of equal importance. On October 1 last a body of accredited delegates from the different nations, on the invitation of the President of the United States, met in Conference to consider the problem first submitted to the world by this Institute. The delegates were the representatives of 25 civilised nations. The Conference continued during the whole month of October, and, as a body, they came to conclusions affecting all peoples living under our theories of civilisation.

It was early understood that a determination with respect to Universal Time was not possible without the general recognition of a Prime Meridian. Hence the importance attached to its choice, that it should be universally accepted.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 10, 1885.—Abstract of a Paper on "Preliminary Results of a Comparison of Certain Simultaneous Fluctuations of the Declination at Kew and at Stonyhurst during 1883-84, as recorded by the Magnetographs." By the Rev. S. J. Perry, F.R.S., and Prof. B. Stewart, F.R.S.

The authors remark that such fluctuations almost always occur as couplets or groups of couplets; a couplet meaning first an ascent and then a descent, or the reverse. In their opinion this duality and the other facts of their paper can best be explained by supposing that a recorded magnetic fluctuation is the joint result of two causes: the one of these being a true magnetic change, and the other a secondary current caused by this change. The secondary current would probably appear as an earth-current. Its maximum strength would depend on the maximum rate of magnetic change, but as this last element is quite unknown, we may perhaps suppose that this maximum strength will be practically proportional to the mean rate of magnetic change.

On this supposition the authors suggest the following formula as capable of being used as a preliminary working hypothesis.

Let K denote the observed Kew change, and k the true magnetic change at Kew, also let t represent the duration; then $K = k\left(1 \mp \frac{\alpha}{t}\right)$ where α is a constant. Also if S represent the observed simultaneous Stonyhurst change, then $S = k\left(\beta \mp \frac{\gamma}{t}\right)$, the sign − being applicable to the first limb, and the sign + to the second limb of the couplet.

It follows from this that $\frac{S}{K} = \frac{\beta \mp \frac{\gamma}{t}}{1 \mp \frac{\alpha}{t}}$, or, in other words, that the ratio between the Kew and Stonyhurst observed disturbances will be a function of the duration, quite apart from all theoretical considerations, which can only in the meantime be regarded as pointing out a method of treatment. The authors then practically discuss their results, and have obtained the following preliminary conclusions:—

(1) S is always greater than K, or the ratio $\frac{S}{K}$ is always greater than unity.

(2) This ratio appears to depend in some way on the duration of the disturbance;

(3) But not, as far as can be seen at present, upon its magnitude.

Finally, they hope to make a more extended investigation of the subject, going over a greater number of years, and perhaps adding to their methods of treatment.

"On the Limited Hydration of Ammonium Carbamate." By H. J. H. Fenton.

The hydration of ammonium carbamate affords an example of a chemical action of the simplest type, namely, the direct union of two simpler molecules to form one more complex—

$$CO(NH_2)(ONH_4) + OH_2 = CO(ONH_4)_2.$$

There are but few actions of this type which can be investigated when all the substances concerned are in the liquid state, and all extraneous matter absent.

In a former paper it was shown that ammonium carbamate when acted upon by sodium *hypochlorite* in presence of sodium hydroxide, yields one half of its nitrogen in the free state, the other half remaining in the form of sodium carbamate—

$$2CO(NH_2)(ONH_4) + 3NaClO + 2NaOH = 2CO(NH_2)(ONa) + 3NaCl + 5OH_2 + N_2.$$

Sodium *hypobromite* at once decomposes sodium carbamate, yielding the nitrogen in the free state. This, in fact, is claimed as a specific reaction for carbamates, since no other substance yet investigated will yield free nitrogen by action of a hypobromite *after* the completed action of a hypochlorite.

Based upon this reaction, then, we have a direct and simple method of determining the amount of carbamate existing in a solution at any given time.

Experiments were conducted with a view of examining the influences of time, mass, and temperature upon the hydration of ammonium carbamate, and also the reverse action, namely, the dehydration of normal ammonium carbonate into ammonium carbamate. The hydration is expressed by the ratio—

$$\frac{\text{molecules of water assimilated}}{\text{molecules of carbamate taken}}$$

(1) *Influence of Time.*—Solutions of ammonium carbamate of different strengths were examined at stated intervals. In all cases the action proceeds rapidly at first, becomes progressively slower, and finally reaches a limit short of complete hydration.

The time required to reach a determinate state of hydration is less as the relative number of water-molecules is greater.

(2) *Influence of Mass.*—The hydration is shown to be a function of the number of water-molecules present. As far as the action could be legitimately studied, the minimum hydration corresponded to the case in which the substances are present in equal molecular proportions.

(3) *Influence of Temperature.*—The hydration is in all cases less, as the temperature is lower. Probably at a sufficiently low temperature the hydration would be practically *nil* when the substances are present in equal molecular proportions—*i.e.* ammonium carbamate and water would practically not combine at all.

(4) *Dehydration of Normal Ammonium Carbonate.*—It was shown that this salt undergoes dehydration in solution, becoming in part converted into carbamate. The dehydration is greater, as the relative number of water-molecules is less. It seems not unlikely that if the same relative number of molecules could be started with, the same equilibrium state between carbamate, carbonate, and water, would be arrived at for the same temperature, whether ammonium carbamate or normal ammonium carbonate were initially taken.

Since there is a tendency for normal ammonium carbonate to become in part dehydrated in aqueous solution, and for the system to come to a state of equilibrium where the carbamate and carbonate co-exist, it seems probable that the hydrolysis of urea under the action of ferments may be less simple than is usually represented. The author proposes to attack the problem by a method based on the actions of sodium hypochlorite and hypobromite, by means of which it is possible to detect, and quantitatively estimate, urea, carbamic acid, and ammonia, when all present in the same solution. A preliminary trial of the method gave satisfactory results.

Geological Society, December 16, 1885.—W. Carruthers, Vice-President, in the chair.—Charles John Alford, Samuel Blows, James Warne Chenhall, William Farnworth, Paget

Henry Cater Fulcher, and Harold Temple Wills, were elected Fellows of the Society.—The following communications were read:—Old sea-beaches at Teignmouth, Devon, by G. Wareing Ormerod, F.G.S. The author stated that while old records show that no important changes have taken place in the level of the Teignmouth district during the historical period, the excavations made in recent drainage-operations in the present year showed the existence of at least two series of beaches. The oldest sea-beach, which is a few feet above the present sea-level, was partly washed away and then covered up by later deposits exhibiting evidence, in a number of delicate bivalve shells in an unbroken condition, of having been deposited in a calm sea.—On the gabbros, dolerites, and basalts of Tertiary age in Scotland and Ireland, by Prof. John W. Judd, F.R.S. In previous papers published in 1874 and 1876, it has been demonstrated by the author that there exist in Scotland and in Hungary igneous rock-masses presenting the most perfectly crystalline characters, and belonging to the Tertiary period. It was further shown that such highly crystalline, plutonic rocks are seen passing insensibly into volcanic rocks of the same chemical composition—gabbros into basalts, diorites and quartz-diorites into andesites, and quartz-andesites and granites into rhyolites—the lavas in turn graduating into the perfectly vitreous types known as tachylites and obsidians. The present paper deals with the basic rocks of Western Scotland and Northern Ireland, which are shown to exhibit the most marked analogies with rocks of the same age in the Faroe Isles and Iceland; these facts lend strong support to the doctrine of the existence of petrographical provinces. The Tertiary age of the Scotch and Irish rocks is placed beyond dispute by the fact that they overlie unconformably the youngest members of the Cretaceous system, and are interbedded with stratified deposits of Lower Tertiary age. With regard to the nomenclature of these rocks, the identification of the more crystalline forms with the gabbros, which was made by Zirkel and Von Lasaulx, is supported; while the use of the term "dolerite" as a convenient one for the connecting links between the gabbros and basalts is advocated. Of the original minerals contained in these rocks, plagioclase felspar (ranging in composition from anorthite to labradorite), augite, olivine, and magnetite, are regarded as the essential ones; while enstatite, biotite, chromite, picotite, and titanoferrite are among the most frequently occurring accessories. It is shown, however, that these original minerals may belong to different periods of consolidation. The Secondary minerals are very numerous, including quartz, epidote, zoisite, hornblende, serpentine, and zeolites, with many other crystallised and uncrystallised substances. There are remarkable variations in the relative *proportions* of the original minerals in different examples of the rock; and by the complete disappearance of one or other of the constituents, the gabbros are sometimes found passing into picrites, eucrites, or troctolites. In their microscopic structure these rocks present many interesting features. From the highly crystalline gabbros there are two lines of descent to the vitreous tachylites: one through the *ophitic* dolerites and basalts, and the magma-basalts with skeleton-crystals; and the other through the *granulitic* dolerites and basalts, and the magma-basalts with granular microliths. The former are shown to result from the cooling down of molten masses which were in a state of perfect internal equilibrium, while the latter were formed when the mass was subject to movement and internal strain. It is shown that in the most deeply-seated of these rocks (gabbros) the whole of the iron-oxides combines with silica; but, as we approach the surface, the quantity of these oxides separating as magnetite increases, until it attains its maximum in the tachylites. In all the varieties the order of separation of the different minerals is shown not to depend solely on chemical causes, but to be influenced by the conditions under which the rocks have cooled down. Although these rocks are not highly-altered ones, yet they afford admirable opportunities of studying the incipient changes in their constituent minerals. The nature of these changes is discussed, and they are referred to the following causes:—(1) The corrosive action of the surrounding magma on the crystals; (2) the changes produced by solvents acting under pressure in the deep-seated masses (these have been already described under the name of "schillerisation"); (3) the action of heated water and gas escaping at the surface; (4) the action of atmospheric agents on the rocks when exposed by denudation; and (5) the changes induced by pressure during the great movements to which rock-masses are subjected.

Physical Society, December 12, 1885.—Prof. Guthrie, President, in the chair.—Mr. C. F. Casella and Prof. T. E. Thorpe were elected Members of the Society.—The following papers were read:—On a magneto-electric phenomenon, by Mr. G. H. Wyatt. The author had conducted a series of experiments with a view of testing experimentally an expression obtained by Mr. Boys for the throw of a copper disk suspended by a torsion-fibre between the poles of an electro-magnet, when the current was made or broken, and communicated by him to the Society on June 28, 1884. Disks of various metals and of various dimensions were used, the results being such as to agree with the theory within narrow limits. It was, however, found that when the throw of the disk was used to measure the magnetic field, the value obtained from the throw at break was uniformly greater than that obtained on making the current. Prof. S. P. Thompson observed that the case presented was analogous to that of the ballistic galvanometer, and that for the theory it was necessary that the magnetic field should be made and destroyed before the disk had moved sensibly. Mr. Boys believed that the results of the experiments showed this to be the case, since the result of such a movement would be to increase the throw on breaking the current when the disk made an angle of less than 45° with the lines of force, and to decrease it when the angle was between 45° and 90°, whereas no such variation from the theoretical result was observed.—On some thermodynamical relations, by Prof. William Ramsay and Dr. Sydney Young. In this paper experimental proof is given of the following relations:—(1) The amount of heat required to produce unit increase of volume in the passage from the liquid to the gaseous state, at the boiling-point under normal pressure, is approximately constant for all bodies. (2) If these amounts of heat be compared at different pressures, for any two bodies, then the ratio of the amount at the boiling-point under a pressure, p_1, to the amount at another pressure, p_2, is approximately constant. (3) The products of the absolute temperature into the rate of increase of pressure with rise of temperature are approximately the same for all stable substances. (4) The rate of increase of this product with rise of pressure is nearly the same for all stable substances. (5) A relation exists between the absolute temperatures of all bodies, solid or liquid, stable or dissociable, which may be expressed in the case of any two bodies by the equation

$$\frac{T_A}{T_B} = \frac{T'_A}{T'_B} + \epsilon(T'_A - T_A),$$

T_A and T_B being the absolute temperatures of the two bodies corresponding to any vapour-pressure; T'_A and T'_B, absolute temperatures at any other pressure; and ϵ, a constant which may be zero or a small positive or negative quantity. (6) The variations from constancy of the expression $t\frac{dp}{dt}$, though small, may be expressed by a similar equation. (7) If L_A, L_A', L_B, and L_B', represent similar relations of latent heat at different pressures, the same for A and B, it appears probable that

$$\frac{L_A}{L_A'} = \frac{L_B}{L_B'} + \epsilon(T'_A - T_A).$$

(8) The ratio of the heats of vaporisation of any two bodies at the same pressure is approximately the same as that of their absolute temperatures at that pressure. The authors conjecture that this statement is also true of dissociating bodies. A large part of the experimental work consisted in obtaining the relation between vapour-pressure and temperature of different substances, values of $\frac{dp}{dt}$ had been obtained from these observations in two ways, by plotting curves with t and p as co-ordinates and drawing tangents, and by the method of differences. Prof. Perry suggested that the curve should be expressed in such a form as

$$\log p = \alpha - \frac{\beta}{t} - \frac{\gamma}{t^2},$$

which Rankine has shown to be a very true expression for the relation between pressure and temperature, and that $\frac{dp}{dt}$ should be obtained from this by differentiation. Prof. Guthrie hoped the authors would experiment upon the vapour-tensions of mixed liquids, a subject to which he had himself given some attention.

EDINBURGH

Royal Society, December 21, 1885.—Prof. Douglas Maclagan, Vice-President, in the chair.—Mr. J. Y. Buchanan,

communicated a paper on the temperature of Loch Lomond and also one on oceanic islands and shoals.—Prof. Herdman discussed elaborately the phytogeny of *Tunicata*.—Mr. John Aitken gave a communication on dew, which will be found in full at p. 256.—Mr. Frank E. Beddard read a paper on the structure of *Lumbricus complanatus*, Dugès.—In a paper on the salinity of the water about the mouth of the Spey, Messrs. H. R. Mill and T. Morton Ritchie show that the sea-water slowly forces its way like a wedge between the river-water and the bottom as the tide rises, and dams back the water further up the stream, while the surface-water always remains quite fresh, and a brackish zone separates the two strata. When the ebb sets in the salt water runs out very rapidly, and before half ebb there is only fresh water inside the bar. The salinity of the water in Spey Bay was also studied. The river-water could be traced as a stream sweeping to the north-east, with a sharply-defined western margin. Alkalinity and temperature observations were also given.—Mr. A. Wynter Blyth discussed the distribution and significance of micro-organisms in water.

January 4, 1886.—The President submitted notes on the recent experiments at the South Foreland lighthouse.—Mr. Omond, of the Ben Nevis Observatory, communicated an account of the glories, halos, and coronæ observed there. The small number of glories seen is remarkable. Only four have been noticed since the Observatory was established.—Prof. Crum-Brown read a note on the simplest form of half-twist surface.—The Rev. T. P. Kirkman submitted a discussion of the linear section PR of a knot M_n, which passes through two crossings, P and R, which meets no edge, and which cuts away a $(3 + r)$-gonal mesh of M_n.—Messrs. Rainy, Ellis, and Clarkson gave an account of the exploration of the central portion of the field of a Helmholtz galvanometer.—In a paper on systems of colliding spheres, Prof. Tait showed that Maxwell's law of the distribution of energy between two different sets of molecules is erroneous. If two sets of molecules at a given temperature and pressure be mixed, the resultant temperature and pressure will be the same, but the average kinetic energy of the less massive molecules will exceed that of the more massive molecules. In the case of hydrogen and oxygen the excess will be 25 per cent.

PARIS

Academy of Sciences, January 4.—M. Jurien de la Gravière, President, in the chair.—On the potential of two ellipsoids, by M. Laguerre.—Researches on the sulphur of antimony, by M. Berthelot. Here the author determines the measure of the heat of formation of this compound under its various conditions, that of its chlorides and oxichlorides having already been ascertained by MM. Thomsen and Guntz.—Remarks on Dr. A. Sprung's treatise on meteorology ("Lehrbuch der Meteorologie"), recently published at Hamburg, by M. Faye. The author's comments are confined chiefly to the vexed question of the ascending or descending movement of the air in whirlwinds or cyclones. Three points he considers now settled: (1) that the movement of translation is inexplicable according to the old theory; (2) that this rapid movement of translation corresponds with the upper cirrus-bearing currents; (3) that a descending movement cannot be denied within the cyclones themselves. Another step, and the old ascending will give place to the new descending theory.—Note on the differential invariants of M. Halphen, by Prof. Sylvester.—Note on the angular movement which a vessel takes on a wave of given size and velocity, by M. L. de Bussy.—Rectangular co-ordinates and ephemeris of Fabry's comet, by M. Gonnessiat.—Note on the new star in Orion, by M. Ch. Trépied. The magnitude of this star is 6·7, its colour an orange-red, and its spectrum very remarkable, showing six dark bands, two in the red and orange, four in the green and blue; bright lines have also been doubtfully detected in the green.—Note on the transformation of the Fuchsian functions, and on the reduction of the Abelian integrals, by M. H. Poincaré.—A tentative application of the calculus to the study of colour sensations, by M. R. Feret.—On the emetics of tellurium, by M. Daniel Klein. The author has succeeded in preparing some tartrotelluric emetics with the tellurites of the alkaline bases, which are alone soluble, and treating them with tartaric acid in due proportion.—On the transformation of the essence of turpentine to an active terpilene, by MM. G. Bouchardat and J. Lafont.—Note on the employment of the metallic oxides for the purpose of detecting in wines colouring substances derived from coals, by M. P. Cazeneuve.—Note on the cultivation of beet-root in the Wardrecques district, Pas-de-Calais, during the year 1885, by MM. Porion and Dehérain.—On the toxic action of the alkaline salts, by M. A. Richet. From a series of experiments made on fishes, pigeons, and guinea-pigs, the authors conclude that in absolute weight the metals are the less toxic the higher their atomic weight, which reverses the law formulated by Rabuteau; also, that the chlorides are, in absolute weight, more toxic than the bromides, and these than the iodides. But, with equal molecular weight, the reverse is the case. In general the alkaline salts are toxic through their chemical molecule, and the higher the weight of this molecule the more toxic it becomes, although the difference is slight and the molecule always about equally toxic.—On the circulation in the ganglionary cells, by M. Alb. Adamkiewicz.—On the morphology of the ovary in insects, by M. Armand Sabatier.—Note on the trunks of fossil fern-trees occurring in the Upper Carboniferous formations, by MM. B. Renault and R. Zeiller.—On the present value of the magnetic elements recorded at the Observatory of the Parc Saint-Maur.—Notes were presented by M. Ch. Beaugrand, on the meteoric dust collected in the atmosphere on November 27–30, 1885; by M. L. Sandras, on the modifications of the human voice by means of inhalations; and by M. Durif, on a remedy for diseased vines.—This number of the *Comptes rendus* contains a complete list of the members of the Academy on January 1, 1886, and announces the election of M. Gosselin as Vice-President for the current year.

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THURSDAY, JANUARY 28, 1886

LOUIS AGASSIZ

Louis Agassiz: His Life and Correspondence. Edited by Elizabeth Cary Agassiz. Two Volumes, 8vo. (London: Macmillan and Co., 1885.)

SELDOM has the influence of early environment been more marked in a scientific career than in the life of Louis Agassiz. Born in 1807 at the little village of Motier, in the plains of Switzerland, he passed his childhood on the shores of the Lake of Morat, the waters of which were a perennial source of delight to him. He took more special interest in its living things; knew the haunts and habits of its fishes, and could lure them to him by various ingenious boyish spells, or track them to their hiding-places in the old walls that were lapped by the water. He began to collect birds, insects, shells, and other objects long before he had acquired any book-knowledge of natural history. Between the Lake of Morat and the larger expanse of the Lake of Neuchâtel lies a strip of fertile country rich in woodlands and flowers, and full of bird-life. On the further side of Lake Morat, towering above the scene of the great battle wherein the Swiss routed the army of Charles the Bold, rise the far snowy summits of the Bernese Oberland. Nursed amid these surroundings, and encouraged and guided by wise parental care, the child most truly was father to the man. His intense love of nature and of all living creatures developed into the enthusiasm of one of the foremost naturalists of the time. His childish devotion to the fishes of Lake Morat settled into the earnest and untiring spirit of research among living and extinct fishes which made him the leading ichthyologist of Europe. His passion for the mountains with their snow-fields and glaciers grew into that clear insight and power of philosophical generalisation which have placed the name of Louis Agassiz at the very head of the pioneers by whom the story of the wonderful Ice Age has been unravelled.

The ardent boy with his eager pursuit of natural history was designed for commerce. His father, a poor country clergyman, had no fortune at his disposal which could save his son from the necessity of choosing a profession. But the studies and discipline of school life by no means checked the boy's longing for some career that would enable him to follow his bent towards the prosecution of science. He begged for two years more of the College at Lausanne, and this was granted by his parents, who, though they seem to have been quite aware of his peculiar abilities, never allowed themselves to lose sight of the necessity that their son should at all events qualify himself for some honourable means of making his own livelihood. His future appears to have been considerably influenced by a medical uncle at Lausanne, who, recognising the lad's special bent, suggested that he should take to medicine. This advice being followed, young Agassiz went for two years to the Medical School at Zurich, and then, at the age of nineteen, betook himself to the life of a German student at Heidelberg. It was there that his scientific career received its first great impetus, and that it became certain that, though he might persevere with his medical studies and take his degree, he would ultimately distinguish himself and make his career, not as a physician, but as a naturalist. At Heidelberg he laid the foundations of some of the most precious and enduring friendships of his life, more particularly with Alexander Braun the botanist, whose sister he afterwards married, and with whom and Schimper he next year migrated to Munich, famous at the time for the varied attainments of its professors of science and philosophy. Entering there on a wider field of study, Agassiz and his comrades distinguished themselves among the students by their enthusiastic devotion to natural science. Meeting at each other's rooms, they formed a band known outside as "the Little Academy," discoursing on all manner of questions, starting new problems, proposing solutions for old ones, and creating so much interest in their proceedings, that even learned professors were sometimes to be seen among their listeners.

It was but natural that in the midst of such a life the drudgery of the medical profession should grow more and more irksome. Again and again warning comes from home that the practical aim of his University studies must not be lost sight of, and that he must surely qualify himself to practise as a doctor. His mother's strong common sense would from time to time brush away the golden haze through which the hopeful enthusiast looked at his prospects. In her letters too, she warned him against his "mania for rushing full gallop into the future," engaging in too many different undertakings, and wasting by diffusion an energy which would carry him successfully to his goal, if he would only concentrate it upon what was essential for the purpose. Long before he took his medical degree his power of original research in ichthyology was widely known, and Martius placed in his hands for description the Brazilian fishes left undescribed by Spix. This work was completed and published in 1829, when the young author was only twenty-two years of age. Next year he gratified his parents by formally taking the degree of M.D.

But the prospect of settling down as a country medical practitioner was more than ever distasteful to him, though there seemed no very clear outlook in any other direction. He himself, however, was full of hope. His Brazilian fishes had brought him no money indeed, but it had given him a reputation throughout Europe as one of the rising naturalists of the day. Already he was full of schemes for the production of a work on fossil fishes, and he had actually made considerable progress in the preparation of a monograph on fresh-water fishes. He felt sure that he could command his own terms from publishers, and that the sale of the works would enable him to live in the quiet way he desired to do. So he went home for a year, which he spent in increasing his collections of natural history—now large and valuable—and in prosecuting the works on which he had been occupied at Munich. But his ambition to take a leading place among the naturalists of Europe, and the necessity for increasing his knowledge by study in some of the best museums of the Continent, led him at last irresistibly to Paris, where he arrived towards the end of the year 1831. From Cuvier he received much kindness. The veteran naturalist had made some progress with a work on fossil fishes, but when he saw what Agassiz had done and proposed to continue, he generously presented him with

all his own drawings and notes upon the subject. A. von Humboldt also took the warmest interest in the young Swiss, aiding him by help of the friendliest and most practical kind. But Agassiz was still without any regular means of self-support; the publishing schemes were not so successful financially as he had fondly anticipated, and at last, after some months of over-strain among the treasures of the Paris museums, he gladly accepted, in the autumn of the year 1832, the offer of a Professorship of Natural Science created for him at Neuchâtel by the exertions of his friends. For the first time he had now the opportunity of appealing to a wider circle of listeners than his own fellow-students. The enthusiasm of his nature soon made itself felt in the new vigour with which natural science was followed in the canton. A Society for the prosecution of the study of nature was founded, with Agassiz as one of its leading spirits. Hill and dale, river and lake were explored far and near, and the systematic lectures of the class-room were supplemented by even more valuable discourses in the field. From this period onward a large part of Agassiz's time and thought was given to the promulgation of a knowledge of nature, not only to professed students but among the general public. With his extraordinary energy he still found time for an amount of original research that would have been more than enough for most naturalists. Bold almost to recklessness, in his disregard of financial difficulties, he now (1833) launched the first number of his "Poissons Fossiles," and, in spite of incredible obstacles, continued the preparation and publication of the work for the next ten years. In the course of his researches for this great monograph he came several times to England, bringing with him the artists he had trained in drawing natural history specimens, and spending much time in the public museums as well as in the private collections where he found such a wealth of palæontological material.

The "Poissons Fossiles" will ever remain as a monument of extraordinary industry and of a remarkable insight into the relationships between recent and extinct types of life. The keynote of all Agassiz's work in natural history sounds out clear and distinct in the introduction to this great work. He proposed a new classification of fishes which, though it has been subsequently considerably modified, was of great geological value in showing the true history and importance of the great order of Ganoids, which he first recognised. With a keen eye for real or supposed analogies and relationships, he saw in the earlier fishes of the geological record a commingling of ichthyic with reptilian characters which suggested to him his "prophetic types," and, following out the same idea, he made the startling announcement that in the phases of the embryonic development of our living fishes there is a close analogy to the successive types of fishes which have appeared in the past history of the earth. It is curious to remember that a naturalist who saw so far ahead of his contemporaries remained a consistent opponent of all theories of evolution. He admitted in the fullest sense the evidence of "the most admirable progressive development to which our own species is linked," but to him the progress was one of plan in the mind of the Creator, and not the mere material change of one form into another.

One of the most characteristic features of Agassiz's mind was its restless activity and untiring energy. The labour entailed by his great work on fossil fishes would have been enough or more than enough for any ordinary man. But while it was in progress he found time for the prosecution of his researches among recent fresh-water fishes; for an investigation of Echinoderms recent and fossil, and for the study of fossil Mollusca, and the evidence for these added labours appeared in bulky quarto memoirs with numerous plates. Besides these works, however, he undertook the almost incredible drudgery of compiling a zoological "Nomenclator," containing the names of living and fossil genera of animals, and a "Bibliographia Zoologiæ et Geologiæ," giving a full list of published papers on these sciences. Dissatisfied with the delays and defects of the Munich engraving establishments, he founded a lithographic workshop at Neuchâtel, and astonished the world by the beauty of the chromolithographed fossil fishes which he there produced, the art of chromolithography being then in its infancy.

With this mental activity was combined a bodily vigour which carried him unwearied through long excursions. As a recreation he turned to the glaciers of the Alps. Before his student days at Heidelberg he had made himself acquainted with that mountain-world. But in the summer of 1836, under the guidance of Charpentier, he began the systematic study of the glaciers. Before the end of that excursion he had seized the meaning of the scattered erratic blocks and ice-worn bosses of rock that lie far above and beyond the present limits of the ice. He saw as by a kind of inspiration the evidence for the former vast extension of the Alpine glaciers, and though he continued in later years laboriously to fill in the details of the picture, his first rough draft remained unchanged in all its essential features. As soon as he began to make known his ideas in glacial geology, he was met with a storm of opposition. Even his kind friend Humboldt could not forbear words of gentle reproof and warning. But he remained unshaken in his faith, and eventually had the satisfaction of seeing one after another of his opponents candidly acknowledge themselves mistaken. From 1836 to 1846 he continued with unabated enthusiasm his glacial researches, scaling mountain-pass and glacier, and publishing first his "Études sur les Glaciers" (1840), and then his "Système Glacière" (1846), besides separate papers in scientific journals. Among these minor contributions, undoubtedly the most memorable is the short communication made to the Geological Society of London in 1840 on the evidence of glaciers in Britain. Agassiz came to this country in that year convinced beforehand that there must be abundant evidence of former glaciers among our uplands. With the genial Buckland he went into the Scottish Highlands, and found everywhere, as he had anticipated, the most convincing proofs of ancient glaciers. From that time onward the study of Pleistocene geology took a new departure among the geologists of this country, and the opposition to glacial agency soon died out.

The "Poissons Fossiles" was followed soon after by the publication of the monograph on the fishes of the Old Red Sandstone—another land-mark in the progress of palæontology. Since the appearance of these works a new generation has appeared; the number and size of

author, because there is a large amount of valuable observation which readers should have occasion to refer to after the first perusal of the work, but which would be lost without such an index, owing to the necessarily disjointed mode of treatment entailed by an adherence to seasonal records. We need only refer to the early editions of Kirby and Spence's "Introduction to Entomology" as an example of a work containing a large collection of facts and observations rendered almost useless for want of an index.

Dr. Abbott is evidently a close observer, and English naturalists will derive both pleasure and profit by a perusal of his chronicle. It is rather to be regretted that he has confined himself so much in the text to the local trivial names of the animals and plants of his district. It places English readers at a disadvantage, for example, to have to turn to the index each time a species is mentioned in order to find out what is referred to under such names as "grakles," "quaker-girls," "quahog," or "scuttle-bug." But this is, after all, a matter of small importance, because the scientific names will be found in the index, and the criticism is made only on behalf of that large circle of readers in the old country which the work ought to attract, and to which it appeals through its English publishers.

The author's strong point appears to be ornithology, but his sympathies are fairly distributed, and his observations are recorded in a pleasant, chatty style which is sure to be attractive to general readers :—

"To realise what a wealth of animal and vegetable life is ever at hand for him who chooses to study it, let a specialist visit you for a few days. Do not have more than one at a time, or you may be bewildered by their enthusiasm.

"I have had them come in turn—botanists, conchologists, microscopists, and even archæologists. What an array of names to strike terror to the breasts of the timid; yet they were all human, and talked plain English, and, better than all, were both instructive and amusing."

As a specimen of the author's style we give the following from Chapter II., entitled "Poaetquissings in Winter."

In order to carry on observations without frightening the denizens of the creek, the author was in the habit of lying down upon the ice, covered over with a blanket so as to be able to see into the frozen depths. The terrestrial life soon became accustomed to his presence, and at length became inquisitive. "This was amusingly illustrated in one instance by a weasel, in crossing the creek on the ice, stopping to investigate the peculiar something lying in its path. Peering under the blanket, it either heard my blood circulating or smelled it. At all events it gave my ankle a nip which brought me quickly to my feet, and sent the bloodthirsty wretch scudding over the ice with marvellous rapidity. How the crows laughed! I had noticed a flock of these birds when I went to the creek, and had been wondering if their incessant cawing was not a discussion of my curious movements. They were, possibly, disposed to think me a trap laid for them, but were astonished or amused at my sudden regaining of the perpendicular when the weasel offered to investigate the matter."

In the third chapter, "Twixt Cold and Heat," will be found a good collection of observations and experimen bearing on the subject of instinct, with special referenc to the nesting of birds. Whether the author's views o this much-vexed question will command assent we canno undertake to say, but whether we differ from his con sions or not, his experiments are certainly worthy serious consideration. Among these we have a seri experiments with a chromo-picture of a cat, w mirror, and with coloured yarns, the latter havi their object the testing of the sense of colour. case of a Baltimore oriole in course of building its decided choice was exerted—red, yellow, purpl green yarns having been refused, and gray only sel till the nest was nearly finished, when a few of the strands were used. Other amusing experiments transference of eggs are described in this same

With reference to the subject of migration the states in Chapter IV., on "Marsh Wrens," that "t ature and migration are largely coincident, but can considered as cause and effect." He further ad certain rules respecting the habits of America which had been regarded by previous observers a and invariable, are quite variable if observations a continued over a sufficiently long period of time. " results of a single year will have but little bearing u the regularity or want of it in a bird's movements. observations of the same person in the same loc must extend over at least a decade before it is safe arrive at any general conclusions." We commend t passage to the members of our county field clubs are in want of material for observation.

Space will not permit us to make any lengthy ex cts from the book, but we cannot refrain from calling the attention of the bird-destroyers of this country to the admirable "apology" for the grakle (*Quiscalus versicolor*) which the author makes in the fifth chapter. These birds were formerly regarded as enemies to agriculture, owing to their habit of feeding upon ripe grain, which led to their being dubbed by the unpopular name of "maize thieves." But, according to Dr. Abbott's observations, it is at least doubtful whether, on the whole, man does not profit more by the existence of these birds than is lost by the attack upon the grain. To get an idea of the amount of insect food consumed by a pair with five young, he observed the birds for two hours (10 to 11 a.m. and 2 to 3 p.m.), during which time thirteen trips were made by each bird, each returning with an insect every time. The young thus got a "square meal" at least every ten minutes. The feeding goes on for ten hours per diem till the young are twenty-five days old, when they leave the nest, so that during this period each young bird has been supplied with 1300 insects, or 6500 altogether. The eleven nests in the colony under observation were supplied, therefore, with 71,500 insects, and as seven pairs in the colony raised second broods, a further supply of a 45,500 insects was "requisitioned," thus bringing up total number consumed by one colony of birds to enormous total of 117,000, or, including the food of t parent birds, about 150,000 "forms of insect life de stroyed, all of which would have proved more or less destructive to the growing crops." We hope that the lesson taught by this observation will not be lost upon those who fail to see in persecution by birds a sufficient

ause for the marvellously perfect cases of adaptive esemblance so common among insects.

Apropos of the extermination of plants, Dr. Abbott emarks (p. 41) with respect to the witch-hazel (*Hamamis virginica*):—"Bent twigs of this plant are still d by the 'gifted' to find water, lost farming tools, by one enthusiast, Indian graves. The faithful still it as efficacious, and he who doubts is sneered at if presses his opinion. All that the rambler can ask is he plant be not exterminated, and that the fools e." We may perhaps echo this sentiment on this f the Atlantic without offence to the members of nrose" or any other floral "Leagues." A protest st the extermination of rare plants by "dealers" rculated by the Corresponding Societies Committee British Association last year.

ave given a sufficient idea of this work to commend e notice of English naturalists, and we may remark nclusion that, although the animals and plants l to are not familiar to the ramblers by our own s, the sparkling anecdotal style will cause the e to be enjoyed by all, whether trained observers or country wanderers, and the spirit in which the hor goes forth into the fields and woods or saunters by favourite "Poaetquissings" may be well imitated by numerous field naturalists now being called into ivity by the widely-spread establishment of local cieties. "He who has this interest in the life about m can never be lonely, wander wheresoever he will, nor urn from a contemplative ramble other than a wiser happier man."

R. M.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On Refractometers

I OBSERVE that in your issue of June 17 (p. 157) there is an article by Mr. Gordon Thompson on "The Determination of the Index of Refraction of a Fluid by Means of the Microscope." The method there described was, I believe, first proposed by the Duke de Chaulnes in 1767; and in 1876 was suggested by Dr. Royston Pigott in connection with his refractometer. It was employed in 1878 by Dr. Sorby for recognising the minerals in thin slices of rocks; and in 1884 by Dr. Bleekrode in determining the refraction of liquefied gases (*Proc.* Royal Society, vol. xxxvii. p. 343). In these two instances the ordinary method was unavailable. The proposed method has not been much used owing to the fact that the index of refraction cannot be at all depended upon beyond the third place of decimals.

Mr. Thompson considerably exaggerates the difficulty of the usual method by means of a hollow prism: the angle of the prism may be determined once for all; the position of minimum deviation presents no difficulty; and the use of monochromatic light is unnecessary. Indeed it would be objectionable, as it would prevent the determination of the dispersive power, which is often of equal importance with the refractive power of the substance. In my own experiments I have often taken observations both of the refraction and dispersion of five or six liquids during the course of an hour, including the cleaning of the prism between each.

The suggested method seems scarcely to admit of determining the temperature of the drop with any accuracy, which is an important matter where liquids are concerned. It may, however, doubtless be employed by those who have a good microscope, where great accuracy is not required.

There is an instrument called Abbe's refractometer, which I have recently used for preliminary determinations, and I find it gives accurate results to the third place of decimals. It is founded on the principle of total reflection. It requires also only a drop of the liquid, and as the index of line D is read off without any calculation a complete determination can be made in a minute or two. There is also an arrangement by which the dispersion D to F can be observed and calculated, but I do not find that this is accurate enough to be of much service. The instrument is to be obtained of Carl Zeiss of Jena.

17, Pembridge Square, June 26 J. H. GLADSTONE

Luminous Boreal Clouds

DURING the past two or three years what appears to the writer a distinct class of luminous night clouds in the north sky have occupied his attention. They have probably not escaped more competent observers, and been perhaps referred to simple auroral phenomena, thus escaping discussion. A very marked example was visible here the night before last (22nd inst.), of which inclosed is an illustration from a sketch at the moment.

I may premise the sky was generally clear, stars bright, temperature very low, and wind strong (N.B.) from north-west—a direction maintained for the past two days. Only a slight degree of illumination was imparted to the clouds by a low moon in the south-east, near last quarter. Some light cirrus "scud," high up, conformed to direction of wind.

Above and behind a dark but very limited bank of strato-cumulus, a luminous cloudlet of brilliant pearly lustre appeared, not concurrent exactly with either the magnetic or true meridians, in altitude from 5° to 10° from the horizon, and for 7° in horizontal arc. Its shape, character, and position little varied during observation from 11.30 p.m. to 2 a.m. The structure in this case (only partially realised in the sketch) was striated, the "strike" of main streaks being north-east and south-west. *Transverse bars of luminosity conformed closely to the direction of the cirrus clouds above, and of the wind.* On the three or four other occasions of such observations these luminous cloudlets have been devoid of structure, but in every case they have presented, as in this, an opaque pearly lustre, with definite outline.

Of an entirely different type to the eye are the sudden, diffuse, variable, and transient transparencies of auroræ. Avoiding premature discussion, one cannot but suspect the former occur in much lower and less rare sky-tracts probably than the latter, with a possible frictional factor in their development; and might be distinguished as *nubeculæ boreales* if accorded a special place on further observation. The temperature has been keeping low, and sunset after-glows have in some degree reappeared during the past week; especially gorgeous being the cloud-tints at sunset of the 22nd inst.

D. J. ROWAN

Dundrum, co. Dublin, June 24

Ampère's Rule

WITH regard to Ampère's rule I should be glad to know what is the general experience of actual teachers?

I have taught electricity to boys for four years, and when at Rugby I learned the subject for I think two years. My experience has been that "Ampère's rule" is *not* confusing; and as a teacher I find it best to give both this rule and the "screw-motion" rule. I see that Mr. Cumming gives both, on p. 222 of his book.

W. L.

The College, Cheltenham

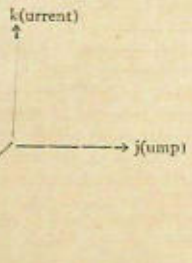
As Prof. Daehne (NATURE, June 24, p. 168) has called attention again to the treatment of Ampère's rule in my "Electricity Treated Experimentally," perhaps you will allow me to point out that the rule given by Ampère is quoted *historically* only, and for it is substituted a rule, due, I believe, to Clerk-Maxwell, which seems to me preferable to either the original rule of Ampère, or to that quoted by Prof. Daehne, namely, that the movement of a north pole is right-handed to the direction of the current. That is to say, if we assume any right-handed screw to be propelled along the current, the north pole will move in the direction of the twist in the muscles of the wrist in propelling it; and *vice versâ*, if the north pole move in

the direction of propulsion, the current urging it will be in the direction of twist in the muscles of the wrist. In treating the movement of a conductor carrying a current in the magnetic field, I have used a rule identical in character with Ampère's, and that was probably the rule to which J. T. B. referred in his critique, namely, that a figure swimming in the current and looking along the lines of force is carried to his left. I should be glad to find a rule at once as complete and more simple, although after a pretty wide experience, not always with the very brightest of pupils, I have not been sorely pressed with the difficulty J. T. B. seems to have felt. All the required attitudes are pretty familiar to a boy who is accustomed to diving in the water and swimming on his front, side, or back. L. CUMMING

Rugby, June 24

THE following version of Ampère's Rule is one which I communicated some time ago to a few friends, but it did not appear to me to be expressed in language sufficiently grave to justify its publication. Still, as the Rule is a simple and useful one, your readers, in general, may be disposed to overlook its levity.

Draw the three well-known Hamiltonian vectors, i, j, k. After i put (nduction), after j put (ump), and after k put (urrent). Then the figure explains the action of magnetic induction on an electric current. The figure in fact asserts that i(nduction) in i makes k(urrent) in k to j(ump) along j.



Of course the same figure gives the direction (according to the Law of Lenz) of the current generated by a motion (*i.e.* a jump) of a conductor in a given direction in a magnetic field in which the direction of the induction is given.

R.I.E. College, Cooper's Hill GEORGE M. MINCHIN

An Earthquake Invention

IN my letter to NATURE, vol. xxxiii. p. 438, I clearly showed that the supposition of Mr. D. A. Stevenson and Prof. Piazzi Smyth that I had endeavoured to claim the aseismatic joint of Mr. D. Stevenson was due to their imperfect acquaintance with seismological literature. I certainly intercalated a *note* about aseismatic structures in a report to the British Association on earthquake phenomena in general, without mentioning Mr. Stevenson's name.

Previous to this, when specially speaking or writing upon aseismic structures, I have *repeatedly* referred to the work of Mr. D. Stevenson. Such references were quoted. Under the circumstances I asked Messrs. Stevenson and Smyth to distinctly state whether they still considered themselves justified in continuing their accusations. If this point was overlooked the discussion might be considered as at an end. Mr. D. A. Stevenson has replied, but the question at issue *has been distinctly evaded* (NATURE, vol. xxxiii. p. 534).

I deeply regret that Messrs. Stevenson and Smyth should allow a discussion to terminate in such a manner.

Tokio, May 22 JOHN MILNE

[This must now close.—ED. NATURE.]

Professor Newcomb's Determination of the Velocity of Light

I HASTEN to correct an error which has crept into my account in last week's NATURE (p. 171) of Prof. Newcomb's measures of the velocity of light. The arrangement employed by Foucault in 1862 was *not* that adopted by Newcomb, and illustrated in Fig. 1, but that sketched in Fig. 2. In other words, he placed his lens between the revolving and fixed mirrors. His apparatus is described in *Comptes rendus*, t. lv. p. 792, where the velocity of the rotating mirror is stated to have been 400 revolutions a second, and the total length of path between the mirrors 20 metres. A. M. CLERKE

June 28

Solar Halo and Sun Pillar seen on June 5, 1886

WHEN approaching the Observatory, about 6.45 p.m., my attention was drawn to portions of a solar halo, which appeared as in Fig. 1.

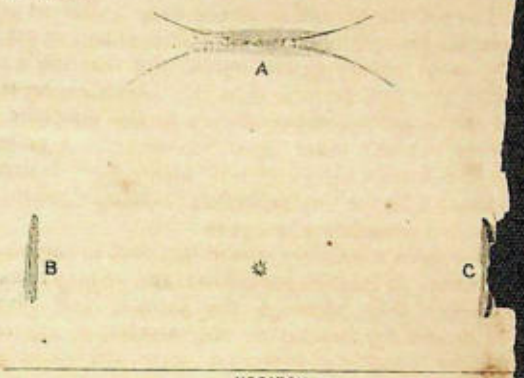


FIG. 1.—A, very bright; C, fainter; B, very faint.

This remained visible until after 7 p.m., and nothing was seen before 7.30 p.m. When looking out at 7.40 G.M.T., I noticed something unusual, and came at once to the conclusion that it was a solar pillar, and made a sketch in my note-book and the following remarks:—

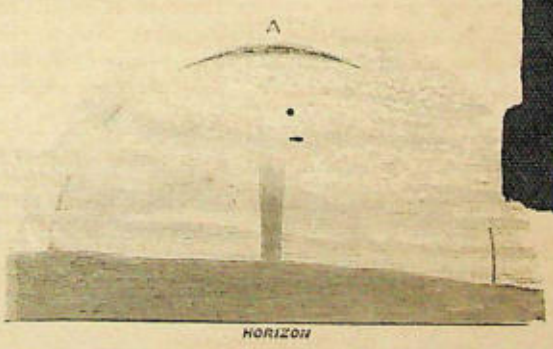


FIG. 2.

The shaded part in the foregoing, other than the halo, pillar, and stratus cloud, represents cirrus.

The pillar apparently rose from the sun, which—when I looked out at 7.40—had just gone below the top of some dark stratus cloud, directly to the upper part of the halo marked A. It was not more than 10° high at the brightest, but quite as much, as I estimated it to reach *nearly* half-way to the portion of the halo A, and the width four times the diameter of the sun. The lower part of the pillar was well defined and of a golden colour; as it approached the halo it gradually became fainter, and was then lost in the cirrus cloud. The upper part was somewhat wider; perhaps this was due to the greater amount of cloud there, which diffused the light.

At 7.55 G.M.T. all portions of the halo had gone except a small piece at A, and the pillar was fainter, but still quite visible. At 8.3 the halo and pillar had disappeared. The sun set at 8.14 p.m.

An ordinary halo (22½°) was visible, more or less bright at times, complete nearly from sunrise to sunset.

I could not fix the position of the pillar by stars, none near it being visible. The sketch was made at the time from a window of the library of the Observatory.

That seen here on 1883 April 6, by Mr. W. A. Robinson, was about 15 minutes *after* sunset; this observation was 30 minutes *before*. The time at which the pillar was visible on the former date was given by nearly all your correspondents as

5 m. to 45 m. *after* sunset, and in most cases in a cloudless sky; but that on 1886 June 5 was the reverse in both points. Some notes will be found in NATURE, 1883, April and May, for the pillar observed in that year. That seen here partly resembles Fig. 4, Plate III. in *Symons's Meteorological Magazine*, 1871. F. A. BELLAMY

Radcliffe Observatory, Oxford, June 21

The Enemies of the Frog

WHEN living at Mackay, Queensland, I frequently observed the common house-frogs (*H. cærulea*) were injured in the limbs, and on several occasions I would hear them croaking ; but on arrival all I saw would be a wretched exhausted creature painfully hopping away with a wound in the hind-leg, from which the blood would be oozing. Later on I found that rats were the frogs. The rats catch the frog by the hind-leg, and gently suck the wound they cause, then let the frog crawl away, attack it and suck it again, and so on until the rat has had enough. I believe the rats suck the blood, because I was unable to discover a frog so attacked on which the flesh had been destroyed.

W. P. Fletcher, a well-known local naturalist, once gave me the following account of a mantis attacking a frog. It was in the autumn of 1877, at Rockhampton, Queensland. He was attracted by hearing the noise of a frog in distress, in the garden, in some garden-shrubs about 6 feet high ; he went to the cause, and found a green frog about 2 inches long, and a mantis about 5 inches long, with one claw had hold of the frog's neck, so that the frog could not move, and the mantis was chewing, and did chew off, the hind-leg, the blood flowing profusely." He called Mrs. Fletcher to see them, and destroyed the mantis, whereon the frog crawled away.

Lake Elphinstone (100 miles from Mackay) I once found a small frog (*H. rubella*) in the house in a very exhausted condition ; on examination I found a large leech on its tongue. This specimen, with the leech attached, I gave to Mr. Boulenger for the British Museum, where it can be seen.

Round Mackay the chief enemies of the frogs appeared to be the rats and the *Agamidæ*. H. LING ROTH

Chronology of Elasticians

In forming a chronological list of writers on elasticity I have been unable to ascertain the following dates, which I should be much obliged if any of your readers would kindly supply: Mariotte (*né près de Dijon vers* 1620, Marie). Is nothing more definite known as to the date of his birth ?

F. E. Neumann	Death years.
W. Weber	
Eaton Hodgkinson	
S. Haughton	Birth years.
J. H. Jellett	

University College, London, June 27 KARL PEARSON

SOLAR METEOROLOGY[1]

SIG. TACCHINI'S detailed report on the various phases of solar activity during the year 1884 deserves, as might be expected from the reputation of its author, most careful attention. Exceptionally fine weather permitted observations of sunspots and faculæ to be made at the Collegio Romano on 307 out of the 365 days, so that the materials accumulated were more than usually abundant. We are thus particularly well informed regarding the symptoms attending the protracted maximum which culminated in February 1884.

This is the more fortunate as that maximum was distinguished by features of special interest. It was delayed considerably beyond the usual term, the interval from the maximum of 1870 being no less than 13·4 in lieu of the normal 11·1 years. And to this delay corresponded a greatly reduced intensity, in accordance with the law by which the undulations of the curve representing spot-frequency are low in proportion as they are long. The maximum of 1884, accordingly, was by much the feeblest which had occurred since 1830. It was moreover a hesitating—it might almost be called an abortive—maximum. Some unknown cause apparently interfered with its due and punctual development. Partial anticipatory outbreaks betrayed the tendency, continually repressed, to complete the cycle at the regular epoch, and with the regular expenditure of energy. Now perturbation—of whatever nature—is always instructive: hence Signor Tacchini's laborious statistical results acquire added significance.

They have been gathered along several closely connected lines of research. The various classes of solar surface-phenomena—spots, faculæ, prominences, metallic eruptions—have been studied apart, and the several resulting inferences as to the progress of solar disturbance subsequently confronted. The trifling discrepancies thus revealed show the mutual dependence of no two such species of commotion to be absolute. Each swells or subsides on the whole without immediate or invariable reference to any other, although under the obvious control of some common underlying cause.

Sunspot activity received a notable accession in the beginning of October 1883, the phase of excitement reaching its acme in the following February,[1] and persisting until the end of May. Since then, some slight oscillations notwithstanding, it has continually declined. The sun was not, however, observed at Rome to be free from spots on a single day in 1884. The maximum for prominences occured in March, and they continued exceptionally numerous down to the end of October. In all, 2714 were delineated and described in 242 observations with the spectroscope, being at the average rate of 11·22 per diem. Sixty metallic eruptions, observed on the same occasions, gave a mean diurnal frequency of 0·248 as against 0·171 for 1883. The richest crop was collected in November 1834, during which month ten eruptions were recorded in sixteen observations. The development of faculæ deviated so markedly from that of spots that their respective fluctuations were at times even inverted. It should also be noted that the mean area per spot in 1884 was of little more than half its value in the preceding year, and that the magnetic instruments at Rome remained throughout comparatively calm

Much valuable information is afforded by Signor Tacchini's careful inquiries as to the distribution on the sun's surface of the different orders of solar phenomena. All these showed, during 1884, a conspicuous prevalence of activity in the southern hemisphere ; and the inequality—as appears from a note by the same author presented to the Reale Accademia dei Lincei, March 7. 1886—became still more striking in the ensuing year. No spot was observed in either hemisphere during 1884 at more than 30° from the equator ; nor on the northern side, during the latter half of the year, at above 20°. With this contraction of the spotted zone coincided a close approach to the equator of the parallel of maximum frequency ; and the usual equatorial minimum was both in 1884 and 1885 very imperfectly maintained.

Prominences were plentifully distributed between 60° north and 50° south latitude, with maxima between 20° and 30°. As during the spot-maximum of 1870, they showed no disposition to avoid the vicinity of the equator ; while in 1880, 1881, and 1882, the equatorial minimum of prominences was very marked, and remained perceptible in 1883. Although some rare instances of metallic eruptions were detected in high northern latitudes, they affected chiefly a zone bounded by parallels of 20°. Faculæ occurred predominantly in the same region, and nowhere appeared in latitudes above 50°. On the whole, a concentration towards the equator of the whole range of phenomena was unmistakable, and might be thought to

[1] "Meteorologia Solare." Note di P. Tacchini. Estratto dagli *Annali della Meteorologia Italiana*, Parte 3. 1884. (Roma : Tipografia Metastasio, 1885.)

[1] M. Rudolf Wolf places the maximum in November 1883.

public and private collections have greatly increased, and the facilities for transport and for comparison of specimen with specimen have been enormously augmented. Those who revise the work of the great pioneer in fossil ichthyology will no doubt find much to amend, and no one knew this better than he himself. But they will not forget the difficulties under which he worked, and which he so pathetically describes. It was an enormous service to science to group and describe, as he did, all that was then known of the fishes of the past.

During the years in which Agassiz was engaged upon these and kindred researches he often turned his eyes wistfully to America as a land where many of the problems that so profoundly interested him could be even better studied than in Europe. There were many obstacles in the way of his crossing the Atlantic. In 1833 he had married the sister of his old college friend, Braun, and a young family was growing up round him. The emoluments of his Professorship at Neuchâtel were scanty enough even for his domestic needs, and he always had scientific work on hand that could not make progress without money. At last, however, he saw his way to visit America and pay the expenses of the journey by lecturing.

It was in the beginning of October 1846 that Agassiz arrived in Boston. Intending at first merely to make a lecturing tour, seeing what he could of the country and the people, but returning eventually to his home and its duties at Neuchâtel, he was gradually led to prolong his stay in the United States. His pleasant, genial ways, his captivating enthusiasm as a naturalist, and his activity of mind and body, gained him many friends; and at last, in the early part of 1848, he was offered and accepted the Chair of Natural History in a scientific school then organised in connection with Harvard University. Thenceforward he became an American citizen, and the record of his life is that of the growth of a remarkable personal influence which, holding up constantly before the public the claims of natural science for recognition, carried away all kinds of obstacles, personal, political, and financial, and planted firmly in the national mind a deep respect for scientific worth and the value of scientific training—an influence too which powerfully affected the young intellects that came in contact with it, kindling in them a spirit of brotherly co-operation and emulation in the study of nature. Without following the details of his busy and useful career, we may note the frequent excursions to distant regions for the purpose of gaining fresh materials for study. Thus we find the Professor at one time navigating the bays and creeks of Lake Superior; at another exploring the Florida reefs; then sailing up the Amazon and investigating its natural history; or dredging among the West Indies: studying glaciers in the Straits of Magellan, and voyaging up the western coast of America to San Francisco. Of these various expeditions narratives were published giving a pleasant picture of the life of the naturalists and of the chief scientific results obtained by them. Turning over the reports, we every now and then come upon some pregnant suggestion, some luminous generalisation, or some significant deduction, showing how the characteristic breadth of grasp and clearness of insight had undergone no diminution by transference to the New World. What, for instance, can be more suggestive than the sentence with which Agassiz begins one of his reports on these deep-sea dredgings? "From what I have seen of the deep-sea bottom, I am already led to infer that among the rocks forming the bulk of the stratified crust of our globe, from the oldest to the youngest formation, there are probably none which have been formed in very deep waters." In this conclusion and in his inference that the oceanic and continental areas have retained from the beginning the same general positions, he anticipates some of the most remarkable results of later research. Again, how prescient was his expectation that the deeper sea would show relics of older types of life that had vanished from the shallower waters!

One of the most important of Agassiz's labours in America was the founding of the Museum of Comparative Zoology at Cambridge—a museum which should not only present an orderly reflection of the structure and history of the whole animal creation, past and present, but which should contain such ample store of duplicates as to offer to students unlimited means of practical study, and should thus become one of the great centres for the radiation of knowledge throughout the community. To the realisation of his dream of founding such a museum he devoted the best energies of the last twenty years of his life, and lived to see it established and recognised as one of the great scientific institutions of the world. Full of labours to the last, happy in the hearty recognition of his scientific contemporaries, happier still in troops of friends in the Old World and in the New, and soothed by the tender affection of a loved home circle, Agassiz died on December 14, 1873.

The memoir which is the subject of this article has been written by his widow, whom he married in America after the death of his first wife. It is a most interesting narrative, bringing before us the man as he was, and, though making no pretence to appraise his scientific work, yet giving a graphic picture of the conditions under which the work was done. A simple boulder from the glacier of the Aar rests above his grave in the cemetery at Mount Auburn; a few sapling pine-trees sent from his old home in Switzerland throw their shadow over stone and grass. And no more fitting memorial could have been added to these tributes of affection than the story of his life so simply and gracefully told by Mrs. Agassiz.

ARCH. GEIKIE

OUR BOOK SHELF

Die äusseren mechanischen Werkzeuge der Thiere. Von Vitus Graber. (Leipzig: G. Freytag, 1886.)

THIS little work appears as the 44th and 45th of a series which, under the title "Das Wissen der Gegenwart," is published at Leipzig. The series embraces works on Astronomy, Geology, Physics, Biology, as well as treatises on History, Geography, Philosophy, and Art, all of which are issued at the extremely low price of one mark each. The present work consists of two parts, each of about 220 pages, with illustrations, and treats of the mechanics of the animal machine. The first part is concerned with the Vertebrates—where the construction is more complex—and in eight chapters we have the first principles of mechanics, so far as they relate to animals in general, discussed, and then the actions involved in locomotion, prehension, &c., are treated of in

detail. The second part glances at the same facts, so far as they are found manifested in the lower animals, more especially in the Arthropods, Mollusca, and Worms. Many of the woodcut illustrations are from original drawings, and of these those representing the muscles engaged in prehension and mastication are very good.

Animal Life on the Farm. By Prof. G. T. Brown, Agricultural Department, Privy Council. (London: Bradbury and Agnew.)

THIS is the last of a series of eight convenient handbooks covering the whole field of agricultural study. Dr. Masters's "Plant Life on the Farm" is ably followed by the excellent little book from the pen of Prof. Brown; and what may at first appear in the light of omissions in a treatise upon animal life as seen upon farms is at once corrected by the previously-published account of the live stock of the farm. Thus, while the subject of crops of the farm and live stock of the farm were ably treated, there was still room for more purely scientific writers, such as Dr. Masters and Prof. Brown, to treat of life more as biologists than as practical farmers. Accordingly, what is true of life on the farm is in many respects true of life in the forest and life in the city; but this does not detract from the value of facts about life wherever it may be found. It was probably an agreeable task to the writer to put this little volume together. It is full of matter with which he is very familiar, and which he is able to present with that admirable clearness and precision which has always characterised both his oral and written teaching. Commencing with the two opposite conditions of life, and death, as abstractions, we are pleasantly led to the consideration of the beginnings of life in the egg, and by a natural progress to a popular, but at the same time accurate, description of tissues, organs, and functions, which carry the reader through about two-thirds of the book. The remaining third is devoted to the peculiarities of domesticated animals, and in fact becomes more thoroughly specialised upon the farm. The variability, the precocity, the delicacy, the plasticity of domesticated animals are each dealt with by a master hand, and illustrated by examples taken from the experience of breeders and our great agricultural societies.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Iridescent Clouds

IN a letter published in NATURE for January 7 (p. 220), I tried to describe the appearance of the iridescent clouds as seen here on the afternoon of December 28. The phenomenon was repeated on December 29 and 31. On December 30, and again on January 1, the sky was overcast, but since then, though I have looked for them at different times of the day, and especially about sunrise and sunset, I have seen no further trace of iridescent clouds.

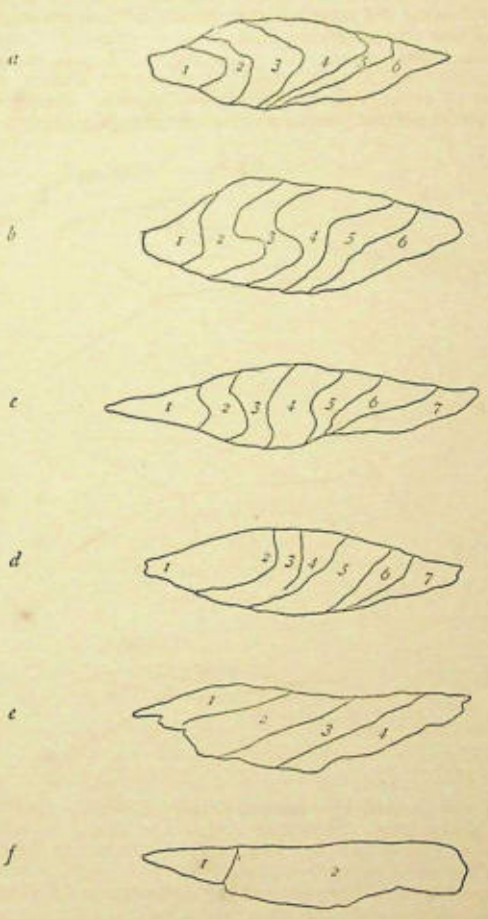
What struck me as most remarkable about them was, not the prevalent colour which they have been said to possess (see pp. 199, 219), for I cannot point out any as being peculiar to them, but the changes of colour undergone, often rapidly, by each individual cloud. As a record of these changes in the few instances I am able to give may perhaps help to throw some light on the nature and origin of these clouds, I trust I may be excused for occupying so much of your space.

December 29.—3.15 p.m., the sun a few degrees from setting, light cloud partly covering the sky, heavy snow-clouds near the horizon. At about 10° north of the sun and at an altitude of about 25°, there was a small cloud, 5° in length, consisting of four or five narrow bands nearly parallel to the horizon, all of a faint, but beautiful, violet colour. Soon after this, it was hidden by snow-clouds.

3.44.—This cloud was again visible, showing iridescent colours, no longer consisting of bands, but oval in form and slightly inclined to the north. Half a minute later, a branch of the same form and size, but rather more inclined to the north, appeared on the right, very faint, but increasing rapidly in brightness, until it equalled that of the original cloud. The new branch was at first violet, but in part tinged with rose-colour. The original cloud soon, however, began to fade, and by 3.47 had disappeared, the remainder being then green, except the upper edge slightly tinged with pink.

3.50.—The colours almost gone, but I believe the cloud was at this time covered by a thin haze. At 3.52 the cloud was very faint, and white.

Fig. 1.



3.55.—The colours again appeared, in three bands, blue on the left (nearest the sun), green in the middle, and on the right pink. But, immediately, the colours began to change, the blue and pink to fade, the green band becoming wider and brighter, until, in a few seconds, the whole cloud was green. It grew brighter and brighter until, at 3.57, it shone out a pure beautiful green almost of rainbow-brightness. But, at this moment, the snow-clouds, which had been rising rapidly, passed over it, and heavy driving snow began to fall.

At 4.18 the snow-storm was over, and in nearly the same place as the cloud just described were two small clouds, each about 5° long, at altitudes of about 20° and 25° respectively. They were faint, and had a slight trace of indefinite colouring. By 4.26 they had both disappeared.

4.28.—The two clouds again visible, the lower green, and the upper rose-coloured. But the clouds began to fade at once, and a minute later both had disappeared finally, the sky being now, and continuing, quite clear.

Besides these there were a few other small clouds, white, and of unusual character and brightness, but at no time did I detect in them any certain trace of colouring.

December 31.—At about 10 a.m., and for some time after, I noticed a small coloured cloud, above, but a little to the west of, the sun, and at an altitude of about 30°. The lower edge was blue, immediately above this a narrow band of green, the rest of the cloud being faint, almost colourless, but occasionally showing a slight yellowish tinge, and at the upper edge a touch of red.

At sunset there was the most wonderful display. At 4 p.m. in all parts of the sky were bands of light cirrus cloud, flushed with crimson by the setting sun. In the west, higher than the cirrus, and shining through them and in the intervals between, were splendid iridescent clouds, set off against a background of blue. I have never yet seen anything to equal the glory of this sky. It is impossible to describe it, the colours were so varied and their changes so rapid. I confined my attention, therefore, to the two largest and most beautiful clouds, and the following is a record of the colours and their variations, so far as I was able to observe them.

(1) One of these clouds is shown in Fig. 1. It was situated a few degrees south of west, about 20° above the horizon, and was about 15° in length and 5° in greatest breadth. During the whole time it seemed stationary, though changing slightly in

Fig. 2.



form. It was crossed by beautiful bands of colour, separated by fairly sharp lines. Sometimes, when the stripes of colour were narrow, I have included them in one band, to save time in drawing; the order being then given from left to right.

4.5 p.m.—Fig. 1, *a*. The right end of the cloud hazy. (1) Green, (2) yellow, orange, red; (3) blue, green, yellow, red; (4) red, with a tinge of purple; (5) bright purple; (6) red, green.

4.11.—Fig. 1, *b*. Both ends hazy. (1) Pink in the haze, blue; (2) yellow, green, orange; (3) green; (4) red; (5) blue; (6) red, ending in green in the haze.

4.18.—Fig. 1, *c*. The cloud rather longer and narrower than before. (1) Green; (2) green; (3) yellow, orange; (4) green; (5) red; (6) green; (7) red.

4.21.—The orange band 3 beginning to invade the green band 2.

4.22.—The red band 5 growing brighter.

4.25.—The red and orange bands, 3 and 5, widening, and becoming the predominant colours of the cloud.

4.27.—Fig. 1, *d*. (1) Light haze; (2) hazy; (3) red; (4) green; (5) bright red; (6) greenish; (7) orange red. The general hue of the cloud was at this time reddish orange, the red and orange bands being much brighter than the rest.

4.30.—Fig. 1, *e*. The outline hazy. (1) Haze; (2) red: (3) reddish orange; (4) red.

4.32.—Fig. 1, *f*. (1) Thin haze; (2) not quite so bright as before, but all of a deep rose-colour.

4.34.—The rose-coloured part had a slight tinge of purple, which, two minutes later, had become more marked, but rising clouds now stopped further observation.

(2) The other cloud was in a west-south-west direction, about 10° above the horizon, and partly hidden by a bank, which served, however, to show how slightly the cloud altered its position.

4.7 p.m.—Fig. 2, *a*. (1) Green; (2) orange red; (3) light green; (4) violet. All these colours very bright.

4.13.—The colours had changed, so that the general hue of the cloud was blue.

4.14.—Fig. 2, *b*. (1) Orange; (2) bright blue; (3) violet. The right edge hazy.

4.16.—The left side blue, the right violet, with a narrow pink band on the lower edge.

4.17.—The greater part of the cloud a very bright light blue, violet on the right, pink on the upper edge towards the left.

4.22.—Very faint and bluish.

4.25.—The cloud smaller, and bluish-green, but still faint.

4.26.—Green, and brighter.

4.29.—Fig. 2, *c*. The whole cloud much brighter, though not so bright as when first seen. (1) Reddish; (2) green; (3) reddish.

4.34.—The cloud the same shape as at 4.29, and the whole of it orange-coloured. After this moment it was hidden by heavy clouds.

Beside the two clouds above described, and several other smaller ones similar to them, there was visible in the west, at 4.26, a long narrow band of cloud (about 20° long and 3° or 4° broad), parallel to the horizon, and of a distinctly violet colour throughout.

CHARLES DAVISON

Sunderland, January 12

Parallel Roads in Norway

IN Mr. Hansen's account of the terrace formation of Central Norway he discards the sea theory of their origin, as well as the detrital dam, the local glacier theory, and also that of Prof. Prestwich, of landslips. The cause he ascribes to rests in the passage of the inland ice seawards, allowing lakes to form in the watershed while ice remained in the valleys seaward. Does this idea not reverse the order of Nature? Would it not be far simpler, more reasonable, and more in accordance with the laws of Nature to conclude that ice would remain in the highest valleys of the country longest, and that the parallel roads or terraces are the ice margins or lateral moraines where the ice rested after the most intense glaciation ceased, while the surplus passed over the cols, and the passage seaward was more or less retarded by the configuration of the country? The Lochaber roads are mostly composed of the usual glacial stuff of the district, it is neither washed as lake margins or sea beaches. The only water-washed material seems to have run down from the hills above, before glaciation ceased, and vegetation covered the surface. The roads are neither strictly parallel or horizontal, and just what might be expected to be formed by ice lying for a long time in a valley when the growth did not greatly exceed the waste and the motion was slow.

JAMES MELVIN

Edinburgh

Dew

HAVING read with interest the abstract in NATURE of January 14 (p. 256) of Mr. Aitken's observations on dew, I noted attentively during a walk this morning the behaviour of the hoar-frost as deposited on different objects. The morning was fine and frosty after a clear cold night. There was a copious deposit of hoar-frost upon the grass, upon the upper side of wooden rails, and upon the topmost twigs of the bushes in the tall hedges (6 to 8 feet high), but the lower twigs in the hedges had little or none. On stones in the road, as Mr. Aitken observes, there was little hoar-frost on the upper surface, only lines of ice crystals along the salient angles, but their under surfaces were thickly covered. With the loose heaps of broken stones by the road-sides the case was different: here the uppermost stones were thickly coated with frost on their upper surface, but had little on their lower surface; the stones underneath the uppermost layer, on the contrary, were coated with hoar-frost on their under, but not on their upper, surfaces. The hollow "cat's ice" on the road-side puddles, where previously

unbroken, was copiously coated with ice crystals above, but only scantily underneath; but where the ice had been broken so that the cavity beneath it had communicated freely with the open air, the crop of ice crystals was equally copious on both sides. A large hollow iron roller, 24 inches in diameter, had a copious crop of ice crystals on the upper surface, but little on the sides. Underneath, however, it had a coating of ice which extended about an inch from the point at which it rested on the earth, and then ended abruptly.

These observations seem to show that for the formation of hoar-frost, and inferentially also of dew, upon solid bodies, two factors are necessary, viz. (1) a sufficient cooling of the bodies by radiation below the temperature of the surrounding air; and (2) a supply of watery vapour in the air; and that within certain limits an excess of one of these factors may compensate for a deficiency of the other. Thus upon the top twigs, on the uppermost stones in the heaps, and on the upper surface of the iron roller—all these bodies being freely exposed to radiation, and not directly connected with the warm earth—a copious deposit of hoar-frost took place; and this deposit, it is to be remarked, must have been condensed from the vapour diffused in the layers of air in contact with those bodies, and not from that issuing from the earth. Vapour from the ground could not pass through the impervious iron roller to reach the upper surface; it may indeed be supposed to have passed round the circumference, but the sides of the roller were, as I have said, comparatively free from hoar-frost. On the other hand, the under sides of the stones, and of the roller, though to a considerable extent protected from radiation, had on them a deposit of ice, seemingly condensed, as Mr. Aitken supposes, from the vapour exhaled from the comparatively warm ground beneath them.

The scantier deposit of hoar-frost upon the under surface of the "cat's ice" when unbroken than when broken is, I presume, due to the more rapid cooling of the ice when the space beneath it communicates with the open air, than when closed. H. F. P.

January 19

Clouds and Upper Wind-Currents over the Atlantic Doldrums

THE first of the two following weather sections across the Atlantic doldrums was taken in June and July last on board the s.s. *Tongariro*, during her voyage from Rio Janeiro to Teneriffe.

Practically clouds in these latitudes may be taken as belonging to three levels: a small cumulus, low down; a middle layer of some stratiform cloud; and a high-level cirrus. Any one of these may appear by itself, or all may be present simultaneously. The depth of the various air-currents which drive these clouds, I take to be of great importance in any general theory of the circulation of the atmosphere in the equatorial regions.

Space will not permit me to give here the details of each day's observations, but the results may be briefly stated thus: South of the equator, the low or middle clouds over the south-east trade, which we picked up in 10° S. lat., invariably came from some point to the right of the surface-wind, when you stood with your back to it, *i.e.* if the surface-wind was south-east the clouds would drive from about east-south-east. This is the usual rotation of upper currents in the southern hemisphere.

But, north of the Line, when for reasons which cannot be discussed here, the south-east trade did not turn to south-west, as might have been expected, the upper currents continued to follow the rotation of the southern, and not that of the northern hemisphere, that is to say, the upper currents over the south-east surface-wind continued to come from some more easterly point. In the "doldrums," also, which extended from about 8° to 13° N., the same rule obtained, and the middle cloud-layer over some "cat's-paws" of south-east wind drove from the east.

In the north-east trade I only got one unsatisfactory observation in 22° N., 19° W., which gave a middle layer of north-north-east wind over an east-north-east surface trade. This is contrary to what might have been expected.

The second section was taken in December last on board the s.s. *Drummond Castle*, during part of her voyage between Lisbon and Cape Town, with much better appliances for observing clouds than on my former voyage.

In the north-east trade, from 30° N. lat. down to the doldrums in 5° N., the upper layers of cloud invariably came from some point to the left of the surface-wind. When you stood with your back to it, *i.e.* if the surface-wind was from north-east, the higher clouds would come from east, or south-east, or even south by west. This is the usual rotation of upper wind-currents in the northern hemisphere. As far north as 20° N. the middle clouds came from south by west, and in 10° N. this current had descended to the level of the low cumulus, and the middle clouds drove from west.

But as we touched the doldrums in 5° N., a totally different wind-system became apparent. Over the oily calm of that district I could just detect, through the universal haze and gloom, a middle current from the east; and when, in a few hours, we picked up the south-west monsoon of the Gulf of Guinea, here coming from south by west, the low clouds drove from south-east. This continued till we reached the Line, and the single observation which I got of high cirrus in 1° N. lat. showed an easterly current at that level. Thus, for 8° N. of the equator the rotation of the upper winds was that proper to the southern hemisphere, for south-east and east were over a south-west surface-wind instead of west or north-west, as might have been expected. This is the more curious, because the surface-wind has the south-west set proper to the northern hemisphere.

But the greatest interest of this last observation is to be found in the extraordinary analogy which the wind-system over the Gulf of Guinea presents to the wind-system over the north-west monsoon in the Indian Ocean, which I discovered last spring, and described in a letter to NATURE of October 29, 1885 (p. 624). In that region I found that as the north-east monsoon crosses the Line and turns to the north-west, the upper currents are those proper to the northern hemisphere, that is to say the low and high layers of cloud come from north and east respectively. Now we see that both in the Gulf of Guinea and mid-Atlantic, as the south-east trade crosses the Line, it carries the rotation of the higher currents, proper to itself, up to the doldrums.

After crossing the equator in the *Drummond Castle* the wind turned to south by east or south-south-east, and as far as 18° S., beyond which we need not follow them, the upper currents were either identical in direction with the surface-wind, or else a very little more easterly—that is, they followed the normal rotation of their hemisphere.

In conclusion, I may point out another very important result of these observations as far as they have gone yet:—The highest current between the equator and the doldrums is always from some point near the east, whatever the westerly set of the surface-wind may be. I have had no opportunity of estimating the velocity of this current, but the impression on my mind has been that it is not apparently very rapid, though, of course, the height is very considerable. RALPH ABERCROMBY

Cape Town, December 18, 1885

Ventilation

HAVING read your late article on ventilation, and letters referring thereto, I think it may be of interest to your readers to know something of what we have done in this quarter. Since the year 1877 we have had in Dundee a number of schools and other buildings ventilated and heated by propelling large volumes of heated air into the rooms with a small-power engine.

The system, as now generally introduced, is as follows:—Rotary air-pumps, or a Blackman air-propeller, driven by a small gas-engine, are placed in the basement floor. The air is conducted thither by flues from an altitude of 30 feet, so as to be as free from dust and other impurities as possible. This cold air is discharged into large wooden flues under the ground floor, which are painted with asbestos paint. Running parallel to these flues are others containing hot-water high-pressure pipes, about 1½ inches in diameter. These hot flues are divided into air-tight sections, suitable for the heating of the different rooms. The air from the cold flue passes into the different sections of the hot flue, from which again it passes out, heated, into the different rooms, about 5 feet from the floor, by long and narrow flues, so that it may be well diffused. Each room has its own exhaust-flue or flues, reaching within 1½ feet of the floor, and passing into the space between the upper-floor ceiling and the roof. This space is made into a large flue, into which all the foul air from the different rooms passes. On the roof there are constructed one or more square shafts, with fixed louvre boards on each of the four sides. Inside the louvres are fixed valve-frames covered with a large number of light waterproof cloth

valves, which prevent the air passing inwards. There are always one or more sides on which the wind does not blow, allowing the foul air free egress from within out. Some of the school buildings where this system has been introduced are having as much air passed through them as will refill the rooms every 10 or 15 minutes.

This system, as explained, can be seen in operation at the chemical laboratory of the Dundee University College, the Harris Academy, Dundee, and at the Dundee High Schools, the directors of which are introducing the system into another large new school for girls, which is to be opened in a few months.

WILLIAM CUNNINGHAM

Dundee, January 12

A Family of Rare Java Snakes

AT the Zoological Gardens, on Saturday, the 9th inst., a rather rare "Green-Tree Snake" (*Dryiophis prasina*), from Java, produced eight snakelings under circumstances which tend to confirm recent observations regarding the uncertain period of gestation in snakes, otherwise the voluntary retention or deposition of their eggs or even their young. The mother was brought to the Reptilium five months ago (August 15), and allowing two months for her transportation from Java, it must be at least seven months since she was captured and separated from her mate. The normal period of gestation in a snake of this size may be about three months, but incubation, which begins at once, would in all snakes seem to depend a good deal on temperature and on other propitious circumstances; nor can it be positively asserted that such or such a species is invariably oviparous or viviparous, as in several instances the same snake has been known to be both—*i.e.* under certain conditions an oviparous snake has become viviparous. In sunny weather a high temperature is obtained in the cages where this snake is; and it is probable that the late cold season may have materially affected this *Dryiophis*. It is probable that, lacking the dense foliage of her native forests, together with these adverse conditions of her small glass dwelling, she retained her progeny until the latest moment.

The snakelings average 20 inches in length. The mother is over 5 feet, and like all the family of whip-snakes is exceedingly slender, with the long tail tapering to a cord-like fineness. She is of a bright emerald green, while the little ones are of a dull ashy hue, with tongues of the same colour; the mother's tongue is pinkish. The parent has fed well on small lizards during her captivity, but it is to be feared that the little family will fare badly, as at the present time suitable food is difficult to procure. They were at once removed into another cage, or their mother might have reduced their numbers at dinner-time. They soon found their way to the water-pan and drank freely, and began to cast their skins at an early day.

CATHERINE C. HOPLEY

15, Queen's Crescent, Haverstock Hill, N.W.

Vibration of Telegraph-Wires

I NOTICED to-day a curious vibration of telegraph-wires near here, and perhaps some reader of NATURE may be able to explain it. Each wire was vibrating rapidly, but instead of the nodes being only at each post, there were several in each span (of about 88 yards). The number of nodes varied in each span; I counted seven in one, nor did the wires vibrate together as a rule. In some spans four out of five wires were vibrating, and in others only one. The total amplitude of vibration did got exceed 1½ inches, I should think. I noticed this peculiar action in some five or six contiguous spans only. There was a very hard frost at the time, and the wires were coated with snow which had fallen some thirty-six hours previously. There was no wind, and the sun was just breaking through a fog. The wire was galvanised iron, No. 8 B.W.G.

E. DE M. MALAN

Howden, East Yorkshire, January 19

HEREDITARY STATURE [1]

IT will perhaps be recollected that, at the meeting last autumn of the British Association in Aberdeen, I chose for my Presidential Address to the Anthropological Section a portion of the wide subject of "Hereditary Stature." My inquiries were at that time advanced only to a certain stage, but they have since been completed up to a well-defined resting-place, and it is to their principal net results that I shall ask your attention to-night.

I am, happily, released from any necessity of fatiguing you with details, or of imposing on myself the almost impossible task of explaining a great deal of technical work in popular language, because all these details have just been laid before the Royal Society, and will in due course appear in their *Proceedings*. They deal with ideas that are perfectly simple in themselves, but many of which are new and most are unfamiliar, and therefore difficult to apprehend at once. My work also required to be tested and cross-tested by mathematical processes of a very technical kind, dependent in part on new problems, for the solution of which I have been greatly indebted to the friendly aid of Mr. J. D. Hamilton Dickson, Fellow and Tutor of St. Peter's College, Cambridge. I shall therefore quite disembarrass myself on the present occasion from the sense of any necessity of going far into explanations, referring those who wish thoroughly to understand the grounds upon which my results are based, to the forthcoming memoir in the *Proceedings* of the Royal Society, and to that amplified and illustrated extract from my Address at Aberdeen, accompanied by tabular data, which appeared among the "Miscellanea" of the *Journal* of this Institute last November.

The main problem I had in view was to solve the following question. Given a group of men, all of the same stature, whatever that stature may be,—it is required to be able to predict two facts regarding their brothers, their sons, their nephews, and their grandchildren, respectively, namely, *first*, what will be their average height; *secondly*, what will be the percentage of those kinsmen whose statures will range between any two heights we may please to specify:—as between 6 feet and 6 feet 1 inch, 6 feet 1 inch and 6 feet 2 inches, &c.?

The same problem admits of another rendering, because whatever is statistically *certain* in a large number is the *most probable* occurrence in a small one, so we may phrase it thus: Given a man of known stature, and ignoring every other fact, what will be the most probable average height of his brothers, sons, nephews, grandchildren, &c., respectively, and what proportion of them will most probably range between any two heights we may please to specify?

I have solved this problem with completeness in a practical sense. No doubt my formulæ admit of extension to include influences of a minor kind, which I am content to disregard, and that more exact and copious observations may slightly correct the values of the constants I use; but I believe that for the general purposes of understanding the nearness of kinship in stature that subsists between relations in different degrees, the problem is solved.

It is needless to say that I look upon this inquiry into stature as a representative one. The peculiarities of stature are that the paternal and maternal contributions blend freely, and that selection, whether under the aspect of marriage selection or of the survival of the fittest, takes little account of it. My results are presumably true, with a few further reservations, of all qualities or faculties that possess these characteristics.

Average Statures.—The solution of the problem as regards the average height of the kinsmen proves to be almost absurdly simple, and not only so, but it is explained most easily by a working model that altogether supersedes the trouble of calculation. I exhibit one of these: it is a large card ruled with horizontal lines 1 inch apart, and numbered consecutively in feet and inches, the value of 5 feet 8 inches lying about half way up. A pin-hole is bored near the left-hand margin at a height corresponding to 5 feet 8½ inches. A thread secured at

[1] Extracts from Mr. F. Galton's Presidential Address to the Anthropological Institute, January 26.

the back of the card is passed through the hole; when it is stretched it serves as a pointer, moving in a circle with the pin-hole as a centre. Five vertical lines are drawn down the card at the following distances, measured horizontally from the pin-hole: 1 inch, 2 inches, 3 inches, 6 inches, and 9 inches. For brevity I will call these lines I., II., III., VI., and IX. respectively. This completes the instrument. To use it: Hold the stretched thread so that it cuts IX. at the point where the reading of the horizontal lines corresponds to the stature of the given group. Then the point where the string cuts VI. will show the average height of all their brothers; where it cuts III. will be the average height of the sons; where it cuts II. will be the average height of the nephews; and where it cuts I. will be the average height of the grandchildren. These same divisions will serve for the converse kinships; VI., obviously so; III., son to a parent; II., nephew to an uncle; I., grandson to a grandfather. Another kinship can be got from VI., namely, that between "mid-parent" and son. By "mid-parental" height I mean the average of the two statures: (*a*) the height of the father, (*b*) the transmuted height of the mother. This process, I may say, is fully justified by the tables already printed in our *Journal*, to which I have referred. It is a rather curious fact that the kinship between a given mid-parent and a son should appear from my statistics to be of exactly the same degree of nearness as that between a given man and his brother. Lastly, if we transmute the stature of kinswomen to their male equivalents by multiplying them after they are reduced to inches, by 1·08, or say, very roughly, by adding at the rate of 1 inch for every foot, the instrument will deal with them also.

You will notice that the construction of this instrument is based on the existence of what I call "regression" towards the level of mediocrity (which is 5 feet 8½ inches), not only in the particular relationship of mid-parent to son, and which was the topic of my Address at Aberdeen, but in every other degree of kinship as well. For every unit that the stature of any group of men of the same height deviates upwards or downwards from the level of mediocrity as above, their brothers will on the average deviate only two-thirds of a unit, their sons one-third, their nephews two-ninths, and their grandsons one-ninth. In remote degrees of kinship, the deviation will become zero; in other words, the distant kinsmen of the group will bear no closer likeness to them than is borne by any group of the general population taken at random.

The *rationale* of the regression from father to son is due (as was fully explained in the Address) to the double source of the child's heritage. It comes partly from a remote and numerous ancestry, who are on the whole like any other sample of the past population, and therefore mediocre, and it comes partly only from the person of the parent. Hence the parental peculiarities are transmitted in a diluted form, and the child tends to resemble, not his parents, but an ideal ancestor who is always more mediocre than they. The *rationale* of the regression from a known man to his unknown brother is due to a compromise between two conflicting probabilities; the one that the unknown brother should differ little from the known man, the other that he should differ little from the mean of his race. The result can be mathematically shown to be a ratio of regression that is constant for all statures. The results of observation accord with, and are therefore confirmed by, this calculation.

Variability above and below the Mean Stature.—Here the net result of a great deal of laborious work proves, as in the previous case, to be extremely simple, and to be very easily expressed by a working model. A set of five scales can be constructed, such as I exhibit, one appropriate to each of the lines I., II., III., and VI., and suitable for any position on these lines. They are so divided that when the centres of the scales are brought opposite to the points crossed by the thread, in the way already explained, we shall see from the divisions on the scales what are the limits of stature between which successive batches of the kinsmen, each batch containing 10 per cent. of their whole number, will be included. Smaller divisions indicate the 5 per cent. limits. The extreme upper and extreme lower limits are perforce left indefinite. Each of the scales I give deals completely with nine-tenths of the observations, but the upper and lower 5 per cent. of the group, or the remaining one-tenth, have only their inner limits defined.

The divisions on the movable scales that are appropriate to the several lines VI., III., II. and I., are given in the table, where they are carried one long step further than I care to recommend in use.

Per-cents. of included statures	Divisions, upwards and downwards, from centres of the scales; in inches		
	VI.	III.	II. and I.
10 ...	0·5 ...	0·6 ...	0·6
20 ...	1·0 ...	1·3 ...	1·3
30 ...	1·6 ...	2·0 ...	2·1
40 ...	2·4 ...	3·0 ...	3·1
45 ...	3·1 ...	3·9 ...	4·0
49·5 ...	4·8 ...	6·1 ...	6·3

The divisions are supposed to be drawn at the distances there given, both upwards and downwards from the centres of the several scales, which have to be adjusted, by the help of the thread, to the average height of the kinsmen indicated in the several lines. The percentage of statures that will then fall between the centre of each scale and the several divisions in it is given in the first column of the table. Example:—In line VI. 40 per cent. will fall between the centre and a point 2·4 inches above it, and 40 per cent. will fall between the centre and a point 2·4 inches below it; in other words 80 per cent. will fall within a distance of 2·4 inches from the centre. Similarly we see that 2 × 49·5, or 99 per cent. will fall within 4·8 inches of the centre.

In respect to the principle on which these scales are constructed, observation has proved that every one of the many series with which I have dealt in my inquiry conforms with satisfactory closeness to the "law of error." I have been able to avail myself of the peculiar properties of that law and of the well-known "probability integral" table, in making my calculations. A very large amount of cross-testing has been gone through, by comparing secondary data obtained through calculation with those given by direct observation, and the results have fully justified this course. It is impossible for me to explain what I allude to more minutely now, but much of this work is given, and more is indicated, in the forthcoming memoir to which I have referred.[1]

I know of scarcely anything so apt to impress the imagination as the wonderful form of cosmic order expressed by the "law of error." A savage, if he could understand it, would worship it as a god. It reigns with serenity in complete self-effacement amidst the wildest confusion. The huger the mob and the greater the apparent

[1] The following will be of help to those who desire a somewhat closer idea of the reasoning than I can give in a popular Address.

m = mean height of race = 68·25 inches.

$m \pm x$ = height of a known individual.

$m \pm x'$ = the probable height of an unknown kinsman in any given degree.

$\frac{x'}{x}$ (which I designate by w) = the ratio of mean regression: it is shown by direct observation to = ⅔ both in the case of mid-parent to son, and of man to brother; it is inferred to be ½ in the case of parent to son. It is upon these primary kinships that the rest depend.

The "probable" deviations ("errors") from the mean values of their respective systems are—

p = that of the general population = 1·70 inch.

b = that of any large family of brothers = 1·0 inch.

f = that of kinsmen from the mean value of $m \pm x'$.

Since a group of kinsmen in any degree may be considered as statistically identical with a sample of the general population, we get a general equation that connects f with w, namely, $w^2p^2 + f^2 = p^2$.

The ratio of regression in respect to brothers can be shown to depend on the equation $w = \frac{p^2 - b^2}{p^2} = \frac{2}{3}$ nearly.

anarchy the more perfect is its sway. Let a large sample of chaotic elements be taken and marshaled in order of their magnitudes, and then, however wildly irregular they appeared, an unsuspected and most beautiful form of regularity proves to have been present all along. Arrange the statures side by side in order of their magnitudes, and the tops of the marshaled row will form a beautifully flowing curve of invariable proportions; each man will find, as it were, a preordained niche, just at the right height to fit him, and if the class-places and statures of any two men in the row are known, the stature that will be found at every other class-place, except towards the extreme ends, can be predicted with much precision.

It will be seen from the large values of the ratios of regression how speedily all peculiarities that are possessed by any single individual to an exceptional extent, and which blend freely together with those of his or her spouse, tend to disappear. A breed of exceptional animals, rigorously selected and carefully isolated from admixture with others of the same race would become shattered by even a brief period of opportunity to marry freely. It is only those breeds that blend imperfectly with others, and especially such of these as are at the same time prepotent, in the sense of being more frequently transmitted than their competitors, that seem to have a chance of maintaining themselves when marriages are not rigorously controlled—as indeed they never are, except by professional breeders. It is on these grounds that I hail the appearance of every new and valuable type as a fortunate and most necessary occurrence in the forward progress of evolution. The precise way in which a new type comes into existence is untraced, but we may well suppose that the different possibilities in the groupings of some such elements as those to which the theory of pangenesis refers, under the action of a multitude of petty causes that have no teleological significance, may always result in a slightly altered, and sometimes in a distinctly new and fairly stable, position of equilibrium, and which, like every other peculiarity, admits of hereditary transmission. The general idea of this process is easy enough to grasp, and is analogous to many that we are familiar with, though the precise procedure is beyond our ken. As a matter of fact, we have experience of frequent instances of "sports," useful, harmful, and indifferent, and therefore presumably without teleological intent. They are also of various degrees of heritable stability. These form fresh centres, towards which some at least of the offspring have an evident tendency to revert. By refusing to blend freely with other forms, the most peculiar "sports" admit of being transmitted almost in their entirety, with no less frequency than if they were not exceptional. Thus a grandchild, as we have seen, regresses on the average one-ninth. Suppose the grandfather's peculiarity refused to blend with those of the other grandparents, then the chance of his grandson inheriting that peculiarity in its entirety would be as one to nine; and, so far as the new type might be prepotent over the other possible heritages, so far would the chance of its reappearance be increased. On the other hand, if the peculiarity did not refuse to blend, and if it was exceptional in magnitude, the chance of inheriting it to its full extent would be extremely small. The probability (easily to be calculated for any given instance by the "probability integral" tables) might even be many thousand times smaller. I will give for an example a by no means extreme case. Suppose a large group of men, all of 6 feet 5 inches in height, the statures of whose wives are haphazard, then it can be shown that out of every thousand of the sons not more than one on an average will rival or surpass the height of his father. This consideration is extremely important in its bearing on the origin of species. I feel the greatest difficulty in accounting for the establishment of a new breed in a state of freedom by slight selective influences, unless there has been one or more abrupt changes of type, leading step by step to the new form.

It will be of interest to trace the connection between what has been said about hereditary stature and its application to hereditary ability. Considerable differences have to be taken into account and allowed for. *First*, after making large allowances for the occasional glaring cases of inferiority on the part of the wife to her eminent husband, I adhere to the view I expressed long since as the result of much inquiry, historical and otherwise, that able men select those women for their wives who on the average are not mediocre women, and still less inferior women, but those who are decidedly above mediocrity. Therefore, so far as this point is concerned, the average regression in the son of an able man would be less than one-third. *Secondly*, very gifted men are usually of marked individuality, and consequently of a special type. Whenever this type is a stable one, it does not blend easily, but is transmitted almost unchanged, so that specimens of very distinct intellectual heredity frequently occur. *Thirdly*, there is the fact that men who leave their mark on the world are very often those who, being gifted and full of nervous power, are at the same time haunted and driven by a dominant idea, and are therefore within a measurable distance of lunacy. This weakness will probably betray itself in disadvantageous forms among their descendants. Some will be eccentric, others feeble-minded, others nervous, and some may be downright mad.

It will clear our views about hereditary ability if we apply the knowledge gained by our inquiry to solve some hypothetical problem. It is on that ground that I offer the following one. Suppose that in some new country it is desired to institute an Upper House of Legislature consisting of life-peers, in which the hereditary principle shall be largely represented. The principle of insuring this being that two-thirds of the members shall be elected out of a class who possess specified hereditary qualifications, the question is, What reasonable plan can be suggested of determining what those qualifications should be?

In framing an answer, we have to keep the following principles steadily in view:—(1) The hereditary qualifications derived from a single ancestor should not be transmitted to an indefinite succession of generations, but should lapse after, say, the grandchildren. (2) All sons and daughters should be considered as standing on an equal footing as regards the transmission of hereditary qualifications. (3) It is not only the sons and grandsons of ennobled persons who should be deemed to have hereditary qualifications, but also their brothers and sisters, and the children of these. (4) Men who earn distinction of a high but subordinate rank to that of the nobility, and whose wives had hereditary qualifications, should transmit those qualifications to their children. I calculate roughly and very doubtfully, because many things have to be considered, that there would be about twelve times as many persons hereditarily qualified to be candidates for election as there would be seats to fill. A considerable proportion of these would be nephews, whom I should be very sorry to omit, as they are twice as near in kinship as grandsons. One in twelve seems a reasonably severe election, quite enough to draft off the eccentric and incompetent, and not too severe to discourage the ambition of the rest. I have not the slightest doubt that such a selection out of a class of men who would be so rich in hereditary gifts of ability, would produce a body of men at least as highly gifted by nature as could be derived by ordinary parliamentary election from the whole of the rest of the nation. They would be reared in family traditions of high public services. Their ambitions, shaped by the conditions under which hereditary qualifications could be secured, would be such as to encourage alliances with the gifted classes. They

would be widely and closely connected with the people, and they would to all appearance—but who can speak with certainty of the effects of any paper constitution—form a vigorous and effective aristocracy.

DEPOSITS OF THE NILE DELTA

IN a previous communication I referred to the probability that the lower portion of the Delta borings belongs to the Pleistocene and Isthmian deposit which underlies the modern Nile mud, and which has been recognised as an important formation by nearly all geologists who have studied the Nile Valley. I now propose to state shortly some objections to the generalisations of the Report on the Nile borings with reference to the causes assigned for the comparative purity of the waters of the Nile, and the character of its sediment, viz. that the former is due to its flowing through a rainless country, and that the latter is derived from the decay of rocks in this rainless area, and this decay produced not by "chemical agencies," but by "mechanical forces," namely, the "unequal expansion" of the constituent minerals under the influence of heat and cold, aided by "the force of the wind."

It is scarcely necessary to premise that neither the water nor the mud of the Nile can be derived from the rainless district through which the river flows, but from the well-watered regions of interior Africa. The White Nile, which carries scarcely any sediment, is a somewhat constant stream, draining a country of lakes, swamps, and forests. The Blue or Dark Nile and the Atbara drain the mountainous country of Abyssinia, deluged with rain in the wet season, and it is these streams, swollen by violent inundations, that supply the Nile with its sediment, the quantity of fresh material carried into the river below the confluence of the Atbara being very small, as the results of the microscopic study of the sediment sufficiently proves, and I can testify from my own examinations of the Nile mud, that its composition, as stated by Prof. Judd, is essentially the same along the course of the Nile as in the upper layers of the Delta borings, though with some local differences in the fineness of the sand and the proportion of argillaceous matter. Thus both the water of the inundations and the material of the alluvial deposit come from a region of copious rains, and where decay of rocks may be supposed to proceed under the ordinary conditions.

What then is the cause of the freedom of the Nile water from saline matter? Simply its derivation from a country of siliceous and crystalline rocks. If, instead of comparing it with the water of the Thames and other streams draining sedimentary districts, it had been compared with that of the lakes and streams of the Scottish Highlands (by no means rainless districts) this would have been apparent. Dr. Sterry Hunt has described and referred to its true cause a fact of the same kind in the case of the Ottawa and St. Lawrence. The former, rising in a region of crystalline rocks, has little more than one-third of the saline matter in solution that is found in the latter, which drains principally a sedimentary country. The proportions in 10,000 parts are, for the Ottawa, only 0·6116, and for the St. Lawrence, 1·6055.[1]

But it may be asked, Why in that case is the Nile mud so deficient in kaolin? The answer is, that the current of the river is sufficiently strong to wash out all the more finely comminuted argillaceous matter and to carry it in its turbid waters to the sea. In connection with this, every voyager on the falling Nile must have observed how the mud-banks are constantly falling as they are undermined by the river, and their material carried down to be redeposited. This work goes on even more energetically in the time of the inundations. Thus any given quantity of sediment on its way from Abyssinia to the Delta is lixiviated thousands of times, and necessarily deprived of its lighter and finer constituents.

But the quantity of kaolin need not originally have been large. The older gneisses and schists do not kaolinise after the manner of Cornish granites, but, when decomposed so as readily to crumble into sand, they still contain much of their more refracting felspar in a perfect state.

These facts are farther illustrated by the agricultural qualities of the Nile alluvium, as they have been explained by Schweinfurth and others. If the alluvial soil were a stiff clay, it would be practically incapable of cultivation in the circumstances of Egypt. If it were mere quartzose sand, it would be hopelessly barren. It is, in fact, an impalpable sand, highly absorbent of water, crumbling readily when moistened, and containing not merely quartz but particles of various silicates and of apatite and dolomite, which, though unaltered when under water, are gradually dissolved by the carbonic acid present in the cultivated soil, yielding alkalies, phosphates, &c., to the crops. In connection with this, recent microscopic examinations by Dr. Bonney of the old crystalline rocks of Assouan, which are probably similar to those farther north, show that, like those of Canada and Norway, they contain numerous crystals of apatite.

As to the mechanical action of the heat of the sun on crystalline rocks, any one who examines the polished surfaces still retained by monuments which in Upper Egypt have been exposed to this influence for thousands of years, must be convinced that no disintegration of this kind occurs. The only evidence of such actions that I have been able to find is the chipping of little circular disks from the exposed sides of nodules of flint on the surface of the desert. Granitic rocks decay, however, in Egypt, as elsewhere, where they are exposed to moisture from the soil, or where, as at Alexandria, they are subjected to the influence of frequent rains and of saline particles carried from the sea. In this connection I may add that Hague, in a paper in *Science* on the decay of the New York obelisk, shows that it had probably suffered (as, according to Wigner, that in London has also done) from atmospheric action before its removal from Alexandria, and that this decay has been greatly increased by the alternations of moisture and frost to which it is subjected in New York.[1]

At Assouan, in a climate at present rainless, or nearly so, I was surprised to find that the surface of the gneiss and crystalline schists was in many places decayed to the depth of several feet, so that it was impossible to obtain fresh specimens except from the railway cuttings. This may be due to the action of water and carbon dioxide oozing through the ground, but is more probably a result of more humid climatal conditions in former ages.

I hope at a future date to pursue these interesting questions farther; but in the meantime I shall be content if it has been shown that Egypt owes the advantage of pure, sweet water to the fact that it drinks of mountain streams which the rainless character of its own climate merely preserves from pollution by the drainage of the Cretaceous and Tertiary beds, and that its rich alluvial soil has not been produced by any mechanical action of an exceptional nature, but by the ordinary atmospheric agencies of denudation.

These conclusions, as well as those stated in my previous letter, respecting the depth of the modern alluvium and its relation to the well-known Pleistocene formation which underlies it, could be confirmed by the testimony of most geologists who have studied the valley of the Nile, and more especially of Lartet, Fraas, and Schweinfurth. I hope that as now stated, however imperfectly, they may suffice to induce the Committee materially to modify its Report, or to postpone its publi-

[1] Logan's "Geology of Canada," 1865, p. 565.

[1] The freezing of water in the pores of rocks is undoubtedly an important cause of destruction in the colder climates.

cation until those members of the Royal Society who have studied the geology of Egypt can have opportunity to discuss it fully. J. WILLIAM DAWSON

December 28, 1885

NOTES ON THE "MUIR GLACIER" OF ALASKA

IN a recent number of NATURE (vol. xxxii. p. 162) an abstract is made of a San Francisco newspaper account of the "Great Glacier" of Alaska. This account is not very accurate, and as I spent a few hours on this glacier during a flying visit to Alaska in the summer of 1884, I think my observations may be worth recording. I have heard that some descriptions by American observers have already been published, but have not been able to procure them. However, as there are one or two features to which it may be useful to draw the attention of future explorers in this region, I will give my observations just as I made them, and apologise beforehand if they should be found to overlap those of others.

On August 1, 1884, I took passage from Victoria, Vancouver Island, on the steamer—on this occasion the *Idaho*—which carries the monthly mail from ports on Puget Sound to Sitka, Alaska, and eight days later we steamed up the long fiord known as "Glacier Bay," which opens into the Chilcoot Inlet, being then not far from latitude 59° N. and longitude 136° W. of Greenwich.

On either side of us high snow-capped mountains bordered the fiord, and in their recesses we could see glaciers of all sizes. One large mass filled a deep valley on our left, and reached nearly down to the sea, being apparently only separated from it by a ridge of moraine; and everywhere little patches of blue rested in all the *coulées* near the mountain-tops, and showed by their trail of bare striated rocks and long strings of moraine how much further they must recently have extended.

Here and there a small island rose above the waters of the fiord, and, by its bare rounded outline and *moutonnéed* surface, gave evidence that it, too, had once been overspread by the ice. The Indians say that one of these islands which is now above a mile distant from the Great Glacier, was embedded in the ice during their recollection, and I was told that early Russian charts of the coast do not show this fiord at all, but make note of a line of ice cliffs near its present entrance; but though the fiord has undoubtedly been at one time filled with ice, I cannot think that the period was so recent as this would indicate.

All round us the waters of the bay were strewn with masses of floating ice of beautiful colour and fantastic outline, but none were large. Right ahead, a gleaming wall of ice rose up out of the water and completely blocked the fiord, extending with a slight outward bulge from shore to shore. This was the "Great Glacier," or the "Muir Glacier," of Alaska.

In the account in NATURE it is stated that the height of the ice-wall is 500 feet, but I think this is an exaggeration. The master of our steamer thought its highest point might reach 450 feet; my own estimate would place it much lower even than this. Where I stood beneath it on the eastern shore I do not think it was more than 240 feet high, judging from the better-known height of an abutting cliff of sand and gravel presently to be described; but as the upper surface of the glacier appeared to be slightly domed, so as to be highest in the centre of the bay and lowest near the mountains, I should say that near the middle of the fiord the cliffs might be nearly 100 feet higher than where I stood; but in my opinion they nowhere exceeded 350 feet.

The breadth of this ice-wall was about three miles. Huge masses were constantly splitting from it and sliding down into the sea with a loud dull roar. As they slid they raised a white dust-like cloud, and when they fell into the water great waves leaped in upon them and dashed high up the ice cliff, rebounding and causing every now and again a broad deep ground-swell which we could watch as it rapidly swept towards us.

The water through which we passed had changed when we first entered the fiord from the deep dark blue of the outer channel to a beautiful pale green, and now became quite clouded and of a milky greenish-white; and when we came nearer the glacier strong springs were observable, bursting up through the sea-water so as to rise slightly above its level. These were some little distance from the ice-cliff, which must have projected forward under water.

After having failed in an attempt to make fast to a grounded mass of ice—the largest near us—which rose up in pinnacles to the height of our somewhat stunted topmasts, we anchored near the right, or eastern, shore. Our party was then put ashore on a fine beach of washed sand and shingle, about half a mile from the foot of the glacier.

This beach is formed by the action of the waves on a mass of morainic material which is piled up irregularly between the shore and the bare mountain-side, and, where we landed, sloped back almost insensibly into the glacial gravels. But nearer the glacier the moraine had been cut back so as to form a low cliff, which increased in height as it approached the ice.

This cliff exhibited a clear and very interesting section, of which I made a sketch on the spot, shown in Fig. 1.

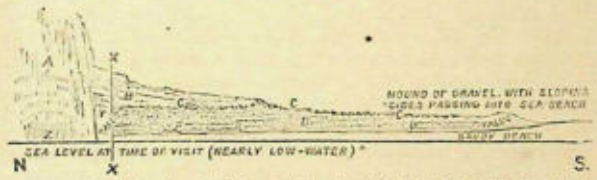


FIG. 1.—Sketch Section of Cliff at the head of Glacier Bay, Alaska, on the eastern shore, adjoining the glacier, Aug. 9, 1884. Length of section about 400 yards; height at X about 100 feet.

A, Eastern end of terminal precipice of Muir Glacier, a nearly vertical wall of very clear blue ice, without stones: the ice shows lines of bedding towards the base, which are strongly curved over a dome-shaped cave (E) from which issues a strong current of muddy water; this cave is filled by the sea at high tide; full height of ice wall, which is about 240 feet here, is not shown.

B, Flange of very stony, dirty ice, apparently descending and flowing forward from the main mass of the glacier at a point some distance behind the line of section: about 60 feet thick at *V*....*V*: this passes over the sands and gravels D, and covers them for some distance, but rapidly diminishes in thickness, and seems to fade away into the *remainder-bed* C.

C, Rubble of angular and water-worn boulders and pebbles mixed with sand and clay; derived from the melting of the stony ice, B, whose lower layers are scarcely distinguishable from this bed.

D, Steep cliff of evenly-bedded sand and gravel; pebbles small and water-worn; shows signs of erosion at junction with C, but the bedding is not disturbed: height at *V*....*X* 40 feet.

F, A small boss of stony, bluish-gray clay resembling till, outcropping below the sands and gravels: full of small water-worn pebbles.

F, Similar boss of fine gray clay without stones: no observable bedding.

NOTES.—In the above figure that part of the section marked A is not on the same plane as the rest, which recedes about 20 yards—the width of the sea-beach.

A narrow gully (*y*) had been excavated between A and D by water derived from the melting ice, and the lower part of the section was here obscured by talus: C crossed the head of this gully and joined the main mass of the glacier, but it was difficult to study this junction, as the ice of C overhung the gully, and was constantly shedding masses into it.

The size of the patches of clay marked E and F is somewhat exaggerated in the section to make them apparent. I saw only a small surface of each rising above the beach in the cliff-foot: but from the manner of their outcrop I think they may form part of a clayey base on which the gravels rest.

I was not able to give much time to the study of this remarkable section, but was able to satisfy myself on the following points:—That a considerable thickness of *evenly-bedded*, water-worn gravel and sand was in close proximity to an almost vertical wall of ice, if not actually abutting on it. That this bedded gravel and sand was covered for some distance by a mass of dirty ice, full of stones, which was connected in some way with the main mass of the glacier. That the bedding of this deposit

was in no way disturbed by either of these masses of ice. That a loose unstratified deposit containing both angular and water-worn pebbles and a little clay and sand, evidently the remainder-beds from the melting of the dirty and stony ice, overlay the bedded gravels. And that fine grey clay, in one place with stones, in another without, resembling glacial clays with which I am well acquainted, occurred below the bedded gravels.

A gentleman on board the steamer, Captain H. E. Morgan, of Port Townsend, W.T., with whom I had become acquainted during the voyage, had made several previous visits to the glacier; and we agreed to set out together for its upper surface as soon as we landed, and go as far along it as we could in the time allowed us.

We therefore struck out at once for the top, and, skirting the heaps of moraine which fill a large hollow space caused by the shrinking of the glacier from the mountain-side, we soon commenced to ascend, passing diagonally along steep slopes of what looked like rough gravel, but was really stony ice covered with a thick crust of loose stones, as some dark water-pools and narrow crevasses soon showed.

Along these slopes we rose rapidly for some distance, the rubbly covering becoming thinner and thinner, till we emerged on a tolerably even plane of clear dark ice, with a rough and evidently rapidly-wasting surface which afforded excellent foothold.

I should think we were now at least half a mile from the mountain-side, and this space was altogether occupied by moraine or moraine-covered ice. Our elevation would be about that of the end of the glacier—350 feet above sea-level. In front of us the surface rose rather steeply for another mile or so.

Up this slope we moved, following a course nearly parallel with the broad moraine on our right, which we had just crossed. On our left, at some distance from us, we could see another well-marked train of moraine, in which were many blocks of large size. The ice we were now passing over was very clear and unencumbered with debris, and of a magnificent pale blue tint. It was fissured transversely by deep crevasses, which, however, were not very wide, so that we could generally find a place to cross without diverging far from our course, though they seemed to widen as they left the margin of the glacier.

We went on in the same direction till we reached the crest of the slope. Up to this point I do not think the glacier anywhere exceeded a width of three miles, but now in front of us there lay a great expanse of ice which spread out like a lake, having a width which we estimated to be from six to eight miles. It seemed to me that from where we stood we looked slightly downward upon this basin. Numerous feeders poured into it on either side, one very large tributary coming in from a deep valley on our right about three miles distant, but its main gathering grounds were on some mountains at the head of the valley, which we estimated were about forty miles distant, our estimate being based on their appearance as compared with that of those off the mouth of the inlet, whose distance was known.

This basin discharged itself into the fiord by the steep slope we had just passed, which no doubt represented a similarly narrowed and increased slope in the buried valley beneath it. Our elevation here was probably not far short of 1000 feet. About three miles ahead of us an island of whitish rock cropped high up above the surface of the ice. This seemed to cause an eddy, as it were, in the current, there being a swerving of the ridges of ice on either side and a depression under its lee.

After passing the crest we found that the crevasses were no longer open, their sides coming together at a short distance below the surface, so as to form deep V-shaped troughs, or wells, which were filled with water of brilliant purity. The exquisite tints of blue deepening with the depth of the water exhibited by these ice pools made them a most beautiful spectacle. At the same time the surface of the glacier became very hummocky, so as to resemble a short cross-sea suddenly frozen, but as the decaying upper layer still afforded excellent foothold, and as there were now no black, open gulfs to startle one, travelling, though laborious, was quite practicable in any direction. We therefore changed our course and, striking out diagonally, soon crossed the narrow moraine on our left. This, which would be about a mile from the edge of the ice, we found to consist chiefly of blocks of gray granite of all sizes, mixed with much sand formed by the decomposition of the small boulders which had often crumbled away into little heaps of grit. Beyond this there did not seem to be any rocky debris on the ice nearer than the moraines of the opposite shore, and the glacier consisted entirely of clear massive ice cut up into grooves and ridges. I noticed here and there amongst this clear ice, however, patches of small extent through which a muddy yellow stain was suffused. Seeking a cause for this, I found in the midst of one of these patches a pasty-looking mass of gritty matter of the colour of rusted iron, forming a centre from which the stain had evidently diffused itself through the ice.

As this was not only far away from the moraine, but was also widely different from anything I had seen there, and as it did not in any way resemble an organic growth, I concluded that it might be of meteoric origin, and brought part of the mass away with me.

With the kind assistance of Mr. G. Carr-Robinson, F.R.S.E., F.C.S., I have lately been able to make a rough qualitative analysis of this substance, which has shown it to consist in great part of iron oxide, with a trace of nickel, and my suspicion that it may be a decomposed meteorite has thus been considerably strengthened. A more complete analysis will shortly be made. I hope that some future visitor to the locality will more thoroughly investigate this point, and carefully examine any stained ice which he may meet with in the body of the glacier. I took hasty notice of several instances, but only found this substance in the one case mentioned. A melting glacier of great age is certainly a likely place to reveal meteorites.

Capt. Morgan told me that once before when he was on the glacier he had come across the weathered bones of a bear protruding from the ice; he afterwards showed me one of the teeth which he had brought away with him.

After going a little further we found it was high time to return to the ship. There was now nearly two miles of ice and moraine between us and the mountain-side which bounded the glacier on our right, whilst on our left the ice still rose before us in broken hummocky ridges, with deep pools between. I pressed on alone to the crest of one of the ridges ahead of us, which promised a more extended view. Looking forward from this point, the surface seemed to become more and more broken, but I still could not see any open crevasses, and think it might have been possible to cross the glacier.

I then hurriedly retraced my steps, but instead of going directly back to the beach, swerved to the left, and passed down into the hollow between the glacier and the mountain-side to which I have already referred, wherein was heaped a great mass of moraine. This consisted chiefly of sand and gravel piled up in long ridges running roughly parallel with the flank of the glacier and with each other, with here and there a dangerous slough of soft tenacious mud between them, deposited by waters welling up from below. These ridges, of which there were three or four between the glacier and the mountain, were from 30 to 100 feet high, and were steeper on one side than the other; they seemed to contain both water-worn and angular pebbles, with a thin scattering of large blocks. I crossed two of them, but had not time to go

further. To all appearance they were made up altogether of moraine matter, but in ascending the steep side of one of them I was surprised to find that my feet, after sinking through a few inches of loose stone, struck upon a hard surface of ice, and that the bulk of the ridge was made up of stony ice.

Seeing also that muddy water was welling out in the depression between this ridge and the next, I came to think that a buried portion of the glacier probably still underlay all this ground, perhaps even reaching down to the beach. Then, observing huge piles of similar material on the mountain-side, I concluded that a portion of the ice might remain hidden there also.

If this were so, then the downward pressure of this mass on the one hand against the sloping and partially-buried flank of the glacier on the other would readily explain the presence of these ridges.

This view of their origin is illustrated in the following diagram (Fig. 2), which I drew just after leaving the glacier; it would account for the mixture of water-worn and angular debris in the ridges, the former resulting from the watercourses between the glacier and the mountain, and the latter from the melting of stony ice.

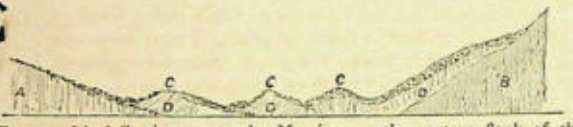


FIG. 2.—Ideal Section across the Moraine on the eastern flank of the Muir Glacier.

A, Eastern slope of the glacier: stony ice covered with a deep layer of loose stones.

B, Solid rock of the mountain-side.

C C C, Ridges apparently consisting of water-worn gravel and sand, with some angular debris, but probably hiding a core of stony ice, D D.

D D D, Buried portion of the glacier, supposed to exist below the moraine at C C C, and also on the mountain-side, which has been pressed up into ridges.

The ridges at the time of my visit were about half a mile in length, but may of course grow much longer as the glacier shrinks back. Though more or less regular, they were here and there interrupted and confused so as to form hollows surrounded by mounds, and in one case I noticed that the drainage of a gully had been dammed back so as to form a pond, in which the muddy water deposited much of its fine rock-flour, and issued out comparatively clear at the other side of the obstruction.

The boulders and pebbles of the moraine were chiefly of gray granite, but I noticed also quartzite, gneiss, a few fragments of slaty shale, and a mass of ancient-looking conglomerate—the last-named on the beach. During the day I saw only one scratched block; this was low down on the moraine near the beach.

We were now obliged to join the boat, which was waiting to take us back to the ship, and very much did I regret that circumstances would not permit me to stay longer.

Before leaving the ice-cliffs we fired a shot or two from our small signal cannon, to try to bring about an avalanche, but it had no perceptible effect, and the avalanches continued to choose their own time to fall.

This whole region forms a magnificent field for the study of glacial phenomena, and to any geologist who may follow I would especially say—examine the hollow between the ice and the mountains; go to the foot of the ice-cliff at low water; and, wherever there is stained ice on the top of the glacier, trace out the source of the discolouration.

G. W. LAMPLUGH

NOTES

THE honour of knighthood was conferred upon Prof. Robert Stawell Ball, LL.D., Astronomer-Royal for Ireland, at the *levée* of the Lord-Lieutenant, on January 25.

LORD IDDESLEIGH has selected Mr. D. Morris, Director of the Public Gardens, Jamaica, for the appointment of Assistant Director of the Royal Botanic Gardens at Kew.

DR. RILEY, Entomologist to the United States Agricultural Department, has presented his collection of insects to the United States. It is said to contain 115,000 specimens of 20,000 species or varieties of insects.

THE Committee of the François Arago centenary have appointed M. Mouchez, Director of the Observatory, President; M. Floquet, President of the Chamber of Deputies, has been appointed Honorary President. The principal part of the celebration will take place at the Observatory.

M. PAUL BERT will not leave Paris so soon as was expected for Tonquin; the delay is occasioned by the organisation of the scientific part of his mission.

THE late M. Bertillon has bequeathed a sum of 4000 francs to the Paris Anthropological Society, to found a biennial prize to be awarded for the best work on some anthropological subject.

A SHOCK of earthquake was felt at about 7 o'clock on the morning of January 20 at St. Austell and in the neighbourhood. It appeared as if an explosion had taken place, so great was the noise, and the sound was immediately followed by the shaking of the ground. Persons felt their beds moving under them, and many others had an impression that a portion of their house was falling down. The shock was also felt at Mevagissey. Many people were shaken in their beds. In one instance a clock was stopped, and in many houses the doors and windows shook violently. The inhabitants of St. Blazey and neighbourhood were greatly startled, about a quarter past 7, by hearing a loud rumbling noise and by houses being shaken from foundation to roof. It appeared to come from a northerly direction, and the vibration lasted about 4 or 5 seconds. Persons coming in from the outlying districts and giving an account of the shock being more or less severe all agree as to the time of its taking place.

A TELEGRAM from Mexico states that there was a renewed eruption on January 16 from the Colima volcano. Enormous stones were thrown out, and great streams of lava appeared. The eruption was accompanied by earthquakes.

MR. J. FRANCIS COLE, writing from Sutton, Surrey, informs us that he was a spectator of the remarkable meteor alluded to in our columns of the 21st inst. (p. 278). As seen by him, the meteor appeared to explode or extinguish itself at a point about midway between the horizon and Capella, and was of a form like a well-shaped pear. It seemed so near that he felt he could have hit it with a stone. At the moment of exploding it opened in the centre of the lower part with a well-defined slit, and then widening, showed a light of the character of a hydrogen flame. The direction of the meteor was clearly from west to east, and at the same time the wind was blowing strongly from the west.

AMONGST the objects of interest at the forthcoming Colonial and Indian Exhibition will be a rare collection of indigenous Australian grasses. The specimens are named to correspond with the nomenclature used in the "Flora Australiensis," and there is in addition much practical information about each, derived from general sources.

WE have received Prof. Baird's last Report on the work of the Smithsonian Institution, which deals only with the half year ending June 30 last, in consequence of a resolution of the Board of Regents directing that the fiscal year, instead of extending from January to December, shall, like the Government fiscal year, extend from July 1 to June 30 in future. Amongst the publications promised by the Institution we notice the scientific

writings of Prof. Joseph Henry, which will consist altogether of 1050 printed pages, and which are due now; also a work by Prof. Cope, of Philadelphia, on the reptiles and batrachians of North America. A compact manual on this subject was wanting, although numerous monographs on reptiles have been published, and when this has been completed, the entire field of the vertebrates of North America will have been covered by convenient and effective text-books prepared under the direction of the Institution. The various departments of the museum are treated, as usual, in successive paragraphs describing their work for the year. Under the head of "Explorations" we notice that Mr. Thomas Wilson, United States Consul at Nantes, and afterwards at Nice, has presented a very large collection of the remains of prehistoric man around these two places. It is believed that this collection, filling a large number of boxes, will prove to be one of the richest and most complete ever sent to the United States.

THE idea of an International Exhibition at Geneva has been abandoned, and it is now intended to hold only a national Swiss Exhibition.

A SOUTH AMERICAN Exhibition will be held at Berlin by the Central Verein für Handelsgeographie during May, June, and July, in which Brazilian products will be specially represented.

IN Germany an unusual number of white varieties of animals are noticed this winter. A white chamois was shot in the Totengebirge, a white fish otter was caught near Luxemburg, white partridges were shot near Brunswick, and a white fox was killed in Hessen.

THE recently-formed Central-Swiss Geographico-Commercial Society at Aarau is collecting funds for the erection of an ethnological museum.

IN the new number (No. 15) of the *Journal* of the Straits Branch of the Royal Asiatic Society, Mr. Wheatley, in a paper on the rainfall of Singapore, urges that the Straits Settlements are almost the wealthiest of the British colonies, and that it is not too soon to provide for an Observatory under an astronomer and meteorologist. The equatorial position of Singapore, he adds, would give to the astronomer a more interesting field for observation than can be obtained at higher or lower latitudes. Meanwhile, private observers are doing their best to study the meteorological features of the Straits, and Mr. Wheatley publishes tables of mean annual rainfall and number of rainy days from 1869 to 1884. Mr. Dodd, whose name is given to a conspicuous mountain-range in Northern Formosa, and who has already written on the "aborigines" of that island, describes the hill-tribes in the north, occupying the savage forest-clad mountains to the south-east and south of the town of Banka. These appear to have no negro features whatever; the hair is lank, not curly or frizzled, their lips are not so thick even as those of Malays, and the high noses possessed by many approach often the European type. The complexion, too, of the younger men who had not undergone much hardship or exposure is as light and fair as that of the Japanese. The paper is not finished in this number. The other papers are mainly geographical.

IN a recent paper to the *Archiv für Anthropologie* on the capacity and chief diameters of the skull in different nations, Herr Welcker considers that nine-tenths of all the figures of capacity given in literature are incorrect, most of them being excessive. After discussing different modes of measurement, he gives the following results of his own observations:—In the Germanic peoples the average internal capacity varies between 1400 and 1550 c.cm. In Celts, Romans, and Greeks we find 1400 to 1500; in the Slavs the width of variation is about the same as in the Germans (but less exactly determined). Quite out of the series are the peoples of Hindostan; the narrow range of 1260 to 1370 includes all the members of this group. Individual examples of the Semitic and Hamitic peoples (of which the author had but few to examine) differ widely; but the Jews and Arabians here take a good position—1450 to 1470 c.cm. The Mongolians range from about 1320 (but mostly 1400) to 1500; 1350 to 1450 seems the proper range of the capacity of the Malays, and only very isolated stocks exceed these limits on both sides. The Papuans and Australians show the averages 1370 and 1320 respectively. The negroes vary between 1300 and 1400. A much lower figure appears for the Bushmen (1244). The Americans, finally, have a wide range; while they are normally between 1300 and 1400, they reach in some of their artificially deformed members a mean value of 1200 and even less. Sexual dimorphism (female skull smaller and flatter) is most pronounced in all civilised peoples.

FROM a study of 650 thunderstorms that occurred in Italy in 1881, Signor Ferrari concludes that every thunderstorm is connected with a barometric, hygrometric, and thermic depression; it is behind the two former, and in front of the last. All three depressions, but especially the two latter, are associated with maxima, which are situated behind the barometric and hygrometric depressions, but before the thermic one. Most of those storms arose in the wide plain of the Po. Coming from west north-west with a velocity of 30–37½ km. per hour, they passed (in case of their greatest range) with slackening speed over the Apennines in Upper and Middle Italy. For a given moment the thunderstorm has the form of a long narrow band, advancing, with numerous bends outwards and inwards, parallel to itself, and having its various characteristic phenomena most intense along the middle line. The *isohyetes*, or curves of equal rainfall, often take the form of ellipses, whose longer axes coincide with the direction of the storm. The dominant wind-direction is generally parallel to that of propagation of the storm.

THE Penny Science Lectures at the Royal Victoria Hall are about to recommence after the Christmas interval. Lectures hove been promised as follows:—Tuesday, February 2, Mr. W. P. Bloxam, "Fire, Fuel, and Illumination"; February 9, Mr. J. M. Thomson, "Dirty Water and how to Cleanse it"; February 16, Prof. George Forbes, "Shooting-Stars and Comets"; February 23, Mr. Wm. Lant Carpenter; March 2, Mr. T. Cunningham Porter, "English Cathedrals"; March 9, Dr. J. A. Fleming, "Niagara."

DR. ALFRED DANIELL'S "Text-book of the Principles of Physics" has been adopted, in Polish translation, by the University of Craców.

A FOURTH edition of Prof. Tyndall's "Six Lectures on Light, delivered in the United States in 1872–73," has been issued by Messrs. Longmans and Co.

THE Council of the City and Guilds of London Institute have received an application from the Board of Technical Education of New South Wales requesting them to forward examination papers in technology to the colony, and award certificates and prizes on the results. This application has been referred to the special committee of the Institute on technological examinations.

AT the forthcoming Indian and Colonial Exhibition the Canadian Government intend to demonstrate the manner in which fish culture is prosecuted in the Dominion, and the various methods adopted in regard thereto will be practically illustrated to the public, and shown together with live specimens of Salmonidæ indigenous to native waters. Canada now possesses about twenty hatcheries, most of which have been constructed since 1873, and worked with the greatest success, whitefish being the chief source of reproduction. Preparations are already being made for the reception of the Canadian exhibits, which will be very numerous, and replete with interest.

LARGE consignments of whitefish and trout ova have arrived at the South Kensington Aquarium from America as a presentation from the Commissioners of that country. In consequence of the success attending the introduction of the first-named fish into this country last year, special attention is to be given to their culture during the present season with a view to their distribution in some of our chief lakes. The National Fish Culture Association have extended their hatchery, and, in order to secure healthy embryos, have adopted the new method, viz. the "underflow" system, which has been found to incubate the ova at a less rate of mortality than the "overflow" system.

DR. SAMUEL TENNY, the indefatigable investigator of Roman antiquities on and around the Lake of Constance, has now at last succeeded in laying bare the forum of the old Roman city of Brigantium (Bregentz), the so-called "Rhätische Pompeii." It consists of an area on the "Oelrain" inclosed by a wall furnished with roofed halls. There are also the remains of a building with stairs and eight columns, evidently a portico of imposing proportions, besides two gates leading to streets. The remains are unfortunately in a very dilapidated condition, and their total destruction is imminent.

IN the eleven years from 1873 to 1884 the number of lions killed in Algeria was 202, for which a premium of 400*l.* has been paid by the Government. The number of panthers destroyed in the same period is 1214, and the money paid by the Government 720*l.* About 400*l.* has been paid for 1882 hyænas, and 1600*l.* for 27,000 jackals. The large felidæ are almost extirpated principally in the western provinces, and the lion of the desert is fast becoming a myth.

IN the *Transactions* of the Verein für Erdkunde at Halle a writer describes certain cave-dwellings in the province of Saxony. These are occasionally found in loess formations in the Balkan Peninsula (in the Lom Palanka region, for instance), but it is somewhat startling to find them used now in such a cultivated place as Saxony. They are in the neighbourhood of Halberstadt, quite close to the village of Langenstein. Here in a sandstone hill, about a dozen caves have been dug, which are used as dwellings. They have different rooms, light and dark, as well as chimneys, windows, and doors, and are said to be very dry and habitable. The writer of the account, a physician, says that he found the inhabitants quite comfortable, and that some of them had lived there for more than thirty years without suffering from any evil effects to their health.

WE have on our table the following new books:—"Zoological Record," vol. xxi. 1884 ("Zoological Record" Association); "The Definitions of Euclid," by R. Webb (Geo. Bell and Sons); "Organic Chemistry," by H. F. Morley (Churchill); "Elementary Algebra," by Chas. Smith (Macmillan and Co.); "Eminent Naturalists," by Thos. Greenwood (Simpkin and Co.).

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, deposited; two White-billed Parrakeets (*Tanygnathus albirostris*) from Celebes, a Bearded Lizard (*Amphibolurus barbatus*) from Australia, purchased; a Common Otter (*Lutra vulgaris*), British, received in exchange.

OUR ASTRONOMICAL COLUMN

THE DENSITY OF SATURN'S RING.—M. Poincaré supplies a short note on the stability of Saturn's ring in the November number of the *Bulletin Astronomique*. Laplace had shown that the ring could only be stable if it were divided into several concentric rings revolving at different speeds. M. Tisserand had confirmed this result, and had recognised that a single ring must, in order to exist, possess a much higher density than the planet, and had calculated the maximum breadth of each elementary ring in terms of its density and mean radius. M. Poincaré has carried this investigation a step further, and shown that if the density of a ring be less than a certain amount, it will, under the influence of the slightest perturbation, no longer break up into a number of narrower rings, but into a great number of satellites, and that if the rings be fluid and turn each as a single piece, the density of the inner ring must be at least 1/5, and of the outer ring 1/16 that of the planet. For a ring of very small satellites (not for a fluid-ring, as M. Poincaré erroneously states), Maxwell has shown the condition to be that the density should not *exceed* 1/300 part of that of Saturn.

We do not at present know the actual density of the ring from observation sufficiently accurately to make therefrom any certain inference as to its physical condition. Bessel's determination from the movement of the peri-saturnium of the orbit of Titan gave the reciprocal of the mass of the ring as compared with that of Saturn as 118, which, since the volume of the ring—adopting Bond's value of 40 miles for its thickness—is about 1/400 that of the planet, would make its density about 3·4 times greater than the planet's. Bessel's value is, however, clearly too great, as he neglected the influence of the equatorial protuberance of Saturn on the movement of the apsides. Meyer's determination of the secular variation of the line of apsides of Titan, viz. $d\varpi = 1726''{\cdot}5$, gives the reciprocal of the mass of the ring as 26700, but from all the six brighter satellites as 1960; the latter value closely agreeing with Tisserand's. It does not, however, seem to have been noticed that even the smallest value for the mass considerably exceeds the highest permissible in accordance with Maxwell's result, since that would make the mass of the rings only 1/120,000 part of the planet's, an amount we cannot hope to detect with our present resources.

THE ORBIT OF TETHYS.—Herr Karl Bohlin has recently communicated to the Swedish Academy of Sciences an interesting discussion of the elements of the orbit of Tethys. The observations discussed are those of Sir Wm. Herschel, 1789, reduced by Lamont, Lamont, 1836, Sir J. Herschel, 1835–7, the Bonds, 1848–52, Secchi, 1856, Capt. Jacob, 1857–8, Newcomb and Holden, 1874–5, and Meyer, 1880–1. The elements are calculated for each period of observation, without taking account of perturbations. Herr Bohlin, then specially treating the mean longitude of the epoch, and adopting 190°·69812 as the value of the mean motion, draws up tables of the differences between observation and calculation, and attempts to represent them by an empirical formula. The corrected value of the mean motion is 190°·698169, almost identical with that found previously by M. Baillaud. Herr Bohlin finds that the annual motion of the peri-saturnium amounts to 33°. M. Baillaud's results and M. Tisserand's investigations had given the value as 70°. The excentricity is found as 0·00803 ± 0·00077.

THE ORBIT OF IAPETUS.—Prof. Asaph Hall has published a memoir containing a very full discussion of all the observations of Iapetus made at Washington from the mounting of the 26-inch refractor until February 29, 1884. His finally adopted elements are deduced from his own observations made between June 10, 1875, and the above-mentioned date. And in deducing them he has taken account of the perturbations produced by the sun, Iapetus being so distant from its primary that, notwithstanding the distance of Saturn from the sun, these perturbations cannot be neglected. The periodic time of the satellite was found, from a comparison of Herschel's observations in 1789 with the conjunctions observed in 1880 and 1881, to be 79·3310152 mean solar days. The adopted mean distance determined by two different methods of observing—one by differences of R.A. and declination, and the other by angles of position and distances, which give very accordant results, is 515″·5195 ± 0″·02645. The corresponding reciprocal of the mass of Saturn (including the planet, its ring, and its satellites) is 3481·3 ± 0·54, closely agreeing with that found by Meyer from his observations of the six brightest satellites, viz. 3482·93 ± 5·50.

A NEW METHOD OF DETERMINING THE AMOUNT OF ASTRONOMICAL REFRACTION.—M. Lœwy proposes to determine refraction by placing a glass prism with silvered faces, forming a double mirror, in front of the object-glass of an equatorial. By means of this arrangement the images of two stars—one at the zenith, and the other near the horizon—can be simultaneously viewed in the field and their distance measured. This distance will be affected by the maximum amount of refraction.

If after an interval of three or four hours, when the stars have equal zenith distances (and therefore are relatively but little displaced by refraction), the observation be repeated, the comparison of the two measures gives the means of determining the amount of refraction with great accuracy. For the success of the method it is, of course, essential that the measured distance should be absolutely independent of every possible displacement of the various parts of the apparatus in the interval between the observations. This result is attained, M. Lœwy considers, by placing the double mirror in such a position that the planes of reflection for the two stars coincide, as he finds that under these circumstances, whatever small displacements the prism may undergo, the distance in the field of the telescope measured in the plane of reflection or the projection of this distance on the trace of the plane of reflection in the field remains invariable.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 31—FEBRUARY 6

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 31

Sun rises, 7h. 42m.; souths, 12h. 13m. 42·5s.; sets, 16h. 46m.; decl. on meridian, 17° 19′ S.: Sidereal Time at Sunset, 1h. 29m.

Moon (New on February 4) rises, 4h. 54m.; souths, 9h. 21m.; sets, 13h. 47m.; decl. on meridian, 18° 25′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 8	11 8	15 8	22 23 S.
Venus	8 2	13 48	19 34	3 30 S.
Mars	20 36*	3 7	9 38	5 23 N.
Jupiter	21 44*	3 43	9 42	0 59 S.
Saturn	13 15	21 26	5 37*	22 40 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Phenomena of Jupiter's Satellites

Jan.	h. m.		Feb.	h. m.	
31	1 21	I. occ. reap.	5	1 7	II. ecl. disap.
31	22 30	I. tr. egr.	5	5 32	I. ecl. disap.
Feb.			5	5 47	II. occ. reap.
2	22 19	III. ecl. disap.	6	3 36	I. tr. ing.
3	1 14	III. ecl. reap.	6	5 51	I. tr. egr.
3	2 19	III. occ. disap.	6	21 53	II. tr. ing.
3	5 1	III. occ. reap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Feb. h.
6 ... 9 ... Venus at least distance from the Sun.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Feb.	1, 23	0 *m*
			,,	6, 22	39 *m*
Algol	3 0·8	40 31 N.	,,	3, 4	4 *m*
			,,	6, 0	53 *m*
λ Tauri	3 54·4	12 10 N.	,,	3, 2	6 *m*
ζ Geminorum	6 57·4	20 44 N.	,,	2, 9	30 *M*
U Monocerotis	7 25·4	9 32 S.	,,	3,	*M*
δ Libræ	14 54·9	8 4 S.	,,	5, 0	20 *m*
U Coronæ	15 13·6	32 4 N.	,,	6, 5	23 *m*
U Ophiuchi	17 10·8	1 20 N.	,,	1, 0	51 *m*
		and at intervals of		20	8
R Scuti	18 41·4	5 50 S.	Feb.	5,	*m*
β Lyræ	18 45·9	33 14 N.	,,	1, 17	0 *m*
δ Cephei	22 24·9	57 50 N.	,,	4, 2	30 *M*

M signifies maximum; *m* minimum.

Meteors

The *Virginids*, R.A. 175°, Decl. 14° N., form the principal February shower. Fireballs may be looked for on February 2.

GEOGRAPHICAL NOTES

The *Izvestia* (1885, v.) contain another letter from M. Potanin, describing his interesting journey to the Upper Hoang-ho. Leaving Si-nin (Tsin-ning) on May 2, the Expedition visited the Humbum Monastery—a trading-place for Russian goods brought from Urga and transported further to Thibet—and crossed a high ridge of mountains, the pass having an altitude of no less than 12,000 feet above the sea. Following the valley of the Lan-chou (Dun-ho-tsian on Prjevalsky's map), they ascended to the plateau of Rchandza-tan, about 10,000 feet above the sea, leaving to the north the snow-clad mountains of Naryn-jamba, where Prjevalsky spent the winter of 1880. Only Tanguts inhabit this elevated table-land, and a few lamas who occupy several monasteries. Descending from the plateau into a deep valley, Naryn-jamba, which joins that of the Urung-yu River, they were soon compelled to climb another plateau of the same height, the Ganja-tan, also peopled by Tanguts. The Amni-Tunglyng Mountains raise their snow-covered summits towards the north. On May 16 the Expedition reached the Labran Monastery, situated at an altitude of 10,000 feet, and still containing several hundred well-built houses, some of them with two and three stories. The Gue-guen—a religious chief, who is also chief of the neighbouring Tanguts—resides at this rich monastery. From Labran, MM. Potanin and Skassi again climbed a high plateau, and followed it until they arrived at the Renu-kika Pass. A high snow-covered ridge extending west and east on the left bank of the Tao-ho, was seen to the north; it is inhabited by a tribe of Tangut robbers—the Teba. The Tao-ho flows along a valley more than half a mile wide, between picturesque craggy mountains, the slopes of which are thickly wooded. The town Ming-cheu, situated in the same valley, could thus soon be reached. Leaving it on June 16, the Expedition easily reached also the Yali-san Mountain, which is the watershed between the tributaries of the Tao-ho and the Yang-tse-kiang, the ascent to the watershed offering no difficulties. The further journey to Si-gu-sian was made in an alpine country, intersected by deep and narrow valleys, which have a flora offering some notable differences from that of the Si-nin and Min-cheu region. The town Si-gu-sian is situated in the region of the monsoons. The further intentions of the Expedition were to go to Niang-pin, leaving M. Berezowski at Si-gu-sian to make collections of mammals and birds.

An extraordinary meeting of the Geographical Society of Paris was held on the 21st inst. to receive M. de Brazza on his return from his latest expedition to that part of Western Africa which is now described as the French Congo. M. de Brazza gave an account of his journey undertaken in the summer of 1883, on a subsidy from the Government of 1,250,000 francs (50,000*l.*). In the beginning of June he and his party had reached Franceville on the Ogowai. At this place he concluded new treaties with the chiefs of the tracts adjoining the river, and opened warehouses for carrying on trade. After instructing in their duties the Europeans who were to remain at Franceville, M. de Brazza crossed the elevated tract which separates the basins of Ogowai and Alima to join Dr. Ballay, who was conducting negotiations with the Bapfourous, a tribe settled near the junction of the Alima with the Congo. Dr. Ballay had a steamer on the latter river, the first French vessel of the kind which had penetrated so far into these regions. M. de Brazza then narrated his adventures in the two years and nine months during which he was engaged in exploring the banks of the Ogowai, the Alima, and the Congo, in laying the foundation of eight stations.

The *Ca'cutta Englishman* states that Mr. Needham, of the Assam Police, and Capt. Molesworth, of the Bengal Staff Corps, who left Sadiya on December 12 for Rima, in Thibet, have returned to Dibrugarh. They reached Rima, but were unable to enter the place, owing to the hostility of the Thibetans. Having followed the course of the Brahmaputra the whole way from Sadiya to Rima, they are able to state authoritatively that the river corresponding in size to the "Sanpo," as described by the explorer "A. K.," falls into it; and that the identity of the "Sanpo" with the Dijong may be deemed to be finally settled.

The Government of the Congo State has commissioned several geographers to execute maps of the entire State. Lieut. Massari is surveying the right bank of the Congo between the Alima and Mobangi Rivers. The topographical party under Lieut. Junghers has surveyed Banana completely, and is now engaged, in two divisions, in surveying the districts between Banana and Boma, and between Boma and Vivi. The Swedish geographer Herr Hakanson has drawn a map of the district between the village of Mvinda, above Vivi, and the Issanghali Station.

Advices received in Berlin contradict the statement of the death of the German traveller, Dr. Büttner, who is now alleged

to have escaped all the dangers that beset him in the Congo region, and to be on his way back to Europe.

WITH the beginning of next month a party organised by the German New Guinea Association will start from Hamburg. The command of the expedition has been intrusted to Dr. Schraber, one of the staff of the Hamburg Observatory, who was chief of the scientific expedition sent in 1882 to the southern hemisphere. The preparations are almost completed. Six experienced foresters have been already sent on in advance. Fifteen block-houses have been constructed, some at Hamburg, some in Norway, to be put together at chosen points in New Guinea. Forty Malays have been hired in Java to act as bearers and servants, and five persons trained in various branches of natural science will form the staff of the party. Their explorations will be confined to the portion of the island which is under the German protectorate, and will, it is expected, occupy about three years.

THE Milan Society for the commercial exploration of Africa is preparing a new expedition to Zeila and the neighbouring districts. It will be led by Count Peter Porro.

THE census returns of the provinces of Bosnia and Herzegovina for 1885 show an increase of 15 per cent. in the population since the previous returns for 1879, the respective figures being 1,158,440 and 1,336,101. Nearly all the inhabitants are of South Slavonic (Servo-Croatian) stock and speech, and, according to religions, they were distributed in 1885 as follows:—Mussulmans, 492,710; Orthodox Greeks, 571,250; Roman Catholics (Greek and Latin rites), 265,788; Jews, 5805; Miscellaneous, 548.

THE Viennese firm of Hartleben has begun the publication of Dr. F. Umlauft's important work on the Alps, entitled "Manual of Alpine Sciences." It will be issued in fifteen parts.

FATHER LEO M. ALISHAN, of the Armenian Mekhitarist Congregation of St. Lazarus near Venice, has recently published a sumptuous work entitled "Sissúan," the term applied by the Armenians to the province of Kilikia at the end of the twelfth century, when it was governed by Leo the Magnificent. The work deals with the physical geography, history, and literature of this region of Asia Minor, and contains numerous maps, fac-similes, and illustrations, besides several valuable unedited documents.

THE *Bollettino* of the Italian Geographical Society for December has a short obituary notice of the distinguished geographer and geologist, Prof. Giuseppe Ponzi, who was born in Rome in 1805, and died there on November 30, 1885. He filled the Chair of Geology in the Roman University since the year 1866, and on his careful surveys of the basin of the Tiber were based the first geological maps of that district.

THE same *Bollettino* contains some particulars of the Capucci-Cicognani Expedition, which arrived at the capital of the Anfari (Sultan) of Aussa at the end of August. Here it was detained by the Anfari, who demanded 3000 dollars for the right of passage, and after tedious negotiations Capucci returned to Assab in order to procure this sum, and thus obtain permission to pass on to the kingdom of Shoa in Southern Abyssinia. On his return he induced the Anfari to accept less than half the amount claimed, a payment of which the Expedition continued its journey through Gafra for Shoa.

TO the *Bollettino* Count A. Salimbeni sends a description, with illustration, of the bridge he has now completed over the Temcha, a river in Gojam, which flows through the Birr to the Abai (Bahr el-Azrag, or Blue Nile). The bridge, the first constructed in Abyssinia since the time of the Portuguese, spans the river with three arches of 8·50 metres each, is 4 metres wide, and has a total length of 38 metres. The work, which was begun in December 1884 and finished the following March, is looked on as a marvel by the natives, and has given great satisfaction to King John.

THE BENEFITS WHICH SOCIETY DERIVES FROM UNIVERSITIES[1]

NEXT, I mention as the subject for university study, Psychology, the nature of man's soul, the characteristics of his mental and moral activity. This science has lately made great progress,—it has improved its methods and enlarged its scope. Those who are devoted to it appreciate the inherited experiences of the human race and are not indifferent to the lessons which may proceed from intuition and introspection; they study all the manifestations of intellectual and spiritual life; but, on the other hand, they are not afraid to inquire, and they know how to inquire, into the physical conditions under which the mind works; they watch the spontaneous, unconventional actions of children; they investigate the laws of heredity; they examine with curious gaze the eccentricities of genius, and with discerning, often with remedial eye, the alienation of human powers, and they believe that by a combination of these and other methods of research, among which experiment has its legitimate place, the conduct of the human understanding and the laws of progressive morality will be better understood, so that more wholesome methods of education will be employed in schools of every grade. They acknowledge the superiority of the soul to the body, and they stand in awe before the mysteries which are as impenetrable to modern investigators as they were to Leibnitz and Spinoza, to Abelard and Aquinas, to Aristotle and Plato, the mysteries of man's conscious responsibility, his intimations of immortality, his relations to the Infinite.

I do not know whether philosophy is on a "return to Kant," or to common sense, but I believe that standing firm on the postulates, God, Soul, and Immortality, it will in years to come disentangle many perplexities, brush away heaps of verbal accumulations, and lead the mind to purer and nobler conceptions of righteousness and duty. I go even farther, and, as I believe that one truth is never in conflict with another truth, so I believe that the ethics of the New Testament will be accepted by the scientific as well as the religious faculities of man; to the former, as Law; to the latter, as Gospel.

In confirmation of these views, let me quote to you the language of that one among us who is best qualified to speak upon this subject.

"The new psychology, which brings simply a new method and a new standpoint to philosophy, is, I believe, Christian to its root and centre; and its final mission in the world is not merely to trace petty harmonies and small adjustments between science and religion, but to flood and transfuse the new and vaster conceptions of the universe and of man's place in it—now slowly taking form and giving to reason a new cosmos and involving momentous and far-reaching practical and social consequences—with the old scriptural sense of unity, rationality, and love beneath and above all, with all its wide consequences. The Bible is being slowly re-revealed as man's great text-book in psychology, dealing with him as a whole, his body, mind, and will, in all the larger relations to nature and society, which has been so misappreciated simply because it is so deeply divine. That something may be done here to aid this development," continues the lecturer, "is my strongest hope and belief."

The study of Society engages the earnest interest of another set of men, and the apparatus of their laboratory includes archæological and historical memorials of the activity of the race. The domain of history and political science has never been cultivated as it is in modern times. The discovery of primæval monuments and the interpretation of long hidden inscriptions, the publication of ancient documents once hidden in monasteries and governmental archives, the inquiry into primitive forms of social organisation, the development of improved modes of research, the scientific collection and classification of facts which illustrate the condition of ancient and modern communities and especially the interest awakened in the growth of institutions and constitutions, give to this oldest of studies the freshest interest. Papers which have lately been printed on rudimentary society among boys, on the laws of the mining camp, on the foundations of a socialist community, on the differences between parliamentary and congressional government, on the derivation of modern customs from the ancient beginnings of the Aryan people, on the nature of communism and many more such themes, afford illustrations of the mode in which the historical student among us, following the lines of Stubbs, Maine, Freeman, Seeley, Bluntschli, Roscher, and other celebrated workers, are advancing historical science, and developing the true historical spirit. The aim of all these inquiries is to help on the progress of modern society by showing how the fetters which now bind us were forged, by what patient filing they must be severed, and at the same time to work out the ideal of a society in which Liberty is everywhere, but "Liberty sustained by Law."

Languages and Literature have always received attention in universities, and will always be dominant for reasons which are

[1] An Address by D. C. Gilman, President of the Johns Hopkins University. Continued from p. 283.

as enduring as language itself. We study tongues that we may know the men of other climes and other days; we study literature to enjoy it. As an aid to intercourse with people of other nations and for the purpose of keeping up with the record of modern science, nobody doubts that the modern languages are to be encouraged; but if we really would own the inheritance which is our birthright, if we wish to appreciate the masterpieces of literature, if it is well to put ourselves in sympathy with mankind, to laugh with those who have laughed, and weep with those who have wept, we must not be restricted to the writings of to-day. In science, it has been said, read the newest and latest; not so in literature—but the best. Isaiah and John, Homer and Æschylus, Cicero and Virgil, the "Nibelungen Lied" and Chaucer, Dante and Petrarch, are as full of life, beauty, instruction, and entertainment to us as to former generations. But from the classical standard of excellence this busy world would soon depart, were it not that in every university there are scholars keeping bright the altar fires, and warming us with the glow of their enthusiasm, whenever we come under their influence—sharpening too our wits by their critical acumen.

It is not uncommon, nowadays, to hear objections to classical education, usually from those who have never had it, and declamations against dead languages, usually from those who have never learned them. But the Humanists may unquestionably leave it to the Geologists to fight the battle for antiquity. The latter assure us that the older the fossils the more instructive their lessons; indeed, so much importance is attached to ancient animal life that the national government, with great liberality, encourages its study by promoting explorations, museums, and costly publications. Be it so; but let not the nation which does this forget that men are of "more value than many sparrows"; that the oldest literature is not old or dead, but fresh and living in comparison with the bones of the cave-dwellers; and that though a Megatherium is wonderfully instructive, an ancient epic or a drama is not unworthy of attention.

Jebb, in his life of Bentley, asserts that probably "the study of classical antiquity, in the largest sense, has never been more really vigorous than it is at the present day." We might add that classical poetry has never been so popular—else why these innumerable editions and translations? Why, after Worsley, Butcher, Bryant, and their predecessors, are we reading aloud and smiling over the immortal Odyssey as it is given to us in the rhythmical prose of Palmer? This is a good sign; only it is well to remember that reading translations is not reading Greek, and, as Jebb goes on to say, we must not forget the difference between "the knowledge at second hand," which the intelligent public can possess, and "the knowledge at first hand" which it is the business of the libraries and professorships of a university to perpetuate.

If the defenders of classical study would confine their argument to the line which was lately followed by Butcher, they would silence their opponents. "To Greece," he says, "we owe the love of science, the love of art, the love of freedom—not science alone, art alone, or freedom alone, but these vitally correlated with one another and brought into organic union. . . . The Greek genius is the European genius in its first and brightest bloom. From a vivifying contact with the Greek spirit, Europe derived that new and mighty impulse which we call progress."

But I must not pass from the subject without a word upon the study of language in general, that faculty of the human race which was never half understood until the universities of Germany entered upon the study of comparative philology, by the introduction of Sanscrit study. With this new torch they have thrown a flood of light upon the nature of speech, the history of our race, the brotherhood of nations, and the development of ideas which lie at the basis of all Indo-European civilisation.

The Shemitic tongues have long been subjects of university study, especially Hebrew and Arabic—the former so much esteemed as the language of the Old Testament that it used to be spoken of as the language of Paradise, and the latter being regarded as a key to the ideas and religion, the ancient literature and science, of one of the largest families of men. Of late years the domain of Shemitic study has been widened; libraries long hidden have been exhumed on the sites of ancient Babylon and Nineveh; records, the very existence of which was unknown at the beginning of this century, written in characters to which there was then but the slightest clue, are now read and printed and studied as a part of the history of mankind. Assyrian becomes a language of university study—not, indeed, for many scholars, but for a few, and the bearing of their discoveries is so important upon the language and history of the Hebrews that one of the most learned of English theologians has recently said that, in respect to certain of the obscurer passages of the Old Testament, the world must wait for the light which would come from Assyriology.

Certainly, if the history of mankind is worth studying, if the lessons of the past are of value, language and literature, the ancient, the modern, the primitive, and the cultivated, will never be neglected among the studies of an enlightened community.

When we turn from Man to his environment, we soon perceive that mathematics lies at the basis of all our knowledge of this world. To count, to measure, and to weigh, are steps in civilisation, and as we extend our powers in these directions, we find that even the distance and mass of the planets, the form of the earth, the velocity of light, the mechanical equivalent of heat, and the unit of electrical resistance may be accurately ascertained, and the results, with many of the ideas which they involve, may become a part of the intellectual possessions of every educated person. Yet when we reflect that hardly any branch of knowledge is so depreciated by the average man as the modern advancement of pure mathematics, we must believe that its influence upon civilisation is not sufficiently considered.

Prof. Cayley, in a recent address, alluded to the connection of mathematics with common life, on the one hand, and with the deepest questions of philosophy, for example, the metaphysical ideas of time and space, on the other. As to its utility he declared that he would defend this science as Socrates defended justice, quite irrespective of worldly advantages,—and then he proceeds to show the relations of mathematics to the certainty of knowledge, and to emphasise the idea that mathematical science is not built upon experience but upon certain fundamental assumptions—which are indeed found to be in conformity with experience. I wish that every student, however remote his studies may be from mathematical text-books, would turn to the opening passages of this discourse, and steady his own mental equilibrium by the assurance that the science which is most exact, and most satisfactory in its reasonings, is based upon fundamental postulates which are assumed and not proved by experiment. "In the theory of numbers," he says, "there are very remarkable instances of propositions observed to hold good for very long series of numbers—and which are nevertheless untrue."

If you persist in taking the utilitarian view, and ask me what is the good of Mr. Glaisher's determination of the least factors of the missing three out of the first nine million numbers, the volume containing the sixth million having lately been published; —or if you put a much more comprehensive question, what is the use of the Abelian functions, I shall be forced to say, I do not know; and if you press me harder I shall be obliged to express my conviction that nobody knows; but I know, and you know, and everybody may know, who will take the pains to inquire, that the progress of mathematics underlies and sustains all progress in exact knowledge.

Whewell, the author of the "History of Inductive Sciences," has brought out very clearly the fact that "the opening of Greek civilisation was marked by the production of geometry, the idea of space was brought to a scientific precision; and likewise the opening of modern European civilisation was distinguished by the production of a new science, Mechanics, which soon led to the mechanics of the heavens, and this step, like the former, depended on men arriving at a properly distinct fundamental idea, the idea of force." Henry Smith, arguing for the value of his favourite study to mankind, points out the injury which would come to the intellectual strength of any nation "whose notions of the world and of the things in it, were not braced and girt together with a strong frame-work of mathematical reasoning. It is something," he continues, "for men to learn what proof is and what it is not." The work in mathematics at Alexandria or Syracuse two thousand years ago is as perfect in its kind and as direct and unerring in its appeal to our intelligence, as if it had been done yesterday at Berlin or Göttingen by one of our own contemporaries. In kindred language, Cayley, working forward as well as backward, and not unmindful, let us hope, of the Sylvestrian school upon this side of the Atlantic, in which he had been a master and a guest, thus concluded the address from which I have already quoted:—

"Mathematics has steadily advanced from the time of the Greek geometers. Nothing is lost or wasted; the achievements of Euclid, Archimedes, and Apollonius are as admirable now as

they were in their own days. Descartes' method of co-ordinates is a possession for ever. But mathematics has never been cultivated more zealously and diligently, or with greater success than in this century—in the last half of it or at the present time; the advances made have been enormous, the actual field is boundless, the future full of hope. In regard to pure mathematics we may most confidently say,

"'Yet I doubt not thro' the ages one increasing purpose runs,
And the thoughts of men are widened with the process of the suns.'"

Many who hesitate to assent to these views of the relation of pure mathematics to civilisation, have no hesitation whatever in lauding applied mathematics, especially astronomy and physics; and no wonder, for within the memory of this generation, the world has gained these five results of physical science, steam locomotion, telegraphy, telephony, photography, and electric lighting. The first three, it may be said, have revolutionised the methods of human intercourse; the fourth has multiplied infinitely the means of communicating knowledge to the brain by what Sir William Thomson, following John Bunyan, has termed the Eye-gate; and the fifth, still in its dawn, includes possibilities of illumination, which we are not likely to exaggerate. But I have no time to eulogise these recent gains of civilisation; every word I can spare must be given to emphasise the fact, which is most likely to be forgotten, that these wonderful inventions are the direct fruit of university studies. I do not undervalue the work of practical men when I say that the most brilliant inventor who ever lived has been dependent upon an unseen company of scholars, the discoverers and the formulators of laws which he has been able to apply to methods and instruments. Nor do I forget that Faraday, like Shakespeare, was not a university man. But I mean to say that the manifold applications of science, about which everybody is talking, are only possible because of the abstract studies which universities promote. The electro-magnetic inventions which are now so multiform are only possible because scores of the greatest intellects of the century, one after another, have applied their powers of absolute reasoning to the interpretation of phenomena which could have been elucidated in any part of the world, and at any epoch of the past, if only the right methods had been employed. As long as universities held aloof from experimental sciences, these discoveries were not made, but when laboratories for investigation were established, an alliance was formed by mathematics and physics, and a new type of intellectual workers was produced, men whose hands were as cunning to construct and make use of instruments, as their brains were cunning to develop the formulas of mathematics. Take the splendid list of leaders who have followed Franklin and Rumford. They may be called the school of Sir Isaac Newton, so much of their inspiration is due to him. Not all were trained in academic walls; but not one failed to derive help from the advantages which universities provide and perpetuate.

One of the greatest of these men, Sir William Thomson, has lately been here. He was invited to come because it was believed that he, more than any other foreigner, could give an impulse to the study of physics in this country. His lectures were on a subject so remote from ordinary thought that I do not suppose its announcement conveys to those who are unfamiliar with the present position of physical inquiries, the least idea of what the lecturer was to talk about. Nevertheless, so great was the attraction of his powers, that a large company, two or three from England, one from Japan, several from beyond the Alleghanies, and many from this neighbourhood, most of them teachers and professors of physics, here assembled daily for a month to catch what they could of his learning and his enthusiasm. His words were taken down and have been given to the public in the form of lecture notes, and have thus reached already the principal seats of learning abroad and at home, but the chief results of his visit will be seen as the years go on in the increased devotion of his followers to their science, and in their emulation of his enthusiasm and concentration. Could I give you a more interesting example of the way in which a university may encourage physical science?

Notwithstanding all the progress in physics and astronomy which has been made during a century, those who know the most about these subjects will assure us that they are but at the alphabet of their science. Read the address of the Astronomer of Princeton, on a recent occasion, in which he enumerates the impending problems of astronomy; or that of one of our own staff, when he reviews the condition of electrical science, and declares that "as the region of the unknown is infinitely greater than the known—there is no fear of there not being work for the whole world for centuries to come;" and he adds (to please, I suppose, the practical men) that in the applications of science, "the telephone, the telegraph, and electric lighting, are but as child's play to what the world will see."

Chemistry is the child of the nineteenth century. The atomic theory, which lies at the foundation of all modern investigations, was announced by Dalton,—(that English Friend after whom it would not be amiss to name our chemical laboratory "Dalton Hall," as a tribute alike to his eminence and to the society in which our founder was also trained),—Dalton's law, I say, was announced between 1804 and 1808, so that we can trace more distinctly than in most sciences the exact influences under which chemistry has grown up. Alchemy, the search for gold or for the philosopher's stone, never became a science, and contributed very little to the good of man; but when the universities of Europe, with their trained observers, their methods of accurate work, their habit of publication, and especially their traditional principles of co-operative study, directed their attention to the fundamental laws of atomic combination, the science of chemistry grew with rapidity, and with benefits to mankind which can never be enumerated. To no man were its early days more indebted than to Liebig—"of organic chemistry the very source and fountain-head"—good as a thinker, good as an investigator, good as a lecturer, but better still, as one of his most illustrious pupils has informed us, "in the peripatetic teaching of his laboratory."

"It was at the small University of Giessen," says Hofmann, from whom I have just quoted, that "Liebig organised the first educational laboratory that was ever founded. This school forms an epoch in chemical science. It was here that experimental instruction such as now prevails in our laboratories received its earliest form and fashion, and if we are proud of the magnificent temples raised to experimental science in all our schools and universities, let it never be forgotten that they all owe their origin to the prototype set up by Liebig, half a century ago." The world appreciates the results which have proceeded from these laboratories—let it also be remembered that they were the creation not of industrial fabrics, not of mercantile corporations, not even of private enterprise, but of universities, and that the motive which inspired their founders and directors was not the acquisition of wealth, but the ascertainment of fundamental law.

The science which began with the century is going forward more rapidly than ever. Yet, if we examine a recent exposition of the principles of theoretical chemistry, we may discover that here, as in mathematics and in physics, the most expert perceive that the field which is open to investigation is much vaster than that which has been surveyed. Here, as everywhere else, the higher one ascends the greater his horizon. What good is to come to men from these researches it would not be wise to predict; but we may reflect on what has recently occurred. Within the last few months a boon has been conferred on humanity so great that all the cost of all the laboratories of all the lands in Christendom would have been a small price to pay for so precious a pearl. It came into the world never again to leave it, unheralded, unexpected, from the laboratory of science, to deaden for a few moments and then restore to life the organs of the sight, so that operations on the eye, hitherto dreaded, may be performed without the slightest pain. The chemists may modestly say that this discovery was an accident not to be compared in significance with the discovery of Avogadro's law. That may be so, yet this sort of accident does not happen in Africa or the Fiji Islands,—it "happens" where there are universities and laboratories, and trained men able and ready to observe, discover, and apply.

The hour has passed, and I have hardly introduced a theme which would be more appropriate for a volume than for a discourse. I have not spoken of the study of the structure of the earth, the physics of the globe, the laws of storms, the constituent rocks and minerals of the earth, the record of life hidden in ancient strata, the living kingdoms of animals and plants, the distribution of the races of men, the progress of archæology—or of innumerable subdivisions in the great branches of human knowledge. Such a task would be beyond my powers; I have only attempted to suggest what each one of you may study for the rest of your lives, as you watch the growth of universities and the progress of knowledge. I have purposely left for another occasion all questions pertaining to professional and technical education.

A few miles east of one of my former homes—the settlement of Berkeley, in California—there is an isolated peak of moderate height, from the top of which you may survey an area equal to that of the State of New York. From Mount Shasta on the north to Mount Whitney on the south, you may trace the jagged, often snow-white, crest which bears the name of Sierra Nevada. Here and there a peak rises a little higher than its neighbours, and can be identified from the look-out: but human vision cannot see the chains beyond the chains, nor the marvellous valley Yosemite and the beautiful Lake Tahoe which are sheltered within the nearest range of hills. All that the eye can distinguish on the horizon are a few of the loftiest summits as it turns toward the east, and a glimpse of the Farallone Islands as it turns toward the west. So to-day, from a hill not very high, we have looked upon a broad area, distinguishing only the chief features of the landscape,—but we have seen the mountains and the sea.

A NEW ISLAND IN THE SOUTH SEAS

ACCORDING to the *Melbourne Argus* of December 10, further news respecting the volcanic outbreak which recently occurred in the Friendly Group has been received from Fiji, *viâ* Auckland. Intelligence concerning it first arrived there by the schooner *Midge*, from Tonga. Before the vessel arrived, however, the eruption had already reported itself to the eastern portion of the Fiji Group, and the *Argus* Correspondent furnishes the following account of it:—

"At Ogea, one of the island outposts lying nearest to the point of eruption, and distant from it about 175 miles in a south-west direction, heavy discharges as of siege artillery were heard on October 14, and continued at short intervals up till the 17th. It is to be noted in connection with this that the outbreak occurred, or was first noticed, in Tonga on the 12th, and that mention is made of 'a low rumbling noise at intervals during the night.' During the continuance of these heavy discharges, Ogea was frequently and very violently shaken by earthquakes, so that the people were in a state of great consternation. At night-time a lurid glare, as from a great fire, was visible in the direction of Tonga, and these phenomena culminated in a terrific roar on the morning of the 17th, such as might be produced by thousands of big guns being discharged simultaneously. Next day a small vessel which had been working the open sea between the Fijian and Friendly Groups, called in to Ogea and reported having passed through vast fields of pumice. This served to confirm the idea generally prevailing that a terrible calamity in the form of a volcanic outbreak had befallen and had overwhelmed Tonga."

The Tonga Correspondent of the *Fiji Times*, who was an eye-witness of the eruption, has communicated the following account of it to that journal:—

"On the night of Sunday, October 11, 1885, more than one slight shock of an earthquake was felt, and lightning was seen at intervals at different quarters. Several persons noticed a low rumbling noise at intervals during the night. At sunrise on Monday morning, October 12, the natives reported that a steamer was coming in. The Tongan Government was induced to send out the schooner *Sandfly*, and about noon on the day the outbreak was first seen Dr. Buckland, accompanied by the Premier and various officials, started to see the volcanic eruption which it was evident was going on. The *Sandfly* returned on the 16th inst. and reported having reached the scene of the eruption on the 13th, but too late to see much: that on the following morning a small island became for the first time visible, and that the vessel had approached within about a mile of the shore, but a strong current prevented nearer approach. On October 17 a number of residents chartered Tugi's schooner, and started for the spot, and on the succeeding morning witnesed a spectacle of such surpassing magnificence as men have seldom been permitted to view. An island of, I believe, not less than nine miles superficial area was seen by us, which had been upheaved, presuming the *Sandfly's* observations to be correct, within four days. On its shore a submarine volcano was belching out a fearful quantity of what I believe to be steam and salt water, throwing it upwards in a column for a distance, I was told by a competent gentleman, of a mile. To give an accurate description in detail of the column and eruption generally is impossible. It is indescribable. The shapes assumed by the steam clouds, after the greatest height had been reached, were inexpressibly beautiful, and were fantastic to a degree. While these clouds were still wreathing and curling, another and another column, with well-defined lines, would shoot upwards, and the downpour of liquid and the wreathing and curling were again and again renewed. The island, named by many 'Fakaogo fei lagi,' or Takaogo Island, is situated about 16 or 20 miles to the north-west of Honga Hapai. I have not a chart to refer to, but believe it is on the site of the Culdibras (?) Reef, marked on the chart, and which is some distance south of Tonga and Kao. Vessels coming here from Fiji will be able to visit the island without going much from their course. At night time flashes of light are seen, but whether proceeding from flames of volcanic fire or from the electricity generated during the condensation of the volumes of steam, will be best known to scientific people. Many and various are the conjectures as to how the island has been formed, and conjectures alone can be made until the island is visited. The whole matter is likely to create great interest, and will afford an opportunity to scientific people to ascertain, with a tolerable amount of certainty, the exact manner in which these islands of the Pacific have in past ages been produced. The height of the island on the occasion of the visit of the *Sandfly* was from 20 to 30 feet, and when we saw it on Saturday it appeared to be from 200 to 300 feet."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—Whatever be the fate of the new Moderations Scheme now being considered by a Committee of Congregation, the present academic year will be remarkable for the vigorous onslaught made by the younger Faculties on the time-honoured requirement at Pass Moderations of "a little Latin and less Greek." The waste of a year over classical work having no direct bearing on the final school chosen by the student had become so great a tax on time and patience that, when a blow was at last struck at the evil, but little opposition was expressed in quarters where small sympathy with modern studies was thought to dwell. If the Committee can agree on a working scheme, a great relief will be afforded to students in Natural Science in Oxford.

It is with much pleasure that we notice, after long interval, two Colleges offering Fellowships in Pure Science. Merton offers a Fellowship in Physics, and Lincoln in Biology. Besides these Fellowships, Pembroke has a vacant Medical Fellowship.

The nomination of Examiners in the Honour School of Natural Science (now conducted by a Committee of the Faculty) took place this week. Prof. Burdon-Sanderson succeeds Dr. Gamgee in Physiology, Mr. H. B. Dixon succeeds Mr. Vernon Harcourt in Chemistry, and Mr. J. Walker succeeds Mr. Hayes in Physics.

The following courses of lectures and practical classes will be held during the present term:—

In the Physical Department of the Museum, Prof. Clifton lectures on Electricity, Mr. Walker on Polarised Light, and practical instruction is given by the Professor, Mr. Walker, and Mr. Selby. At Christchurch Mr. Baynes lectures on Thermodynamics, and gives practical instruction in Electrical Measurements. At Balliol Mr. Dixon lectures on Elementary Heat and Light.

In the Chemical Department of the Museum Prof. Odling lectures on the Phenic Compounds; Mr. Fisher continues his course on Inorganic Chemistry, and Dr. Watts continues his course on Organic Chemistry. Practical instruction is given by Messrs. Fisher, Watts, Marsh, and Baker. Practical instruction is also given in the Christchurch and Balliol Laboratories.

In the Morphological Department Prof. Mosley lectures on the Anatomy of the Vertebrata; Mr. Spenser has a course on Elementary Animal Morphology; and Mr. Barclay Thompson, on the Osteology and Distribution of the Amphibia and Reptilia. Mr. Arthur Thomson lectures on Human Myology, and has a class for Practical Anatomy. Practical instruction in Comparative Anatomy is given by the Professor, and Messrs. Robertson and Spenser.

In the Physiological Department Prof. Burdon-Sanderson lectures on the Physiology of the Nervous System, and will also give twelve elementary lectures during the present and next term on the Vital Phenomena of men and animals. Mr. Dixey lectures and has a class for Practical Histology; Dr. Gotch has a class for Practical Physiology; and Mr. Poulton lectures on the Physiology and Histology of the Special Senses.

In the Geological Department Prof. Prestwich lectures on the Palæozoic series; Prof. Story-Maskelyne on Crystallographic Symmetry; and Dr. Tylor on Mankind, their Distribution, Antiquity, and Early Condition.

At the Botanical Garden, Prof. Bayley Balfour lectures and gives practical instruction in Vegetable Morphology and Physiology. Prof. Gilbert lectures on Field Experiments.

Scholarships in Natural Science are offered this term by Magdalen and Jesus Colleges, and next term by Queen's College.

The next examination for a Radcliffe Travelling Fellowship will commence on Monday, February 8.

CAMBRIDGE.—Mr. J. H. Randell, M.A., who has been elected to a Fellowship at Pembroke College, was 5th Wrangler in 1882, first class in the Natural Sciences Tripos, Part II., 1883, and is now additional Demonstrator of Experimental Physics.

It is proposed by the Council that the appointments of University Lecturers shall be tenable "for such a term of years, not exceeding five, as the General Board shall prescribe," the statutable provision for cancellation remaining still in force for extraordinary occasion.

A Shuttleworth Scholarship at Gonville and Caius College is vacant, and an examination for it will commence on March 19 next. The subjects are Botany and Comparative Anatomy in the most general sense (including Zootomy and Comparative Physiology), and there will be practical work in all these subjects. Candidates must be registered medical students of Cambridge University, and at least of eight terms' standing. The Scholarship is of the value of 60*l.* per annum, and tenable for three years. A Foundation Scholarship may be awarded to the successful candidate in addition.

In the scheme of Entrance Scholarship Examinations at Girton College recently issued no Natural Science subject is included in the optional subjects. One Gilchrist Scholarship, tenable at Newnham or Girton, will be awarded, among other groups, for proficiency in Physical and Natural Science at the next Cambridge Higher Local Examination.

OWENS COLLEGE, MANCHESTER.—The following appointments have recently been made:—To the Brackenbury Professorship of Physiology, William Stirling, M.D., D.Sc., Regius Professor of the Institutes of Medicine in the University of Aberdeen; to the Lectureship in Medical Jurisprudence, John Dixon Mann, M.D., M.R.C.P.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, No. 717, September 1885.—J. Sartain, on the ancient art of painting in encaustic.—Dr. P. H. Van der Weyde, on the new system of telegraphy to and from moving trains. This paper describes Phelps's method of communicating by induction.—A. E. Outerbridge, a lecture on matter.—S. W. Holman, friction of leather belts on iron pulleys; an experimental study of the slip, and coefficients of sliding friction.—A. S. Greene, on the jacketing of working cylinders of steam-engines.—Otto Luthy, on Florida sugar.—Pedro G. Salom, on the metallurgy of steel; an essay on Bessemer and other modern processes.

No. 718, October 1885.—E. A. Gieseler, on tidal theory and tidal prediction.—Chief-Engineer Isherwood, an account of experiments on a condensing compound engine.—C. L. Gateley and A. P. Kletzsch, cylinder condensation in steam-engines. Gives first part of some researches made on a large engine by two students of Stevens Institute.—W. Curtis Taylor, three new portraits of Washington. A study in composite photography.—F. Lynwood Garrison, the microscopic structure of iron and steel. Accompanying this paper are several photo-lithographed plates, one of which shows the transition in structure of a "burned-out" fire-grate bar of cast-iron into steel by the action of the fire.

No. 719, November 1885.—E. A. Gieseler, on tidal theory and tidal prediction (conclusion).—C. L. Gateley and A. P. Kletzsch, cylinder condensation (continued).—Pedro G. Salom, recent improvements in the manufacture of iron and steel. Describes the "Clapp-Griffiths," the "Davy," the "Gordon," and the "Avesta" processes.—Prof. E. J. Houston, glimpses of the International Electrical Exhibition, No. 8. Reis's articulating telephone. An exhaustive examination of Reis's various suggestions and instruments.—S. H. Needles, a translation of a note of M. Blavier on the influence of electric storms on subterranean telegraph wires.

Wiedemann's Annalen, Band xxvi. No. 10, October 1885.—Fr. Kohlrausch, on the conductivity of certain electrolytes in extremely dilute aqueous solutions. This paper contains an historical summary of methods and results; a discussion of the method of working with alternate currents; accounts of various new experimental researches.—E. Pfeiffer, on the electric conductivity of mixtures of ethyl-alcohol and ethyl-ether. The author believes that both pure alcohol and pure ether possess metallic conductivity, though both are extremely bad conductors.—G. C. Foster, on a modified form of Wheatstone's Bridge and a method of measurement of small resistances. This is a reprint of Prof. Foster's paper of 1872 in the *Journal* of the Society of Telegraph Engineers, which appears to be unknown out-side England.—A. Oberbeck, on a phenomenon of electric oscillations similar to resonance. This refers to the effect of condensers on alternate currents recently investigated by Hopkinson.—K. Angström, on the diffusion of radiant heat from plane surfaces. The research was made by an apparatus called a "galvanic differential thermometer," resembling Langley's "bolometer." Results are given for a number of substances at different angles of incidence.—A. Schleiermacher, on the dependence of heat-radiation upon temperature and the law of Stefan. These researches confirm the accuracy of Stefan's law for perfectly black bodies.—M. Thiesen, on the law of the resistance of air.—E. Dorn, experimental confirmation, for pyro-electricity, of the law that the two kinds of electricity are generated in equal quantity.—E. Dorn, some lecture experiments. These relate to Leslie's apparatus, interference of sounds, vortex-rings, Puluj's apparatus for Joule's equivalent, and cooling of wire by sudden extension.—P. Brühl, on forked lightning.

No. 11, November.—E. Gumlich, theory of Newton's Rings in transmitted light. The author concludes that the effect of multiple reflection in the air-film is to render the dark rings incompletely dark in the transmitted set, and the bright rings incompletely bright in the reflected set.—Leonhard Weber, measurement of intensity of diffused daylight. The quantities and qualities of daylight at Breslau were measured against those of standard flames from December 1884 to July 1885, with the following mean relative figures:—December, red 3834, green 11,514; January, red 6875, green 20,447; June, red 51,803, green 151,233; July, red 37,309, green 105,230.—W. von Bezold, on formation of the triangle of colours by true colour mixture. Three shaded triangles of red, blue, and green are optically superposed.—W. Müller-Erzbach, dissociation of salts containing water.—F. Kohlrausch, on the inconstancy of the damping-function of a galvanometer, and its influence on the determination of absolute resistance by means of the earth-inductor.—R. Colley, on some new methods for observing electric oscillations, and some applications of them. To measure electric oscillations the author has applied (1) a telephone receiver, (2) a mirror-oscillometer, and (3) a gas-flame oscillometer; descriptions of these are given, with drawings.—A. Koepsel, determination of the constants of electro-magnetic rotation of the plane of polarisation of sodium light in bisulphide of carbon. The apparatus was a modified Lippich's half-shadow polarimeter. The result gave for the absolute unit of rotation at 18° C., $0'0419913' \pm 0'0000078'$; in close agreement with Lord Rayleigh's value, $0'042002'$.

Journal de Physique, t. iv., September 1885.—H. Dufet, experimental researches on the variation of the indices of refraction under the influence of temperature. The points comprised are: (1) variation of ordinary and extraordinary indices of quartz; (2) variation of index of water by prism method and by method of Talbot's fringes with aid of a lamina of quartz; (3) variation of indices of fluor and of beryl by the same method; (4) variations of indices of bisulphide of carbon, of monobromnaphthaline, turpentine, and alcohol by means of a lamina of quartz immersed in these liquids. The extraordinary index of quartz varies about seven times as much as the ordinary index, with variations of temperature.—MM. Bouty and Foussereau, on the employment of alternating currents for measuring liquid resistances. They criticise Kohlrausch's methods, in which a bridge and a receiving telephone are used, and show that ordinary resistance coils cannot be relied upon as having no self-induction. They describe a liquid rheostat, without polarisa-

tion, capable of giving resistances from 24 to 62,000 ohms.—M. Bourbouze, new models of hygrometers. In these instruments, which are modifications of the dew-point hygrometer, the formation of the first film of dew is observed by causing the deposit to be made on thin glasses which form the sides of the ether-chamber, when, on viewing a candle or other luminous point through the glass, coloured halos are visible.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 10, 1885.—"On the Relation of the Reptiliferous Sandstone of Elgin to the Upper Old Red Sandstone." By Prof. John W. Judd, F.R.S., Sec.G.S.

The question of the geological age of the yellow sandstones of the district lying to the north of the city of Elgin has been, as is well known, the subject of very animated discussions among geologists. Some have even gone so far as to assert that the evidence on the question, which has been adduced by stratigraphists, is absolutely incapable of reconciliation with that relied upon by palæontologists.

After detailing the successive discoveries of fossils in these beds from 1844 to 1877, in which latter year Prof. Huxley published his well-known monograph on *Stagonolepis*, the author proceeds:—

In the year 1884 I saw in the Elgin Museum the cast of a skeleton which had recently been obtained from the new quarry near Elgin, to be more particularly referred to in the sequel. This fossil appeared to me to be so different from all the remains hitherto found in the formation, that I obtained an impression of it and submitted it to Prof. Huxley, who recognised in it certain characters distinctive of the Dinosauria. From the same quarry a skeleton apparently belonging to another lizard, distinct both from *Telerpeton* and *Hyperodapedon*, with portions of the skeleton of the last-named genus, were also obtained.

Returning to Elgin in the autumn of the present year, I was told by my friend Dr. Gordon that another reptilian specimen, including the skull and some other parts of the skeleton, had been found in the same quarry. On examining this specimen I at once saw that it exhibited the characteristic features of *Dicynodon*, and my opinion on the subject was confirmed by my friend Dr. Traquair, F.R.S., of Edinburgh, who, at my request, proceeded to examine the specimen. A second example of the same genus has since been discovered, and I trust that ere long a full account of this interesting form will be given by Dr. Traquair.

In addition to these facts, I may add that casts of teeth, undistinguishable from those of *Ceratodus*, were some time ago obtained from the Spynie quarries.

The present state of the palæontological evidence concerning the age of the beds then is as follows. The strata have yielded the remains of no less than *four* orders of reptiles, all of them belonging to forms very different from any which have been found in Palæozoic rocks. The Lacertilia are represented by *Telerpeton*, *Hyperodapedon*, and an undescribed form; Crocodilia by *Stagonolepis*; Dinosauria by an undescribed skeleton, and possibly by *Dasygnathus*; and Dicynodontia by two individuals of the type genus. In addition to these we have a great number of footprints differing so greatly in form or size that they must probably have been made by creatures of very different proportions and organisation.

It will be seen from this summary that the palæontological evidence in favour of the Triassic age of the Elgin sandstones is now absolutely overwhelming. Besides the remains of *Hyperodapedon* and *Dicynodon*, genera which appear to be confined to Triassic strata, in districts so widely separated as South Africa, India, the Ural Mountains, and the British Islands, we have *Stagonolepis*, a crocodile with Mesozoic affinities, the highly organised lizard *Telerpeton*, and Dinosaurs; the last-mentioned having never been found in any rocks older than Trias. *Ceratodus*, too, has usually been regarded as having commenced in the Trias, though it must be admitted that difficulty may exist in separating the cast found at Spynie from *Ctenodus*, which occurs in the Carboniferous, or *Dipterus*, which occurs in the Devonian.

Let us now inquire what is the nature of the stratigraphical evidence which has been regarded as opposed to the palæontological arguments in favour of the Triassic age of this formation. At the outset it is necessary to bear in mind two very important circumstances. First. The exposures of the Reptiliferous Sandstone and of the Upper Old Red in the district are more or less isolated, the greater part of the country being thickly covered by drift and other superficial deposits. Secondly. The whole of the rocks in the district exhibit evidence of having undergone great disturbance; this is shown by their steep inclinations, and by the foldings and fractures which can often be recognised in the quarries opened in them.

The Reptiliferous Sandstone makes its appearance at the surface in two parallel ridges, ranging from north-east to south-west for a distance of about nine miles. The most northerly of these ridges extends from Brandenburgh to Burghead. Although the rocks are well exhibited both in sea-cliffs and in reefs on the shore, the only fossils obtained from them are the footprints of the Cummingston and Hopeman quarries, near the south-western extremity of the ridge, and the remains of *Stagonolepis*, *Telerpeton*, and *Hyperodapedon*, found in a single bed at Lossiemouth, at its north-eastern end. A tract of about three miles wide, thickly covered by superficial deposits, completely isolates the northern or coast ridge from the southern one, which is known as the Quarrywood ridge. In this Quarrywood ridge the Reptiliferous Sandstone is only found along its northern face for a distance of about three miles. The southern slope is composed of the ordinary rocks of the Upper Old Red Sandstone, containing *Holoptychius nobilissimus*, Ag., with species of *Glyptopomus* and *Pterichthys*. There is no evidence of the occurrence of Triassic strata, either along the southern slopes of the Quarrywood ridge or in the district lying still further south about the city of Elgin. The localities in which the sandstone containing reptiles has been found along the northern slope of the Quarrywood ridge are as follows:—At Spynie, which may be regarded as a north-eastern prolongation of the Quarrywood ridge, the deep quarries have yielded *Telerpeton*, *Hyperodapedon*, and *Ceratodus*. At Findrassie Wood, a mile and a half further to the south-west, a quarry, now abandoned, has yielded *Stagonolepis* and *Dasygnathus*. Lastly, the quarry near the top of the ridge, above New Spynie Church, and a mile and a half still further to the south-west than Findrassie, has yielded *Hyperodapedon* and another lizard with a Dinosaur and a Dicynodont.

In both the coast ridge and the Quarrywood ridge, as was well pointed out by Dr. Gordon, the Reptiliferous Sandstone is seen to be covered by a very peculiar and easily-recognisable deposit, known as the "Cherty rock of Stotfield." It has been frequently suggested that the preservation of these two sandstone ridges, and thus of the whole peninsula between Burghead Bay and Spey Bay, was in all probability due to the presence of this remarkable rock, which offers such resistance to the ordinary agents of denudation.[1] The rock consists of a more or less intimate admixture of siliceous and calcareous materials, including also crystallised patches of galena, blende, and pyrites; it has yielded no trace of organic remains. Sir Roderick Murchison compared the "Cherty rock of Stotfield" with the Cornstones of the Old Red series, with which, however, they have but little in common; and some confusion appears to have arisen from bands of true Cornstone, which occur in Upper Old Red Sandstone to the south of Elgin, with the Cherty rock of the Trias.

Prof. Harkness in 1864 was able to show that the positions in which the Cherty rock and the Reptiliferous Sandstone occur in the neighbourhood of Elgin are such as can only be explained by the existence of great faults. At a later date I showed how numerous are the indications of disturbance in the district—evidence of tilting of the beds, of actual contortion, and of fracture occurring in many of the quarries. On the north of the coast-ridge I have shown that beds of Inferior Oolite are found faulted against the Trias at Stotfield,[2] and probably also at Burghead. In the great "Scars," or reefs, which lie off this coast red sandstones are seen, and I have been assured that scales of *Holoptychius* occur in them. The presence of these great lines of dislocation is unquestionable, and in the paper referred to I have endeavoured by means of dotted lines to indicate the approximate position of some of them. It must be remembered, however, that in a country so deeply covered by drift as Northern Morayshire, the working out of the relations of the rock-masses by tracing their outcrops at the surface is an almost hopeless task.

As throwing an entirely new light on the age and relations of

[1] *Quart. Journ. Geol. Soc.*, vol. xx. (1864), p. 422.
[2] *Ibid.* vol. xxix. (1873), p. 128, &c.

the Reptiliferous Sandstone of Elgin, I was able to show in the year 1873 that strata identical in character with that deposit and with the Cherty rock of Stotfield occur on the northern as well as on the southern side of the Moray Firth. At Dunrobin, in Sutherland, the yellow sandstones are seen covered by the Cherty rock, and this in turn is overlain in apparently conformable sequence by the various members of the Lias and Oolite. The whole of the Mesozoic strata of Sutherland are seen to be thrown by a great fault against the Lower Old Red and the crystalline rocks of the Highlands.

Although it is certain, however, that some of the cases of juxtaposition between the Old Red and the Triassic strata must be due to faulting, yet there were reasons for believing that the latter strata lie directly and unconformably upon the former. But, as was remarked by Dr. Gordon in 1877, "the district is so covered by drift that no junction of the Holoptychian and the Reptiliferous strata has been laid bare."

It was therefore with the greatest interest that in the summer of 1884 I learned from that veteran geologist, whose important services to science have extended over a period of more than half a century, that the bones of reptiles had at last been detected in the same quarry with the remains of *Holoptychius*. On repairing to Elgin, I found evidence that a somewhat coarse variety of the Reptiliferous Sandstone is seen passing downwards into a bed of conglomerate from three to four feet thick, which is known to the workmen as the "pebbly-post."

It was also found that the "pebbly-post," which in its lower portion becomes more perfectly conglomeratic, and contains pebbles of white and purple quartz up to the size of the fist, rests on beds of pink and red sandstones, very finely laminated, and exhibiting evidence of much false-bedding. These beds are strikingly different in character from the coarse-grained white sandstones lying above the "pebbly-post," in which the bedding is usually indistinct and imperfect. The stone lying below the conglomerate was found to be unsuited for building purposes, and the trial shaft, after being carried to the depth of thirteen feet in the bottom-rock, was abandoned; very fortunately, however, the last blast which was fired in it revealed a remarkably fine specimen of *Holoptychius*, which has been identified by Dr. Traquair as *H. nobilissimus*, Ag., and is now in the Elgin Museum.

These facts all point to the conclusion that the Reptiliferous Sandstone of Elgin passes downwards into a bed of conglomerate, which rests unconformably upon the strata of the Upper Old Red.

The Royal Society long ago testified its sense of the importance of determining the age and relations of the remarkable strata of Elgin, by appointing a Committee and making a grant from the Donation Fund to aid in securing new specimens of the fossils. Seeing, then, that an opportunity offered itself for determining the exact relations of the Reptiliferous to the Holoptychian beds, I preferred a request to the Council of this Society for a grant to be applied in excavations directed to uncovering the line of junction between the two beds.

My request having been granted, I had the great advantage of the aid and judicious counsel of Prof. T. G. Bonney, F.R.S., President of the Geological Society, in examining the section laid bare, and he permits me to state that he fully concurs in the following statement.

We were able to observe that, while the conglomerate of the "pebbly-post" graduates insensibly into the overlying Reptiliferous Sandstone, it is sharply divided from the red sandstones below. It was unfortunately found that, owing to the imperfect bedding of the upper series and the prevalence of oblique lamination in the lower one, it was impossible to obtain decisive evidence of a discordance of dip between them. But the line of junction between the two sets of strata showed every appearance of being an eroded one. We came to the conclusion that while the upper series having the "pebbly-post" for its base, is certainly perfectly distinct from the lower one, there can scarcely be the smallest doubt that the former rests unconformably upon the latter; in other words, the evidence points to the conclusion that during the vast periods of the Carboniferous and Permian, the Upper Old Red Sandstone of the Elgin area was upheaved and denuded, and the Upper Trias beds were deposited unconformably upon their eroded surface.

The paper concludes with a *résumé* of all that is known of this formation, which has proved of such interest both to geologists and to biologists, and a comparison with the strata of the same age in other parts of Scotland and in Scandinavia.

Zoological Society, Jan. 19.—Prof. W. H. Flower, V.P.R.S., President, in the chair.—A letter was read from Dr. C. S. Minot (25, Mount Vernon Street, Boston, U.S.A.), calling attention to the Elizabeth Thompson Science Fund for the advancement and prosecution of scientific research, and inviting applications for assistance from it.—A communication was read from the Rev. T. R. R. Stebbing, containing descriptions of some new Amphipodous Crustaceans from Singapore and New Zealand.—Mr. Howard Saunders exhibited an adult specimen of the Sooty Tern (*Sterna fuliginosa*), caught alive near Bath, October 1885, and pointed out that only two examples of this species had as yet occurred in Great Britain.—Mr. H. J. Elwes read a paper on the butterflies of the genus *Parnassius*, having special relation to the development, functions, and structure of the horny pouch found in the females of this genus. He described the habits, distribution, and variations of twenty-three species which he recognised in the genus; and illustrated his remarks by the exhibition of a very complete collection of specimens and drawings. The paper was supplemented by Prof. Howes's remarks on his examination of the anatomy of the *Parnassius apollo*, and by Mr. Thomson's notes on the habits of the insects as bred in the Society's Gardens in 1885.—Mr. Oldfield Thomas, F.Z.S., read a paper containing a list of the specimens of mammals collected in various parts of India and presented to the British Museum by Mr. A. O. Hume, C.B. The series consisted of about 400 specimens, nearly all in excellent condition and with accurate localities attached to them. A new mouse from Tenasserim was proposed to be called *Mus humii*. A new Flying Squirrel from the Malay Peninsula was named *Sciuropterus davisoni*.—A communication was read from the Rev. Canon Tristram, containing the description of an apparently new species of duck (*Dafila*) from Sidney Island of the Phœnix group in the Central Pacific, which he proposed to name, from its extreme simplicity of plumage, *Dafila modesta*.—A communication was read from Mr. A. G. Butler, containing a description of the larva, pupa, and imago of a butterfly (*Aprita hippia*) from specimens bred in the Society's Gardens.

PARIS

Academy of Sciences, January 18.—M. Jurien de la Gravière, President, in the chair.—Memoir on M. de Saint-Venant and his scientific work, by M. Ed. Phillips.—On a new mercurial bath intended to deaden the vibrations of the ground, by M. Mouchez. This contrivance, at once simple and practical, has been invented by M. Gautier for the purpose of diminishing the vibrations of the ground at the Paris Observatory, caused by passing traffic. A cylindrical cast-metal basin containing the supply of quicksilver, has attached to the centre a wormed axis, to which is riveted a second and somewhat smaller basin furnished with a corresponding female-screw. The latter is pierced with a small aperture, through which the layer of quicksilver enters. This layer then becomes insensible to the vibrations, provided the screw be neither too tight nor too loose. The appliance has already yielded excellent results, for the first time enabling regular observations of the nadir to be taken at the Paris Observatory.—Remarks on MM. Paul and Prosper Henry's astronomical photographs, presented to the Academy by M. Mouchez. Since the proofs obtained of the Milky Way last June, MM. Henry have continued their labours with a success that has surpassed all hopes. The results already secured have been pronounced by competent judges the very perfection of astronomical photography, full of promise for the future of astronomy. Perfectly distinct images of several thousand stars down to the sixteenth and even the seventeenth magnitude have been obtained, as well as the nebula near Maia in the Pleiades and other objects absolutely invisible to the most powerful telescopes. Amongst other photographs presented are forty-two proofs of the Milky Way and various regions of the heavens; the neighbourhood of ε Lyræ showing some stars far smaller than the *delilissima* of Herschel, and below the sixteenth magnitude; the neighbourhood of Vega, with stars even feebler still than the foregoing, some of which have certainly never before been seen; the groups of Hercules, Sobieski, Ophiuchus, and Perseus, and over 600 images of double or multiple stars; a very successful photograph of the nebula of Orion and of several of the planets.—Note on the irreducible pure reciprocants of the fourth order, by Prof. Sylvester.—Note on an electric spectrum peculiar to the rare earths of the terbic group, by M. Lecoq de Boisbaudran.—Collection of plans or designs of ancient and modern vessels, with the elements necessary for their construction; third instalment.

presented to the Academy by Admiral Paris.—Considerations relative to the illumination of lighthouses by means of electricity, by M. Félix Lucas. It is shown that the voltaic arc presents two decided advantages over mineral oil: greater brilliancy and less expense. The only drawback is the somewhat capricious instability of its light, a defect so inherent in the nature of the voltaic arc, that at present it seems impossible completely to remove it.—Note on the solar statistics of the year 1885, by M. Rôd. Wolf. The tabulated results of solar observations made at the Zurich Observatory, and of magnetic observations made at Milan, shows that the relative number and magnetic variation have both considerably diminished at about the same rate since the year 1884.—On hitherto unrecognised wave-lengths, by M. Langley. From his protracted researches the author concludes with some reserve that the radiations, whose lower limit was determined by Newton at 0·0007 mm., have now been extended to 0·0150 mm., that is to say, to over twenty times Newton's limit. Thus the great gap that existed between the lowest known vibration of light and the highest of sounds, has been partly filled up.—On the velocity of the flow of liquids, by M. Th. Vautier.—On the secondary or persistent luminous impressions, second note, by M. F. P. Le Roux. The author concludes for the present that the seat of the phenomenon, to which these persistent images are due, lies about the back part of the eyeball, and that probably one or more fluids play an important part in its production.—Action of the sulphur of antimony on the sulphur of potassium, by M. A. Ditte.—Note on a new synthesis of an inactive borneol, $C_{20}H_{34}(H_2O_2)$, by MM. G. Bouchardat and J. Lafont.—Action of high pressure on the animal tissues, by M. P. Regnard.—Influence of the anæsthesia produced by the inhalation of the protoxide of pure nitrogen on various functions of the animal system, by M. M. Lafont. This species of anæsthesia is not only more or less injurious in itself, but constantly causes functional disturbances, which may give rise to serious dangers, especially in certain physiological conditions.—Researches on the physiological and therapeutic action of acetophenone, by MM. Mairet and Combemale. From their experiments the authors conclude that acetophenone, which acts chiefly on the nervous system, is not a sedative, while its healing virtues appear to be very doubtful.—On the histogenesis of the elements contained in the ovaries of insects, by M. J. Perez.—A contribution to the study of the Eocene palms of West France, by M. Louis Crié.—Note on the Jurassic and Lower Cretaceous formations of the provinces of Grenada and Malaga, by MM. Marcel, Bertrand, and W. Kilian. These Andalusian formations appear to be of an essentially Alpine character, their composition resembling those of Sicily and South Tyrol. The upper layers also show strong analogies with the Balearic Islands, the Apennines and Alps of Lombardy.—Note on the photography of speech and its reproduction by oxhydric projection, by M. Léon Esquile. The author claims to have succeeded, by means of the photophone, in fixing on a photographic plate the modulations of the voice, afterwards reproducing the words by the telephone, projecting in oxyhydric light the positive image of the plate on Mercadier's selenium receiver.—The election was announced of M. Boussinesq as member of the Section for Mechanics, in place of the late M. Rolland.—The Academy was informed by the Mayor of Chamounix that the commune of Chamounix intended celebrating the centenary of the first ascent of Mont Blanc by de Saussure in the month of August 1887, when a monument erected to his memory will be unveiled. Subscriptions for the monument will be received by the Secretary of the Institute.

BERLIN

Physical Society, November 20, 1885.—Dr. Gerstmann having given a report on the "Molecular Physics" of Herr Wittwer, Prof. Schwalbe delivered an address on wind-holes and ground-temperatures, a theme on which he has frequently before made communications to the Society. Notwithstanding that he had been engaged for years in the study of ice-cavities and wind holes, the speaker had yet arrived at no conclusive judgment respecting the cause of them. Having been prevented in 1884 from instituting observations of his own, he had collected the literature of the subject, and had ascertained that ice-cavities and wind-holes were very widely diffused, but had not yet excited general interest to such a degree as to have become the subject of continuous observations. In the summer of 1885 Prof. Schwalbe made a searching investigation into the cold cavities and wind-holes in the neighbourhood of Questenberg, in the Southern Hartz. The gypsum here constituting the main mass of the soil showed very many cavities and wind-holes. The ice-cavity he had described on a former occasion, with its entrance by a smooth gypsum wall, was found by him this year entirely free of ice, and the temperature of the air in it was, on three different visits, always between 2° and 5° C. On the other side of the gypsum mountain he found a hole which, on former visits, was almost entirely filled with water, but was on this occasion quite dry, so that it could be examined to the interior extremity. Here, too, he found a low and uncommonly constant temperature of 5° in the proximity of the mouth, and of 4° at the far end. A large number of more or less small holes, whence cold air issued, was found on the same side of the mountain, which was almost bare, except for a few fruit-trees. Occasionally these holes were very close to the surface illumined by the sun, and yet their temperature, in all kinds of weather, was perfectly constant and low, mostly from 4° to 5°,—in one case 0°. Although, too, most of these cavities communicated by broader or narrower crevices with the interior of the gypsum mountain, yet nowhere in them could there be demonstrated any stronger current of air that might be claimed as the cause of a more powerful evaporation and cooling. Prof. Schwalbe, in conclusion, drew attention to two interesting phenomena he had observed in the gypsum strata of the Southern Hartz. These were the sinking of rivers, often accompanied by loud uproar, and the occurrence of intermittent lakes. The so-called "Bauerngraben" (peasants' ditch), near Rosslau, was, even in the last century, as the old contracts between the two neighbouring villages proved, sometimes a lake serving the one village for fishing purposes, and sometimes dry land, which was then tilled by the other village. Several channels at the bottom of the lake led to the interior of the gypsum rock, nevertheless the water, when it gathered here, stood for several years at a depth of from 10 to 15 metres, suddenly to disappear again. In the years 1876, 1877, and 1878 the "Bauerngraben" was filled with water, and since this last date it had been dry land. The meteorological conditions appeared to exercise no influence on this phenomenon. The cause of the sudden accumulation of water, and the just as sudden desiccation, was yet wholly unknown.

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THURSDAY, FEBRUARY 4, 1886

ASTRONOMY DURING THE NINETEENTH CENTURY

A Popular History of Astronomy during the Nineteenth Century. By Agnes M. Clerke. (Edinburgh: Adam and Charles Black, 1885.)

WE have read this book with very great interest and with no little pleasure. The authoress (for this learned volume is indeed the product of a lady's pen) has modestly described her "History of Astronomy" as a *popular* work. We certainly hope that the book will be as popular as it deserves, and that it will be widely and extensively read. We think, however, that few men of science who use this book will think that it ought to be classed as a popular work in the ordinary acceptation. It might be more correctly described as a masterly exposition of the results of modern astronomy in those departments now usually characterised as physical.

Prof. Grant's "History of Astronomy," now more than thirty years old, treated of astronomy prior to that remarkable development of the science consequent on the invention of the spectroscope; Miss Clerke may thus be said to have resumed the subject from the point which Prof. Grant reached, and her present work is well worthy of a place beside Grant's volume in every astronomical library.

In the opening pages of the introduction Miss Clerke distinguishes the three great branches of the science of astronomy. The primary branch is that known as "observational," which involves the art of observing the returns and measuring the places of the heavenly bodies, but is not concerned with schemes for harmonising these facts into a compendious theory. The second kind of astronomy is that founded by Newton, and is most appropriately termed "gravitational." It seeks to account for the main facts of astronomy, in so far as the movements of the bodies are concerned, by the operation of the law of gravitation. The third branch is that which Miss Clerke terms "physical and descriptive." This branch of astronomy embraces the detailed study of the features of the different celestial bodies, and also the examination of their actual character and chemical composition. The two first branches are the older and better-known parts of astronomy. It is in the third branch that the great developments of modern times have taken place. It is especially in this department that Miss Clerke's work will be found invaluable as giving a succinct and accurate summary of our knowledge.

The work is divided naturally into two portions. The first part describes the progress of astronomy during the first half of the nineteenth century. It opens with an account of the career of Sir W. Herschel and his discoveries. In subsequent chapters of the first part we have the account of the memorable achievements of Bessel and Struve in sidereal astronomy. We have also a useful sketch of the earlier observations on and theories with regard to the structure of the sun; the discovery of the minor planets; the development of the cometary discoveries so far as the laws of their motions are concerned; and an account of the instrumental advances up to the time of the great Rosse reflector.

It is, however, in the second part, on "The Recent Progress of Astronomy," that Miss Clerke has found a new field, which she has occupied with great success. The earlier chapters of the second part relate to the foundations of astronomical physics. There is an admirable account of the state of our knowledge with respect to sunspots, and of the results obtained from recent eclipses. The spectroscopic work on the sun is discussed in an able chapter, while the researches on the great constant of the universe—the sun's distance—fitly occupy another. Then we have an account of the recent discoveries with respect to the planets and their satellites, and of the theory of planetary evolution. Chapters X. and XI., on comets, are especially good, and the spectroscopic labours on stars and nebulæ are also well described. A chapter on the methods of research concludes a volume of 468 pages. The photographic and spectroscopic work is virtually the theme of this book, and any one who desires to learn what has been done by Huggins and Lockyer, or by Young, or Jànssen, or Vogel, will find full and accurate information. An index is provided which might, however, have been a little more extended with advantage.

At nearly every point Miss Clerke is careful to quote the references to the original authorities: this is indeed so characteristic a feature in the work that it would be valuable for these references alone, though in saying this we do not imply the slightest disrespect to Miss Clerke's able epitome of the results of each paper she has quoted. Many years of labour must have been required for the production of this work, for Miss Clerke has evidently studied with elaborate care the original writings on each subject.

So far as we have seen Miss Clerke does not appear to have been herself an observer of the heavens, and once or twice remarks occur which would hardly have been made by one who is familiar with astronomy in its practical sense. We are told, for instance, on page 103, that Bessel when a boy, could see the components of ε Lyræ apart with the unaided eye; no doubt he could, but the remark would hardly have been made by one who knew that everybody with tolerable vision can do the same.

In some few places we think that it would have been better to have allowed vague old speculations to pass into oblivion than to furbish them up once again; what, for instance, is the advantage of reproducing Wright's doctrines about the Milky Way, or the astronomical theories of Kant? No astronomy is worth anything which is not grounded on accurate observation or rigid calculation. The "Central Sun" rubbish ought never to have again been printed. We have however but few criticisms to offer on a work so thorough and so carefully written. Miss Clerke has expressly disclaimed any intention of discussing the more abstract mathematical researches relating to astronomy; one of the few exceptions is to be found in a description of Prof. George Darwin's now celebrated theory of tidal evolution; the account here given is both interesting and accurate so far as it goes, but mathematicians do not like such expressions as "wasting its momentum as heat dissipated through space" (p. 316).

The literary style of Miss Clerke's work is especially

admirable; a brief sentence is frequently found to contain an accurate and vigorous expression of an elaborate point. On page 3 we are told that "observation is the pitiless critic of theory." We are told that the probability of 61 Cygni forming a connected pair is actually greater than the chance of the sun rising to-morrow morning. We read of inconspicuous minor planets being difficult to detect "in the majestic disguise of a distant sun." We are told how Prof. Adams would not "take any steps to obtain a publicity which he was more anxious to merit than to secure." In referring to the same event, Miss Clerke describes how Lalande narrowly escaped the accidental discovery of Neptune, and adds: "An immortality which he would have been the last to despise hung in the balance; the feather-weight of his carelessness, however, kicked the beam." In speaking of the moon and the possible variations of lunar objects, Miss Clerke says: "A change always seems to the inquisitive intellect of man like a breach in the defences of Nature's secrets, through which it may hope to make its way to the citadel." There are charming bits of biography through the book: as of Olbers, who became a mathematician because he was an astronomer; of Encke, who became an astronomer because he was a mathematician; or of Schwabe, who, seeking his father's asses, found a kingdom.

There are, however, some few omissions, for which we hope in a future edition room will be made. We should have an account of Brünnow's work on stellar parallax. We think also that a history of modern researches on double-stars should include a notice of Dembowski's most elaborate observations; while the labours of Doberck deserve notice, as we owe to this indefatigable astronomer the greater part of our knowledge of the binary-star orbits. Miss Clerke has, however, fully appreciated the splendid work of S. W. Burnham, who has in ten years discovered 1000 double-stars. Those who are aware of the magnificent labours of Prof. Rowland, of Baltimore, on the solar spectrum will be disappointed in not finding some reference in a work of this kind. It must, however, be admitted that a complete account of Prof. Rowland's work has not yet been published.

Miss Clerke's most admirable work fills a widely-felt want. The progress of spectroscopy has been recently so rapid that it was often difficult to find out what was known and what was unknown. It is here that Miss Clerke renders an assistance that every astronomer must appreciate. He can in this volume obtain a vivid and accurate summary of what has been done, or, if he prefers to read the original memoirs, he will be directed where to find them. The work has been most skilfully and faithfully executed, and we heartily recommend it to every one who is interested in the noblest of the sciences.

ROBERT S. BALL

CRANIOGRAPHY

Eine exacte Methode der Craniographie. Von Dr. C. Rieger. (Jena: Verlag von G. Fischer, 1885.)

THIS work contains the description of a method of craniography employed by the author for upwards of five years for obtaining exact geometrical drawings from the skull or from the head of the living person. The first question dealt with by the author is the plane of orientation of the skull to be adopted. He discards all those which have for their aim the placing of the skull or head in the position natural to man, namely, with the axis of vision as nearly as possible horizontal, and prefers a plane determined by anatomical considerations alone. After studying different anatomical points on the skull for this purpose, he came to the conclusion that the most suitable is a plane running along the base of the cerebrum, extending in front from the angle which the horizontal and vertical portions of the frontal bone make internally with one another to the upper border of the sulcus transversus of the occipital bone, the attachment line of the tentorium cerebelli. This plane placed horizontally is the orientation of the skull adopted by the author. He then proceeds to consider the question of how far the proposed horizontal corresponds to the base of the cerebrum; and secondly, whether it can be determined on the periphery of the unopened skull or the head of the living. Sections of the skull show that the plane corresponds fairly in front with the base of the cerebrum, but posteriorly there is an elevation of the anterior part of the cerebellum and ganglia, so that it does not follow exactly the line of the cerebellum, though roughly it may be said to do so. The determination of the points on the exterior which correspond respectively to the anterior and posterior ends of the plane or long axis of the skull is of greater importance. The anterior point is defined as that point where a line joining the upper borders of the orbits crosses the median line of the skull. The posterior point is more difficult to define, as here several anatomical questions are involved, such as the relation of the protuberantia externa to the interna, and whether the latter corresponds to a fixed point externally. From his investigations the author found that the position of the attachment of the tentorium on which the posterior end of the cerebrum rests cannot be exactly determined in the unopened head or skull, but the variations in position of the external and internal protuberances in comparison to the whole cranial space are so small that the error is infinitesimal. Both in the skull and in the living the termination externally and posteriorly of the plane may be taken as that point where the linea semicircularis superior intersects the protuberantia occipitalis externa in the middle line, or in the living immediately above the line of attachment of the muscles. Having determined these points, he proceeds to show that the outlines of the dimensions of the skull in relation to this plane can be taken only with the assistance of ordinates standing at right angles to one another. He has satisfied himself that it is necessary to have complete outlines of the whole of the curves, and not only the greatest dimensions, so that a model of the skull from which they are taken can be at once apparent. Only a few of the most important curves require to be taken in every case: these are a curve of the ground or horizontal plane, of the median plane, and a third transversely over the cranium in the plane of the external auditory meatus.

The method of obtaining the curves is as follows:—Two threads are tied in the centre so as to form a cross; each end is weighted with lead. The knot is placed in

the middle line on the crown of the head, so that it lies as nearly as possible on the shortest line between the nasion and the protuberantia occipitalis. It is of no consequence whether the knot of the thread lies a little forward or backward. Two arms of the thread are placed anteriorly and posteriorly, one over the nasion, the other over the occiput. The other two are placed transversely across the skull, so that they correspond to the anterior border of each auditory meatus.

The next thing is to fix the points at which the cross-threads cut the line of the ground-plane. For this purpose an elastic band is placed around the skull so that it lies on the anatomical points indicating the anterior and posterior ends of the long axis, and in a straight curve round the skull between these points. When the skull is placed with this line horizontal, we obtain the ground or horizontal plane from which the other curves are to be taken. For the purpose of recording the curves millimetre paper is used, and the principal axes of the skull marked off on it. The long or median axis is measured with calipers. The total length is divided by two, and each half is measured off in a straight line on the millimetre paper from a centre. By a similar process the transverse axis of the skull is obtained at the points where the transverse threads cut the horizontal plane. A rectangular figure is then drawn through each of these points, indicating the length and breadth of the cranium. This forms a boundary-line for the tracing. In order to determine at what point the transverse axis intersects the longitudinal axis in the skull, it is necessary to find out how far behind the mid-point of the long axis the transverse axis is situated. This is done by measuring the distance from the anterior point on the skull to the point where the transverse and horizontal planes intersect at the anterior border of each auditory meatus (which we shall call the "ear-point"), and then marking it off on the millimetre paper, taking as a starting-point the anterior end of the long axis. The true zero or middle point of the skull will be that at which the transverse axis intersects the long axis. This middle point may bear different relations to the middle point of the long axis in that it may coincide with it or be behind it. Whatever may be its relations to the long axis, the transverse axis must be placed on the paper, so that it crosses the centre of the rectangular figure. If the middle point is behind the centre of the long axis, the anterior end of that line will project a corresponding distance beyond the anterior boundary of the figure, while its posterior end will fall at a corresponding distance within it. This will show the projection of the skull forwards and backwards in relation to the anterior borders of the auditory meatus. Should the base of the skull or the ground plane not be symmetrical, the axis of length and that of breadth will not be at right angles to each other, but more or less oblique. Having fixed the position of the axes with respect to the rectangular figure, the horizontal curve is drawn on the paper in four segments in the following way:—A flexible, but absolutely inelastic piece of lead wire is laid on the skull, with its one end corresponding to the right ear-point; it is moulded to the skull, along the horizontal line, to the anterior point in front, then from the left ear-point to the anterior point, and finally from each ear-point to the posterior point. The segments are then carefully placed on the paper with the points all coinciding to those on the marked quadrilateral, and, with a pencil, a tracing on the paper is made along the inner side of the lead wire. In this way the outlines of several skulls can be superimposed; the transverse and longitudinal axes of all the skulls must, however, be made to coincide.

The median longitudinal curve is taken from the end points of the long axis in two pieces, as it is not possible to take it all at once, and the knot on the cross-threads is utilised for determining a point on the curve from which each segment can be taken. Its position is defined on the paper in the following manner:—With a pair of compasses the distance from the anterior end point to the knot is measured on the skull and then laid off on the paper backwards, starting at the anterior end of the long axis line. The distance from each side point to the knot is measured and laid off on the paper so that the two lines converge and meet in front. The distance of the point of union to the zero will represent the sagittal height of the skull. From the anterior end of the long axis a segment having a radius equal to the distance from the side point to the knot is marked off with the compasses on the paper, and another segment is likewise marked off from the zero point with a radius equal to the distance between the zero point and that at which the two side lines meet. Where the two segments intersect, we have a fixed point which will represent the position of the knot. The accuracy of the point so determined may be further verified by a similar process from the posterior end of the axis line. The lead wire is then laid along the curve, first the one half and then the other, and on being placed on paper is traced with a pencil.

Curves of the transverse diameters of the calvaria are taken in a similar manner.

The method is one which requires a considerable amount of care and time. It has the advantage of not requiring any complicated apparatus, but whether its results are equally reliable and compensate for the time required in the manipulation is possibly an open question. For laboratory work we are inclined to think that the stereograph of Broca will prove much more useful, and repay its cost in the rapidity and accuracy with which all the tracings described in Dr. Rieger's monograph can be made. Moreover, with the stereograph, drawings of the face can be made which are not practicable with the graphic method of Rieger.

The plane of orientation proposed by Rieger cannot be considered quite satisfactory, owing to the difficulty of determining accurately its posterior end. A plane of orientation of a purely anatomical character, which we have frequently used, is that with the basio-nasial line horizontal, it being the axis on which both the brain-case proper and the facial portion of the skull are developed. These anatomical planes have the disadvantage of placing the skull in an unnatural position, but are of the greatest use in comparing outlines of the side view of different skulls. For general purposes, however, we have found the alveolo-condylar plane of orientation to be the most useful.

J. G. GARSON

OUR BOOK SHELF

Studies from the Laboratory of Physiological Chemistry of the Sheffield Scientific School of Yale College for 1884-85. Edited by Prof. R. H. Chittenden, Ph.D. (New Haven, 1885.)

THIS volume of some 200 pages is a reprint from volumes vi. and vii. of the *Transactions* of the Connecticut Academy, which were published between March and November of 1885. It contains eleven more or less important physiological memoirs, the result of work done in the Sheffield Scientific School of Yale College by Prof. Chittenden and his colleagues. The first memoir investigates the diastatic action of saliva as modified by various conditions, studied quantitatively, the joint author being Dr. Herbert Smith. The second is on the amylolytic action of diastase of malt as modified by various conditions studied quantitatively, the joint author being Dr. Cummins. Diastase taken into the stomach must sooner or later be completely destroyed by either the free acid or the large percentage of acid proteids; but in the first stage of digestion, in the absence of free acids and under the protecting influence of proteid matter, the conversion of starch into sugar may still go on, though soon destined to feel the effects of the gradually increasing percentage of combined acid. The third memoir is by the Editor and Dr. Painter, on the influence of certain therapeutic and toxic agents on the amylolytic action of saliva. The substances selected for study, besides those noted for therapeutic or toxic power, were also those possessed of antiseptic properties. Mercuric chloride, which acts so powerfully as a germicide, acts even more energetically on the organised ferment of saliva. It is interesting to find that air, oxygen, and carbonic acid all stimulate the amylolytic ferment, and this approximately in proportion to the extent in which they are present in the natural secretion; while of the reducing gases, hydrogen retards and hydrogen sulphate stimulates. In a fourth memoir, by the Editor and S. E. Allen, the subject is the influence of various inorganic and alkaloid salts on the proteolytic action of pepsin-hydrochloric acid. In this the comparative influence on gastric digestion of various metallic salts well known as poisons or therapeutic agents has been studied, and some experiments on some alkaloid salts are added. The subject of the influence of temperature on the relative amylolytic action of saliva and the diastase of malt is treated of by the Editor and Dr. W. E. Martin. The influence of various therapeutic and toxic substances on the proteolytic action of the pancreatic ferment, and on the influence of bile, bile salts, and bile acids on amylolytic and proteolytic action are investigated in two memoirs by the Editor and Dr. Cummins. There is a very interesting, and, from a medico-legal point of view, important memoir on the absorption of arsenic by the brain tissues, by the Editor and Dr. Herbert E. Smith. Two memoirs on the influence of potassium and ammonium bromides, and on cinchonidine sulphate on metabolism, are by the Editor and Dr. W. Culbert, and the Editor and Dr. Henry Whitehouse; while a memoir on the *post-mortem* formation of sugar in the liver in the presence of peptones, by the Editor and Dr. Alex. Lambert, concludes a volume which in many ways reflects great credit on the work done at Yale College, and shows an intimate knowledge of the labours in the same direction of the authors' fellow-workmen in Europe.

Catalogue of the Lizards in the British Museum (Natural History). 2nd Edition. By George Albert Boulenger. Vol. II.

THE rapid progress made with this important Catalogue shows an amount of energy on which the authorities of the British Museum and herpetologists generally may be congratulated. The first volume appeared early in 1885, and was noticed in NATURE for May 21 (vol. xxxii. p. 49); the second volume was issued before the conclusion of the year.

This volume contains the following families of lizards: Iguanidæ, with 293 species; Xenosauridæ, with 1; Zonuridæ, 14; Anguidæ, 44; Anniellidæ, 2; Helodermatidæ, 3; Varanidæ, 27; Xantusiidæ, 4; Teiidæ, 108; and Amphisbænidæ, 65; or a total of 561 species, distributed amongst 115 genera. The number of species is consequently rather greater than in the first volume, which contained descriptions of 490. In the present as in the preceding volume several genera proposed by previous writers are united into larger generic groups: thus in the Varanidæ only one genus, Varanus, is recognised in place of the seven into which the family was divided in Dr. Gray's Catalogue of 1845. Five new genera are proposed—three in the Iguanidæ and two in the Teiidæ. The construction of one of the names proposed, Enyalioides, is, however, unfortunate, as the termination, that of an adjective, is objected to by many naturalists, and there is consequently the risk of another term being proposed.

Nearly all the Iguanidæ and all the Teiidæ are American, and as these two families contain between them 401 species out of the total number described in the volume there is a great preponderance of types peculiar to the New World. Two of the exceptions to the prevailing American distribution in the case of the Iguanidæ, the genera Chalarodon and Hoplurus, are peculiar to Madagascar, although no species of the family has been discovered in Africa.

The lithographic plates attached to both this and the previous volume are excellent, and the figures of lizards, even if not quite so life-like as the highly artistic drawings of the late Mr. Ford, are far superior to the illustrations usually found in works on Reptilia. W. T. B.

Physikalische Krystallographie und Einleitung in die krystallographische Kenntniss der wichtigeren Substanzen. Von P. Groth. 2nd Edition. (Leipzig: Wilhelm Engelmann, 1885.)

THIS is the most satisfactory work of its kind which has been published in any language. In a very simple way the chemist is made to comprehend the mysteries of geometrical crystallography, the physicist is taught how intimately optical and other physical characters are related to crystalline form, while to the microscopical petrographer is presented a careful explanation of the principles upon which all his determinations must be based. We are glad to see that in this edition the simple notation of the late Prof. Miller, of Cambridge, reigns almost supreme; doubtless, it will soon succeed in driving its unpronounceable rivals completely from the field, to the relief of every student. Stereographic projection too takes a very prominent place. In the present edition the work has been increased by 180 pages, most of which are given to the chapter descriptive of the instruments: there are as many as 631 woodcuts. We wish this edition all the success it deserves.

The Rudiments of Mineralogy. By Alexander Ramsay, F.G.S., &c. Third Edition. (London: Crosby Lockwood & Co., 1885.)

MR. RAMSAY is far from being a master of his subject. We cannot imagine what advantage the elementary student, for whom the book is intended, can derive from information as to the specific gravity of each species relative to *hydrogen:* in the case of native silver, for example, he is told that the specific gravity ranges from 115,123 to 117,369! And in any case what is

the experimental value of the last three or four figures? The specific gravity of each species relative to water is given as usual, so that the reference to hydrogen is only an additional torment for the learner. We doubt too the wisdom of explaining specific and atomic heats, and giving lists of their values. Isomorphism and pseudomorphism are hopelessly confused and interchanged on p. 20, while the illustrative formula is quite unintelligible. The adjusting apparatus of the ungraduated goniometer is, as usual in text-books, wrongly disposed for use. We have noticed several mistakes of fact and errors of printing; but the book is neat in style, and perhaps will not do much harm.

The Prospector's Handbook. By J. W. Anderson, M.A., F.R.G.S. 8vo, pp. 132. (London: Crosby Lockwood and Co., 1886.)

THE author, after traversing the mineral fields of New Zealand, New Caledonia, New Mexico, and Colorado, feels convinced that some simple guide or handbook for the use of prospectors as well as travellers is a desideratum, and the present volume is the outcome of this conviction. It contains a number of notes or paragraphs upon subjects incidental to metallic mining, which are distributed into chapters under the different heads of prospecting, rocks, blowpipe-testing, character of minerals, metals, and metallic ores, other useful minerals and ores, composition of various rocks, testing by the wet process, assay of ores, and surveying; to which are added an appendix of tables and a glossary of terms. As the whole text is contained in rather more than a hundred pages, not very closely printed, it will be easily understood that no one of the numerous subjects included in the author's programme is very thoroughly treated. The best part of the book is the introductory chapter on prospecting, which contains some useful generalisations on mineral deposits and the search for them, which, however, are more likely to be of use to the "tender-foot" than to the prospector properly so called. It would seem, however, that this is what the author has in contemplation, as, from some remarks on p. 9, he appears to consider prospectors and miners as two different classes of men, and evidently has no very favourable opinion of the latter. Our own experience points in the opposite direction and leads us to regard typical prospectors as representing the highest and most intelligent class of operative miners. Unfortunately it is difficult to keep them on regular mining works except during the winter time, when the mountain regions are inaccessible.

The remainder of the book is of very little value. The descriptions of minerals are short, without being clear, and in many cases far from accurate. Thus, the composition of galena is stated to be "80 per cent. of lead, the rest sulphur"; malachite is said to contain 70 per cent. of copper, and silicate of zinc about 67 per cent. of zinc. All of these statements are incorrect, and it is not easy to see why they have been made, as no more space would have been required to give the composition corresponding to the theoretical constitution.

The sections on assaying and analysis are not likely to be required by the prospector in the field, and are too vague to be of much use to sedentary students. A description of the methods adopted in sampling gold and silver-bearing vein-stuff in the Western States and Territories of America would have been of interest, but we find no notice of this or any analogous practice followed elsewhere.

The glossary at the end contains several curious definitions, many of which, however, are reproduced from previously published works. The description of the term "tribute" more properly applies to dues or royalty rents as understood in this country. It may be that the author's definition applies to some local foreign usage, but this is not stated.

H. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Hereditary Stature

PERMIT me to correct one word in my memoir on "Hereditary Stature" in the last number of NATURE (p. 297, col. 1, line 6 from bottom), which should read "seven" on an average. I should be glad at the same time to amplify the passage in which it occurs, as follows:—

The chance that the stature of the son will at least rival the stature of the father, is not uniform; it varies with the height of the father. When he is of mediocre stature, that is, 5 feet 8½ inches, out of every 100 sons born to a group of fathers of that height, 50 will be taller and 50 will be shorter than their fathers (the practically impossible case of absolute equality being neglected). Here then the chance of which we are speaking = 50 per cent. When the father is tall, the chance in question diminishes; when he is very tall, say 6 feet 5 inches, the chance is reduced to seven per thousand. The following table shows the probabilities in various cases. Columns A contain the height of the fathers, Columns B show how many per cent. of the sons will rival or surpass the height of their fathers:—

A ft. in.	B per cent.	A ft. in.	B per cent.	A ft. in.	B per cent.
5 8½	50	6 0	15	6 4	1·4
5 9	42	6 1	9	6 5	0·7
5 10	31	6 2	5	6 6	0·3
5 11	22	6 3	3		

FRANCIS GALTON

Deposits of the Nile Delta

TWO communications from Sir William Dawson, published in NATURE of January 7 and 28 (pp. 221, 298), appear to call for a short notice from me. The report on the above subject which I read before the Royal Society on November 19, 1885, and of which an abstract appeared in NATURE of December 10, ought not to be referred to as "the report of the Delta Committee of the Royal Society." The origin of this report was as follows:—As there was no other geological laboratory available for the examination of the samples of delta-deposits sent home by Col. Maitland than the one connected with the Normal School of Science and Royal School of Mines, the other members of the Delta Committee requested me to undertake the microscopical and chemical investigation of the specimens. In preparing my report on them I was struck by the remarkable and unexpected characters which they presented, and I ventured to suggest a mode of accounting for them. When my report was submitted to the Committee I was requested to lay it before the Society; and, it would seem quite superfluous to add, neither the Committee nor the Society thereby accepted any responsibility for the views which I expressed in the report.

As Sir William Dawson lies under a manifest disadvantage in attempting to criticise a report which he has not seen, it will not be necessary to enter at length upon the subject of his communications. If I understand the first of these aright, he takes the opportunity in it of withdrawing his untenable assertion that "at a depth of 30 or 40 feet the alluvial mud rests on desert sand" in favour of the *totally different* statement that "the modern Nile mud" lies on "a Pleistocene or Isthmian deposit." In the absence of any palæontological evidence I can offer no opinion as to the truth of this latter view; but it is certain that the deposits above and below the limit mentioned are of precisely similar mineral characters. With respect to the second communication, I need only add that when its author has the opportunity of reading the report in question, he will find that the very obvious considerations to which he refers have been by no means lost sight of.

JOHN W. JUDD

Stone Implements and Changes of Level in the Nile Basin

I INCLOSE a letter from my brother at Wady Halfa. The scrapers sent home are all made out of flat oval pebbles of

jasper, one side of which is left untouched, while the other is all chipped away except a small central area; most of them are unfinished. The few implements found among the quartz chips are very rough, and may be classed as lance-heads. The smaller pebbles of agate and carnelian seem to have been broken up in great numbers to obtain, out of the interior flakes, small articles about the length of the thumb-nail, of two types, pointed and rounded.

There is one doubly-pointed arrow head of jaspar carefully finished like Fig. 299 in Evans's "Stone Implements." Also several rough implements of larger size of impure basalt. Many of the hammer-stones are very characteristic, and have been much used. Others show the effect of attrition by sand, &c., as in those from the Irish sand-hills. F. ARCHER

Crosby, Liverpool, January 30

Wady Halfa, January 2, 1886

SIR,—When serving in the Soudan last winter, in the occasional walks I was able to take in the Desert I kept a look out for stone implements, but failed to find any until I reached Abri, where I picked up on the beach a well-worked flake, but much worn, of Egyptian jaspar.

Shortly after my arrival here I found several scrapers in the plain lying between the river and the hills, and more extended search led me to further discoveries. The hills at Wady Halfa, which are of sandstone capped with trap (?), are distant about a mile and a half from the present banks of the river, but at a bend of the Nile about eight miles below our camp the valley narrows, and the cliffs rise almost perpendicularly from the water's edge. To the south it widens to the extent of some six or eight miles between the hills on either bank. The whole of the plain between the sandstone ridges is covered with a deposit of Nile mud of unknown depth, but on the right bank this is to a great extent concealed by the sand and pebbles brought down in past ages by the river. The ground is uneven, here and there rising to mounds of hardened mud. There is, however, a gradual though slight rise towards the hills. Soon after my arrival I picked up a number of flakes of quartz, and found that they were most numerous in a belt of dried mud about half a mile distant from the river and a quarter of a mile in width, and tracing this northward I found a mound, some acres in extent, formed of mud and completely covered with sand and tons of chips of quartz, and also of agate, onyx, carnelian, and other hard stones. It was evidently the site of an ancient manufactory, and on this spot, in the many visits I have since paid to it, I have got numerous more or less well-fashioned specimens. Stone hammers may be picked up by the dozen, and these are made of many different minerals. The most interesting are those formed of silicified wood, of which large blocks, curiously polished by the action of the water and sand, are still lying on the river's bank. Tracing the belt further, I have found, both north and south of the camp for many miles, chips and hammers more or less abundant, and little water-worn. I have reason to think that the same is the case on the left bank.

Rambles in the desert, and search among the debris brought down by the Nile in former times were rewarded by the discovery of many roughly-worked flakes, evidently of much earlier date, being very much water-worn. These were widely scattered over the desert, being nowhere abundant. The highest point at which I found them was on the summit of a gravel-covered mound about 50 feet above the present level of the river.

A proof of the Nile having in former times flowed at a much higher level than it does at present, is found in the fact that valves of the peculiar Nile bivalve, *Etheria*, may still be seen *attached* to the rock close to the foot of the hills, and at an elevation of some 30 feet above the present bank. As this shell must necessarily have lived always under water, the rocks when they are found must formerly have been part of the river-bed. If then as now the difference in height between high and low Nile amounted to 40 feet, it is evident that when the shells were living the stream flowed 60 to 70 feet higher than it now does. Whether the stream has receded or the land been elevated I am unable to decide.

It is stated in Murray's Handbook—I know not on what authority—that there is an inscription at Sannek, 35 miles south of Wady Halfa, which records that in the reign of Amenanhat III. of the twelfth dynasty, the Nile at that place rose to a point 27 feet 3 inches higher than it does at the present time. If this is the case and if the same were true as regards the river at this place, the implements and chips found in the belt previously mentioned are of a date subsequent to the reign of that king. I have found some hammers and flakes in the plain not far from the Nile, and very little above its present level.

If any traveller is desirous of obtaining specimens from this neighbourhood he will find a landmark in the British Military Cemetery, from which point the strip of desert in which the remains are most abundant may be traced north or south. The mound of chips is about a mile to the north of the graveyard overlooking an ancient water-course. S. ARCHER

P.S.—Since writing the above I have found another small mound with quartz flakes only between the Nile and the railway.

Parallel Roads in Norway

PARALLEL roads in Norway, such as those described by Mr. Hansen in your last number (p. 268), have already attracted the attention of several British geologists. Robert Chambers, a careful observer, saw and described them as long ago as 1849. His description, however (*Edinburgh Philosophical Journal*, vol. xlviii. p. 71), seems to be unknown abroad, and is not generally accessible anywhere. With your leave, therefore, I quote it entire.

"The valley of the Laugen, for several miles down, contains great masses of pure sand in the form of terraces and isolated mounts. On one of the latter Dovre Church is situated. . . . In this portion of the valley there is a terrace unlike the rest, in as far as it is a narrow ledge of detrital matter, running continuously along the hill-side for fully fourteen miles, however much more, while the terraces resting on the skirts of the hills lower down are great projecting masses, seldom extending far on one level. This remarkable terrace is most conspicuous on the south-west side of the valley. It begins on that side at Oue, between the Hougen and Tofte post-stations. It is there seen truncating the prominent ancient delta of a side stream, called, in Prof. Munch's map, the Jondals Elv, several hundred feet above the bottom of the valley. As we ascend the valley, it becomes nearer to our eye, but this is only because we rise to it, for, when examined with a correct instrument from its own elevation on the opposite side, it is proved to be for a great way truly horizontal. On the north-east side of the valley the corresponding mark is a line composed of slight projecting banks of water-laid sand. Though not continuous, this line is sufficient to have determined that of a long mountain-path connecting a series of farms. Beyond Lie post-station the road to Molde passes along it, and it here affords positions for a close series of hamlets, which make a conspicuous appearance in the map above cited. I believe it is nearly, if not exactly, of the same elevation with the little *hof*, called Dombaas, of which the height is given by Prof. Naumann as 2162 (English) feet. In its relation to the lakes in the summit between the two valleys (*i.e.* of Laugen and Rauma) it precisely resembles the lowest of the Inverness-shire *parallel roads*, as exemplified in Glen Spean, where advancing to the basin of Loch Laggan, between the Spean and Spey valleys. The terrace in every other respect bears a strong resemblance to the Inverness-shire *roads*, while in some important respects, as already noted, it differs from other terraces. I should much desire to see it obtain the attention of local observers, by whom its internal constitution and other features could be more particularly ascertained."

I offer this extract the more readily that the observations of the paper in which the passage occurs ("On Changes in the Relative Level of Sea and Land in Scandinavia") have scarcely received the attention, among Norwegian geologists, to which their care entitles them. Chambers further refers to the same terrace, in a descriptive and popular way, in his "Tracings in the North of Europe," a little volume reprinted (for distribution, fifty copies only) from *Chambers's Journal* in 1850. You will perhaps allow me to add this short reference to the other.

"In addition to the many sandy terraces at different and indeterminate heights, I discovered one of a much more remarkable character, passing along both sides of the valley for fully twenty miles, always at one elevation, and specifically identical as a terrace with the celebrated *roads* of Glenroy in Inverness-shire. It first became visible at a place called Oue (pronounced Ouya) on the west side of the valley, where it truncates the ancient delta of a side stream far up the mountain-side. It is seen thence passing along through the scraggy woods without any interruption, till, on our turning out of the valley, we lose sight of it among the high grounds near Lasso Lake.

On the east side of the valley, perhaps 150 feet above the level of the road at Lie Station, I could distinctly trace this terrace by its hummocks of water-laid sand, and the farmhouses perched on its favourable points. A long series of hamlets on the road to Molde is placed upon it. As an object in physical geography, in its form, its uniform level on both sides of the vale, and its relation to the lakes at the summit-level, this terrace precisely resembles the lowest of the Glenroy terraces as it approaches Loch Laggan. It must, however, be more than twice the level above the sea" (p. 105). Chambers, of course, viewed it as an ancient sea-margin.

The same long terrace was also seen by my colleague, Mr. J. R. Dakyns, in 1872, and described (without reference to Chambers) in the *Geological Magazine*, 1877, p. 74. "If the terrace is on a level," he says, "with the watershed, and there is certainly no great difference between them, one is irresistibly led to think of the similar case of the parallel roads of Glenroy, and . . . of a gigantic Marjelen See dammed back by ice till it overflowed the summit of the pass at Molmen. It is significant that I could see no trace of terrace or water-mark on the Romsdal side of the pass. There is in the same district a second horizontal mark on the solid rock, several hundred feet higher than the 2000-feet one. This, too, seems to correspond with sand-terraces in the recesses of the high glens. . . . Here again it is striking that the water-mark should seem to correspond with the level of a watershed."

I myself saw Chambers's striking terrace in 1873. But I have nothing to add to the observations above quoted, and I make no claim whatever to have my name connected with them. But I may remark the fact that the little deltas or alluvial cones of the streams, where these cross the terraces, so conspicuously bear reference to the surface of the vanished sheet of water in which they were formed, as to remind one how greatly similar evidence was relied on by Darwin as demonstrating the *aqueous* origin of the roads of Glenroy. Mr. Hansen's discovery of parallel roads at the head of the Glommen and in Jemtland is very interesting, and I hope he will find time to study and *map* them in detail.

HUGH MILLER

51, Lauriston Place, Edinburgh, January 24

Meteorological Phenomena

ON January 4 last, while watching a very bright rainbow with a good secondary from Hoylake racecourse, I observed between the two bows a third, fainter than either, touching the primary at the base and extending upwards in such a way that probably, had it all been visible, it would have touched the secondary at the vertex. It was not all visible because of a break in the clouds. Its colours were in the same order as those of the primary, red outside. This third bow was only visible at one side; but a gentleman who observed it stated that he had seen it before, and symmetrical on both sides, though not extending to the vertex.

Another phenomenon I have observed here some time ago. A fall of hail lasting a few minutes occurred, the hailstones being exact cubes, of size about 7 mm. and of consistency like lumps of salt.

JOHN C. WILLIS

University College, Liverpool, February 1

M. BARRÉ DE SAINT-VENANT

"WE have now to consider the earlier work of the greatest of living elasticians." Within a fortnight after these words were sent to the press, on January 6, M. de Saint-Venant died at Vendôme. The news of his death will have caused a deep feeling of regret among English mathematicians and physicists, to whom his researches are so well known that they have attained in their own field a classical value. We purpose in this notice to give some brief account of this foremost representative of latter-day French mathematical physicists.

Saint-Venant stood out for the younger mathematicians of the English school, as the link between the past and the present. Intimately related to the great period of French mathematical physics, he had continued to produce down to our own day, and we felt him to be as real a personality as Helmholtz or Thomson. A younger member of the school of Poisson, Navier, and Cauchy, he had yet lived to "edit" Clebsch. Deputy for Coriolis at the École des Ponts et Chaussées in 1837, Saint-Venant early received public recognition for his work from Poncelet in his lectures at the Sorbonne in 1840; within the next few years he corrected Cauchy's theory of torsion, and saw his correction accepted by the author of the "Exercices des mathématiques." More than forty years afterwards he "edits" what will long remain the standard treatise on elasticity—the annotated French translation of Clebsch. Thus his work is spread without a break across the middle fifty years of our century; he took up elasticity where Poisson had left it—a mathematical theory; he leaves it one of the most powerful branches of mathematics applied to physics and practical engineering; not a small amount of this transformation is due directly to his researches, or indirectly to his influence.

Turning to the personal character of the man, we find in him the essential characteristics of the scholar and the student, the truest modesty, the complete absence of self, the single-minded devotion to his study. Saint-Venant, whose researches on elasticity undoubtedly far surpass those of Navier and Clebsch, is yet content to appear as their *editor*. But what an editing it is! The original text is hidden, disappears, almost as completely as Peter the Lombard's "Sententia" in a mediæval commentary. It is Saint-Venant's notes, appendices, and corrections, which form the value of these works, which make the third edition of Navier's "Leçons" the standard treatise on the strength of materials, and the French translation of Clebsch the foremost work on mathematical elasticity. Nay, he even praises Clebsch for inventing a term in 1862, which he himself had first proposed in the privately distributed lithographed sheets of 1837! Ever ready with advice and assistance, perfectly free from jealousy, Saint-Venant was a typical scholar. We had occasion, scarcely six months ago, to apply to him for assistance with regard to some of his earlier work. Within a few days we received a packet containing twenty-three of his memoirs, all carefully corrected, and many annotated. He expressed a lively interest in the progress of the "History of the Mathematical Theories of Elasticity," lending the editor of that work several French lithographed courses which were otherwise inaccessible, and accompanying them by letters which amounted almost to a dissertation on the history of elasticity.

"Je desire, bien cher monsieur, que ces quelques renseignements et documents puissent servir à l'utile travail historique que vous avez entrepris, et dont j'apprendrai avec plaisir la publication ainsi que le nom de l'éditeur. J'en verrais même avec plaisir les épreuves."

Shortly before Christmas we received from Saint-Venant corrections for the first three sheets of Dr. Todhunter's ninth chapter, which is devoted to Saint-Venant's earlier work. On January 3 we sent him the remaining proofs of that chapter; a week afterwards we had to mourn the loss of one whose personal kindness had served to intensify the respect raised by his transcendent mathematical ability.

If we examine the leading characteristics of Saint-Venant's scientific work we find them marked by an essentially practical character. We find subtlety of analysis combined always with practical physical conceptions. The problems he attacks are those which are physically possible, or of which the solution is an immediate practical need. He smiles good-naturedly over Lamé's attempts to solve the terrible problem of an elastic solid in the form of a right-six-face, whose surface is subjected to any system of load. The solution would be a triumph of analysis, but its physical and practical value would in all probability be *nil*. He chooses instead a *real* beam, and he obtains a solution which, if it be but approximate, is at least an approximation to reality, and will serve all practical purposes. Saint-Venant never

troubled himself with impossible distributions of load over impossible surfaces, but took the problems of mechanics as they occurred practically, and solved them for practical purposes. This tendency on his part was no doubt greatly due to his training as an engineer. He was Ingénieur-en-chef des Ponts et Chaussées; he had been Professeur de Génie rural à l'Institut agronomique; he had built lock-gates and improved the gutters of Paris; he was an authority on agricultural drainage, and had investigated the best form of the ploughshare; he designed a bridge for the Creuse, and planned a method, afterwards adopted, for drying up the vast marshes of the Sologne. Yet with all this he was a great master of analysis, and knew how to make his analysis fruitful in practice.

It is not our purpose here to give a bibliographical account[1] of Saint-Venant's works; we wish only to sketch the general scope of his researches, and shall confine ourselves to indicating the more important advances he has made in his own peculiar subject—that of elasticity. The first important work by Saint-Venant is the "Cours lithographée" of 1837. This consists of lithographed sheets given to the students of the École des Ponts. A few years previously Vicat had made his crushing attack upon the accepted mathematical—the Bernoulli-Eulerian—theory of beams. Here we find this attack justified and replied to by the introduction of the neglected slide (*glissement*) into the theory, and its application to a number of practical problems. Here, too, we see for the first time the true limit of elasticity expressed by a strain, and not a stress, maximum. This is a correction of the old theory which is of primary practical importance, although the old theory is still to be found in many English practical books, and even in such a theoretical authority as the German Clebsch.

A thorough appreciation of the true relation of theory to practice is evidenced by the following lines, which should be taken to heart by every technical teacher:—

"L'usage des mathématiques cessera de s'attirer des reproches si on le referme dans ses vrais limites. Le calcul pur est simplement un instrument logique tirant des conséquences rigoureuses de prémisses posées et souvent contestables. La mécanique y joint bien quelques principes physiques que l'expérience a mis hors de contestation, mais elle laisse aux expériences particulières le soin de déterminer quelles forces sont en jeu dans chaque cas, et il règne toujours à cet égard plus ou moins d'incertitude qui affecte nécessairement les résultats. Ces résultats ne doivent point être considérés comme les oracles, dictant infailliblement ce que l'on doit décider; ce sont de simples renseignements, comme les dépositions de témoins ou les rapports d'experts dans les affaires judiciaires, mais des renseignements extrêmement précieux et dont on ne doit jamais se priver, car il est extrêmement utile à la détermination que l'on a à prendre, de connaître la solution exacte d'un problème fort rapproché de celui qui est proposé, et de pouvoir se dire, par example, 'si les efforts étaient exactement tels ou tels, les dimensions à donner seraient telles ou telles.' De cette manière le champ de *l'appréciation instinctive* se trouvera réduit aux différences qui ne peuvent pas être le sujet du calcul théorique; et l'on voit que ces deux méthodes, loin de s'exclure, peuvent concourir ensemble, se suppléer et s'aider mutuellement, se contrôler même quelquefois,—enfin contracter sous les auspices du bon sens, une alliance féconde en résultats utiles sous le double rapport de la convenance et de l'économie."

These words represent exactly the spirit with which Saint-Venant entered upon the important investigations of later years. Of other earlier work of Saint-Venant, we may especially note the series of papers in the *Comptes rendus* for 1840-50. These contain the rectification of the theory of elastic rods by the introduction of the third moment in the case of inertial æolotropy in the section,[1] the complete equations for spiral springs, and the first rectification of the theory of torsion by the discovery of the distortion of the primitively plane section. These researches are all epoch-making in the theory of elasticity. To the next decade belong the classical memoirs on "Torsion" and "Flexure," the complete treatment of torsion on the basis of the distortion of the plane sections, and the complete treatment of flexure by the consideration of slide. The beautiful diagrams of the contour lines are known to all students of physics, if not from the original memoirs, at least from the "Treatise on Natural Philosophy" of Thomson and Tait. The very perfect plaster models prepared under the direction of Saint-Venant to illustrate flexure, torsion, and resilience, are less generally known,[2] but for teaching purposes they are of even greater value than the diagrams. In addition to these *opera maxima* we may mention the important researches on impact, belonging to the same period (Société Philomatique, 1853 and 1854). The decade received its final touch in the first volume of Saint-Venant's edition of Navier's "Leçons." This volume presents the first history of elasticity in the brief but luminous "Historique abrégé."

The last period of Saint-Venant's work contains the all-important memoirs on the distribution of elasticity in æolotropic bodies, on the various types of homogeneity, further researches on longitudinal impact, the tract on the undulatory theory of light, the second volume of Navier's "Leçons," the treatise on elasticity in Moigno's "Statique," and, amid a variety of *opuscula*, to crown the work of a life, the annotated edition of Clebsch's "Theorie der Elasticität." The original "Clebsch" contains 420 pages, the annotated translation with a much larger page has more than 900 pages. When will an English elastician arise, who will annotate Saint-Venant as Saint-Venant has annotated Clebsch?

One word more with regard to Saint-Venant's position as an elastician. In England the controversy over the number of elastic constants seems to have been decided in favour of multi-constancy. Saint-Venant was, and remained to his death, a supporter of the French, or rari-constant, hypothesis. The experiments, he argued, upon which the multi-constant elasticians based their theory were not made on truly elastic bodies, or were made upon bodies like wires and plates which are not isotropic. Into his treatment of such bodies he introduced, not the two constants of isotropy, but the constants of a cylindrical or planar distribution of homogeneity. Being written to last September on this point, he replied:—

"Vous voulez bien me demander si je conserve les mêmes opinions que j'ai exprimées et longuement developpées à l'appendix V. de mon édition de Navier, à savoir, la réduction des coefficients des formules d'élasticité à *un seul* (où $\lambda = \mu$ dans les formules de Lamé); ce qui conduit d'après le même principe que chaque action entre deux molecules est fonction de leur seule distance mutuelle, à réduire pour la contexture hétérotrope le plus générale, et à ne reconnaître que 15 coefficients distincts et non pas 21.

"Je reponds *oui* pour les vrais solides (supposés isotropes) comme sont les métaux ordinairement, ainsi que le marbre, le verre; mais *non* si l'on veut absolument par un motif quelconque que je ne conçois guère, appliquer les formules de l'élasticité au caoutchouc, aux gommes molles, aux gelées, et aux autres corps mous et élastiques, car ces corps-là ne sont que des mélanges de tissues cellulaires, de membranes élastiques, et de fluides visqueux que leurs cellules contiennent."

[1] A bibliography of his memoirs relating to elasticity and the strength of materials will be given in the "History of Elasticity." A complete bibliography to 1864 will be found in "Notice sur les travaux . . . de M. de Saint-Venant," Paris, 1864. This is brought up to 1885 with partial completeness in the copy presented to us by Saint-Venant himself.

[1] He shares the honour of this discovery with Bellavitis.

[2] We have a copy of the whole collection at University College.

haps the constant-controversy is not quite so usly settled as some English physicists seem to k. But, however the future may regard it, history will rd that on January 6 of this year died one of the eatest mathematical physicists and undoubtedly the reatest elastician that Europe has seen since the age of Poisson and Cauchy. KARL PEARSON

ON SOME INTERESTING CASES OF MIGRATIONS OF MARINE FISHES, ON THE COAST OF VENEZUELA AT CARÚPANO

CARÚPANO is a thriving seaport on the northern coast of Venezuela, midway between the peninsulas of Araya and Paria, in lat. 10° 14′ 15″ N., and long. 63° 18′ W. from Greenwich, and therefore in close vicinity to the channel which leads from the Atlantic into the Caribbean Sea between Tobago and Grenada on the one side, and Trinidad and the South American mainland on the other side. Through this channel enters the great western current of the Caribbean Sea, running at the rate of about one mile and a half an hour, though not with much regularity. The coast-line forms the western prolongation of the northern shore of Trinidad, trending almost due west. The water is rather shallow to a considerable distance from the land, the 100-fathom line due north of Carúpano being about 60 miles off the shore,[1] which gives for the sea-bottom a gradient of but 1·67 per 1000.[2]

Such are, in a few words, the general hydrographic conditions of that locality, famous in this country for the frequent occurrence of immense shoals of fish of different kinds, which, either alive or dead, are finally thrown by the surf on the beach. The inhabitants call the shoals *ribazones* when the fish arrive alive; in the other case they are called *turbios*, on account of the turbid appearance the sea presents in such circumstances.

Though the *ribazones* may occur at any time of the year, it appears that there is a greater probability of their advent during the rainy season, or from May to November. The weather must be fine, with a moderate breeze from the sea. The shoals are composed of a great many different species; most of the fish are, however, of small size. They are followed by large numbers of predatory denizens of the deep, sharks being generally prominent amongst them. In some cases the presence of whales has been recorded; it is undoubtedly the cachalot (*Catodon macrocephalus*), which occasionally visits the Caribbean Sea.[3] At the same time large flights of sea-gulls accompany the shoal, picking up a considerable number of fish, and, with their deafening shrieks and endless whirls, adding to the picturesque vividness of the scene. Owing to these manifold persecutions the frightened fish make towards the shallow water of the shore in such haste and with such impetuosity that the sea is almost filling with foam for many miles. Most of the fish are still alive when they reach the beach, where the inhabitants, gathered in large crowds, are not slow in securing as many as they are able to carry away. By far the greatest number die on the shore, however, and their remains form a true *cordon littoral*, several feet in width and height, which soon fills the air with a most offensive smell.

The latest *ribazon* occurred on the morning of Oct. 10 last. The shoal seems to have come from the north-west, and was extraordinarily large. It contained such species as the "pargo" (*Lutjanus profundus*, Poey, the same as *Mesoprion aya*, Cuv. and Val.), which, as I am informed, had never been observed in any other *ribazon*. The Royal Mail-steamer *Severn*, going eastward at a speed of about eight miles an hour, was for two hours (from seven to nine in the morning) literally cutting through the shoal, and as she struck its main course at an angle of 45°, approximately, the breadth of the shoal must have been ten miles at least.[1] The shoal finally ran on shore to the east of Carúpano, and such was the quantity of stranded fish, especially between the places called Hernan Vazquez and Guayacan, that the local authorities deemed it necessary to summon a large number of workmen, in order to have trenches dug in which to bury the dead fish.

With respect to the causes of these migrations, I think they cannot differ from those which give rise to the well-known migrations of marine fish in other parts, the search for food being no doubt the most important. The waters of the great western Caribbean current are richer in food than the comparatively quiet part of the sea north of the current. The fish travel, therefore, in this direction, and attract of course a gradually increasing number of their enemies. On the coast of Carúpano the fisheries are insignificant, and thus the shoals are not disturbed in their migrations until they reach the shore. Farther to the west, in the waters of Margarita, the case is different, the large fishery establishments of this island having constantly boats and crews in readiness to intercept the shoals, as soon as their arrival is announced by the fire-and-smoke signals of the look-out men stationed on the different headlands and other places known to be favourably situated. With regard to Carúpano, it is certainly a great pity that the fisheries are so neglected that every year a large amount of what ought to be a rich harvest is lost, and left to turn into noxious and fever-breeding carrion.

The *turbios* are *ribazones* during the arrival of which submarine eruptions of deleterious gases, principally sulphuretted hydrogen, happen to break out, so that the fish are killed before they reach the shore, the water at the same time becoming turbid with the mud from the bottom, which is violently stirred up by the outbreak of the gas. The quantity of the latter must be very considerable indeed, as the foul smell on such occasions is noticed all over land and sea.

Gaseous eruptions of the same nature, as well as sulphurous springs, are not at all uncommon in the neighbourhood of Carúpano; the two *azufrales*, about twenty miles to the south of the town, being the most important.[2] The whole region, in fact, was at the end of the Tertiary period the theatre of a great geological catastrophe, when the Golfo Triste was formed by a sudden subsidence, which was also the origin of the so-called delta of the Orinoco,[3] the Gulf of Cariaco, and the many lagoons in the provinces of Cumaná and Maturin. At the same time extensive tracts of land were submerged to the north of the mountains which run through the whole length of the peninsulas of Araya

1 "Deep-Sea Soundings in the Gulf of Mexico and Caribbean Sea" (Chart No. 21 in *Report* of the U.S. Coast and Geodetic Survey, 1881, Washington, 1883).

2 I take the nautical mile, equal to one-sixtieth part of the length of a degree on the great circle of a sphere whose surface is equal to the surface of the earth = 1853·248m. or 6080·70 feet (J. E. Hilgard, "On the Length of the Nautical Mile," in the *Report* mentioned in the foregoing note, pp. 354-396).

3 There is in the Museo Nacional of Caracas a tooth of this species, from a specimen which was stranded some years ago on the shores of Margarita. I saw myself, in 1873, another whale, but only for about one minute, in the sea between the islands of Tortuga and Margarita. The animal swam with its mouth wide open and the head partially raised above the surface of the water. The upper jaw was small and narrow, so that it certainly was not a cachalot. Though I could not see the back, I supposed then it might be a Balænoptera, perhaps *B. rostrata*. However, I do not know whether this species comes so far to the south.

1 From information given to me by Señor Bastardo, a medical student at our University, who was a passenger on board the *Severn*.

2 Wall and Sawkins, "Report on the Geology of Trinidad," London, 1860, p. 198.

3 The Orinoco has no delta in the true geological sense of this word, as the land comprised between the outer branches of the intricate fluviatile plexus of its mouth has *not* been formed by the river. The southern branch is the old river channel; when the above-mentioned subsidence took place, the land on the left bank sank gradually towards the north, and part of the waters, following the new slope of this northern plane, cut into it the different channels with their connecting branches which, after a slow and tortuous course, empty into the sea between the old mouth of the river and the southern entrance of the Golfo Triste.

and Paria, and thus the Sea of Carúpano was formed. That the South American mainland extended before this catastrophe as far as Grenada, Tobago, and Trinidad, is sufficiently proved by the investigations of Mr. Bland on the land shell fauna of the West Indies, and is moreover corroborated by the comparative shallowness of the sea between the coast of Venezuela and the islands mentioned. Tobago is still within the 100-fathom line, and a rise of the sea-bottom of no more than 400 fathoms would be sufficient to re-establish the terrestrial connection with Grenada.[1]

It is self-evident that an immense quantity of organic matter must have been buried with the sunken land. This organic matter contributes to the formation of sulphuretted hydrogen, and is the stratum which feeds the submarine petroleum springs on the coast of Barcelona; whilst in those parts which afterwards were again lifted above the surface of the sea, it appears in the extensive deposits of asphalt known in Trinidad and Maturin, and performs an active part in the generation of the sulphurous vapours of the *azufrales*.

If we consider what a large quantity of fish-remains must gradually accumulate in the shallow waters on the coast of Carúpano, where they are slowly covered by successive layers of finely-sifted sediment, we are enabled to understand how other deposits of a similar character, for instance, that of Monte Bolca, have been formed in bygone ages; indeed, Carúpano will, in time, be another Monte Bolca to the palæontologist of the Coming Race.

Caracas University, October 22 A. ERNST

KILIMA-NJARO[2]

THE rapid progress of African exploration during the last quarter of a century is strikingly exemplified in the brief history of the monarch of African Mountains. Doubtfully alluded to as the "Ethiopian Mount Olympus" by Enciso in the sixteenth century, and absolutely unknown to science before its discovery by Rebmann in 1848, it has already since that year been several times visited, partly explored, and even ascended to heights of 10,000 and 14,000 feet by Baron von der Decken in 1861-62, by the Rev. Charles New in 1871, and by Mr. Joseph Thomson on his memorable journey "Through Masai Land" in 1883. And the work of these pioneers has now been all but completed by Mr. Johnston, who was early in 1884 specially commissioned by the Royal Society and the British Association to study the interesting fauna and flora of the Kilima-Njaro uplands. During the six months from May to October of that year, passed by him on their southern and eastern slopes, this experienced African traveller has succeeded under great difficulty in collecting abundant materials for illustrating the natural history and physical constitution of the "Mountain of the Snow Fiend," as its euphonious Ki-Swahili name is interpreted. These results are embodied in the work before us, which is alike admirable for its bright and graphic style, and the judicious arrangement of its varied contents. By the simple plan, consistently adhered to throughout, of treating the narrative portion separately, and confining the strictly scientific matter to the concluding chapters, all tastes are consulted, and the common mistake is avoided of sacrificing the interests of the student to those of the general reader.

The few months to which the expedition was limited were passed partly at the station of Kitimbiriu in the Moshi territory ruled over by King Mandara, partly in the more easterly district of Marangu. Both of these tracts are included in the Chaga country, which occupies all the southern slope, which however, as now app does not constitute a single kingdom under Man but comprises a considerable number of petty Ba States, mostly mutually hostile, and seldom combin except to resist the attacks of the common Masai enem Mandara, who had hitherto figured in the history of recen East African exploration as a doughty warrior scarcely second in importance to Mirambo himself, thus sinks to the position of a mere triton amongst the minnows, though still powerful enough to be troublesome, and enjoying a somewhat widespread reputation, if not for personal courage, at least for political sagacity.

As shown in the annexed cut (Fig. 1) the aspect of Kilima-Njaro seen from above Moshi is that of a single snow-capped dome towering to a height of nearly 19,000 feet above the bare or grassy upper slopes, and clothed lower down with a dense and varied tropical vegetation. But when viewed from Lake Jipé, a point lying nearer its base towards the south-east, it appears in its true character of a double-crested snowy mass, in this as in some other respects presenting a remarkable resemblance to the Armenian Ararat. Mr. Johnston, who made two ascents, first from Moshi to a height of 9000 feet, and again from Marangu to about the normal snow-line (16,315 feet, or within a little more than 2000 of the summit, calculated the altitudes of the two peaks, Kibô and Kimawenzi, at 18,800 and 16,250 feet respectively. This only slightly exceeds von der Decken's estimate, who assigns 18,700 feet to Kibô, so that the absolute altitude of the probable culminating point of the continent may be taken at somewhat under 19,000. On the lofty connecting ridge clumps of forest were found still straggling up to 10,000 feet. Many bright-coloured flowers also grew up to this altitude, "notably a vivid blue cynoglossum (houndstongue), mauve and blue irises, and pink, waxy-white, and yellow everlastings. Tufts of artemisia (southernwood) grew in sheltered places. There were many heaths, a small kind of geranium, huge proteas, and divers ferns and mosses" (p. 235). Even at 12,600 feet strange sessile thistles were met, nearly five feet in circumference, besides an extraordinary lobelia (*L. Deckeni*) three to four feet in height, and a very characteristic arborescent plant new to science, and since named *Senecio Johnstoni* (Fig. 2), "looking somewhat like a banana in the distance, but in reality consisting of a tall, black, smooth trunk, 20 to 30 feet in height, and surmounted by a huge crown of broad leaves interspersed or headed up with bunches of yellow blossom. The strange composite grew abundantly in the streamlet's bed, and its trunk was so superficially rooted that, in spite of its height and girth, I could pull it down with one hand" (p. 268).

Beyond 13,000 feet vegetation became stunted and patchy, ceasing altogether about the altitude of 15,000 feet. The last resident bird, a kind of stone-chat (*Pinarochroa hypospodia*) was met in flocks, and showing a total absen of fear, up to 13,700 feet, beyond which no bird was see except a rare high soaring kite, or great-billed raven. Yet such large game as the elephant, buffalo, and antelope are pursued by the natives up to altitudes of 12,000 and 13,000 feet, and captured chiefly by pitfalls. In the Bura district, east of Kilima-Njaro, the *Alcelaphus cokei*, a species of hartebeest, or tall red antelope, was seen associated by a sort of unconscious symbiosis with tall red ant-hills, and deriving some protection from their almost ludicrous resemblance to these objects. "Being a deep red-brown colour, and standing one by one stock-still at the approach of the caravan, it was really most difficult and puzzling sometimes to know which was antelope and which was ant-hill; for the long grass hiding the animal's legs left merely a red-humped mass, which until it moved, might well be the mound of red earth constructed by the white termites. The unconscious mimicry was rendered the

1 See the chart quoted in the first note.

2 "The Kilima-Njaro Expedition, a Record of Scientific Exploration in Eastern Equatorial Africa." By H. H. Johnston, F.Z.S. (London: Kegan Paul, 1886.)

more ludicrously exact sometimes by the sharply-pointed, flag-like leaves of a kind of squill—a liliaceous plant—which frequently crowned the summit of the ant-hill or grew at its base, thus suggesting the horns of an antelope either with the head erect or browsing low down. The assimilation cannot have been fancied on my part, for it deceived even the sharp eyes of my men; and again and again a hartebeest would start into motion at twenty yards' distance and gallop off, while I was patiently stalking an ant-hill, and crawling on my stomach through thorns and aloes, only to find the supposed antelope an irregular mass of red clay" (p. 65).

Amongst the valuable animal specimens secured by our naturalist was one of the new and beautiful species of Colobus (*C. guereza*, Rüpp., var. *caudatus*, var. nov., Fig. 4) first seen and described by Mr. Thomson, which

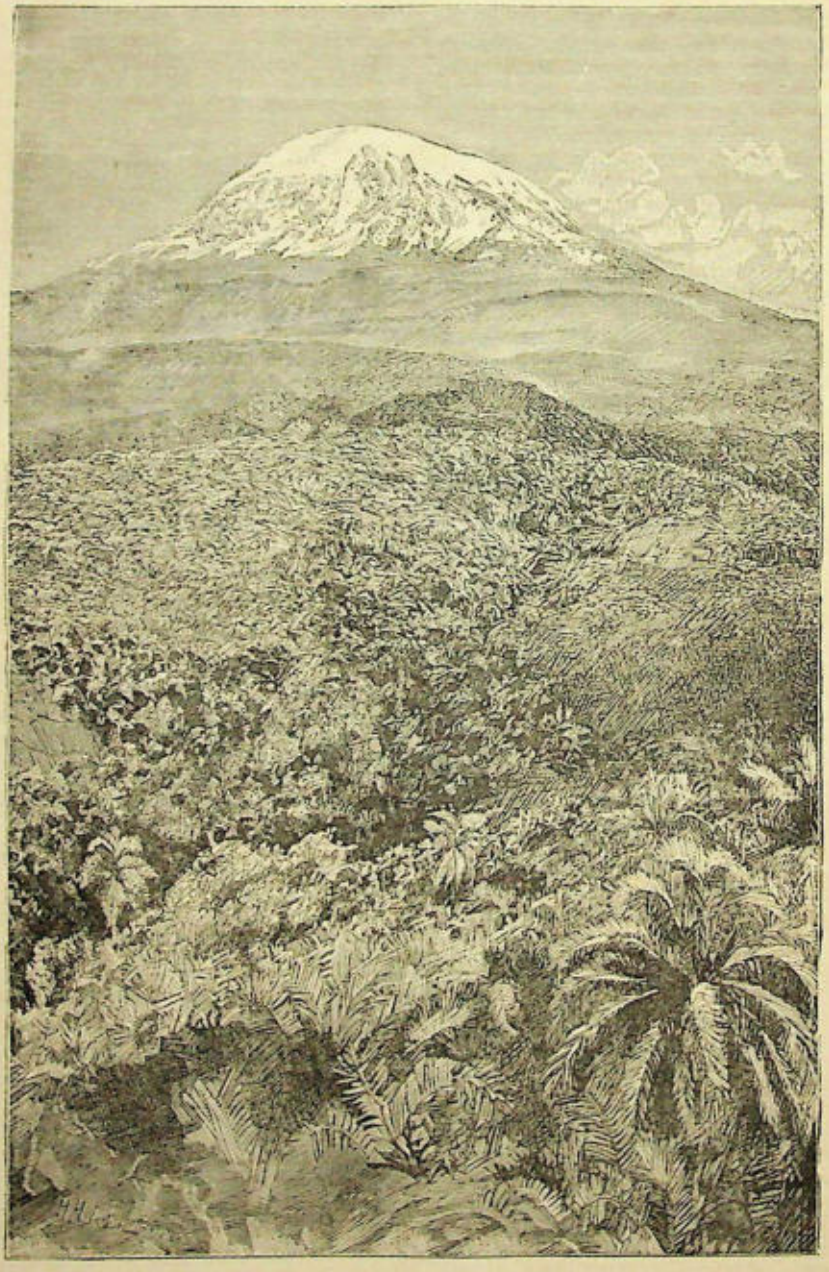


Fig. 1.—Kilima-Njaro seen from above Moshi ("Palms and Snow").

frequents the base of Kilima-Njaro, and is apparently restricted to that region. Mr. Oldfield Thomas, who contributes an important paper on the mammals obtained during the expedition, tells us that it is "characterised by having the white brush of the tail very much larger and finer than is the case in the true Abyssinian *C. guereza*. . . . The hairs of the white body-mantle, entirely cover the black at the base of the tail, the white of the latter and of the mantle being quite continuous" (p. 388).

Besides this paper by Mr. Thomas the work is enriched with several others by specialists, such as Prof. Bonney, who deals with a collection of rocks (mainly igneous) from the higher regions of Kilima-Njaro; Prof. Oliver and Mr. J. G. Baker, to whom botanists will be grateful for a careful enumeration of all the plants collected during

the expedition; Mr. F. D. Godman who classifies sixty-one specimens of Lepidoptera, including at least three new species; Charles O. Waterhouse, by whom examples of fifty-six Coleoptera are similarly treated; Captain G. E. Shelley, who jointly with the author gives a descriptive catalogue of fifty species of birds, of which six are new to science, collected or observed in the district; Mr. E. J. Miers, who describes a new variety of river-crab of the genus Thelphusa doubtfully assigned to the species *T. depressa*, Krauss.

But of all the scientific papers by far the most important are the two chapters contributed by Mr. Johnston himself on the anthropology and philolgoy of the Kilima-Njaro district, or rather of all the East Central African region lying between the great lakes and the Indian Ocean. Measured by a pecuniary standard, it is not too much to say that these two monographs alone are fully worth the 1000*l.* granted by the British Association and Royal Society for the purposes of the expedition. Besides a graphic account of the Bantu and Masai peoples, whose respective domains are conterminous, or overlap each other in this part of the continent, we have here a general disquisition on their mutual ethnical and linguistic



Fig. 2.—*Senecio Johnstoni*.

relations, which fills up at least one great gap in the field of African anthropology. The mystery hitherto surrounding the Masai race is at last largely dissipated, and we are now enabled with some confidence to assign them their true place in the African family. A careful comparative study of their language and physical type clearly shows that their affinities are to be sought amongst the Negro or Negroid peoples of the White Nile, and more particularly the warlike Bari nation of the Gondokoro district. From this basin they appear to have gradually spread in comparatively recent times south-eastwards between the Victoria Nyanza and the coast, encroaching to the east on the Hamitic Gallas, to the south on the Wa-taita, the Wa-chaga, and other outlying branches of the Bantu family. The annexed graphic illustration of a Masai warrior (Fig. 3) betrays some unmistakable Negro features, especially in the short nose, broad nostrils, and thick lips standing wide apart. On the other hand, the close relationship of the Masai and Bari languages is here clearly established, one of the most striking features common to both being true grammatical gender, as indeed had already been pointed out by Lepsius in his Nubian Grammar. Masai must consequently now be separated from the Nuba group, as the Nuba has already been separated from the Fulah of Western Sudan; and thus there is at last an end of Friedrich Müller's "Nuba-Fulah family," which has hitherto figured so largely in treatises on African philology. Its place is taken in East Central Africa by the Bari-Masai group, which Mr. Johnston now proposes to constitute, and which includes, as intervening members, Latuka certainly, Lango, Sûk, and Samburu more doubtfully.



Fig. 3.—A Masai Warrior.

It will be seen that the rich linguistic data here brought together cannot be neglected by the future student of African philology. The patience and ingenuity expended in the collection of this material is aptly illustrated in the account given of a hunt after a single grammatical element of the Ki-Chaga language current throughout the southern districts of Kilima-Njaro. The object is to determine the exact form of the eighth pronominal prefix

(a plural one), of which fifteen altogether are represented in this member of the Bantu family. But "unfortunately I cannot ask any of my friends, 'What is your eighth prefix?' I should never be understood if I explained for a hundred years. I have to get at it in some other way. 'What is this?' I ask, holding up a knife. 'Ki-osho,' they reply. 'Just so,' I replied; 'ki' is the seventh prefix, and the plural must give the form of the eighth. 'How do you say many knives,' I continue; 'ki-osho is *one*; what is many?' 'Shingi' (many), they reply. 'No, but many knives?' 'Shingi' is again repeated. Then I ask, 'See, this is one knife—*ki-osho kimo* (holding up one finger). What is for *two* knives?' (holding up two fingers). 'Two fingers,' they reply, looking up very much puzzled. Then in despair I send for another knife, and placing it beside the original one, again ply them with a question. This only elicits the word for 'another'; but at length after many disappointments they are induced to say *shi-osho shivi* (*two knives*), which gives me *shi-osho* as the plural of *ki-osho*, and consequently *shi* is the form of the eighth prefix, and so on" (p. 162). Of course all travellers amongst the lower races are familiar with difficulties of this sort. But it is not every traveller who during the off hours of a six months' expedition contrives to collect sufficient linguistic materials to reconstitute the philology of a continent.

Mr. Johnston, who is also an accomplished artist, has added much to the value of his work by the numerous illustrations with which he has enriched this handsome volume. His skill especially in portraying animal and



FIG. 4.—*Colobus guereza*, var. *caudatus*.

vegetable forms is sufficiently attested by the specimens here adduced. He also supplies a copious index, as well as carefully prepared route and linguistic charts, besides a large map brought well up to date of Eastern Equatorial Africa between the parallels of 1° N. and 6° S. It remains to be stated that in this notice the somewhat unfamiliar orthographic system of Lepsius, adopted by the author, has been replaced by the usual and sufficiently accurate method adhered to by Stanley, Thomson, and most other English travellers in Central Africa. To the writer it seems that the plan of combining the English consonantal with the Italian vocalic system adapts itself fairly well to the transliteration of most African (Negro) and especially of the Bantu languages. A. H. KEANE

NOTES

LORD ROSEBERY has endowed a new lectureship in the University of Edinburgh. The course, which will extend over five years, will consist of thirty lectures on the Philosophy of Natural History. The lectureship has been offered to, and accepted by, Mr. G. J. Romanes, M.A., LL.D., F.R.S. This is the second lectureship which has recently been founded in connection with the Chair of Natural History. The other one is on Comparative Embryology, and is occupied by Mr. G. Brook, F.L.S.

AN important discovery has been made by Dr. O. Tumlirz, of Prague. Hitherto no substance amongst those which exhibit diamagnetic properties has been observed to possess any per-

manent diamagnetic polarity analogous to the permanent paramagnetic polarity of hard steel. The property of retention of diamagnetisation is, however, found to be possessed by rock crystal. Both those specimens which show right-handed and left-handed optical properties are alike in this respect, and the axis of diamagnetisation appears to be independent of the crystallographic axis, and dependent only on the axis of initial magnetisation. Dr. Tumlirz, whose investigation is published in *Wiedemann's Annalen*, appears to think that these facts negative Becquerel's theory of diamagnetism.

We regret to announce the death of Dr. Oskar Schmidt, the eminent Professor of Zoology at Strasburg University; he died on the 17th ult. Also of Dr. Nikolaus Friedrich von Tschudi, the well-known author of the "Thierleben der Alpenwelt." He died at Melonenhof, near St. Gallen, aged sixty-five years.

M. Faye has been appointed President of the Bureau des Longitudes for 1886.

Dr. W. H. Stone will deliver the Lumleian Lectures this year on April 8, 13, and 15, the subject being "The Electrical Conditions of the Human Body."

Two young persons, natives of the central part of Paraguay, are being exhibited at the Westminster Aquarium possessing an abnormal development of hair on the body, a condition to which the term hypertrichosis is applied. One of these is a girl of about eighteen years of age; the other, her brother, aged six years. In the former the whole of the back is covered with hair about one centimetre in length, which extends in the region of the waist to the anterior surface of the body. In addition to this continuous tract of hair there are numerous small patches of varying size distributed irregularly over the face, trunk, and extremities. In the boy the hair tract on the back begins immediately below the level of the lower angles of the scapulæ and extends downwards on the body and extremities almost to the bend of the knees. There are likewise on the body several patches covered with hair, the largest of which is about the size of the palm of the hand, and situated on the front of the thigh; the other patches vary in size from about one to two centimetres in diameter. Contrary to what might have been expected, there is no development of hair in the mesial line of the body in front, or on the cheeks, chin, or upper lip, as is sometimes seen in such cases. In both cases the skin is deeply pigmented, of a dark brown hue wherever the abnormal hair is developed, and on the back of the girl and outer side of the thigh of the boy there is a large and partially filled cist present immediately below the skin. The cist on the boy's thigh seems to be entirely unconnected with the bursa over the trochanter of the femur with which it might be imagined it had some connection. In the family history there is nothing to account for the occurrence of the abnormal condition presented by these two members of the family. The parents are in all respects reported to be normal, as are the other members of their family, which consists of four children in all. In no other respect do the two abnormal members of the family present any peculiarity, such, for example, as in the growth of the teeth, which is not unfrequently found to accompany extra development of hair. Cases of this kind occasionally occur in different parts of the world. The hairy family from Burmah has been the subject of several notices some years ago, and more recently a child from the same country was exhibited at the Aquarium. Several other cases have been recorded, however, occurring in Russia and different parts of America, and other places. The hair sometimes occurs universally spread over the body, when the term *hypertrichosis universalis* is applied to it, or in patches more or less extensive, *hypertrichosis partialis*, as in the present instances.

One of the most appreciated organs of French anthropology, the *Revue d'Anthropologie* of Paris, founded in 1872 by Paul Broca, and continued since the death of that distinguished *savant* by Dr. Paul Topinard, inaugurates the third series this year with the co-operation of the most distinguished representatives of the various branches of anthropological science. Amongst these we notice the names of Dr. Gevarret, Director of the Ecole d'Anthropologie; Dr. Mathias Duval, Director of the Laboratoire d'Anthropologie de l'École des Hautes Études; the Marquis de Nadaillac, whose works on prehistoric archæology have been translated into several languages; Gen. Faidherbe, Great Chancellor of the Légion d'Honneur, and well-known for his philological works; Prof. de Quatrefages; Dr. Hamy and Louis Rousselet, who highly represent ethnography; Baron Larrey; Jules Rochard, of the Medical Service of the French Navy; D'Arbois de Jubainville, of the Institute; and several others. The editorship of the *Revue* will be retained by Dr. Paul Topinard, the General Secretary of the Anthropological Society of Paris, and author of the "Éléments d'Anthropologie," a work to which we recently called the attention of our readers, and for which we are glad to learn the author has been awarded one of the annual prizes of the Académie des Sciences.

The first Report upon the Fauna of Liverpool Bay and the Neighbouring Seas, written by the members of the Liverpool Marine Biology Committee, and edited by Prof. W. A. Herdman, D.Sc., will be published during the present month, in the form of an octavo volume of about 300 pages, illustrated by six plates and a map.

An exploring expedition was to start from Tiflis on the 2nd inst., with the object of thoroughly investigating the natural history of Khorassan. It will be under the direction of Dr. Radde, who will take charge of the botanical department and of the zoology of the higher animals. Dr. Walter, who was lately assistant to Prof. Haeckel at Jena, will have charge of the lower animals. M. Kontjin will be the geologist, and two general assistants will complete the scientific portion of the expedition. It is hoped that their work will be finished by the end of August. A number of specialists will be charged with the task of examining and describing the collections with a view to publication; and it has been already arranged that Dr. Boettger, of Frankfort, will deal with the mollusca, M. Strauch, of St. Petersburg, with the reptiles and amphibia, and Dr. Radde with the birds. It is understood that the Emperor has expressed a strong personal interest in the expedition.

The Parisian authorities systematically liquefy the snow with salt, except on macadamised streets (where the process causes disaggregation of the stones). This practice has obtained since 1881. Rock-salt is used, costing in Paris about 31 francs a ton. Large quantities are stored in the beginning of winter at different places, and when a snowfall occurs a number of workmen repair to these, and each fills a barrow, and takes it to sprinkle on that part of the streets assigned to him. The salt produces its full effect only when the passage of vehicles has mixed it sufficiently with the snow. In two or three hours liquefaction is so far advanced as to allow of the streets being swept. The salt is little used on pavements. Paris spent about 220,000 francs on the fall of snow of December 8 to 10 last; the thickness of the layer varied from 2½ to 4 inches. The quantity of salt used was about 125 grammes on an average per square metre; the cost of it was only about an eighth of the total expense (sweeping cost 3 to 4 centimes per square metre). The employment of salt in the way indicated is found to effect a considerable economy on previous methods.

Some experiments on a large butcher's dog, with reference to the effects of sundry beverages on digestion, have been recently

described by Signor Ogata (*Archiv fur Hygiene*). The observations were made by means of a stomachal fistula (quite healed); the dog was fed on horse-flesh and fibrin from ox blood. The following conclusions (which may not be strictly applicable to man, accustomed to the drinks named) were reached:—(1) Water, water containing carbonic acid, tea and coffee in moderate amount, do not disturb digestion. (2) Beer, wine, and brandy retard digestion considerably at first, till absorbed; and in the case of beer, the extractive matters act thus as well as the alcohol. Thus beer retards digestion more than wine containing the same quantity of alcohol. (3) Sugar (cane and grape) retards digestion considerably. (4) Common salt accelerates it distinctly.

We have received the report of the administration of the Museum of Science and Art at Dresden for the years 1882 and 1883, which has only just been issued. It contains nothing calling for especial note. The various scientific collections in the anthropological, zoological, prehistoric, and geological departments were largely increased during the two years by purchase, and specially by donations from private individuals, mainly travellers, or Germans residing abroad.

[illegible] the afternoon of the 29th ult. a strong shock of earthquake [illegible] felt at Velez Malaga, which suffered so severely in the earthquakes of December 1884. The town is reported to have suffered little damage, although no precise details have yet been received.

On January 29 earthquakes were again noticed at M'sila, Bordj ben Arendj, and Setif, Algeria, the site of previous commotions, but no accidents are reported, although the shocks are said to have been strong.

Dr. F. J. Hicks writes from Madeira, on January 28, that in the previous week a sharp little shock of earthquake occurred on the island.

A telegram from Mexico states that the Colima volcano continues in active eruption.

The last, or December, number of the *Journal* of the Royal Microscopical Society has a new feature, in the form of portraits of a number of past presidents of the Society; Sir Richard Owen, the first president of the Microscopic (1840-41), and Mr. James Glaisher, the first president of the Royal Microscopical Society (1865-66, 1867-68), have full-page illustrations; the two other plates contain eight vignettes each; on one (1842-57) we have, among others, Dr. Fane, Mr. Busk, and the lately deceased Dr. Carpenter, and on the other Mr. J. B. Reade, Mr. Quekett, and Mr. Sorby. Many, if not indeed all, of the photographs are excellent likenesses. We understand that it is the intention of the Society to publish other similar photographs from time to time.

The so-called wines sent to the Parisian market of late years have been to a large extent, it is well known, vile concoctions, not deserving the name of wine, and a movement is now on foot for replacing such false wine by true cider. The year 1885 has been exceptionally favourable for such an experiment; the crop of apples was so abundant in Normandy and Brittany that growers were obliged to dispose of their products at low prices. Enormous quantities have been sent to Paris to be transformed into cider. It is to be hoped that this new development may check the great falsification of wine.

On January 21 the exhibition of ethnological and natural history objects collected by Dr. Otto Finch, in his travels undertaken at the request of the New Guinea Society, was opened at the Berlin Ethnographical Museum. Dr. Finch himself gave the necessary explanations to the assembly. The objects were all collected in parts never before visited by Europeans. The collection contains numerous face-casts of the various New Guinea tribes and those of the adjacent island, as well as a large number of water-colour drawings of scenes in the new German colonies.

"H. I. M." writes to the *Times* under date Bratton Fleming, Barnstaple, January 28:—"As I was driving near Barnstaple yesterday evening with a friend, we noticed a most remarkable meteor. While we were ascending a hillside, we suddenly became aware of a brilliant light to our side and rather behind us, from over the hill-top. I thought for the moment that it was a flash of lightning, but on looking up we caught a glimpse of the most beautiful meteor I had ever seen. It seemed to be quite close, and described a path like that taken by a stone in falling when flung horizontally from a tower. It appeared (at its distance) to have a diameter of about 6 inches, and was accompanied by a tail of a smoky consistency, rather of the shape of an elongated open fan with the ends rounded, which followed it, altering its position from a horizontal to a vertical one as the body fell. This tail was, I should say, one and a half times as long as the meteor's diameter, and was of a much paler hue and less dense consistency than the meteor, which was of a most glorious yet rather pale emerald green, with a yellow flame, as it seemed, playing all over it; the tail was of the same tint, only in a less intense degree. It may be of interest to any who may have seen it, that the time we saw it was 27 minutes past 7 o'clock."

Elaborate preparations are being made at the fishery of the National Fish-Culture Association at Delaford Park for receiving the fry which are now rapidly becoming incubated at the hatchery in South Kensington, special habitats being constructed for them. The whitefish ova that arrived from America last week commenced to hatch out immediately they were placed in the apparatus; indeed, many came to life during the voyage. Unlike other fry, they never rest, but move rapidly hither and thither, their powers of locomotion being marvellous considering their present alevin stage. Further consignments of eggs are on their way from the American Government, who are doing their utmost to aid fish-culture in this country. The fish reared at the Delaford Fishery last year will shortly be ready for distribution. The stock is extensive and valuable, including *S. schago*, *S. fontinalis*, *S. ferox*, *S. fario*, *S. trutta*, and *S. iridens*.

A closer investigation of the fish-fauna of Lake Balkhash permits M. Nikolsky to arrive at the following interesting conclusions (*Memoirs* of St. Petersburg Soc. of Natur., xvi. 1). The fauna numbers fourteen species, partly described by the late Prof. Kessler (*Perca schrenckii*, *Phoxinus laevis*, var. *balchaschana*, *P. poljakowi*, *Barbus platyrostris*, *Schizothorax argentatus* and *orientalis*, *Diptychus dybowskii*, *Diplophysa strauchii*, *labiata*, and *kungessana*), and three more *Schizothorax*, of which one new one has been described by M. Nikolsky as *S. kolpakowskii*. Of these fourteen species, only one is not new, and none of them has been found either in the Aral-Caspian basin or in the system of the Obi; on the contrary, the fish-fauna of Lake Balkhash is closely akin to that of the lakes of high Central Asia. In both, the Cyprinidæ and Cobitidæ are predominating: four genera of the former are found exclusively in Lake Balkhash and the Central Asian lakes, as also the species of *Diplophysa*. More than that, the *Schizothorax tarimi*, the *S. aksaensis*, and the *Diplophysa strauchii*, which were found by M. Nikolsky in the Ili River, are common to both the Balkhash and the Lob-nor. Only three species distinguish the Balkhash fauna from that of the Central Asian lakes, and make it approach that of the Obi: the *Perca schrenckii*, which, however, differs more from the European and Siberian species than this last differs from the American *P. stizostedium* (which, in fact,

might be considered as a mere variety), and the *Phoxinus poljakowi*, which is nearly akin to the *Ph. lævis* of the Obi and North-East Europe. From these facts M. Nikolsky concludes that if a direct communication between Lake Balkash and Lake Aral has ever existed—that is, if a marine basin ever covered once the three depressions of the Alatau, the Aral-Caspian, and Siberian—the former was separated from the two latter at a much earlier period than the time when, at least, a fluviatile connection between the Aral-Caspian and the Siberian Ocean had ceased to exist. The separation must have taken place earlier than the separation of the two continents of Asia and America. If a connection existed between the Balkhash and the Irtish during the Post-Tertiary period, it could be only by means of shallow streams where the *Phoxini* could live. On the contrary, the Balkhash and the Lob-nor remained connected after the above separation took place. The connection was carried on through Kunges, the Yuldus, and Tarim. The limits of this basin can be easily determined.

MESSRS. SWAN SONNENSCHEIN AND CO. will publish in a few days a "Tourist's Guide to the Flora of the Alps," translated from the German of Prof. Dalla-Torre, and issued under the auspices of the German and Austrian Alpine Club of Vienna. The volume will appear in the form of a handy pocket-book.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius* ♂) from South Africa, a Malbrouck Monkey (*Cercopithecus cynosurus* ♀) from West Africa, presented by Lieut.-Gen. G. W. A. Higginson, C.B.; a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Mrs. J. J. Buchanan; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. H. M. Sharratt; a Common Badger (*Meles taxus* ♂), British, presented by the Hon. Walter de Rothschild; four Moorhens (*Gallinula chloropus*), British, presented by Mr. T. E. Gunn; three Gold Pheasants (*Thaumalea picta* ♂ ♂ ♂) from China, presented by Mr. A. Heywood, F.Z.S.; a Hygian Snake (*Elaps hygiæ*), a Hoary Snake (*Coronella cana*), a Crossed Snake (*Psammophis crucifer*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Great Cyclodus (*Cyclodus gigas*), two Stump-tailed Lizards (*Trachydosaurus rugosus*) a Diamond Snake (*Morelia spilotes*) from Australia, received in exchange.

OUR ASTRONOMICAL COLUMN

PHOTOGRAPHIC EVIDENCE AS TO THE CONSTITUTION OF SUNSPOTS.—M. Janssen, remarking on some exquisite photographs of sunspots which he has obtained during the past year, calls attention to the evidence they supply as to the continuation of the granulation of the general solar surface into the spots. A photograph of the great spot of 1885, June 22, for example, to which he particularly alludes, shows that the bright region which surrounds the penumbræ of large spots has not a different constitution from that of the photosphere in general, since it is made up in like manner of granular elements, usually of a spherical form. The marked increase in brightness of such regions the photographs show to be due to the granulations being more thickly clustered, brighter in themselves, and arranged on a brighter background. In the penumbra the granulations are still distinguishable, but they are less luminous and more scattered, leaving dark gaps between the rows of grains, the familiar striated appearance of the penumbra being due to the arrangement of the granulations in ranks and lines, like beads on a thread. The grains become in general smaller and duller near the nucleus, where they seem to dissolve. The same spot presented two very remarkable bridges, and a very bright isolated mass of luminous matter which united them. This luminous matter and the bridges were also formed of granular elements resembling the others. Many other photographs have revealed a similar structure in penumbræ and their surroundings, so that it is highly probable that "the luminous matter which forms the solar surface has everywhere the same constitution."

THE STRUCTURE OF THE SOLAR ENVELOPE.—A somewhat lengthy paper by M. Trouvelot, on the above subject, originally published in the *Bulletin Astronomique* for June, August, and September last, has recently appeared. The first part of the paper consists of a *résumé* of a number of striking and typical observations which are illustrated in the plate which accompanies it. These observations principally relate to spots of irregular and complicated form; the most remarkable being those in which M. Trouvelot describes the formation of numbers of bright white points over sunspots, like "a fall of snow," sometimes even obliterating them, the formation of purple vapours in connection with both spots and prominences, and the apparent changes and sometimes complete concealment of spots occasionally produced by faculæ. The essentially granular appearance of the sun, so well brought out in M. Janssen's photographs, has by no means escaped M. Trouvelot's notice, and he has even seen the lines C D_1 D_2 b_1 b_2 b_3 and F as themselves granulated, *i.e.* not uniformly dark, but composed of a great number of whitish points separated by dark intervals. The latter part of the paper is occupied with inferences as to the constitution of the solar envelope resulting from a consideration of these observations. The theory formed resembles in its essential characteristics that so admirably set forth by Prof. Young in his book on the sun. The sun is surrounded by a shell relatively very shallow, made up of innumerable vertical filaments due to the condensation of metallic vapours, and which M. Trouvelot proposes to call the *nematosphere*, in distinction to the photosphere, the glo[illegible] summits of these filaments. The behaviour of these filat[illegible] under various circumstances is discussed, and the varying effect[illegible] upon them of hydrogen and metallic eruptions from the solar nucleus below of different degrees of violence is made to account for the varied phenomena of spots, faculæ, and prominences. The brilliance of the photosphere is regarded as due to the high radiating powers of these metallic vapours, when on arriving at the surface of the sun they are condensed, partly from the effect of exposure to the cold of space, and partly from expansion, the granulations being glowing clouds composed of these condensed metallic vapours, the summits of these filaments or columns.

M. Trouvelot expressly contradicts the frequently-made assertion that the bright D_3 line of the chromosphere has no counterpart amongst the dark lines of the spectrum of the disk; the line is indeed an exceedingly fine one, but it is unmistakably present.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 FEBRUARY 7-13

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 7

Sun rises, 7h. 30m.; souths, 12h. 14m. 22·8s.; sets, 16h. 58m.; decl. on meridian, 15° 14′ S.: Sidereal Time at Sunset, 2h. 9m.

Moon (at First Quarter on Feb. 12) rises, 8h. 47m.; souths, 14h. 39m.; sets, 20h. 41m.; decl. on meridian, 2° 12′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 14	11 26	15 38	20 30 S.
Venus	7 20	13 11	19 2	2 42 S.
Mars	20 4*	2 37	9 10	5 51 N.
Jupiter	21 14*	3 14	9 14	0 50 S.
Saturn	12 46	20 57	5 8*	22 41 N.

The planet Venus is now very near to inferior conjunction.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon

Feb.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image °
10	B.A.C. 741	6½	18 6	19 12	157 286
12	48 Tauri	6	20 40	21 40	93 347
12	γ Tauri	4	22 45	23 47	128 323
13	71 Tauri	6	1 43	2 25	95 345

Phenomena of Jupiter's Satellites

Feb.	h.	m.		Feb.	h.	m.	
7 ...	0	0	I. ecl. disap.	10 ...	2	17	III. ecl. disap.
7 ...	0	38	II. tr. egr.	10 ...	5	11	III. ecl. reap.
7 ...	3	8	I. occ. reap.	10 ...	5	40	III. occ. disap.
7 ...	22	3	I. tr. ing.	12 ...	3	43	II. ecl. disap.
8 ...	0	18	I. tr. egr.	13 ...	5	23	I. tr. ing.
8 ...	21	34	I. occ. reap.	13 ...	22	3	III. tr. egr.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, February 7. Outer major axis of outer ring = 45″·0; outer minor axis of outer ring = 20″·1; southern surface visible.

Feb.	h.	
7 ...	6 ...	Mars at greatest distance from the Sun.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h.	m.	
U Cephei	0 52·2	81 16 N.	Feb. 11,	22	19	*m*
Algol	3 0·8	40 31 N.	,, 8,	21	42	*m*
			,, 11,	18	31	*m*
λ Tauri	3 54·4	12 10 N.	,, 10,	23	51	*m*
W Virginis	13 20·2	2 47 S.	,, 8,	0	0	*M*
δ Libræ	14 54·9	8 4 S.	,, 11,	23	54	*m*
U Coronæ	15 13·6	32 4 N.	,, 13,	3	5	*m*
S Serpentis	15 16·3	14 43 N.	,, 8,			*M*
[illegible]hiuchi	17 10·8	1 20 N.	,, 8,	14	0	*m*
		and at intervals of	20	8		
[illegible]e	18 45·9	33 14 N.	Feb. 11,	9	30	*M*
[illegible] Lyræ	18 51·6	43 48 N.	,, 10,			*m*
δ Cephei	22 24·9	57 50 N.	,, 7,	21	30	*m*
			,, 13,	7	0	*m*

M signifies maximum; *m* minimum.

Meteors

There are no important periodical showers at this season of the year. The following are amongst the principal radiants from which meteors may be expected:—Near Capella, R.A. 75°, Decl. 44° N.; three radiants in Ursa Major, R.A. 131°, Decl. 52° N., R.A. 180°, Decl. 56° N., and R.A. 210°, Decl. 53° N.; one from Corona Borealis, R.A. 226°, Decl. 30°; near β Herculis, R.A. 260°, Decl. 0°. February 10 is a fireball date.

Stars with Remarkable Spectra

Name of Star	R.A. 1886·0 h. m. s.	Decl. 1886·0 ° ′	Type of spectrum
72 Schjellerup ...	6 3 49	26 2·1 N.	IV.
η Geminorum ...	6 8 0	22 32·4 N.	III.
μ Geminorum ...	6 16 3	22 37·5 N.	III.
78 Schjellerup ...	6 28 42	38 32·2 N.	IV.
LL 13412	6 49 12	23 46·8 S.	Bright lines
51 Geminorum ...	7 6 49	16 21·2 N.	III.
115 Schjellerup ...	8 48 57	17 39·9 N.	IV.
120 Schjellerup ...	9 3 46	31 25·7 N.	III.
R Leo Minor ...	9 38 45	35 2·1 N.	III.
R Leonis	9 41 26	11 57·5 N.	III.

BIOLOGICAL NOTES

Metamorphosis in Nematodes.—Dr. von Linstow sums up our present knowledge as follows:—The Nematelminthes, according to the medium in which the individual developmental stage is passed, present a truly wonderful series of metamorphoses, and no less than fourteen distinct developmental stages may be enumerated. (1) The embryo passes into an adult form direct (without the intervention of a larval stage) in the one medium, and also passes its existence in fresh, salt, or brackish water, in plants, in the earth, or in decaying substances (Dorylaimus, Enoplus, Plectus, Monhystera, Rhabditis, and many other genera). (2) The larvæ live in the earth, the adult form in plants (*Tylenchus tritici*, *T. putrefaciens*, *Heterodera schachtii*). (3) The larvæ live in worms, and on their death and decay pass into the earth, when they assume an adult form (*Rhabditis pellio*). (4) The Helminth lives bisexual in the earth, the fruitful females enter the bodies of bees, and produce therein offspring (*Sphærularia bombi*). (5) The larvæ live in the earth, assuming the adult condition, in some animal (Dochmius, Strongylus). (6) The Helminth lives as an hermaphrodite form in some animal, the offspring develop into bisexual forms in the earth (Rhabdonema, Angiostomum). (7) Some adult forms differentiate free-living forms developing sexually, and also hermaphrodite forms living parasitically in animals (snails, *Leptodera appendiculata*). (8) The larvæ hatch out in the earth, and then enter some animal, in which they become metamorphosed into hermaphrodite forms (Trichocephalus, Oxyuris). (9) The larvæ live in insects, the adult form in earth or water (Mermis). (10) The larvæ live encapsuled in some animal, and with it pass into the digestive system of some other animal form, in which latter they become adult (Ascaris, Filaria, Cucullanius). (11) For a short time the hermaphrodite form lives in the intestine of some animal, and produces here its larval form, which, penetrating the intestinal walls, makes its way into the muscles, where it becomes encapsuled (*Trichina spiralis*). (12) The adult form lives in the tracheæ of birds; the females lay eggs, which contain well-formed embryos, which get expectorated, to once again enter the bird's system with its ordinary nourishment. In the crop and œsophagus of the bird the embryo hatches out, wandering into the bronchiæ and air-sacs, from whence the larger larvæ find their way to the tracheæ (*Syngamus trachealis*). (13) There will be two larval forms, of which the one will be found in Mollusca, and the other in aquatic beetles and waterboatmen, while the adult form lives in water (*Gordius aquaticus*). (14) There will be two larval forms, of which the one will be found in water, the other in the lung of some Amphibian, from whence it will wander into the intestine of the same animal, where it will develop into an hermaphrodite form (*Nematoxys longicauda*); this latter form is described and figured.—(*Zeitschrift für wissenschaftliche Zoologie*, November 24, 1885, Band xlii. Heft 4, p. 715, pl. 28.)

Artificial Propagation of Oysters.—Mr. W. K. Brooks calls attention in detail to a very important fact in the artificial propagation of oysters to which his notice was first called by Mr. W. Armstrong, of Hampton, Virginia. It would appear that "seed" oysters which Mr. Armstrong had placed on "floating-cars" in the mouth of Hampton Creek not only grew more rapidly, but were of a better shape, and therefore more marketable, than those from seed deposited at the same time in the usual way on the bottom. Immediately after the embryo oyster acquires its locomotor cilia there is a period of several hours, when it swims at the surface, and this is the period when it is swept into contact with collectors. As soon as the shell appears, the larva is dragged down by its weight, and settles at the bottom. The greatest danger to which it is now exposed is that it may not at this stage of its existence find a hard, clean surface for attachment. Being of microscopical dimensions, it may be smothered by a deposit of sediment or mud so light as to be invisible, and most of the failures to get a good "set of spat" are due to the formation of a coat of sediment upon the collectors *before* the young oysters come into contact with them. This danger seems to be entirely avoided by the use of floating collectors, for little sediment can fall on a body which is close to the surface of the water, and most of what may fall will be swept off by the currents which bring the swimming embryo oysters into the collectors. The collector employed by Mr. W. K. Brooks was formed by connecting two old ship-masts together by string pieces, with a bottom of coarse galvanised iron netting which had buoyancy enough to support a large quantity of submerged shells. Such floats should be open at the ends to permit free circulation, and should be so moored as to sway with the current. Mr. Brooks moored a collector, on July 4, in front of the Zoological Laboratory at Beaufort, N.C. Although all the oysters in the vicinity, from being in very shallow water, were nearly through their spawning season, and the conditions were anything but favourable, yet there was immediately secured a good "set," and the young oysters grew with remarkable rapidity, no doubt on account of the abundant supplies of food and fresh water, which gained ready access to all of them, and the uniform temperature which was secured by the constant change of water. The importance of this suggestion is obvious: this method may be used by planters to collect their own supply of seed—an object of great importance—when the feeding regions are far removed from native beds. Perhaps time will prove that it may be also used for rearing the oyster to a stage making it fit for the market; when, if so, the better shape and firmer shell would give the supply thus raised a superior value. Even in places where there are no oysters near to furnish the supply of eggs, a few spawning-oysters could be placed among the shells in the collector, after the French method, to supply the "set." Though, as Mr. W. K. Brooks says, "Engagement in business projects is no part of the [direct] office of a University," still, we venture to hold

that all advance in scientific knowledge has a bearing on the "business" life of a country, and we believe that these hints, based on the practical experience acquired at the Chesapeake Zoological Laboratory, will not be without value as showing what the man of science may do for the man of business. —(*Johns Hopkins University Circulars*, vol. v., No. 43, p. 10, Baltimore, October 1885.)

REPORT OF THE SUPERINTENDENT OF THE U.S. NAVAL OBSERVATORY[1]

WE make the following extracts from this important Report:—

Rear-Admiral S. R. Franklin, U.S.N., continued in the duties of Superintendent until March 31 of the current year, when he was detached therefrom in order to assume command of the United States naval force on the European station. In the interim from that date until June 1, 1885, Commander A. D. Brown, U.S.N., acted as Superintendent, when, under the orders of the Department, Commodore Belknap assumed the duties of the office.

The 26-inch Equatorial.—This telescope has continued in charge of Prof. A. Hall, U.S.N., who has been employed in observing the satellites of the large planets and in observation of double stars.

Though in constant use, the instrument, together with its micrometer, driving clock, and other apparatus, remains in good working order, and the dome, forty-three feet in diameter, covering it, is now revolved with great ease by means of the four horse-power gas-engine which was connected with it in the latter part of 1884. The dome is now turned to any position required in a few minutes, and the work of observing is much facilitated. Mr. George Anderson has charge of the engine, and assists Prof. Hall in the management of the dome.

The complete reduction and discussion of the observations made with this instrument have made good progress during the past year. This is due, in a great measure, to the efficient aid rendered by Lieut. W. H. Allen and Ensign J. A. Hoogewerff, U.S.N. These gentlemen have been very diligent in making the necessary computations, and have shown marked aptitude for the work.

The observations of the satellite of Neptune and those of the two outer satellites of Uranus have been discussed, and the masses of these planets deduced. These results have been published in Appendixes I. and II. of the annual volume of the Observatory for the year 1881.

A discussion of all the observations of Iapetus, the outer satellite of Saturn, is now nearly finished, and will be ready for printing in a few weeks. . . .

The Prime Vertical Instrument.—The work of reducing the observations made in 1883-84 by Lieut. C. G. Bowman and Ensign H. Taylor, U.S.N., for the determination of the constant of aberration, has been pursued. A selection was made of twelve stars of varying right ascension and well-determined places, and the results obtained; the reduction of the remaining observations will be proceeded with as rapidly as possible.

In July of last year a communication was received from the President of the International Geodetic Conference, asking the co-operation of this Observatory with the Royal Observatory at Lisbon in the determination of the problem of the change of latitudes, the observations to be taken with the prime vertical instruments of the two Observatories. Communication was opened and correspondence is still in progress with the Director of the Observatory at Lisbon, and preparations have been made to undertake the work here very soon after it is known that it will be begun at Lisbon. . . .

Photography.—In the programme of work proposed for the current year it was stated that the work of taking sun photographs daily would be inaugurated as soon as practicable. The work of the Transit of Venus Commission has up to this time prevented any regular system being adopted. Such work, if pursued systematically and continuously, would put this institution on a footing in this regard more nearly equal to that of the larger foreign Observatories where a large mass of data has been accumulated for future measurement, computation, and discussion, forming the basis of much information of value to the student of solar physics.

For purposes of co-operation in this scientific work, photographic observations in different parts of the world being supplemental to each other, it is also desirable that this work be begun, and sooner or later it will have to be taken up here in order to keep pace with the requirements of modern astronomical research and observation. It cannot, therefore, be begun too soon.

It is eminently desirable that this Observatory possess a collection of photographs of astronomical subjects, and so be enabled to solicit exchanges from astronomers abroad that are engaged in celestial photography. But we lack the means and equipment for printing and making photographic positives that can properly be used for such purposes of exchange.

Much work is desirable to be done in photographing star clusters, nebulæ, and the spectra of sun-spots, stars, &c., and in the production of star maps by photography. Should a party from this Observatory be sent to observe the total eclipse of 1886, photographs of the phenomenon will have to be taken. The Observatory should at all times be prepared for such an occasion and have a staff drilled in photographic work, and this might be easily accomplished, as the number need not be great, and it could be made up of officers stationed here.

New Observatory.—The Commodore renews the recommendations of his predecessors for the removal, at an early day, of the plant of the Observatory to the new site selected and purchased for such purpose in 1881.

The plans, long since prepared, have received the approval of prominent scientific men of the country, and the work can be begun as soon as the money is forthcoming; and with the [illegible] in hand, it would take fully three years to erect the buil[illegible] transfer the plant, and get everything into good working [illegible]

The National Academy has been requested by the Departme[illegible] to express its opinion officially as to the advisability of proceed[illegible]ing promptly with the erection of the building, and it cannot be doubted that it will express itself affirmatively in the matter.

The disadvantages of the present location have been so often and so forcibly described that the subject is worn almost threadbare.

To the foresight and energy of officers of the Navy is due the inception and development of this institution. It is emphatically the child of the Navy, and the service is much interested in its welfare and in every effort to extend the sphere of its usefulness. From its humble beginning in 1838 it has now grown to be one of the most important astronomical centres in the world, and it is to be hoped that Congress will recognise the good work hitherto done by granting the means to place the institution on a still higher plane than it now occupies.

Board of Visitors.—The Commodore renews the suggestion heretofore made that a Board of Visitors, composed of competent persons, be appointed annually to visit the institution and inquire into its working, with authority to suggest such changes in the methods pursued, or such new lines of investigation, as it might deem proper to recommend.

Solar Eclipse of 1886.—A total eclipse of the sun will occur on August 29, 1886. The line of totality passes over the equatorial portion of the Atlantic Ocean, and reaches the west coast of Africa, near Benguela, in latitude 12° S. This port is easy of access, and as it is the healthy season, there would be no difficulty in sending a party out in a Government vessel. The duration of the totality at this point is four minutes and forty seconds, affording a more than usually good opportunity for photographic and spectroscopic observations. The question as to the propriety of applying for an appropriation to defray the expenses of an observing party has been referred by the Department to the National Academy, and a report may soon be expected.

Miscellaneous.—During the year the names of 1408 visitors have been recorded, and 1137 permits were issued for night visitors, for whose accommodation the small equatorial is set apart. The presence of these visitors is not allowed to interfere with the regular work of the institution, and permits are only issued for one evening in each week, with exceptional instances.

The records kept by the several observers and watchmen show that only about one night in eight is good for observing, while an exceptionally good night for astronomical work cannot be reckoned upon much oftener than once a month.

[1] By G. E. Belknap, Commodore U.S.N., Superintendent United States Naval Observatory. Dated Washington, October 5, 1885

MOLECULAR PHYSICS

AT the meeting of the Berlin Physical Society, on Nov. 20 last, Herr Gerstmann spoke on a work recently issued by Prof. W. C. Wittwer, on "The Principles of Molecular Physics

and Mathematical Chemistry." The main problem to which the work addressed itself respected the nature and properties of the imponderable matter, ether, but its arguments were, in the main, drawn from fancy more than from experience. The work was divided into three parts. The first part, the Constitution of Bodies, formulated the theory that the ponderable atoms were not qualitatively, but only quantitatively, distinguished from one another; that the elastic effect of matter on ether, as on ponderable substances, diminished with the distance; and that the density of the ether ranged round ponderable matter did not diminish in proportion to the distance from the mass of atoms, but increased in proportion to the distance. As essential to the constitution of the bodies was further advanced the pressure of ether on the particles of ether ranged round the ponderable atoms. The second part, the Principles of Chemistry, proceeded from the hypothesis that a material particle was capable of attracting only one, or quite few, particles of ether, acting in such a manner, namely, that a fraction of the attractive force, now of the particle of ether, now of the mass particle, was kept in abeyance (conditions which, for reasons otherwise altogether unexplained, were termed "electro-negative" and "electro-positive" respectively), and made use of an accidental property of the curve of the density of elements contained in L. Meyer's "Modern Theory of Chemistry," namely, that in the case of the maxima and minima of this curve, elements related electro-negatively to the neighbouring elements in the curve always passed over to such in which the reverse condition obtained, in order, by calculations described by the author himself as highly uncertain, to determine the molecular magnitude of some elements and the number of particles of ether attracted by their atoms. The third part, the Doctrine of Heat, propounded heat as elastic concussions; in elaborate calculations brought forward for some examples of numbers the argument that the occurrence of the stationary state was explainable under this assumption likewise; and contended against the Mariotte-Gay-Lussac and Avogadro laws, which were incapable of rightly explaining the facts, seeing that these laws and their deduction took no account whatever of the imponderable ether and the pressure of ether.

THE HISTORY OF FOSSIL CROCODILES[1]

IN this communication the author endeavoured to summarise the main facts already known regarding the palæontological history of the Crocodilia, with full references to the principal literature of the subject. After some preliminary remarks upon the structure and distribution of the living members of the order, the leading types of each geological period were successively considered; and the paper concluded by discussing the bearing of these facts upon the evolution of the Crocodilia, as determined by Prof. Huxley in 1875. The earliest crocodilians hitherto discovered are *Belodon*, *Stagonolepis*, and *Parasuchus*, from the Upper Trias—the first-named being met with on the Continent, in India, and in North America; the second, solely known from the yellow sandstones of Elgin; and the third, only recorded as yet from India. The Rhætic Beds and Lower and Middle Lias do not appear to have yielded any remains of this order, but numerous examples have been found in the Upper Lias, and some in a remarkable state of preservation. At present, however, the precise systematic relationships of the Liassic forms have not been very satisfactorily determined, and those from British deposits are especially in need of further study: there are probably two generic types, *Mystriosaurus* and *Pelagosaurus*, and, if the latest researches are to be followed, it would seem that only two species of each are definitely known. In England, according to M. Deslongchamps, two distinct forms, *Mystriosaurus chapmani* and *Pelagosaurus bronniarti*, have been continually described under the name of *Teleosaurus chapmani*. With the Lower Oolites, *Teleosaurus* proper makes its appearance, and ranges at least as far upwards as the Kimmeridge Clay, from which Mr. J. W. Hulke has described a characteristic snout (*T. megarhinus*). *Steneosaurus* is also a Lower Oolite form, ranging to the Oxford Clay; its British representatives are somewhat imperfectly known, though very complete descriptions have been published of well-preserved cranial fossils from French deposits. *Metriorhynchus* is another genus, from the Middle and Upper Oolites, very fully elucidated by M. Deslongchamps in France, but scarcely determined hitherto in English strata. Two forms described by Prof. Phillips under the names of *Steneosaurus palpebrosus* (Kimmeridgian), and *Steneosaurus gracilis* (Portlandian) are truly referable to *Metriorhynchus*, and fragments agreeing specifically with some of the French Metriothynchs are also recorded. The Upper Oolites also yield the remains of Crocodilia with comparatively short and stout skulls, and very complete specimens have been discovered in the Kimmeridge Clay both of England and the Continent. They belong to the genera *Dakosaurus* and *Machimosaurus*, the former having also been described by Sir Richard Owen under the name of *Plesiosuchus*. Teleosaurians occur rarely in the Wealden and Purbeck Beds—though one or two well-preserved crania of *Macrorhynchus* are known in Germany—and they finally disappear in the Upper Cretaceous series, where they are represented by the scanty remains of *Hyposaurus* and *Enaliosuchus*. Broad-faced crocodilians, adapted for a more terrestrial mode of life than the Teleosaurs, occur somewhat abundantly in the Wealden and Purbeck Beds, and are represented by *Goniopholis*, *Nannosuchus*, *Oweniasuchus*, *Theriosuchus*, and a remarkably interesting genus—*Bernissartia*—recently described by M. Dollo from the now classical deposit of Bernissart in Belgium. The latter, though decidedly Mesosuchian, approaches the living crocodiles and alligators much more closely than any of its congeners, both in the characters of its dermal armour and in certain parts of the skull. The earliest evidence of procœlian crocodiles hitherto made known is from the Cambridge Greensand and the nearly equivalent Gosau Beds of Vienna; Prof. H. G. Seeley has described a few vertebræ, teeth, and fragments of limb-bones, and regards these as referable to at least three specific types. The Upper Cretaceous beds of France and the United States have yielded still more satisfactory remains—including skulls—showing that the Eusuchian sub-order dates back beyond Eocene times; and some of these fossils appear almost indistinguishable from the living genus *Gavialis*. The early Tertiary deposits, both of England and the Continent, are remarkable as affording traces of gavials, crocodiles, and alligators (or alligatoroid genera) associated together, while the three families share no common area of the earth's surface at the present time; the Eocene types, moreover, appear to be rather less differentiated than is the case in the existing fauna. In conclusion, it may be said that the abundant acquisitions of fossil Crocodilia during the last ten years have fully confirmed the views of Prof. Huxley, laid before the Geological Society in 1875; and the Wealden and Purbeck discoveries, particularly, have brought to light facts which were then little more than probable surmises based upon very fragmentary materials.

[1] Abstract of a Paper read at the meeting of the Geologists' Association on December 4, 1885, by Mr. A. Smith Woodward, F.G.S., of the British Museum (Natural History).

PROFESSOR SYLVESTER'S LECTURE "ON THE METHOD OF RECIPROCANTS AS CONTAINING AN EXHAUSTIVE THEORY OF THE SINGULARITIES OF CURVES"

PROFESSOR SYLVESTER sends us the following corrections and additions to his lecture recently given in NATURE (January 7, p. 222):—

Errata

P. 223, 1st column, line 27, for "requirements" read "acquirements."

P. 224, 1st column, line 37, for *geometrical adjustment* read *numerical adjustment*.

P. 225, in the footnote, for $\frac{\eta'''}{\eta}$ read $\frac{\eta'''}{\eta''}$.

P. 226, 2nd column, line 9, p. 227, 1st column, lines 14, 20, 22, 31, 34, 44, and 2nd column, line 16 from bottom, in all thees places for τ read t, and in the last for $\tau - \tau'$ read $t - t'$.

P. 226, 2nd column, line 5,

for $\frac{dy}{dx^2}, \frac{dy}{dx^3}, \frac{dy}{dx^4}, \ldots$

read $\frac{d^2y}{dx^2}, \frac{d^3y}{dx^3}, \frac{d^4y}{dx^4}, \ldots$

P. 226, 2nd column, line 20, for "operation" read "operator."

P. 228, 1st column, line 1, for τ read t.

P. 229, in the 1st line of the footnote in the 1st column, for "generating fraction" read "fractional generating function."

P. 229, the 17th line of the footnote should be

$$\frac{4a^2}{2}\delta_b + 5ab\delta_c + 6\left(ac + \frac{b^2}{2}\right)\delta_d + 7(ad + bc)\delta_e.$$

P. 229, line 21 of footnote, for $\frac{c^2}{2}$ read $\frac{b^2}{2}$.

P. 229, the 22nd line of the footnote should be

$$4a^2\delta_b + 5(ab + ba)\delta_c + 6(ac + b^2 + ca)\delta_d + 7(ad + bc + cb + da)\delta_e + \ldots$$

P. 230, for πραγματων read πραγματων.

P. 230, 2nd column, line 10 from bottom, for "Buckkeim" read "Buchheim."

P. 231.—The greater circle has been erroneously represented as cutting the ellipse. It should pass outside it, thus—



and its centre should be indicated by an asterisk, as well as that of the smaller circle.

P. 231, Chart 5, and p. 226, the syzygy should be in both places

$$(n-1)^2\left(\frac{d\phi}{dy}\right)^3 a + n(n-1)\left\{\frac{d^2\Phi}{dx^2}\cdot\frac{d^2\Phi}{dy^2} - \left(\frac{d^2\Phi}{dxdy}\right)^2\right\}\Phi = z^2H.$$

P. 231, Chart 2, in the last binariant Protomorph but one, for $+ 5abe$, read $- 5abe$.

Chart 6, last line but one, for $H + AU$ read $H = AU$.

For "Boole-Mongian" read "Boolo-Mongian" *passim*.

Those desirous of obtaining systematic information on the subject of the lecture may consult the following recent articles from the pen of its author, viz. one on "Schwarzian Derivatives," followed by another on "Reciprocants" in the *Mathematical Messenger*, four "Sur une nouvelle théorie de formes algébriques," a fifth "Sur les Invariants Différentiels," which have already appeared, and a sixth "Sur les réciprocants purs irréductibles du quatrième ordre," about to appear in the *Comptes rendus* of the Institute.

It may be as well to mention that the papers in the *Messenger* were given in long after the dates which the numbers of the *Messenger* bear on their cover, those dates being by some months anterior to the time of their actual issue. In the absence of this explanation the theory would appear to have been in print long before the time when it is stated to have been discovered.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—Prof. Stirling succeeds Dr. Gamgee as an examiner in the Honour School of Natural Science, not Prof. Burdon-Sanderson, as stated last week.

CAMBRIDGE.—Mr. A. E. Shipley, B.A., Scholar of Christ's College, has been appointed Demonstrator of Comparative Anatomy. Mr. Shipley was placed in the first class in the Natural Sciences Tripos Part II., for Zoology and Comparative Anatomy.

It is recommended by the Council of the Senate that the University should now take over the machinery and other plant of the Engineering School belonging to Prof. Stuart. In 1883 its value was estimated at 2500*l*. It has since been considerably added to. Out of the receipts from students' fees and for payments for work done for University departments and private persons, the machinery has been kept in good repair, 10 per cent. has been set aside each year for depreciation, and 5 per cent. has been paid upon the capital, and in addition a profit of 100*l*. was made last year.

SCIENTIFIC SERIALS

The American Journal of Science, January 1886.—Observations on invisible heat-spectra and the recognition of hitherto unmeasured wave-lengths made at the Alleghany Observatory, by S. P. Langley. It is agreed that all cold bodies must not only radiate heat to still colder bodies, but, according to our present conception of radiant energy, be also capable of giving a spectrum, whether we can recognise it or not. The object of the present paper is to describe the actual formation of such spectra and the recognition of their heat in approximate terms of wave-lengths. From the author's researches it is inferred that some of the heat radiated by the soil has a probable wave-length of over 150,000 of Ångström's scale, or about twenty times the wave-length of the lowest visible line in the solar spectrum as known to Fraunhofer.—Botanical necrology of 1885, by Asa Gray. Obituary notices are here given of Charles Wright, of Wethersfield, Connecticut (1811-1885); George W. Clinton, of Albany, New York (1807-1885); Edmond Boissier, of Geneva (1810-1885); and Johannes August Christian Roeper, of Basle (1801-1885).—The isodynamic surfaces of the compound pendulum, by Francis E. Nipher. It is generally assumed that particles near and below the axis of suspension are retarded, and those near the bottom of the pendulum accelerated, by reason of their connection with the system, while the series of particles forming the axis of oscillation are neither accelerated nor retarded. But although this may be true as regards the time of a complete oscillation, it is shown that in any compound pendulum the particles near the bottom do not exert a constant retarding effect upon the system.—The peridotites of the "Cortlandt Series" on the Hudson River, near Peekskill, New York, by George H. Williams. In his paper the author gives a petrographical description of the most basic members of that most interesting group of massive rocks which occurs on the southern flank of the archæan highlands about forty miles north of the city of New York.—Description of a meteorite from Green County, Tennessee, by Wm. P. Blake. This mass of meteoric iron, which was found by a farmer ploughing his field in 1876, and is now in the writer's collection, weighs 290 pounds, is of the shape of a flattened cigar, 36 inches long, 10 broad, and 6 thick. It clearly belongs to the class of exfoliating deliquescent irons, several examples of which have been found in Tennessee, Georgia, and North Carolina. A quantitative determination of a small slice from one end by Baumhauer's method gave iron 91·421, nickel 7·955.—Tendril movements in *Cucurbita maxima* and *C. Pepo*, by D. P. Penhallow. In his paper, which is not concluded, are contained the results of a study made some years ago on the movements of the squash tendrils and terminal bud. Subsequent discoveries touching the continuity of protoplasm have served to give a clue to certain phenomena observed during the researches, but which at the time could not be satisfactorily accounted for. This clue was followed up during last summer, with the result that the true explanation of the tendril movement in *Cucurbita*, and possibly also in the whole family of *Cucurbitaceæ*, appears to have been reached from histological research.

Bulletin de l'Académie Royale de Belgique, November 1885.—Solution of Wrouski's universal problem, and of another problem relating to the integration of differential equations, by Ch. Lagrange. This is the fifth memoir devoted by the author to the elucidation and correction of Wrouski's writings. Here he demonstrates and generalises for any number of variables, the following theorem: Given a differential equation of any order n:

$$\phi\left(\frac{d^n x}{dt^n}, \frac{d^{n-1}x}{dt^{n-1}}, \ldots \frac{dx}{dt}, x, t, a\right) = 0,$$

between the dependent variable x and the independent variable t (a being a parameter), an equation which may be integrated for $a = 0$, the coefficients of the development of x according to the powers of a are absolutely known functions of t given by simple quadratures.—Researches on the spawning of the toad (*Bufo vulgaris*), and on the protecting layers of the egg in the batrachian family generally, by M. Héron-Royer.—Note on the origin of diastase and on the reduction of the nitrates to nitrites, by M. Ed. Jorissen. The author's experiments tend to confirm the views of Traube and Pfeffer, who regard the physiological character of the Bacteria and of the Mycetæ in general as profoundly different from that both of plants and animals. He further endeavours to show that the reduction of nitrates to nitrites by germinating grains must be attributed to the presence of the Bacteria of putrefaction in the surrounding fluid.—Experimental researches on the influence of magnetism on polarisation in the dielectrics, by Edmond van Aubel. The object of these researches is to ascertain whether it be possible to establish a parallelism between the electro-magnetic rotation of the plane of polarisation of light, the phenomena of the reflection of light on a magnet, and Hall's discovery. But the result so far has been unsatisfactory.—Note on the late Gen. Baeyer's views regarding an annual oscillation in the level of the Baltic Sea, by Gen. Liagre. Even admitting the accuracy of the observations

tending to show that in the Baltic the tides rise higher in summer than in winter, the author is disposed to attribute the phenomenon rather to local physical causes than to Baeyer's astronomic theory of solar action.—Note on the geological formation of the Juan Fernandez islands, by A. L. Renard. The prevailing 'rocks throughout this group would appear to be mainly basaltic, with little or no trace of lavas or other recent eruptive matter.—On some new groups of fossil remains from the Upper Chalk and Lower Eocene Tertiary formations of Belgium, by Ed. Dupont. These specimens, now mounted in the Brussels Museum of Natural History, include fragments of a Dinosaurian (*Orthomerus dollo*) from the Maestricht district; the head and various bones of the gigantic *Mosasaurus camperi*, from Limbourg and Montague Sainte-Pierre; remains of a new type of Mosasaurian recently described by M. Dollo under the name of *Plioplatecarpus marshi*, from Maestricht; remains of another Mosasaurian from Ciply, new in Europe, but well known in America, which M. Dollo has named *Polygonodon ciplyensis*; the carapaces of two large turtles from Maestricht, *Chelonia hoffmanni*, Gray, and *Ch. suyderbuyckt*, Ubags; lastly, the skull of a crocodile affiliated by Dollo to the *Crocodilus affinis* discovered by Marsh in the Eocene of the far west.—Note on the whale captured last May off Fécamp, by P. J. van Beneden. At first supposed to be a *Balænoptera musculus*, L., or else a new species, the author shows that this cetacean is the *Balænoptera rostrata*, Fabricius, a specimen of which was taken in 1878 near Villefranche in the Mediterranean.—A study of François Huet and his philosophic writings, by O. Merten.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 7.—"Contributions to the Anatomy of the Central Nervous System of the Plagiostomata." By Alfred Sanders, M.R.C.S., F.L.S. Communicated by Dr. Günther, F.R.S. (Abstract.)

After referring to the literature of the subject, and describing the macroscopic aspect of the brain, and partly the distribution of the cranial nerves, the author proceeds to give an account of the histology of the segments of the brain.

The olfactory lobes are well developed. They present three layers. Internally cells of the smallest category are found; they give off several processes which join a network penetrating the whole layer; through the medium of this network these cells communicate with the glomeruli which form the middle layer. These glomeruli are much better developed than in the Teleostei; here they present a central core of closely intertwined fibrillæ inclosed externally by fibrils of a larger size, in the course of which cells are developed; these are arranged parallel to the long axes of the glomeruli, and join the external layer, which consists of fibres passing from the anterior end of the olfactory lobe to supply the olfactory organ.

In the Rays these lobes are solid, but in the Scyllium, Rhina, and Acanthias they contain a ventricle which communicates through a long peduncle with the ventricles of the cerebrum.

The cerebrum presents externally a layer of neuroglia without cells, or at least with comparatively few; the remainder of the parenchyma presents cells of a medium size which are usually distributed in groups with neuroglia interspersed between them; these groups in Scyllium contain from nine to fifteen cells, in the Rays generally more. Four special groups of cells occur towards the base of the brain, two in the outer and two in the inner walls: from the former arise the anterior commissure, and from the latter the crura cerebri.

Two ventricles occur in the cerebrum of Scyllium, Rhina, and Acanthias which homologise with the lateral ventricles in the cerebrum of Mammalia. At the posterior part they coalesce into one chamber which is in communication with the third ventricle; this chamber is evidently the foramen of Monro. Dr. Wilder is of opinion that the ventricles of the olfactory lobes represent the lateral ventricles, and that their apertures of communication with the above-mentioned chambers homologise with the foramina Monroi. A consideration of the case renders this idea improbable. In the Rays the ventricles are reduced to a very small chamber occupying the posterior end of the cerebrum.

The crura cerebri form two projecting walls of a gutter-shaped passage which communicates with the third ventricle. As Prof. Owen has already pointed out, they probably homologise with the nervous cords which connect the supra- with the infra-œsophageal ganglia in Invertebrata; and it is through the third ventricle that the œsophagus of the probable invertebrate ancestor of the Vertebrata could have reached the present dorsal surface without breaking through nervous tissue; for dorsally the choroid plexus and pineal gland cover in this ventricle, there being no nervous tissue here, and inferiorly it communicates through a chamber in the hypoarium with a chamber in the centre of the pituitary body; the endothelium lining the former being continuous with the endothelium lining of the latter.

The optic lobe which arches over the aqueduct of Sylvius corresponds to the tectum lobi optici of the Teleostei; the structure is much simpler, although comparatively speaking the lobe is larger. Externally it is occupied by the fibres of origin of the optic nerve; within these a transverse commissure is visible homologising with the transverse commissure in the tectum lobi optici of Teleostei. Internally a ganglion of large cells occurs variously arranged in the different species; these cells are of large size, but differ from the cells of the ventral horn of grey matter of the cord in texture, and in the fact of giving off only one process as a rule, which process runs into the above-mentioned transverse commissure. Numerous cells of small size, many of which are fusiform, occur in this lobe; these are more numerous in the centre.

The author's researches do not bear out the statement of Rohon that the thalamencephalon projects backward and covers the mesencephalon in the optic lobe; so that according to this author it is composed of both these segments of the brain. Apart from embryological considerations, which give no countenance to this idea, there is nothing in the structure of this lobe which indicates an origin from two distinct primary vesicles of the brain; on the contrary, its structure is homogeneous.

The cerebellum presents a structure corresponding to that in the Teleostei. There are, counting from within outward, the granular, fibrous, Purkinje cells, and molecular layers. The differences consist in the greater number of processes given off by the Purkinje cells, and in the greater number of small cells found in the molecular layer. Another difference is found in the presence of a ventricle which is largest in Rhina, Acanthias, and Scyllium, and reduced to very small dimensions in the Raja.

The molecular layer is continued down on to the surface of the medulla oblongata from the cerebellum, forming the restiform bodies. In the spinal cord there are distinguishable three columns on each side: a dorsal above the dorsal cornu, a lateral at the side, and a ventral beneath; the latter consists of fibres of a larger calibre than those constituting the other columns, but no gigantic fibres—the so-called Mauthner's fibres—are present, as in the Teleostei.

The deep origins of the cranial nerves. The optic nerve arises as above-mentioned from the outer half or more of the optic lobes, also by a few fibres from the hypoarium. This fact was contradicted by Bellonci in reference to the origin of this nerve in Teleostei, but further researches and consideration compel the author to adhere to his original statement.

The oculomotor arises from a ganglion in the floor of the aqueduct of Sylvius. There is no decussation of the fibres of origin of this nerve as is stated by some authors; the error probably arose from the presence in this region of a decussation of fibres derived from the transverse commissure in the optic lobe: this decussation of fibres corresponds to the commissura ansulata in Teleostei.

The facial arises from a small bundle of fibres which comes forward from the lateral columns of the cord, and is situated at the side of and slightly above the central canal.

The trifacial arises from a tuberosity overhanging the fourth ventricle immediately contiguous to the restiform bodies, also from the grey matter of the floor of that ventricle.

The vagus arises from a series of rounded tubercles which occupy the lateral portions of the floor of the fourth ventricle.

Linnean Society, January 21.—W. Carruthers, F.R.S., Vice-President, in the chair.—Mr. Harry Veitch exhibited, in illustration of Dr. Masters's paper, a series of living conifers, among which were: *Abies Fortunei*, *A. nobilis*, *A. grandis*, and *A. amabilis*; also *Pseudolaryx Kæmpferi*, *Picea Omorika*, *Pinus Pencei*, *Arthrotaxis selaginoides*, and others.—Mr. E. M. Holmes exhibited a specimen of the ergot of Diss (*Arundo tenax*) from Algeria. This ergot is said to be more active medicinally than that of Rye, and is slenderer and twice or thrice its length, and is attributable to the fungus *Claviceps purpurea*.—Dr. C. Cogswell drew attention to dried specimens of the species of maples (*Acer*) of Canada collected by him in Nova Scotia, and of *Sisy-*

rhynchum Bermudianum and *Bryophyllum calycinum* from Bermuda. He contrasted the great difference of climate and vegetation of the continent and island, observing that the Gulf Stream doubtless had an important influence on the Bermudan flora; moreover, it was notable that Bryophyllum, like the maples, put on a brilliant red autumnal tint.—There was exhibited for M. Buysman examples of Rudbeckia and Lupinus prepared as teaching specimens of medicinal plants.—Dr. Maxwell Masters read a paper, contributions to the history of certain conifers. This comprised the result of observations on the mode of growth and structure of various species of Coniferæ, concerning which much difference of opinion had previously existed owing to the imperfection of our knowledge. Of late years many of these species had been introduced into cultivation and some of them had produced male flowers and cones, thus affording an opportunity for diagnosing the species and ascertaining their limitations. The study of the cultivated plants had likewise shown the natural range of variation in a species or individual plant under comparatively uniform conditions. Our knowledge of their geographical distribution has also been extended, altogether thus enabling a fresh revision to be attempted.—Dr. T. Spencer Cobbold read a paper on *Strongylus axei*, and its affinities. This diminutive maw-worm, obtained from the stomach of a donkey, possesses interest, inasmuch as its structural characters closely correspond with those of the entozoon infesting the ostrich's proventriculus. It also shows affinity with the grouse strongyle and with the stomach-worm of lambs; while its peculiarities throw light upon other questions of morphology, especially its relations to the singular maw-worm (Simondsia) of the hog.—In exhibiting an extensive series of fossil plants from the Island of Mull, Mr. J. Starkie Gardner gave remarks concerning inferences to be drawn from the well-preserved leaves. He mentioned that this fossil Mull flora comprises but one fern undistinguishable from living *Onoclea sensibilis* of Western America and Eastern Asia. There is an Equisetum. The Coniferæ are abundant; a *Ginkgo* resembles existing species, along with numerous firs and larches, a few of these latter being similar to those of Japan. Monocotyledons are represented by one having a sword-shaped leaf. There are at least twenty species of dicotyledons. A *Platanus* obtains, differing somewhat from the recent form, and with resemblances to what is known as *Credneria* and *Protophyllum* of Cretaceous age. This Mull flora, though possessing few novelties, is interesting as supplying fresh confirmation of the view first propounded by Asa Gray—that formerly the entire northern temperate regions possessed a very uniform flora.

Anthropological Institute, January 12.—Mr. Francis Galton, F.R.S., President, in the chair.—The election of Mrs. C. Brooke (H.H. the Ranee of Sarawak) was announced.—Mr. Bryce-Wright exhibited a bronze sword, of the leaf pattern, found by the late Capt. Sir William Peel, R.N., at Sandy, Bedfordshire.—A collection of flint implements from the junction of the Thames and Wandle was exhibited by Mr. G. F. Lawrence.—Dr. R. Munro read a paper on the archæological importance of ancient British lake-dwellings and their relation to analogous remains in Europe. The lake-dwellings of Scotland were essentially the product of Celtic genius, and were constructed for defensive purposes. Dr. Munro believes that those in the south-west parts of the country attained their greatest development in post-Roman times, after Roman protection was withdrawn from the provincial inhabitants, and they were left to contend single-handed against the Angles on the east and the Picts and Scots on the north. He suggested the theory that the British Celts were an offshoot of the founders of the Swiss lake-dwellings, who emigrated into Britain when these lacustrine abodes were in full vogue, and so retained a knowledge of the custom long after it had fallen into desuetude in Europe. Amongst other arguments in support of this hypothesis, Dr. Munro pointed out that the geographical distribution of the lake-dwellings in Europe closely corresponds with the area formerly occupied by the Celts, and that they are identical in structure with the crannogs.—In a paper on three stone circles in Cumberland, Mr. A. L. Lewis showed that in these circles, as in others previously described by him, there is a marked preponderance of outlying stones and prominent hills towards the north-east, and that the circle-builders followed the Babylonians rather than the Egyptians in their rules of orientation. In the relation between stone circles and adjacent hills and outlying stones, suggestions might be found not only of sun-worship, but also of mountain-worship and of phallic worship.

Royal Meteorological Society, January 20.—Mr. R. H. Scott, F.R.S., President, in the chair.—The Secretary read the report of the Council, which stated that the past year had been one of great activity, as the eight Committees which had been appointed had met frequently, and had done much for the advancement of meteorology. The number of Fellows on the roll of the Society is 537.—The President in his address said that, as he had treated of land climatology in his previous address, he proposed to deal with marine climatology on the present occasion, and to take up the subject at the point where he had left it in his paper, "Remarks on the Present Condition of Maritime Meteorology," printed in the Society's *Quarterly Journal* for 1876. He enumerated the various investigations which had been announced to be in progress at that date, and specified the several outcomes of these inquiries which had seen the light during the ten years. The "Meteorological Charts for the Ocean District adjacent to the Cape of Good Hope," published by the Meteorological Office in 1882, were first noticed, and the methods of "weighting" observations of wind, &c., employed in that discussion were fully explained, as well as the mode of representation of barometrical results. The "Charts showing the Surface Temperature of the Atlantic, Indian, and Pacific Oceans," published in 1884, and those of barometrical pressure, now in the engraver's hands, were next noticed; and it was announced that the Meteorological Council had decided to undertake the issue of monthly current charts for the entire sea-surface. The wind charts published by the late Lieut. Brault, of the French Navy, were next described, with an expression of the profound regret with which the intelligence of his premature death in August last had been received by all meteorologists. The wind charts and pressure tables issued by the Meteorological Institute of the Netherlands were then explained, and also the publications of the Deutsche Seewarte at Hamburg, "The Atlas of the Atlantic Ocean," &c. The series of "Monthly Charts for the Atlantic and Pacific Oceans" issued by the Hydrographic Office, Washington, were then described, and the present series of "Pilot Charts" issued by the same office were explained. As for projected work in 1886, Mr. Scott stated that the daily maps of Atlantic weather for the year of the circumpolar expeditions were now complete, and were being engraved, a process which must take several months. The German Office had undertaken the preparation of daily weather maps for the same period for the South Atlantic. The Meteorological Office had also taken up the marine meteorology of the Red Sea. The Dutch Institute had announced its intention to publish an atlas for the Indian Ocean. In conclusion Mr. Scott stated that there still existed a lamentable want of data for the Pacific Ocean, but that, thanks to the energy of the Canadian Government in opening up their new Pacific Railroad, it was to be hoped that every year would bring a greater amount of traffic to British ports on the Pacific Coast, and therefore a greater number of observations to the Meteorological Office, while from the existing trade to San Francisco a mass of materials was quickly accumulating for certain routes at least over the vast area of the Pacific.—The following gentlemen were elected the Officers and Council for the ensuing year:—President: William Ellis, F.R.A.S.; Vice-Presidents: George Chatterton, M.Inst.C.E., Edward Mawley, F.R.H.S., George Mathews Whipple, F.R.A.S., Charles Theodore Williams, M.D., F.R.C.P.; Treasurer: Henry Perigal, F.R.A.S.; Trustees: Hon. Francis Albert Rollo Russell, Stephen William Silver, F.R.G.S.; Secretaries: George James Symons, F.R.S.; John William Tripe, M.D.; Foreign Secretary: Robert Henry Scott, F.R.S.; Council: Edmund Douglas Archibald, William Morris Beaufort, F.R.A.S., Arthur Brewin, Frederic William Cory, M.R.C.S., Henry Storks Eaton, Charles Harding, Richard Inwards, F.R.A.S., Baldwin Latham, F.G.S., John Knox Laughton, F.R.G.S., William Marcet, M.D., F.R.S., Cuthbert Edgar Peek, F.R.A.S., Capt. Henry Toynbee, F.R.A.S.

Physical Society, January 23.—Prof. Guthrie, President, in the chair.—The following communications were read:—A note on the paper by Prof. W. Ramsay and Dr. S. Young on some thermodynamical relations, by Prof. W. E. Ayrton and Prof. John Perry. The authors, after referring in the highest terms to the careful experimental work of Messrs. Ramsay and Young in their investigation upon "some thermodynamical relations," the results of which were communicated to the Society at its last meeting, show that the four laws stated in their paper are in reality only one, since if any one of them is assumed the remaining three may be deduced from it. Hence it is sufficient

to examine only one, and of the four the third is in the form that can be most readily tested. This law, the statement of which is, that for all substances at any given pressure the product $t\frac{dp}{dt}$ is constant, p being the pressure, and t the absolute temperature of saturated vapour at that pressure, is represented mathematically thus—

$$t\frac{dp}{dt} = \phi(p) \quad \ldots\ldots\ldots \quad (1)$$

$\phi(p)$ being a function of the pressure, independent of the substance. Writing this equation

$$\frac{dp}{\phi(p)} = \frac{dt}{t}$$

and integrating, we get

$$t = a\psi(p) \quad \ldots\ldots\ldots \quad (2)$$

$\psi(p)$ being also a function of the pressure only, and a a constant depending only upon the substance employed. It is in this form that the authors have examined the third law; if true, it follows at once from (2) that the ratio of the temperatures of two saturated vapours to one another at any pressure is the same as the ratio at any other pressure. It is seen, however, either by reference to Regnault's numbers, or Rankine's formula—

$$\log p = a - \frac{\beta}{t} - \frac{\gamma}{t^2} - \ldots$$

an expression based upon his molecular theory, and which, as remarked by one of the authors at the last meeting, agrees with Regnault's results with remarkable closeness, that this ratio is far from constant. The authors are therefore compelled to conclude that the expressions given by Prof. Ramsay and Dr. Young must not be regarded as absolute laws.—A note on the paper by Prof. J. W. Clarke on the determination of the heat-capacity of a thermometer, by Mr. A. W. Clayden. The author has applied a correction to an expression given by the late Prof. J. W. Clarke for measuring the heat-capacity of a thermometer, in a paper communicated to the Society at a previous meeting (April 25, 1885). Prof. Clarke's expression was affected by the mercury not entirely filling the bulb and stem of the thermometer. The corrected expression obtained by the author is

$$V_1 = \frac{V(s - s_2)}{s_1 - \frac{s_2(1 + \beta)}{1 + \alpha t}}$$

s, s_1, and s_2 being the mean densities of the instrument, mercury, and glass respectively, β and α the coefficients of voluminal expansion of mercury and glass, V and V_1 the volumes of the instrument and of the mercury.—Note on some organic substances of high refractive power, by Mr. H. G. Madan. In the course of some correspondence respecting M. Bertrand's polarising prisms, the author was informed that the cement used was napthyl-phenyl-ketone dibromide. He has consequently prepared specimens of the ketone, and subjected them to optical examination. The ketone is a thick yellow oil, boiling at a temperature near the boiling-point of mercury; it appears to be a very stable, neutral, and harmless substance like Canada balsam, but unfortunately it does not appear to be capable of hardening, and hence is not by itself adapted for a cement. Its refractive index for the D line is 1·666, higher than that of carbonic sulphide, while its dispersive power is approximately the same as that of that substance. The author has made the bromide of the ketone referred to above, but it seems liable to decompose with formation of hydrobromic acid, which acts upon the spar. Mr. Madan also exhibited a specimen of metacinnamene, a highly refracting glass-like solid obtained by the action of light or heat upon cinnamene. This substance possesses a refractive index of 1·593 for the D line, and would make a valuable cement if it showed a firm adhesiveness for glass.—The President exhibited and described an instrument he had made in the course of an acoustical investigation upon which he had been engaged. It is a musical instrument similar in principle to the harmonicon. In the case of the harmonicon the rectangular plate is usually supported by strings passing through the nodes, but the author wished to make an instrument that could be "bowed." The "nodes" are not absolute positions of rest, the particles at them describing curves having cusps pointing outwards. The plan adopted was to solder two springs to the plate, which was of brass, the points of attachment being slightly outside the nodes, and the springs being such as to give the same fundamental note as the plate. The other ends of the springs were attached to the mouth of a resonator whose fundamental note was also that of the plate. The plate when struck or bowed gave a tone very like that of a tuning-fork, and in a discussion that followed, Prof. S. P. Thompson suggested the possible use of these instruments as a substitute for a series of forks the cost of a complete set of which often places them beyond the reach of the student. Prof. McLeod suggested that the springs should be tuned to the octave of the plate instead of to its fundamental, and that they should have a slightly different form.

Edinburgh

Royal Physical Society, January 20.—Prof. Turner, F.R.S., President, in the chair.—Obituary notice of the late Dr. Carpenter, by Prof. Ewart.—The President read a paper on the occurrence of the bottle-nosed whale (*Hyperoodon rostratus*) in the Scottish seas. After a review of the history of this whale, Prof. Turner proceeded to describe several specimens which had come under his observation, more especially a young male, caught at Dunbar in November 1885. He then compared the external characters of Hyperoodon, Mesoplodon, Ziphius. A detailed description of the rudimentary teeth in the upper and lower jaws of Hyperoodon was also given, and the periods of the year when this animal migrated southwards and northwards were referred to.—Mr. Brook read a paper on the relation of yolk to blastoderm in fish-ova. The author endeavoured to show that the function of the cortical protoplasm surrounding the yolk (the parablast) is primarily a digestive one. The existence of this layer is a necessary consequence of the separation of yolk from protoplasm in meroblastic ova. The material thus elaborated in the parablast is undoubtedly budded off in the form of cells. It has been asserted by Hoffmann and others that these take no part in the formation of the embryo, but are used up in the temporary circulatory system around the vitellus. In the herring, cod, Trachinus, and probably the whole group of pelagic ova, there is, however, no trace of a vitelline circulation, yet cells are produced in the parablast of these forms in the same manner as in the trout. There thus appears no alternative but that the cells must take part in the formation of the embryo. It was therefore argued that, from a consideration of the physiological function of the parablast, the morphological value of this layer is more important than has been hitherto admitted.—A note was communicated from Mr. Dendy, on an abnormal specimen of Comatula (which had twelve arms) from the Firth of Clyde; Mr. Raeburn read extracts from his journal on the birds of the Shetland Islands; and Mr. Muirhead exhibited a specimen of the Glossy Ibis (*Ibis falcinellus*) shot last September on the borders of Roxburghshire, and a Garganey shot last February in Berwickshire.

Dublin

Royal Society, December 16, 1885.—Physical, Experimental, and Applied Science Sections.—Sir Robert W. Jackson, C.B., in the chair.—On the description by points of the principal caustics of a circle, by G. Johnstone Stoney, D.Sc., F.R.S.—Meteors and meteorites, by W. H. S. Monck, M.A.—On the fog-penetrating power of the double quadriform burner, by Prof. W. F. Barrett. The author described the results of some experiments recently made to test the illuminating power of Mr. Wigham's latest adaptation of gas to lighthouse illumination. The double quadriform burner consists of a series of four superposed 88-jet gas-burners placed alongside of four similar superposed burners. The eight burners are in one plane, parallel to which, and at the proper focal distance, are placed eight annular lenses on one side, and a similar set of lenses on the other side. The lights blend into one at a distance of about 1500 feet from the lighthouse. Experiments were made on two evenings, both of which were foggy. On the second evening the fog was so dense that a powerful revolving light less than half the distance of the double quadriform was entirely cut off, and the sound of a large fog-siren, driven by a gas-engine and placed alongside the experimental light, was also extinguished by the fog; nevertheless, on both occasions the double quadriform was easily seen by the naked eye, and its position readily determined, at six miles' distance. The author expressed his unqualified satisfaction at the result of his observation, and hoped that the authorities at Trinity House would be induced to come to Dublin and judge for themselves of the merit of Mr. Wigham's invention.

Section of Natural Science.—V. Ball, M.A., F.R.S., in the chair.—Note on the deposit of supposed worked flint implements at Thenay, near Blois, by Prof. J. P. O'Reilly, C.E.—On the occurrence of a tract of Old Red sandstone and Conglomerate amongst the Knockalla Hills, co. Donegal, by Prof. E. Hull, LL.D., F.R.S.—On a Clogg almanac in the Science and Art Museum, by B. H. Mullen, B.A.—Prof. Haddon exhibited models made by Krantz, illustrating the evolution of the shells of fossil Cephalopoda.—Mr. Greenwood Pain exhibited a remarkable fungus-growth on paper.—Mr. V. Ball exhibited a specimen of meteoric iron from Glorieta, Mountain, New Mexico.

PARIS

Academy of Sciences, January 25.—M. Jurien de la Gravière, President, in the chair.—Remarks in connection with a heliographic engraving representing the aërostatic experiments at Chalais-Meudon presented to the Academy by M. J. Janssen.—Studies on a phanerogamous plant (*Cymodoceites parisiensis*) belonging to the order of the Naiadeæ, which flourished in the marine waters during the Eocene epoch, by M. Ed. Bureau. This new genus, which is named Cymodoceites, in consequence of its numerous points of analogy with the genus Cymodocea, was widely diffused over the Paris basin, and tends to confirm the Indian affinities of the Middle Eocene flora already revealed by Ottelia, Nipadites, *Nerium parisiense*, &c.—Description of a differential sphygmograph invented for the purpose of easily demonstrating the peculiar veinous circulation "by influence" discovered in 1875, by M. Ch. Ozanam.—Further observations and studies on the parthenogenetic reproduction of the Phylloxera of the vine, by M. P. Boiteau. The fifteenth generation, obtained during the year 1884 by cultivation in tubes, was increased by a new series of four generations in 1885. All are at present hibernating, and appear to show no symptoms of degeneracy. Nevertheless the Phylloxera, after a prolonged existence, will probably become less vigorous, and, like the oidium, anthracnose, and mildew, may cease to be destructive to the plants which it infests.—Note on the comet recently discovered by M. Fabry at the Paris Observatory, by M. Weiss.—Orbit and ephemeris of Fabry's comet, calculated by M. Lebœuf. The elements of the orbit deduced from observations made at Paris on December 1 and January 10 are as under:—

T = 1886 April 6, 1372, Paris Mean Time

$$\left.\begin{array}{rl} \omega = & 126^\circ\ 30'\ 48''\cdot0 \\ \Omega = & 36\ 23\ 29\cdot1 \\ i = & 82\ 46\ 5\cdot5 \end{array}\right\} \text{Mean Equinox of 1886·0.}$$

$$\log q = 9\cdot808992$$

—Determination of the error of the constant of astronomical refraction by meridian observations, by M. A. Gaillot.—Note on the residuums of the double integrals, by M. H. Poincaré.—On the theory of linear equations, by M. E. Goursat.—Note on telemicrophonic instruments, by M. E. Mercadier. By telemicrophone the author understands a combined apparatus simultaneously producing the effects of the microphone and telephone, and reversible like the latter. He has constructed instruments of this kind, for which he claims the following advantages over the ordinary microphone: the possibility of a double mode of transmission with the same apparatus; reversibility of the transmitter, whereby the reception is greatly simplified; reduction of the number of organs on the microphonic posts, and consequent diminution of the total resistance of the apparatus on the same line. By this reduction the construction of the instrument may also be simplified, and its size considerably reduced.—Observations in connection with Prof. Langley's recent note on the hitherto recognised wave-lengths of light and sound, by M. Henri Becquerel. The statement attributed to the author by Prof. Langley that the most extreme radiations whose existence has been experimentally determined, do not reach a wave-length of 0·0015 mm., is denied, because the limit of observation depends essentially on the nature and delicacy of the methods employed to reveal the presence of ultra-red invisible rays.—On the transmission of copper through a volume of gas, and on the direct combination of copper with nitrogen, by M. R. Blondlot.—On some properties of the sulphur of antimony, by M. A. Ditte.—On a reagent, by means of which it may be possible to detect the acid function of the weak acids, by M. R. Engel.—On the composition of brandies distilled from wine, by M. Ch. Ordonneau. In order to ascertain the cause of the difference between neutral spirits distilled from grain, beet, potatoes, &c., and true wine brandies, the author has made a series of analyses, from which it appears that the unmistakable flavour of the latter is due to the presence in small quantities of a terpene boiling at 178° C., and whose products of oxidation are characteristic of old brandies.—On the digestive apparatus of the Phylloxera (*Ph. punctata*), by M. Victor Lemoine.—Note on the comparative morphology of the labium in the Hymenoptera, by M. Joannes Chatin.—Zoological and anatomical observations on a new species of Balanoglossus (*B. sarniensis*), discovered in the month of August 1885 at the island of Herm, a little east of Guernsey, by M. R. Koehler.—Note on the roots of the Calamodendreæ (*Calamodendron striatum*, *C. congenium*, &c.), by M. B. Renault.—On the pollinic tube and its physiological *rôle*; a new reaction of the deposits improperly called cellulose knots, by M. Ch. Degagny.

BOOKS AND PAMPHLETS RECEIVED

"The Pictorial Arts of Japan," part i. section 1, General History: Wm. Anderson (S. Low and Co.).—"Calendar of University College of South Wales and Monmouthshire," 3rd Session, 1885 and 1886 (Owen, Cardiff).—"Proceedings and Transactions of the Royal Society of Canada for the Year 1884," vol. ii. (Dawson, Montreal).—"Elements of Chemical Physics," 4th Edition: J. P. Cooke, Jun. (Macmillan and Co.).—"A Text-Book of Deductive Logic," 2nd Edition: P. K. Ray (Macmillan and Co.).—"The Year-Book of Treatment for 1885" (Cassell).—"Dogs in Health and Disease": J. S. Hurndall (R. Gould).—"Modern Science": Edward Carpenter (Heywood).—"Chemistry of the Non-Metallics": Dr. E. B. Aveling (Hughes).—"The Reign of Law in Medicine": Dr. Dyce Brown (Trübner).—"University of Wales Calendar, 1885-86" (Cornish, Manchester).

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THURSDAY, FEBRUARY 11, 1886

PRECAUTIONS AGAINST HYDROPHOBIA

THE frequency of the terrible and incurable disease known as hydrophobia has led to precautions being adopted in London, which, if universally carried out, would probably rid us of the plague.

The recent progress of scientific pathology, *i.e.* of medical knowledge which advances by the methods of observation and experiment—has made clear much which was previously obscured by traditional fables.

It is now certain that hydrophobia is a real disease, not the mere result of fright, not primarily a mental disorder at all, but a definite sequence of bodily symptoms. Even its anatomy has been investigated by the beautiful methods of modern microscopical research; and the coincidence of the results obtained by skilled histologists, working independently, makes it probable that the lesions discovered are essential and not accidental. If so, the typical part of the disease consists in a perivascular inflammation of the central nervous system, and particularly of the part known as the "bulb," or *medulla oblongata*, which is situated between the spinal marrow and the brain. Moreover, it has been ascertained that hydrophobia belongs to the group of "specific," or, as they were termed by the late Registrar-General, "zymotic," diseases, which always arise by contagion, and always "breed true." It is most improbable that it ever appears, either in man or animals, spontaneously or from common causes. In men and in brutes alike it follows the bite of a rabid dog, or other animal. How it first arose, and whether in dogs, wolves, foxes, cats, badgers, or in Carnivora before they were differentiated into the three groups of cats, dogs, and bears, with their several allied kinds—is quite unknown. But we have no historical knowledge of the origin of small-pox or measles, or even of diseases once thought to be unknown before modern times, such as syphilis, diphtheria, and cholera. The evolution of diseases, like that of the human beings and the brute creation they infest, is matter of speculation only.

Now there are three ways of dealing with these specific diseases. One is by treatment when they are fully developed. This is the business of the physician, and in some of them his treatment is so far effectual that, though prevention would be better than cure, yet cure is generally the result of rational treatment. But no effectual treatment of hydrophobia is known. In spite of the pretensions of charlatans and the constant attempts of physicians, no plan of treatment has yet been discovered which can show a single instance of success.

The second method is to arm the domain of life against an invading pest beforehand, instead of driving it out when already an entrance has been gained. This is the method first applied to small-pox by inoculation with imperfect success, and afterwards far more efficiently by Jenner's discovery of vaccination. No corresponding process of protection against other human diseases had been discovered until Pasteur's recent attempts to apply the principle to hydrophobia; but the same eminent *savant* had before devised similar inoculations to prevent more than one epidemic disease peculiar to domestic animals. We referred in a previous number to his system of inoculation as a preservative against hydrophobia, and since then the cases on which he has operated have multiplied. One difficulty of judging as to the efficacy of his method is that not more than half the persons bitten by rabid dogs develop hydrophobia; the poisonous saliva may have been wiped off the teeth by the clothing as it was penetrated, or the effusion of blood may have immediately washed it away, or some local application may have destroyed it. Another is that hydrophobia has such an uncertain and often protracted period of "incubation," more uncertain and more protracted than that of any other specific disease, varying from a few weeks, or even possibly a few days, up to eleven or twelve months, and in some rare cases reaching two years, or possibly a longer period. But now that Pasteur's inoculations have considerably exceeded a hundred in number, these sources of fallacy are more likely to be eliminated, and as the mass of evidence increases, and the time grows longer, a conclusion one way or the other will become inevitable.

There is, however, a third method of dealing with hydrophobia, independent of future possible treatment and of inoculation. It is what the late Sir James Simpson called "stamping out" the infection in the case of cattle-plague. If we could kill every rabid dog and wild animal throughout the world at once, we have reason to believe that hydrophobia would become of only historical interest. Happily it has never (so far as we know) been transmitted from one human being to another, so that it would not be necessary even to await the death of the victims already bitten before feeling secure. Destroy the disease in animals, and it would perish from among men.

But since the infection takes place in the great majority of cases by means of a dog's bite, it would be sufficient to prevent every rabid dog from biting. This of course is impossible: but if we could make a dog's bite a very rare instead of a very common occurrence, the chance of being bitten by a rabid dog would become indefinitely remote. If we could prevent dogs from biting one another, hydrophobia would cease from among dogs also. The rabid dogs would die innocuous. It has been proposed to draw the large canine teeth, but this would not entirely prevent dangerous bites, it could never be carried out thoroughly, it would give needless pain to intelligent animals, and in attempting to enforce it more bites would probably be inflicted on the operators than if the dogs had been let alone.

The only rational methods yet proposed of preventing, or rather of reducing, the number of dog-bites is first to diminish the number of dogs by imposing a higher tax on those kept as domestic animals, and by destroying ownerless, miserable, and half-starved curs; and secondly to prevent dogs biting when abroad by enforcing the use of muzzles. These may be constructed so as not to interfere with the animal breathing, perspiring, and even drinking with comfort, and yet to prevent his using his teeth.

Such muzzles are enforced and worn by a recent regulation of the Metropolitan Police, and troublesome as such interference with individual liberty (whether of dogs or their masters) is felt to be in this country, it may be

hoped that the rational part of the community will see its reasonableness, and will do their best to have it thoroughly carried out.

Similar measures have long been enforced in Berlin and other Continental cities, and have been followed by the most gratifying results in the diminution or suppression of the dreaded hydrophobia.

BOTANICAL RESULTS OF THE "CHALLENGER" EXPEDITION

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 under the Command of Capt. G. S. Nares, R.N., F.R.S., and Capt. F. T. Thomson, R.N. Prepared under the Superintendence of the late Sir C. Wyville Thomson, F.R.S., &c., and now of John Murray, one of the Naturalists of the Expedition. Botany—Vol. I. By William Botting Hemsley, A.L.S. (Published by Order of Her Majesty's Government, 1885.)

THE botanical results of the voyage of the *Challenger* hitherto published have been confined to the reports of Mr. Moseley, sent home from time to time during the voyage, along with collections of plants made by him, to Kew, and published, along with lists of the species, in the *Journal* of the Linnean Society. In the volume before us we have the results of a more detailed working up of the material thus obtained so far as it belongs to insular floras. Mr. Hemsley, who is responsible for the book, brings to his task botanical experience which begets the liveliest confidence in the thoroughness and accuracy of the work, and the volume will certainly compare with any of those upon the zoological results of the voyage already published. It is necessary to emphasise the fact that Mr. Hemsley is the author of the book, for it is not patent on first inspection. The title-page, where one naturally looks for information upon the subject of authorship, tells that the volume is published under the superintendence of Mr. John Murray, who writes barely a page of preface, but it says nothing of Mr. Hemsley, the author of the rest of the book—over 900 pages—and it is only by turning up the table of contents that his connection with the book is found recorded. This may be consistent with uniformity in the appearance of the *Challenger* publications, but hardly, we think, with consideration for the author.

Although appearing amongst the scientific results of the *Challenger* voyage, Mr. Hemsley's work has a considerably wider basis than the botanical insular collections made during that voyage. From the rich stores of the herbaria at Kew and the British Museum he has sought out and made use of collections and records of observations of travellers, both old and recent, so far as they relate to islands from which Mr. Moseley procured specimens, and he is thus enabled to present an account of all that is known of the vegetation of these islands,—in some cases their complete flora. The book is, then, no mere descriptive synopsis of the botany of the *Challenger* Expedition. Its nature may be gathered from Mr. Hemsley's own description:—

"In the introductory notes on the vegetation of the various islands included in the reports on the botany of the Expedition are embodied tables showing the distribution of the genera and species of each island or group of islands. There are also observations on the composition, affinities, &c., of the different insular floras, together with references to the diverse agencies operating in the dispersal of plants, whilst numerous facts and suggestions bearing upon the same subject are scattered throughout the lists. Finally, the appendix to the third part of the botany is devoted to the record of evidence of the part played by oceanic currents and birds in the transport of seeds from place to place. The general introduction is not limited to a mere summary of the facts contained in the reports, and speculations thereon; it has been so extended as to form an epitome of the botany of a large number of oceanic islands and of the Antarctic regions generally. The special characteristics of insular vegetation in various parts of the world are set forth and compared with continental vegetation; and, as a whole, the work may perhaps serve as an indication to travellers of the nature and extent of the observations required for the advancement of this most interesting subject."

As to method the book is divided into four parts. The first is a "Report on the Present State of Knowledge of various Insular Floras," being an introduction to the botany of the *Challenger* Expedition. The second and third parts are Reports "On the Botany of the Bermudas and various other Islands of the Atlantic and Southern Oceans," namely, St. Paul's Rocks, Fernando Noronha, Ascension, St. Helena, South Trinidad, Tristan d'Acunha Group, and St. Paul and Amsterdam Islands, and the chain of islands from the Prince Edward Group to the Macdonald Group. The fourth part consists of a "Report on the Botany of Juan Fernandez with Masafuera, San Ambrosio, and San Felix, the South-Eastern Moluccas, and the Admiralty Islands," to which is added an Appendix "On the Dispersal of Plants by Oceanic Currents and Birds."

The scope of the volume is so comprehensive, and the subject is in touch with so many of the interesting problems connected with plant-distribution, that in this notice we must content ourselves with merely indicating some of the more prominent features that characterise the book. At the outset we may state that it abounds with interesting and new facts, and the analytical tables graphically representing various facts of distribution, compiled evidently with great care, are exceedingly striking, and bring out contrasts in a manner no amount of writing could effect.

The introductory part is really a series of essays on various interesting subjects connected with phytogeography which are mainly treated in their bearing on insular floras. An early chapter deals with the classification of islands in relation to the composition of their vegetation. Wallace's classification of oceanic and continental islands, whilst harmonising with the features of vegetation of many islands, is not adapted, Mr. Hemsley thinks, for exhibiting the floral peculiarities of islands generally. The Bermudas and Galapagos, for example, included in Wallace's oceanic group, cannot be fairly placed in the same category. He therefore proposes a classification which in effect, so far as it is applied in this volume, amounts to the subdividing of Wallace's oceanic group into ancient, more recent, and new sub-groups. Islands may be arranged, he says, for phytogeographic purposes, in three categories, according to their endemic element,

namely:—(1) Those with "vegetation comprising a large endemic element, the nearest affinities of which are not always found in any one continent"; to this category belong St. Helena, Juan Fernandez, the Sandwich, Galapagos, and Seychelles Groups. (2) Those with "vegetation comprising a small, chiefly specific endemic element, the origin of which is easily traced"; here are included the Bermudas, Azores, Ascension, the islands in the southern part of the Indian Ocean, and the Admiralty Islands. (3) Those with a "vegetation comprising no endemic element" (which have become stocked with plants in very recent times); such are the Keeling and other coral islands in the Indian and Pacific Oceans. A statistical account of floras of several islands not treated of in detail in the subsequent reports is given to illustrate the feature characteristic of these several categories.

A very prominent place is given by Mr. Hemsley to the question of the "dispersal of plants by oceanic currents and by birds." In the appendix to Part III. there are descriptions of drift-seeds and seed-vessels, and of seeds and fruits from the crops of birds, collected by Mr. Moseley, Dr. Guppy, and others, to which is prefaced an historical *résumé* of the subject. We have in fact an epitome of all that has been written upon the subject up to the present time. The evidence Mr. Hemsley brings forward of the potency of these agencies in plant-dispersion is irresistible, and effectively overthrows the opinion so frequently expressed by Alphonse de Candolle—an opinion founded in great part upon the capacity of seeds to retain vitality when immersed in sea-water, as determined by experiment—that oceanic currents have played and play an unimportant part in plant-diffusion. The views of the two botanists are placed in striking contrast by a comparison of the list of species certainly or probably dispersed by ocean currents given by each: De Candolle's contains about two dozen, Hemsley's over 100. Mr. Hemsley guards himself against being supposed to regard the sea as the principal agent, or indeed as anything more than a subordinate agent in bringing about the present distribution of plants, "for it is manifest that the action of currents and birds of passage are insufficient to account for certain elements in the vegetation of many islands." But at the same time he goes so far as to maintain that the littoral flora owes its present characteristics to the fact that the seeds of the plants composing it are capable of withstanding long immersion in sea-water, and are thus suited for oceanic transport. That the present general diffusion of a large proportion of the plants inhabiting the tidal forests and sandy and muddy sea-shores of the tropics is in a great measure due to oceanic currents is, in his opinion, quite certain from the evidence; a view from which few, we imagine, will be inclined to dissent. In illustration of this subject he gives (taking a small selection of flowering-plants whose seeds are transported by oceanic currents and by birds) the following picture of the gradual invasion of an island by herbs, shrubs, and trees. "The seeds of many almost ubiquitous sand-binding grasses may be reckoned among those which are cast ashore in a vital condition, and we assume that these grasses are amongst the first flowering-plants to obtain a footing. Other herbaceous plants met with in the earliest stage of such an insular flora are *Portulaca*, *Sesuvium*, *Canavalia obtusifolia*, and *Ipomœa biloba* (*I. pes-capræ*); all of which seem to possess an unlimited power of colonisation. Moreover, they provide the conditions necessary for other plants to be able to establish themselves. Among the early shrubby occupants, *Suriana maritima*, *Pemphis acidula*, *Scævola Kœnigii*, and *Tournefortia argentea* are prominent, being found on the most remote islets of the Pacific and Indian Oceans within the tropical and sub-tropical zones. Where there are muddy shores, there the various mangroves (*Rhizophora*, *Bruguiera*, *Avicennia*, *Vitex*, &c.) take possession. Among the first real trees are *Heritiera littoralis*, *Hibiscus tiliaceus*, and *Barringtonia speciosa*, together with screw-pines. After this nucleus of a flora has been formed, it is comparatively easy for other arrivals to establish themselves; and every addition in a measure helps to provide the conditions for a still more varied vegetation." And he concludes:—"It may be safely assumed, therefore, that if oceanic currents and birds have not been the means of dispersing a large number of species of plants, and it is not certain that they have not, they are certainly the most important agents in stocking islands, for without their action the numerous remote coral islands, at least, would still be utterly devoid of phanerogamic vegetation, and consequently uninhabitable."

As a concrete illustration of the influence of these agencies in stocking islands, an analysis of the indigenous vegetation of the Bermudas is given, which shows that 45 species are chiefly littoral plants, the seeds having been probably conveyed to the island by oceanic currents; 38 are marsh plants, with small seeds, possibly conveyed to the island in mud adhering to birds, though many may have reached in vegetable drift; 13 are plants with more or less fleshy fruits, and probably were carried by frugivorous birds, leaving a very small number of species introduced, probably indirectly, by man.

In a chapter upon the Antarctic flora, and the origin of the vegetation of the islands of the South Indian Ocean, Mr. Hemsley subscribes to the view advanced by Sir Joseph Hooker, and maintained by others, that a former greater land connection in the southern hemisphere is necessary to account for the present distribution of the vegetation in this region, and that a northward migration of southern forms has taken place in the past, and has perhaps hardly ceased. He thinks a greater land connection than Wallace allows must have existed, though the continental extension demanded by Hutton is unnecessary. At the same time he admits that a land connection so great even as Wallace assumes, along with alternations of climate, removes many of the difficulties in the way of accounting for present distribution, and if Thiselton Dyer's hypothesis be accepted, that the northern hemisphere is the primary home whence a southward migration of the forms of vegetable life has taken place, he considers a sufficient explanation is obtained. But he dissents entirely from Thiselton Dyer's view, holding that "until more conclusive testimony is forthcoming of the former existence of *Proteaceæ*, *Eucalypti*, &c., in Europe, we cannot avoid the conviction that they originated in the south."

Mr. Hemsley points out that the absence of general structural peculiarities in insular plants, and the occur-

rence of their physiognomic features in many continental areas, adds to the difficulties of plant geographers. He shows that no order, no sub-order, not even a tribe, is endemic in the smaller oceanic islands, and that the very distinct genera that occur are not disproportionate. To the question, Do the flowers of endemic insular plants present any peculiarities of size, shape, or colour? we get an instructive answer in the tabulated analysis of the endemic plants of St. Helena. From it we learn that "the size of the flowers and flower-heads in this flora is on the whole rather above than below the average of those of their allies in other parts of the world. When we come to colour, however, the equality fails altogether, red being almost entirely wanting in the insular plants, and blue unknown." The absence of butterflies and the abundance of moths on the island is a significant concomitant circumstance, as Mr. Hemsley remarks. Particulars are not yet forthcoming from other islands to permit of like analysis, and Mr. Hemsley merely concludes that brilliantly-coloured flowers are rare in such islands.

Amongst the special features of insular floras discussed and illustrated by Mr. Hemsley in the introductory portion of the volume, is the preponderance of shrubby and arboreous Compositæ, and of woody plants generally. That islands "often possess trees and bushes belonging to orders which elsewhere include only herbaceous species" as Darwin stated, he shows, by tabulated evidence of the occurrence of arboreous or shrubby forms allied to insular ones upon continental areas, requires modification. To illustrate the difficult problem of the absence or rarity of large, almost ubiquitous, orders in oceanic islands, he selects Leguminosæ, Orchideæ (the table showing the absence of species or the number of species of Orchideæ in various islands is extremely interesting), and Gymnospermæ; and the concomitant rarity of insects is suggested as a probable explanation so far as the first two orders are concerned. We cannot further notice these and other fascinating subjects dealt with by Mr. Hemsley in the introduction, but must recommend botanists and all interested in the subject of plant-distribution to peruse the volume, where, in addition to the information imparted by Mr. Hemsley himself, they will find a serviceable bibliography of insular floras and an index of islands with the names of authors who have written about them.

In the introductory notes to the several floras in the second, third, and fourth parts of the book Mr. Hemsley manages to convey a vast deal of information. Accounts of the physical features, the history of the island, as well as analyses of the vegetation are given, and he finds room for illustrative extracts from the works of travellers who have visited the islands. Many interesting subjects crop up in these—for example, the question of the sandal-wood in Juan Fernandez; but space forbids our noticing them. It needs, however, little examination of this portion of the book to convince one of the genuine character of the work which has been put into the preparation of the floras. The synonymy, the distribution, the critical notes, and the general information regarding each species, all testify to a conscientious search after completeness and accuracy, the result being a thoroughly trustworthy record of what is at present known regarding them. One point we may criticise unfavourably. We notice Mr. Hemsley has adopted the system of writing all specific names with a commencing small letter. This, though a prevailing custom with zoologists, is an innovation in botanical description in this country, and without discussing methods of nomenclature, which would be beside our purpose here, we would simply say that we do not agree with Mr. Hemsley in admiring it.

We have only been able to touch upon a few points in this excellent volume, sufficient, we hope, to indicate its importance. Problems of plant-distribution meet us frequently throughout the volume, and Mr. Hemsley's work is a most important contribution towards their solution. Of especial value is his treatment of the subject of the sea and birds as factors in distribution. A somewhat disjointed character in the book and frequent repetition are defects which are perhaps inseparable from the method of its preparation. For inequalities the author apologises, and the merit of the book as a whole fully atones for them. Mr. Hemsley's deservedly high reputation as a systematic botanist, confirmed by his "Botany of Central America," now approaching completion, is still further enhanced by this his most recent work.

We may add that the volume is illustrated by many excellent plates, chiefly drawn by Miss Smith.

Besides bearing witness to the good fortune which placed the making of botanical collections during the voyage of the *Challenger* in the hands of so able a naturalist as Mr. Moseley, the volume testifies in a very emphatic manner to the inestimable value of our national herbaria, especially that at Kew. Collections of plants, small and incomplete in themselves, are there accumulated ready for use when occasion requires, forming the material from which such volumes as this we notice may be constructed. We cordially join Mr. Hemsley in his hope that his work may direct attention to the nature and extent of the observations required from travellers for the advancement of our knowledge of the subject of plant-distribution, and we may conclude with one other aspiration. There is at present no authoritative book in our language on the subject of botanical geography, and too many of the phytogeographical works published nowadays are purely statistical compilations. Is it, then, too much to expect from the pioneer in the philosophical treatment of plant-distribution, Sir Joseph Hooker, whose name is in so special a manner associated with the subject of insular floras, a comprehensive work on botanical geography such as he alone could write? We hope not.

HALSTED'S "ELEMENTS OF GEOMETRY"

The Elements of Geometry. By G. Bruce Halsted. (New York: John Wiley and Sons, 1885.)

MR. HALSTED is already favourably known to English mathematicians by an excellent "Elementary Treatise on Mensuration" (published in the summer of 1881), and by one or two carefully compiled bibliographies in the *American Journal of Mathematics*. The faithful chronicler records of Tom Tulliver that he called his Manual of Geometry "the exasperating Euclid," a title richly deserved if his desire to be excused the "doing" of it were really based upon the reason he assigned, viz. "It brings on the toothache, I think." Now we have not an annotated copy of the "Mill

ss," and so cannot identify the particular hich produced such a wretched result, but we ot it was one of the ordinary small text-books which youth were well acquainted, in shape at least, he time referred to. And this makes us allude to the ortentous dimensions of the book before us, which consists of some 370 large octavo pages. The book is not for schoolboys, but is intended for students of larger growth. It commences, as does also "The Elements of Plane Geometry" (brought out by the Association for the Improvement of Geometrical Teaching), with a preliminary chapter on Logic, which gives sufficient introduction to a subject in which "the mind first finds logic a practical instrument of great power."

We turn aside for a moment to state a *raison d'être* for the volume before us. "In America the geometries most in vogue at present are vitiated by the immediate assumption and misuse of that subtile term 'direction'; and teachers who know something of the non-Euclidian, or even the modern synthetic geometries, are seeing the evils of this superficial 'directional' method. Moreover, the attempt, in these books, to take away by definition from the familiar word 'distance' its abstract character and connection with length-units, only confuses the ordinary student. A reference to the article *Measurement*, in the 'Encyclop. Britannica' will show that around the word 'distance' centers the most abstruse advance in pure science and philosophy. An elementary geometry has no need of the words 'direction' and 'distance.' The present work, composed with special reference to use in teaching, yet strives to present the elements of geometry in a way so absolutely logical and compact that they may be ready as rock-foundation for more advanced study."

This lengthy extract puts our readers in possession of Mr. Halsted's views: the result of his efforts is an edition which will, we think, repay perusal.

Now, in reply to old Tulliver's query, "Wat's Euclid?" it was replied, "It's definitions, and axioms, and triangles, and things. It's a book I have got to learn in—there's no sense in it." (Such is the view of some boys of the present day, as we discovered in looking over answers to a recent examination paper.)

Mr. Halsted defines a straight line thus:—It is a line which pierces space evenly, so that a piece of space from along one side of it will fit any side of any other portion. In his definition of an angle (*AOB*) one of the angles is said to be the *explement* of the other; he uses the term "straight angle," calls a terminated line (as in his "Mensuration") a *sect*, and "the whole angle which a sect must turn through, about one of its end points, to take it all around into its first position, or, in one plane, the whole amount of angle round a point, is called a *perigon*." Other definitions do not call for notice, except that in the definition of a circle he has, by an oversight, omitted to state that the sect must revolve in a plane.

The First Book is divided into eight chapters, and embraces the matter of Euclid's First Book, with several other important propositions: the order is not that of Simson's text, but propositions are grouped under problems, inequalities, parallels, triangles, and polygons. This last head is broken up into the divisions, general properties (congruence), parallelograms, equivalence, and axial and central symmetry.

In Book II. the commutative law (for addition and multiplication), the associative law, and the distributive law are established, and the propositions proved symbolically. Books III., IV., V., and VI. correspond to Euclid's divisions, but the selection of propositions and their arrangement and treatment agree with results we have seen nearer home.

But we hasten to a close, remarking that the remaining books treat of planes and lines (VII.); tri-dimensional spherics (VIII.); two-dimensional spherics (IX.); polyhedrons (X.); mensuration or metrical geometry (XI.) in five chapters, length, area, ratio of a circle to its diameter, measurement of surfaces, space-angles, and the measurement of volumes. The work closes with short paragraphs on direction, principle of duality, linkage, and cross-ratio.

There are some 234 exercises grouped together at the end, and also interspersed throughout the text.

There are a few typographical errors and a few slips in statement, and very many novel terms, *i.e.* to persons who have not read the "Mensuration" referred to above. We understand that the book is about to be published in this country, when geometers will be easily able to procure a copy for an examination, which will not be unattended, we believe, with profit.

The figures are in the main carefully drawn, though some few require correction.

OUR BOOK SHELF

The Zoological Record for 1884. Edited by Prof. F. Jeffrey Bell, M.A. (London: John Van Voorst, 1885.)

WE have to congratulate the *Zoological Record* Association on having brought out this the twenty-first volume of the *Record* within the year. The publication of the *Zoological Record*, begun in 1865, was continued from 1871 by this Association, which well deserves every encouragement that the biologist can give to it. It would be a deep disgrace to our British School of Natural History if so valuable a work should be allowed to come to an end after having well and bravely struggled for existence for one-and-twenty years. At present the Association numbers only fifty-three members and seventy-one subscribers, in addition to which several of our public libraries no doubt take their copies from the publishers; but to make the Association a self-supporting one, it should have a couple of hundred new subscribers, and such a number ought to be had from among the numerous students of zoology in this country. A vigorous effort now made might mark this year in the history of the *Zoological Record* as one of financial success.

While writing thus of the present, our thoughts also wander to the past. Although none of the original writers for the *Record* have gone to their long account, yet with the present volume, the last of them, Prof. E. von Martens, ceases from his *Record* labours, and his place is to be taken by four very excellent recruits.—Prof. Herdman, Messrs. W. E. Hoyle, G. R. Vines, and G. H. Fowler. The only one of the Recorders who kept in the race for the whole of the twenty one years—Prof. von Martens—had all through the great group of the Mollusca to record, and then, on the dropping out of the ranks of other Recorders, he took the Molluscoida and Crustacea. It is not possible to part with such a contributor without publicly recording the great debt that all interested in zoology owe to him for his labours.

One other contributor, also of long standing, now parts company from his comrades. On Mr. Kirby had fallen the parts of Dallas and Rye. No less than Prof. von Martens he deserves our thanks. His part we are

delighted to know will be for the future filled by Dr. Sharp.

The editor's preface opens with a few feeling words relating to the death of the late editor, E. C. Rye; he is also obliged to record a broken promise, which thus recalls to mind an almost similar one recorded in vol. i., but with this difference—that for vol. xxi. though at the last hour a Recorder was found to supply the not forthcoming record, and has done so in a manner that, novice though he may be, shows the master's hand, for Mr. P. L. Sclater's record of the Mammalia forms not alone a scientific record, but its arrangement and style is so good and the summary of work on the general subject is so excellent as to mark it out for special notice.

Mr. Bowdler Sharpe, owing to his visit to Simla, left the record of the birds to Mr. A. H. Evans.

Mr. Gibson-Carmichael, in his record of Arachnids for 1883 and 1884, apologises for not recording a list of the new species described in the papers quoted owing "to his not feeling competent to judge of the value of new species." Here we may be allowed to utter a word of caution. A record should not of necessity be a criticism, and we would have preferred to have seen a statement of all the new species and their habitats than merely the titles of papers. For a zoological inquirer the habitat is often an assistance, and we notice that the same Recorder has not in the case of the Myriapoda been as particular in quoting these as we could have wished. Prof. Haddon has recorded the Infusoria. Certain very desirable changes in the sequence of some of the groups have been made by Prof. Jeffrey Bell, who acknowledges the receipt of money grants in aid of the publication from the Government Grant Committee of the Royal Society and the British Association, and whom we wish every success in his arduous and difficult task as editor of our British Record of Zoological Science.

Elemente der Lithologie. Von Dr. Ernst Kalkowsky. (Heidelberg: Carl Winter, 1886.)

THIS is an atteinpt, and a very successful one, to present to the student an elementary treatise, which shall be at once brief but well up to date; a difficult task in the case of a subject of which our stock of knowledge is being continually increased by results scattered through, or buried in, countless separate memoirs. The work is without figures, and is compressed into 316 pages, the first 57 of which are given to a general and introductory discussion of the characters of rocks and the methods of investigation. The reader's sound knowledge of the principles of chemistry, mineralogy, and physical optics is assumed by the author. The classification used in the larger treatises is generally adhered to. The arrangement of the information relative to each rock-family is very neat and compact: first is given a list of chemical analyses, and next a description of the macroscopical and microscopical characters of the component minerals; then follow accounts of the modes of occurrence, alteration, and genesis; and finally a short description of the varieties. The work is altogether satisfactory.

Notions Générales sur l'Éclairage Électrique. Par Henry Vivarez. (Paris: J. Michelet, 1886.)

THIS is a second edition of one of those readable and well-illustrated *brochures* that the French know so well how to write, and that have such a ready sale in their country, but which fail to secure even a publisher in this. The author is known in this country principally as a contributor to *Engineering*. His name has not been associated with any electric light enterprise, but he clearly understands that which he writes about. There is not much in the book that is new, indeed there is much that is obsolete, but what there is is clear and comprehensive. That which is French has naturally a preference over that which comes from "barbarians." The [illegible] meters and photometers is excellent. The follo[illegible] is useful:—

One carcel = 8·3 English standard candles.
= 7·5 German " " "
= 6·5 Munich " " "
= 105 litres per hour of gas

The work is not scientific. It is popular, readable, and useful.

Rome in Winter and the Tuscan Hills in Summer; a Contribution to the Climate of Italy. By David Young, M.D. (London: Lewis, 1885.)

THIS little volume must prove of practical value to a considerable class of people, that class which every year furnishes a large contingent of visitors to Italy and winter residents in Rome. Dr. Young has himself long resided in Italy, and has had ample opportunity of observing its climatal and sanitary conditions. He shows in his instructive book that Rome has got an undeservedly bad name for its climate, and the object of the volume is to show exactly what that climate is, under such heads as—the climate of Rome and its effects upon health and disease; the unhealthiness of Rome; Roman fever and malaria; water-supply of Rome; how to live in Rome; class of invalids likely to derive benefit from a resi[illegible] in Rome, and so on.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Barometric Pressure in the Tropics

THE American Eclipse Expedition to the Caroline Islands in May 1883 also made exceedingly interesting meteorological observations, of which the most important are those on the pressure of the air, as they elucidate some points in the daily period of this phenomenon (*Memoirs* of the National Academy of Sciences, vol. ii.). As this is very regular in the tropics, any difference in it points to exceedingly potent influences, and it is easy to surmise that, in the daytime, *none, except a cyclone, can be more potent than an eclipse, as no other can shade the whole extent of the atmosphere.* The result was an accelerated diminution of pressure from 10.15 to 11.30 a.m. (totality 11.32 to 11.37 a.m.), then a rise to about noon—*i.e.* at a time when there is generally a great fall—and later again an accelerated fall. The explanation is probably the following:—The accelerated fall at the beginning is caused by the diminished temperature and elasticity of the air. Then, as the height of equal pressure diminished in the shaded area, air began to flow in from the vicinity, causing a rise of pressure, and the subsequent rapid fall was a return to the normal condition.

The next total eclipse is to be on August 29 next, being visible in the morning on the Isthmus of Panama, the Leeward Islands, then Tobago, Grenada, the Grenadine Islands, and Barbados, and in the afternoon in South Africa from Benguela to Mozambique and the southern part of Madagascar. It would accordingly be important to have half-hourly barometrical observations (self-recording barometers or aneroids would be better still) at many points both of America and the adjacent islands and of Africa. We should expect to see the morning rise of pressure interrupted on the Antilles Islands (totality 7.23 a.m. at Barbados), and the afternoon fall of pressure also interrupted in Africa (totality 3.10 p.m. at Benguela).

The varying cloudiness in America and the Antilles (as the rainy season there has not the steadiness of the Indian monsoon and does not exclude clear days) would add a feature of even greater interest, as the influence of the eclipse on the daily period of pressure in clear and cloudy days could be compared. In South Africa, except the coast, where fogs are frequent at

this season, clear weather prevails, and thus there is much more hope of good observations of the eclipse. As to pressure observations, they would be most interesting at some distance from the coast. A. Woeikof

St. Petersburg, January 24/February 5

Parallel Roads

The following, from an old note-book, may be of interest in connection with this subject :—

I observed, in 1881, the formation of parallel roads on a small scale still in progress in a small plain about 3 miles long and 1 broad, marked in maps of Iceland as a lake, Sandklettavatn (lat. 64° 21′). This was surrounded on three sides by mountains, and the fourth was closed by a lava-stream. The plain is a perfect level of dark sandy mud without a vestige of vegetation, and is evidently a shallow lake for the greater part of the year. The shore is regularly terraced, the terraces being 2 or 3 feet apart. I thought at the time that the water must be dammed back regularly during the winter to a certain height, but that this height has diminished at three successive periods owing to fresh channels being found through the lava at lower elevations. In Goddalir there is a most instructive example of the formation of river-terraces. Above the broad valley there are two groups, over 1000 feet deep, terminating in a vast glacier or ice-cap. These seem to have been filled in solid with moraine, the remains of which still cling to the sides at all elevations. The eastern one evidently became cleared out first, with the [illegible] that an enormous mass of gravel was spread over the [illegible]e width of the valley below. The western one next started [illegible]rrent of its own, which cut down the level for some distance on its own side to 30 or 40 feet lower. Finally, both torrents united, and their greater transporting power again cut down the level some 30 feet, with the result that there are now two level terraces and the basis of a third. J. Starkie Gardner

Colours in Clouds

The coloured fringes to, and in, clouds I long ago found to be very common, but I had no idea that there was any novelty, as there would seem to be, in this fact.

When the sun is setting behind a bank of clouds and there are high cumulo-strati or strati, these will almost always, I believe, be found coloured, at the proper distance from the sun, if viewed through a suitable dark glass. The edges of the dark cloud will often be so too. I believe these colours are always present ; hidden by the brightness of the cloud which shows them, and the glare of the lower air. The former is removed by the dark glass, the latter by the interposition of the bank.

The tint I believe depends on the density of the cloud where it is formed. But it seems more probable that the real cause is that the particles (of ice?) are larger and more numerous where the cloud is more dense, and that, if their size were increased independently of the density we should have exceptional cases.

I have seen these fringes to bright edges of dense cumulus, but I must own that I never was quite satisfied that I was not seeing two strata of cloud. The colours are very beautiful, and often so strong that it is difficult to realise that the dark glass has only removed a concealing glare. J. F. Tennant

Ealing, January 29

Movement of Telegraph-Wires

I have frequently noticed the peculiar movement of telegraph-wires noticed by your correspondent. For some time I took it to be an ordinary case of vibration, but it presented so many peculiar features that I was induced to examine it more closely. It frequently happens that when the temperature and dew-point of the air are at or about the freezing-point, and the sky is clear, the wires are chilled by radiation, and hoar-frost is deposited upon them. With an almost imperceptible wind the hoar-frost collects almost wholly upon one side of the wire in the form of a wing, producing a torsional strain. The weight of the hoar-frost, as compared with the weight of line, is so small that their common centre of gravity is almost coincident with the centre of the wire. When in this condition, if a light wind acts upon the frozen wing, it imparts a reciprocating rotary motion to the wire. Each time the vibration brings the plane of the protuberance in a line with the eye, the wire almost disappears from sight, while when it is at right angles to that line it flashes suddenly into view. If looked at from such a point that the wing of hoar-frost moves backwards and forwards behind the black wire, the effect is very much more marked.

R. Mountford Deeley

Mill Hill, Derby, February 2

The Deltas of Glacial Rivers

An interesting fact connected with the Lake of Geneva has recently been brought to light by M. Hörnlimann, who is now preparing a hydrographical chart of the Leman basin. From the point where the Rhone enters the lake, to a distance of more than 6 kilometres, the river-water, which is denser than the lake-water, follows a trench in the alluvial deposits which is from 500 to 800 metres wide, and which, even beyond St. Gingolph, where the depth exceeds 200 metres, is 10 metres deep. A precisely similar groove has been observed at the mouth of the Rhine in the Lake of Constance, with a depth of 70 metres and a width of 600 metres ; and similar though less deep grooves are found opposite to the old mouths of the Rhone and the Rhine in the two lakes. The greater density of the river-water is owing to its lower temperature and to the vast quantity of sediment suspended in it. The deltas of glacial rivers flowing into lakes differ, then, in a remarkable manner from the deltas of most rivers flowing into the sea ; the water of these rivers, being less dense than that of the sea, spreads over the surface, and thus helps to form bars. G. H. W.

MAHWA FLOWERS

Attention has been publicly drawn of late to "Mahwa Flowers"—the corollas of *Bassia latifolia*—as a cheap source of cane-sugar. This species of Bassia is a tree attaining to a height of 40 to 60 feet, and common in many parts of India, especially in Central Hindustan. It has oblong leaves of firm texture, from 5 to 6 inches long ; these fall in February, March, or April, and are succeeded in March or April by the flowers. These last for two or three weeks and then begin to fall. The falls take place at night, and continue sometimes for a fortnight. The fruits, which resemble a small apple, ripen in three months ; the seeds, one to four in number, yield an edible oil by pressure. It should be added that the trees are self-sown, and that they flourish in very poor and stony soil.

When the Mahwa tree is in bud, the ground beneath it is cleared of weeds, sometimes by burning. A single tree may yield as much as six to eight maunds[1] of flowers ; even thirty maunds have been asserted to have been collected from one tree. These flowers have a luscious but peculiar taste when fresh ; when dry they resemble in flavour inferior figs. They form a very important addition to the food of the poorer classes in those districts where the tree abounds, particularly in the neighbourhood of woodlands and jungles. They are specially useful in economising cereals in seasons of famine and drought. They are sometimes eaten fresh, but more commonly sun-dried, and are usually consumed with rice and the lesser millets, or with seeds of various kinds, and leaves. It is said that a man, his wife, and three children may be supported for one month on two maunds of Mahwa flowers.[2]

It is not, however, as a direct article of food, nor as a material for the preparation of a rough spirit by fermentation (a very common use of these flowers) that Mahwa blossoms are now recommended. It has been affirmed that they may be employed as an abundant and very cheap source of cane-sugar. In the *Morning Post* of October 15, 1885, appeared an article on this subject, in which it was stated that, "If the Mahwa flowers be available in sufficient quantities for the sugar-makers of Europe, there can be no question that the days of the

[1] A Bengal maund equals 82¼ lbs. av. indepdt.

[2] For an interesting account of the Mahwa tree and its products, see a paper by E. Lockwood in the *Journal* of the Linnean Society ("Botany"), vol. xvii. pp. 87–90.

beetroot are over, and sugar-cane will go the way of all discarded products." This prediction depends, however, upon another condition besides that of the abundance of the flowers. If the sugar they contain be wholly or chiefly cane-sugar, that is, "sucrose," then the argument is not without weight. But the nature of the saccharine matter of the Mahwa does not appear to have been ascertained. MM. Riche and Rémont (*Journ. de Pharm. et Chimie*, 1880, p. 215) stated that the air-dried flowers contain 60 per cent. of fermentable sugar, of which about one-seventh is crystallisable. The material available for analysis in Europe consists, of course, of the dried flowers. These may have suffered some change beyond the mere loss of water, but the evidence they afford on chemical examination is not favourable to the view that they are likely to compete with sugar-beet or sugar-cane as a source of cane-sugar. Here is the result of an analysis of a sample of Mahwa flowers (from the Kew Museum) in their air-dried condition :—

	In 100 parts
Cane-sugar	3·2
Invert-sugar	52·6
Other matters soluble in water ...	7·2
Cellulose	2·4
Albuminoids	2·2
Ash	4·8
Water lost at 100° C....	15·0
Undetermined	12·6

The flowers analysed had a slight smell of fermented saccharine matter and a distinct acid reaction. But it is not at all probable that they could have contained any large proportion of cane-sugar even when quite fresh, and that 15/16ths of that sugar had been inverted during the process of desiccation. We cannot argue from analogy in this case. For while the nectar of many flowers contains no sugar except sucrose, invert-sugar occurs in some blossoms, as well as in many other parts of plants. Even the unripe and growing stems of the sugar-cane and of many grasses contain much invert-sugar. It must, however, on the other hand, be remembered that cut sugar-canes imported into this country contain a large amount of invert-sugar, and that if they be kept a week only after the harvest the invert-sugar naturally present in the juice shows a marked increase and the cane-sugar a corresponding diminution. On the whole, then, so far as the materials at my disposal enable me to judge, I believe that the saccharine matter of fresh Mahwa flowers will be found to consist mainly of dextrose and levulose, and that consequently they will not be available as a material for the economic production of sucrose.

I have to thank Mr. W. T. Thiselton Dyer, C.M.G., Director of the Royal Gardens, Kew, for drawing my attention to this subject, and for a supply of the material on which I have worked.

A. H. CHURCH

THE UNIVERSITY EXTENSION MOVEMENT[1]

THIS "movement" is one of the most significant of the present day, and provides a most useful step in that ladder of learning which it is desirable to see reaching from the elementary school up to the University degree.

Under the University Extension system, knowledge of the highest character is offered by its acknowledged possessors to all classes alike, yet with the very popular qualities of cheapness and attractiveness. The contents of this paper fall naturally into two heads : first, the advantages offered and the objects aimed at by those engaged in the work ; and, secondly, hints and instructions as to the methods by which the work may be successfully carried on. Mr. Moulton vigorously urges the former, and has ten years' experience in the latter.

The ideal aimed at is, that a University education should be placed within the reach of any "person" in any grade of society, and that large bodies of students all over the country should be attached to the University as associates, of whom, if few ever became full members, yet any might do so, and all have started on the road. The Universities have set themselves to meet the wants of classes who have been long debarred from such privileges ; and an ample page of knowledge will be spread before the eyes of all whom partial education may lead to seek it yet further.

The desire has long been felt both among middle and lower classes. The old Literary and Philosophical Society on behalf of the one, and the old Mechanics' Institute of the other, were both anxious attempts to do, by voluntary effort and amateur work, what the University now offers to undertake as a special business, by means of an itinerant system of authorised teachers taken from their most highly-trained and successful graduates. Under the eye of the Syndicate, and not making popularity their end, they will have a power at their back and a guarantee of their quality and of its permanency which the old lecturers could never give.

The great difference, accordingly, from the single desultory lectures given at the old institutions [illegible] thoroughness of the instruction aimed at under new system rising by stages to the full studies of the University. No subject is undertaken in a set of less than twelve lectures ; notes are expected to be taken, the books recommended by the lecturer are expected to be read, and a class is held before or after the next lecture to incite and help the students. An examination takes place at the end of the course requiring a higher standard than the ordinary college examination, and not a lower one on account of the student's difficulties, for such students are allowed eventually to take a University degree, and it is correctly felt that it would be exceedingly mischievous in any way to lower the standard now required for that. This may seem a high one for candidates often consisting of a large proportion of working men, but nevertheless, in many cases where comparison could be made with young men resident at college, the former have proved to have the advantage over the latter. This again is not incredible ; persons attending these lectures are drawn from all classes alike, yet all are volunteers, who have felt their want and chosen their subject—the best soil for any seed of knowledge to fall upon. It is not the upper classes only who are found to appreciate higher education, but it has proved to be a cause which can rouse passionate effort among working men placed in the most unfavourable conditions.

The Universities thoroughly sympathise with the demand in these days for knowledge in the lines of science and of modern history. There is perfect freedom from holding up classics and ancient languages, and abstruse mathematics as the *summum bonum*. The principal supporters of the movement are clearly divided into favourers of science, and favourers of literature and art, and an effort is made to thoroughly meet either demand. Indeed, nothing is more striking in reading this publication than the elasticity with which the University sets itself to fit its syllabus of subjects, and its arrangements for teaching them, to the various wants of the different bodies who wish to avail themselves thereof—whether colleges, philosophical societies and institutes, free libraries, subscription libraries, or special societies or companies for the purpose. Instances are given of the lectures being carried on by all these various bodies, and to all who would make use of this means of increasing knowledge, practical advice is here given upon matters down to those of the smallest range, and we may quote the following experiences :—

Ladies more than gentlemen are glad of the educa-

[1] "The University Extension Movement." By R. G. Moulton, M.A. With an Introduction by Prof. Stuart, M.P. (London : Bemrose and Sons, 1886.)

tion here offered, and ladies accordingly should always form part of the committee; young people also who have lately left school and can attract their companions to continue whatever study they have liked or felt the value of; pupil teachers—often, hereafter we hope, as at Hull now, the School Board paying the fee—attending as a matter of business; and artisans who feel their deficiencies. The trades unions of the latter already, some of them, spend 1000*l.* a year in education, and if men can also be attracted here to increased knowledge, lay in a solid foundation of some science at a course of lectures, and get their intelligence awakened to what is going on in the world around them, public-houses will to them be no great temptation, and much of their work will be carried on more intelligently.

Where, as is generally the case, from three to five towns at no great distance apart can agree upon a course of lectures to be given, and audiences can be drawn to both afternoon and evening deliveries, it is found that the charge made to one of the courses need not exceed three shillings for the set of twelve lectures. Nevertheless the financial difficulty is described as the greatest both to lecturers with the rich University at their back, and to hearers, who certainly may lose working-hours and perhaps feel the attendant small expenses of books, &c. It is one of the most curious characteristics of this movement that the lectures are assiduously attended by all classes of society alike, and yet the seekers after knowledge themselves do not value it at its cost price, even when offered on so liberal and economical terms. However, higher education always did require the help of the patron of letters and of the founder of the college, and he who assists these classes may rest satisfied that he is carrying on their work in a modest way.

Prof. Stuart in his Introduction hopes, and cannot doubt, that the University or some other competent body may realise the vast influence and noble position here to be attained. The compressed population of England possesses great economical advantages over the scattered townships of America. It cannot be believed that financial difficulties will be suffered to stand in the way of this movement, and we may look forward to seeing our Universities literally worthy of their name through offering all knowledge to all sorts and conditions of men.

W. ODELL.

THE NEW NATURAL HISTORY MUSEUM IN VIENNA

THE two magnificent palaces in the Ringstrasse, opposite the old Kaiserburg, designed, the one for the conservation and exhibition of the art history, the other of the natural history, collections of the Imperial Court, are rapidly approaching completion. Completely alike as they are in their decorations and their style of architecture generally, their interior arrangement does of course in each case conform with the special requirements of the collections each is intended to receive. The lateral front, 69·38 metres long, faces the Ringstrasse; the main fronts, at right angles to the Ringstrasse, run, with a length of 169 metres, parallel to each other, separated by a square which is laid out in garden plots, and is to be crowned in the centre by the monument of Maria Theresia. The design and execution of the two buildings emanate from one of the most eminent architects of Vienna, Karl Baron Hasenauer, who is at present directing likewise the erection of the Court Theatre, and the reconstruction of the Hofburg.

The building occupying the more western site, and destined to receive the Natural History Museum, is somewhat further advanced as a whole than its eastern compeer. A few particulars regarding this Institute will be acceptable to the readers of NATURE.

The collections hitherto kept apart, and now about to be united into one grand and indivisible whole in the new building, are under the supreme direction of the Royal and Imperial Chief Staff of Stewards of the Court (*Oberstthofmeisteramt*), the present head of which, Prince Constantine Hohenlohe, takes a most lively interest in this branch of his administration. They embrace:—

(1) The Mineralogical Court Collection, hitherto distributed in four rooms of the Hofburg and some smaller underground compartments there. These comprise the mineralogical, geological, and palæontological treasures.

(2) The Zoological Court Museum, popularly known as the "Naturalien Cabinet," hitherto exhibited in a quarter of the Hofburg, in Josephsplatz, adjoining the Court library.

(3) The Botanical Court Museum, which, along with the herbarium of the University, found its accommodation in a structure situated in the Botanical Gardens, and belonging to the University.

(4) The Prehistoric, Anthropological, and Ethnographical collections, hitherto not exhibited, but kept packed in various depots.

The new building destined for the accommodation of these collections possesses four stories. The lowest, elevated but a few feet above the level of the street, and distinguished as the "*Tiefparterre*," is arranged as a storehouse, with assorting rooms for the different divisions of the Museum, and here, too, the chemical laboratory for the mineralogical department is to be fitted up. The next two stories, distinguished as the "*Hochparterre*" and "First Floor," are designed for the exhibition of the various objects that will be arranged for general view. Each of them consists of a suite of nineteen halls, ranging from 200 to 260 square metres in area, disposed all round the exterior face of the building, which stands on free and open ground, in such order that, entering from the staircase, visitors will be enabled to pass through them in a continuous series, re-issuing into the staircase at a place opposite to that by which they entered. Inside this exterior suite of rooms, and looking down into the two large courts, are ranged a series of smaller compartments in a line parallel to that of the large halls, destined in part likewise for purposes of exhibition, but mainly for the libraries of the different departments and the laboratories of the various divisions.

The plan for the distribution of the different collections in the halls, and for the general arrangement of the whole, was drawn up by my predecessor, Intendant Hofrath von Hochstetter, who, unhappily, was called away in the midst of his ardent activities in the summer of 1884; and, except in the case of a few quite subordinate alterations, this plan has been completely maintained.

The former Mineralogical Court Collection is divided into two assortments: a mineralogical-petrographical and a geological-palæontological. The first, which is under the care of the custodian, Dr. A. Brezina, assistant to Dr. Friedrich Berwerth, has the Halls I. to V. inclusive in the *Hochparterre* (see figure) assigned to it. In the central repositories of the Halls I. to III. will be shown the finest specimens of our long-celebrated collection of minerals, arranged in the main according to the system of Groth. The wall-cases, having higher frames, will exhibit in part the larger specimens, and in part local series of minerals. In the window recesses in Hall III. will be disposed a collection of polished precious stones.

Hall IV. will display in its wall-repositories a collection representing the paragenetic relations of minerals, as also smelting processes.

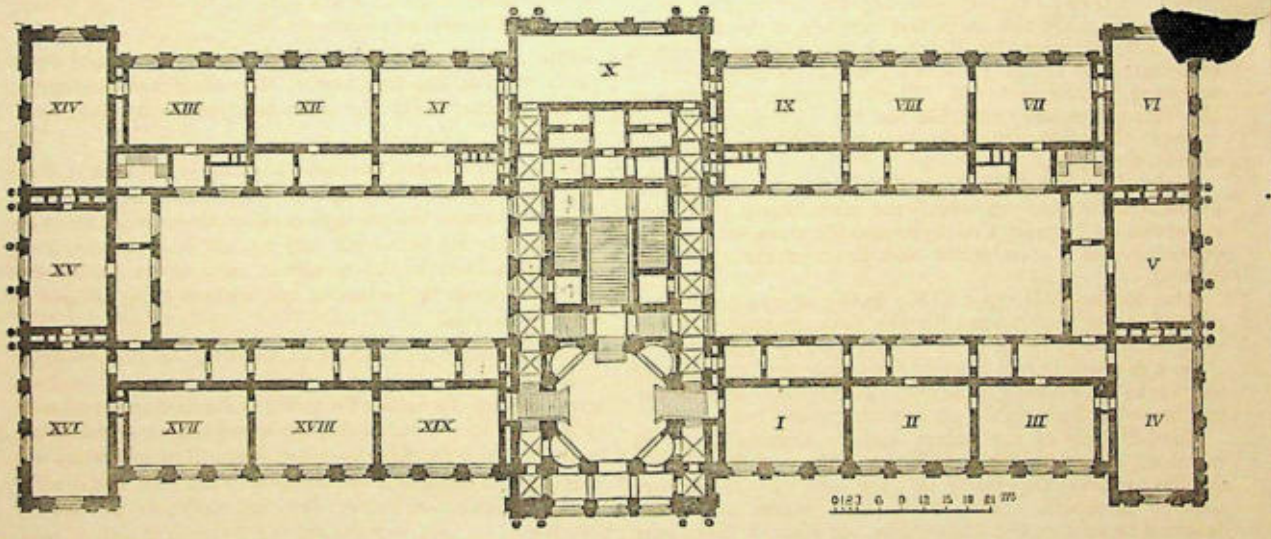
The central cases of Hall V. are intended to accommodate the meteorites. These will constitute the most brilliant point in the whole division. According to the last inventory of Dr. Brezina ("Year-Book of the Royal and Imperial Geological Institute," 1885, p. 151), this collec-

tion, on May 1, 1885, represented no less than 358 localities in 1197 specimens, having a total weight of 1,134,836 grammes. The wall-repositories of this hall will contain the collection of stone species, as also the beautiful and instructive collection of building materials amassed by a voluntary fellow-labourer, Herr Felix Karrer.

The Halls VI. to X. are destined for the Geological Division. At the head of this department is Herr Theodor Fuchs, with his assistants, Herren E. Kittl and F. Wähner. In Hall VI. will be displayed the rich phyto-palæontological collection acquired for the Museum in largest part by purchase from Baron von Ettingshausen, and containing the types enumerated in his many descriptive works, a collection which has already been exhibited by himself. In the wall-repositories of this hall a collection of instructive specimens is to be presented, illustrating the dynamic processes in the formation and transformation of stones. The Halls VII. to IX. will present to view the collection of petrifactions classified, in the first place, according to the grand orders of the different ages and, within this classification, according to the zoological system. Hall X., finally, is destined for the exhibition of the skeletons of the larger Mammalia of the Cænozoic age, as also of the numerous and beautiful moa skeletons we possess.

The treasures of this last hall will enable the student to pass now, without break of continuity, into the prehistoric series of specimens under the direction of Herr F. J. Szombathy, with Herr N. Wang as his assistant. This collection will extend through the Halls XI. to XIII. Sorted into great groups, there will be displayed in these spaces the accumulations of the Palæolithic and Neolithic periods, the Bronze period, the Hallstätter period, the Latèn period, then of the Roman and Merovingian periods. Within these large groups the distribution will be of a geographical character, so that each locality will have its own treasures of the prehistoric age grouped by themselves. The most prominent section in this division will be formed by the excavations from the celebrated burying-field on the Hallstätter Salzberg, and hardly less interest will be excited by the disentombments from the caves of Moravia and Krain, from the settlements and burying-grounds in Carinthia, in Krain, in Northern Bohemia, &c.

The remaining spaces of the *Hochparterre* are allotted to the ethnographical collections under the supervision of the Custodian, Herr Franz Heger, with his assistant, Dr. M. Haberlandt. Here, too, the arrangement will be of a geographical nature, Halls XIV. and XV. being



assigned to the ethnography of America, Hall XVI. to that of Australia and Oceania, and Hall XVII. to that of Africa, while Halls XVIII. and XIX., along with some smaller adjoining compartments, will represent the ethnography of Asia. In this division, which will have all the charm of novelty for our Viennese public, the richest collections are those from Brazil, and, next to these, from the regions of the Upper White Nile.

In complete accordance with the structural arrangement of the *Hochparterre* is that of the "First Floor," in which the Halls XXI., XXII., and so on, will range themselves exactly above the Halls I., II., &c., the intermediate number of XX. being borne by the vestibule in the *Hochparterre*. The whole of this "First Floor" is devoted to the exhibition of the zoological collections. This division falls under the supervision of the Director, F. Steindachner, who has, in addition, specially reserved to himself the care of the collections of Fishes, Amphibia, and Reptiles. Other officials of this division are Herr A. von Pelzeln and Friedrich Kohl for the Mammalia and Birds; Profs. Brauer and Dr. E. Becher for the Mollusca; Herr A. Rogenhofer for the Lepidoptera, Hemiptera, and Hymenoptera; Herr L. Ganglbauer, for the Coleoptera and Orthoptera; Prof. F. Brauer, for the Diptera and Neuroptera; Herr C. Kölbl, for the Crustacea, Myriapoda, and Arachnida; Dr. G. von Marenzeller and Dr. von Lorenz, for the other divisions of the invertebrate animals.

Most richly represented in the zoological division are,—the group of birds, in respect of which, and more particularly the types from Brazil—thanks to the collections of Natterer, formed in his time—our Museum still, perhaps, takes the first rank among the Museums of Europe; the group of fishes, which recalls to mind the labours of Heckel, a Kner, and recently our excellent Steindachner; the group of insects in general, and, in particular, that of the Diptera, in which are incorporated, among other collections, the celebrated ones of Meigen and Schiener, &c.

In Hall XXI. are exhibited the Protozoa, Cœlenterata, Echinodermata, and Vermes; in Hall XXII., the Arthropoda; in Hall XXIII., the Mollusca; in Halls XXIV. to XXVI., the Fishes; in Halls XXVII. and XXVIII., the Amphibia and Reptiles; in Hall XXIX., a special collection of the Birds of Austria-Hungary; in Halls XXX. to XXXIII., the systematic collection of Birds; and in Halls XXXIV. to XXXIX., the Mammalia.

In some adjoining rooms on this floor will be exhibited the very rich and magnificently prepared collection of

fish skeletons presented to the Museum by the Director, Steindachner.

The highest story of all, the so-called "Second Floor," presents the same distribution of halls and adjoining rooms as do the *Hochparterre* and the "First Floor." The halls distinguished by the numbers from XLI. to LIX. correspond with the Halls I. to XIX. in our sketch.

The spaces on this floor will, as a rule, not be admissible to the public at large, but will be mostly appropriated as workrooms for the officials of the establishment and for experts to whom the use of the collections and other appliances is to be granted on the most favourable conditions possible.

One half of the second floor, comprising the halls from XLI. to XLIX. inclusive, will be set apart for the zoological division. Here the main collections of the invertebrate animals, only a small part of which can be exhibited on the first floor, will be kept in closed cases. Two halls will accommodate the skeletons of the Mammalia and birds, and one hall will lend itself as a library to the accommodation of periodical literature of general interest, while all publications of special departments will be distributed in the workrooms of the respective divisions.

Hall L. is destined for the collection, already very rich, [illegible]man skulls and skeletons.

[illegible]ls LI. to LIV., inclusive, are devoted to the botanical division. On the death, last summer, of the custodian of this department, Dr. Reichardt, the charge of it was committed to Dr. G. Beck, with whom is associated as assistant, Dr. Szyszylovic. The first three halls contain the herbarium, very valuable for the numerous original types it possesses; the last comprises the collections of woods, fruits, &c.

Halls LV. and LVI. form the reserve rooms for the geological division, in which the particularly rich chief collection of Tertiary Conchylia and the more subordinate collections of Foraminifera and Bryozoa are to be bestowed.

The Halls LVII. to LXIX., finally, are to be appropriated as reserve rooms for the ethnographical collection, which is growing at an extraordinarily rapid rate.

Be a few words still allowed me respecting the state of the works yet needing to be completed before our Museum can be opened for public entertainment and instruction.

The building of the palace and its decoration in all exterior parts is finished. All the halls, workrooms, and dwelling-rooms are ready for use and in large part already occupied. The cases and stand apparatus destined to receive the collections are also in large part already set up or in process of being set up. Building operations of any serious extent yet remaining to be done are confined to the interior, and more particularly the central axis of the building in which the staircase stands. This work, however, is of such compass that, according to the declaration of the superintendent of the building, it will yet claim nearly two years before it is ended. So far as the collections themselves are concerned, they are all, with the exception of the large Mammalia, already transferred into the new building, and a beginning has also been made in arranging and disposing them. With the final completion of the building, this latter work will likewise be completed, and then will this new establishment for scientific labour and for the instruction of the public be at once opened.

FRANZ VON HAUER

Vienna

NOTES

THE Council of the Royal Meteorological Society have arranged to hold at 25, Great George Street, S.W., on the evenings of March 16 and 17 next, an exhibition of barometers. The Exhibition Committee invite co-operation, as they are anxious to obtain as large a collection as possible of such instruments. A list of some of the principal patterns of which the Committee desire specimens has been prepared, and may be had by applying to Mr. William Marriott, Assistant Secretary. The Committee will also be glad to show any new meteorological apparatus invented or first constructed since last March, as well as photographs and drawings possessing meteorological interest not previously exhibited.

THE appointment of Sir Lyon Playfair to be Vice-President of the Council will be welcomed by all friends of education and of science. Sir Lyon's recent utterances on the duty of the State as to the promotion of scientific research must be fresh in the memories of our readers; and it will be interesting to watch to what extent the Minister's practice accords with his creed.

THE inauguration of the statue of Claude Bernard by Guillaume took place on Sunday last, at the entrance of the Collège de France. Speeches were delivered by MM. Paul Bert, Berthelot, Chauveau, Dastre, Fremy, and Renan. The audience was large, in spite of the very cold weather. The statue of Bernard stands near a table on which has been placed a dog undergoing dissection. The animal is partly concealed by a large bronze sheet on which are written these words—"Glycogenie Diabete—Nerfs vaso-moteurs—Substances toniques—Liquides digestifs," which may be considered as giving a summary of the extent of Claude Bernard's disquisitions and discoveries.

THE death is announced of Dr. Arnold Konstantin Peter Franz von Lasaulx, Professor of Mineralogy and Geology at Bonn University. He died at Bonn on January 25, aged forty-six years.

AT the last sitting of the Paris Academy of Sciences M. Paul Bert took leave of his colleagues. He said that his academical qualifications were the principal cause of his appointment to his mission. He will be brought into contact with the *savants* of the East, and he is hoping to convert them to the principles of the West merely by persuasion and without being obliged to resort to coercion.

THE Académie des Sciences, in awarding the Prix Montyon to M. Girard, the director of the laboratory opened in Paris seven years ago for testing the quality of the food and drink sold by the tradesmen of the capital, has issued a report which shows how much good this laboratory has done. The laboratory was first opened in 1878, and specimens of wine, beer, cider, milk, chocolate, coffee, tea, &c., are examined daily; so, too, are the colours used for toys, sweetmeats, and liqueurs, as well as pork suspected of containing trichinosis, and tinned meats. Some of these samples are brought by the public, and the analysis is made free of cost when all that is asked is whether they are free from adulteration. If, however, an analysis of their proportionate composition is required, the laboratory makes a small charge, and this brings in an annual income of about 1200*l.* a year. A larger number of samples are, however, brought in by the twenty inspectors who are attached to the laboratory, and whose duty it is to visit the different taverns and grocers' shops, and examine the articles offered for sale. These inspectors are provided with a microscope and with acids, which enable them to test a good deal of merchandise on the spot, and they only bring back to the laboratory specimens of the articles which they have reason to suspect are adulterated. There are twenty-five chemists attached to the laboratory, each of whom has his own special department, one taking milk, another wine, and so on. Each sample is divided into two parts, one of which is kept as evidence in case it should be found to be adulterated. The municipal laboratory analyses about 25,000 samples per annum at a cost of about 8000*l.*

THE total rainfall at the Ben Nevis Observatory during 1885 was 146·50 inches, the largest monthly fall being 24·33 inches in

December, and the least 4·97 inches. On December 12 there fell 5·34 inches, and on the following day 3·52 inches, or 8·86 inches on these two days.

Amongst the objects which will be exhibited in the Ceylon Section of the forthcoming Indian and Colonial Exhibition will be a large ethnological collection from the Maldive Islands.

The discovery of a portion of the vertebral column of a specimen of *Mosasaurus gracilis*, Ow., is announced to have been made in the hard white limestone or chalk of Whitewell, near Belfast.

Dr. Archibald Geikie, Director-General of the Geological Survey, has now completed his "Class-Book of Geology," and the work will be published during next week by Messrs. Macmillan and Co. This volume completes the series of educational works on physical geography and geology projected by Dr. Geikie.

It is interesting to note that the trout and salmon reared in February last year by the National Fish Culture Association have achieved the growth of 6½ inches, which is remarkable considering they have been subjected to an artificial existence. The whitefish hatched in 1885 have reached the size of 5 inches.

The iris of the eye of Italians is most commonly chestnut; according to M. Mantegazza, the proportion of such is 64 per cent., the black eyes number 22 per cent., the blue 11, and the gray 3. Piedmont and Lombardy have the largest proportion of gray eyes; Venetia, of blue. In general the chestnut colour of hair amounts to 71 per cent.; then comes the black hair, 26 per cent.; then the blond, 3 per cent. (though in Venetia it is 8). Black hair is rare in Venetia. More than three-fourths of the Italians have abundant hair. Southern Italy excels Northern in this respect; in Tuscany the poor heads of hair preponderate (58 against 42 per cent.). As to beards, the colour does not always coincide with that of the locks. While chestnut preponderates, this preponderance is less marked; and one sometimes finds chestnut locks with blonde, and more often brown, beards. Bushy beards with abundant locks are most common in the South of Italy. In two-thirds of Italy, the natives wear the beard short or are clean shaven. This practice dominates especially in Tuscany (82 per cent.); the Sardinians have most long beards (50 per cent.). Red hair in Italy has been a subject of discussion among anthropologists; some think red-haired persons are remnants of a race almost extinct, and which extended to the banks of the Rhine and into England; others think red hair a mere physiological accident, from which no conclusion can be drawn. In Italy throughout one finds a few cases of red hair. In one commune, Sant' Agata di Puglia, red hair is predominant. No explanation has been given of the fact. Baldness is most common in Tuscany. In Italy generally, of 10,000 young men examined for military service 20 were rejected for premature baldness, and 52 for diseases of the scalp.

Mr. Charles T. Newton, C.B., will on Tuesday next (February 16) give the first of three lectures at the Royal Institution on "The Unexhibited Portion of the Greek and Roman Sculptures in the British Museum" (illustrated by drawings and casts).

It has been recently pointed out that the number of births in France per 10,000 inhabitants has diminished more than one-third in a century. It was 380 in 1771-80, 289 in 1831-40, and only 241 in 1871-80.

Several Continental geologists have been lately engaged in tracing the marks of the Ice Age on the Northern Alpine slopes. According to Dr. Brückner (in *Naturforscher*), the decrease of size in the diluvial ice-streams from west to east, corresponding to a decrease in the glaciers of the present, and due, no doubt, to the lowering of the region eastwards, is a noteworthy feature. Then it is becoming even more clear that there were at least two ice-periods, separated by a long interglacial period. The number of geological profiles containing two moraines (an older and a younger) deposited by glaciers, and separated by a layer which cannot have arisen under the ice, is considerable; in the region indicated nineteen such are known. The separating layer is in some cases loam (from weathering); in others it contains diluvial coal; in others it is formed of river deposits, &c. The position of these profiles shows that the ice-masses must have shrunk to the highest parts of the range after the first ice-period. The climate of that interval was probably much like the present; this is inferred from examination of the interglacial coal of Innsbruck, &c. The second glaciation was not so extensive as the first; for to the north of the moraines of the later glaciers appears a projecting strip, of more or less breadth, of the older moraines. This outer zone of moraine has also some special features in composition. In the interglacial period the rivers cut valleys in the masses deposited by the older glacier-streams; and these were filled again when the later glaciers came. Between the Rhine and the Traun there is evidence of a still earlier period of glaciation. Again, the coincidence of limits of the lake-region in the northern border of the Alps with those of the diluvial glaciers is significant. While some geologists attribute the lake-basins to erosion by glaciers, others think they were pre-glacial, and only prevented by the glaciers which occupied them in the Ice Age from being filled with earthy matter, &c. Dr. Brückner notes the fact that most of the geologists who have studied the features of the Bavarian lakes, take the former view, while those who have studied the Swiss lakes (where the relations are more complicated) take the latter.

The London Stereoscopic Company's second annual International Amateur Photographic Exhibition, 1886, will be held at the Art Galleries, 103, New Bond Street, W., from April 15 to May 24.

There were (according to Dr. Dujardin-Beaumetz) 19 deaths from hydrophobia in Paris last year—a number higher than in previous years; and yet the number of stray dogs destroyed was also higher (viz. 5060). Of these 19 persons, 15 were males and 4 females. The youngest was a little girl of 5½ years; the oldest, a man of 63. The time of incubation varied from 19 months (in the case of a young man of 26) to 29 days (a child of 11). In only one case was the time of the bite unknown. Excluding that, and the exceptional case of 19 months, an average of about 2 months is arrived at for the time of incubation. As to duration of the disease, the extreme limits were 1 day and 8 days; average 3½ days. In no case were the lower limbs bitten. In 12 cases out of 18, the upper members were bitten, especially the hand (9 times out of 12), the wrist twice; in the 6 other cases it was the face (5 times) and the skull (once) that were attacked. Lastly, in 17 cases of the 18, the bite was that of a dog; in the remaining case, it was that of a cat. It will be noted that these statistics relate only to *deaths* from hydrophobia.

Fermentation can be utilised (as was shown by Roberts in 1861) for quantitative determination of sugar in urine. The method has been recently developed by Herr Einhorn (*Virchow's Archiv*), and he claims that the test will indicate one-tenth per cent., or even, if the fermenting liquid be previously boiled ten minutes, one-twentieth per cent. of sugar (the common reduction and polarisation-tests are exact to about 3 per cent.). Herr Einhorn uses three tubes of special shape: one with normal urine having no sugar, another with the urine to be examined, and the third with urine having sugar added to it. The urine, whether containing sugar, or normal, is boiled and diluted with boiled water to the amount of the original volume. Compressed yeast is added to the liquid in the proportion 10 per cent. Acetic acid is of no use for the fermentation, and may be prejudicial.

A SWEDISH naturalist has collected some remarkable statistics of the important part natural history and certain other branches of science have played in the names assumed by the Swedish nobility when elevated to that rank. As regards zoology, five names begin with Lejon (lion), and six with the German equivalent Löwen, Lewen, or Len. Only one name begins with Örn (eagle), but six with the German form, Adler. The mythical animals Grip (griffin) and Drake (dragon) have been appropriated by six and three families respectively. Of other animals and birds of prey, Tiger (tiger) is represented by four families, Ulf (wolf) by three, Björn (bear) by three, Falk (falcon) by three, Geijer (hawk) by two, and Räf (fox) by one. There are, further, two families whose names begin with Oxe (ox), one with Hast (horse), two with Elg (elk), one with Hjort (stag), one with Rålamb (doe), one with Get (goat), one with Svin (swine), one with Bäfver (beaver), one with Dufva (dove), one with Reiher (heron), one with Stork, one with Gadda (pike), three with Rud (carp), one with Ödla (lizard), and one with Bräma (gadfly). Many more names have been taken from trees and plants. Thus, fourteen begin with Lilje (lily) and Ros (rose) respectively, eleven with Lager (laurel), nine with Ceder (cedar), seven with Ek (oak), six with Lind (lime), and [illegible]non. If we turn to astronomy, numerous stars form the pre- of [illegible]es of names, but in no case the sun or the moon. Fourteen begin, and eleven end, with Stjerna (star). It is mentioned that the famous name, Oxenstjerna, is a corruption of the German word Stirn (forehead), which is proved by the family escutcheon, and is not derived from the above word.

A CORRESPONDENT gives some interesting particulars to a Norwegian journal of the habits of herring jumping out of the water when frightened. He states that he has observed whole shoals of this fish, in their anxiety to escape when pursued by whales, piled up above the surface of the sea to a height of from three to six feet. On one occasion the fish formed a mass even with the top of the mast of a fishing-boat, viz. about fifteen feet, and had part of the same fallen into the boat it would doubtless have sunk.

THE following are the results of a very elaborate mathematical inquiry which Prof. N. Joukowsky has recently made into the laws of motion of a solid body having hollows filled up with a homogeneous liquid. Various shapes of hollows filled with liquid have been considered, as also the case of a vortex-motion of the liquid having interior friction. Some phenomena of the interior motion of the liquid itself, in the case of the solid body when caused to rotate, were verified by experiments which proved conformable to the theory; they have shown that in a body whose rotation-velocity is decreasing from its surface to its centre (*e.g.* a glass sphere filled with water, and which is brought into motion), the molecules flow from the poles to the [illegible]uator, and *vice versâ* where, the rotation being suddenly [illegible]pped, the speed of rotation is on the decrease from the centre to the circumference. The general conclusion of the inquiry is, that if we have a hollow body filled with a liquid, and this system be brought into motion, its motion will tend to reach a limit characterised by one of the chief axes of inertia of the body taking the direction of the chief momentum of the communicated motion, and the whole system will rotate around this axis as a single body—the speed of rotation being constant, and equal to the quotient obtained from the division of the force applied by the momentum of inertia of the system with regard to this axis. M. Joukowsky asks,—Does it not explain the circumstance that our planets, notwithstanding the variety of their occasional primary velocities, all rotate around their axes of inertia?

IT is stated in Paris that the telegraph now extends to Langson in Tonquin, on the Chinese border. As already mentioned in NATURE, on the Chinese side the telegraph was carried during the recent military operations in Tonquin from Canton to Lungchow, about thirty miles from Langson. Hence, with the exception of this short gap of thirty miles, the telegraph extends in an unbroken line from Saigon in the south of the Indo-Chinese peninsula to Pekin, where five years ago there was no telegraph whatever. The rapidity with which, since 1881, it has spread all over China, and has come into general use, is one of the wonders of modern days.

THE "binding" effect of intense cold and a fierce wind on snow is remarkably illustrated by a photograph, in *Science*, of a large mass of snow formed on one side of a telegraph pole (at the top) near the summit of Mount Washington. Lieut. Schwatka notes this in relation to the building of snow houses by the Eskimo. While the cohesion of snow in our latitudes (and the early Arctic snow) is of a plastic, wet, or "pasty" nature, the snow used in building, packed by high wind and cold, is dry and almost stone-like. Cutting a thin portion gives a shower of fine powder as from loaf-sugar. Blocks of this snow ring like a well-burnt brick, or a bar of suspended steel struck with the hand. Lieut. Schwatka remembers a block rolling down hill 15 or 20 feet, and says, "I doubt if a rolling guitar would have given forth many more confused musical tones than the bumping block as it struck and bounded down the hard stone-like bank of snow." The least quantity of ice in the snow, however, makes it more or less worthless for building. To produce this snow, it may not be necessary that the wind and the low temperature have occurred together, but both must have happened before the Eskimo will use the snow for building.

A STRONG shock of earthquake took place in the Island of Lemnos in the night of January 17-18. There was no subterranean noise.

AN earthquake is reported from Jaska and Samobor (Croatia) on January 23. Two violent shocks were felt at 9.35 a.m. on that day. No considerable damage was done, although many walls show fissures.

AN International Exhibition will be held at Madrid in 1888.

THE Calcutta Correspondent of the *Times* telegraphs, under date the 7th inst., that Mr. Ney Elias, the new British Consul to Kashgar, has made a successful journey down the Upper Oxus, through Shignan and Koshan, to Badakshan. He was everywhere well received.

THE Calcutta *Englishman* states that, shortly after the last cyclone suddenly burst over Madras, the local Government wrote to the Government of India, suggesting that telegraphic communication should be established between Madras and either Sumatra or the Nicobars for the despatch of storm-warnings. The Indian Government, however, considers that the value of meteorological stations in these localities in relation to the Storm Signal Service on the Madras coast is by no means established. Experience has shown that the storms which reach Madras are in most cases formed on the east or the north-east coast of Ceylon, and that therefore telegrams from the opposite side of the bay would give little or no help in forecasting the approach of storms. The Government of India, therefore, suggests that the telegraphic reports from Pondicherry and Negapatam, as well as from Jaffna and Trincomalee in Ceylon, would be more likely to give the required information.

A REMARKABLY strong Artesian spring has been struck, at a depth of 155 feet below the surface, at Alnwick, in a boring which the Local Board are having sunk for the supply of the town. This spring, which was met with in a bed of sandstone, rises to no less than 30 feet above the surface, and is flowing with increasing volume at the rate of 115,000 gallons per diem. The site of this boring is at an elevation of some 200 feet above the level of the town, from which it is about two miles distant

THE additions to the Zoological Society's Gardens during the past week include two Maholi Galagos (*Galago maholi*) from West Africa, presented by Mrs. Max Michaelis; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Corbet; an Indian Otter (*Lutra nair* ♂) from Ceylon, presented by Capt. J. C. Withers; a Ring-tailed Coati (*Nasua rufa* ♂) from South America, presented by Lieut. J. H. N. Theed, R.N.; a Red-bellied Waxbill (*Estrelda rubriventris*) from West Africa, presented by Mrs. T. Johnson; two Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Mr. F. J. Dawe; a Malbrouck Monkey (*Cercopithecus cynosurus* ♀) from West Africa, two —— Lemurs (*Lemur* —— ♂ ♂) from Madagascar, a Common Boa (*Boa constrictor*), an Anaconda (*Eunectes murinus*) from South America, deposited; a Great Kangaroo (*Macropus giganteus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE DOUBLE-STAR 61 CYGNI.—The determination of the orbit of this double-star has hitherto baffled those astronomers who have attempted to deduce it from the numerous measures which have been made. Thus one computer finds the relative motion of the components to be rectilinear, another hyperbolic, and another circular, but in no case have the determinations been altogether satisfactory. Recently, however, Dr. C. W. Peters, of Kiel, has succeeded in obtaining elliptic elements, with a periodic time of 782·6 years and angle of eccentricity = 10°, which appear to represent the great mass of observations which have been made from the earliest times down to 1883, with considerable accuracy. Herr Peters has computed the following ephemeris from his elements:—

Epoch ...	1885·0 ...	1886·0 ...	1887·0 ...	1888·0
Position ...	119° 44′ ..	120° 7′ ...	120° 31′ ...	120° 55′
Distance ...	20″·60 ...	20″·71 ...	20″·81 ...	20″·92

Taking the parallax of 61 Cygni to be 0″·45, it appears from these elements that the combined mass of the system is about one-half of the sun's mass, whilst the mean distance between the components is about 70 times that of the earth from the sun.

THE ZODIACAL LIGHT.—In October 1883 Prof. Arthur Searle presented to the American Academy of Arts and Sciences a very valuable paper on the zodiacal light, in which he had collected and reduced on a uniform system the evening observations of all the principal observers. The principal points then brought out were that in all probability the apparent changes in the latitude of the zodiacal light were due mainly, if not entirely, to the effect of atmospheric absorption, and that the method of observation by drawing outlines must be replaced by careful photometric observations if definite knowledge was to be substituted for the vague information we now possessed as to the "Gegenschein," the "zodiacal bands," &c.; and Prof. Searle concluded with the suggestion that the ordinary meteoric theory would gain greatly in simplicity by the substitution of meteoric dust scattered generally throughout the solar system for the meteoric rings that have been usually imagined. Prof. Searle has continued his investigations in a recent memoir, in which he corrects, for the effect of atmospheric absorption, Jones's observations of what the latter called the "stronger light" at the elongation 60°, whether made in the morning or evening. The result of the inquiry is to confirm the view arrived at previously, that atmospheric absorption largely affects the apparent position of the zodiacal light, and Prof. Searle again lays stress on the need for photometric observations. Prof. Searle concludes that, after correcting for atmospheric absorption, there seems reason to think that the zodical light has had, during the present half-century, a more northern latitude near the longitude 180° than near the longitude 0°. He also shows, from a careful study of the distribution of the stars in the *Durchmusterung*, that "upon the meteoric theory of the zodiacal light it is to be expected that a continuous zodiacal band should be present; but the question of its actual visibility is complicated by the slight maxima of stellar density which are situated along those parts of the ecliptic most readily accessible to observation from stations in the northern hemisphere." An interesting result is obtained from an examination of the elements of the 237 asteroids first discovered, from which it would seem that "the belt of sky occupied by the projections of the orbits of" these asteroids "presents certain peculiarities which correspond to those of the zodiacal light, and suggest the hypothesis that the light may be partly due to minute objects circulating in orbits like those of the smaller planets."

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 FEBRUARY 14-20

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 14

Sun rises, 7h. 18m.; souths, 12h. 14m. 23·7s.; sets, 17h. 11m.; decl. on meridian, 12° 56′ S.: Sidereal Time at Sunset, 2h. 50m.

Moon (Full on February 18) rises, 12h. 34m.; souths, 20h. 27m.; sets, 4h. 21m.*; decl. on meridian, 18° 22′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	7 15 ...	11 46 ..	16 17 ...	17 29 S.
Venus ...	6 39 ...	12 29 ...	18 19 ...	2 51 S.
Mars ...	19 27* ...	2 4 ...	8 41 ...	6 32 N.
Jupiter ...	20 44* ...	2 45 ...	8 46 ...	0 37 S.
Saturn ...	12 17 ...	20 28 ...	4 39* ...	22 43 N.

* Indicates that the rising is that of the preceding evening and the set that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

Feb.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
14 ...	111 Tauri...	... 5½ ...	1 51 ...	2 34	... 164 273
14 ...	117 Tauri...	... 6 ...	3 10 ...	3 59	... 130 297
18 ...	ξ Leonis ...	... 6 ...	2 19 ...	3 21	... 95 296
19 ...	48 Leonis...	... 6 ...	3 44 ...	4 43	... 87 301
20 ...	τ Leonis ...	... 5 ...	1 5 ...	2 0	... 23 293
20 ...	13 Virginis	... 6 ...	21 36 ...	22 23	... 72 176

Feb.	h.	
18 ...	19 ..	Venus at inferior conjunction with the Sun.
19 ...	4 ...	Mercury in conjunction with and 11° 22′ south of Venus.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2 ...	81 16 N. ...	Feb.	16, 21 58	*m*
λ Tauri	3 54·4 ...	12 10 N. ...	,,	14, 22 43	*m*
			,,	18, 21 35	*m*
W Virginis	13 20·2 ...	2 47 S. ...	,,	17, 0 0	*m*
δ Libræ	14 54·9 ...	8 4 S. ...	,,	18, 23 28	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,,	20, 0 48	*m*
U Ophiuchi	17 10·8 ...	1 20 N. ...	,,	16, 3 9	*m*
			and at intervals of	20 8	
β Lyræ	18 45·9 ...	33 14 N. ...	Feb.	14, 14 30	*m*
			,,	17, 7 0	*M*
δ Cephei	22 24·9 ...	57 50 N. ...	,,	14, 21 30	*M*

M signifies maximum; *m* minimum.

CHEMICAL NOTES

WE have already mentioned M. Konovaloff's researches into contact actions, published in the *Journal* of the Russian Chemical Society (1885, vii. and viii.) The following conclusions of his inquiry are worthy of being noticed:—The capacity of solid bodies for condensing gases on their surfaces is generally recognised, but their capacity of dissociating them under certain conditions must also be recognised now as a property of all solid bodies, although shared in by them in different degrees. Platinum enjoys this property to a high degree, but also many other solid bodies, glass among them, the intensity of its contact action obviously depending upon several circumstances: its chemical composition, the structure of its surface, and its temperature, as also upon the density of the gas it is brought in contact with. It being so, it appears possible, in the author's opinion, that in the dissociation phenomena studied by Sainte-Claire Deville (and having so great an importance for the theoretical discussions upon the dynamics of chemical reactions), the dissociation observed was a consequence of the contact action of

the solid body. Contact action seems also to have played its part in the researches of M. Lemoine on the dissociation of hydrogen iodide. On the whole, in all those cases where the process of chemical transformation in a gaseous medium offers an uninterrupted character, there is reason to suppose that a contact action has been taking place. But if this supposition proved to be correct, we should be compelled to admit that the chemical transformation, even in its simplest shape in a gaseous medium, is intimately connected with the action of molecular forces—that is, with such actions which do not have the characters of determinated chemical combinations. Molecular forces ought to be taken into account even in the transformations going on in a gaseous medium; both factors—the chemical affinity and the cohesion—appear so intimately connected that it would be impossible to delimitate them: the chemical reaction would appear as a result of both the forces which unite atoms in molecules and those which are at work between the molecules.

THE last issue of the *Journal* of the Russian Chemical Society (xvii. 7) contains the first part of a most valuable inquiry, by M. Konovaloff, into the part played by contact actions in dissociation. Without undertaking to deal with this immense subject in full, the author, taking advantage of observations he had made together with Prof. Menschutkin during their experiments as to the dissociation of compound ethers, has submitted to a closer investigation the contact phenomena when gases are brought into contact with solids. The want of cohesion between the gaseous molecules, and the great difference of densities of both the gas and the solid, give better conditions under which to study the influence of the solid. Summing up the researches of Sainte-Claire Deville, Würtz, Faraday, Ramsay, Berthelot, and many others who have devoted attention to the subject, the author shows that capillary structure and porosity are not necessary conditions in a solid body for producing dissociation: smooth surfaces may also condense vapours and gases, and sometimes retain them with such a force as to make the disengagement of the absorbed gas quite correspond to the dissociation of a chemical compound. The character of the surface, having of course a great importance, M. Konovaloff has carried on his experiments so as to study the influence of the character of the surface. The first part of his inquiry contains the experiments made as to the dissociation of the tertiary amylacetate, the method of inquiry being successive determinations of the density of its vapours on W. Meyer's method. The result arrived at is obviously that the structure of the surface of the glass which is brought into contact with amylacetate vapours is of great importance; but it is worthy of notice that the rough surface of the glass-powder condenses the vapour without producing a notable dissociation, while the smooth surface of the glass-cotton dissociates it.

THE INSTITUTION OF MECHANICAL ENGINEERS

THIS Institution held its annual meeting at the theatre of the Institution of Civil Engineers on Thursday and Friday last under the presidency of Mr. Jeremiah Head, who was re-elected for the ensuing year.

A paper was read by Mr. J. H. Wicksteed descriptive of an autographic test-recording apparatus of a very ingenious character. It is designed to obviate both the labour of observation and that of hand-plotting. But, beside the saving of time and labour, there is the further gain, in obtaining the diagrams autographically, that the progress of the test is continuous; and as time is a factor in the behaviour of a test-piece, it is important in making tests for comparison that there should be no irregularity in this factor.

The sample is held between an upper and lower gripping-box. The upper box is suspended from the back centre of a steelyard, which, by the adjustment of its poise-weight, weighs whatever pull is put upon the sample. The lower box is connected with a hydraulic cylinder, which puts the pull upon the sample, and extends it until it breaks. Thus while the hydraulic cylinder is doing the mechanical work of breaking the sample, the steelyard is measuring the load it sustains. The object of the indicator is to record simultaneously the amount of the load and the extension due to it. To get this simultaneous record the horizontal ram of the indicator, which carries the tracing pencil, is in fluid connection with the hydraulic cylinder which puts the load upon the sample, and the indicator therefore partakes of that load. Round the outer end of the ram is coiled a spiral spring, which is compressed as the pressure on the ram increases, and expands as the fluid pressure on the ram decreases; the pencil records the point of equilibrium between the two. The friction of the leathers in the hydraulic cylinder and that of the indicator ram are both eliminated from the diagram, the first by putting on to the piston of the hydraulic cylinder a gross pressure equal to the effective pressure on the sample and the friction of the hydraulic leathers, and the second by revolving the indicator ram by belt power and gearing; the driving power being applied in a plane at right angles to the longitudinal travel of the ram has no effect upon that travel, but entirely overcomes the obstruction which the friction of the leather would otherwise offer to the free travel of the ram, so that the ram becomes sensitive enough to respond to the very smallest want of balance between the opposite forces of the water pressure and the spring. For recording the extension of the sample simultaneously with the load upon it, the metallic paper on which the pencil travels is mounted on a brass barrel like that of an ordinary steam indicator; and in accordance with the extension of the sample the barrel is made to revolve by means of an arrangement which eliminates any general movement of the sample, recording that only which is due to its extension.

The author summarises the autobiography of every specimen strained to the breaking-point in the testing machine. Entering the machine in a state of internal equilibrium, its first stage is what is called in the paper one of unyielding elasticity; it extends about 1/10,000 of its length per ton of load, but on removal of the load remains unstrained. In its second stage the strains and stresses fluctuate, the bar yielding about 2 per cent. of its length, the strain being beyond recovery. The pencil of the indicator hesitates and almost trembles. There would seem to be a succession of local extensions in the bar, as was lately pointed out by Prof. Kennedy in this journal (NATURE, vol. xxxi. p. 504). These local extensions reduce the area locally in a higher ratio than the cohesive force increases; fracture would at once occur were it not that after a short critical interval the bar sets up increased resistance, thus entering its third stage. Stable equilibrium is restored, but the permanent strain increases in its ratio with every additional ton, and the bar may stretch 20 per cent. During the last stage the equilibrium is again unstable; the pencil steadily records a rapidly-decreasing resistance, accompanied by a local strain which, over the part where it occurs, is very much greater than in any preceding stage. The author concludes by drawing attention to the circumstance that the apparatus records definitely the elastic limit of the material, the diagram traced gives the gross mechanical work put upon the sample, as it enables the local extension about the breaking-point to be separated from the general, thus affording a means of comparing samples of different shapes; and lastly the apparatus makes its record quite independently of the manipulation of the poise upon the steelyard.

A paper descriptive of tensile tests of iron and steel bars was read, prepared by the late Mr. Peter D. Bennett. His principal object in making these tests was to ascertain the relative effect produced on the tensile strength of a flat bar of iron or mild steel: (1) by a hole drilled out of the bar to the required size; (2) by a hole punched ⅛ inch smaller in diameter, and then drilled out to the size of the first hole; and (3) by a hole punched in the bar to the size of the drilled hole. In each of the former cases the average strength was increased per square inch of the original area across the fracture; in the third case there was a falling off in strength of nearly 20 per cent. owing to the method of perforation. The results in the first two cases were alike both for iron and mild steel, but in the third case the diminution in strength of mild steel was only 6 per cent. In another series of tests the perforated hole was filled with a rivet put in by a hydraulic machine with a pressure of thirty-one tons on the head, the results being relatively as before. The author considers these results to be due to the fact that in the drilled bar the slightly greater strain indicated was reached only along the transverse diameter of the hole, and that the strain on the metal decreased along the longitudinal diameter of the hole until it was distributed over the whole width of the bar. Thus, at the point where it was most severely strained the metal would receive some support from the less severely strained parts adjoining.

The tests go to prove that the elongation of different test-bars, all of the same length, is greatly affected by their diameter, those of larger diameter elongating more than those of smaller

diameter, and that as the specimens decrease in length the contraction of area at the point of fracture decreases also; and, in consequence, the tensile strength increases when reckoned on the original area, and decreases when reckoned on the fractured area. The elongation in percentage of the original length is also very much increased in the shorter specimens, owing to the fact that the greater part of the elongation then takes place much nearer to the point of fracture, instead of being more equally distributed, as it is along the length of the longer bars.

A paper was read by Mr. A. A. Langley, descriptive of a hydraulic buffer-stop for railways, the chief advantages of which are absence of recoil after collision, continuous uniform resistance for bringing a train to rest, and absence of shock or breakage either in train or in buffer. The chief feature is the application of hydraulic resistance by the use of pistons working in horizontal cylinders filled with water, and fixed in line with the buffers of the rolling-stock.

THE VALUE OF THE REFRACTION GONIOMETER IN CHEMICAL WORK[1]

IMPORTANT advances in chemistry have often been the result of new methods of research, and these have generally involved the use of new apparatus. The introduction of the balance made the greatest of revolutions in chemistry; but the thermometer, the blowpipe, the polariscope, and the spectroscope in its multifarious applications may also be cited as examples.

My object is to speak of the refraction goniometer or spectrometer, by which the refraction and dispersion of bodies can be measured. The construction of this instrument, and the use of it, which ought to be a part of the regular training of chemical students, may be learned from many works on physics, but it is very fully described in Glazebrook's "Optics," together with the manner in which the angular measurements are reduced to refractive indices. By means of this instrument the index of refraction is easily obtained for liquid bodies; solids or gases require a more complicated apparatus, but those of them which can be readily dissolved in any liquid can be determined from their solutions.

The index of refraction (μ) of a body is a definite physical property, like its boiling-point, specific gravity, or solubility, and ought to form part of our knowledge of any substance. I have generally determined it for the line A of the spectrum of the sun; but Continental observers have usually adopted the red line of hydrogen, which is coincident with the solar line C.

The length of the spectrum—that is, the difference between the indices of refraction of extreme rays, say the lines H and A, which may be taken as the measure of dispersion—is another physical property, and an equally important one.

If the index of refraction and the dispersion of a substance be accurately known, we have a double test of the purity of any specimen that may have to be examined.

As, however, the refraction varies with temperature and other circumstances, it is better to deal with the specific refraction, that is, the index, minus unity, divided by the density $\left(\frac{\mu - 1}{d}\right)$. This is little, if at all, affected by pressure, heat, change of aggregate condition, mixture, solution, or, generally speaking, by chemical combination. Thus the specific refraction of water under different circumstances has been determined as follows, the observations being reduced for the line A of the spectrum:—

Water	Specific refraction
Liquid, at 1° C.	0·329
,, at 48° C.	0·329
Solid	0·331 [2]
Gas	0·324
Mixture with alcohol ...	0·330 [3]
Water of crystallisation ...	0·330 [4]
,, ,, ...	0·327 [5]

The identity of the specific refraction of a body in the solid state or in solution has been frequently proved; the last instances determined were as follows, the observations on the crystals being made by M. Soret, and on the solutions by myself:—

Substance	Solution	Crystallisation
Ammonia alum	0·2780 ...	0·2784
Soda alum	0·2613 ...	0·2604

For the purpose of calculation, however, it is more convenient to adopt what Landolt denominated the refraction equivalent, that is, the specific refraction multiplied by the atomic weight $\left(p\frac{\mu - 1}{d}\right)$. The refraction equivalent of water may be taken, therefore, as $0{\cdot}3295 \times 18 = 5{\cdot}93$. Of this, the two atoms of hydrogen may be assumed from observations on other bodies to represent 2·6, leaving for the atom of oxygen 3·33.

The specific refraction and dispersion of a body not merely gives an indication as to its purity or otherwise, but tells the quantity of the substance with which it may be mixed, if that substance is known. Thus Landolt has applied it to the quantitative analysis of mixtures, and gives examples, such as ethyl alcohol and fousel oil, ethyl alcohol and ether. I have applied it myself in the estimation of carbolic acid in disinfecting powders, by dissolving the acid out in a known quantity of alcohol, and determining the refraction and density of the solution.

In chemical investigations among organic compounds the determination of the specific refraction of the products is very valuable. Thus, in a recent investigation on the action of the copper-zinc couple on bromide of benzyl by Mr. Tribe and myself, there were three different ways in which it led us to results which we should not otherwise have arrived at.

(1) The viscid mass which resulted from the action appeared very unpromising, but, on examining it with the prism, its specific refraction and dispersion were so high that we determined to purify it, and this led to the discovery of the new hydrocarbon benzylene.

(2) When the reaction was performed in the presence of alcohol, it seemed probable that toluene would be produced; but the liquid, when heated, distilled off at 78°, which is the boiling-point of pure alcohol. Instead, however, of throwing the distillate away, it was examined in a hollow prism, and seen at once to be something very different. Indeed, the increased refraction and dispersion led to the belief that one-fifth of it was toluene, though that boils at 110°. On adding water, a liquid separated, which was proved to be toluene by its boiling-point and density, as well as by its specific refraction and dispersion, 0·5604 and 0·0474, agreeing sufficiently well with the known figures.

(3) On another occasion, among products of fractional distillation was a liquid which had too small a refraction to allow of its being considered a hydrocarbon. It was suspected that the low refraction might be due to oxygen or bromine; and this led to a further examination and the discovery that the liquid contained a new bromine compound.

But another important application of these physical properties is to the elucidation of the chemical structure of various bodies. A very large amount of information as to specific refraction is now at our disposal through the labours of different experimenters, not only in this country, but in Germany, Italy, Russia, Holland, and Sweden; and the whole course of recent investigations goes to show (1) that the specific refraction of a body depends essentially on its ultimate atomic constitution; but (2) that this is modified in certain definite ways by the molecular arrangement or structure. Thus, to take an instance: sugar, $C_{12}H_{22}O_{11}$, whether crystallised or dissolved, has the refraction equivalent of 119·3. If, however, we take each atom of carbon at 5·0, and water at 5·93, we should obtain the figure 125·1 as the calculated value. The discrepancy is far too great to be attributed to errors of experiment, and points to the fact that sugar is not, strictly speaking, a carbohydrate; that really it does not contain water, but that the hydrogen and oxygen are otherwise arranged, as chemists have concluded on other grounds. The oxygen in all hydroxyl compounds is 2·8, according to Brühl, and this would give for sugar the theoretical value 119·5, which is almost identical with the experimental number.

In a similar way it has been very fully substantiated that carbon, whenever it is in the condition which is termed "double-linked," has the value, not of 5·0, but of about 6·1. Hence in any compound the constitution of which is doubtful, we can tell how many carbon atoms are in this condition. Thus, to take terpene, $C_{10}H_{16}$. This has been the subject of much discussion among chemists, one considering it to have one pair of carbon

[1] Communicated to Section B of the British Association, at the Aberdeen meeting, September 1885.
[2] Rausch. [3] Landolt; mean of three observations.
[4] In ammonia alum; Charles Soret.
[5] In double sulphates; Topsoe and Christiansen.

atoms double-linked, others two pair, and another as many as three pair. On these three suppositions its refraction equivalent would be 73·0, 75·2, and 77·4 respectively. Now the various isomeric terpenes have a refraction equivalent of about 72·9, leading to the belief that only one pair of carbon atoms is in that condition. This conclusion is enforced by the specific dispersion, which averages 0·0299. From the analogy of other compounds containing ten atoms of carbon and which are of known constitution, about this amount of dispersion might be expected to occur in a $C_{10}H_{16}$ having one pair of carbon atoms double-linked.

I do not know how far chemists may be disposed to accept these optical properties as the arbiter between rival theories of constitution; but their value as helps will not be denied.

With reference to this mode of experimenting, it should be borne in mind that a very small quantity of a substance suffices for the purpose of observation; and whereas chemical processes use up material, the refraction of a liquid can be taken with no other loss than the small amount which unavoidably clings to the vessels employed. This even may be recovered if it is worth the trouble.

A table of the approximate refraction equivalents of forty-six of the elements was drawn up for my paper in the *Phil. Trans.* of 1869. Many of these have since been re-determined, either by myself or other observers, and a new edition of the table was prepared for the Montreal Meeting of the British Association, and appears in the *American Journal of Science* of January 1885. Carbon, oxygen, nitrogen, sulphur, phosphorus, iron, chromium, silicon, and doubtless other elements have two or three different values; and the special circumstances under which these different effects upon the rays of light occur offers a most promising field for any future investigator.

J. H. GLADSTONE

THE RAINFALL OF THE BRITISH ISLANDS[1]

CLIMATE may be defined as that peculiar state of the atmosphere in regard to heat, moisture, and rainfall which prevails in any particular place, together with its meteorological conditions generally, in so far as these influence animal and vegetable life. The diversified characters which climate displays may be referred chiefly to the combined operation of these four different causes, viz., distance from the equator, height above the sea, distance from the sea, and prevailing winds.

The greatest differences, however, in the local climates of places situated at no great distance from each other arise from differences in the rainfall. The arid plains of the North-Western Provinces of India as compared with the fertile higher slopes of the Himalayas contiguous to them, and the widely contrasted climates of the western and eastern slopes of Scandinavia respectively, may be cited as illustrations. In the British Islands there are perhaps no stronger contrasts of climate than those presented by Skye and the Laigh of Moray. The mean temperature of these two regions in no month of the year differ so much as two degrees, and for several of the months they are nearly identical. But the rainfall of Skye rises towards, and in many places exceeds, 100 inches annually, whereas over the Laigh of Moray it is only about 26 inches. Now it is this difference in the rainfall, with the clear skies and strong sunshine that accompany it, which on the one hand renders the south shores of the Moray Firth one of the earliest and finest grain-producing districts of Scotland; and, on the other, renders the island of Skye quite unsuitable for the remunerative cultivation of cereal crops. It is this aspect of the rainfall which gives it so paramount a place in the climatology of a country.

Of all meteorological data, the rainfall is the most difficult to represent cartographically; and there is no other way to arrive at even a tolerable approximation to the average rainfall of a district than by numerous rain-observing stations well distributed over its surface. Hence in this inquiry all available statistics of the rainfall for the period of years selected have been used,—the number of stations being 1080 in England and Wales, 547 in Scotland, and 213 in Ireland—in all, 1840 stations. Notwithstanding this comparatively large number of rain-gauges, very extensive districts remain wholly, or all but wholly, unrepresented.

The period selected for the investigation is the twenty-four years ending 1883, and the principal sources from which the information has been obtained are the returns published by the Meteorological Societies of England and Scotland and by Mr. Symons. For the method of discussing the results we refer to the recently published Part of the *Transactions* of the Scottish Meteorological Society, pp. 131-33. It may be here enough to say that the whole of the averages have been calculated for, or reduced to, the same term of twenty-four years beginning with 1860 and ending with 1883.

The 1840 averages were then transferred to large maps of England, Scotland, and Ireland, and from the results thus shown the British Islands were shaded into six divisions, these shadings showing the districts where the mean annual rainfall

1st does not amount to 25 inches
2nd is from 25 to 30 ,,
3rd ,, 30 ,, 40 ,,
4th ,, 40 ,, 60 ,,
5th ,, 60 ,, 80 ,, and
6th above 80 inches.

On the map exhibited on the wall these divisions are shown by three tints of blue and three of red,—the blue showing a rainfall exceeding forty inches annually, and the deepest tinted blue the regions of largest rainfall; and the red a rainfall less than 40 inches, the lightest tint marking off those parts of England where the rainfall is least, or where it is less than 25 inches annually.

The regions of heaviest rainfall, marked off by 80 inches annually, or upwards, are these four:—

(1) The greater part of Skye, and a large portion of the mainland to the south-east, as far as Luss.

(2) The greater part of the Lake District.

(3) A longish strip including the more mountainous portion of North Wales, and

(4) The mountainous district of the south-east of Wales.

The rainfall is also heavy on Dartmoor, and certain portions of the west of Ireland; but in these parts it does not appear quite to reach 80 inches.

The West Highlands present the most extensive region of heaviest rainfall in the British Islands. The mountain-masses along whose slopes and plateaus the rainfall is precipitated, offer a practically unbroken face of Highlands directly in the course of the rain-bringing winds from the Atlantic. Particular attention is drawn to the circumstance that these mountain-masses present many lochs and valleys directly in the course of these winds, up which therefore the winds are borne, and these cooling as they ascend pour down the deluges of rain which deeply trench the sides of the mountains in the lines of their water-courses.

This region of heaviest rainfall lies so far to the north of Ireland that the rainfall is not lessened by a previous partial drying of the Atlantic winds in their passage thither. To southward, however, it is quite different. Over the whole of the extensive tract of Great Britain from Luss to the Lake District there is not a single rain-gauge whose annual average reaches 80 inches, even although a number of rain-gauges have been planted in the higher districts, and in positions likely to furnish approximately the maximum rainfall of these districts. The diminished rainfall is no doubt due to the partial drying of the Atlantic winds in their passage across Ireland before they reach Southern Scotland.

St. George's Channel and the Irish Sea open a free passage to the south-westerly winds, here diverted into a more southerly course, to the north of England and to Wales, and accordingly where the mountain masses of the Lake District and of North and South Wales oppose their course the rainfall over large portions of these high districts exceeds 80 inches.

The maximum falls in these four districts respectively are 185·96 inches at The Styx, in the Lake District; 128·50 inches at Glencroe, Argyllshire; 116·90 inches at Beddgelert, North Wales; and 96·18 inches at Ty-Draw-Treherbert, South Wales.

The largest region of 60 to 80 inches rainfall is in the West Highlands, surrounding the region of still larger rainfall of 80 inches and upwards, and it extends from the Crinan Canal to beyond Loch Assynt in Sutherland. Then follow the hills to the north of Galloway, the hills to the north and east of Dumfriesshire, large portions of the Lake District, of North and South Wales, of West Galway, the mountainous districts of Kerry, and Dartmoor in Devonshire.

[1] An Address delivered to the Philosophical Society of Glasgow on December 16, 1885, at the request of the Council, by Alexander Buchan.

An annual rainfall of 40 to 60 inches covers extensive tracts of the British Islands; a rainfall of at least 40 inches characterising the climates of about a fourth part of the surface of England, of about the half of Ireland, and considerably more than the half of Scotland, the latter taken as a whole being by far the rainiest of the three divisions of the United Kingdom. It is to be noted that nowhere along the east coast of Great Britain, or for some considerable distance inland, does the average rainfall anywhere reach 40 inches. In the east of Ireland, on the contrary, the rainfall exceeds 40 inches in Wicklow, the south of Down, and the middle districts of Antrim, which is probably due to the south-westerly winds being diverted into a more southerly direction in their passage through the Irish Sea.

Over the whole of the west of Great Britain the rainfall exceeds 40 inches annually, except from St. Bees' Head to Dumfries, and from Holyhead to Lancaster, these districts being largely protected from the rain-bringing winds by the Cumberland and the Welsh mountains respectively. It may also be stated that the rainfall of the Orkney and the Shetland Islands falls short of 40 inches, whereas in the Hebrides it exceeds that amount.

The shadings of blue on the map show in a striking manner the extension eastwards of the areas of the 40 inches and upwards annual rainfall by the mountains of Sutherland, the Grampians, the Cheviots, the Pennine Range, and the hilly ground of the south-western counties of England.

On the other hand, the breakdown at various intervals of the mountainous or hilly plateau which may be regarded as extending along the west of Great Britain from Cape Wrath to the Land's End has an equally striking influence on the distribution of the rainfall, and as regards man's material interests is even more important. Thus the opening of the Bristol Channel, between Wales and the Cornish Peninsula, is the avenue through which is spread a more generous rainfall over a large portion of Central England than would otherwise have been the case. Through the breakdown of the plateau between the Pennine Range and North Wales another large portion of England, extending from Cheshire round by Derbyshire, and thence northward through Yorkshire, has its rainfall also very materially increased.

But the most remarkable of these breakdowns is the great lowering of the water-parting between the Firths of Forth and Clyde. Through the opening thus formed the south-westerly winds pass freely, and overspread Dumbartonshire, Stirlingshire, and the whole of Western Perthshire, precipitating over these regions a rainfall truly western as regards its copiousness and the direction of the winds with which it falls; and through the same breakdown there is extended, even eastward through Kinross-shire, a rainfall of fully 40 inches—an amount which occurs nowhere else over comparatively level plains so far to the east of the water-parting between eastern and western districts.

Of the greatest importance is it to note the rainfall of Clydesdale, lying to the south of this breakdown. The amounts are, in inches, 29·98 at Bothwell Castle, 30·54 at Dalziel House, 31·66 at Auchinraith, and 32·37 at Murdostoun. Now it is simply the *southerly* element of the rain-bringing winds which makes the rainfall of the Hamilton district of Clydesdale so essentially different, both as respects its amount and the times of its occurrence, from that of the Clyde below Glasgow. It may be noticed here that when the rainfall of the west is in excess of the average the rainfall of West Perthshire is also in excess; and on the other hand, when there is an excessive rainfall over the Hamilton district, it generally occurs that the rainfall of eastern districts is also in excess. The peculiarity of the rainfall of Glasgow consists in this—that it lies midway between those districts which are so differently circumstanced.

The valleys of the counties of Kirkcudbright with Dumfries and the intervening ridges lie awthart the course of the rain-bringing winds, and show the inevitable result of a rainfall successively diminishing on advancing eastward. But on arriving in Eskdale, the most easterly of these valleys, we meet with a rainfall considerably in excess of that of any of the valleys to westward at the same elevations. The larger rainfall of Eskdale is due to its lying more in the line of the Solway, and having immediately to eastward a high mountainous region which the south-westerly winds must cross in their passage to eastward.

The distribution of the rainfall over this hilly region and over the valleys on each side of it is instructive. Thus at Kirkconnel Hall, near Ecclefechan, it is, in inches, 39·64; Canonbie, 49·72; Carlesgill, 58·00; Eskdalemuir, 63·30; Tudhope (on the ridge, 1961 feet high), 76·43; and on the east of the watershed at Teviothead, 54·86; Borthwickbrae, 44·36; Hawick, 33·55; and thence continues diminishing in descending the valley to 26·50 at Springwood Park, near Kelso. The reason why the rainfall of this region is thus distributed is that the air on the windward side of the ridge being suddenly raised to a greater height in crossing the range its temperature is continually reduced by mere expansion, and copious precipitation follows; whereas on the leeward side, as the air descends to lower levels, its pressure (or density) being increased, and its temperature also thereby increased, it gradually becomes drier, and accordingly the rainfall diminishes rapidly with the descent of the aerial current to the lower plains. A similar distribution of the rainfall is seen in crossing the Downs from Brighton to London, and over all other regions similarly situated.

It is the rapid increase of the temperature and drying of the air as the wind passes from high and wide plateaus into lower levels which determines the areas of least rainfall of the British Islands. Accordingly the smallest average annual rainfall, varying from about 22½ to 25 inches, occurs in England, and overspreads a large portion of the south-eastern counties extending from the Humber to the estuary of the Thames, exclusive of the higher grounds of Lincoln and Norfolk, where the rainfall rises above 25 inches. In every other part of the British Islands the rainfall is above 25 inches. The influence of the higher grounds of Norfolk and Lincoln in swelling the rainfall, most probably by increased falls with easterly winds, is very striking. Similarly the rainfall of the Yorkshire Wolds is in excess of surrounding districts. Between the valley of the Thames and the Humber the rainfall nowhere exceeds 30 inches, except near the Chiltern Hills.

It will be observed that the northern limit of the region marking off a rainfall under 25 inches annually is at the Humber, or near where Great Britain suddenly shrinks in breadth. It is, however, probable that the larger rainfall of the eastern part of Yorkshire, as compared with what obtains further south, may also, in part, be occasioned by causes analogous to those which give Western Perthshire its large rainfall.

In Scotland no rain-gauge gives an annual average under 25 inches. In three districts, however, the averages are only slightly in excess of 25 inches, and less than 27 inches: these districts being (1) Lower Tweeddale from about Coldstream to Jedburgh; (2) the low-lying parts of East Lothian; (3) the shores of the Moray Firth from the mouth of the Spey round to Tain. It will be seen that these districts are not only well protected by extensive highlands from the rains of the south-westerly winds, but also from the, in many cases, torrential downpours of south-easterly winds. It is this double protection which gives the driest of its climates to these parts of Scotland.

In Ireland, on the contrary, only a small district round Dublin shows a rainfall less than 30 inches, this district being well protected by the Wicklow mountains from the rain-bringing winds; and as in that island there is no continuous mountain-mass stretching north and south there is no such great difference of rainfall and temperature shown between the eastern and western climates of Ireland as in the case of Scotland and England.

The narrowness of the strip round the east of Scotland where the rainfall does not exceed 30 inches a year is an interesting feature, of which the rain-maps constructed for individual months suggest the explanation. Of the rainfall of eastern districts a larger proportion is due to easterly winds, and by much the larger portion of these falls usually takes place neither on the low-lying coasts, nor at any great distance inland, but in the intermediate region at heights from about 250 feet and upwards. The falls are also very heavy in low-lying valleys that open out so as to face these rain-bringing easterly winds. Of these rains the weather of October 1880 afforded an excellent illustration. The rains of that month fell with strong north-easterly winds, and the foreshores, looking to the north-east, of the Firth of Forth, the Moray Firth, and the Pentland Firth, had a monthly rainfall above the average, being in some places more than double the average; whereas over the rest of Scotland the rainfall was under the average, being over very extensive breadths from 70 to 98 per cent. less than the mean rainfall for October.

One of the most marked features of the climates of the south of England, to which many of our invalids are sent, is due to the influence of the Downs on the rainfall. Over the whole of the somewhat broad region occupied by the Downs the rainfall exceeds 30 inches, rising near Petersfield to 40 inches. Along the south coast, and for a varying distance inland as determined by

the physical configuration, the average is less than 30 inches from Dover westward as far as the east shores of the Isle of Wight. On proceeding still farther westward, the annual rainfall slowly but steadily rises, till on rounding Prawle Point in Devonshire it begins to exceed 40 inches, and with this increase of the rainfall there is a still more striking increase of temperature in the winter months.

The whole of the results arrived at in this inquiry show conclusively that the key to the distribution of the rainfall of the British Islands is the direction of the rain-bringing winds in their relation to the physical configuration of the surface.

Looked at broadly, there are four very distinct causes of rain, viz. (1) the moist south-westerly winds; (2) rains, often very heavy rains, from the east, extending but a little way inland; (3) the annual fall of temperature from August to January; and (4) those peculiar influences that have their fullest development in the thunderstorms of summer over low-lying extensive plains.

The rainfall of the British Islands has been examined with reference to its seasonal distribution in relation to the physical configuration of the surface. The mean amount of each place for the past twenty years has been calculated for the twelve months, these being reduced to thirty days each. The mean of these twelve months being taken, the mean monthly rainfall of the year was then ascertained, and with this latter mean each monthly mean was compared, and its excess, or defect, entered in percentages on twelve maps.

The moist south-westerly winds acquire their maximum annual predominance in December and January, and as these winds come loaded with the vapour of the Atlantic the rainfall rises above its monthly mean over nearly the whole of Scotland. Two patches, however, are to a great extent exempt, the e being the districts lying on the lee side of the greatest stretch of mountainous land, viz. to the north-east of the Grampians and to the east of the Moffat and Lead Hills. Similarly, in England, during these months, the rainfall is considerably above the average over the whole of the dry districts extending from the Tweed southwards, and bounded on the west by the water-partings of the Mersey and the Severn, and on the south by the Thames, including the northern slopes of Kent.

During the great annual fall of temperature from August to January the greatest excess over the mean monthly rainfall occurs in September and October, when the fall of temperature is most rapid, south-westerly winds very prevalent, and heavy rains with easterly winds, chiefly the easterly winds of cyclones, of most frequent occurrence. In these months the rainfall reaches the annual maximum over large districts in the east of Scotland, and over all but the whole of England.

In northern and extreme western districts nearly all thunderstorms occur during the winter months, whereas few occur in eastern and central districts at this season; but nearly all occur in the summer months—a remark which applies with greatest force to the more extensive level, or comparatively level, portions of the country. Now, from the frequent occurrence of the thunderstorms and thunder-showers, the annual rainfall of these districts approaches to, and in not a few cases reaches, the annual maximum in the summer months. The local excess begins to show in June, and is extended in July much more decidedly over the agricultural districts of England and Scotland that are best suited for the ripening of wheat and barley. In August there is shown a still further development and extension of the summer rains over these and adjoining districts. It is to be noted, however, that during this time the rainfall remains under the average over the extreme south-western, southern, and south-eastern districts of England. In these characteristics of the summer rainfall these important agricultural centres resemble the climates of Central Europe, where the rainfall rises to the maximum during the summer months

The following are the annual amounts of the rainfall, in inches, in certain districts and along certain lines radiating from Glasgow:—Glasgow 40·20, Bresley Hill 37·33, Bothwell Castle 29·98, Dalziel House 30·50, Lanark 35·66, Wiston 45·33; Queen Park 36·24, Newton Mearns 52·63, Black Loch 57·60; Paisley 45·37, Castle Semple 52·10, Blair 53·62, Ardrossan 41·03; Kilbarchan 57·28, Kilmalcolm 57·28, Greenock 64·25, Overton 71·45; New Kilpatrick 48·05, Dumbarton 48·25, Cameron House 62·95, Luss 80·45, Firkin 96·05, and Ardlui 115·46. These figures show in a striking manner the extraordinary variations of climates there are in the immediate neighbourhood, or within easy reach, of Glasgow. Quite recently an inquiry was set on foot in Berlin, where numerous rain-gauges were planted with the view of arriving at some clear understanding as to the amount of observational information required in order to state definitely what the actual rainfall of a district is. Might I suggest to the Mathematical and Physical Section of the Philosophical Society that a similar investigation be taken in hand, and forty or more rain-gauges be added to those already in use. In a few years not only would they be able to answer the question proposed by the Berlin meteorologists, but in answering it they would state with satisfactory precision the character and limits of the various local climates which differ so widely from each other in the neighbourhood of Glasgow.

THE AUSTRALIAN MUSEUM, SYDNEY[1]

(1) THE Museum has been, during the year 1884, as in previous years, open to the public daily, except on Mondays, when it is necessarily closed for the purpose of cleaning. The largest attendance on any one day was on December 26, when 1643 persons were registered at the doorway. The greatest Sunday attendance was 1315, on April 13. The average daily number of visitors throughout the year was 262 on week-days and 853 on Sundays. The total for the year is 126,040.

(2) The collections are still being increased by means of purchases, exchanges, collecting expeditions, and donations. A list of these additions, under their separate heads, will be found in Appendices V., VI., VII., VIII. Among these may be specially mentioned several pairs of large antelopes from South Africa, a full-grown ourang-outang of the larger species (*Simia satyrus*), and several of the smaller species (*S. morio*); a fine specimen of the Chimpanzee (*Troglodytes niger*); two whales, one from Kiama (*Physeter macrocephalus*), and one from the coast of England, belonging to the extremely rare species known as Rudolf's Whale (*Balænoptera borealis*); casts of gigantic fossil remains from the British Museum, including *Elephas ganeta*, *Mastodon andium*, *Toxodon platensis*, *Sivatherium giganteum*, *Megalania prisca*, &c.; and large and important ethnological collections.

(3) Great alterations and improvements have been effected by the erection of additional wall-cases, constructed upon the best principles and at considerable cost, for the reception of large collections of skeletons and Australian fossil remains; and for groups of Birds of Paradise, and other exhibits of great interest from New Guinea and elsewhere. Additional cases and cabinets have been provided for the mineral collections, and others are in course of construction for similar purposes.

(4) Want of sufficient space in the present building is still felt as a serious drawback to the usefulness of the Museum. The Trustees nevertheless gladly express their obligation to the Government for the provision now made for further accommodation. An additional shed has been erected, which is used as a store for timber and other material. A large iron workshop has also been provided, and another of similar dimensions is in course of erection. These are to be used for the storage of spirits and bottles, and for workrooms in connection with spirit specimens.

(5) Catalogues, not only of the various collections in the Museum, but also of all branches of Australian Zoology, are still in course of preparation; but no new publications have been issued during the past year.

(6) Mr. Ramsay's visit to Europe in connection with the International Fisheries Exhibition enabled him to examine various Museums, Zoological Stations, and Aquaria, and has been productive of much advantage to this Museum. A report, with particulars of his proceedings and details of his arrangements for purchase and exchange of specimens, will be found in Appendix XI.

(7) The exhibits which are sent to the Calcutta Exhibition have been presented by the Trustees to the Government of India.

(8) The Teaching Collection, consisting of skeletons, models, and specimens illustrative of comparative anatomy and natural history, which for some years past occupied the north room in the upper floor of the Museum, has been transferred to the University. This collection was specially prepared for teaching purposes, and, as most of the specimens were already represented in the Museum, and it occupied space which could be better used for the display of other objects of interest, the

[1] Report of the Trustees for 1884.

Trustees felt themselves justified in making the transfer. Although this collection is now at the University, its ownership remains with the Trustees.

9. There has been no change in the Board during the year, by death or otherwise.

10. Annexed to this Report are the following Appendices :—

I.—Annual Balance-sheet.
II.—Attendance of Visitors.
III.—Attendance of the Trustees.
IV.—Work done by Taxidermist and Articulator.
V.—Specimens collected.
VI.—Specimens purchased.
VII.—Exchanges.
VIII.—Donations.
IX.—Books acquired.
X.—Duplicate Books.
XI.—Mr. Ramsay's Report.

(Signed) ALFRED STEPHEN,
Crown Trustee and Chairman

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Special Board for Medicine have presented to the Vice-Chancellor the following Report with a view to its communication to the Senate :—"The Board have considered the requirements of the Previous Examination from the point of view of its suitability as a preliminary examination for students entering on the study of medicine, and have come to the conclusion that in the interests of mental training these requirements may with advantage be modified. They would desire to see introduced an adequate examination in the elementary mechanical principles of Physics, meaning thereby—the fundamental notions of matter, motion, and energy, and the simple laws which govern their relations ; the physical properties of matter in the solid, liquid, and gaseous states ; and the application of these properties and laws in the case of simple instruments and machines. An examination in these principles need not involve any but the most elementary mathematics, yet it could be made to exercise the student in clearness of conception, in accuracy of statement, and in soundness of reasoning. These qualities are in a special degree essential to students of medicine, but from our Report of November 11, 1885, it would appear that in these respects the preliminary training of many who propose to become students of medicine has not been satisfactory. The subject we propose is already well taught and appreciated in many good schools, and it appears to us extremely desirable that the University should encourage all schools to improve themselves in this direction by including the subject in its Previous Examination. It is not for the Board to say whether the subject should form part of the Previous Examination proper (though many considerations might be urged for this plan), or be required as an additional subject in place of the present examination in Elementary Mechanics. They are, however, persuaded that, if introduced in some form, the examination would be for all students at least of equal value to the present examination in additional subjects, and for students whose work at the University is to consist largely in the study of nature it would be of considerably greater value."

Mr. H. D. Rolleston, of St. John's College, has been appointed Assistant Demonstrator of Physiology, in succession to Mr. Green. Mr. Rolleston was placed in the First Class in the Natural Sciences Tripos, Part I., in the Easter Term, 1885.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 12, December 1885.—J. Fink, on the influence of pressure on the electric resistance of electrolytes. Cailletet's apparatus was used for producing compression, Kohlrausch's induction apparatus for the electric measurements. A solution of hydrochloric acid (5·02 per cent.), having a resistance of 7·490 Siemens' units at 1 atmo., fell to 7·335 at 200, and to 7·126 at 500 atmos. A weaker solution (0·98 per cent.) showed a diminution of 7·39 per cent. in its resistance at 500 atmos. A similar solution of zincic sulphate showed a diminution of 11·74 per cent. The diminution is proportional up to 300 atmos.—E. Edlund, on the transition-resistance in the voltaic arc. The conclusion is against the existence of such a resistance.—K. Wesendonck, on the fluorescence of naphthalin-red.—H. W. Vogel, on the relation between absorption by colouring matters and their sensitising action on bromide of silver.—G. Kotschau, studies on fluid motions. Some very extraordinary figures are produced by careful introduction of a coloured liquid into an uncoloured one.—F. Himstedt, a determination of the ohm. This paper describes the method, depending on a knowledge of the coefficient of mutual induction of two coils, which has already been discussed by Lord Rayleigh, and which is similar to that of Rolti. The final result gives as equivalent to the ohm a column of mercury of 1 square millimetre section and 105·98 centimetres length.—W. B. Brace, on the magnetic rotation of the plane of polarisation, and some special cases of refraction. It is shown that there may be in a calc-spar crystal three rays which suffer no double refraction. Experiments are also described concerning prisms of heavy glass in a magnetic field.—G. Stern, position of the commutator in electro-dynamic machines. A discussion of Clausius' formulæ with respect to the relation of the current to the angle of lead.—E. Mach and J. Wenzel, a contribution to the mechanics of explosions.—K. L. Bauer, apparatus for demonstrating that electricity resides only on the surface of a conductor. This is a modification of Biot's apparatus, consisting of two concentric hemispheres, and convenient means of insulating and discharging.

Journal of the Russian Chemical and Physical Society, vol. xvii. fasc. 7.—On the part played by contact actions in the phenomena of dissociation, by D. Konovaloff.—Thermic data for some combinations of the aromatic series, by E. Werner, being numerical data as to the heat of neutralisation of saligenin and oxybenzoic aldehydes and acids, and mellic acid.—On the oxidation of oleic and elaidic acids by permanganate of potassium, by A. Saytzeff.—Notes by MM. Albitzky, Nikolsky, and Ustinoff.—On the motion of a solid body having cavities filled with a homogeneous liquid, by M. Joukowsky, being the second part of a mathematical inquiry into ellipsoidal, cylindrical, and such other cavities as have the shape of a rotation-body, and also several cavities connected together.—On the collision of absolutely solid bodies, by M. Schiller, second part, being a further mathematical development of the theory, together with answers to Prof. Joukowsky's observations.—On the influence of an electric current on the resistance of selenium and its sensibility to light, by N. Hesehus, being an explanation of the experiments of Fritts by the theory of allotropic dissociation.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 17, 1885.—"On the Formation of Vortex-Rings by Drops falling into Liquids." By Prof. J. J. Thomson, M.A., F.R.S., and H. F. Newall, M.A.

When a drop of ink falls into water from not too great a height, it descends through the water as a ring, in which there is considerable rotation about the circular axis passing through the centres of its cross-sections ; as the ring travels downwards, inequalities appear, and the ring breaks up into a number of smaller rings, which in turn may again subdivide.

It is shown that capillarity plays no essential part in the formation of the rings ; in fact, it may be said that, with very few exceptions, rings are formed only when a liquid is dropped into one with which it can thoroughly mix. There are very many cases in which rings are formed when there is no possibility of capillary action, such as when the liquid into which the drop falls is the same as the drop itself.

The drops were observed by instantaneous illumination ; and it was seen that the drop enters the liquid as a sphere, becomes flattened as it descends, and finally breaks into a ring more than half an inch below the surface.

When a sphere moves through a liquid, the tangential velocity of the liquid is different from that of the sphere. If the sphere be a liquid drop, there is no absolute discontinuity in the motion, but only a very rapid change, so that there is a finite alteration in a very small distance. This is equivalent to a vortex-film covering the sphere, the lines of vortex-motion being horizontal circles. If the liquid be viscous, the vorticity will diffuse inwards and outwards. The drop, as it falls, becomes flattened, on account of the resistance to its fall ; and if by

the time it becomes disk-shaped the drop is full of vortex-motion, the disk must break up—for it is an unstable arrangement of vortex-motion—and assume the stable arrangement, namely, that of the anchor-ring. Then the most important property of the liquid involved is its viscosity. If this is too small, the vortex-motion will not have time to spread far by the time the drop has become disk-shaped; whilst if the viscosity is too great, the vortex-motion will all be dissipated before the drop becomes disk-shaped.

To avoid complication, experiments were made in which drops were let fall into liquid of the same kind as that composing the drop. Liquids so treated were found to arrange themselves into four classes, distinguishable by the character of the ring formed. The quotient μ/ρ was determined for each of the liquids—μ being the coefficient of viscosity found by Poiseuille's capillary tube method, and ρ the density, water being the standard in both cases. It was then found that the four classes were also distinguishable by the value for μ/ρ.

Thus in Class I. ether, chloroform, and carbon bisulphide give rings only very uncertainly, the drop breaking up and spreading irregularly through the column of liquid. For these μ/ρ is not greater than 0·7.

To Class II. belong water, alcohol, turpentine, paraffin, and other liquids; these give the best rings: and for them the value of μ/ρ is between 1 and 3.

For Class III. μ/ρ is between 3 and probably 8 or 10: and this class includes moderately viscous liquids, such as butyl-alcohol, amyl-alcohol, fairly strong sulphuric acid, and diluted glycerine. In these cases the rings form very slowly.

Class IV. includes all the most viscous liquids, like strong solutions of sugar, potash, sulphuric acid, glycerine. The value of μ/ρ is much larger (about 15 to 30), and no ring is formed at all, unless special precautions are taken to get very large drops.

It is pointed out that nothing can depend on the absolute value of μ/ρ, since it has the dimensions of the product of a length and a velocity. The naturally comparable length in the system is the size of the drop. It is shown that diminishing the size of the drop has the same effect as increasing the value of μ/ρ. The velocity of the drop is probably the comparable velocity; but this cannot be varied much without introducing large disturbances.

The more complicated problem of a drop of one liquid falling into a vessel of a different liquid is treated briefly, and the analogy of the diffusion of vortex-motion with the conduction of heat is referred to; μ/ρ, in the present problem, corresponding with the diffusivity in the conduction of heat.

The breaking up and subdivision of the rings is shown to depend on (1) motion in the column, which brings about irregularities in the ring, when the vortex-motion has nearly or quite died out; (2) the difference of density of the liquids composing the drop and the column, on account of which the parts of the ring, in which most of the liquid is gathered, fall most quickly, and give rise to rings in the same way as that in which the original ring was formed. Strong evidence is adduced to show that capillarity is not concerned in the subdivision.

Instances in which a small surface tension exists are also referred to, and figures of some curious cases are given.

The paper closes with a section in which it is shown that a connection exists between the depth to which a ring travels in the column and the form of the drop at the moment of impact at the surface of the column.

January 14.—Abstract of a Paper "On the Action of Sunlight on Micro-organisms, &c." By Arthur Downes, M.D.

In previous memoirs (*Proc. Roy. Soc.*, 1877-8-9), of which preliminary notes appeared in NATURE, Dr. Downes, with the collaboration of Mr. T. Blunt, showed that sunlight was fatal to Microsaprophytes by a process of hyper-oxidation thereby induced.

In this process the more refrangible rays were the most active. In the course of the induction which led to this conclusion two other facts of importance were elicited. The molecule of oxalic acid was speedily resolved into water and carbonic acid by the combined effect of light and free oxygen, and a typical representative of the diastases, the invertive ferment of cane-sugar, had its qualities completely destroyed by sunlight, which was, however, without effect in a vacuum or a neutral atmosphere.

During the past eight years evidence confirmatory of these conclusions has accumulated from various sources, and the principal facts are reviewed by the author.

After referring to the observations of Warington and others on the nitrifying ferment, of Tyndall in regard to the insolation of putrefiable infusions under an Alpine sun, and to others, Dr. Downes summarises the recent results of Duclaux, who finds, from an examination of several species, that *Micrococci* are apparently far more sensitive to sunlight than the more resistant *spore-forming Bacilli*. Duclaux, who has likewise observed the destructive effect of sunlight on a diastase, agrees that this injurious action on germs is an affair of oxidation. In his previous papers the author had noted the different powers of resistance of various organisms to sunlight, notably of *Saccharomycetes* or *Mucedines*, as compared with *Bacteria*. He now describes a specially resistant *Bacterium*, roughly resembling, but not identical with, the *Ascobacterium* of van Tieghem, of which he finds no previous record.

In refuting the conclusion of Jamieson, an Australian observer, that both he and Prof. Tyndall had mistaken effects of heat for effects of radiant energy distinct from heat, Dr. Downes describes recent experiments of his own, which indicate that a similar action, though of course in a less degree, is exercised by diffused light. He concludes with a reference to the well-known observations of Pringsheim on the destruction of vegetable protoplasm by the more refrangible rays, and claims them as evidence of the truth of his former generalisation that the hyperoxidation of protoplasm by light is a general law from the action of which living organisms require to be shielded by a variety of protective developments of cell-wall, aggregation of tissue or colouring matter, and in other ways.

January 21.—"On the Clark Cell as a Standard of Electromotive Force." By Lord Rayleigh, M.A., D.C.L., Sec.R.S.

This paper, supplementary to that "On the Electrochemical Equivalent of Silver, and on the Absolute Electromotive Force of Clark Cells" (*Phil. Trans.*, part 2, 1884), gives the further history of the cells there spoken of, and discusses the relative advantages of various modes of preparation. The greatest errors arise from the liquid failing to be saturated with zinc sulphate, in which case the electromotive force is too high. The opposite error of *super*-saturation is met with in certain cases, especially when the cells have been heated during or after charging. Experiments are detailed describing how cells originally supersaturated have been corrected, and how in others the electromotive force has been reduced by the occurrence of supersaturation consequent on heating. If these errors be avoided, as may easily be done; if the mercury be pure (preferably distilled *in vacuo*); and if either the paste be originally neutralised (with zinc carbonate), or a few weeks be allowed to elapse (during which the solution is supposed to neutralise itself), the electromotive force appears to be trustworthy to 1/1000 part. This conclusion is founded upon the comparison of a large number of cells prepared by the author and by other physicists, including Dr. Alder Wright, Mr. M. Evans, Dr. Fleming, Prof. Forbes, and Mr. Threlfall.

As regards temperature coefficient, no important variation has been discovered in saturated cells, whether prepared by the author or by others. In all cases we may take with abundant accuracy for ordinary applications—

$$E = 1{\cdot}435\{1 - 0{\cdot}00077\,(t - 15°)\},$$

the temperature being reckoned in Centigrade degrees. For purposes of great delicacy it is advisable to protect the standards from large fluctuations of temperature. Under favourable circumstances two cells will retain their relative values to 1/10,000 for weeks or months together.

Unless carefully sealed up, the cells lose liquid by exudation and evaporation, and then the electromotive force gradually falls. Marine glue appears to afford a better protection than paraffin-wax, and there seems to be no reason why cells thus secured should not remain in good order for several years.

In cells of the H-construction (§ 29 of former paper), the leg containing the amalgam (but not the one containing pure mercury) is liable to burst, apparently in consequence of a tendency to alloy with the platinum. Protection with cement of the part of the platinum next the glass has been tried, but no decisive judgment as to the adequacy of this plan can as yet be given.

Recent cells, intended for solid zincs, have been made of a simplified pattern—nothing more, in fact, than a small tube with a platinum wire sealed through its closed end. The zincs are not re-cast, and the paste is prepared from (unwashed) mercurous sulphate rubbed up in a mortar with *saturated* solu-

tion of zinc sulphate and a little zinc carbonate. A stock of paste may be prepared and retained for use in a bottle.

Experiments are described tending to prove that the irregularities observed during the first few weeks of the life of a cell prepared with acid materials have their origin principally at the mercury electrode.

Cells prepared with dilute solutions have a lower temperature coefficient (about 0·00038), but would be more difficult to use as standards whose value is to be inferred from the mode of preparation.

Details are given of H-cells charged with amalgams of zinc and mercury in both legs, without mercurous sulphate. A very small proportion of zinc is sufficient to produce the maximum effect. Pure mercury, neither alloyed with zinc nor in contact with mercurous sulphate, has an uncertain electromotive value.

Since the comparison of cells does not absolutely exclude a small general alteration of electromotive force with age, further determinations of the standard cell (No. 1) have been effected by means of the silver voltameter. The results—

TABLE XVIII.

Date	E.M.F. of No. 1 at 15° C. in B.A. volts.
October 1883 to April 1884	1·4542
November 1884	1·4540
August 1885	1·4537

are very satisfactory, and indicate a constancy sufficient for almost all practical purposes.

Finally, some comparisons are given between Clark cells and Daniells, with equi-dense solutions, both of Raoult's pattern and of that described recently by Dr. Fleming.

Entomological Society, January 20.—Fifty-third Anniversary Meeting.—Mr. R. McLachlan, F.R.S., President, in the chair.—An abstract of the Treasurer's accounts was read by Mr. H. T. Stainton, F.R.S., one of the auditors, and the Secretary read the report of the Council.—The following gentlemen were then elected as the Council for 1886:—President: Robert McLachlan, F.R.S.; Treasurer: Edward Saunders, F.L.S.; Secretaries: Herbert Goss, F.L.S., and the Rev. W. W. Fowler, M.A., F.L.S.; Librarian: Ferdinand Grut, F.L.S.; other Members of Council: T. R. Billups, Edward A. Fitch, F.L.S., F. Du Cane Godman, M.A., F.R.S., W. F. Kirby, E. B. Poulton, M.A., F.G.S., H. T. Stainton, F.R.S., S. Stevens, F.L.S., and J. Jenner Weir, F.L.S.—The President then delivered an address, and a vote of thanks to him was moved by Mr. Stainton, and seconded by Mr. F. Pascoe, and the President then replied. A vote of thanks to the officers was then moved by Mr. J. W. Dunning, and seconded by Mr. Distant, and Messrs. Saunders, Fitch, Kirby, and Grut replied. This was the first annual meeting since the incorporation of the Society by Royal Charter.

Zoological Society, February 2.—Prof. W. H. Flower, V.P.R.S., President, in the chair.—Mr. W. B. Tegetmeier, F.Z.S., exhibited and made remarks on a Pheasant from the Persian borders of Transcaucasia.—Mr. C. A. Wright, F.Z.S., exhibited a Dove of the genus *Turtur* from Malta, and identified it as a semi-albino variety of *Turtur auritus*.—Mr. Sclater exhibited, on behalf of Mr. W. H. Dobie, a young specimen of Sabine's Gull (*Xema sabinii*), which had been obtained at Mostyn, on the coast of Flintshire.—Mr. Seebohm exhibited a specimen of Ross's Sea-Gull (*Larus rossi*) obtained in June last in the neighbourhood of Christianhaab, Disco Bay, Greenland.—Capt. R. G. Wardlaw Ramsay exhibited and remarked on a specimen of a new bird of the genus *Copsychus* obtained by Mr. H. Pryer in North-Eastern Borneo, which he proposed to call *C. niger*.—A communication was read from Prof. R. Collett, C.M.Z.S., containing an account of the external characters of the Northern Fin-Whale (*Balænoptera borealis*), based upon the examination of numerous specimens of this whale killed on the coast of Norway during the past summer.—A communication was read from Dr. G. Stewardson Brady, F.R.S., containing descriptions of some new freshwater Entomostraceous Crustaceans from South Australia.—Dr. H. Woodward, F.Z.S., communicated, on behalf of Dr. Monticelli, a catalogue of the species of Bats found in South Italy.—Mr. R. B. Sharpe, F.Z.S., read the first of a series of notes on birds in the Hume Collection. The present communication treated of the specimens supposed to belong to the Hawfinch of Europe, which had been collected at Attock, and showed that they belong to a different species, which Mr. Sharpe proposed to call *Coccothraustes humii*.—Mr. F. E. Beddard read the third of his series of notes on the Isopoda collected during the voyage of H.M.S. *Challenger*. The present paper completed the preliminary description of the new species of this group collected during the voyage, which amounted altogether to about forty-five in number.—Mr. J. H. Leech, F.Z.S., exhibited and described specimens of a Butterfly from Mogador, which he referred to a variety of *Anthocharis eupheno*.

Geological Society, January 27.—Prof. T. G. Bonney, F.R.S., President, in the chair.—H. Kirby Atkinson was elected a Fellow, and Prof. Gustav Tschermak, of Vienna, a Foreign Member of the Society.—The following communications were read:—On the fossil Mammalia of Maragha, in North-Western Persia, by R. Lydekker, F.G.S.—On the Pliocene of Maragha, Persia, and its resemblance to that of Pikermi, in Greece; on fossil elephant-remains of Caucasia and Persia; and on the results of a monograph of the fossil elephants of Germany and Italy, by Dr. H. Pohlig. Communicated by Dr. G. J. Hinde, F.G.S.—The Thames Valley surface-deposits of the Ealing district and their associated Palæothic floors, by John Allen Brown. Communicated by A. Ramsay, F.G.S.

Victoria (Philosophical) Institute, January 18.—Rev. Dr. Thornton in the chair.—A paper upon "A Samoan Tradition of Creation and the Deluge" was read by the Rev. T. Powell, F.L.S. Mr. Powell said he thought the Samoans were of Semitic origin; and if Hebrew characters had been used instead of the Roman alphabet for the writing of their language, the triliteral, Semitic nature of the language, in which hundreds of words were identical with Hebrew, would have been obvious.

MANCHESTER

Literary and Philosophical Society, November 3, 1885.—Prof. W. C. Williamson, LL.D., F.R.S., President, in the chair.—On the different arrangements in a state of maximum density of equal spherical granules, by R. F. Gwyther, M.A.—Note on the velocity with which air rushes into a vacuum, and on some phenomena attending the discharge of atmospheres of higher, into atmospheres of lower, density, by Mr. Henry Wilde. Since the reading of my paper before the Society on the efflux of air, I have thought that it might be useful to recapitulate, briefly, the fundamental grounds upon which my experiments and the general reasoning thereon were based. This appears to me to be further necessary, from the dual sense in which the term "velocity" may be considered in the discharge of elastic fluids: the term, as I have already pointed out, has been applied by some, indifferently, to express the rate of increase of volume after leaving the aperture, and the velocity of the stream through the aperture before expansion. It is in the latter sense that the term is used in my paper, and the velocities shown in the several tables have been calculated on this basis. The application of the laws of discharge of inelastic fluids to those which are elastic is a natural principle of reasoning sufficient for us to assume a theoretic velocity for air rushing into a vacuum of 1332 feet per second; and the corollary to this proposition, that the velocity of efflux through the aperture into a vacuum is the same for all pressures above and below that of the atmosphere also follows, naturally and directly, from the reciprocal relations of the elasticity and density of the homogeneous atmosphere. But, just as the theoretic velocity of discharge of water and other inelastic fluids is diminished by the opposing motions and friction of the issuing stream of particles, so that the amount of discharge is only ·62 of that required by theory; so from the varied mobility of different gases there was an antecedent probability that an ideal law would not prevail for the velocity with which air has been assumed to flow into a vacuum. Hence, just as the hydraulic coefficient ·62, expressing the actual amount of efflux through a hole in a thin plate, could only be arrived at by experiment; so by experiment only could the actual velocity with which the atmosphere rushes into a vacuum be ascertained. This velocity, therefore, as determined by experiment, may be represented by the coefficient ·77 for the contracted vein. Or, $V = ·77 \times 1332 = 1025$ feet per second. From Tables I. and II. it appears that the corollary of the equality of the velocities for all pressures, when air flows into a vacuum, is not strictly applicable for the lower pressures, but is approximately true for pressures above 120 lbs. That air of lower density acts as a vacuum to the discharge into it of air of higher density, under certain conditions, is a truth so well established from the experiments described as to require no further proof, but, that the reduction of temperature at the orifice of the discharging vessel did not sensibly affect the velo-

city of the air through the orifice under such conditions, was evident from an inspection of the tables, and more particularly of Table V., where a pressure of six atmospheres acts as a vacuum to a pressure of nine atmospheres. In this experiment it will also be seen that 21·22 cubic inches of air, of a constant density of nine atmospheres (the equivalent of 5 lbs. of pressure), were discharged successively into a vacuum and into atmospheres of increasing densities up to six atmospheres, when the several discharges were made in equal times, viz. 7·5 seconds. Now, the velocity for this time, as shown in Table I., is 1210 feet per second for the contracted vein, and as the times were equal, so were the velocities equal, for the successive discharges up to six atmospheres. The velocity for low pressures, as I have shown in Table III., is compounded of the rate of discharge into a vacuum and the resistance of the atmosphere, and approximates to the square roots of the pressures. For effective pressures below 1 lb. above the atmosphere the rates of discharge are as the square roots of the pressures, as has been shown by Dr. Joule in the paper previously referred to. That the phenomenal rates of discharge which I have described are manifested whenever slight differences of pressure exist between the discharging and receiving atmospheres, may be inferred from the familiar experiment of fixing a perforated disk of cardboard by its centre to the end of a small metal tube or a piece of tobacco-pipe; when a similar plain disk, placed on, or against the other, instead of being driven off by a jet of air blown through the pipe, is attracted to it.

SYDNEY

Linnean Society of New South Wales, October 28, 1885.—Mr. C. S. Wilkinson, F.L.S., Vice-President, in the chair.—The following papers were read:—Notes from the Australian Museum, by R. von Lendenfeld, Ph.D. Note 1.—The vestibule space of *Dendrilla cavernosa*. In this note a very remarkable structure is described; the sponge forms wide ramified tubes with thin walls; and the terminations of these tubes are closed by sieves, as in *Euplectella*. Rings of sensitive and ganglia cells are described round the pores in this membrane. Gland cells similar to those of other *Aplysillidæ* are also described. Note 2.—*Raphyrus hixonii*, a new gigantic sponge from Port Jackson. A sponge, weighing over 400 lbs., was recently dredged in Port Jackson. A detailed description of it is given in this note. The author wishes to keep the two genera *Papillina* and *Raphyrus*, combined by O. Schmidt and Norman, distinct. He has found, besides the spicules known of the European species, two other kinds in this Australian sponge. The structure of the whole sponge is reticulate, as in the Aulenina. Remarkable, very granular, amœboid cells, which are very abundant around the inhalant lacunæ, are described as digestive cells. Note 3.—*Halme tingens*, n.sp. A sponge with peculiar staining qualities. This is a sponge from Thursday Island, which becomes blue after some time, and stains paper, &c., placed in the same spirit with it a remarkably dark blue. The spirit remains light yellow. The author thinks that this colour might be turned to practical account. Note 4.—A case of mimicry. Four sponges are described and photographed in this note. Two are *Ceratospongiæ*, and two are *Monactinellæ*. The two former belong to the genus *Chalinopsis*, R. von L.; the two latter to the genus *Dactylochalina*. The author agrees with Maer that the horny sponges have descended from the *Lactindlid* siliceous sponges. Forms like those described connect the two groups. Their similarity in external appearance is considered a case of mimicry. Whilst the internal structure changed, and the sponge lost its spicules, it kept up a close resemblance to the ancestral siliceous sponge which was defended by its spicules. The case is a very interesting one.—Descriptions of some new or rare Australian fishes, by E. P. Ramsay, F.R.S.E., and J. Douglas-Ogilby. The species here described are *Pteroplatea australis*, *Sebastes scaber*, and *Platycephalus arenarius*, all new species, and *Cirrhitichthys graphidopterum* and *Lepidotrigla pleurasanthica*, species previously known.—On the genus *Trachichthys*, by J. Douglas-Ogilby. A full description and synonymy of the genus is here given, the author expressing an opinion that the *T. australis*, Shaw, and *T. jacksonensis*, Macleay, are the same species.—Catalogue of Australian Coleoptera, part ii., by George Masters. The families catalogued in this part are the *Dytiscidæ*, *Gyrinidæ*, *Staphylinidæ*, *Pedaphidæ*, *Pausside*, *Scydmænidæ*, *Silphidæ*, *Trichopterygidæ*, *Scaphidiidæ*, *Histeridæ*, *Phalacridæ*, *Nitidulidæ*, *Trogositidæ*, *Colydiidæ*, *Rhysodidæ*, *Cucujidæ*, *Cryptophagidæ*, *Lathridiidæ*, *Mycetophagidæ*, *Dermestidæ*, *Byrrhidæ*, *Georyssidæ*, *Parnidæ*, *Heteroceridæ*—in all, 970 species.—The Plagiostomata of the Pacific, part iii., by N. de Miklouho-Maclay and William Macleay, F.L.S. Three fishes are here described: (1) A *Heterodontus* from the Chinese Seas, identified as the true *Heterodontus zebra* of Gray, hitherto looked upon as a synonym of *H. phillippi*; (2) a species of ray (*Myliobatis punctatus*), taken in 1879 in the Lub or Hermit Islands, north of the Admiralty Group; and (3) a ray from Sorry Island, north-west of the Admiralties, which is placed in a new genus of the *Trygonidæ*, and named *Discobatis marginipinnis*.—Fourth addendum to the Monograph of the Australian Hydromedusæ, by R. von Lendenfeld, Ph.D. In this paper a new species of Hydra is described, which possesses six arms, and on them cells, which the author considers more nearly allied to the Palpocils of Sarsia (Schulze) than the ganglia cells of Hydra.—Prof. Selenka's researches into the development of the American opossum, by R. von Lendenfeld, Ph.D. Prof. E. Selenka's most important discoveries regarding the concupiscence and the commencement of the development of the embryo of this marsupial are enumerated in this short preliminary report.—Second note on Macrodontism, by N. de Miklouho-Maclay. The author states his opinion about the very large teeth which he has observed in natives of different islands of Melanesia. The results of observations during his last two trips (1879 and 1882) to the Admiralty and Lub Islands is the conclusion that the enlargement of the teeth is nothing but an *excessive accumulation of a special kind of tartar* deposited on the incisors and canines of the upper and lower jaw.—Note on the "Kéu" of the Maclay Coast, New Guinea, by N. de Miklouho-Maclay. On the authority of the late Dr. R. Scheffer, Director of the Botanical Garden of Buitenzorg, Java, the author states that *two* species of *Piper*, allied to *Piper methysticum*, but different from it, were brought by him in 1873 from the Maclay Coast. The author gives a full description of the preparation of the "Kéu"-drink on the Maclay Coast, as well as of the effects of the same, which are more soporific than intoxicating. He adds further some remarks about the general use of the "Kava" root (*Piper methysticum*) throughout the islands of the Pacific.

PARIS

Academy of Sciences, February 1.—M. Jurien de la Gravière, President, in the chair.—On the theory of Mitchell's screw-pile, and on the "vrille," a small apparatus terminating in a sort of conic screw, used for making the scarfs of borings with the screw-pile, by M. H. Resal.—On the measurement of the velocity with which vibrations are propagated in the ground, by MM. F. Fouqué and Michel Lévy. They describe an instrument which they have invented for the purpose of automatically recording the velocity of propagation, as well as the intensity and duration of vibrations such as those produced by the blow of a Nasmyth hammer.—Note on some hyperelliptical formulas, by M. Brioschi.—Report on M. Romieu's work entitled "Essai sur les décans égyptiens," by M. Jules Oppert. In this work the author has endeavoured with partial success to determine the names of the thirty-six so-called "decans," stars which played such a large part in ancient Egyptian astronomy.—Determination of the constant of astronomic refraction by meridian observations (continued), by M. A. Gaillot.—On the integrals of total differentials of the second species, by M. E. Picard.—Geometrical theory of the articulated hyperboloid, by M. A. Mannheim.—Experimental verification of a new geometrical representation of the colour-sensations, by M. R. Feret. After establishing certain properties of the colour-sensations, and founding on them the principles of a new diagram representing these sensations, the author proceeds to show that the results furnished by experience harmonise at all points with those anticipated theoretically. But although the theory leads to the same equations as those already determined by Maxwell, it differs essentially from them in so far as it is founded on the rule of the parallelogram, and is independent of the notion of the three fundamental colours.—Thermic researches on hypophosphoric acid, by M. A. Joly. The thermic properties of the two hydrates of phosphoric acid already determined are compared with those of the various hydrates of phosphoric and arsenic acid, the study of which the author has now completed. Hypophosphoric acid is further compared with the other acids of phosphorus and arsenic by studying its saturation with an alkaline base, and two metallic bases, the oxide of manganese and the oxide of silver.—Note on the indicators of the different energies of the polybasic acids, by M. R. Engel.—A study of chlorophyll, in connection with M. Regnard's induction that the

chlorophyll function, that is, the property of decomposing carbonic acid in the light, is of a purely chemical order, inherent to chlorophyll, and continuing to act apart from the physiological conditions, by M. Victor Jodin. Without denying this conclusion the author recalls certain former experiments, which apparently point at a different result, and which should be taken into consideration in order to establish a general theory of chlorophyll based on all the known facts.—On the morphology of the ovary in insects, by M. Armand Sabatier.—A contribution to the anatomy of the Chloræmidæ, by M. Et. Jourdan.—Observations in connection with M. Köhler's recent note on a new species of Balanoglossus, by M. G. Pouchet. It is shown that this species is identical with that which MM. de Guerne and Barrois found in abundance in 1880 in the Island of Loch (Glenans Archipelago), and is also probably the same as that found in 1879 by M. de Lacaze-Duthiers at Frez-Hir, Finisterre.—On the optical properties of some fibrous minerals, and on some critical species (arseniosiderite, wawellite, vadiscite, davreuxite, hydrated anthophyllite, hydrotephroite of Langlan, Sweden), by M. A. Lacroix.

BERLIN

Physiological Society, November 27, 1885.—Dr. Benda spoke on mammalian spermatogenesis. The results recently communicated to the Society by Dr. Biondi (NATURE, vol. xxxii. p. 544), of his investigation into the genesis of spermatozoa, had, in view of their divergence from the ideas of earlier observers, induced Dr. Benda to examine the subject more closely. By application of the best hardening and staining methods he had obtained precisely the same figures as had all earlier observers. In particular, through the preparations he had made from rats, bulls, and dogs, he had convinced himself of the actual existence of Ebner's spermatoblasts. Upon a large cell arising from the wall of the canal, the foot-cell, a thin stalk projects, on which was situated an oval formation consisting of small flaps. In his interpretation of this stalk, however, Dr. Benda differed from Ebner, taking the spermatoblasts as he (Dr. Benda) did, for a heap of daughter-cells connected by the stalk with the foot-cell. He further deviated from earlier observers in assuming that the foot-cell originated from a large wall-cell provided with a quiescent nucleus, which interiorly developed a process with which the daughter-cell then united into the spermoblasts. Not till later on did the spermatozoa appear. Examinations of a large series of different kinds of animals would enable a plan to be taken of all the stages of spermatogenesis.—In the discussion which followed the address, Prof. Waldeyer urged that the type of the spermatogenesis, as described by Dr. Biondi, namely, that of cell-columns with progressive development from the interior outwards of the spermatozoa out of cell-nuclei, proved conclusively in the case of the rat, might possibly not hold good for all kinds of animals. It was possible that in other kinds of animals the several stages passed, not successively, but simultaneously and less distinctly, one from another, so that whole knots of cells may be involved in the same stage of development. A subsequent conjunction of daughter-cells with the process of a foreign cell seemed to him improbable.—Dr. Müllenhof presented a series of photographs of horses in movement, prepared by Herr Anschütz in execution of a commission from the Royal Ministry of War. One series exhibited the successive positions of the horse in the act of springing; another in the act of trotting. Dr. Müllenhof followed this up with some observations on the way in which these images were obtained, and drew special attention to certain positions in the body of the animal.—Dr. Wolffberg described a case of abnormal single vision which had recently come under his observation. A man of sound health in every respect complained that for some time he was constantly seeing two objects of the same kind, or very similar to each other, as a single object when they were lying beside each other. It made no difference what was the form of the objects, whether they were letters of the alphabet, numbers, strokes, crosses, and so on. In all these cases he saw the two objects constantly as a single object when they stood at a short distance from each other. In a horizontal position the two objects might be placed at a greater interval from each other than in a vertical position, in order to be seen by him as a single object. The position of the singly seen image was always that of the fixed object. The single seeing of two objects was confined to the macula lutea. If the objects were not entirely alike, but only very similar to one another, then did they likewise appear as one. If they had different colours, then were they likewise seen as one object with rivalry of colours. In the eyes of the patient the existence of no objective anomaly could be established. By way of explanation of this hitherto unobserved phenomenon, Dr. Wolffberg called to mind the physiological phenomena of normal single seeing in the case of two images striking identical spots of the retina, and of abnormal single seeing in the case of objects in the circle of vision which did not indeed hit identical spots of the retina, but yet appeared as single. The physiological abnormal single seeing in this latter case respected, however, only objects to which attention was not turned, which were not fixed, and in such contingency the images appeared always between the two objects. If, then, the physiological single seeing, in the case of non-identical spots of the retina being hit, distinguished itself so far from the above-mentioned pathological condition, it yet had in common with the pathological condition the rivalry of the colours, the single seeing of similar objects, and the greater interval in horizontal than in vertical directions. In the opinion of the speaker, the observed pathological condition was due to a psychical cause, and was to be classed in the category of illusions.

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THURSDAY, FEBRUARY 18, 1886

PRACTICAL BACTERIOLOGY

An Introduction to Practical Bacteriology, based upon the Methods of Koch. By Edgar M. Crookshank, M.B. (Lond.), F.R.M.S., Demonstrator of Physiology, King's College, London. (London: H. K. Lewis, 1886.)

THIS excellent work is based upon notes made in different Continental laboratories, and is intended to be a laboratory hand-book as well as a text-book of bacteriology, including as it does "a systematic sketch of the genera and species of micro-organisms, as well as the methods employed in the investigation of their life-histories." The science is intimately connected with the etiology of the infectious and contagious diseases, and by enlarging knowledge as to the origin, causes, and spread of these diseases, has greatly aided, and may be expected in the future greatly more to aid, in the acquisition of knowledge as to the measures necessary to be adopted for their prevention; nevertheless it has received attention in this country from but a few earnest inquirers, the great mass of information now at our disposal having been accumulated in Germany. This fact is apparent at once on glancing through the pages of this book; for every English work, six German at least are referred to as having been consulted by the author. Apart also from its association with medical pathology, the subject is of the greatest interest to the naturalist, be he botanist or zoologist. It is only necessary to refer to the work of Pasteur in this connection for a proof of the vast amount of benefit to commerce and science which may still be anticipated to arise from a fuller knowledge of the life-histories of those organisms which are associated with so many diseases of plants, animals, and men. The importance of a study, not merely of the pathogenic or disease-producing, but of all the different species of Bacteria and Fungi is fully grasped by the author in the following paragraph: "It is impossible, by localising one's knowledge to pathogenic species to thoroughly understand the life-history of these particular forms, or to be able to grasp and appreciate the various arguments and questions that arise in comparing their life-history with the progress of disease."

The postulates formulated by Koch for establishing the exact relationship, and ascertaining beyond question whether a micro-organism associated with disease is actually the cause of that disease, are quoted by the author in the introductory chapter, and bearing as they do so intimately on the controversies which have raged over the relations of micro-organisms to disease, especially of Koch's comma-bacilli to Asiatic cholera, may be given here. They are as follows:—(*a*) The micro-organism must be found in the blood, lymph, or diseased tissues of man, or animal, suffering from, or dead of, the disease. (*b*) The micro-organisms must be isolated from the blood, lymph, or tissues, and cultivated in suitable media, *i.e.* outside the animal body. These *pure cultivations* must be carried on through successive generations of the organism. (*c*) A pure cultivation thus obtained must, when introduced into the body of a healthy animal, produce the disease in question. (*d*) Lastly, in the inoculated animal the same micro-organism must again be found.

The first part of the work is devoted to a description of the "apparatus, material, and reagents employed in a bacteriological laboratory"; to the methods employed for the "microscopical examination of Bacteria in liquids, in cultivations on solid media, and in tissues"; to the "preparation and staining of tissue sections"; to the "preparation of nutrient media and methods of cultivation"; to the subject of "experiments upon living animals"; and to the method of "examination of animals experimented upon, and the methods of isolating micro-organisms from the living and dead subject."

The multiplicity and complexity of the apparatus, materials, and reagents required for this work, and the great care and nicety in manipulation necessary for its proper execution, may well dismay the scientific inquirer who wishes to make a practical study of the subject. The expense alone of fitting up a laboratory on the lines indicated by our author, must form a great obstacle in the path of the would-be student. The license to experiment upon animals which would be necessary for a thoroughly systematic investigation is, as is now well known, most difficult to obtain. And yet there is no laboratory in this country at which such investigations could be undertaken by any one at a moderate expense. Surely London is rich enough, and earnest enough in the cause of sanitary progress, to found an establishment on the model of the Hygienic Laboratory at Berlin. There is fortunately no lack of men, thoroughly capable of undertaking its supervision, and its popularity and usefulnesy would not be a matter of doubt to those who are acquainted with the work of the Biological Laboratory at the Health Exhibition of 1884.

Part II. is "systematic and descriptive, with special microscopical methods," and commences with the history of our knowledge of Bacteria, the difficult question of classification being also here dealt with. In 1872 Cohn published his first classification. He considered the Bacteria to be a distinct group belonging to the Algæ, but from the absence of chlorophyll allied to the Fungi, and divided them into four tribes according to their shape, as globules, short rods, long rods, and spirals, these four tribes including six genera. In 1875 Cohn, in answer to Billroth, who disputed the division into species, considering that all the forms described by Cohn were but developmental forms of one organism, *Coccobacteria septica*, propounded a second classification, in which he still maintained that distinct genera and species existed. The genera Cohn considered to be distinguished by definite differences in shape, which were adhered to throughout life, while some special feature, as a difference in size or physiological action, or some minute difference in form, determined the various species. "Researches," writes our author, "by competent observers have quite recently clearly demonstrated that several micro-organisms in their life-cycle exhibit successively the shapes characteristic of the orders of Cohn. This had as early as 1873 been observed by Lister in a Bacterium in milk. Lister detected forms of Cocci, Bacteria, Bacilli, and Streptothrix genetically connected." Recent observers also have obtained similar results, so that the very foundation of Cohn's classification has been shaken, and "we are left

without possessing a sound basis for classification into genera or species. The mode of reproduction is not sufficiently known to afford a better means for distinction than the other morphological appearances taken alone; nor can we depend upon physiological action, which is held by many to vary with the change of form according to altered surroundings." We have the authority, however, of Koch and Klein for believing that a Bacillus cannot change its nature, and be converted from a harmless into a pathogenic form, as asserted by Büchner.

It is usual now to regard Bacteria, yeasts, and moulds as constituting a class, the *Achlorophyllous Thallophytes*, divided into three orders: (1) *Schizomycetes* (Bacteria or fission-fungi); (2) *Saccharomycetes* (yeast-fungi); (3) *Hyphomycetes* (mould-fungi). Zopf, who, we learn, has warmly supported the pleomorphism of Bacteria, has suggested, as a result of his investigations, a division of the *Schizomycetes* into the following four groups: (1) *Coccaceæ*; (2) *Bacteriaceæ*; (3) *Leptothricheæ*; (4) *Cladothricheæ*. This classification is adopted by the author, but only as a provisional arrangement, pending increase in knowledge. "In determining," he writes, "the distinctions into species, we must take into account, not only microscopical appearances of the micro-organisms themselves, and their physiological actions, but the character of their colonies in plate cultivations, under a low power of the microscope, and the macroscopical appearances displayed in the various nutrient media. In this way, by considering each individual characteristic, Koch showed that the comma-bacillus of Finkler was a different organism from the Bacillus which was present in Asiatic cholera."

Group I., the *Coccaceæ*, are divided into five genera. Genus 1, *Streptococcus* (chain-cocci), includes the cocci found singly or in chains in acute abscesses; the cocci occurring in chains in the lymphatic channels of human erysipelatous skin, and in the fluid of erysipelatous bullæ, which produce typical erysipelas when re-inoculated in man and animals; cocci found in diphtheritic membranes and the surrounding tissues, and described as characteristic of this disease (but a Bacillus and a Bacterium have also been described as the specific micro-organisms of diphtheria); cocci of vaccine lymph, of which they are regarded as the active principle, since filtration deprives the latter of its infectious element, and successful vaccination has been stated to result from artificial cultivations. Numerous other forms are also included in this genus. Genus 2, *Merismopedia* (plate-cocci), includes *Coccus gonorrhœæ* and *Micrococcus tetragonus*, pathogenic to mice. Genus 3, *Sarcina* (packet-cocci), includes *Sarcina ventriculi*, a coccus occurring in the stomach of man and animals; *Sarcina lutea*, a non-pathogenic form; and some other forms. Genus 4, *Micrococcus* (mass-cocci), includes the coccus of yellow pus, which is also the specific organism of acute infectious osteo-myelitis, a destructive disease of the marrow of bones; the coccus of blue pus; the coccus of fowl-cholera; *Micrococcus prodigiosus*, a harmless organism which produces a blood-red colour when cultivated on potatoes; the micrococcus of septicæmia and that of pyæmia in rabbits, and numerous other forms. Genus 5, *Ascococcus* (pellicle-cocci), only one form known.

Group II., *Bacteriaceæ*, is divided into six genera. Genus 1, *Bacterium* (cocci and rods, or only rods, which are joined together to form threads; spore-formation absent or unknown), includes the *Bacterium aceti* which causes the conversion of alcohol into vinegar; the bacterium of croupous pneumonia, occurring in pneumonic exudations, which by inoculation can produce the disease in mice. Genus 2, *Spirillum* (threads screw-form, made up of rods, or of rods and cocci; spore-formation absent or unknown). In this genus is contained the spirillum of Asiatic cholera—curved rods or commas, spirilla, and threads. The commas occur isolated or attached to each other, forming S-shaped organisms or longer screw-forms, and are found in the superficial necrosed layer of the intestines, in the mucous flakes and liquid contents of the intestinal canal of cases of Asiatic cholera. They were also detected by Koch in India in a tank used to supply drinking-water. Their development is arrested by deprivation of air, and they are destroyed by drying and various antiseptics. The results of their injection into the duodenums of guinea-pigs, said to have produced choleraic symptoms, have been by others asserted to have been due to septicæmic poisoning. The difference in appearance produced by pure cultivations in gelatine-peptone broth of Finkler's comma-bacillus and Koch's cholera-bacillus are very well illustrated, and the differences in growth of these two spirilla in other media carefully described. Finkler's bacillus or spirillum has been discovered in the evacuations of cases of cholera nostras, and has been shown quite recently to be also pathogenic. In this genus is also contained the spirillum of relapsing fever, observed in the blood of patients suffering from relapsing fever, but present only during the relapses. Monkeys have been successfully inoculated from cases of the disease in man. Genus 3, *Leuconostoc* (cocci and rods; spore-formation present in cocci), contains the frog-spawn fungus, which occurs occasionally in beet-root juice, and the molasses of sugar-makers, forming large gelatinous masses resembling frog-spawn. "The vegetation is so rapid that 49 hectolitres of molasses, containing 10 per cent. of sugar, were converted within twelve hours into a gelatinous mass; consequently it is a formidable enemy to the sugar manufacturers." Genus 4, *Bacillus* (cocci and rods, or rods only, forming straight or twisted threads; spore-formation present either in rods or cocci), includes *Bacillus subtilis*, the hay-bacillus, occurring widely in air, water, and soil; *Bacillus anthracis*, or bacillus of splenic fever in cattle, and of woolsorter's disease or malignant pustule in man, of which a very full and descriptive account is given, its morphological and biological characteristics having been very completely worked out. This disease, anthrax, is one of those in which Pasteur has succeeded in attenuating the virus so as to produce a "vaccin" capable of conferring immunity on animals after inoculation. The *Bacillus tuberculosis* also belongs to this genus. The numerous methods of preparing and staining the bacilli are fully described. The bacillus of blue milk, the bacillus of malignant œdema in mice, and that of septicæmia in mice, the bacillus of typhoid fever, observed in inflamed Peyer's glands, in the spleen, mesenteric glands, and the lungs in fatal cases of typhoid fever, but not as yet imparted to animals by inoculation, the bacillus of leprosy, the bacillus of malaria, the bacillus of glanders, and some others,

complete a class of micro-organisms of the greatest importance from the number of pathogenic forms it contains. Genus 5 is the *Vibrio* of ordinary putrefaction; screw-form threads in long or short links; spore-formation present. Genus 6, *Clostridium* (same as bacillus, but spore-formation takes place in characteri-tically enlarged rods). In this genus are the bacillus of butyric acid fermentation, which converts the lactic acid of milk into butyric acid, and produces the ripening of cheese, and the clostridium of symptomatic anthrax, the cause of "black-leg" or "quarter-evil" in cattle.

Group III., *Leptothricheæ*, contains the following genera: (1) *Crenothrix* (threads articulated, cells sulphurless, habitat water), occurring in wells and drain-pipes. (2) *Beggiatoa* (threads unarticulated, cells with sulphur-granules, habitat water), of which the best-known is *Beggiatoa alba*, or the "sewage fungus," found in sulphur-springs and marshes, as well as in sewage-polluted streams. (3) *Phragmidiothrix* (threads jointless, successive subdivision of cells is continuous, cells sulphurless, habitat water), found attached to crabs in sea-water. (4) *Leptothrix* (threads articulated or unarticulated, successive subdivision of cells not continuous, cells sulphurless), found in carious teeth.

Group IV., *Cladothricheæ* (possessing cocci, rods, threads, and spirals: thread-forms provided with false branchings), contains *Cladothrix dichotoma*, said to be the commonest of all Bacteria in both still and running water, in which organic substances are present.

Amongst species of Schizomycetes mentioned by writers, and not described or not recognised as distinct species in the preceding classification, are *Micrococcus indicus*, *Micrococcus septicus*, *Micrococcus endocarditicus*. The micrococci of measles, scarlatina, cerebro-spinal meningitis, typhus, acute yellow atrophy of the liver, whooping-cough, puerperal fever, gangrene, yellow fever, dental caries, and saliva. Most of these organisms are only known to be associated with the diseases in question, the causal relations, if existent, have yet to be determined. In this chapter are also described *Bacterium termo* of common putrefaction, *Bacterium lactis*, *Bacillus figurans*, the bacillus of swine fever, the bacillus of choleraic diarrhœa from meat-poisoning, the bacilli of septicæmia in man, of syphilis, and of rhinoscleroma, the comma-bacillus of the mouth, various forms of spirillum and monas, *Proteus vulgaris*, described as intimately connected with the process of putrefaction, *Actinomycetes*, said to be the cause of actinomycosis, a disease of the jaws and lungs in men and animals, and many others too numerous to mention.

An appendix is devoted to the consideration of the yeast-fungi, or *Saccharomycetes*, and of the mould-fungi, or *Hyphomycetes*: under the latter are described the various species of *Mucor*, *Oidium*, *Aspergillus*, &c. The volume concludes with an account of Koch's methods for the examination of air, water, and soil, with a view to the detection and recognition of their contained micro-organisms.

Enough has probably been said to show the wide range covered in this work and the full and able manner in which its matter has been treated. On the importance of the subject and the want that has been supplied by the production of a work that has condensed into one volume a subject, the literature of which in English is diffused in numerous reports and periodicals, we have already remarked. The numerous coloured plates of test-tube and potato cultivations and those of microscopic appearances are admirably designed and executed, and greatly enhance the value of the work.

The book, we believe, will be widely read and appreciated by all interested in science.

THE ANATOMY OF THE NETTLE

*Recherches anatomiques sur les Organes végétatifs de l'*Urtica dioica, *L.* By A. Gravis. (Brussels, 1885.)

A WORK of more than 250 pages devoted exclusively to the anatomy of the vegetative organs in one species of nettle is a publication of a somewhat unusual kind, even in these days of scientific specialisation. The author has evidently bestowed a vast amount of labour on his subject. He states in his introduction that no less than 15,000 sections had to be made in the course of his investigation of this one plant, and twenty-three beautifully executed plates bear witness to the laborious accuracy with which the work has been carried out. The treatise is one which hardly admits of an abstract, as in a monograph of this kind details are everything. We shall only attempt to give a sketch of the order in which the author has arranged his facts, and to indicate one or two points on which his conclusions have some general interest.

The investigation was originally intended to serve as a basis for a general comparative study of the family Urticaceæ. The question of the value of anatomical characters in classification is one which has engaged the attention of many botanists during the last few years. So far the results have proved of very unequal importance in different cases. The author notices the much more considerable part played by anatomy in zoological than in botanical classifications. This he attributes in a great degree to the frequent neglect on the part of botanists to examine every part of the plant in question, at all ages, and under varying biological conditions. Too often one or two sections are made, almost at haphazard, from each species, with the result that things not truly comparable are frequently compared. One of the main objects of the work before us is to show how great the variations are which are due to the differences just mentioned.

The treatise is divided into three parts, devoted respectively to the stem, the leaf, and the root. The first part begins with a general account of the external conformation of the stem of the nettle, and its systems of subaërial and subterranean branches. For the purposes of his exposition the author divides the stem into *segments*, each segment including a node, with the lower half of the internode next above it and the upper half of that next below it. He then proceeds to classify the variations of structure investigated. First he distinguishes variations *according to level*, by which he indicates the different structures shown by transverse sections of different parts of the *same* segment, the most important of these differences being those between the nodal and internodal structure. Next come variations *according to age*, namely, those which are presented by corresponding sections taken at different periods of development. The third

class of variations are those *according to height*, that is to say, those shown by corresponding sections of *different* segments of the stem. Fourthly, and lastly, we have variations *according to the biological conditions*.

The first chapter contains a detailed account of the structure of "segment 1" of the principal stem, *i.e.* the segment including the node next above the cotyledons. In the succeeding chapters the anatomy of the segments superior to segment 1, and the development of an apex of large diameter are treated of. The fourth chapter deals with the hypocotyledonary axis, under which term the radicle of the embryo is included.

The second part treats in a corresponding manner of the leaf, only here the cotyledons first receive attention, then the leaves next above them, and so on. The increasing complication of structure along the sub-aërial stems, and the converse degradation along those which are subterranean, form the subject of a special chapter.

In the third part the variations in the structure of the root according to age and height are considered, the subject of apical development having a chapter to itself.

The method of successive transverse sections was used throughout the investigation.

The author compares the constantly increasing complexity of the successive segments of the principal stem to an accelerated movement, the amount of the acceleration varying according to the biological conditions. This strikes us as a neat mode of expression.

The author's account of the progress of secondary thickening in the stem is interesting, especially the observation that in the lower segments cauline plates of vascular tissue of secondary origin occupy the same position as that assumed by additional primary bundles in the more complicated segments above them. This and similar facts lead the author to a generalisation which he expresses in a phraseology adapted from Haeckel's famous law, namely, that "the organogeny of the stem repeats its ontogeny."

We must enter a protest against the use of the word "cambiform" for cambium which gives rise to secondary fundamental tissue. The word cambiform has long been used for certain cells of the phloëm-parenchyma, and we already have quite ambiguities enough in the use of the word cambium and its derivatives.

The work concludes with the expression of the author's conviction that vegetable comparative anatomy demands a knowledge of the structure throughout the whole extent, and at all ages of the plant. A formidable task is thus imposed on the anatomists of the future. D. H. S.

OUR BOOK SHELF

Magnetism. By Willoughby Smith. (London: November, 1885.)

A PECULIAR pamphlet, said to be compiled for the instruction of the electrical staff of the Telegraph Construction and Maintenance Company, but issued gratis by the author, and devoid of any publisher. It commences with a novel version of the story of the shepherd of Mount Ida, who is given not only a local habitation, but a name, and it ends with a material notion of lines of force which will startle some of our readers. Moreover, electrical discharges, magnetic clicks, &c., are "caused by the lines of force adjusting themselves to each other." It contains nothing new of magnetism, but it promulgates some strange notions. "The Great Architect of the universe employs no rectilinear motions or angles." "Each atom of matter possesses in itself all the properties of a magnet, and emits its own lines of force." "All particles of matter, solid, liquid, or gaseous, are in a polarised state, and consequently emit lines of force." "The (electrical) conducting properties are the result of forced polarisation." "Each atom composing our atmosphere is in a state of polarisation, and is influenced by the magnetic force emanating from the earth." "The force which is called gravity is the effect of such an universal system of polarisation, with which God has endowed all matter." "Iron is very susceptible of polarisation from the effects of what is called terrestrial magnetism (the polarised atoms of the air)."

These extracts are enough to show the tenor of the paper, which will not enhance Mr. Smith's reputation. He has evidently not read Airy's "Treatise on Magnetism," where it is laid down that terrestrial magnetism is not produced in any important degree by magnetic forces external to the earth, and it does not even reside on the earth's surface. Its source must lie deep. The apparatus and experiment given at p. 29 are detailed more fully and clearly in Thompson's "Dynamo-Machinery," and that at p. 41 would be more elegantly obtained by Hughes's induction-balance. It is curious that no reference should be made to the labours of Sturgeon, Scoresby, W. Thomson, and Hughes, and that the laws of Lenz, Jacobi, Dub, Müller, and others are ignored. It is not a pamphlet on magnetism, but a vehicle for the promulgation of certain individual ideas, which it is to be hoped will not take root among those who have been favoured with the gift of this well-printed *brochure*. Indeed, its *raison d'être* is shrouded in mystery.

An Introduction to the Osteology of the Mammalia. By Wm. H. Flower, LL.D. Revised with the assistance of Hans Gadow, Ph.D. Third Edition. (London: Macmillan and Co., 1885.)

WHEN Prof. Flower published, in 1870, the first edition of his "Introduction to the Osteology of the Mammalia," the student at once recognised that he had been supplied with a text-book of convenient size and form, which furnished him with an admirable introduction to Mammalian osteology. The appearance of a second edition of this book in 1876, and of a third edition at the end of last year, are renewed evidence of the usefulness of the work, and that it continues to be appreciated by those who are engaged in the study of the anatomy of the Mammalia.

This edition has been revised throughout, and we notice in it many alterations and additions. The most important change is in the chapter "On the Classification of the Mammalia," which appropriately precedes the purely descriptive part of the book. This chapter has practically been rewritten, and embodies the introductory observations which the author has given to his important article "Mammalia," in the ninth edition of the "Encyclopædia Britannica." A very useful table has also been introduced in connection with the chapters on the vertebræ, which the author has compiled from his Catalogue of the Mammalia in the Museum of the Royal College of Surgeons of England. This table gives the number of the vertebræ situated in each region of the spine in the skeletons of about 350 mammals, and is the most complete record of the kind which has yet been prepared.

In this, as in the preceding editions, the dog's skull has been taken as that from which the general description of the Mammalian skull has been written, and with which the study of the skull may appropriately be commenced, and its description has not been changed; but in addition a useful abstract of our present knowledge of the development of the skull has been drawn up from Balfour's "Treatise on Comparative Embryology."

We have observed also a number of short but useful additions and emendations in the descriptions of various of the bones, so that the present edition exceeds the last by thirty-eight pages. The illustrations also have been increased by the insertion of eight more woodcuts. We wish to give a hearty recommendation to all students of the Mammalia, to use this new edition of a book, written by the anatomist who is admittedly one of the highest authorities on their structure.

Catalogue of the Fossil Mammalia in the British Museum. Part II. Artiodactyla. By Richard Lydekker, B.A. (London: Printed by order of the Trustees, 1885.)

MR. LYDEKKER published in January 1885 the first part of the Catalogue of Fossil Mammals in the British Museum, and in it he recorded the specimens belonging to the Orders Primates, Chiroptera, Insectivora, Carnivora, and Rodentia. He has rapidly followed this up by the preparation of the second part, containing the sub-order Artiodactyla of the great Order Ungulata. The Natural History Department of the British Museum is remarkably rich in specimens of this sub-order, and though in the Catalogue, in the larger number of instances, only the briefest possible description of each specimen is given, yet the volume has reached 324 octavo pages. The collections, in addition to those enumerated in the first part, which have furnished specimens, are the Bowerbank, Layton, Sloane, and Wigham collections. The author points out that he has employed generic terms in a wider sense than is the case with many writers. Thus he does not regard a difference of one or more premolar teeth, or in the number of digits, in allied forms, as a bar to generic unity, and accordingly he includes the genus *Eurytherium* in *Anoplotherium*. The Catalogue has been compiled with the care which distinguishes the catalogues of our great national Museum.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On "Seter," or Parallel Roads

I SEE to my great vexation that in my former letter on parallel roads (NATURE, January 21, p. 268) I have made a rather hideous blunder in my English to the great disadvantage of the clearness of my theory. I have used the French-German-Norwegian term "rest" as signifying *le reste*. My theory is that the last "rest," *i.e.* residue, of the inland ice formed a great dam somewhat seaward from the watershed; I do not refer to any "rests," *i.e.* reposes, in the great ablation.

It is a fact that the glacier-shed in Central Norway was situated as far as 150 kms. to the south or east of the watershed. The direction of the striæ and the boulder-transport renders this indisputable. By the melting of the ice I now suppose that the last remains must have lingered near the glacier-shed. We find the last residue far to the south of the watershed. I cannot find with Mr. Melvin that this idea reverses the order of Nature. The precipitation and temperature in Christiania and in Trondhjem now differ very inconsiderably, and the difference in height between the former glacier-shed and the watershed is not very great, while the distance from this to the sea is five times as great to the south as to the north.

This residue now in all valleys dams up lakes to the cols; in these lakes the terraces of gravel with laminated clay are built up; and on their shores the *seter* or parallel roads are formed. Nothing is simpler.

When I first got this conception I only knew the Österdal (and Lochaber) *seter*, but I concluded that parallel roads and inland terraces were to be expected in all valleys where the striæ proved that the glacier-shed lay seaward to the watershed. I next found some notice of such formations in the neighbouring valleys Gudbrandsdalen in Norway, and Herjedalen in Sweden. Having already finished my paper, I got a dissertation of Högbom in which, as expected, Jemtland was included in my *sete* region. In my letter to NATURE I further inferred that parallel roads must needs exist in Swedish Lappmark. This conclusion has also since proved to be correct. Dr. Svenonius has found a *sete* at Sitasjaur: the correlation of striæ going upwards against the drainage with terraces and parallel roads at a height corresponding with the cols. This is established between 61° 40′ and 68° in Scandinavia as well as at Lochaber. Nowhere else are parallel roads known in Europe. This local geographical distribution is perhaps the best argument for my theory of lakes dammed up by the gradually diminishing residue of the inland ice situated at a distance from the watershed, near the former glacier-shed.

Mr. Melvin's theory of lateral moraines was also my original working hypothesis; but it gives no explanation of the great terraces which are connected with the parallel roads, nor of the laminated clay (with Desmidieæ) in the terraces as well as in the *sete* itself. Any one who has walked for kilometres on a *sete*, smooth as a road, without any variation of the aneroid (the greatest difference in Lochaber is 4 metres), will hardly be able to dismiss the idea of a water-level. How Mr. Melvin will account for the alternating shelves *cut in the rock* I cannot see.

ANDR. M. HANSEN

University Library, Christiania

P.S.—Errata in my former letter: p. 268, col. 2, line 11, for "280 kms." read "150 kms."; line 30 from bottom, for "till" read "tell."

Mimicry in a Neuropterous Insect

I HAVE been much struck by a somewhat complex form of mimicry in a neuropterous insect of the genus Mantispa, which would not be suspected if only a cabinet specimen were seen, with the wings extended motionless, with its raptorial fore-legs folded in front of the head. The insect, as I observed it, was on the bare whitewashed wall of a house at Delhi, exposed to the afternoon sun. As I then believed it to be a dipterous insect feeding on some substance stuck to the wall, it is probable that its prey, most likely the common house-fly, would be similarly deceived, and, being attracted to the spot in hopes of sharing the food, would fall a victim.

The prothorax is curiously modified, both in colour and shape, so as to resemble a proboscis, while the head and fore-legs are so compactly folded that they look like some solid substance adherent to the wall or stone on which the insect is resting, and not part of the creature itself. The mesothorax has two eye-like spots shaded so as to simulate the reflections of light from the compound eyes of an insect, while the markings of the abdomen, seen through the transparent wings, are very dipterous in character.

The points where the Mantispa seems to fail in its likeness to a fly are in the size of the prothorax, which is more massive and thick than the proboscis of any fly; there is a want of prominence in the mesothorax representing the fly's head; the venation of the wings is different; and, lastly, there are apparently only four legs instead of six.

These faulty points are seen at once on a minute inspection; but it may be imagined that it is only necessary to attract the attention of a fly passing at some distance, and convey a certain mental impression, which in the simple mind of a fly may not be effaced till the desired object has been attained, and the victim brought within reach of the Mantispa's arms.

The resemblance between the fore-legs of the praying Mantis and the same organs in Mantispa is remarkable when it is remembered that the two insects belong to different natural orders. The fore-leg of Mantispa is the more specialised, and has great lateral motion, while the edges of the femur are armed with teeth slightly blunt at the tips, so that the captured insect can be shifted if necessary. The joints in the same limb in the Mantis are simple hinges, and both the femur and tibia are fringed with a double row of very sharp spines, which are necessary to pierce and retain a hold on the thin unsubstantial wings

of a butterfly which the Mantis patiently waits for, perched on the top of some conspicuous head of flowers.

Simla, January 17 E. R. JOHNSON

Fabry's Comet

ON the 6th inst., with a power of 38 on a 4½-inch refractor, I observed that this comet had a distinct, though very faint, tail, at a position-angle of about 85°; length 13½'. The radius of the coma was about 3'. I thought I could see the tail on the 1st inst., but was not quite sure of it then. The comet's spectrum strikes me as less distinct than is the case with most comets. On the 1st inst. I could only see two bright lines (or bands) certainly; and the less refrangible of these was very faint. I suspected a third band towards the more refrangible end of the spectrum.

T. W. BACKHOUSE

Sunderland, February 13

Mist-Bow

ON the Wiltshire Downs, near Marlborough, at about 4 o'clock on February 10, I observed a white mist-bow, in position and shape resembling the rainbow, but pure white, and the arc was of considerable width throughout, estimated at 5°–10°, altitude of the sun 15°–20°, altitude of the summit of the bow 35°–45°. The wind was slight, and there was a frost at the time, and a thick deposit of rime on the trees, &c. Has this been observed elsewhere or explained? Is the phenomenon due to the superposition of coloured bows, or to the polarisation of the semi-crystallised vapour composing the fog?

A. E. E.

Movement of Telegraph-Wires

THERE can be no doubt that Mr. Mountford Deeley correctly attributes the rotatory oscillation of the wires during frost to the air-current acting upon a "wing" of ice-spicules. I described this phenomenon in *Science Gossip*, 1874, p. 254, and explained the cause of it in NATURE, vol. xxiii. p. 338.

Birstal Hill, Leicester F. T. MOTT

HENRY BRADSHAW

UNFORTUNATELY it far too often happens that there seems to be an impassable gulf fixed between the man of letters and the man of science, which hinders the one not only from partaking in, but even from appreciating, the ideas, the objects, and the methods of the other. There is no need, especially here, to impute blame to either; but when a man of letters is found who, modestly making not the least pretension to scientific knowledge, yet sympathises deeply with the man of science, some acknowledgment of the fact seems to be due. Such an instance there was in Mr. Henry Bradshaw, Senior Fellow of King's College, and Librarian of the University, whose sudden removal Cambridge is now mourning. Of his literary ability, his bibliographical accuracy, his mastery of one important period of English poetry, and his knowledge of early printed books, this is not the place to speak. Justice to those qualities doubtless is being, or will in due time be, rendered by other writers, better fitted to pronounce an opinion upon them. But here may be appropriately recorded the enthusiasm—for no other word will suit—with which he at all times entered into and aided inquiries, investigations, and researches that most men in his position would have considered to lie entirely outside of their own, and as such to be without any dereliction of duty disregarded. His time, his energy, and his varied attainments were always at the disposal of any member of the University, whose servant, in the highest sense of the word, he rejoiced to be. But there was no need for any one to be a member of the University to obtain his help. Accessible at all times to all who sought him, the asking of a simple question was a sufficient introduction, and whether that introduction was only the prelude to an acquaintanceship which might speedily ripen into a friendship depended far more on the person who asked it than on himself. By the younger members of the University to whom he was known, and the number of them was vast, he was regarded with feelings of affection, that it would seem almost exaggeration to describe, and his influence over them, always tending towards the highest ends, was proportionately great. But here it is more fitting to dwell upon the active sympathy he showed with students of biology. His great intimacy with the late Mr. G. R. Crotch had led him to take an extreme interest in the literature of systematic zoology, and particularly in the precision which is required of those who pursue the branch of it relating to the Coleoptera, not that Mr. Bradshaw must be supposed to have had any knowledge of the subject. It was simply the method of accurate work which excited his admiration, and that method, he has more than once told the present writer, had largely influenced his own bibliographical investigations, the high value set upon which must be told by those whom they concern. Never taking offence, wholly free from pride, always ready to put the best construction on every man's conduct, catholic in all his feelings, Mr. Bradshaw passed away in his College rooms, apparently without any suffering, on the night of the 10th or morning of the 11th of this month—an end to be envied by most men.

A. N.

THE COAL-DUST QUESTION

IN the last paragraph of my letter to NATURE (Dec. 31, p. 197), I stated that those who, having investigated the question of the influence of coal-dust in colliery explosions, had come to the conclusion that coal-dust is not, as a rule, the principal agent in an explosion occurring in a dry and dusty mine, appear to have omitted to take one important element of the case into consideration; and in saying so I implied that, if they had not made this omission, their conclusions in this respect would probably have been more in accordance with my own.

All the important experiments with coal-dust on a large scale have been made in wooden boxes or galleries of greater or less length, open at one end and closed at the other. The ignition or explosion has usually been begun at or near the closed end, and been propagated towards the open end, driving part of the contents of the gallery out into the air in front of it.

Certain conclusions in regard to colliery explosions have been drawn from the results obtained on this small scale which appear to ignore the fact that the conditions here prevailing are far less favourable to the propagation of the coal-dust flame than those which obtain in a mine at the instant an explosion is sweeping through it. For, it is obvious that in the former case the air is practically at *constant pressure* while the explosion lasts, whereas in the latter case it is practically at *constant volume* during the same period. But as the amount of heat required to raise the mixture of air and coal-dust to the temperature of ignition in the first case is greater than that required to effect the same result in the second case in the ratio of 1·41 to 1, it follows that an explosion having been once begun in either case will be propagated much more rapidly and surely in the mine than in the apparatus. Thus it is that a kind of coal-dust which produces comparatively feeble results in the apparatus may give rise to very disastrous consequences in the mine.

An illustration of this difference of behaviour under the two sets of conditions has been furnished by the dust of Camphausen Colliery in Germany. When subjected to the experimental test in the large apparatus at Neunkirchen, already described in these pages, it was found to be far down the list in point of relative danger, and was pronounced to be, like most of the other dusts in the same list above and below it, of a comparatively harmless

nature. But when an explosion subsequently occurred in the mine, and traversed the whole length and breadth of the workings, which were known to be practically free from fire-damp at the time, producing the most disastrous effects, the fallacy of the conclusions drawn from the experimental results was rendered abundantly evident.

In the whole of my papers on this subject, and most pointedly in my last article on coal-dust explosions published in *Iron*, in the year 1878, I have carefully indicated that a difference was to be expected in the behaviour of dust ignited under the two conditions named. It has therefore been with feelings of considerable surprise that I have observed members of the French, English, and German Mining Commissions, and others who have investigated this subject since the publication of my first paper, one after the other pronounce some very decided opinions as to the relatively subordinate part which coal-dust plays in a colliery explosion, while at the same time they were neglecting to take into account this very simple and yet all-important element. W. GALLOWAY

VESUVIAN ERUPTION OF FEBRUARY 4, 1886

THE rent that was formed on May 2, 1885, in the upper part of the great cone (NATURE, vol. xxxii. p. 55) gave issue to lava until December 25. A small quantity again issued between January 2 and January 5, 1886, after which no more made its appearance till this new outburst. In consequence of the rise of level of the magma in the chimney, the cone of eruption has grown very much during the last month.

On February 4, at about 8 p.m., lava broke forth at the foot of the old crater ring of 1881-2 at a point bearing from the main vent about 10° W. of N., traversed the crater plain, which is here very narrow, in a somewhat oblique direction, and ran down the slope of the cone between north and north-north-east. The lava soon reached the foot of the cone, but even up till midday to-day, when I left the mountain, it had not yet commenced to cross the Atrio del Cavallo. The eruption took place from probably the same dyke that gave rise to that of January 9, 1884.

To-day, February 6, the lava bubbles up like a spring at the foot of a hill, and flows for some distance in a kind of trough which it has raised on each side of itself above the level of the crater plains. After a short distance it enters one of its own tunnels to reappear again at some distance. It was very interesting to watch its welling, and from time to time the bursting of a steam bubble as big as a bucket, which would throw up splashes against the imperfect arch at the immediate exit. These splashes partly adhered to the roof and partly fell, drawing out the suspended portion into irregular strings, illustrating the formation of the stalactitic lava that is so common in fumaroles.

The chloride crusts in the neighbourhood were uncommonly rich in copper, so that my boot-nails were thickly plated with that metal.

The lava makes its appearance at about 100 yards from its entrance in the tunnel near the main spring, although it is now divided into two streams. The eastern, which is the largest, is 1 metre broad; I plunged a stick in to the depth of 1 metre, but the shortness of the stick and the great heat prevented me from touching the bottom. The current ran at the rate of 1 metre per 6 seconds, which, making allowance for viscous drag at the edges and bottom, will give an output of at least 360 cubic metres per hour, or at least 17,280 cubic metres during the 48 hours up to 8 o'clock this evening. The more western stream was 50 centimetres broad, over 1·20 metres deep (as far as I could reach with my stick), and flowed at the rate of 1 metre in 8 seconds. Giving a loss of 2 seconds of speed from drag at sides and bottom, we have an output, for 48 hours, of 10,368 cubic metres. The two streams together would, therefore, have afforded, since the commencement of the eruption, 27,648 cubic metres.

As the altitude of the lateral outlet is much more than that of May 2, both on the night of the eruption and the following one, the volcano showed the *first stage of activity* as judged by the appearance of the main vent.

This winter the mountain has been covered by snow several times, and to-day it extends down nearly to the level of the Observatory. During our ascent we had to walk through a stratum of about 8 inches, though much thicker in the drifts. Two-thirds of the crater and part of the cone of eruption were also covered.

I should have sent news yesterday, but, on attempting an ascent, I was driven back by wind, rain, and mist.

Naples, February 6 H. J. JOHNSTON-LAVIS

TIDAL FRICTION AND THE EVOLUTION OF A SATELLITE

A PAPER by Mr. James Nolan has recently appeared which is devoted to an adverse criticism of my views concerning the effects of tidal friction as a factor in the evolution of the moon and earth.

The title of the pamphlet, "Darwin's Theory of the Genesis of the Moon,"[1] shows, I think, that the author has misconceived the scope of my work. It was not supposed that the investigation threw light on the actual mode of genesis of the moon, but was rather applicable to the subsequent history of the moon and earth. Mr. Nolan attributes to me views as to the condition of the moon immediately after her birth which do not appear a just interpretation of my writings, and although it might have been well to use more guarded expressions in some passages, the justice of his condemnation of the whole theory cannot be admitted. He sums up his case by the three following propositions:—

"(1) That the moon could not have existed bodily so near the earth as the greatest initial distance fixed.

"(2) That in any form possible there she could not have receded by the agency assigned—tidal friction.

"(3) That, if a modification be made by allowing her to have separated at a greater radius than that corresponding to a period between 2 and 4 hours, the moon would be no longer traceable to the earth's *present* surface on which condition the theory has been founded."

The first of these propositions is interesting, and I have to thank him for drawing my attention to it.

When a small satellite revolves about a planet with a certain proximity, the sum of the centrifugal and tidal forces may be such as to overbalance the gravitation towards the centre of the satellite. When this is the case, the satellite cannot exist as a single mass. The complete solution of the problem, concerning which Mr. Nolan adduces certain elementary considerations, is of extreme difficulty. At present I do not wish to go into this question, but shall consider the point on another occasion. It may, however, be admitted that the moon could not subsist as a single continuous body with its surface in contact with the earth.

On p. 4 he quotes a passage from the abstract of one of the papers (*Proc. R.S.*, No. 200, 1879), which must be surrendered; it is as follows:—

"The coincidence is noted in the paper that the shortest period of revolution of a fluid mass of the same mean density as the earth, which is consistent with an ellipsoidal form of equilibrium is 2 hours and 24 minutes; and if the moon were to revolve about the earth with this periodic time, the surfaces of the two bodies would be almost in contact with one another."

Now, since 1879 it has been shown by Sir William Thomson that the ellipsoidal form referred to could not

[1] Geo. Robertson and Co., Melbourne, Sydney, Adelaide, and Brisbane, 1885. Pp. 16.

subsist, because it is dynamically unstable. It does not, then, seem worth while to consider the remarks made on that passage.

With regard to the first proposition that, if the moon separated from the earth near the present earth's surface, it can only have subsisted as a flock of meteorites, my own words may be quoted as follows :—

"The planet then separates into two masses, the larger being the earth and the smaller the moon. I do not attempt to define the mode of separation, or to say whether the moon was initially more or less annular. At any rate it must be assumed that the smaller mass became more or less conglomerated, and finally fused into a spheroid, perhaps in consequence of impacts between its constituent meteorites, which were once parts of the primæval planet. Up to this point the history is largely speculative, for, although the limiting ellipticity of form of a rotating mass of fluid is known, yet the conditions of its stability, and *a fortiori* of its rupture, have not as yet been investigated. . . . At some early stage in the history of the system the moon has conglomerated into a spheroidal form."[1]

When, however, Mr. Nolan goes on to his second proposition, and states that this amounts to saying that the moon must have been a ring of fragments revolving in the plane of the equator, and that such a ring must be uniformly distributed and therefore incompetent to raise frictional tides, it is not easy to follow him. Is there any objection to the existence of a flock of meteorites? And would not such a flock raise tides in the planet which, if subject to friction, would introduce forces tending to make the meteorites recede? It seems that there is no such objection, and that the flock of meteorites would follow the same fate as the satellite when conglomerated in a single mass.

The difficulties which are raised by the author in the conception of the conglomeration are such as meet us in all evolutionary theories, and whether or not it is possible as yet to see our way mentally through the changes which may have taken place, yet it is generally admitted that conglomeration took place in some way.

He then points out that no other satellite is traceable up to the surface of its planet, and concludes that it is a coincidence that the masses and periods of the moon and earth are apparently such as fit into the theory. No one has pointed out the non-existence of such a satellite more clearly than I,[2] but the absence of reference to my work seems to show that Mr. Nolan has not looked at it. It is not then surprising to read : "Is it not very illogical to suppose that the moon originated in a way which cannot have been the way of origin for other planets and satellites?" And the reader of this sentence would hardly think that my position is that there is a probability that a cause which was subordinate in the history of the other planets was predominant in the case of the moon and earth, and that it is proved numerically that in the terrestrial sub-system the actual distribution of masses and momenta (the factors governing tidal friction) differs at least as much from the corresponding factors in the other planetary sub-systems as the supposed modes of evolution.

On p. 13 we read :—

"There is a law, according to which two heavenly bodies cannot revolve about their centre of gravity with their surfaces nearly in contact, unless one be smaller than the other by a certain amount, and, further, that the small one be denser than its companion by a certain value."

I do not know where to find the proof of such a law, and at the present moment am disposed to doubt its correctness.

Next, on p. 14, we find :—

"Rapid rotation would never cause a quantity of the matter of a body to become piled up at one particular place, and form into a separate single body there of any appreciable size."

Now very recently M. Poincaré has rigorously proved in a very remarkable paper[1] the possibility and even the dynamical stability of such a "piling up," and has given a sketch of the mode of separation of a portion of the mass of rotating fluid. In a paper of my own, now nearly finished, the same problem is treated, but from a different point of view.

It will be perceived from the quotations that the pamphlet is true to its title, and refers almost entirely to the genesis of the moon. This affords some proof that my speculative remarks hazarded as to the mode of origin of the moon, were not so guarded as was intended. The justice of the third of Mr. Nolan's propositions may, however, be denied, and certainly the theory cannot be held to depend on the genesis of the moon at the *present* surface of the earth.

The present opportunity will be convenient for a short reiteration of my point of view with regard to the whole subject.

In tidal friction we have a *vera causa* of modifications in the configuration of the earth and moon. If we adopt provisionally the hypothesis of an adequate lapse of time, we can trace the changes, and find that the obliquity of the ecliptic, the eccentricity of the lunar orbit, and its inclination to the ecliptic (all unmentioned by Mr. Nolan), the lunar periodic time, and that of the earth's rotation, are co-ordinated together by supposing that the moon first had a separate existence at no great distance from the present surface of the earth, and with small differential motion with respect thereto. Then it is maintained that this co-ordination is so remarkable as to give good reason for accepting the hypothesis as in accordance with truth. Concerning the earlier stage in which the moon may be supposed to have separated from the earth, nothing more than conjecture is possible, but undoubtedly the condition adduced by Mr. Nolan escaped my notice.

In examining the rest of the solar system, it is found that, amongst other things, the Martian satellites afford a striking confirmation of the influence of tidal friction, and that the system of the moon and earth presents features so distinct from those of the other planets, as to justify the belief that tidal friction, subordinate in its influence on the other systems, may have been predominant in our own. The theory is also found to throw light on the distribution of satellites in the solar system.

It is as yet too soon to say how far these views embody the truth, but even should they be found untenable, yet certainly the determination of the effects of tidal friction on a system of planets and satellites is a problem of physical astronomy which was well worthy of attack.

G. H. DARW[illegible]

ON THE SOUND-PRODUCING APPARATUS OF THE CICADAS

HAPPENING to refer to Prof. Jeffrey Bell's "Comparative Anatomy and Physiology" on the question of the sounds produced by insects, I read, with reference to the Cicadas :—"The sound seems to be produced by the vibration of membranes, placed on either side of the stigmata of the metathorax, and set in motion by the respiratory air" (p. 389).

As this wind-instrument theory of Landois seems to be supplanting, in our text-books and popular natural histories (*e.g.* Cassell's), the drum theory advocated by Réaumur and the earlier writers, I think it permissible to draw attention to certain observations I made on this

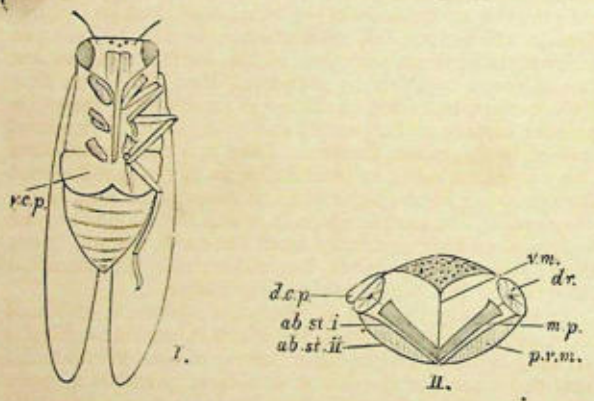
[1] *Phil. Trans.*, part 2, 1880, pp. 880-81.

[2] "On the Tidal Friction of a Planet attended by several Satellites" *Phil. Trans.*, part 2, 1881).

[1] *Acta Mathematica* (1885), 7, 3, 4. "Sur l'équilibre d'une masse fluide animée d'un mouvement de rotation."

subject some six years ago. They were published in the not readily accessible *Proceedings* of the South African Philosophical Society (1879-80, part iii. p. 161), and were not illustrated by any figure.

The Singerjie (*Platypleura capensis*) is a well-known and tolerably abundant insect at the Cape; and few visitors to the shores of Table Bay can have failed to notice, in the hotter months of the year, the sharp shrill metallic sound produced by the "little singer." It is soon found that the male Cicada alone possesses the power of singing, the female—recognised at once by the long ovipositor folded beneath the abdominal somites—being dumb. If the ventral surface of a male singerjie be examined (Fig. I.) two large ventral cover plates (*v.c.p.*) are seen, one on either side, meeting in the central line and extending backwards from the metathorax over the anterior abdominal somite. On turning the insect over and looking at the dorsal surface, two very much smaller dorsal cover plates are seen extending forward from either side of the first abdominal somite. If one of these plates be removed with fine pointed scissors, there is seen the wrinkled surface of a thickish chitinous membrane, the drum. Turning the insect over again, so as to examine more carefully the ventral aspect, and removing one of the ventral cover plates, two membranes are disclosed, separated by a transverse chitinous support. Of these the anterior is white, narrow, and opaque, the posterior (*p.r.m.*, Fig. II.) translucent, oval, and tightly stretched.



The transverse chitinous support (*ab.st.*i) is the sternum of the first abdominal somite; the membranes are intersternal membranes which would seem to be specially modified to act as resonators. The second ventral cover plate may now be removed, disclosing the anterior and posterior resonator membranes of that side; the anterior resonator membrane of each side may be cut through; and the abdominal portion of the insect may be separated from the thorax. When this is done there are seen, taking their origin from the mid-line of the first abdominal sternum (Fig. II., *ab.st.*i), two muscular pillars (*m.p.*), each of which, proceeding upwards and outwards, terminates in a chitinous plate, the upper surface of which is, in turn, connected by a fine ligament with the drum (*dr.*). Under a low magnifying power this drum is seen to be strengthened with brownish ribs, which, together with its general elasticity, cause it to spring back after it has been drawn forward by the action of the muscular pillars, the fibres of which are beautifully striated. Each time the drum is drawn forward and springs back, by the alternate contraction and relaxation of the muscular pillars, a sharp click is heard, as may readily be proved experimentally on the dead insect. That the well-known metallic sound is produced by a rapid succession of such clicks is put beyond question by the fact that, by irritating the muscular pillars in a freshly killed insect, the singing noise may be set agoing, and will then continue for several seconds or even minutes. This I had the pleasure of demonstrating to Mr. Roland Trimen, F.R.S., curator of the Cape Town Museum, the abdomen singing merrily when the head and thorax had been pitched out of window or destroyed. A weak current of electricity would also cause the singing to commence. The sound generally ceased after a while in a few isolated clicks, and at that time the waves of contraction in the muscular pillars were plainly visible. The singing noise was less sharp and clear than in the living insect, owing probably to the disruption of some of the resonator membranes; and I have noticed that rhythmical motions of the abdomen in the live insect produce rhythmical alterations in the intensity of the sound. The cover plates are doubtless mainly for protection; but the fact that on their removal the sound is less full and intense shows that they also may play the part of sounding-boards.

Fig. II. is a slightly diagrammatic view of the severed abdomen as seen from the anterior end. *ab.st.*i and ii are the sterna of the first and second abdominal somites; *p.r.m.* the posterior resonator membrane stretched between them; *v.m.* a vertical membrane; *m.p.* the muscular pillars; *dr.* the drum; and *d.c.p.* the dorsal cover plate of the right side, that of the left side being removed.

I may mention, by way of appendix, that in this species the rostrum contains only three stylets: two lateral, toothed on their external edges; one central and smooth. Although this central style shows, in some cases, indications of its having arisen by coalescence of two lateral styles, it is distinctly one and indivisible.

C. LLOYD MORGAN

University College, Bristol

RADIANT LIGHT AND HEAT[1]

V.

Evidence afforded by the Spectroscope as to the Nature of the Elements

THE point of greatest speculative interest connected with our subject is perhaps that regarding the constitution of the so-called elements.

What light, it may be asked, does spectrum analysis throw on this vexed question? Does it lead us to imagine that these bodies are truly elementary? Or to believe that they are in reality compounds which might be broken up if we had sufficiently powerful instruments for this purpose at our disposal?

I shall begin my remarks on this subject by taking it for granted that the constitution of matter is atomic and molecular.

When, therefore, two chemically different substances combine together we have the union of two heterogeneous atoms, forming a molecule of the compound substance. Thus, when an atom of chlorine and one of sodium combine together we have, as a result of the combination, chloride of sodium or common salt, and an ultimate molecule or compound atom of chloride of sodium may be described as the smallest portion of that substance which possesses all the properties of common salt, and which, if divided further, would be split up into one atom of sodium and one of chlorine.

The molecules of bodies are very frequently so placed as to have an attraction for each other, under the influence of which the body assumes a solid, or, it may be, a liquid state.

Sometimes, however, we have the body in the state of gas, in which the various molecules are so far apart as to have no perceptible attraction for each other. It is by means of such a gas that we can best study the properties of molecules as far as radiant light and heat are concerned. Now, spectrum analysis unquestionably tells us that at comparatively low temperatures and great nearness of particles we have a comparatively complicated

[1] Continued from p. 254.

molecular structure. When, however, the temperature is high and the particles far apart, this structure, as revealed by its spectrum, is much simpler. A process of splitting up has taken place in the interval.

While, however, this is universally allowed, there is a difference of opinion as to the nature of this simplification, which, we are assured by the spectroscope, has taken place. Thus we have already seen that in gaseous water or steam we may have, at a somewhat high temperature, a considerable variety of structures and a partial dissociation of the various compound molecules. In such a case we have at the same time portions of the compound and portions of the components, thus exhibiting a more or less complicated structure of the gas. When, however, the temperature gets very high, the dissociation is practically complete, and the compound structures disappear, leaving us with molecules of oxygen and hydrogen. But what will happen if we treat the vapour of iodine in a similar manner? It will be allowed that as the temperature gets higher we shall have a simplification of molecular structure accompanied and exhibited by a great change of spectrum, but will the iodine ever split up into components which bear to iodine a relation similar to that which oxygen and hydrogen bear to water?

In fine, we call iodine a simple body because in the conditions in which we are placed in our laboratories we cannot decompose it; but what is it in the vacuum-tube and under the spectroscope? Is it still an element, or does it give any evidence of being a compound?

It is taken for granted that at high temperatures its molecules split up, but do they split up into portions of iodine or into portions of the components of iodine? In discussing this and similar questions we shall begin by acknowledging that the strongest and best proof of the compound nature of any element is the exhibition of its components in a separate state, while at the same time we must confess that we are at present unable to do this for the so-called elements. Nevertheless this inability forms no ground for the assertion that the elements are simple bodies, inasmuch as certain substances which we know to be compound reveal their components momentarily in the spectral flame. There is a momentary dissociation at a high temperature followed by a reconstruction at a low.

A good instance of this is the yellow flame produced by introducing chloride of sodium into a Bunsen's burner. This yellow flame attests the existence of sodium in the free state, but this existence is merely temporary, and at the end of the process there is no perceptible trace of the presence of this metal. Thus the only difference between the experiment in which the presence of sodium is temporarily revealed and that in which splitting up takes place when the various elementary gases are brought to a high temperature *may be* that in the former instance we can obtain the sodium by another means, whereas in the latter experiments we cannot obtain these constituents by any other means. We say *may be* because we know that our powers are limited and can very well conceive their extension in the future as we know they have extended in the past. We think it, therefore, unphilosophical to assume that there is any real difference between those bodies which we cannot decompose and those bodies which we can, unless there is some good reason for this distinction apart from our inability to decompose the former. Let us now, therefore, inquire whether any such grounds exist.

Our first remark is that in certain respects the elements, with one or two exceptions, may be looked upon as belonging to a distinct family each member of which possesses the same or nearly the same *atomic heat*. This means that the amount of heat necessary to raise through a given temperature range an atom of any one element is equal to that necessary to raise through the same range an atom of any other element.

This fact was first discovered by Dulong and Petit, and is expressed by saying that the product of the specific heat into the atomic weight, or the atomic heat, as this is called, is nearly the same for all the elements.

This peculiar law is not confined to the elements, for it has been found that in all compound bodies of similar atomic composition the product of the specific heat into the atomic weight is likewise constant. This product is, however, greater in the class of compound bodies than it is for the so-called elements. For the latter the product is about 6, while for the chlorides of barium, strontium, calcium, &c., it is over 18, and for the carbonates of lime, barytes, &c., it is nearly 22.

Thus the distinction which the elements enjoy as a family consists in the fact that their atomic heat is less than that of families of compound substances. In order to perceive the physical meaning of this peculiarity let us imagine that we make a mixture of two substances, A and B, which have no sort of chemical attraction for each other. Now in order to heat this mixture through a certain temperature range, the heat required will be the sum of the heats required for the two components, and neither more nor less, the one being in this respect absolutely independent of the other.

Next let us suppose that A and B are both chemical compounds, but that the atomic constituents of a compound atom of A exercise on each other (in order to form the compound atom) attractions vastly greater than those which the compound atoms of A so formed exercise upon each other.

Let us also imagine that a similar law holds for B, so that in fine we have to deal with the following forces, some of which are strong and others weak. Thus we have:—

(α) The strong forces exercised by the various chemical constituents of a compound atom of A on each other.

(β) The strong forces exercised by the various chemical constituents of a compound atom of B on each other.

(γ) The relatively feeble forces exercised by the various compound atoms of A upon each other.

(δ) The relatively feeble forces exercised by the various compound atoms of B upon each other.

(ϵ) The relatively feeble forces exercised by the compound atoms of A upon the compound atoms of B.

Under these circumstances there are perhaps theoretical grounds for imagining that when we mix A and B together not only shall we have, as above-mentioned, an independence between the specific heats of A and B, but in addition the specific heat of a compound atom of A will be found to be equal, or nearly so, to that of a compound atom of B.

If we now apply these principles to the so-called elementary bodies, we shall, I presume, be all willing to own in the first place, that (assuming for the sake of argument that they are in reality compounds) the force which binds their various constituents together must at any rate be vastly greater than that which represents the attraction of one so-called element for another. Imagine now, one atom of barium and two of chlorine to combine together to form one compound atom of chloride of barium, we may safely assert that the strength of the chemical ties which bind together the various constituents of this compound atom must be vastly weaker than those which bind together the assumed constituents of the element chlorine or of the element barium. In conformity therefore with the suggestions we have ventured to make we might expect two things to happen:

First, the heat necessary to heat through a given temperature range a compound atom of chloride of barium ought to be nearly equal to the sum of the heats necessary to heat through the same range an atom of barium and two atoms of chlorine.

Next the heat necessary to heat through this range an atom of chlorine ought to be nearly the same as that

necessary to heat through the same range an atom of barium, provided both substances are taken in the same state—both solids for instance.

If then the specific heat of an elementary atom is represented by 6, that of a compound atom of chloride of barium will be represented by 18. This is in truth the law which Kopp has found to hold with respect to the atomic heat of compound bodies, and the theoretical conclusion to be derived from it, and that of Dulong and Petit, is, not that the elements are essentially different from the compound bodies, but that, if compound, the forces which bind together their constituents are vastly more powerful than those which bind together the so-called constituents of bodies known to be compound.

Again, if we compare together the atomic weights of the so-called elements with those of compound bodies, we shall find that as a whole the former are smaller than the latter—that is to say, the family of elements have on the whole smaller atoms as well as smaller atomic heats than the families of compounds. Now, if the elements are in reality compounds we might expect in like manner that those which have the smallest atoms should have the smallest atomic heats.

We have great reason for supposing that this is the case, for, although we have not obtained the specific heat of either oxygen or hydrogen in the solid state, Kopp has found that his law with regard to compounds will only hold good under the hypothesis that the atomic heats of hydrogen and oxygen are decidedly less than those of the great bulk of the elementary bodies, that of hydrogen being likewise smaller than that of oxygen. Furthermore carbon and boron are two elements which have small atoms. Now if we make the observation at ordinary temperatures it will be found that the atomic heats of these two elements are decidedly less than those of the great bulk of the elements. In fine, elements of small atomic weight and presumed simplicity of structure appear to bear to those of great atomic weight a relation similar to that which the elements as a class bear to the compounds as a class, as far as atomic heat is concerned.

On the whole the result of this discussion appears to be in favour of the so-called elements being in reality compound structures the components of which possess attractions for each other vastly greater than those exhibited in ordinary chemical combinations.

In connexion with this branch of my subject I may allude to the peculiar family relation between certain elements which all chemists are now agreed in recognising.

This means that the various members of a group of the elements consisting, let us say, of A, B, C, and D, bear to one another some peculiar relation different from that which they bear to the other elements. Now this is precisely what happens in the case of groups of substances which we know to be compound, and the impression is thus conveyed that the elements themselves consist of varied groupings of some still simpler substance. Indeed it seems quite possible that there may be only one kind of primordial atom, and the fact that the force of gravitation bears a constant relation to mass quite independently of chemical constitution seems to speak strongly in favour of some such hypothesis.

Let us now try to picture to ourselves what would have happened had spectrum analysis been known as an instrument of research at the time when we were yet unable to isolate the metal sodium. Under such circumstances chloride of sodium and caustic soda would both be considered as separate elements and the spectra of both these bodies exhibiting the same yellow line would lead to the conclusion that these substances contained some common principle which was momentarily dissociated from its surroundings in the spectral flame. This leads us to ask whether there are any such coincident lines in the spectra of the various so-called elements besides those which may be caused by common impurities. Lockyer, who has greatly studied this subject, tells us that short-line coincidences exist between many metals, the impurities of which have been eliminated, or in which the freedom from mutual impurities has been demonstrated by the absence of the longest lines. Some of his results are exhibited in Fig. 25, in which the lines marked – are due to impurities, while those marked + are common or basic lines. It would thus seem that these short-line coincidences cannot be due to impurities, and the question at once arises whether they do not indicate the presence of some common principle in the spectra before us momentarily dissociated from its surroundings by the high temperature.

It is important here to explain what we really mean when we speak of a coincidence between two spectral lines. We mean simply that there is no perceptible difference in their position when examined with an instrument of a certain power. Mr. Lockyer therefore did not with his instrument perceive any such difference in the spectral position of certain short lines given by various elements. Messrs. Liveing and Dewar, however, applied to some of these lines an instrument of greater power, and succeeded in showing that in many cases there was a slight difference between their spectral positions.

This result raises a new question. We have now to ask ourselves what, under these circumstances, is the value that we can attach to this very near but not quite absolute coincidence between certain short lines of various elements?

Now, in comparing together certain absorptive spectra of compound bodies which have some principle in common, we learn from the researches of Russell and others that we can sometimes trace a band presumably due to the common principle, the spectral position of which is, however, slightly different in the various compounds. The want of perfect freedom may, it is imagined, alter slightly the time of vibration of the molecular groupings, and thus displace the spectral position of the absorption bands. I think we are justified in imagining that something of this kind may take place in the elements, in which, the forces being so intense, our highest attainable temperature may be insufficient to produce complete dissociation. In this case the want of complete concordance in the short lines common to various elements, or *basic lines*, as these have been named by Lockyer, may denote nothing else than this absence of power.

It is imagined that these approximate coincidences are too frequent and too near to be due to chance, but this is a subject that will ultimately require mathematical investigation. In fine, we may conclude this short account of the terrestrial evidence regarding the nature of the elements by saying that—(1) there is no proof that they form a class essentially different from compound bodies, but much to the contrary; and (2) that, if compound, the forces which bind their constituents to one another must be very great.

Before discussing the spectra of the sun and stars it may be well to pause for a moment and ascertain what we mean when we say that sulphur, for instance, is an element. It is quite clear that solid sulphur, liquid sulphur, and gaseous sulphur are different things; also, we may have two kinds of solid sulphur, while if we take the spectrum of gaseous sulphur there is little doubt that the molecular groupings suffer vast changes as the temperature rises.

Now, in all its various states we still call the substance sulphur, because if we bring it down to the temperature of our laboratories it will combine with other bodies as sulphur and as nothing else. Thus the word *sulphur* does not in reality mean a definite arrangement of matter. Similar remarks apply to other elements, several of which are in the form of gas and give us their spectra in

vacuum-tubes. Now it is quite possible that in one of these vacuum tubes as we pass the spark through it, we may have various atomic structures, some of which if we could carry them away to a separate place might on cooling present us with something we had never seen before. But this is precisely what we cannot do in the conditions under which we are placed, nevertheless it can be done in the atmospheres of the sun and stars. Prof. Pierce has shown that in such atmospheres where gravity is very powerful, the heavier molecular structures will

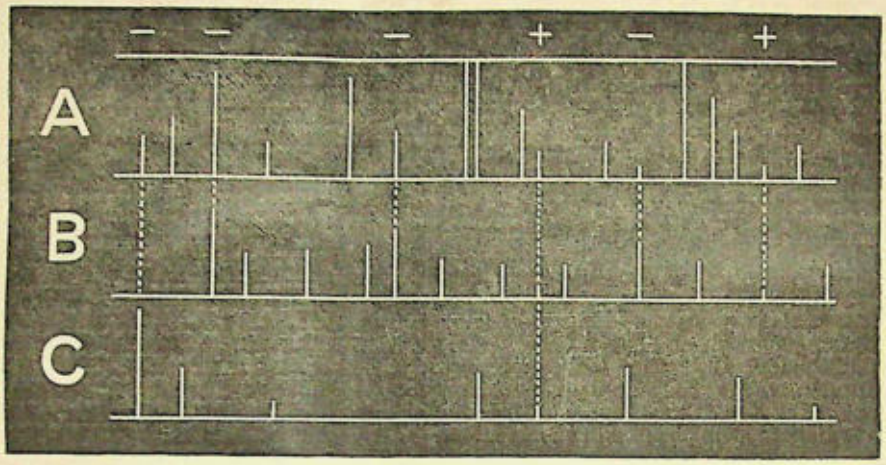


Fig. 25.

naturally separate themselves from the lighter, and seek a lower level. Lockyer therefore imagines that in such atmospheres there is the separation of molecular structures always going on, the heavier falling downwards until they reach a region of higher temperature where they become dissociated or broken up, and the lighter mounting upwards until they reach a region of lower temperature, where they combine together, and hence become

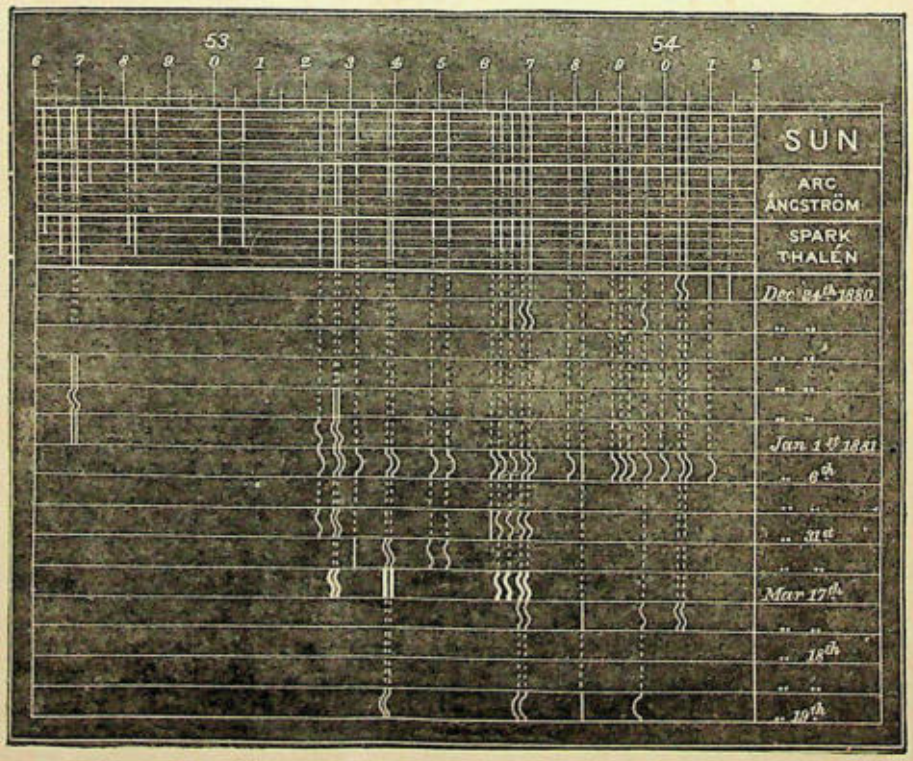


Fig. 26.

heavier. This kind of sifting process must not be confounded with the rapid motions of ascent and descent of the various solar currents, sometimes carrying a body of particles downwards, and thus heating it in the process and sometimes carrying it upwards and cooling it in the process. Both of these causes must be regarded as at work together in the solar atmosphere, and they give us no doubt the best explanation of a very peculiar circumstance

which Lockyer was the first to observe. It appears that lines which, judging from terrestrial experiments, belong to one element, sometimes appear in the solar spectrum as distorted or displaced in different directions, indicating perhaps that the substance producing the one line is moving towards the eye with great velocity, while that producing the other is moving in a contrary direction. It is thus certain that the substances producing the two lines must be in different places, and under these circumstances we can hardly come to any other conclusion than that these lines are given out by different molecular groupings which have become separated from each other by the sifting process already mentioned.

From Fig. 26 it will be seen that different rates of solar motion are exhibited by different iron lines.

It would thus appear that a study of the solar spectrum is likely to furnish us with much information regarding the modes of vibration of molecular structures. It would also seem that in view of these facts we should revise our nomenclature. What, for instance, do we mean when we say that iron occurs in the sun? Clearly nothing more than that certain molecular structures in the sun's atmosphere are the same as certain terrestrial molecular structures momentarily formed when we obtain the spectrum of iron. But if we could seize upon the various particles that unite in giving out some one iron line, and put them into a bottle, we might perhaps find that they were not iron, and they might even be different from the thing obtained by treating some other iron line in the same way.

The following statement of Mr. Lockyer's views is taken from the Report of the Solar Physics Committee:—

"The view of the construction of the solar atmosphere to which Mr. Lockyer has been led, may be stated as follows:—If the atmosphere of the sun were quite tranquil, and if we could see the spectrum of a section of it, we should see it divided into an almost innumerable number of layers, each with its appropriate spectrum. So far from each substance (with some notable exceptions), *as determined by a spectral line*, extending very far above or below its normal position, it would be confined to one heat-level, and the spectrum, taken as a whole, would get simpler as we approach the photosphere from without. The metallic elements, instead of existing as such in a so-called 'reversing-layer,' resting on the photosphere, are entirely broken up there, and their germs are distributed throughout the atmosphere, the molecular groupings getting more complex as the distance from the region of greatest heat increases. The Fraunhofer spectrum, as regards any one element, does not result from the vibration of the molecules of that element existing as such at any given height in the sun's atmosphere, but results

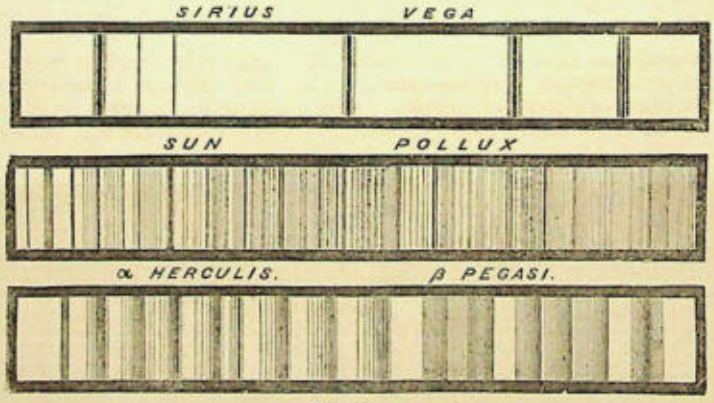


FIG. 27.

from an integration of the vibrations of the germs of that element existing, perhaps distributed, from the top of the atmosphere to the bottom."

It may be said, however, that, while we have strong evidence of a splitting up and also of a sorting or sifting process of the various molecular structures going on in the sun, we are yet without evidence that the molecular structures of two different elements can be split up into the same component. The reply to this will be found in a statement made by Mr. Lockyer (*Proc. R.S.*, December 15, 1881) that the greater part of the lines seen at the bottom of solar spots and in solar flames are lines apparently common to two or more terrestrial substances with the dispersion employed—in other words, basic lines, as these have been termed. He has exhibited some of these results in a diagram which will be found in NATURE, vol. xxiv. p. 323. Now, even if we imagine that the coincidence in position of these lines, as derived from two or more substances, is not absolute, yet the fact that such lines form the greater portion of the spectra belonging to the hotter regions of the sun is a very significant one, and surely implies something more than a mere chance correspondence.

Rutherfurd and Padre Secchi were the first to attempt a preliminary classification of the stars into groups, but for a spectroscopic analysis of these bodies we are especially indebted to Dr. Huggins. Lockyer thus sums up the information which we have thus obtained (December 12, 1878), the symbols indicating the metallic lines visible in the various spectra:—

Hottest Stars	Lines of	H + Ca + Mg
Sun... ...		H + Ca + Mg + Na + Fe
Coolest Stars		— — Mg + Na + Fe + Bi + Hg.
Coolest ...	Fluted bands of	... ... Metalloids.

I may here remark that the hottest stars in the above table are chosen because of their superior brilliancy, and the cooler stars because of their inferior lustre. We are thus entitled to say that the most brilliant and presumably the hottest stars are those in the spectra of which the prominent black lines are the lines of hydrogen, calcium, and magnesium, while in those stars of which the sun is a type we have in addition lines of sodium and of iron. In the cooler stars hydrogen and calcium have disappeared, and we have lines of magnesium, sodium, iron, bismuth, and mercury, while in the coolest stars of all we have no metallic lines but only fluted bands of metalloids. In these last we may imagine that all the metallic lines have

disappeared through association at the comparatively low temperature of the stars.

Fig. 27 gives us a representation of the three chief types of stellar spectra.

It is thus manifest that in stars where the temperature is very high and the dissociation very great we have fewest lines, or at least fewest lines of that prominence and thickness which entitle us to associate them with substances existing below the surface of the stellar atmosphere. Here let us pause for a moment and reflect what this implies. If each element were in reality a simple body, and if the splitting up which occurs in the spectrum of each were merely molecular and not atomic, the result of a high temperature in a mass of matter containing presumably all the elements would certainly not diminish the number of the spectral lines indefinitely. For, even suppose that it split up all the molecular structures of each element into their simplest forms, yet on the supposition that they are elements, the ultimate molecular structure for one element would be different from that for another, and there would thus be at least as many molecular structures and spectral lines as there are elements. On the other hand, if these substances are not elements, we may imagine them to be split up into a comparatively small number of ultimate structures, and we might even imagine that at an enormously high temperature everything might be reduced to a single structure.

Thus the fact that in the hottest stars we have the fewest atomic structures is in favour of the hypothesis that the elements are not really simple bodies but compounds, it may be, of some primordial atom.

Let us now sum up the evidence derived from terrestrial and celestial sources in favour of this hypothesis.

First. There is experimental evidence of various kinds tending to show that the so-called elements are not essentially different from other bodies.

Secondly. In the terrestrial spectrum of pure metals at a high temperature certain lines are obtained for some one element that are extremely near, if not coincident, in spectral position with those obtained for some other element or elements. These have been called "basic lines."

Thirdly. We know that in the sun's atmosphere there is a process at work tending to separate the various molecular and atomic structures, and we find that the greater number of the lines given out from the sun's hotter regions are basic lines, such as we have above defined.

Fourthly. In the very hottest stars, where the dissociation is greatest, we have only a few prominent lines given out, these being lines belonging to hydrogen, calcium, and magnesium. I think we must conclude that the hypothesis that the elements are in reality compound bodies offers, with our present knowledge, a very good and simple explanation of the results of spectroscopic analysis in the earth, the sun, and the stars.

Now, bearing in mind the extreme usefulness of some such hypothesis to aid us in collecting facts, I do not hesitate to say that this hypothesis can only be legitimately overthrown in one of two ways. We may either, in the first place, obtain some indisputable fact bearing conclusively against the hypothesis that the elements are compounds and in favour of their being essentially simple bodies, and may thus overthrow the above hypothesis in the same way that Fizeau, by his experiment, overthrew the corpuscular theory of light, if, indeed, it had not fallen to pieces before he made the experiment; or, on the other hand, the hypothesis that the elements are essentially simple bodies may be applied by some skilled advocate to our terrestrial and celestial spectroscopic observations and a consistent explanation of these afforded, simpler and better than that given by the above-mentioned hypothesis. But until either of these two things is done we are justified in using the compound nature of the elements as a working hypothesis.

It would, no doubt, be premature to bring it forward at the present moment as an established theory, because an established theory means a working hypothesis which, having overcome the perils of infancy and youth, lives to justify an honourable and useful existence on the principle of the survival of the fittest. BALFOUR STEWART

NOTES

THE Paris Academy of Sciences has suffered another loss in the death of M. Jamin, Perpetual Secretary for the Section of Physical Science, and the immediate successor of M. Dumas. M. Jamin can hardly be said to have filled his office, as he was attacked by disease of the heart very soon after his nomination. He was elected a member of the Academy in 1858 to fill the place vacated by the death of Pouillet. He was a very eloquent teacher and debater, and a frequent contributor to the *Revue des deux Mondes*. His "Cours de Physique à l'École Polytechnique," is a very extensive work. He also published many papers in the *Transactions* of the Academy of Sciences, and patented an electric light. He was born in 1813, and educated at l'École Normale.

THE death of Mr. Edward Thomas, one of the most eminent of English numismatists, took place on the 10th inst. at Kensington, in his seventy-third year. After a distinguished career in the public service in India, he returned home and devoted himself to the study of the antiquities and history of India and Asia generally. He was a Corresponding Member of the French Institute and of the St. Petersburg Academy, as well as a Fellow of the Royal Society. His writings were very numerous, and many of them are still only to be found scattered throughout the journals of different learned Societies, to which he had contributed for upwards of forty years. Amongst his most important works were his edition of Prinsep's "Antiquities," published in 1858; papers on ancient Indian minerals in the *Journal Asiatique;* on early Sassanian inscriptions, seals, and coins; his essay on ancient Indian weights prefixed to the "Numismata Orientalia" is the standard work on the subject. Between 1848 and 1866 he contributed sixteen papers to the *Journal* of the Royal Asiatic Society on Eastern coins. These were subsequently republished under the title of "Tracts on Oriental Literature."

THE death is announced of Dr. Heinrich Fischer, the mineralogist and professor at the Freiburg University, well known through his work on "Jadite and Nephrite."

IN a lively and interesting article in Tuesday's *Times* on the work of the Smithsonian Institution in the field of ethnology it is urged with some force that the British Government is bound to render a similar service to science in the case of the numerous races under our dominion, many of whom are dying out, or changing their old habits and customs. "All the arguments which could be urged for the maintenance of the Smithsonian Bureau of Ethnology apply to the establishment of a similar bureau for the British Empire. In British India the State from time to time undertakes fragments of the task. Elsewhere it is being effected occasionally and piecemeal. The want is of a body which should carry on the enterprise as a whole, and in a manner to borrow light from one quarter to elucidate the rest. Types of tribal, social, and national existence are vanishing on every side. They are changing, or giving place to new. Some had always the germs of incurable decay in them. British civilisation is treading out others. British dominion, whether directly answerable or not for the mortality, is in the position of administrator, and is bound to keep account of the estate of ancient and curious memories. Being where and what it is, it ought to be executing on a scale yet ampler the work the Smithsonian Institution is doing diligently from and at Washington."

This really forms a part of the much wider question of the duty of the State to science; though with our officials spread everywhere over our world-wide possessions, it ought to be an easy matter to collect abundance of data with which the ethnologist could deal.

M. GRANET, the French Minister of Posts and Telegraphs, is connecting telephonically Paris and Brussels. When the connection has been completed he will also connect Lille and Paris.

IT is satisfactory to learn that success has attended the attempts lately made by the eminent Norwegian naturalist, Herr Bock, and his coadjutor, Herr Schwabe-Hanssen, to introduce a new form of industry into their native land, by utilising some of its numerous beautiful native minerals for the fabrication of various objects of art. For this purpose they have made use of the light-green so-called "precious" serpentine, which, although generally scarce, occurs in abundance at Modum, where ophite and magnetite are also found in sufficient quantities to warrant the hope that the supply will repay the necessary cost of raising and working these decorative minerals. Equally valuable for ornamental purposes are the iridescent, or Labrador, feldspar of Fredriksværn, the avanturine of Tvedestrand, and the tulite of Leksvik, near Trondhjem, but hitherto these minerals have not been found in sufficient quantities to admit of including them among the genuine Norwegian materials of decorative industry.

HERR WERENSKJOLD reports in *Naturen* that on January 5, at 5.20 p.m., he noticed a so-called fire-ball, which was observed in the district of Aas to be moving in a south-westerly direction near Orion's Belt, till it disappeared behind a bank of clouds in the neighbourhood of β Ceti. Its motion was undulatory and slow, and in size and brightness it resembled Venus on an ordinarily clear evening, while it was surrounded by a luminous circle, whose diameter seemed to the observer to be about 2 metres. It continued visible for fully 20 seconds.

IN an interesting paper on the Bushmen and their language, by Mr. Bertin, published in the last number (vol. xviii. part 1) of the *Journal* of the Royal Asiatic Society, the writer discusses the ethnological position of this people. He agrees with Dr. Fritsch in thinking that they have none of the characteristics which would warrant either of the suppositions that they are the result of a mixture of all the runaway slaves, or that they are the broken remnants of a degraded and decayed population. They can only be said to have decayed when they have accepted a certain measure of civilisation. The area formerly covered by them was much larger, and extended over regions now exclusively occupied by Hottentots and Bantu; but there is no means of knowing how far they extended into the interior, although there is some reason to suppose that at one time they occupied the central part of the African continent. Anthropologically, the Bushmen, Mr. Bertin states, offer all the characteristics of the Negritos, especially of those of the Andaman Islands. The similarity is not confined to the skull, as noticed by Prof. Flower, but extends to the colour of the skin, formation and tint of the hair, absence of hair on the body, proportion of the limbs, smallness of the extremities, and reduced size of the stature. The central part of Africa is not yet sufficiently known to enable us to say with certainty whether the Bushmen may be connected with any other African population; but there was, the writer says, a race, now nearly extinct or obliterated, which shows many of the same characteristics, namely, the Egyptian race of the first dynasties. He thinks it safe to say that both populations came from the same primitive stock, and have been modified by crossing with other races, and many other causes. This stock was a kind of Negritoid race; the ancestors of the Bushmen were thrown on the Hottentot population, whether or not this was indigenous or extraneous—in their tales the Bushmen always speak of a previous population inhabiting the country—and it is no doubt the inevitable infusion of Hottentot blood which has given them the few characteristics they have in common.

HERR L. RUTENBERG, of Bremen, the father of the well-known traveller recently murdered in Madagascar, has presented the Bremen Natural History Society with the sum of 2500*l.* for a Rutenberg Fund in commemoration of the services his son rendered to science.

TWO moderately violent shocks of earthquake are reported to have occurred in Rockland County, N.Y., on January 16 about midnight. They were noticed in various localities, such as Haverstraw, Rockland Lake, Spring Valley, Piermont, Sparkill, Nyack, and Suffern; no damage was done.

AN East Greenland Exhibition at Copenhagen, consisting principally of ethnographical objects brought home by the Danish East Greenland Expedition under Lieut. Holm, is attracting much attention in the Danish capital.

THE proprietors of the Ostrau Karwin mines in Silesia have offered, through the Minister of Agriculture, a prize of 1000 ducats to any one who shall discover a method for extracting coal from pits without occasioning accidents by explosions of fire-damp or combustion of coal-dust.

THE will of the late Prof. Henri Milne-Edwards, F.R.S., has been proved in England, the personalty in this country being over 8000*l.*

THE temperature of German Alpine lakes has been recently studied by Herr Geistbeck. It is shown, *inter alia*, that some lakes have a much wider annual variation of temperature than others. Small depth and large affluent streams are causes of a higher temperature in summer and a lower in winter. The cooling in autumn, it is noted, goes on much more rapidly than the heating in spring; for in autumn the upper layers of water, getting heavier through cooling, sink and give place to others, causing a strong and continuous vertical circulation till the whole mass reaches the temperature of greatest density; but in spring this circulation fails. Large affluents, too, by promoting mixture, cause rapid heating. Herr Geistbeck distinguishes three or four zones in these lakes in midsummer. Down to about 6 to 8 metres the fall of temperature is very slight, only a few tenths of a degree. Then, to about 18 metres, there is a rapid fall, from about 14°–20° C. to 8°. The fall continues to about 50 metres, but is now very slow (3½° to 4°). Below 50 metres the temperature is about constant and 4·2°–4·5°. The daily variation disappears within the highest zone.

FROM a simple experiment with a small ballistic pendulum (*Wied. Ann.* 36), Prof. Mach estimates the velocity of the wave of explosion of 0·02 gr. fulminating silver to be about 1750 metres (say 5833 feet) per second, and so, very much greater than that of ordinary projectiles. Thus is readily explained how a little of the substance exploded electrically on a glass or metal plate, or a card, fixed in a free position, makes a hole through it. The resistance of the air would appear to have nothing to do with it, for explosion *in vacuo* penetrated a card quite similarly, though with less noise. The gases of explosion acquire, in an immeasurably short time, and with nearly the same density as the solid body, the whole high velocity imparted by the work of explosion. As this is of the order of projectile-velocities, the plate is shot through, the lower half of the exploding mass acting against the upper, and the two acquiring equal and opposite velocities. With paper or tinfoil on a table, explosion produced (by reaction, no doubt) an upward convexity, sometimes with rupture.

It is the intention of the authorities at the South Kensington Aquarium to endeavour to introduce herrings into the collection of fish now on view there. The difficulty of naturalising this species to artificial existence is very great, as has been proved by former experiments. At sea-port aquaria, however, where a continuity of salt water may be obtained, this difficulty is obviated to a great extent, but at inland aquaria, where the water is seldom changed, it necessitates extraordinary skill to keep them alive.

At a meeting of the Council of the National Fish Culture Association, held last week, it was stated that the American Government had forwarded another consignment of Salmonidæ ova since the previous week, and the hatchery was now replete with eggs. It was further stated that the hatchery had been reconstructed and enlarged to meet the strain placed upon its accommodative capacity, so that the Association was in a position to incubate any number of ova.

A large supply of salmon and trout ova has been despatched to New Zealand by Sir Francis Dillon Bell, who is most desirous of stocking the waters of that country with Salmonidæ. The ova were obtained by the Tay District Fishery Board, and deposited in the Howietown establishment until ready for shipment. Much is being done to advance the New Zealand fisheries, and the attempts made in this direction have terminated successfully in nearly every instance.

The additions to the Zoological Society's Gardens during the past week include a Pennant's Broadtail (*Platycercus pennanti*) from New South Wales, presented by Mr. H. Stacy Marks, R.A., F.Z.S.; five Adorned Ceratophrys (*Ceratophrys ornata*) from Buenos Ayres, presented by Dr. F. C. Strutt; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. Charles Kershaw; a Common Gull (*Larus canus*), a Black-headed Gull (*Larus ridibundus*), a Kittawake (*Rissa tridactyla*), British, purchased.

OUR ASTRONOMICAL COLUMN

Naval Observatory, Washington.—The following novelties occur in the programme of work to be pursued during the year 1886 at the Naval Observatory, Washington, recently published:—

"With the great equatorial it is proposed to make observations of some of the fainter stars in the Pleiades to connect them with the bright ones recently measured with the Yale College heliometer. With the 9·6-inch equatorial observations of variable stars will be commenced. A photometer for this instrument has been ordered from Alvan Clark and Sons; a spectroscope by Hilger is ready for attachment."

The Secular Nutation of the Earth's Axis.—M. Folie, having deduced a periodic formula for the secular variations in obliquity and in longitude, applies the designation secular nutation of the earth's axis to these variations. Defining the *normal* equator as a plane the inclination of which to the ecliptic of a certain epoch is equal to the mean obliquity of that epoch, and the intersection of which with this latter plane passes at each instant through the mean equinox of that instant, he concludes that, in virtue of the secular nutation of the earth's axis, the mean pole describes round the normal pole, considered as fixed, an ellipse the major axis of which, directed towards the pole of the fixed ecliptic (*i.e.* the mean ecliptic of the epoch) is sensibly constant during several centuries. The period of the secular nutation is about 30,000 years, differing little from that of the precession on account of the slow motion of the node of the ecliptic, which is only 8″·7 per annum. Assuming a uniform value of 50″ for the secular diminution of the obliquity, M. Folie compares the results obtained from his formula with ancient observations of the obliquity, and is thus led to announce that the empirical expression $\epsilon_1 = -0''{\cdot}476 + 0''{\cdot}000018t$ for the annual diminution (where t is the number of years from 1850) satisfies very closely the observations from − 250 to + 1487. This expression, however, gives a considerably greater variation to the secular diminution of the obliquity than that which results from Leverrier's researches.

Astrophysical Observatory of Potsdam.—The first part of the fourth volume of the publications of this Observatory, which was published in the latter part of last year, contains three papers. The first of these is by Prof. Vogel, and contains the observations which he made with the great Vienna refractor in 1883 for the purpose of testing the performance of the great object-glass. Prof. Vogel's final verdict is altogether favourable: "The Vienna objective," he says, "leaves nothing to be desired as regards the precision of the images;" and he speaks of using with advantage a power even of 1500 upon planetary markings, a statement which is illustrated by a sketch of part of Saturn's ring, as seen with that magnifying power. His principal observations were, however, spectroscopic, Prof. Vogel utilising the great light-gathering power of the Vienna equatorial for a detailed examination of the remarkable spectra shown by several faint stars, classified by him under types II.*b* and III.*b*; the former including spectra showing both dark and bright lines, and the latter, spectra crossed by dark bands, for the most part sharp towards the red and shaded towards the violet. The bright lines in the former class, with the exception of the green line of hydrogen, have not been identified with those of any element. The principal bands of the latter class Prof. Vogel refers, as Dr. Duner does, to the absorption exercised by hydrocarbons in the atmosphere of the star. The paper also contains a number of observations of nebulæ, principally planetary, and is illustrated by four lithographic plates.

The second paper contains meteorological observations made in the years 1881 to 1883, and the third is a very careful investigation by Dr. G. Müller of the influence of temperature on the refraction of light through prisms, of various kinds of glass, of Iceland-spar and rock-crystal.

Comets Fabry and Barnard.—The brightness of these two comets continues to increase, Fabry's comet in particular promising ere long to be visible to the naked eye; and it seems probable that at the end of April and the beginning of May we may see the unusual spectacle of two bright comets near each other, and very nearly in the zenith.

The following ephemerides are given for Berlin midnight, that for Fabry's comet being by Dr. H. Oppenheim, and that for Barnard's by Dr. A. Krueger:—

Fabry's Comet

1886	R.A. h. m. s.	Decl. ° ′	Log. r	Log. Δ	Brightness
Feb. 19	23 21 32	27 13·7 N.	0·0370	0·2058	4·1
23	23 21 0	28 10·6	0·0121	0·1958	4·8
27	23 20 27	29 11·0	9·9860	0·1836	5·7
Mar. 3	23 19 49	30 14·8 N.	9·9591	0·1639	6·9

Barnard's Comet

Feb. 18	2 1 42	18 20·1 N.	0·2017	0·2412	2·9
22	1 59 29	19 20·7	0·1836	0·2426	3·1
26	1 57 39	20 23·4	0·1646	0·2432	3·4
Mar. 2	1 56 8	21 28·4 N.	0·1443	0·2429	3·7

Stellar Photography.—The new nebula around Maia, discovered by means of the photographs taken at the Paris Observatory, has since been seen with the great Pulkova refractor.

M. Cruls, Director of the Rio de Janeiro Observatory, has been commissioned by the Emperor of Brazil to have a photographic apparatus constructed similar to that devised by the Brothers Henry at Paris, in order to co-operate with them in the proposed photographic survey of the sky.

Harvard College Observatory.—Prof. E. C. Pickering has issued his Report for the year 1885. As in former years, chief interest attaches to the photometric researches carried out at the Observatory. With the 15-inch equatorial the photometric observations of the eclipses of Jupiter's satellites have been continued. In all, 319 eclipses have now been observed, 35 since the end of October 1884. The reduction of the photometric observations of the zone stars between the declinations +0° 50′ and +1° 0′ has been carried on, and the observations of DM. stars between +49° 50′ and +50° 0′, as well as those between +54° 50′ and +55° 0′, have been completed. These observations have been made with the wedge photometer attached to the large equatorial. The resulting magnitudes have been computed by means of the stars occurring in the zones which are also under observation with the meridian photometer.

The work of the wedge has thus been made homogeneous with that of the meridian photometer. The extensive use thus made of the wedge photometer seems to show that the instrument used at Harvard College is not capable of the great degree of precision which is claimed for that employed by Prof. Pritchard. To determine whether this difference is due to the form of the instrument, Prof. Pritchard has kindly undertaken to superintend the construction of a wedge photometer made upon his plan. The number of series of observations made during the year with the meridian photometer is 202; the number of separate settings somewhat exceeding 50,000. The accordance of the results continues satisfactory; the average deviation of the separate measures of the standard circumpolar stars being 0·12 of a magnitude. The entire series of stars to be observed with this instrument includes zones at intervals of 5° from the equator to the pole; the system adopted insuring a regular distribution of stars down to the ninth magnitude. An important investigation has also been undertaken in stellar photography. A Voigtlander portrait lens of 8 inches aperture and 44 inches focus has been mounted equatorially, and with this many photographs have been taken of the trails left by a star when the telescope is not driven by clockwork, polar stars as faint as the fourteenth magnitude and equatorial stars of the sixth magnitude having been thus photographed. Some most striking results have been obtained with stellar spectra. By placing a large prism in front of the lens, photographs have been obtained of stars as faint as the eighth magnitude, in which lines are shown with sufficient distinctness to be clearly seen in a paper positive. As all the stars in a large region are thus photographed, more than a hundred spectra have been obtained on a single plate.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *FEBRUARY* 21-27

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 21

Sun rises, 7h. 4m.; souths, 12h. 13m. 48·0s.; sets, 17h. 24m.; decl. on meridian, 10° 28′ S.: Sidereal Time at Sunset, 3h. 30m.

Moon (at Last Quarter on Feb. 25) rises, 20h. 2m.*; souths, 2h. 17m.; sets, 8h. 19m.; decl. on meridian, 0° 22′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 13	12 7	17 1	13 17 S.
Venus	6 1	11 45	17 29	3 51 S.
Mars	18 48*	1 29	8 10	7 24 N.
Jupiter	20 13*	2 15	8 17	0 22 S.
Saturn	11 49	20 0	4 11*	22 44 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Feb. 21,	21 38	*m*
			,, 26,	21 17	*m*
Algol	3 0·8	40 31 N.	,, 23,	5 47	*m*
			,, 26,	2 35	*m*
λ Tauri	3 54·4	12 10 N.	,, 22,	20 28	*m*
			,, 26,	19 20	*m*
ζ Geminorum	6 57·4	20 44 N.	,, 27,	21 30	*m*
U Monocerotis	7 25·4	9 32 S.	,, 25,		*m*
S Cancri	8 37·4	19 27 N.	,, 26,	1 54	*m*
W Virginis	13 20·2	2 47 S.	,, 25,	5 0	*M*
δ Libræ	14 54·9	8 4 S.	,, 25,	23 2	*m*
U Coronæ	15 13·6	32 4 N.	,, 26,	22 30	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 21,	3 55	*m*
		and at intervals of		20 8	
W Sagittarii	17 57·8	29 35 S.	Feb. 24,	2 30	*m*
β Lyræ	18 45·9	33 14 N.	,, 21,	2 30	m_2
			,, 24,	7 0	*M*
R Lyræ	18 51·9	43 48 N.	,, 25,		*M*
δ Cephei	22 24·9	57 50 N.	,, 24,	0 0	*m*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Mira Ceti, R.A. 2h 13·6m., Decl. 3° 30′ S., should arrive at maximum about this time, but there seems a little uncertainty as to the precise date. It is possible that it has already passed the maximum. Its spectrum should be examined whilst it remains bright.

Occultations of Stars by the Moon (visible at Greenwich)

Feb.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
21	Uranus	—	5 53	6 34	51 334
23	κ Virginis	4½	1 3	1 20	325 298
25	49 Libræ	5½	2 13	near approach	313 —

Feb.	h.	
21	2	Jupiter in conjunction with and 0° 8′ south of the Moon.
24	16	Mercury in superior conjunction with the Sun.

GEOGRAPHICAL NOTES

LIEUT. WISSMANN, who was on his way back to Europe from his last great journey in the Congo district, stopped at Madeira for the benefit of his health, and has now returned to Africa for further explorations. Lieut. von François, who took part in Lieut. Wissmann's expedition on the Kassai River, has returned to Brussels. He reports that on June 16, 1884, he started with Wissmann from Malange to the Lulua River; thence Wissmann turned northwards and founded the station of Luluaburg, while François investigated the Mukenge district. As he wished to regain Wissmann he built five large boats, in which he reached Luluaburg on the Lulua. He also met Tchingenge, the chief of the Balubas tribe, and Mutenda, one of the first chiefs of the Camokas, who received him kindly. After consulting Wissmann he travelled to the Kassai, which they ascended; then, descending the Congo, they eventually reached Leopoldville, after fifty days' journey. Afterwards François accompanied the missionary, Mr. Grenfell, to the tributaries of the Upper Congo. They first ascended the Lulongo (on the right bank of the Congo), and then the Shuapa, which Stanley names the Uranki. The Shuapa retains its name for the whole length of its course, a circumstance which does not often occur in the Congo lands. It is a large river, navigable everywhere, with extremely fertile banks, which for objects of navigation even surpasses the Kassai. The inhabitants of Batua, on the middle Congo, are a real race of dwarfs. The men have an average height of 1·30 metres, the women of 1·10 metres; but they are well developed and very warlike. When the travellers ascended the river they were attacked by the inhabitants, while on the return journey they were very well received. They also discovered the Bussera, a tributary of the Shuapa. Further on they examined the mouth of the Mobangi, a large tributary of the Congo on its right bank. Grenfell is of opinion that the Mobangi and the Welle River, which has its sources in the Southern Soudan, are one and the same river; François, however, believes that the Mobangi is the continuation of the Nana River, situated further to the north. François states that the land of the Balubas is extremely fertile, no less than three harvests annually being the rule. When exploring the Kassai, François and Grenfell found that this river, instead of joining the Uranki (Shuapa), as Stanley supposed, flows into the Congo near Kwamouth. The Leopold Lake flows into the Kassai at a distance of about 1½° from the Congo. The Lulongo runs parallel to the Congo for a considerable distance on its northern side. The two travellers discovered numerous other smaller tributaries.

A RECENT number of *Cosmos* contains an article by M. de Morgan, who was employed by the Government of the Straits Settlements to prepare a map of the State of Perak in the Malay peninsula, on the Stone Age there. In the course of his work, the writer had to visit the range of mountains forming the watershed of the peninsula, and here came into contact with the Sakayes, Seumangs, Rayats, and other pre-Malay Negrito tribes, as nearly in their original state as they can now be found in these regions. He refers to other tribes living in recesses of the mountains, of whom he learnt from the Sakayes. The latter call them "fire apes"; their language is said to have nothing in common with Malay or Negrito dialects. M. de Morgan received here two polished stone axes, which were said to be made by the "fire apes." One was made of a fine-grained yellow porphyry, and was 224 mm. in length, 53 mm. in breadth, and 16 mm. thick; the other was of a green quartz schist, and

was smaller in size. They were polished with great care, and in shape resembled certain Scandinavian stone axes. From inquiries which he made, he came to the conclusion that in recent times there existed in the centre of the Malay peninsula a people wholly ignorant of metals, and he asks whether these "fire apes" are a remnant of the aborigines, who were overwhelmed by a Negrito invasion, or whether they are merely Sakayes who fled before the Malays. The Sakayes, it should be noted, preserve a tradition of the use of stone implements, and it is probable that before the Malay invasion they knew nothing of metals. It is curious to notice that the Malays, who frequently find stone axes in the soil, called them "thunderstones," believing that they proceed from a thunderbolt, thus reproducing an old Breton notion in the centre of the Malay peninsula.

WE have more than once referred to the extraordinary diversity and confusion of the names of States and towns in the eastern half of the Indo-Chinese peninsula. The Marquis d'Hervey de Saint-Denys, well-known for his Chinese researches, has recently read a paper on this subject before the Paris Academy of Inscriptions, which throws much light on the history of this nomenclature. In the sixth century of our era the Chinese, regarding the populations of the present Kuantung, Kwangsi, and Tonquin as barbarians, called them Yuen. When the present Tonquin was conquered and reduced to a Chinese province, they called it Kiao-chi or Kia chow, from the name of the capital, the Hanoi of our days. In 756 they established in Tonquin a great district, which they styled the Annam, or "pacificator of the south." This is the origin of the present designation. In the fifteenth century Annam, then become a feudatory kingdom, was divided into two principalities: the Western Court, Si-tong, and the Eastern Court, Tonquin; hence the latter name. In 1775 the kingdoms of Annam and Cochin China were destroyed by a rebellion, and the last king of the former died at Pekin, whither he had fled. The King of Cochin China, however, succeeded in recovering his throne, and in adding, with the consent of the Chinese, Annam to his dominions. But, in ratifying this union, the Emperor of China bestowed a new name on the whole, Yue-nan. The writer concludes that the country called Annam by the Chinese never went beyond the seventeenth parallel of latitude, and that in every document in which the title occurs the present Tonquin is really meant. It would thus appear that there are, historically, only two countries on the east coast of the peninsula, viz. Annam (which is Tonquin, and nothing more) and Cochin China. But this leaves the present Annam to be accounted for. Possibly nothing short of an International Geographical Congress will succeed in producing a simple uniform nomenclature for this region.

THE *Revue Scientifique* bases the following conclusions on the climate of Tonquin on the evidence given by medical and sanitary experts before the recent Commission of the French Chamber on the subject. Compared with Cochin China, Tonquin is not unhealthy; from September to April there is regular spring, and it is from May to October that the heat is almost insupportable. Except in the mountains, which are dreaded by the natives, and in the forests in the neighbourhood of Hung-hoa, there are no deadly fevers as in Cochin China; especially are there no serious diarrhœas as in the latter. In the delta of the Red River, cultivation and vegetation render it healthy. It is doubtful whether cholera is endemic in Tonquin; the last epidemic appears to have been imported from the Pescadores, and it attacked natives rather than Europeans. But sunstroke is rather prevalent. Two years is the limit assigned for the residence of troops having to undergo great fatigue, with an insufficient quantity of good food; but on occasion this stay may be prolonged without harm to three or four years. Merchants and officials may safely spend fifteen to twenty years in the country.

AT the meeting of the Geographical Society of Paris on January 8, M. Duveyrier described some observations made at Tuggurt in 1860, from which he calculated the latitude at 33° 7′ 0″ and the longitude at 3° 36′ 24″ east of Paris. M. Le Chatelier sent several notes relating to the southern part of Algeria.

THE *Compte rendu*, No. 1, 1886, of the Paris Geographical Society, contains a suggestion from M. Alphonse de Candolle referring to the want in geographical books and works of travel of an analytical index. These works, he says, contain information on natural history, agriculture, mines, ethnography, language, arts, religion, &c., which interest all classes of students, but it is scattered throughout the various works, and few have the patience or the time to get at them by an attentive perusal of the whole. He has often experienced this want himself in preparing his botanical geography, and more recently the work on the origin of cultivated plants. As models of indices he points to Darwin's works, and adds that the more detailed the index is the better. He therefore invites the Society to encourage the addition of indices to geographical works.

THE last *Bulletin* (No. 4, 1885) of the same Society contains the full text of M. Velain's geographical and ethnographical sketch of French Guiana, and the basins of the Yari and Paru, affluents of the Amazon, based on Dr. Crevaux's exploration; of M. de Saint-Pol Lias's account of his journeys in Sumatra and Malacca ("Aché and Pérak"); and of the journeys of MM. Senèze and Noetzli in Ecuador and Peru in 1876-77.

Globus (No. 5, 1886) contains an article by Prof. Blumentritt on the tribe of Guinaus of Abra, in Luzon, based on a communication by Lieut. Trullens, of the Spanish Army, to the *Boletin* of the Philippine Society of the Amigos del Pais. The article describes the houses, mode of life, manners and customs of the tribe. They are confirmed head-hunters, notwithstanding the presence of Spanish troops and police in their territory. Their superstitions, Prof. Blumentritt says, go to strengthen the theory that the religious notions of the Malays all over the Archipelago are broadly the same. It is noteworthy that he laments the general ignorance of ethnology displayed by most Spanish writers on the Philippine races.

THE LUMBAR CURVE IN MAN AND APES[1]

IN this investigation the fresh spines of twelve Europeans, of four anthropoids, of fifteen different species of the lower apes, and several quadrupeds were examined. In each case the body was frozen, and then divided by a saw in the mesial plane. When still in the frozen condition a tracing was taken of the outline of the body, and of the centra of the vertebræ. The results obtained all tend to minimize the importance of the lumbar curve as a distinctive character of any special group. It is present in a well-marked form not only in the chimpanzee, but also in most of the lower apes, and even, under certain conditions, in some quadrupeds (*i.e.* bear). In the chimpanzee the quality of the curve is identical with that of man: it only differs in degree. The latter point could not be absolutely determined, as the four anthropoids examined were little over four years old, and yet the degree of curve was much greater than that of a child of six—indeed it was comparable with that of a child of thirteen.

The second part of the memoir dealt with the adaptation in form of the vertebral bodies to the lumbar curve. By measurements it can be established that in the low races the lumbar curve is not stamped upon the spine so firmly as in the case of the Europeans. In other words, the European lumbar vertebræ are moulded in accordance with the curve, whilst the corresponding vertebræ of the low races are not.

Taking the anterior vertical depth of each vertebral body as 100, the following indices were obtained:—

MAN

		76 Europeans	17 Australians	3 Tasmanians	3 Bushmen	23 Andamans	10 Negroes
Five lower true vertebræ	*a*	106·1	119·8	115·1	115·9	112·6	113·5
	b	101·4	113·	109·9	113·4	111·2	111·3
	c	97·2	113·6	110·1	109·9	108·1	105·9
	d	93·5	103·9	109·5	100·8	102·6	105·1
	e	81·6	90·4	92·4	95·3	91·4	92
Average index		95·8	107·8	107·2	106·6	104·8	105·4

[1] Abstract of a Paper on "The Lumbar Curve in Man and the Apes, with an Account of the Topographical Anatomy of the Chimpanzee." By D. J. Cunningham, M.D. (Univ. Dub.), Professor of Anatomy in Trinity College, Dublin. Read before the Royal Irish Academy, January 26, 1886.

	Ape						
	5 Gorillas	9 Chimpanzees	4 Orangs	6 Gibbons	2 Babouins	3 Macaques	1 Colobus
Five lower true vertebræ *a*	115·3	125·3	113·7	112·8	117·7	109·7	103·8
b	111·7	117·1	118·9	108·8	120·6	107·8	103·8
c	111·3	116·4	119·7	107·5	108	103	103·8
d	105·3	116·1	111·9	106·4	107·3	103·2	108
e	101·9	115·8	103·5	104·1	92·8	96·2	90·4
Average index	108·1	117·5	112·9	107·1	108·5	103·7	102·4

It can be proved in many ways that the lumbar curve of the spine is more marked in the human female than in the male. The methods adopted for the elucidation of this point were: (1) tracings of mesial sections of the frozen spines of the two sexes; (2) Measurements of the anterior and posterior surface of the lumbar region; and (3) measurements of the individual lumbar vertebræ.

The difference between the indices of the vertebræ of the two sexes are not confined to Europeans, but are also observed in four of the five lower races examined, as will be seen from the following table:—

	Irish		Andamans		Negroes	
	21 ♂	23 ♀	14 ♂	9 ♀	7 ♂	3 ♀
Average index of the five lumbar vertebræ ...	96·2	93·5	106·3	102·4	106	103·4

	Australians		Tasmanians	
	10 ♂	4 ♀	2 ♂	1 ♀
Average index of the five lumbar vertebræ ...	110·1	103·1	108·5	104·7

It can be shown that the indices of the lumbar vertebræ of a given European spine are in strict accordance with the degree of lumbar curve. But, whilst this is the case, the difference between the anterior and posterior vertical diameters of the vertebral bodies is so slight (as Weber has observed) that it can have little effect in producing the lumbar curve. The form-adaptation of the vertebral bodies must, therefore, be regarded as the consequence, and not as a cause, of the curve: at the same time it cannot be due to an immediate and mechanical influence operating upon the vertebral bodies during the life of the individual. If it were so, the same characters would be present in the lumbar vertebræ of the low races, and even of the anthropoid. It is an hereditary condition.

The European, who leads a life which rarely necessitates his forsaking the erect attitude except as an intermittent occurrence, and then for short periods, has sacrificed in the lumbar part of the vertebral column *flexibility* for *stability*. It is evident that the deeper the bodies of the vertebræ grow in front, the more permanent, stable, and fixed the lumbar curve will become, and the more restricted will be the power of forward-bending in this region of the spine. The savage, in whose life agility and suppleness of body are of so great an account, who pursues game in a prone position, and climbs trees for fruit, &c., preserves the anthropoid condition of vertebræ, and in consequence possesses a superior flexibility of the lumbar part of the spine.

SNOW-COVERING AND THE WEATHER

DR. WOEIKOF, who is one of the meteorologists of the modern school, has long entertained a deep conviction that meteorology ought not to limit itself to a mere observation of those few instruments which for nearly fifty years have constituted the plant of meteorological Observatories. In the development of its general laws and the application of them to forecasts of weather, it must widen the circle of its observations, and take into account those factors upon which weather and climate depend in each given locality. For the past fifteen years he has devoted his time to the study of local climates and their dependence upon local causes, such as the local deflections of the paths of cyclones and anticyclones; the proximity of seas, steppes, marshes, and forests, and the local heating and cooling of the ground. His chief work, published in Russian, entitled "The Climates of the Globe," is most valuable, on account of the wide knowledge it evinces of the various circumstances on which climate depends, especially with regard to the immense plains of Russia.

The influence of the snow on climate, of its depth and consistency, the time of its first appearance and disappearance, the evaporation from its surface, the purification of air when it has fallen, and a variety of minor circumstances, the importance of which has been insisted on by Dr. Woeikof since 1872, are all referred to. Unhappily, observations on snow are very few and imperfect, and in a paper recently read before the Russian Geographical Society, and now printed in its *Memoirs* (xv. 2), he returns to the subject, illustrating the importance of such observations by a few well-chosen examples.

The year 1877 was a striking instance of how the absence of snow was accompanied by a far less notable lowering of temperature during the prevalence of anticyclones than would have been the case had the soil been covered with snow. In 1877 there was no snow in Eastern Russia until Christmas, and in November and December the anticyclones occurred, accompanied by no wind, or only by feeble breezes. Quite bright weather lasted in December for more than ten days; and still in the region which remained uncovered with snow no great cold was experienced as usually happens in such circumstances: the minima were 8° to 9° above their average values. The same conditions were noticed during the winters of 1879-80 and 1881-82, in West Europe, as shown by Dr. Billwiller in the *Zeitschrift für Meteorologie* for 1882.

In Dr. Woeikof's opinion the relatively high mean temperature of November, as compared with March, in South-East Russia and the Kirghiz Steppe may be explained by the circumstance that in these localities the soil usually is not covered with snow in November; and thus, not being separated from the air by the snow, which is a bad conductor of heat, it rather contributes to maintain a higher temperature in the air resting on it. On the other hand, towards the end of winter the surface is much cooled and exercises a refrigerating influence on the air. Examples from the United States adduced by M. Woeikof seem also to confirm this view.

The refrigerating influence of a thick covering of snow in the spring and the influence it exercises in retarding the arrival of warm weather is so obvious that it need not be insisted on. A paper was written by M. Woeikof, in 1872, on this subject; and the very interesting illustrations he has adduced to show the refrigerating influence of a snow-covering during years when snow was abundant, are very striking. He has since returned to this subject in his "Climates of the Globe," and in the paper we mention; and we may consider it quite established that it is precisely to this agency that the relative coolness of the spring months in Russia and Siberia is due. Moreover, it may be considered as certain that when the snow-covering has been thick, and especially when the snow has a harder consistency, the arrival of warm weather will come on late in the spring.

Another result which Dr. Woeikof has established relates to the commencement of first durable frosts. As long as there is no snow, or little, he argues that frosts may begin, but they will not be durable, and the temperature may rise above the freezing-point; but it is the snow-covering, although not very thick, which gives durability to cold weather. It is easy to foresee how important it becomes, in forecasting the weather, to know, both in spring and autumn, if there are, to the north and east of any region, broad spaces covered with snow.

It is useless to insist upon the importance of an exact knowledge of the depth and consistency of the snow for forecasts in the interests of navigation, especially in countries like Russia, where navigation on so many rivers is carried on only at high water. Several interesting illustrations of this influence are given by the author. In view of these important results, it is

most desirable that all observations regarding snow should be made part and parcel of regular meteorological observations. The Ural Society of Naturalists has already collected valuable materials under that head, and it may be assumed that scientific and practical meteorologists will not be slow in taking advantage of such observations. P. K.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Mr. S. F. Harmer, B.A., has been appointed Demonstrator of Animal Morphology, in the place of Mr. Walter Heape, resigned. Mr. Harmer was previously Demonstrator of Comparative Anatomy.

The subject for the Sedgwick Prize Essay in 1889 is the Petrology of the Igneous Rocks associated with the Cambrian (Sedgwick) of Carnarvonshire. The essays must be sent in on or before October 1, 1888. It is open only to graduates of Cambridge who have resided sixty days during the year preceding that date.

On the 22nd inst. the General Board of Studies will proceed to nominate a University Lecturer in Geology for five years, in the place of Dr. R. D. Roberts, now Secretary to the London Association for the Extension of University Teaching.

A report of the General Board of Studies has been carried, recommending that no fees shall be paid by students to Professors and Readers in consideration of the lectures which form part of the ordinary duty of their office, but only for further assistance and material or apparatus; also that a return shall be given to the Board of lectures delivered, extra teaching given, and fees charged.

The important proposals respecting the additional subjects in the Previous Examination required of candidates for honours have been carried in such a way as to make them broader in their effects. The substitution of Mechanics for Statics was carried by 58 to 44. The alternative of French or German was introduced by 59 to 42; and then, somewhat surprisingly, the restriction of this alternative to candidates for the Mathematical Tripos, and the requirement that candidates for any other tripos than the Mathematical should pass in the mathematical additional subjects, were rejected by 53 to 49. Thus a great step in advance is made, and any candidate for honours can take Mathematics, French, or German as an additional subject.

Mr. Leslie Stephen has been reappointed an Elector to the Knightbridge Professorship, Lord Rayleigh to that of Chemistry, Mr. Christie, Astronomer-Royal, to the Plumian Professorship; Dr. Humphry has been appointed an Elector to that of Anatomy in place of the late Dr. Allen Thompson; Mr. F. Darwin has been reappointed an Elector to that of Botany; Dr. G. J. Hinde has been appointed an Elector to the Woodwardian Professorship of Geology in place of Rev. E. Hill; Prof. Stokes, P.R.S., has been reappointed an Elector to the Jacksonian Professorship; Dr. H. C. Sorby, F.R.S., to that of Mineralogy; the Right Hon. G. J. Goschen, M.P., has been appointed an Elector of that of Political Economy, in place of Prof. A. Marshall; Prof. H. N. Moseley, F.R.S., has been reappointed an Elector to that of Zoology and Comparative Anatomy; Prof. Stokes, P.R.S., to the Cavendish Professorship; Lord Rayleigh to that of Mechanism; Dr. F. J. Farre to the Downing Professorship of Medicine; Prof. Huxley to that of Physiology; Sir James Paget to that of Pathology; Prof. William Wallace has been appointed an Elector to that of Mental Philosophy and Logic, in place of Mr. James Ward; and Mr. Cadge to that of Surgery. The appointments in each case are for eight years.

The report recommending the institution of a Tripos Examination in Engineering, to be combined to some extent with the Natural Sciences Tripos, has been discussed at some length in the Senate. Mr. Hill thought parts of the Mathematical Tripos and the Special Examination of Engineering sufficient. Mr. Trotter throught the proposed examination was required both for engineering students and students of physics. It was desirable to increase the mathematical training of students of engineering. The Mathematical Tripos had, he thought, suffered from its long and illustrious history. The Examiners felt bound to find something new, and a good deal of students' time was spent in recognising old things in disguised forms, and in solving mathematical puzzles, not suitable for an engineering student pressed for time, or for a student of experimental physics. Prof. Stuart said he was in a position to state that the University had now the opportunity of making its engineering certificate very much ahead of anything else in the world. In one very important respect the new examination would differ from the Mathematical Tripos; it would include practical work in its earliest part.

NEW science buildings are now being erected for Tonbridge School at a cost of nearly 14,000*l*. They will contain chemical and physical laboratories, lecture-room, class-rooms, preparation-rooms, and in addition a library and room for drawing.

SCIENTIFIC SERIALS

The Journal of the Royal Microscopical Society for December 1885 contains:—On some new and rare Desmids, by W. Barwell Turner (plates 15 and 16). Describes a number of new species, for the most part from the United States of America, but the localities are not always very definitely given. A new genus, Leptorosma, is made for a filamentous form near to Bambusina, Kütz, but differing in the sutures. The various forms mentioned are all figured.—Further experiments on feeding insects with the curved or "comma" Bacillus, by Dr. R. L. Maddox. The curved Bacilli are apparently able to retain life in the intestinal tract of flies, and so might possibly become a source of injury to animals.—On the cholera "comma" Bacillus, by G. F. Dowdeswell, M.A.—On an improved form of Stephenson's binocular prisms, by C. D. Ahrens.—Remarks on Prof. Abbe's note on the proper definition of the amplifying power of a lens or lens-system, by Dr. E. Giltay.—On the limits of resolution in the microscope, by Frank Crisp, LL.B., with a note by Prof. Abbe.—The usual summary of current researches and the proceedings of the Society.—At one of the meetings Mr. Crisp exhibited a series of photographic portraits of all the Presidents of the Society. These—eighteen in number—appear in the present part, arranged on two plates of eight portraits each and two full-page portraits of Sir R. Owen, the first President of the Microscopical Society, and of Mr. Glaisher, the first President of the Royal Microscopical Society.

Wiedemann's Annalen, Bd. xxvii. No. 1, January.—F. and W. Kohlrausch, the electro-chemical equivalent of silver, together with an experimental proof of the measurements of intensity of terrestrial magnetism. These determinations, chiefly by the method of Joule, appear to have been made with the utmost regard for precision in all details. The value of the electro chemical equivalent of silver deduced is about 0·06 per cent. higher than that given by Lord Rayleigh, being 0·0011183 gramme per ampere, as against 0·0011179. Mascart's latest value was 0·0011156. This would make the equivalent of hydrogen 0·000010386.—A. Kundt, on double refraction of light in metal films which are produced by disgregation of a cathode. Films deposited by electric discharges from a pointed cathode show a circularly-arranged dichroism when viewed in the polariscope.—Ch. Lüdeking, on the specific heats, specific gravities, and heats of hydration of the fatty acids and of their mixtures with water.—Otto Schumann, on the density of the adsorbed films of air on surfaces of glass.—J. Lahr, Grassmann's vowel-theory in the light of experiment. Discusses the results obtained by Jenkin and Ewing with a phonograph, and by Schneebeli with a phonautograph.—E. Aulinger, on the relation of Weber's theory of electrodynamics to the principle of unity of electric forces propounded by Hertz.—O. Tumlirz, on the properties of rock crystal in the magnetic field. This paper announces the discovery in this body of residual diamagnetic properties.—Eug. Blasius, notice on Japanese mirrors. Describing kindred phenomena with glass plates which have been scratched at the back with a writing diamond.—E. Lommel, aërostatic balance for the determination of the specific gravities of gases.

Archives Italiennes de Biologie, tome vi. fasc. 3, May 30, 1885.—This part completes volume vi. of this *Archiv*, and in it the editors apologise for its tardy and irregular appearance, which was caused by the terrible epidemic which afflicted Italy in 1884. For the future the *Archiv* will appear not at stated periods, but as matter is ready for publication, every three parts to form a volume. This part contains the last part of a notice of Dr. Beccari's work on "Piante Ospitatrici," by M. E. Levier. These host plants, noticed first by Rumphius in 1750, have been studied in New Guinea and in the Malay Archipelago by Beccari, the first part of whose deeply interesting account of them and their ant guests has but recently been published.—On a case of congenital cataract, by J. Albertotti. The patient was operated on at the age of 21. The operation

was a brilliant success, and the experiences noted in this paper are of great value; but the result to the patient may be guessed at by his exclamation some months after the operation: "C'était mieux quand je ne voyais pas."—On the sensibility and motility of nerves by ... tion produced on the ... by Dr. C. Negro.—Note on ... pneumonococcus, a grave complication in pneumonia, by P. ... Foa and G. Rattone.—On the physio-pathological aspect ... of stratified pavement epithelium, and on the pathogeny of albuminuria, by Prof. G. Tizzoni.—On the presence of albumen in saliva, a criticism of the views of Madame Dessales by Prof. Brancaccio, and a reply by Madame Dessales.—On the central termination of the optic nerve in some mammals, by Dr. J. Bellonci.—On the influence of chloral on gastric digestion, by A. Fiumi and A. Favrat.—Anatomical and clinical study of Morgagni's cataract; and on congenital micro-ophthalmy, by Dr. Falchi.

Rivista Scientifico-Industriale, December 15-31.—Dr. Pietro Cardani, variation of the diameter of the sparks with the potential and the resistance: a study of the way the diameter of the sparks is modified by the resistance of the circuit, and how the diameter itself varies with the increase of the explosive distance. The diameter is found to increase proportionately to the square root of the potential, and to decrease according to a hyperbolical function with the increased resistance; hence for great distances this diameter becomes sensibly constant. The same physicist deals with Harris's second law that the explosive distance varies inversely with the pressure of the gas, and concludes that this law is true only within certain limited conditions.—Dante ...ter, remarks in connection with Prof. Mariacher's observa...s on the food of birds. These studies have a practical value, tending to determine those birds which are insectivorous, and consequently harmless, and those that are graminivorous and injurious to the crops.

Reale Istituto Lombardo, January 7.—Summary of Tito Vignoli's monograph on "The Psychic Act of Attention in the Animal Series," in which the author describes the genesis of attention from the lowest to the highest organisms, analysing the elements of sensation and perception, and determining their comparative values. The physiological and psychological conditions of attention are held to be identical in the higher animals and in man, differing only objectively, and man alone being capable of introspective thought. Hence man is distinguished from other animals, not by the physio-psychic act of attention, but by the faculty of submitting his own intelligence to examination.—In a supplementary note on the transition from animal to human intelligence, Vignoli argues that Darwinism will never succeed in explaining the evolution of the organic from the inorganic, nor of sensation and consciousness from the mere organic. The passage from the intelligence of animals to that of man is not a gradual development of the faculties, but is accomplished by a reflex act of animal intelligence on itself. This act must be instantaneous, consequently is not the result of evolution, as are the physical conditions leading up to it.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 7.—"Experimental Researches on the Propagation of Heat by Conduction in Muscle, Liver, Kidney, Bone, and Brain." By J. S. Lombard, M.D., formerly Assistant Professor of Physiology in Harvard University. Communicated by Charles E. Brown-Séquard, M.D., LL.D., F.R.S.

January 14.—"Notes upon the Straining of Ships caused by Rolling." By Prof. Francis Elgar, LL.D., F.R.S.E.

It does not appear that any serious attempt has yet been made to investigate the amounts, or even the nature, of the principal straining actions which the rolling of a ship brings into play, or of the effect of those straining actions upon the material of which the hull is composed. Various writers, from Bouguer in 1746, down to Prof. Macquorne Rankine in 1866, and Sir E. J. Reed in 1871, have discussed the straining actions that are caused by longitudinal racking and bending when a vessel is floating in statical equilibrium. Sir E. J. Reed elaborately investigated the subject in a paper contained in the *Philosophical Transactions* of the Royal Society for 1871, and gave examples of the amounts and distribution of the stresses caused by such straining actions in several typical ships of Her Majesty's Navy. Mr. W. John supplemented this by a paper on the strength of iron ships, read before the Institution of Naval Architects in 1874, in which similar results were given for various classes of vessels in the mercantile marine.

The later investigations of these longitudinal straining actions apply not only to the case of a ship floating in equilibrium in still water, but also to cases in which she is (1) in instantaneous statical equilibrium across the crest of a wave; and (2) in instantaneous statical equilibrium across the hollow of a wave—the wave-length being equal to the length of the ship.

Cases frequently occur which show that the maximum stresses of the material of a ship's hull are not in proportion to the results obtained by the ordinary calculations; and that certain deductions that have been drawn from those results are by no means sound. For instance, it is said to follow from the analogy between the longitudinal bending action upon a ship afloat and that upon a loaded girder, that there is little or no stress exerted upon that portion of a ship's plating which is in the vicinity of the neutral axis for the upright position; and the inference has been drawn that, subject to the consideration of the sides being occasionally brought, in some degree, into the positions of flanges of a girder at large inclinations, the thickness of the material may be decreased with advantage near the neutral axis. Now it cannot be shown that the plating which is in the vicinity of the neutral axis when the ship is upright, is ever brought into such a position by the rolling of a vessel as to be much affected by mere longitudinal bending.

Other propositions respecting the distribution of stress in various parts of the structure have been deduced from considerations and assumptions upon which the ordinary calculations of longitudinal strength are based; and rules have, in consequence, been proposed for regulating the strength of the principal component parts of ships' hulls. It is only necessary here to say that many of those deductions, like the one already noticed, are unsound, and are not consistent with the effects that may be observed of straining action at sea.

A considerable experience at sea, where the author has closely observed the effects of straining action caused by twisting moments, and a further experience in investigating the stresses to which the various portions of ships' hulls are subjected according to the theories referred to, and in comparing the results so obtained with the visible evidences of straining action, have convinced him that the stresses caused by twisting moments are much greater than is generally supposed, and that no rules for regulating the strength of ships can be satisfactory if based upon hypotheses that exclude all practical consideration of twisting moments.

The straining action considered in this paper is that caused by the twisting moments which operate when a ship rolls from side to side, and which are caused by differences in the longitudinal distribution of the moments of the forces that cause rotation, and those which resist rotation.

After describing at length the manner in which the twisting moments may be approximately calculated, the author proceeds to consider the amounts and distribution of the stresses upon the material of the hull which are caused by a given twisting moment:—

We can learn something of the nature and distribution of those stresses; but, at present, their amounts cannot be calculated with any reliable approach to accuracy. Experiments are required upon the torsion of thin shells of various prismatic forms in order to furnish the requisite data for dealing with so complicated a case as that of a ship's hull. The difficulty of obtaining exact data is very great; but attention is drawn to some of the general considerations which affect the twisting moments and the distribution of the twisting strains and stresses over a ship's hull; and to the bearing which these have upon the important practical problems that relate to the structural strength of ships.

The best data available for guidance in judging of the distribution of strain and stress due to twisting over the structure of a ship are to be found in M. de Saint-Venant's investigations of the torsion of prisms.[1]

The distribution of the torsional stresses over the transverse section of a ship's hull is obviously different from the distribution

[1] "Mémoires présentés par divers Savants à l'Académie des Sciences de l'Institut Impérial de France," tome 14, 1856. "Mémoire sur la Torsion de Prismes, &c." Par M. de Saint-Venant," pp. 233-560. Also Thomson and Tait's "Natural Philosophy," vol. i., part 2, secs. 699-710.

of the stresses due to longitudinal bending. The parts subjected to greatest stress by twisting are those which are near to the centre of gravity of the transverse section; and they are the side plating near the neutral axis of longitudinal bending in the upright position and the middle portions of the plating of the decks. Those parts of the hull which are usually made the strongest, viz., the strakes of side and bottom plating that are farthest from the neutral axis, and the upper deck stringer plate, are those which are least affected by twisting. It is probably owing, in great measure, to the straining action caused by twisting, that experience has proved it to be necessary to make the outside plating of a ship of nearly uniform thickness over the whole section; and it cannot be because of the reason sometimes given, that the plating in the vicinity of the neutral axis when a ship is upright is often brought by rolling into positions in which it is greatly strained by longitudinal bending.

The importance of many of the structural arrangements of ships which practical experience has shown to be necessary are described in the present paper, and may be understood from the considerations adduced; and it may also be seen that no rules for regulating the strength of ships are likely to be satisfactory if based, as is often done, upon the hypothesis that the straining actions caused by longitudinal bending are so much more important than all others that it is sufficient to regard them alone.

Abstract of Paper on "Proteid Substances in Latex." By J. R. Green, B.Sc., B.A., Demonstrator of Physiology in the University of Cambridge.

The author, after calling attention to the researches of other writers into the nature of the proteids found especially in seeds, described certain bodies found by him to be present in the latex of various plants, chiefly East Indian and South American. The most noteworthy of these was a curious proteid exhibiting relations to the peptones and to the albumoses, resembling the former in being soluble in distilled water, in not being coagulated by heat, and in dialysing through membranes, and agreeing with the latter in being precipitated from its solutions by saturation with solid neutral salts. In addition to this body, which was present in all the samples examined, others were described, including a form of albumen, a globulin, and two albumoses, one of the latter being identical with the hemi-albumose described by Vines as occurring in many seeds. The paper concluded with a recapitulation of the bodies found, and with a detailed summary of their distinguishing reactions.

February 4.—"On Intra-vascular Clotting." By L. C. Wooldridge, M.B., D.Sc. Communicated by Prof. Sanderson.

The author has isolated from the perfectly fresh thymus gland and testis of the calf a substance which, when dissolved in alkaline salt solution and injected into the blood of an animal, causes instantaneous death.

The substance in question is a complex proteid body, and as proof that the effects it produces are due to this proteid and not to any accidental admixture, the author adduces the fact that it becomes entirely inactive after having been subjected for a short time to the action of artificial peptic digestion.

The cause of death is extensive intra-vascular clotting of the blood; if a sufficient quantity be injected, complete thrombosis of the whole vascular system is produced. The substance does not contain any fibrin ferment, nor does the blood which is obtained from an animal after injection of this substance contain more than a minute trace of ferment.

Mathematical Society, February 11.—Mr. J. W. L. Glaisher, F.R.S., President, in the chair.—Prof. P. H. Schoute, Ph.D., Groningen, Netherlands, was elected a Member.—Capt. P. A. Macmahon, R.A., read a paper on perpetuant reciprocants, the object of which was to present the numerical enumeration of the perpetuant reciprocants of the first six degrees carried out on the plan initiated by Prof. Sylvester (see NATURE, January 7, p. 222, *Comptes rendus*, and the *Messenger of Mathematics*).—The President communicated a note on the functions $Z(u)$, $\theta(u)$, $\pi(u,\alpha)$ by himself, and a note on a $Z(u)$ function by Mr. J. Griffiths.—The Secretary read part of a paper by Mr. R. A. Roberts on polygons circumscribed about a conic and inscribed in a cubic.

Anthropological Institute, January 26.—Anniversary Meeting.—Mr. Francis Galton, F.R.S., President, in the chair.—The following gentlemen were elected Members of the Council for the ensuing year:—President, Francis Galton, F.R.S.; Vice-Presidents, John Beddoe, F.R.S., Capt. R. F. Burton, Prof. G. Busk, F.R.S., John Evans, F.R.S., Prof. Flower, F.R.S., Prof. Huxley, F.R.S., Sir John Lubbock, Bart., F.R.S., Major-General Pitt-Rivers, F.R.S., Edward B. Tylor, F.R.S., Hyde Clarke, Lieut.-Col. H. H. Godwin-Austen, F.R.S., Prof. A. H. Keane; Secretary, F. W. Rudler, F.G.S.; Treasurer, F. G. H. Price, F.S.A.; Council: S. E. B. Bouverie-Pusey, Sir W. Bowman, Bart., E. W. Brabrook, F.S.A., Sir George Campbell, C. H. E. Carmichael, M.A., W. L. Distant, A. W. Franks, F.R.S., J. G. Garson, M.D., A. L. Lewis, Prof. A. Macalister, F.R.S., R. Biddulph Martin, Prof. Meldola, Prof. Moseley, F.R.S., C. Peek, M.A., J. E. Price, F.S.A., Charles H. Read, F.S.A., Charles Roberts, F.R.C.S., Lord Arthur Russell, Prof. G. D. Thane, M. J. Walhouse, F.R.A.S.

Entomological Society, February 3.—Mr. R. McLachlan, F.R.S., President, in the chair.—The President appointed Mr. F. Du Cane Godman, F.R.S., Mr. Stainton, F.R.S., and Mr. J. Jenner Weir, Vice-Presidents for the year.—Dr. Livett, Lieut. Goodrich, Mr. Eustace Bankes, and Mr. F. Enock were elected Fellows, and M. Ragonot of Paris, ex-President of the Entomological Society of France, was elected a Foreign Member.—Mr. C. O. Waterhouse exhibited some cocoons of *Coccida* (*Eriopeltis*) found by Mr. Moore on blades of grass at Ilfracombe.—Mr. Douglas sent for exhibition leaves of *Euonymus japonicus*, received from M. Lichtenstein, infested by a coccid, *Chionaspis euonymi*, first noticed in the United States, but which occurred in great numbers at Montpellier and Nîmes, and always destroyed the shrubs attacked by it.—The President exhibited specimens of *Tettix australis*, received from Mr. Oliff of the Sydney Museum, who had captured them near Penrith, New South Wales. Mr. Oliff stated that the insects were decidedly sub-aquatic, as he had found them 8 or 10 inches below the surface of the water on the stems of water plants.—Mr. W. F. Kirby exhibited, on behalf of Mr. Ralfe, a series of specimens of *Lycæna corydon* of a very extraordinary character.—The Rev. W. W. Fowler exhibited a specimen of the almost unique beetle, *Harpalus calceatus*, taken by himself at Bridlington; also a specimen of *Apion Lemoroi*, a new French *Apion* taken on the coasts of Normandy and Brittany. He also exhibited several species of British *Helophori*, and read notes on their synonymy.—Mr. H. Goss read an analysis of M. Brongniart's recent work on "Les Insectes fossiles des Terrains Primaires," and expounded that author's views on the classification of insects from geological data.—The Rev. W. W. Fowler read notes on a small collection of *Languriidæ*, with descriptions of two new species.—Dr. Baly communicated a paper containing descriptions of new genera and species of *Galerucidæ*.—Mr. J. Edwards communicated the first part of a synopsis of British *Homoptera* (*Cicadina*).

Institution of Civil Engineers, January 26.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The paper read was on the injurious effect of a blue heat on steel and iron, by Mr. C. E. Stromeyer, Assoc.M.Inst.C.E.

MANCHESTER

Literary and Philosophical Society, December 1, 1885.—Prof. W. C. Williamson, LL.D., F.R.S., President, in the chair.—The diffraction of a plane polarised wave of light, by R. F. Gwyther, M.A.—On the different arrangements of equal spherical granules, so that the mean density may be a maximum, by Prof. Osborne Reynolds, F.R.S.

DUBLIN

Royal Society, January 20.—Section of Physical and Experimental Science.—C. R. C. Tichborne, Ph.D., in the chair.—On a nomenclature for facilitating the study of music, by G. J. Stoney, D.Sc., F.R.S.—Notes on improvements in equatorial mountings, by Howard Grubb, M.E., F.R.S. These consisted of a new slow motion in declination, a new position finder, and a modification of the old differential slow motion in right ascension. Mr. Grubb also described a new slow motion in right ascension, and a new arrangement for electric clock control specially adapted for celestial photography.—Dr. Stoney communicated notes on observations made by Prof. Vogel with the great Vienna refractor.—On a method of determining the specific gravity of a small quantity of a dense solid, also applicable to finding the specific gravity of a small quantity of a porous substance, by J. Joly, B.E. The ordinary method of dealing with

minute fragments of minerals, by balancing in a liquid of a specific gravity adjustable to that of the mineral, fails altogether (*a*) when the substance has a specific gravity over 4·5 about; (*b*) when it is of a porous nature. The author deals with minerals having a specific gravity above that of Thulet's solution, or of a porous nature, by embedding a known weight of the mineral in a known weight of paraffin of known specific gravity, and then determining the specific gravity of the mixed bodies by balancing in a solution of low density. From these data the required specific gravity is calculable. Several experiments carried out on fragments of heavy or dendritic minerals ranging in quantity from 12 to 35 milligrames were quoted. These gave results concordant with recorded densities, and, where carried out on pieces removed from the same hand specimen, were uniformly consistent.—Celestial phenomena explicable by meteors, by W. H. S. Monck, M.A.

Section of Natural Science.—J. P. O'Reilly, C.E., in the chair.—Notes on the energy of the Ischia earthquakes of 1881 and 1883, by Rev. Dr. Haughton, F.R.S.—Dr. Haughton also communicated an extract from a letter from a lady in India, respecting the fall of a meteoric stone at Roorkee.—Note on *Edwardsia timida* (Quatr.), by G. T. Dixon, M.A. The specimen was found at Malahide, Co. Dublin. This is the first record of the occurrence of this species in the British Isles.

SYDNEY

Linnean Society of New South Wales, November 25, 1885.—W. J. Stephens, F.G.S., President, in the chair.—The following papers were read:—A list of the Trogositidæ of Australia, with notes and descriptions of new species, by A. Sidney Olliff, F.E.S., Assistant Zoologist, Australian Museum.—Notes from the Australian Museum—a new butterfly of the family Lycænidæ, from the Blue Mountains, by A. Sidney Olliff, F.E.S., Assistant Zoologist, Australian Museum.—On a remarkable fish, from Lord Howe Island, by William Macleay, F.L.S., &c. Under the name of *Ctenodax wilkinsoni*, Mr. Macleay described a fish picked up on the beach at Lord Howe Island, and made some remarks on its probable affinities. He considers it not referable to any known family.—Recent changes in the forest flora of the interior of New South Wales, by R. von Lendenfeld, Ph.D. Based on observations made by Mr. Forest Ranger Ridston and others, and on his own experience in the Nymagee-Condobolin district, the author gives an account of the rapid spreading of the pine (*Frenela robusta*) within the last twenty years. A table giving averages of the rainfall, the spread of the pine and of the beetle *Diadoxus erythrurus*, White, which in its larval stage destroys the young pine-trees, accompanies the paper.—The Australian freshwater Rhizopods, Part I., by R. von Lendenfeld, Ph.D. This paper is the first of an intended series in which the Australian Protozoa belonging to the groups Rhizopoda and Heliozoa are to be registered, and the new species described. In this paper six species are mentioned, two are new. It is a most remarkable fact that the common and well-known European forms are all apparently found in equal abundance in Australian waters. The new species are very similar to European ones, and do not present any marked peculiarities. It does not appear likely that there were no Rhizopods in Australian creeks before the advent of Europeans, and so it cannot be assumed that all these Australian species have been imported. As they cannot travel over the oceans dividing Australia from other continents, it must be assumed that they are unchanged descendants of the Rhizopods of that geological period, in which Australia was not isolated. The absence of forms peculiar to Australia speaks strongly against any recent spontaneous generation.—An Alga forming a pseudomorph of a siliceous sponge, by R. von Lendenfeld, Ph.D.—*Onchidium chameleon*, sp. nov., and the structure of the dorsal skin of this and other Onchidia, by R. von Lendenfeld, Ph.D., and John Brazier, C.M.Z.S.—Observations on some Australian Polychæta, by W. A. Haswell, M.A., B.Sc., &c.—Descriptions of two new fishes from Port Jackson, by E. P. Ramsay, F.R.S.E., &c., and J. Douglas-Ogilby, Australian Museum.—On some remarkable crystals of siderite, by F. Ratte, Eng., Arts and Manufactures (Paris).

PARIS

Academy of Sciences, February 8.—M. Jurien de la Gravière, President, in the chair.—Discourses on the occasion of unveiling the statue erected in front of the Collège de France to the memory of Claude Bernard, on February 4, by MM. Paul Bert, Berthelot, Fremy, and Chauveau. The statue, which is cast in bronze, is the work of M. Guillaume, Member of the Institute.—Farewell address of M. Paul Bert on his departure to Tonquin, where he has recently been appointed Civil Administrator. In the course of his remarks the speaker expressed a hope that the young naturalists of the West would begin to turn their attention to the Far East, and teach the learned classes of those regions more fully to appreciate the superiority of European science. "I rely on them," he added, "to increase our moral influence, and also to enlarge our knowledge of that region, in many places still unexplored, to study its resources, and prepare the way for the introduction of the great European industries. They will thus at once promote the interests of science and of France, a task enviable beyond all others."—Remarks on the celebration of the centenary of Arago's birth, on February 26th prox., by M. Mouchez. It was stated by the speaker that the celebration would take the form of a public ceremony in the presence of the various deputations, during which would be crowned the bust of Arago, occupying the site on the Boulevard Arago, where a monumental statue is subsequently to be raised to the great astronomer by public subscription. The proceedings will close with a subscription banquet at the Hôtel de Ville, to which will be invited the members of the Arago family.—Note on celestial photography, by M. Mouchez. Amongst the stellar photographs already obtained at the Paris Observatory, was one of the nebula near the star Maia in the Pleiades, which had never before been seen with the best glasses. But M. Struve now telegraphs to the author that he has just detected this nebula with the new large equatorial of 0·80 m., recently set up in the Pulkova Observatory. It was added that Dom Pedro, Emperor of Brazil, had instructed M. Cruls, Director of the Rio de Janeiro Observatory, to prepare a photographic apparatus similar to that now in use in Paris, for the purpose of co-operating in the general project of photographing the starry regions, already begun with such unexpected success at the Paris Observatory.—Determination of the elements of refraction, two diagrams, by M. Lœwy. It is shown that, in spite of all the rotatory movements of the double mirror, the fundamental condition for determining the constant of refraction is always fulfilled. This principle rests on the geometrical property that the projection of the distance of two images on the trace of the plane of reflection remains invariable and always equal to the distance $r'\rho'$ relative to the epoch when the two stars and their two reflected images are found comprised in the same plane.—On some hyperelliptical formulas, by M. Brioschi.—Note on the first botanical collections that have reached the Paris Natural History Museum from Tonquin, by M. Ed. Bureau. This first collection, carefully prepared by M. Balansa, is confined exclusively to the neighbourhood of Hai-Phong and of Quang-Yen; but it gives a complete picture of the flora of these districts.—Remarks on the admission of patients suffering from pulmonary tuberculosis into the public hospitals, with a view of determining how far this disease is contagious, by M. E. Leudet. The elements that have served to offer a solution of this question are the records of 16,094 adult patients of both sexes treated in one of the wards of the Rouen Hôtel-Dieu during the thirty-one years from 1854 to 1885. The author concludes that the propagation of pulmonary tuberculosis by contagion in hospitals has not been demonstrated, or that it is at least very restricted.—Observations on Fabry's comet made at the equatorials of the Bordeaux Observatory, by MM. G. Rayet and Courty.—Equatorial observations on Barnard's comet, made at the Bordeaux Observatory, by M. F. Courty.—Observation of Brooks's comet made with the 14-inch equatorial of the Bordeaux Observatory, by MM. G. Rayet and Courty.—On the shower of shooting-stars observed on November 27, 1885, at the Zi-ka-wei Observatory near Shanghai, China, by Père Marc Dechevrens. The meteoric display is described as less imposing than that of November 27, 1872. The stars appear to have swept by at the rate of about a hundred every 15 minutes. Notwithstanding the moonlight a few were still seen so late as 4 a.m. the following morning.—On a new system of projection of the sphere suggested by an inquiry into the means of representing the elliptical functions geometrically, by M. Guyon.—Note on Ivory's theorem and on some theorems in connection with the homofocal surfaces of the second order, by M. A. Mannheim.—Researches on the groups of finite order contained in the group of the linear substitutions of contact, by M. Autonne.—Note on a new process for

preparing orthophosphoric acid, and the titration of phosphoric and arsenic acids by means of various indicators, by M. A. Joly.—Note on the action of acetic acid on the essence of turpentine, by MM. G. Bouchardat and J. Lafont. It is shown that acetic acid combines already in the cool state with the essence of turpentine, yielding monacetates belonging to two entirely distinct series. At the same time the uncombined essence is transformed into two carburets $C_{20}H_{16}$, one monovalent, analogous to terebinthene, the other bivalent, or active terpilene.—Note on a new direct method of studying animal heat, by M. Desplats. The method here described is carried out by means of M. Berthelot's water calorimeter, but it is applicable only to small animals, such as rats, guinea-pigs, sparrows, &c. At equal weight and in a given time birds are found to evolve three times more heat than mammals, absorbing thrice the quantity of oxygen and emitting three times more carbonic acid.—Note on the Eocene Echinidæ belonging to the family of the Spantangideæ, by M. G. Cotteau.—On some fossil Cycadeæ of the Carboniferous formations, by M. Daubrée.—On a sub-lacustrine moraine on the bar of Yvoise, which divides Lake Geneva into two distinct basins, by M. F. A. Forel. The dredgings carried out in September 1885 have satisfied the author that this bar is, in fact, a glacial moraine like the neighbouring hills. That this moraine, 60 metres below the surface and 1 kilometre from the shore, has been kept clear of recent lacustrine alluvial deposits, is attributed to the action of the sub-lacustrine currents.—Remarks on the geological map of Russian Turkestan prepared by MM. Mushketoff and Romanovsky—six chromolithographic sheets to the scale of 1 : 1,260,000, by M. Venukoff.—Note on the relations existing between the geological, topographic, and chemical properties of the soil and the vegetation covering it in Central Russia, by M. Venukoff.

BERLIN

Meteorological Society, December 1, 1885.—Prof. Börnstein reported on a treatise by Herr van Bebber, which had just appeared, in which the latter, on the ground that typical weather phenomena accompanied the minima that advanced along the well-known highways of storms over Europe, demonstrated that, from the position of the minimum on one of the five highways of storms, and from the local condition of the weather, might be derived the best data as a basis for a trustworthy prognostication of the weather.—Prof. Schwalbe made a comprehensive survey of the investigations that had been carried on by him for several years respecting the ice cavities. In supplement of former reports on these investigations (*vide* NATURE, January 28, p. 312) the following is abstracted from the address which dealt at large with the subject. The earliest notice of the occurrence of ice cavities was contained in an account written in the end of the seventeenth century. In the last and in the beginning of the present century ice cavities had been variously described, but the descriptions were greatly exaggerated. Down even to the present time these enigmas of nature were little known and little investigated. Of all students of natural science whom this subject had engaged, the speaker had assuredly examined the greatest number of ice cavities. Ice cavities formed but one group of ice phenomena, which comprehended likewise dolines, ice holes, rolled ice, ventaroles, and the cold strata of the ground. In the temperate zone they were pretty widely distributed, and occurred in the most varied mountain systems of Europe at heights of from 2000 to 4000 metres above sea-level, and some individual ones at much lower elevations. They were found principally in limestone, in gypsum, in basalt, and lava, but were present likewise in mica slate and other stones. The most essential condition of their presence was that the stone should be readily percolable by water. In the majority of cases the entrance into these cavities was from above, and the passage was directed downwards, yet there were also cases in which the entrance was from below and the passage upwards. The cavities themselves were completely isolated, and no draught of wind was ever perceived in them. The air in the cavities was in winter somewhat colder than in summer, in winter the temperature sinking to 0° C., and somewhat lower, in summer ranging from 4° to 5° C. The walls were always colder than the air in the central part, and the air, moreover, was always completely saturated with moisture. The ice is formed in spring, when the water began to filter through the ground, and almost exclusively on the floor of the cavities. The ceiling was always free of ice, the floor more or less uniformly covered with a thick layer of ice, which, on being broken, splits into prismatic pillars resembling honeycombs. The walls were covered with pearl-like ice-crystals, and stalactitic ice formations came multifariously to view. There was frequent opportunity for observing in an ice cavity how the water-drops, having filtered through the stone, fell to the ground, and there at once congealed. The speaker then referred to and combated the various theories which had been brought forward to explain the ice formation in the cavities. His own view was that the water filtering through the cold stone became refrigerated to excess, and therefore, on falling, at once congealed.

BOOKS AND PAMPHLETS RECEIVED

"Report of the Meteorological Council to the Royal Society for the Year ending March 31, 1885."—"Jubilee Volume of the Statistical Society" (Stanford).—"British Petrography," Part I.: J. J. H. Teall (Watson, Bros., and Douglas, Birmingham).—"Register zu den Bänden 86 bis 90 der Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften" XI. (Gerold's Sohn, Wien).—"Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften; Mathematisch-Naturwissenschaftliche Classe:—Zoologie, Geologie, und Paläontologie," June and July, October to December, 1884, January to April, 1885. Ditto, "Mathematik, Physik, Chemie, Mechanik, Meteorologie, und Astronomie," June and July, October to December, 1884, January to March, 1885. Ditto, Physiologie, Anatomie, und theoretischen Medicin," March to July, October to December, 1884; January and February, 1885 (Gerold's Sohn, Wien).—"Contributions to Canadian Palæontology," vol. i. part 1: J. F. Whiteaves (Dawson, Bros., Montreal).—"Report of the Meteorological Service of the Dominion of Canada for the Year ending December 31, 1883": C. Carpmael (MacLean and Co., Ottawa).—"Common-Sense Euclid": A. D. Capel (J. Hughes).—"Poultry for Prizes and Profit," parts 4 and 5: J. Long (L. U. Gill)—"British Cage-Birds," parts 5 and 6: R. L. Wallace (L. U. Gill).—"Bees and Bee-keeping," parts 5 and 6: F. R. Cheshire (L. U. Gill).—"Book of the Goat," parts 5 and 6: H. S. H. Pegler (L. U. Gill).—"Fancy Pigeons," parts 5 and 6: J. C. Lyell (L. U. Gill).—"Why we do not adopt the French Metrical System in place of our Anglo-Saxon Metrology": C. Giles (Banks and Son).

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THURSDAY, FEBRUARY 25, 1886

PRESTWICH'S "GEOLOGY"

Geology: Chemical, Physical, and Stratigraphical. By Joseph Prestwich, M.A., F.R.S., F.G.S., Correspondent of the Institute of France, Professor of Geology in the University of Oxford. Vol. I. *Chemical and Physical.* (Oxford: Clarendon Press, 1886.)

THE last few years have been signalised in the annals of geological science by the publication of a number of excellent treatises and students' text-books. Not to mention the appearance of new editions, admirably brought up to date, of such deservedly popular works as Dana's "Manual of Geology," and Credner's "Elemente der Geologie," and of the "Geology for Students and General Readers" of Prof. Green, which is unfortunately still incomplete, we have the revisions of Lyell's "Students' Elements of Geology" by Prof. P. M. Duncan, and of Phillips' "Manual of Geology" by Prof. Seeley and Mr. Etheridge, in which last the additions and alterations are so numerous as to make it practically a new work; among text-books altogether new must be especially noticed the valuable and almost encyclopædic treatises of Dr. Archibald Geikie and Prof. de Lapparent—the necessity for works of this class being shown by the fact that in the course of less than four years they have both reached a second edition. As compared with all these works, however, the new treatise by Prof. Prestwich will be found to cover a somewhat different ground, and indeed to occupy a perfectly unique position among them. It deserves, therefore, to be regarded from another point of view, and to be judged by a somewhat different standard from any of them. Its author is the acknowledged Nestor of British geology, and it may be safely affirmed that no living geologist has contributed in a greater degree to the advance of the science by his important original researches. More than fifty years have elapsed since his first original contribution to geological science was published, and from that date forward his activity has been ceaseless; it is worthy of remark, that while his earliest papers were occupied with the description of some of the oldest formations—the Old Red Sandstone of Banffshire, and the Carboniferous of Coalbrookdale—his later researches have been devoted to the Tertiary and post-Tertiary deposits. But among the writings of Prof. Prestwich will be found some of the most philosophical contributions to geological literature—among which may be especially cited his memoirs on the circulation of underground waters, on the thickness and extension of deep-seated rock-masses, and on the age and relations of the deposits which have yielded the oldest known relics of the human race. A general survey of the wide fields of geological science, by one so especially qualified to undertake the task, may be expected to be of the greatest interest and value; and the expectation is not disappointed by the work now before us.

Upon the death of Prof. Phillips, the University of Oxford, in seeking for a worthy successor to that erudite and versatile geologist, wisely determined to invite Mr. Prestwich to accept the vacant Chair. His able inaugural dissertation on "The Past and Future Work of Geology," which was published in 1875 (see NATURE, vol. xi. pp. 290 and 315), sufficiently informed the world of the position with regard to the different schools of geological philosophy which the new Oxford Professor was prepared to take up. In the present work we find his matured conceptions of the subject, tested in the best possible manner as to their mode of presentation, by having been made the basis of a number of successive courses of University teaching. Every geologist will turn with interest to these pages, and even where they feel compelled to differ from the conclusions arrived at by their author, will render a just homage to the great learning and the judicious thought which are everywhere conspicuous in them.

In the plan of the work, we think Prof. Prestwich has shown the soundest judgment. After a brief introduction treating of the objects and methods of the science, the author proceeds to "give the reader a general sketch of the nature and distribution of the materials with which the geologist has most commonly to deal;" by the avoidance at the outset of difficult and doubtful questions of cosmology, and by reserving those "theoretical questions connected with cosmical and physical phenomena, which relate to the evolution of the globe and historical geology" to the end of the work, he best consults the needs of students—leading them up gradually from a survey of what is simple and known to a consideration of what is complex and unknown.

The two chapters dealing with chemistry, mineralogy, and petrography, large portions of which are printed in small type as being unnecessary for the general reader, would have proved more satisfactory if the author had been more fortunate in the selection of his authorities. Recent researches in those departments of science have been so numerous and of such importance, that few geologists would regard the "Gesternlehre" of Cotta, or the rehabilitation of Cordier's work by Charles D'Orbigny, as affording a sound basis for a summary of the present state of knowledge on these subjects.

But when the author comes to a discussion of the results of the decomposition of the igneous and metamorphic rocks, he is dealing with questions to which he has evidently devoted a large amount of personal study, and his own observations are of the highest value, while his citations from the works of other authors, are in nearly all cases of a very judicious character. The line of argument adopted in the work is necessarily interrupted for a time by the necessity for giving some account of the "place and range of past life," and here, as in the chapters dealing with minerals and rocks, the author has perhaps not consistently followed the best guides. But in the chapters on the formation of sedimentary strata, on the relations of littoral and deep-sea deposits, and on meteorological agencies and the circulation of underground waters, we recognise the hand of a master; and these portions of the work will be found to be worthy of the most careful study. In the very excellent chapter on ice and ice-action, we find many quotations from recent authorities on the subject; and some very interesting illustrations and descriptions are taken from Kane's "Voyages."

In the chapter on volcanoes, the author explains the theory which he first broached at the York meeting of the British Association, and which he has since elaborated in a paper read before the Royal Society. Upon this subject, as well as upon numerous others discussed in the

remaining chapters of the volume, geologists will be glad to have brought together the results of the author's extensive study and exceptionally wide experience. While every one will be glad to see the excellent use which has been made of the splendid researches of Delesse and Daubrée, it might perhaps have been better if the author had relied less implicitly upon some others among the older school of French geologists. All will look forward with interest to the appearance of the second and concluding volume of the work, which will treat of stratigraphical geology, and the broader and more theoretical aspects of the science.

The present volume is worthy of the University Press, from which it is issued: well printed upon excellent paper, and illustrated by numerous woodcuts; these have been derived from other standard works, or are founded on sketches by the late Dr. Buckland, while not a few of them bear testimony to the fact that recent publications, like those of the U.S. Geological Survey of the Territories, have been freely placed under contribution: the general appearance of the book is all that could be desired. Among the six excellent folding plates, the first place must be assigned to the beautiful reproduction, on a small scale, of Marcou's geological map of the world, which has been revised by its author for the present work.

We cannot better conclude this notice of a very important contribution to geological literature than by quoting the sentences in which the author himself defines his position towards the different schools of geological thought.

"The fundamental question of *time* and *force* has given rise to two schools, one of which adopts uniformity of action in all time,—while the other considers that the physical forces were more active and energetic in geological periods than at present.

"On the Continent and in America the latter view prevails, but in this country the theory of uniformity has been more generally held and taught. To this theory I have always seen very grave objections; so I felt I should be supplying a want by placing before the student the views of a school which, until of late, has hardly had its exponent in English text-books.

"The eloquence and ability with which uniformitarianism has been advocated, furthered by the palpable objections to the extreme views held by some eminent geologists of the other school, led in England to its very wide acceptance. But it must be borne in mind that uniformitarian doctrines have probably been carried further by his followers than by their distinguished advocate, Sir Charles Lyell, and also that the doctrine of non-uniformity must not be confounded with a blind reliance in catastrophes; nor does it, as might be supposed from the tone of some of its opponents, involve any questions respecting uniformity of law, but only those respecting uniformity of action.

"I myself have long been led to conclude that the phenomena of geology, so far from showing uniformity of action in all time, present an unceasing series of changes dependent upon the circumstances of the time; and that, while the laws of chemistry and physics are unchangeable and as permanent as the material universe itself, the exhibition of the consequences of those laws in their operation on the earth has been, as new conditions and new combinations successively arose in the course of its long geological history, one of constant variation in degree and intensity of action."

Extreme Catastrophists—if indeed any such have escaped extinction during the evolution of modern geological philosophy—will find little in the way of comfort in the above sentences, or indeed in any part of the volume before us. The most pronounced Uniformitarian, on the other hand, will find equally little to take exception to in the general tone of Prof. Prestwich's conclusions; he will perhaps only ask that before recourse is had to non-uniformity in the action of existing causes, the incompetency of the uniform action of those causes to produce any particular phenomena shall be distinctly demonstrated.

THE PICTORIAL ARTS OF JAPAN

The Pictorial Arts of Japan. With 80 Plates and Chromolithographs, and numerous Engravings on Wood and Copper, and with General and Descriptive Text. By W. Anderson, F.R.C.S., late Medical Officer H.M. Legation in Japan. To be complete in 4 parts. Part 1. General History. (London: Sampson Low, 1886.)

OF the aboriginal inhabitants of Japan we know but little. A Polynesian element with some Melanesian admixture probably predominated in the southern, as an Aino element did in the northern, islands. Of the latter race the shell-mounds that line the coasts of the main island have afforded many interesting relics, among others fragments of pottery showing a simple ornamentation recalling the zigzags and curves characteristic of the Zuñi and Tesuke pottery of Arizona and New Mexico. It was in the main island, often called Hondo, that the history of Japan began. Not more than two or three centuries probably before the compilation in the eighth century of the Kojiki, the oldest extant document in Japanese literature, a colony of Ural-Altaic origin occupied the broad plain that extends from the northern shores of the Japanese Mediterranean to the foot of the Kiyoto hills. Tradition points to previous settlements of the strangers on the southern islands, whither, pushed by some Central Asian stress from their former home in the Korean peninsula, they had wandered across the narrow waters that separate the Land of Freshness from the Land of Dawn. The new-comers did not easily subdue the Aino tribes, remnants of whom in the north and east still existed, when Yoritomo was created Barbarian-beating Generalissimo in the thirteenth century. More or less amalgamation took place between conquerors and conquered, but the former did not wholly lose their purity of blood, and, to this day, broad physical differences distinguish the peasantry from the more aristocratic strata of the population—differences amply and graphically rendered in the innumerable drawings of Hokusai. These founders of the Japanese State, which, despite the assertions of native writers, can boast of no high antiquity, were a simple folk, living principally on fish and the produce of the chase, clothed in hemp and cloth made of broussonetia bark, and dwelling in wattled huts roofed with bark and reeds. It was not until they were touched by Chinese civilisation that they entered upon the evolutionary course which has ended in a somewhat naïve preference of the civilisation of the West.

There is a difference between symbolism, which all races of men have practised, and art. The reindeer and mammoth drawings of the Cave-men show that a faculty of correct and even spirited drawing was developed at a very early stage

in man's history. But the art, like the civilisation, of Europe cannot be traced to the Cave-men; both are a heritage from the Greeks, distributed westwards by Rome. Nor was Greece itself other than an apt soil for the development of seeds brought from Egypt. Who that has gazed upon the wall-paintings of the tomb of Ti at Sakkarah, or has seen the wonderful wooden statue at Boulak, known as the Shêkh-el-Beled, or the sculptures on the sandstones of Wady Mughara, or the figures cut on the obelisk of Heliopolis, can doubt that the men who did these works, full of truth, grace, and vigour, were the worthy foregoers of the sculptors of Greece and the painters of Italy? As the message of Greek art was borne by Rome to the West, so was it carried by the Macedonian conqueror to the northern frontiers of India, where the Buddhists of the Punjab countries pressed it eagerly into the service of their religion. In the sculptures of the monasteries of Yusufzai (Swat frontier of the Punjab) brought to light by Major Cole, R.E., and admirably photographed in the magnificent publication of the Indian Government issued under the title "Preservation of the National Monuments of India," this Græco-Buddhic art is amply exemplified, and most interesting it is to trace in these remains both the reposeful strength which the mobile Greek admired, and the vigorous action which pleased the contemplative Asiatic. Among the most striking of the sculptures are a figure of Maya being borne to the Trayastrinsha heaven, recalling, and probably suggested by, the work of Leochares (B.C. 365) known as "Ganymede carried off by Jupiter's Eagle," the figure of Prince Siddhartha before he left home to become a mendicant, and the wonderful group representing the death of the Buddha, with the face of Devadatta full of evil glee behind the couch. The best Buddhistic works of China or Japan, in comparison with these remains of early Græco-Buddhic art, are merely feeble grotesques, in which the majesty and grace of the prototypes have degenerated into strained pose and gesture and the lifeless prettiness of craftsmanship. The great gateways of the Tope at Sanchi, it may be noted *en passant*, bear a curious resemblance to the *torii* of Shinto shrines in Japan, the principal difference being the presence of a third cross-piece in the former, and the elaborate sculpture of their elements.

In the first century of our era the Buddhist apostles reached China, in the fourth they were in Korea, and in the sixth in Japan. Their art they bore with them, and used as a means of propagation of their doctrines. In the plates numbered 1, 2, 4, 8, 9, 10, and 70—the last a particularly interesting representation by the Chinese artist of the eighth century, Wu-tao-tsu, of the eight Nirvana of Buddha—the characteristics of this missionary art are well displayed, and may be instructively compared with the Yusufzai sculptures.

But even the art of Egypt had its birthplace elsewhere than in the Nile Valley. Recent investigations of the earliest monuments tend to prove, as Mr. Bertin has lately shown, that the Egyptians were not of a Semitic, but of an Equatorial African, stock. Mr. Bertin advances also good grounds for supposing that the Bushmen of South Africa, whose rock-paintings every traveller who has seen them has extolled for their faithfulness and vigour, came of the same or an allied stock. The Bushmen are by no means a degraded, though a stunted, race. They have no kinship with the Negro or even with the Bantu races. Their skulls are well-formed and free from prognathism, and their meagre physique may perhaps be due to the hardship they endured in their secular wanderings over the vast deserts that intervene between the equator and the tracts to the north of the Cape Colony. A psychological connection is thus established between South Africa and the Far East which is worthy of being more fully investigated. There are many facts which tend to add force to this theory, startling though it may appear, which I have no space to dwell upon. I may, however, cite the analogy which seems to exist between the Bushman clicks and the Chinese tones, the former having a similar relation to consonantal to that which the latter possess to vocalic sounds.

Up to the middle of the last century the Chinese school of painting, more or less directly developed from Buddhistic art, held sway in Japan. Its history and the modifications it underwent in the latter country are admirably set forth by Mr. Anderson, and to his account I must refer the reader. About the period referred to a sort of revolt took place in Japan against Sinicism generally. The great Shinto revivalists, Mabuchi, Motöori, and Hirata, scouted Buddhism and Confucianism with equal emphasis. There is a quaintness in their logic which is not unamusing. Motöori, for instance, defends the Shinto lack of a moral code by the answer that the very possession of a moral code was a badge of inferiority, proving as it did the need of it, a need which Japan did not feel, as the people had merely to obey the Mikado, the direct descendant of the Sun Goddess, to be assured of their righteousness. While this religious renaissance was preparing the way for the return of the Mikado to power, a sort of Giottesque revolution took place in art: classicism was, though only partially, abandoned, and a Realistic school (*ukiyoye*) came into existence, of which the master spirit was Hokusai, who died at the age of ninety in 1849. In the *Hiyaku shō den* (the Hundred Heroes) are sketches made by him at the age of eighty-eight. The *ukiyoye* school was that of Japanese art *par excellence*, to a very considerable degree freed from Chinese trammels, and full of the lively and mobile spirit of the people. Mr. Anderson gives a good account of it, but hardly so full as it merits. Nor is it adequately represented in the present instalment, though doubtless it will be so in the complete work. The woodcut, after a drawing by Hokusai, called "The Maniac" (Pl. 37) is a fine example of his fluent drawing and skill and breadth in composition. The last is to me by far the most interesting phase of Japanese art. So it was to Motöori, whose very sensible observations on the subject have recently been translated by that excellent scholar, Mr. Basil Hall Chamberlain (*Tr. As. Soc. Jap.*, vol. xii. p. 223). To Sinico-Japanese art, Motöori, though an enthusiastic patriot, preferred Chinese art, especially the finished pictures of the Chinese, and their rapid drawings of birds, flowers, fish, insects, and the like, and again I share his opinion.

The *ukiyoye* style may indeed justly be regarded as the highest expression of the art of the furthest East. Its limitations are sufficiently obvious and not without interest. The quite childish drawing of quadrupeds is singular. The Japanese artists could draw them well

enough when they chose. In one of the volumes of that interminable romance, the "Satomi Hakkenden"—there are more than fifty volumes—there is a splendid sketch of a bull, the wild boar is not seldom vigorously delineated, and Mr. Anderson gives a spirited and fairly correct drawing of a deer (Pl. 31). The explanation probably is that quadrupeds did not interest the Eastern artist, the chase, save of the wild boar, was little in vogue, and rather discouraged by Buddhism. The human face was regarded generally as a mere accessory, and conventionally rendered. There were exceptions: Kikuchi Yosai drew faces vigorously, though even he seemed to limn a profile with difficulty, and the portrait-sculptors of the seventeenth century displayed considerable power. No attempt whatever seems to have been made to portray human beauty of face or form, and the renderings of female beauty are insipid in the extreme, as well seen in the sketch of an ancient hetaira, somewhat truculently called "Hell" Reigan (Pl. 41). The stronger emotions, however, are delineated with a power that would have delighted Darwin, exemplifying admirably his descriptions of the modes of facial expression of the passions of anger, fear, despair, and horror. In some of the novel-illustrations I have seen disdain, reflection, and slyness admirably portrayed. But the softer sentiments are either not depicted at all, or depicted after a purely conventional fashion. The Turanian countenance is not expressive, save of the stronger emotions. A curious mode of portraying anger is to paint streaks of red round the eyes and along the principal lines of expression, nor is the device altogether ineffectual. The Japanese flush with anger, but not with shame; indeed, the feeling of shame they seem to possess but in a minor degree. In some other particulars their modes of expression are peculiar. They nod assent (*unadzuki*), but do not shake their head in dissent. They talk without gestures and with little emphasis of accent, but with curious changes of note and intonation. They never kiss; mothers even do not kiss their children, and they have singularly few terms of endearment. By way of compensation they have few terms of abuse, and no oaths. Their individuality is small, reflected in the curious impersonality of their language (see some excellent remarks on this characteristic by Mr. Aston, *Tr. R. As. Soc.*, vol. xii.); every Japanese is through life a member of a family, or, if a head of a family, a member of some guild or fraternity; he never "paddles his own canoe." Thus may be explained, in great measure, their neglect of humanity in art.

On a future occasion I trust to be allowed to offer a few more remarks on some points in connection with the art of Japan that seem to me interesting in relation to it as a phase in human history. Meanwhile I must not omit a recognition, not the less hearty because necessarily brief, of the value of Mr. Anderson's labours, the extent of which my own studies enable me to appreciate. This is not the place to enlarge upon the artistic merits of his work; they have been, or will be, sufficiently appreciated elsewhere. But the stores of folklore he has gathered together form a contribution to our scientific knowledge of man of extreme importance, and his account of the development of Japanese art is as interesting as it is instructive. The present instalment is admirably got up, and the illustrations, particularly the chromolithographs by Greve of Berlin, are of unsurpassed excellence. Altogether the work promises to be of equal interest and value to the student of man and society, to the lover of art, and to the collector of Oriental curiosities.

F. V. DICKINS

THE EVOLUTION OF THE PHANEROGAMS

L'Évolution des Phanérogames. Par MM. Saporta et Marion. Second Notice. (Paris: Alcan, Boulevard St. Germain, 1885.)

IN our previous notice (vol. xxxii. p. 289) of this important work we traced the evolution of gymnosperms down to a certain point. Prof. Williamson soon afterwards communicated the chief point of difference between his views and those of our authors, in a very interesting letter (NATURE, vol. xxxii. p. 364). We were not able at the time to follow the subject farther, and this was of less consequence, as the points at issue, though extremely important in themselves, are not claimed to be in the direct line of evolution of the existing phanerogams. The palæozoic heterosporous cryptogams, with exogenous stems, are chiefly interesting, from the evolutionary standpoint, for the light they throw on what must probably have been the structure of the common ancestors, from which they, as well as the gymnosperms, were derived. A *résumé* of what is known regarding the ancestry of the Eocene Coniferæ will shortly be published by the Palæontographical Society, the compilation of much of which has been directly assisted by Prof. Williamson himself, and has also been revised in part by Mr. Carruthers. As it is not claimed by Saporta and Marion in any way that angiosperms have been evolutionised from gymnosperms, even through the Gnetaceæ, it is unnecessary to pursue that branch of the subject farther now. The interest of the work centres, in fact, in the attempt to trace the ancestry of the monocotyledons and dicotyledons, groups which to ordinary observers seem to appear with startling abruptness in the geological record.

The differentiation of angiosperms, no less than gymnosperms, originally took place, it would appear, in pre-Carboniferous times, the ancestral forms common to both being heterosporous cryptogams, destitute of exogenous wood. The fundamental difference at starting seems to be that, in the gymnosperms, one of the macrospores contained in the ovule immediately absorbs all the rest, enabling their evolution to proceed with rapidity; while in the angiosperms there is a period of struggle among the macrospores before one finally obtains the advantage and obliterates its fellows. Want of space renders it impossible to give any account of the steps by which the authors have traced out this process. The common source, at a remote period, of the monocotyledons and the dicotyledons, is assumed from the fact that the early stages of the development of the embryo, in some of the former, approach nearer to dicotyledons than to plants of their own class. Moreover, the essential organs, the carpels, stamens, petals, and the fruits, are sufficiently analogous to indicate a common origin. The problem attempted is to reconstruct the "pro-angiospermic" stage whence these two opposite lines have issued. The fully-developed leaves of monocotyledons and dicotyledons embrace many varieties, from the most simple to others

that are immensely complicated. Those of the former are generally of the more simple kind, but in the aroïds and Smilax they equal in complexity, and resemble, dicotyledons. It is not among these, however, but, as in zoology, among the embryonic stages, that the ancestral forms are likely to be traced. In many young plants the first leaves are very different in form and structure to [illegible]horn when maturity is reached. Examples are [illegible]sheathing, amplexicaul phyllodes in *Cicer arietinum*, *Quercus pubescens*, *Asparagus officinalis*, and [illegible]e *Rosaceæ*, most of which are scale-like and parallel-[illegible]ed. In *Aralia nymphæfolia* the stipules embracing [illegible]e young shoot are of considerable size and adherent for some time. They have a fine parallel venation which scarcely anastomoses and resembles not only the fully-developed leaves of some monocotyledons, but the petals and sepals of many flowers. In *A. Sieboldi* the bracts enveloping the buds and young shoots are similarly constructed, the petiole and true leaf barely emerging from their summit. The sheath, representing the primitive leaf, is in some Umbelliferæ, as the fennel, more important than the secondary leaves, and in one dicotyle-[illegible]t least, *Eryngium bromeliæfolium*, the latter are not [illegible]loped at all, the leaves resembling those of a yucca. On the other hand, it is not every monocotyledon that has preserved its primitive leaves only. In *Canna indica*, for example, the inferior and sheathing portion represents the primitive leaf, the middle part, or petiole, the original mucronate apex, and the blade the secondary leaf. Nearer the flower-spike only the primitive leaf-development remains in the form of bracts. The same characters are observed in *Strelitzia regina*. In Aroïdeæ the first leaves are simple and sheathing and the second as complex as those of dicotyledons. *Smilax* furnishes an example of a monocotyledon which has elaborated precisely the same kind of secondary leaf as a dicotyledon. In the grasses the primitive leaf appears on the underground rhizome as a sheath, later reduced to the ligule, while the ribbon-leaf is the homologue of the ordinary dicotyledonous leaf. In palms the primitive leaves are traceable in germination and later in the spathes and bracts, and in an altered condition in the leaf petiole, only the fan part being the secondary leaf.

The ancestral "pro-angiosperms" are supposed to have borne leaves such as are found diminished or masked in so many of their existing descendants—that is, entire, more or less elongated, ribbon-like leaves, amplexicaul at the base, attenuated and mucronate at the apex, and traversed by numerous longitudinal veins, connected by transverse veinlets, or even areolated.

Monocotyledons have, as a class, preserved their primitive foliary appendages more perfectly than dicotyledons, in which they are frequently so reduced as to be barely traceable as lateral expansions of the petiole, or in minute stipules.

The flower is an organ common to both, and must, therefore, have been produced before the two classes had become differentiated. The relative simplicity of structure seen in their several parts is thus explicable—sepals, petals, and bracts being frequently almost reproductions, as to form and venation, of the vagina, or the first sheath leaves, which in many plants succeed the cotyledons, and the terminal mucro can also sometimes be detected. Examples of primitive flowers are seen in *Magnoliaceæ*, *Ranunculaceæ*, and *Nymphaceæ*, but others have doubtlessly been profoundly modified to meet the needs of fertilisation. That the sexual leaves bearing the micro- and macro-sporangia—stamens and pistils—are similarly modified leaves, is also apparent in the case of *Magnolia*. Originally the "pro-angiospermic" flower must have consisted of an axis bearing the sexual appendages spirally disposed one above another, the microsporangial leaves at the base, and the ovule-bearing ones above. Though the flower has became consolidated through the shortening of the axis, its primitive spiral arrangement is traceable in a multitude of angiosperms.

Even the stems in the two classes are not really fundamentally different, the permanent presence or the absence of a productive region of cambium alone sufficing to have originated the two divergent types. In the remote past, before even the seasons were well defined, the cambium layer may have existed in an irregular or fugitive manner in the "pro-angiospermic," as it did in the "pro-gymnospermic" stem, and thence increasing differentiation have produced the two parallel series forming respectively at last dicotyledonous and monocotyledonous stems. Branching probably took place in such primordial stems by means of solitary terminal buds, accompanied perhaps by a restricted number of lateral ones, after the fashion of the screw-pines, aroids, and aloes.

Such was the nature of plants in their "pro-angiospermic" stage. Even the initial difference in the number of cotyledons characterising each class is explicable by supposing them to have been originally of unequal size, and that progressive differentiation led, in the one direction to equalisation, and in the other to suppression. The inequality is preserved in *Nymphaceæ*, which thus serve to diminish the difference in this respect between the two classes.

J. STARKIE GARDNER

OUR BOOK SHELF

A Tangled Tale. By Lewis Carroll. With Six Illustrations by Arthur B. Frost. Pp. 152. (London: Macmillan and Co., 1885.)

THE first half of this delightful book consists of ten chapters, or "knots," as they are labelled by the author. Each of these contains a quaint and humorous description of some romantic episode, imagined in order to furnish occasion for proposing certain ingenious mathematical problems to the younger actors in the drama.

The author states that his intention was to embody these questions in each knot "like the medicine so dexterously, but ineffectually, concealed in the jam of our early childhood." This, however, may be noted: in the several doses presented in the volume before us the patient may assimilate all the jam, and, at will, reject the medicine.

The fun and humour with which these sketches sparkle may be enjoyed—and the many sly hits to be found therein may be appreciated—by those who are unwilling or unable to grasp the mathematical question involved.

And for another class of readers there is furnished, in an appendix which fills the latter half of the book, plenty of strong medicine ready to be taken undiluted, if so they choose.

"A Tangled Tale" having originally appeared as a serial in the *Monthly Packet*, many of the fair readers of that magazine, and also some of their brothers, sent up answers month by month to the questions proposed, and

these are dealt with in the appendix referred to. A special interest, befitting the occasion, seems to have been taken by several subscribers in the problems so gorgeously dressed up and so prettily put before them. Not only were solutions forthcoming which were correct and neat, but now and then a talented contributor emulates the author himself in regard to the manner and style of wording the answer.

Whilst ample meed of praise is awarded to all good work—and the author's fund of humour never seems to fail him, causing even the initials of his anonymous correspondents to lend themselves to give point to his remarks—where there is any falling away from his high standard of excellence, the criticisms are serious enough, and, if need be, severe.

Fallacies and shortcomings in the answers are laid bare as mercilessly as in the treatise on "Euclid and his Modern Rivals." But great care is taken to bring home to the mind of the hapless contributor a full sense of the error into which he has fallen; and there are several very apt analogies and illustrations to be found in this appendix.

When the sketches first appeared, editors of the puzzle columns of other magazines must have been filled with "mingled feelings of admiration and despair" as they viewed these emanations from Lewis Carroll. And we do not doubt that very many mathematical tutors, as well as their pupils, will read with pleasure and profit "A Tangled Tale," and the appendix thereto, and feel deeply grateful to the author for publishing in book form this further example of his genius.

Mr. Frost has furnished a very striking frontispiece; and of his other illustrations the last may be specially noted here, wherein is depicted a martyr to experimental science who remains steadfast and unmoved at his observations whilst the waves close round and drown him: this is apropos of an exceedingly clever and entirely new "hydrostatic paradox," which the author has invented by dressing up, with the aid of Lardner's "Physics," a very old fallacy. A. R. WILLIS

Tableaux-Résumés des Observations Météorologiques faites à Bruxelles pendant une période de cinquante années (1833-1882). Préparés par A. Lancaster. I. "Température de l'Air." (Bruxelles, 1886.)

IN this pamphlet of seventy-nine pages Mr. Lancaster admirably resumes the observations of the temperature of the air made at Brussels during the fifty years from 1833, when they were begun by Quetelet, to the end of 1882. An important consideration kept in view throughout is the climatological aspects of the observations, particularly the frequency or rareness of certain temperatures in different times of the year which bear more or less immediately on vegetable and animal life.

From 1833 to 1877 the observations were made with thermometers exposed 10 feet above the ground at a north window of the Observatory; but from the beginning of 1878 the thermometers were placed in a Stevenson screen in the garden at a point 16 feet distant from their original position, and at a height of 4½ feet from the ground. Care was taken at the time of the change to make a double series of observations in the two positions, from which it is shown that the earlier series were 0°·8 too high as compared with the observations made with the Stevenson screen arrangement.

The mean annual temperature of Brussels is 50°·5. The highest annual temperature was 53°·8 in 1834, and the lowest 47°·1 in 1879, there being thus a difference of 6°·7. During the fifty years the greatest difference in the temperature which occurred in the space of any one day was 37°·4 on January 26, 1881. In midsummer the daily maximum occurs at 3.22 p.m., and the minimum at 3.39 a.m.; but in midwinter these phases of the temperature occur at 3.39 p.m. and 6.36 a.m. As regards very high temperatures, 90°·0 or upwards has not been observed earlier than June 6 or later than August 19; and as regards the periods of intensest cold, a temperature of zero Fahr. has been recorded only between January 16 and 26. The longest continued frost was in 1845, when from February 7 to March 22, or during 45 days, the temperature fell to freezing or lower each successive day. The hardest winter was that of 1844-45, when temperature fell to freezing on 90 days, and the most open winter that of 1846-47, when frost was recorded only on [illegible] January 1838 was characterised by severe and continued frosts, temperature falling to 23°·0 or lower 22 consecutive days, to 14°·0 on 13 days, and to 5°·0 5 days. The absolutely lowest temperature recorded [illegible] −4°·4 on January 25, 1881, and the highest 95°·4 on Jul 19 of the same year. The five mean coldest consecutive days of the year are January 8 to 12, the mean being 34°·4; and the five warmest July 15 to 19, the mean being 66°·5. A second maximum occurs from August 13 to 17, when the mean is 65°·5. The most marked interruptions in the annual rise of temperature from January to July are February 10 to 14, April 10 to 14, the middle of May, and June 26 to July 2; and the interruptions in the fall of temperature from July to January are August 13 to 17, already referred to, and December 4 to 7. The interest of these temperature interruptions is their wide geographical range, and no quite satisfactory explanation of them has yet been given.

Notes from the Leyden Museum. Vol. VII. (1885.)

UNDER the able editorship of Dr. F. A. Jentink, the Director of the Leyden Museum, these "Notes" have been published as quarterly parts throughout the past year. They form a volume of some 286 pages, which is illustrated by 10 plates. Among the more important "Notes" we may mention a monograph of the genus Cuscus by the Editor. Four species are recognised: *C. orientalis*, *C. celebensis*, *C. maculatus*, and *C. ursinus*. Gray's species, *C. celebensis*, is re-described, if indeed the original description can be said to merit such a title, being contradictory on most important points, and illustrated with figures of another species. In a note on some rare mammals the same author describes and figures *Hapalemur griseus* and *H. simus*, and notes the occurrence in Central Africa of *Epomophorus comptus* and *E. gambianus*, of *Paradoxurus stigmaticus* and *Ptilocercus lowii* from North-East Sumatra. He also re-describes, almost re-discovers, the rare *Antelope doria*, Ogilby, and *A. longiceps*, Gray. Mr. J. Büttenkofer's "List of Birds collected in Western Liberia" is prefaced by a most interesting account of the Zoological Expedition sent out to the West Coast of Africa under the supervision of the late Prof. Schlegel. Two years and a half (1880–82) were spent in Western Liberia, of which a rough sketch-map is given. The ordinary temperature of Liberia may tolerably well be compared to that of a European summer, rarely ever becoming insupportable. It has its dry and rainy seasons, and produces an extremely rich flora and fauna. His companion, C. F. Sala, died in June 1881, and Mr. Büttenkofer, from ill-health, was obliged to leave for Holland in April 1882. Mr. Stampfli has since gone out, and is now carrying on very successful researches in the southern portions of the district. This paper on the birds of Liberia is to form but one of a series devoted to the different groups collected.

The entomological notes are numerous, and contain descriptions of new or rare Coleoptera by C. Ritsema, J. W. van Lansberge, Neervoort van de Poll, Ant. Grouvelle, Rev. H. S. Gorham, and E. Candèze. Some of the new species are represented on coloured plates. F. M. van der Wulp continues his descriptions of exotic Diptera.

Mr. Schepman describes and figures a new Neritina from Gara, already named in manuscript by E. von Martens as *N. subocellata*, and Dr. Horst gives an ac-

count of a new Entozoon from the coeca of *Struthio molybdophanes*, Rchw. This Nematoid (*Sclerostoma struthionis*) is figured on Plate 8.

A title-page and table of contents and index accompany the October part.

Solutions of Weekly Problem Papers. By the Rev. J. J. Milne, M.A. (London: Macmillan and Co., 1885.)

In our notice of the "Weekly Problem Papers" we gave an account of the contents, and accorded to the collection a warm welcome. In the meanwhile we have gone through the major part of the papers, and have found the questions to be well suited for their purpose: here and there may occur occasional apparent exceptions, but if these are exceptions, then were they also in the original papers in which they occur.

The solutions are neat, and in several cases elegant, and in all the object of "increasing a student's stock of mathematical knowledge, and of teaching him to put it to a practical use" is well kept in view. Mr. Milne is prodigal in his solutions, as not unfrequently he gives two solutions of the same question. To compensate for the non-insertion of solutions already printed in the collections of Answers to the Tripos questions of 1875 and 1878, Mr. Milne appends a collection of an equal number of questions of a similar character, with their solutions; these, with two appendices, occupy about one-fifth of the whole volume. The two notes are on the geometrical theory of envelopes and geometrical maxima and minima.

We congratulate Mr. Milne on having so successfully carried out his design. We believe it was originally in his plan to trace each question up to its original proposer, but this very difficult task he has apparently abandoned, at any rate he makes no sign in this first edition.

The two books together will be of great service to students who cannot afford to read with a private tutor, as the solutions are written out in proper style, and are as full in explanation as a student could expect them to be. There is a long list of errata, but of these the greater part are due to the original papers. We have noticed several more, but this is not the place for indicating them, as the student will in most cases be able to detect them himself.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Heat Quantities

It would be a great advantage if some definite and generally-accepted meaning were attached to the words "capacity for heat," "thermal capacity," and "specific heat." As it is I find that scarcely two text-books give the same definitions of these quantities. The French writers, Verdet, Jamin, Fourier (Freeman's translation), and Deschanel (Everett's translation), seem to agree in considering specific heat a quantity of heat; so also do B. Stewart and Daniell. Prof. Everett, in "Units and Physical Constants," defines thermal capacity as a quantity of heat, and on p. 79 says that specific heat is also a quantity of heat, while on p. 80 he points out that it is of zero dimensions. In Maxwell's and Garnett's books it is pointed out that specific heat is a ratio, but in the latter the term is used loosely later in the book. Glazebrook and Shaw, in their "Practical Physics," make it a ratio.

To avoid all this confusion, I would propose the following definitions, on the analogy of the accepted ones for density and specific gravity:—

"*Capacity for Heat.*—The quantity of heat required to raise the temperature of any body, under given conditions, by 1° C., is called its 'capacity for heat' under those conditions.

"*Thermal Capacity.*—The quantity of heat required to raise the temperature of unit mass of any material, under given conditions, by 1° C., is called its 'thermal capacity' under those conditions.

"*Specific Heat.*—The ratio of the thermal capacity of any material to the thermal capacity of some standard material is called its 'specific heat.' This standard material is usually water at 0° C. or 4° C."

If some such definitions as these were generally accepted, a good deal of confusion would be avoided, and the analogy with density and specific gravity would be accentuated. At the same time the word "specific" would be defined to mean that the quantity to which it was applied was a ratio, and of zero dimensions.

HARRY M. ELDER

Wellington College, Wokingham

Permanent Polarity of Quartz

The second note in NATURE (Feb. 4, p. 325) contains an account of an "important discovery" by Dr. O. Tumlirz, which is wrong in all essential particulars. The permanent polarity discovered by that gentleman is not diamagnetic, but paramagnetic. Nor is it correct that "Dr. Tumlirz appears to think that these facts negative Becquerel's theory of diamagnetism," but on the contrary, he takes some trouble to show that his experiments are in complete agreement with that theory.

"Becquerel's theory (1850)" seems to be a name for the one discussed, though not adopted, by Faraday in his second paper (1845) on the subject, that all matter is magnetic, the medium occupying an intermediate position between so-called paramagnetic and so-called diamagnetic bodies.

ARTHUR SCHUSTER

[Dr. Tumlirz's own words are: "Der Bergkrystall ist hiermit der erste diamagnetische Körper der eine dauernde Polarität zeigt."—ED.]

Variegated Iridescent Halo

About noon of January 28 the sky was overcast by a horizontal cloud, and an iridescent halo appeared directly beneath the sun. The length of the arc was not measured, but appeared to be nearly or quite 90°. The most of the halo was of a bright yellow colour, but not far from the middle of the arc was a spot of green separated on each side from the yellow arcs by a short neutral tract. The green spot was nearly round, and its breadth (as measured from the sun) was nearly the same as that of the yellow arcs, and the angular distances from the sun of both the yellow and green arcs were approximately equal. Iridescent halos are seen here every year, usually as complete circles about the sun, and often showing all or several of the prismatic colours, each forming its own definite ring at different distances from the sun. Such halos appear through a thick haze, or quite thin cloud. This variegated halo appeared through a cloud so dense that the position of the sun could barely be made out by the eye, and it was of very variable density. The borders of the coloured arcs were not clearly defined, and apparently the light had been somewhat scattered by reflection upon the lower cloud particles. The temperature was several degrees below the freezing-point of water. Twice before during the present winter short monochromatic arcs of halos have appeared, once a yellowish-green, once a bright red.

The iridescent clouds recently seen by so many of your correspondents in Scotland appear to be, in part at least, the same phenomenon as here recorded, only in this case there was enough of the arc visible to definitely show that the colour was due to an iridescent halo.

G. H. STONE

Colorado College

White Rainbows

Probably A. E. E. will find some answer to his questions in the under-mentioned articles:—R. Smethurst, "Account of a White Solar Rainbow" (*Mem.* Phil. Soc., Manchester, iii. pp. 176-78, 1819); Aug. Bravais, "Observations sur le Phénomène de l'Arc-en-Ciel blanc" (*Proc. Verb.* Soc. Philom., pp. 33-35, 1846; *Ann. de Chimie*, xxi. pp. 348-61, 1847); F. Moigno, "Nouvelle Théorie de l'Arc-en-Ciel blanc" Moigno, *Cosmos*, ii. pp. 107-11, 1852-53); G. J. Symons, "On

a White Rain- or Fog-Bow" (*Quart. Journ.* Met. Soc., October 1875). A. RAMSAY

A Nocturnal Hymenoptera of the Genus *Bombus*

MR. LEONARDO FEA, Assistant in the Museo Civico of Genoa, who is now engaged in a zoological exploration of Upper Burmah, and who has extensive experience in collecting insects, writes to me from Mandalay that, on the night of January 17, as he was walking in the "compound" of Dr. Barbieri, the moonlight being very bright, he was surprised to hear humming around a clump of flowering acacias. He at once proceeded to fetch a net, and, on capturing the hummers, found, to his no small astonishment, that he had got a fine species of the genus *Bombus*, of a uniform fulvous colour.

Being unaware that the fact of a nocturnal melliphagous Hymenoptera (all of which are eminently diurnal) has been before noticed, I should be glad to hear of any other cases to the point. G. DORIA

Genoa, February 16

PHYLLOXERA AT THE CAPE

WE have received from a correspondent in South Africa some details of the long-dreaded appearance of the Phylloxera in the vineyards of the Cape Colony. As long ago as 1880 the importation of living plants in any form or shape was forbidden by the Cape Government. This measure was so strictly enforced that consignments of young beech-trees from England and of tree-ferns from New Zealand were not allowed to be landed.

In 1884 the prohibition was for a short time relaxed. But it was speedily revived, under a penalty of 500*l.* or two years' imprisonment with or without hard labour in the case of any one infringing it.

The insect has now, notwithstanding, actually appeared in a few vineyards near Cape Town, and in two others about twenty-four miles off.

Fortunately the Cape Government has competent scientific advice at hand. Mr. Roland Trimen, F.R.S., the Director of the South African Museum, and a well-known entomologist, attended the Phylloxera Congress at Bordeaux in 1881 as the representative of the Cape Colony. A Commission to examine and report on the outbreak has been appointed, consisting of Mr. Trimen, of M. Péringuey his assistant, and of Prof. Macowan, F.L.S., Director of the Botanic Garden. M. Péringuey is a Bordeaux man and a good entomologist; he first drew Mr. Trimen's attention to some suspicious-looking mites on a slide which had been taken from a Cape vineyard by the doctor of a French ship, about Christmas.

Two or three of the vineyards are simply swarming with Phylloxera. But in others it appears to have only recent centres. Unfortunately sulpho-carbonates and carbon bisulphide are little more than names in the colony, and it has been necessary to telegraph for a supply. Pending the arrival of the insecticide, the vines are being uprooted and burnt. The result so far is encouraging, and the small range of the insect leads to the hope that it may be well kept under if not stamped out.

OSCAR SCHMIDT

EDWARD OSCAR SCHMIDT was born at Torgau on February 21, 1823. When he had finished his preliminary education he was sent to Berlin, where he had the advantage of studying natural history, to which his mind early had a bent, under the superintendence of Johannes Müller and Ehrenberg. Schmidt, however, proceeded to Jena to take his degree in 1849, and he held the post of Professor of Natural History in the University until 1855. His "Manual of Comparative Anatomy," which went through several editions, was first published in 1849. Appointed Professor of Zoology in the University of Cracow in 1855, he was obliged, two years afterwards, to quit the country, owing to some unfortunate political complications, and he took refuge in Gratz. He was appointed Professor of Zoology and Comparative Anatomy in the University, and in time was made its Rector. During many of his vacation tours he visited the Ionian Islands and other places on the shores of the Adriatic, and, diligently working out the fauna of this almost tideless sea, he became more and more interested in the natural history of the Sponges, with the result that in 1862 he published his well-known and important work, "Die Spongien des Adriatischen Meeres," to which two supplements were issued in 1864 and 1866, followed in 1868 by a third supplement, which formed part of a new work on "Die Spongien der Küste von Algier." It will be conceded that this work of Schmidt's marked an epoch in the history of this interesting sub-kingdom. The enormous progress made in our knowledge of the natural history of the Sponges during the twenty-four years that have elapsed since Schmidt put forward his classification, and the immensely improved methods of research, may be said to have revolutionised the subject; but Schmidt's work will always be of value, and the merit of having grasped the leading features of the classification of the Sponges will generally be awarded to him. That he for the most part failed to perceive the proper specific and generic characters of the forms he describes and figures is not to be much wondered at. In 1870, leaving the Sponge fauna of the Mediterranean, he published his "Grundzuge einer Spongien Fauna des Atlantischen Gebietes," which was followed in 1874 by an account of the Sponges collected by the German Expedition to the North Sea; and his latest contribution to this subject was his work on "Die Spongien des Meerbusen von Mexico, 1879-1880." In 1872 he was appointed Professor of Zoology to the University of Strasburg, returning thus once more to his fatherland.

Though his works on "The Natural Sciences and the Philosophy of the Unconscious" and on "The Descendance Theory of Man and Darwinism" passed through several editions, and were translated into French, they need not be more particularly referred to here. As already noticed in these volumes, Prof. Schmidt died at Strasburg on January 17 last.

THE STORY OF BIELA'S COMET[1]

I ASK you to listen to-night to the story of Biela's comet. I will weave into the story enough of astronomy to justify its place in this course as a lecture.

This story has none of the interest which human passions give to stories of human life, and yet if it shall not be to you as interesting as a novel, it will be because I shall spoil the story in telling it to you. It is a true story. In other words, I mean to separate sharply what we know from what we guess.

One hundred and two years ago last night (March 8, 1772) a Frenchman named Montaigne, in the provincial city of Limoges, found a comet. He did what little he could with his small telescope to mark its place in the heavens, but it was not much that he could do. The comet was a faint one, not to be seen by the naked eye, and had a short tail, only one-eighth as long as across the disk of the moon. He did not dream that that little foggy speck of light was to be one day one of the most interesting comets in the solar system; in fact, that he himself was to be known to history only for having first seen it. This little comet is the hero of my story—a hero from humble life. Montaigne wrote to Paris of his discovery, and they saw it three or four times before it disappeared.

[1] A Lecture delivered by Prof. H. A. Newton, on March 9, 1874, at the Sheffield Scientific School of Yale College, U.S. The renewed interest in Biela's comet created by the great shower of meteors on November 27 last justifies giving space for this lecture. From the *American Journal of Science*.

Thirty-three years later, November 1805, another Frenchman, named Pons, saw the comet. It passed rapidly from the northern heavens, and in a month went below our horizon. It came this time very close to the earth, and I shall in a moment tell you how it appeared. It was visible to the naked eye, even in strong moonlight. Twenty years later, February 1826, an Austrian officer, Von Biela, again found the comet. So soon as an orbit could be computed, it was seen that the three comets of 1772, 1805, and 1826 were the same body. This has since been known as Biela's comet. Its exact path around the sun could now be told. Let me show it to you.

Let us look down upon the solar system from a point several hundreds of millions of miles north of it. Looking southward we should see the sun in the centre. The earth, with its moon, would travel around the sun in a path or orbit denoted by the circle in the figure (Fig. 1).

It goes about the sun once a year, being, on the 10th days of January, April, July, and October, at the points so marked on the diagram. The motion is opposite to that of the hands of a watch. Outside, five times as far from the sun as is the earth, will be the huge planet Jupiter, a part of whose path you see. It goes about the sun once in twelve years. The paths of the other planets are not in the figure, as I have nothing to say about them to-night. In the figures which I show you the earth's orbit is twenty inches in diameter, or one inch to nine million miles. An express railway train travelling all the time for a fortnight would pass over about the thousandth of an inch in this figure. The comet's path is the ellipse. Around this ellipse it travelled three times in twenty years, or once each $6\frac{2}{3}$ years. When nearest to the sun, or at perihelion, it went within the earth's orbit, and when most distant it passed beyond Jupiter.

The comet's motion is very unequal. At D it moves very slowly. As it falls towards the sun the sun's attraction makes it move faster and faster, so that it whisks rapidly by P. As it then rises from the sun on the other side of the orbit, the sun not only turns it ever out of the straight path it would move in, but it stops its upward momentum, so that when it reaches D again it has only its old velocity with which to repeat its circuit. At P its velocity is twenty-eight miles, at D four miles, a second. In fact, to pass over the part lying apparently outside of Jupiter's orbit, just half of the whole $6\frac{2}{3}$ years is required. I said *apparently* outside, for another fact must be noticed: while Jupiter and the earth may be said to move in the same plane, that of the figure, the comet's orbit, lies at an angle. Suppose the ellipse to be a metal ring, and let it turn about the line A B as a hinge, the part A D B rising toward you, and the part A P D retreating from you. The parts near D must rise about the half-diameter of the earth's orbit to give the true position of the two planes. Notice that the comet's and the earth's orbits cut each other

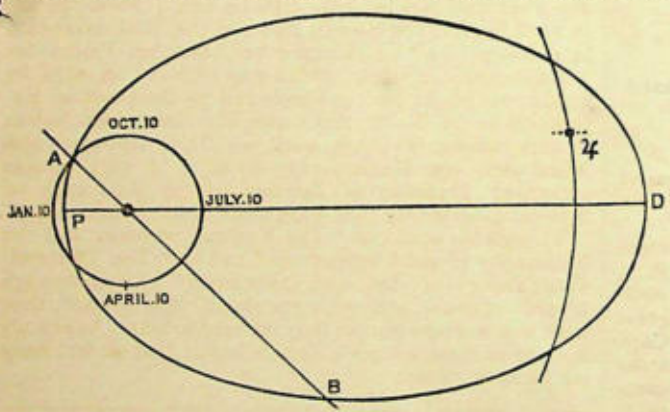


Fig. 1.

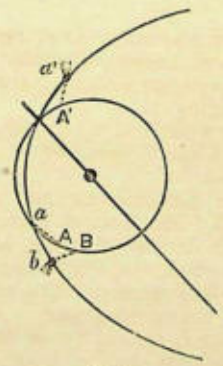


Fig. 2.

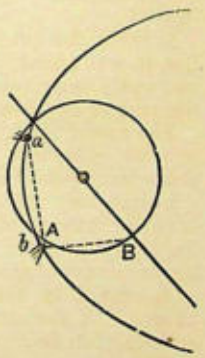


Fig. 3.

at the node on the line A B. The importance of this fact will by and by appear. The two orbits seem to cut each other at another point (below P), it is true, but because of the angle of the planes the cutting is only apparent.

Like all other comets, this one was visible only when near the earth and near the sun. Through the outer part of its path it was never seen, even with a telescope. The comet was seen in 1826 for the third time.

Positions in 1772 *and* 1805.—In March 1772 it was first seen from A in the direction A *a* (Fig. 2). It was last seen four weeks later from B in the direction B *b*. In November 1805 Pons found it when the earth was at A' and the comet at *a'* (Fig. 2). Both the earth and the comet were going to the node, the comet going faster than the earth. The earth passed the node just ahead of the comet. I have told you that the comet was then visible to the naked eye even in moonlight, and well it might be. On December 8, with the scale of the figures before you, it was only $\frac{3}{5}$th of an inch from the earth at the node. On the same scale the moon is $\frac{1}{40}$th of an inch from the earth. The comet passed $\frac{1}{16}$th of an inch outside the earth's orbit, but the earth was already past that point.

Dr. Schröter describes the comet: To the naked eye it was (Dec. 8) a large round cloud of light nearly as large as the moon. In a 13-foot telescope it had the same appearance, though it was much smaller, and it had a bright, star-like nucleus. The nucleus had not sharp edges, not even a definitely round form, but was like a light shining through a fog. Its diameter was about 112 miles, or, if we take its central light, 70 miles; speaking roughly, as large as the State of Connecticut. The whole cloud, as seen in the telescope, was some 6000 miles in diameter; to the naked eye perhaps 30,000 miles. How much smaller than 70 miles was the hard part of the nucleus we cannot say.

Position in 1826.—In 1826 it was first seen from A in the line A *a* (Fig. 3). Astronomers followed it with care, as they had come to know that it was a comet of short period, and not many such were then known. Its path then crossed just inside the earth's orbit at the node, but only $\frac{1}{50}$th of an inch in the diagram, or 20,000 miles, in fact, from it.

Position in 1832.—Six and two-thirds years brings us to 1832, and you can readily imagine with what interest this first-predicted return was watched for. Some of you also remember the widespread, though groundless, fears at that time of a collision of the earth and the comet. The comet was first seen by Sir John Herschel in September. In his 20-foot reflecting telescope he saw it pass centrally over a group of small stars of the 16th or 17th magnitude. The slightest bit of fog would have at once blotted out the stars. Through the comet, however, they looked like a nebula, resolvable, or partly resolvable, into stars. How thick the cometic matter was we do not know. Its extent

laterally, was not less than 50,000 miles. Again, M. Struve saw it pass centrally over a star of the 9th magnitude. A like star was seen in the telescope at the same time, so that he was able to say that the comet did not dim in the least the one which it covered. The comet, as the figure (Fig. 4) shows, was in 1832 always at a great distance from the earth.

Another 6⅔ years brings us to 1839. The comet came to perihelion, at P, in July. The earth and comet were on opposite sides of the sun both before and after July, and of course the comet was not seen.

Position in 1845.—Another circuit was finished in 1845-6.

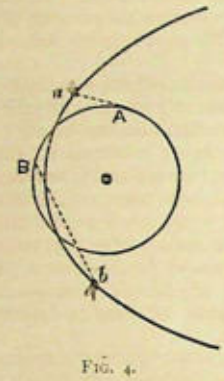


Fig. 4.

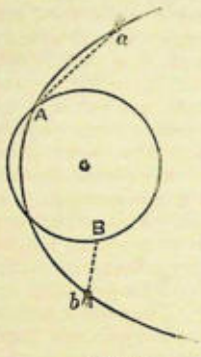


Fig. 5.

The comet was visible then during five months, from *a* to *b* (Fig. 5), or as viewed from the sun through nearly half its circuit. At this time it was that the comet became all at once famous.

On December 29 Mr. Herrick (then Librarian of Yale College) and Mr. Francis Bradley (then in the City Bank) were watching the comet through the Clark telescope in the Athenæum tower yonder. They saw a small companion comet beside the larger one! What did it mean? Had the comet a satellite like the earth's moon? Or had the comet been split by some convulsion? Two weeks later the companion comet was seen by Lieut. Maury and

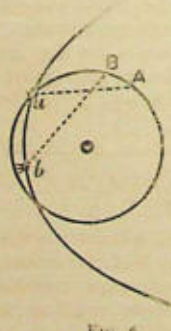


Fig. 6

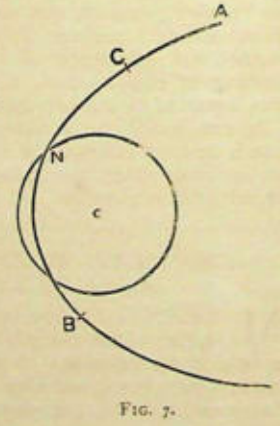


Fig. 7.

Prof. Hubbard at Washington, and two days after that it was seen by two or three European astronomers.

Changes were seen in the larger telescopes that increased the mystery. The faint companion grew in size and brilliancy. Each comet threw out a tail. Then the smaller one had two tails. Then the larger one had a pointed, or diamond-shaped, rather than a round head. Two nuclei were seen in the larger one, and it also had two tails. An arch of light was thrown over from one to the other. For some days in February the companion was the brighter of the two. Presently three tails were seen running from the primary, and three cometary fragments (one observer says five) around its nucleus. What could it all mean? Do you wonder that astronomers were excited by these wizard changes?

The companion comet was seen in Washington by Maury and Hubbard two weeks after it was seen here by Herrick and Bradley. Prof. Joseph Hubbard was the son of a resident of New Haven, well known to many of you from his connection with the New Haven Bank. Prof. Hubbard was graduated two years before (in 1843) at this College, and was now Professor in the Naval Observatory at Washington. He took up the study of the motions of the two Biela comets as special work, outside of his hours on duty. How faithfully he worked, four thick manuscript volumes of figures might tell. I cannot show you those books. They form, since Prof. Hubbard's death, a cherished memento in the possession of a friend. But I have brought another of Hubbard's volumes from the College Library, one of three upon the comet of 1843, in order to show you by what patient labour some of the results of astronomy must be wrought out. In your school days you called it a wondrously long sum that covered both sides of the slate. On the leaves of this book there are, as you see, one, two, three, and in some cases, I think, even four thousand figures upon the page. You will, I am sure, excuse me from telling in detail to-night how we learn about the sizes, distances, and motions of the comets. Eight or ten such volumes of figures, to be increased in time, we hope, by the four Biela volumes, form a monument to a true, devoted, gentle scholar of science. You will not wonder when I tell you that he hated shams.

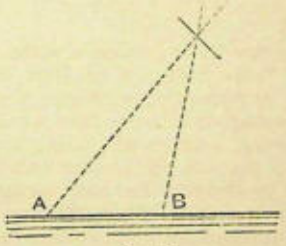


Fig. 8.

Position in 1852.—In 1852 the comet was always at a great distance from the earth (Fig. 6), and only to be seen through the largest telescopes. The changes of size and brightness of the two comets were remarkable, and as they could but just be seen, sometimes one and sometimes the other alone was visible; which one it was that a person saw at any time was only told by computation afterwards.

The two comets were now eight or ten times as far apart as they had been seven years before. They were at the point P, 1,250,000 miles apart. Prof. Hubbard found that he could not tell which comet of 1852 was preceding and which following in 1845. One supposition agreed as well with the observations as the other.

Perhaps the knowing ones among you have noticed that the arc from the node to the point marked Jan. 10 in the first diagram is too large for one month, for in 1772 the earth passed the node Dec. 9. But you will notice that when the comet is at D, and the large planet Jupiter is near by, he draws the comet toward the plane of the figure. The result is to bring the comet down to meet the earth's orbit farther from P. The node thus went back from Dec. 9 to Nov. 27, a distance of 12 days, or 12° in the circle. The figure represents this last orbit. By the same cause the inclination was reduced one-fourth, or from 17° to 12°.

Since September 1852 (with one doubted exception to be spoken of), neither of the two Biela comets had been seen. In 1859 their path was to us behind the sun. In 1866 they should have been at the point P on January 26.

A better chance of seeing them could hardly be. They were at all times to be away from the sun's light, and when nearest to the earth not more than one-fifth the sun's distance. The paths were carefully computed, and the action of all the planets, notably that of Jupiter, allowed for. A dozen observers for months swept the heavens with their telescopes, but not the slightest trace of the comets was seen.

Again, they should have come to perihelion a year ago last autumn (Oct. 6, 1872), but, as I suppose, neither of them was seen. With the loss of its hero, our story would seem to come to an end. I must ask your indulgence, however, for another chapter.

I suppose that each one of you has often seen a shooting-star. On a clear night you have seen a bright point of light travel quickly across the sky, as though a star had been shot from its place in the firmament. It may, if it was a large one, have broken into sparks as it disappeared, or have left a cloudy train along part of its path for an instant; or perhaps it was so faint even that you could not be quite sure that you saw anything. Some of you have seen those shooting-stars by hundreds in star showers.

Until near the close of the last century, poets dreamed, and other men guessed, about these objects, but knew nothing. Two German students, Brandes and Benzenberg, found out, and told us, that these bright flights were in the upper parts of the atmosphere. From the two ends of the city a track always appeared to be in the same part of the heavens. But when one went to a village many miles away, a track was seen by the two persons (at A and B, Fig. 8), in different parts of the sky. Hence they were able to measure the height of the shooting-stars from the ground.

We now know that these luminous paths are rarely less than 40 miles or more than 90 miles from the earth. We also know that any shooting-star was a small body, of unknown size, perhaps not larger than a pebble or a grain of coarse sand even, undoubtedly solid, which has been travelling around the sun in its own independent orbit, like any planet or comet. Its path came within 4000 miles of the earth's centre, and so the small body struck into the earth's atmosphere. Its velocity was so great—fifty or a hundred times that of a cannon-ball—that even in our rare upper atmosphere an intense light and heat was developed by the resistance, and the body was scattered in powder or smoke. These bodies before they come into the air, I call meteoroids. It is only when they have reached our atmosphere and begin to burn that we ever see them. They are then within 90 miles of the ground.

(To be continued.)

ON THE COAGULATION OF BLOOD[1]

BRÜCKE'S researches on the conditions of coagulation of blood have shown that, on the one hand, contact with foreign bodies makes blood coagulate, and, on the other, that contact on all sides with the fresh vascular wall obviates coagulation (Durante). Lacker has proved the influence of foreign bodies on blood-coagulation by microscopic observation of coagulation in its first stages. In partial contradiction to these results was the observation of Grünhagen that blood, when received into glycerine, and so long as it did not mix, remained liquid. To determine the nature of these influences the following experiments were made. Blood was drawn under oil from the carotid artery of a dog, and let stand at ordinary indoor-temperature; after twenty-four hours it was *not* coagulated. Then the blood was drawn into a vessel smeared inside with vaseline, and it too *did not coagulate*. When it was stirred with an oiled glass rod, no fibrin was separated; but when, even after several hours, part of this blood was poured into an ungreased vessel, it coagulated in a few minutes. Moreover, contact with an ungreased glass rod sufficed to make the blood in the greased vessel coagulate outwards from the rod.

Further experiments showed that the drying of the upper layers of the blood, and the presence of small quantities of dust, caused coagulation even in the greased vessel; if this was guarded against, the blood remained liquid for days, and the corpuscles sank to the bottom, the plasma remaining as a clear liquid above.

After pouring out the blood, the greased walls of the glass vessel showed neither blood-colouring matters, nor traces of a separated albuminous body. A repetition of these experiments at 37° C. gave the same result. In all the experiments blood was also, for comparison, drawn off into ungreased vessels, and in all these it coagulated, at the most, in a quarter of an hour.

In further experiments a small vaseline-lined glass tube was used as a canula; and the blood drawn through this into vaseline-lined vessels also remained uncoagulated.

When the outer orifice of a canula inserted in the carotid was closed, the blood column in it pulsated, without showing the least sign of coagulation even after two hours.

In all these experiments there was nowhere in the vessels with which the blood came into contact even a point for adhesion—such a point would have caused in shorter or longer time coagulation of the whole mass of blood. Thus the coagulative influence of foreign bodies appears to be due to their adhesion.

But to demonstrate that the anti-coagulative property of the vascular walls is due to the lack of adhesion, a further series of experiments was made with soaked fish-bladders and parchment-tubes.

The membranes lay several hours in 0·6 per cent. chloride of sodium solution; the blood was drawn off through a vaseline-lined canula into the bladders and tubes, which were then so hung in a litre of the salt-solution that the mass of blood was under the surface. In these experiments also the blood remained liquid, the surrounding salt-solution having no coagulative effect, while some of the blood, poured after twenty-four hours into an ungreased porcelain vessel for comparison, soon coagulated. Like the blood-vessels, which, unlike manufactured vessels, after being emptied of the blood, retain no colouring-matter, the membranes, even after several days, showed neither imbibition with blood-colouring matter, nor any trace of coagulated fibrine. Thus, by soaking in salt-solution, a property of the blood-vessels was imparted to the fish-bladders and parchment-tubes.

It can hardly be doubted, then, that while, on the one hand, lack of adhesion prevents blood from coagulating, so, on the other, the presence of adhesion gives the impulse to coagulation.

[1] By Ernst Freund, in *Wiener medicinische Jahrbücher*, 1885, Heft 1.

INOCULATION AS A PRESERVATIVE AGAINST CONSUMPTION

M. VERNEUIL has lately published a letter to the editor of the *Gazette hebdominaire*, M. Lereboullet, in which he proposes to set on foot an experimental inquiry into the possibility of finding some method of "attenuating" the presumed *virus* of tubercle, so as to make inoculation therewith practically useful against consumption, either as a prophylactic measure, like vaccination against small-pox, or as a means of cure, like Pasteur's inoculations in hydrophobia.

Three thousand francs have already been subscribed, and the respectable names of Cornil, Bouchard, Damaschino, and Potain are mentioned among those who approve of the investigation.

It must however be remembered (1) that with the exception of hydrophobia, an exception still on trial, no human disease but small-pox is known which can be prevented by inoculation; (2) that of epizootic diseases

anthrax is only in certain cases guarded against by Pasteur's attenuated virus; (3) that the dependence of consumption on Koch's *Bacillus tuberculosis* is far from established; (4) that its fatality is very far below that of small-pox or hydrophobia, and its treatment far more successful.

Consumption is the most important disease of temperate climates, both by its prevalence, its mortality, and its incidence on young adults; so that the sacrifice of a few rabbits or cats for even a remote chance of controlling its ravages is well justified. But the chance is, we fear, remote.

NOTES

THE friends and former students of Prof. P. J. Van Beneden, of Louvain, are about to celebrate there the fiftieth year of his professorship. Since the year 1836 this distinguished *savant* has occupied the position of Professor of Zoology at the Louvain University, and it is proposed to present him, on the occasion of his jubilee, with a gold medal bearing his portrait. After half a century of teaching and the accomplishment of a vast amount of other work, Prof. Van Beneden still remains fresh in mind and body. His writings have embraced with equal success various branches of biological science, and have gained for him a reputation of the first rank, which has just been crowned by the award of the Cuvier Prize by the Academy of Sciences of Paris. There is no doubt that the proposed demonstration to honour Prof. Van Beneden on his jubilee will find a ready echo in this country, where he possesses numerous friends.

IN a recent debate in the French Chamber of Deputies on a Bill permitting any person by will to regulate the conditions of his funeral, a clause was added at the instance of M. de Mortillet, the eminent anthropologist, enabling any person to dispose of his body in favour of educational or learned societies. M. de Mortillet stated that the Autopsy Society founded by Broca had been allowed to retain the brains of Gambetta, Dr. Bertillon, and two journalists, but the authorities might at any time take these away from its museum, as also any bones or skeletons. The proposition was adopted by 268 votes to 198.

WE are glad to receive a copy of the *Annual Companion to the "Observatory."* Its object is to give, in a collected form, the whole of those Ephemerides which have hitherto been printed month by month in the *Observatory*. This issue is regarded as an experiment, and the editors ask for suggestions for the improvement of future *Companions*, and for criticisms on the present one. In future it is intended to issue it with the December number or before. The principal sources from whence the Ephemerides have been derived are as follows:—The "Meteor Notes" have been taken principally from the valuable series of papers by Mr. Denning in vols. i., ii., and iii. of the *Observatory*, supplemented from the British Association *Reports*. Mr. Denning has also kindly revised them. The Ephemerides for the physical observations of Jupiter and Mars are derived by permission from those calculated by Mr. Marth, and published by the Council of the Royal Astronomical Society in the *Monthly Notices*. The Ephemerides for the satellites of Mars, Saturn, Uranus, and Neptune are taken from the *American Nautical Almanac*, corrected, in some cases, for recent observations made at Greenwich. The elements of occultations and times of eclipses of Jupiter's satellites are extracted from the English *Nautical Almanac*. The Catalogue and Ephemerides of Variable Stars are derived from the *Annuaire du Bureau des Longitudes*. The publication will certainly be of much practical value.

ON the evening of Wednesday, February 17, Prof. A. B. W. Kennedy and the Committee of the Engineering Society held a successful *soirée* at University College, London, in connection with the College Society. Visitors were received in the engineering laboratory, where machinery was in motion, and Mr. A. S. Ashcroft's autographic stress diagram apparatus was shown in action. All the available space was occupied with exhibits. The College Society organised a show of photographs and photographic apparatus in the library, where Messrs. Clarke and Clarke exhibited their method of printing by gaslight. The *soirée* was attended by about 1000 visitors.

LAST autumn the run of salmon up most of our rivers, especially those falling into the North Sea, was quite unprecedented. It is worthy of notice that at the same time (that is from August to November) they ascended, in equal, if not still more remarkable, numbers, the rivers that flow into the North Pacific Ocean, as well on the Japan side as the American. The "canning companies" in British Columbia were quite unable to obtain boxes and barrels quickly enough to keep pace with the supply, and fine large fish were sold for a cent apiece. Had this abundance of the Salmonidæ (sea-trout and bull-trout were as numerous in proportion as salmon) been confined to this part of the world, one might have supposed that an epidemic amongst dog-fish had enabled a much greater number of smolts to escape at the mouths of the rivers on their descent than commonly do; but under the circumstances some more satisfactory explanation seems to be required. Possibly in some manner the quantity of ice in northern waters on both sides of America had an influence upon these fish, or those that prey upon them in the deep water.

THE Italian Ministry of Agriculture has just undertaken an interesting experiment. Half a million of fish eggs were artificially hatched, and the young brood has been distributed all over the centre of the Lake of Como. If the experiment succeeds fairly well, it will be taken up on a large scale, and the department will undertake the re-stocking of the Italian waters. Efforts will be made immediately to revive and extend the rearing of lobsters.

THE old Tour St. Jacques la Boucherie, Paris, celebrated in connection with Pascal's experiments on atmospheric pressure, is now the site of a Laboratory of Physics. The inauguration took place on January 13. The tower was lighted by incandescent lamps.

LARGE sulphur deposits are reported to have been recently discovered on the southern slopes of the Caucasus.

ECUADOR was visited by natural calamities during January, which probably have been the cause of great loss of life. On January 12 the sky in and around Guayaquil was of a dark red colour, as if coloured by an immense conflagration. Detonations heard in the direction of Cotopaxi, and accompanied by earthquakes and subterranean noises, showed that some volcanic eruption was in progress. The noise and shocks lasted for two days and nights. At Yaguachi, opposite Guayaquil, a rain of ashes was observed. It is feared that the town of Latacunga, which is situated at the foot of Cotopaxi, is destroyed.

A REMARKABLE effect of lightning has been recently reported by Prof. L. Weber in a German serial. At Ribnitz, in Mecklenburg, during a violent thunderstorm, with rain and hail, about 6 a.m., the lower pane of a window on the first floor was broken by lightning, and a jet of water was thrown upwards through the aperture to the ceiling, where it detached part of the ceiling, and this, falling with the water, broke a small cigar-table below. Three bucketfuls of water were afterwards taken from the room. The hole in the window was like that from a bullet, and there were radial cracks. The path of the lightning is not very clear, but that it passed through the glass could not be doubted. Some cigars on the table, it may be mentioned, were

carbonised. As to the jet of water, Prof. Weber rejects the hypothesis of a sudden generation of vapour forcing up water from the street. Another explanation offered is that the lightning, passing through the window to the street, generated a vortex of air about itself with vacuum in the interior, through which the water was driven as through a tube. A third hypothesis remains, viz. that a conical *trombe* struck the street, was reflected, and passed through the window in the form of a jet of water. In this case the lightning would merely have accompanied or preceded the *trombe*. Prof. Weber seeks further light on such phenomena.

On the evening of January 9 a very fine display of the aurora borealis was seen in the southern parts of Norway.

A magnificent meteor was seen by the station-master at Leangen Station, in the north of Norway, on January 16, at 8.15 a.m., it being still dark. He states that the meteor first looked like a small star, but, approaching with great velocity, soon attained the size of a cheese-plate. It had a dazzling white light, very like the electric, and was clearly visible, being below the clouds in the upper part of the sky. When it had passed the zenith and reached the eastern horizon, it separated into several parts, which gradually became extinguished. It left a trail for a few seconds, brownish-yellow in colour. Another meteor, to which we referred last week as having been seen at Aas, near Christiania, at 5.30 p.m. on January 5, was also seen in various other parts of the province of Smaalenene, even as far south as Frederikshald, near the Swedish frontier (distance from Aas about 100 kilometres = 63 miles). It appeared there in the constellation Taurus, at 5.15 p.m., and moved in a north-westerly direction. It left a long bright trail, and its passage was, according to some, accompanied by a faint hissing.

On New Year's Eve an earthquake was felt in the central parts of Norway, particularly at Elverum and Löiten, where the houses shook. Another shock was felt in the province of Christiansand, at about 4 a.m. on January 16, followed by vivid flashes of lightning. In several houses the doors sprang open, and furniture, &c., was moved. A girl was thrown out of bed in one place. The barometer was very low at the time, but remained the same as on the previous day.

Prof. Lommel has recently described (*Wied. Ann.* 1) an aërostatic balance for determining the specific gravity of gases. It is useful for lecture experiments. Under one scale of a balance is hung, by means of a wire, a closed glass balloon, which is inclosed in a glass vessel having in its cover a small hole for the wire. This vessel has a side tube, with stopcock, near the bottom. The instrument being balanced while air is in the vessel, another gas is allowed to stream in and displace the air, whereupon the balloon rises or sinks according as the gas is heavier or lighter than air. By adding weights in one scale or the other equilibrium is restored, and one finds how much more or less a volume of gas equal to that of the balloon weighs than the same volume of air at the same temperature and pressure.

We have received the Calendars of the University College of Aberystwith and Cardiff for the Session 1885-86, and the reports of work in both cases are very satisfactory, showing, as they do, a considerable increase in the number of students, and in the general scope of the educational work. We have examined with especial interest the Aberystwith Calendar, for it will be remembered that during last summer the College there was almost wholly destroyed by fire. The Council met the situation by taking a large hotel, where the work of the institution is carried on apparently without any serious inconvenience. The Principal of this College calls attention to a question which requires the careful consideration of the responsible authorities of the three University Colleges of Wales, and which, for the sake of the equitable distribution of the prizes and scholarships of these institutions, it is to be hoped may speedily be settled. Principal Edwards points out the danger that healthy and legitimate rivalry between the Colleges is in danger of degenerating into a bid for students by the offer of money bribes, and he quotes the case of a student who wandered from one to the other, taking scholarships at all three by recommencing his course at each in succession. There is apparently no regulation preventing a graduate of one beginning as an undergraduate at each of the others, and carrying off the prizes to the disadvantage of *bonâ-fide* students. Unfortunately, the negotiations which have been undertaken to prevent this grave abuse have hitherto proved unsuccessful, but it behoves the authorities concerned to prevent this misapplication of money so nobly subscribed for education by all classes of the Welsh people. Two very interesting and suggestive tables will be found at page 25 of the Aberystwith Calendar. The first gives the ages of the students: 76 are over 20 years of age, 22 over 25, and 5 over 30. The second contains the occupations of the parents, and shows in the most marked way the struggles which, to their infinite credit, Welsh parents make to educate their children. This trait in the Welsh character is well known, but we have not seen it exhibited in this definite, concrete manner before.

The additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Miss Douglas; a Chacma Baboon (*Cynocephalus porcarius* ♀) from South Africa, presented by Mr. F. Radcliffe; a Ring-tailed Coati (*Nasua rufa* ♀) from South America, presented by Miss A. Pagella; an Orange-winged Amazon (*Chrysotis amazonica*) from South America, presented by Mr. G. F. Richards; two Feline Douracoulis (*Nyctipithecus vociferans*), two Silky Marmosets (*Midas rosalia*), a Razor-billed Curassow (*Mitua tuberosa*), a Mantled Buzzard (*Leucopternis palliata*) from Brazil, a Raccoon (*Procyon lotor*) from North America, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

The New Star in the Great Nebula in Andromeda.—As the *Nova* in Andromeda was the first object of its kind to which accurate photometric methods of observation were applied, Prof. Seeliger of Munich has taken the opportunity of investigating whether the observed variations of brightness throw any light on the physical history of the phenomenon. If we suppose that the surface-temperature of a "new" star is suddenly increased by an enormous quantity, and, in consequence, the brightness increased to a corresponding extent, and assume that the latter is proportional to an arbitrary power, n, of the temperature, then the light curve constructed from the observations will be a curve which represents the nth power of the successive temperatures of a cooling body. Prof. Seeliger has deduced an expression for the temperature of a sphere at any time, t, on the assumption that the sphere is homogeneous with respect to the conduction of heat, that at the time $t = 0$ it has the same temperature throughout its interior, and that the temperature of the surrounding medium is zero. If, then, h be the brightness corresponding to a temperature θ, we have $\theta = h^{\frac{1}{n}}$, and using Pogson's scale for transforming brightness into stellar magnitude, there results a formula for the magnitude of the cooling star at any time. For the purpose of comparing his formula with Herr Müller's photometric observations of the *Nova*, extending from 1885 September 2 to October 13, Prof. Seeliger assumes that $n = 1$, and that the epoch for which $t = 0$ is 1885 August 27d. 8h. Berlin M.T. He also uses quite approximate values for the constants involved in his formula, the more accurate determination of which would be a work of difficulty. Under these circumstances he gets a very fair agreement between the observed and computed values, which would,

he considers, be improved by using more accurate values of the constants, and of the epoch for which $t = 0$. The magnitude corresponding to this latter epoch is 7·73. Considering that there is evidence to show that the Andromeda nebula is, in part at least, a star-cluster consisting of a vast number of faint stars, Prof. Seeliger thinks it not improbable that the blazing forth of the *Nova* may have been due to a collision which caused an enormous development of heat and light. At all events, the fact that his formula represents the observations tolerably well appears to him to be sufficient evidence to show that the supposed conditions are not, in the main, at variance with the actual circumstances of the case.

PRESENT STATE OF THE SOLAR ACTIVITY.—The sunspot maximum, after some remarkable oscillations, was definitely attained about the close of 1883, the interval from the period of minimum having been nearly two years longer than usual. Since that date there has been a steady diminution in both the numbers and areas of the sunspots. M. R. Wolf gives (*Comptes rendus*, vol. c. No. 3, and vol. cii. No. 3) the following values for his relative numbers for the last three years: 1883, 63·7; 1884, 63·3; 1885, 50·3. The diminution in the last part of 1885 was particularly marked, there having been a vigorous rally in the months of May, June, and July, followed by a rapid decline. The relative numbers for the last three months of the year fell far below the mean of the twelvemonth. The figures given by M. Tacchini closely correspond to those given by M. Wolf, as the following table will show. The last three columns give Tacchini's numbers:—

1885	Wolf's numbers	Relative frequency	Relative size	Daily number of groups
January	31·4	19·57	43·19	4·33
February	67·2	23·81	77·33	5·96
March	46·6	16·23	44·92	2·92
April	54·6	15·10	56·86	3·48
May	80·5	18·68	86·21	5·80
June	82·1	22·36	132·76	5·21
July	61·4	15·41	90·22	4·45
August	47·7	11·20	44·70	3·40
September	43·4	9·14	59·20	3·31
October	42·6	12·55	55·64	3·09
November	26·8	6·35	22·90	2·30
December	18·9	4·84	21·44	2·12

Faculæ have not shown so rapid a decline, but there has been a distinct falling off in these also; the difference, however, is at present noticed rather in a loss of brilliancy than of apparent area. But hitherto the prominences have shown but slight indications of a participation in the falling off so strongly exhibited by the spots. The following numbers, derived from papers by the Rev. S. J. Perry in the *Observatory* for February 1885 and 1886, show indeed a slight increase of energy for 1885 over 1884:—

Year	Mean height of chromosphere, excluding prominences	Mean height of prominences	Mean extent of prominence arc
	"	"	° ′
1880	7·93	23·46	23 21
1881	8·04	24·61	33 18
1882	8·24	24·55	40 57
1883	8·27	27·23	41 24
1884	7·94	25·74	29 6
1885	8·00	28·67	28 25
Mean 1880-1885	8·07	25·71	32 45

The mean extent of prominence arc is thus the only element which seems to point to the maximum being past.

But if the prominences do not show any close correspondence to the behaviour of the spots, M. Wolf finds that the variations of magnetic declination have responded to their changes fairly closely. In the paper alluded to above he gives, side by side with his "relative" spot numbers, the monthly means of the variations in magnetic declination as observed at Milan. The mean observed value for 1885 is 7′·95, whilst 7′·88 is the mean value computed from the formula M. Wolf had deduced in former years for Milan, $v = 5'{\cdot}62 + 0{\cdot}045\ r$, where r is the relative sunspot number for the year.

Prof. Spörer points out (*Comptes rendus*, vol. ci. No. 26) that the spots have not been equally distributed between the two hemispheres during the period of maximum, but that throughout the years 1883, 1884, and 1885 there has been a nearly constant predominance of southern spots over northern; whereas in the period from minimum to the end of 1882 the predominance rested, on the whole, with the northern hemisphere. This alteration has also been accompanied by somewhat of a check in the regularity of the progress of the spots towards the equator, which is usually so marked in the interval from one minimum to the next.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 FEBRUARY 28—MARCH 6

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 28

Sun rises, 6h. 49m.; souths, 12h. 12m. 41·5s.; sets, 17h. 36m.; decl. on meridian, 7° 52′ S.: Sidereal Time at Sunset, 4h. 10m.

Moon (New on March 5) rises, 3h. 39m.; souths, 8h. 6m.; sets, 12h. 34m.; decl. on meridian, 18° 16′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 5	12 28	17 51	7 59 S.
Venus	5 28	11 4	16 40	5 19 S.
Mars	18 7*	0 53	7 39	8 23 N.
Jupiter	19 41*	1 45	7 49	0 4 S.
Saturn	11 21	19 32	3 43*	22 45 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

March h.
- 3 ... 5 ... Saturn stationary.
- 5 ... ... Annular eclipse of the Sun; not visible in Europe.
- 6 ... 12 ... Mars in opposition to the Sun.
- 6 ... 18 ... Mercury in conjunction with and 0° 8′ north of the Moon.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Mar.	3, 20	57 *m*
Algol	3 0·8	40 31 N.	Feb.	28, 23	24 *m*
			Mar.	3, 20	13 *m*
λ Tauri	3 54·4	12 10 N.	,,	2, 18	12 *m*
R Lyncis	6 51·9	55 29 N.	,,	2,	*M*
ζ Geminorum	6 57·4	20 44 N.	,,	4, 21	30 *M*
V Geminorum	7 16·8	13 19 N.	,,	6,	*M*
δ Libræ	14 54·9	8 4 S.	,,	4, 22	36 *m*
U Coronæ	15 13·6	32 4 N.	,,	5, 20	13 *m*
V Coronæ	15 45·5	39 55 N.	,,	5,	*m*
U Ophiuchi	17 10·8	1 20 N.	,,	3, 5	28 *m*
		and at intervals of		20	8
X Sagittarii	17 40·4	27 47 S.	Mar.	3, 0	0 *m*
			,,	5, 21	30 *M*
W Sagittarii	17 57·8	29 35 S.	,,	6, 21	30 *M*
β Lyræ	18 45·9	33 14 N.	,,	6, 0	0 m_2
δ Cephei	22 24·9	57 50 N.	,,	3, 0	0 *M*
R Aquarii	23 37·9	15 55 S.	,,	3,	*M*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Meteor Showers

The first week in March furnishes the most favourable nights of the month for meteor observation, but none of the great periodical showers occur at this time. Amongst the radiants represented are the following:—

Near γ Orionis, R.A. 80°, Decl. 6° N.; near α Persei, R.A. 50°, Decl. 48° N.; near η Bootis, R.A. 205°, Decl. 17° N.; near ξ Sagittarii, R.A. 280°, Decl. 17° S.; Ursa Major, R.A. 180°, Decl. 60° N.

BIOLOGICAL NOTES

CONTINUITY OF PROTOPLASM.—M. L. Olivier proposes, in the *Comptes rendus*, the following methods for determining the connection between the protoplasmic contents of adjacent cells:—(1) Photography. This distinctly reveals the perforation by canals of the cell-walls, when photographed direct with a magnifying power of 300-700 diams. (2) Direct observation, with

powers magnifying from 700-900 diams. Though successful in some instances, this method is for the most part wholly insufficient. (3) Staining sections. This was successful in many plants in demonstrating the protoplasmic connection. (4) Injection into organs. When injected slowly, under pressure, with a fluid capable of colouring protoplasm, if the injection took place in a sufficiently uniform way, the canals were rendered visible. By the methods thus indicated continuity of protoplasm was established in the stem and leaves of the box-tree, and in *Cucurbita*.

NEW EDIBLE FUNGUS.—Mr. Colenso calls attention to the rapidly-increasing value as an article of export from New Zealand of *Hirneola polytricha*. This mushroom, first described from the East Indies and Java by Montagne, is of various sizes and shapes, some specimens measuring even a few inches. It is found in New Zealand growing on the trunks of trees, both on living and on decaying ones, especially on the latter while standing, particularly on the stems of *Corynocarpus lævigata* and on *Melicytus ramiflorus*. Both of these are endemic. The former is mostly confined to the sea-shore, where it often forms dense and continuous thickets. The latter tree is scattered plentifully throughout the country. When dry, the mushroom becomes shrivelled up, and is as hard as horn; when wet, it is soft and elastic, almost subgelatinous. It grows in compact gregarious masses. The market for this fungus is China, where it is largely used by the Chinese in soups. It appears that another species of the same genus indigenous in North China has long been an article of commerce. Mr. Berkeley notes of our British species, *H. auricula-judæ*, that it was once a popular remedy for sore throats, and adds that it is still occasionally sold at Covent Garden Market. The New Zealand species is plentiful, and obtained at little cost, the drying of it being an easy matter. Originally the price paid to collectors was a penny per pound; now it is nominally twopence halfpenny, while its retail price in China is five times this. The *declared* value per ton at the Customs ranges from 33*l.* to 53*l.* a ton, and is doubtless much below its real value. During the last twelve years some 1858 tons of this fungus were exported, chiefly from the ports of Auckland and Wellington, and of a declared value of almost 80,000*l.*—(*Trans.* Penzance Nat. Hist. and Antiq. Soc., 1884-85.)

WORMS IN ICE.—Prof. Leidy had examined a block of ice which was part of the stock of ice stored at Moorestown, N.J., and had been nearly a year in store; it was full of air-bubbles and water drops. On being melted a number of worms were liberated, and proved to be in a living and quite active condition. It is probable that while imprisoned in the ice they may not have been frozen, but perhaps remained alive in a torpid state in the water-drops; but it seems remarkable that these animals should remain so long alive in the ice, and yet die, as they did, almost immediately, in the melted ice-water. Of course the fact points to the advisability of not employing spongy ice as an article of food. Dr. Leidy, believing the form to be as yet undescribed, gives a diagnosis of it under the name *Lumbricus glacialis*; it is from 4 to 6 centimetres long, of from 35 to 50 segments; oral segment unarmed, eyeless; succeeding segments with four rows of podal spines, in fascicles of three.—(*Proc. Nat. Sci. Philadelphia*, December 22, 1885.)

STAR-FISHES FROM SOUTH GEORGIA.—Dr. Studer describes a small collection of star-fishes made by Dr. v. d. Steinen, the naturalist of the German Polar Expedition in 1882-83, who had an meteorological station at South Georgia. Of the 14 species collected, 7 belonged to the family Stellerida, and 7 of these were new, 5 to the Ophiuridæ, of which 4 were new. Most were collected in quite shallow water. The general character of the fauna is like that of Kerguelen Land; and, to assist the comparison, Dr. Studer gives a comparative list of the known species from the South American (Falkland Islands, Magellan Straits) district and that of Kerguelen Land. All the new species are well figured in two plates which accompany the memoir.—(*Aus dem Jahrbuch der wissens-Anstalten zu Hamburg*, xi. 1885.)

GEOGRAPHICAL NOTES

THE last number (15) of the *Journal* of the Straits Branch of the Royal Asiatic Society contains several papers of much geographical interest. In the first, Mr. Swettenham describes a journey across the Malay peninsula from Kwala Bernam in Perak, through Pahang to Kwala Pahang on the east coast. The paper is in the form of a journal, but, unfortunately, the accompanying sketch-map is so defective as to be quite useless to assist the reader in following the narrative. Père Couvreur, of the Missions Etrangères at Singapore, contributes an account of a recent journey through Laos from Bangkok to Ubon, a town on the Szimún, a tributary of the Mekong, including a visit to the ancient Khmer city of Puthai-Saman, the monuments and architecture of which make it similar to the renowned Angkor, but on a reduced scale. To the people of the country these magnificent ruins are the work of avals, so completely has all trace of the great civilisation of which they are the eloquent witnesses disappeared from Cambodia. This paper is also in the form of a journal, but is not accompanied by a map. There are several other papers of interest (such as the translation of old Valentyn's account of Malacca, and the account of the Dutch expedition of 1877-79 to the interior of Malacca), but these are not original to the Straits Asiatic Society.

THE *Verhandlungen* of the Berlin Geographical Society just published (Band xiii., No. 1) contains an account, by Dr. Wolff, of the journey of the expedition sent out by the African Society in 1884 from San Salvador to the Quango and back, and Dr. Diener writes on the mountain system of Lebanon, on which he has also a paper, already noticed, in the February *Petermann*. The current *Zeitschrift* (Band xx., Heft 6) of the same Society is largely occupied by a bibliography of the works, papers, maps, &c., relating to geography published during the year ending November 1885. There is, however, a curious list of the lengths and drainage areas of 376 rivers of the world. These figures are necessarily approximate only in most cases. It is noticeable that, while the Mississippi is 5882 kilometres in length, and the Amazon only 4929, the drainage area of the former is less than half that of the latter, the figures being: Mississippi, 3,201,545, and the Amazon 7,337,132, square kilometres. The only other paper in the number is an exceedingly interesting one by Herr Rohde, on the Terenos tribe, which inhabits the district to the west of the Brazilian town of Miranda, and stretches as far as the Bolivian frontier. They are really Chaco Indians who have migrated from Bolivia. The writer describes, all too briefly, their appearance, mode of life, occupation, and customs—especially their festivals.

THE Austrian traveller, Mr. C. Hermann, who started on a West African exploring tour in April last, has returned to Vienna. Having visited Liberia, Cameroon, Eloby, Gaboon, and other points on the coast, he arrived at the Congo early in July, and expected the arrival of Dr. Lenz at Banana. In order to engage the necessary porters for Dr. Lenz's expedition he went to Loango, but returned to Banana without having succeeded. He left Dr. Lenz on October 20 and returned to Europe.

DR. BERNHARD SCHWARZ writes from Monrovia (Liberia), under date January 23, as follows:—"As chief of an official expedition 'for the investigation of the up-country districts of Cameroon,' I reached Cameroon on November 6 last, and thence I proceeded eastwards with forty Bakwiri porters (from the Cameroon Mountain) on the large main road leading to the interior over the magnificent slopes of the Cameroon Peak. I penetrated through the immense virgin forests, which are peopled with elephants, and in which coffee, india-rubber, &c., grow, and and safely reached the interior of our colony, never before visited by a white man on account of the energetic resistance offered to all traders by the natives. Here live the Bafarami in the Bafon Land, hitherto not even known to the world by name. They cultivate the soil and keep cattle, and are comparatively civilised. I visited Kumba and Kimendi, their large towns, but on account of an attack made upon us by 500 armed slaves I could not see the upper Calabar, which must have been quite near. The maps hitherto existing of this interesting district, which may be of the highest importance for the whole future of our colony, are either insufficient or else quite wrong."

THE SUN AND STARS[1]

WHEN we have to consider the stars taken in their entirety, it is obviously convenient that we should begin with the sun, because in that way we shall be enabled to go outwards from the known; since it is easily to be understood that it is within

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes.

our power to know very much more about the sun, which is the star that lies nearest to us, than about the other stars, so far as detailed structure, at all events, is concerned, for the reason that the sun, although actually so far away, is relatively very near to us.

The Sun's Distance[1]

The distance of the sun we may take to be about 93,000,000 of miles, and, although that seems a long way in terrestrial reckonings, twice that distance is the smallest base line which astronomers can use in dealing with the distance of the star which is next nearest to us, to say nothing of the millions of others more remote. The sun, from being relatively so near to us, appears as a body of a different order. The stars proper, however powerful the telescope with which we regard them, appear to us as the finest points imaginable, whereas the sun gives us the appearance of a circular disk, this disk being the projection of a sphere. That part of the sun with which we are most familiar is in fact a sphere of something like 860,000 miles in diameter; hence, taking the diameter of this world of ours roughly at 8000 miles, the diameter of the sun is more than 100 times as great.

The moon, the nearest celestial body to us, journeys round us at the relatively small distance of about 240,000 miles. The

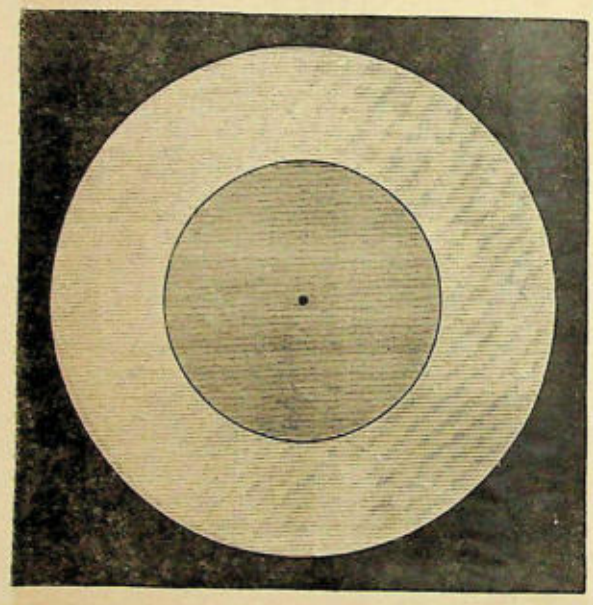


FIG. 1.—The orbit of the Moon and the circumference of the Sun compared.

accompanying drawing will enable us to compare the orbit or path of the moon round the earth and the space which it incloses, with the actual circumference of the sun (Fig. 1).

In the centre we have the earth very much larger than it ought to be, and the inner disk represents the space included in the orbit of the moon. The outer one represents the disk of the sun; so that it is clearly seen that if the sun were a soap bubble it would be quite easy for the earth's attendant satellite, the moon, to carry on its revolution inside it; in fact the orbit of the moon would not lie very much past half-way from the centre of the earth to the circumference of the sun.

The Sun's Envelopes

The next point which has been made clear by the work of the last quarter of a century, let us say, is that this central nucleus which we see ordinarily and call the sun, is only, after all, a very small part of it. Outside it there is a shell very exquisite in colour. This might be described as a sort of sea surrounding the central nucleus, if that expression did not give the idea that the nucleus itself was a solid, which it is not.

This first envelope, the *chromosphere*, as it is called, represents a sort of atmosphere or sea surrounding what is named the *photosphere*, to a height varying, say, from 5000 to 10,000 miles. I have said that it is exquisite in colour. It is of an intensely brilliant pearly white at the base, and of a magnificent scarlet, as a rule, higher up. But this is not the outside of the sun by any means. Further from the centre, again, there is another region, which we may call the inner corona, overlying the photosphere and chromosphere; the height of this atmosphere—I mean the distance from the top of it on the average down to the photosphere—we may again roughly take at something like 100,000 miles. Not very many years ago, in the text-books we were told that the earth's atmosphere only extended to a height of 50 miles, so that it can be easily recognised that we are dealing with an atmosphere on a very large scale indeed when we come to touch the sun.

These portions of the sun's atmosphere are only very rarely seen under the best conditions. We can feel, so to speak, the lower reaches every day in our observatories, but we can only see them when the sun is eclipsed. When, in an eclipse, we can get a good sight of the inner corona, what we see is very beautiful indeed, because we not merely get a pearly shell of light, which, roughly speaking, may be taken to be 100,000 miles high, but we see stretching into it from and through the chromosphere beautiful and curious objects called "red flames," or "prominences," or "protuberances."

Have we yet finished with the solar envelopes? No; there is still another. There is still an upper atmosphere, and to this I must ask you to give a height of anything you like between half a million of miles and a million and a half; and I speak thus indefinitely for the reason that the exact limit is at the present moment occupying those who are concerned in these matters. The limit of course you will understand is a limit which can only be determined during eclipses. Now the sun is only eclipsed for something less than a week in a whole century over the whole earth, and I suppose that if an observer of eclipses were to give his whole time to them he could not spend more on the average than six minutes every two years, so that the time is not excessive in which the astronomer either has to make observations or to make up his mind as to what he sees. You must not, therefore, be surprised when I give you this large choice. If we call it roughly a million of miles, we at all events shall not be very far off the truth, even supposing the height to be constant; but it would appear indeed that the height varies every time we have a chance of observing it. On that point we shall have a great deal to say further on.

When we come to this outer atmosphere, we pass from one with a more or less concentric boundary, to one with a most irregular outline, full of strange forms varying in an almost inexplicable manner from eclipse to eclipse.

In the eclipse of 1878 one of the observers who took special precautions to shield his eye from any brighter light at the moment that the eclipse took place, imagined, or saw, the fainter portions of the solar corona, or some solar surrounding, extending to several diameters. The outer corona is not only very strange in its appearance, but wonderful in colour, and full of detail for a considerable distance from the dark moon.

To sum up some of the principal points—by no means all of them—we may say, first, that its outline is very irregular; that there seems to be a flattening, or very often two opposed flattenings, at opposite ends of a solar diameter. This tends to make the thing look very often more or less square. In all parts of it, irregularly (by which I mean that you cannot predict quite where they will be), you get radial rifts in which the light is much less intense than elsewhere.

I have, then, indicated that the sun that we see is not the whole of the sun. Hence, when we study the stars we shall probably find that we have not only to take into account the phenomena presented by the sun as we ordinarily see it, but others associated with those parts of the sun which are only revealed to us from time to time, and the possibility that such phenomena as we see on the sun may be enormously intensified in other bodies.

The Sun's Rotation

The next question that we have to put concerning the sun is this:—Since it is a sphere as the earth is, and since the earth rotates on its axis, does the sun rotate on its axis? How are we to answer that question?

[1] The most recently determined value of the sun's distance depends upon Prof. Newcomb's determination of the velocity of light. This velocity Prof. Newcomb values at 299,860 kilometres per second, with a probable error of 30 kilometres either way. Combining this with Nyrén's value of the constant of aberration 20".492, the solar parallax = 8".794, which gives a distance of 149·61 millions of kilometres. This equals 92,965,020 British statute miles.

In this way. Sometimes when we look at the sun it is a beautifully pure hemisphere, almost equally illuminated all over it with the exception of a darkening towards the edge, about which more presently; but at other times these conditions are altered. It is more or less covered with what are called spots. It is more than two centuries and a half ago since it was clearly demonstrated that these spots belong to the sun itself; and it will be clear, therefore, that if these spots really do belong to the sun, or, to be more precise, are phenomena occurring in the photosphere—which is the part of the sun which we usually see, the rotation of the sun will be demonstrated if these spots are found to travel regularly across its disk; whereas its fixity will be demonstrated if we find that the spots do not move at all. A very great deal of work has been done in this direction, and it has been determined beyond all question that the sun does rotate like the earth and like the other planets of our system, and that it rotates from west to east, contrary to the hands of a watch, as the earth does.

We next have to consider the plane of this rotation. The earth moves round the sun in a plane which we call the plane of the ecliptic; but we know that the earth does not rotate in this plane. There is a difference of 23½° between the equatorial and ecliptic planes. We therefore say that the earth's axis is inclined 23½° to the plane of the ecliptic. Further, if we wish to know the particular direction in which it is inclined, we must determine the longitude of the ascending node, and this done, we can determine the star towards which the earth's axis points.

Well, can we get out these facts with regard to the sun? Yes. The sun does not rotate in the plane of the ecliptic as we might first of all imagine that it would do. Its axis is inclined at about 7° to that plane, and its ascending node does not lie in the same direction in space as the ascending node of the earth, but it is distant from it some 73°. We have two very accurate determinations of these two sets of data. Carrington's first value gives—

Longitude of node	73°	40′
Inclination	7	15

We see, although the sun's rotation does not take place in the plane of the ecliptic, it does not take place in a plane very far removed from it.

Spörer, a German observer, who has taken up this question since Carrington, makes some very slight changes. He gives—

Longitude of node	74°	36′
Inclination...	6	57

The right ascension of the star towards which the sun's pole points is 18 hours 14 minutes, and its declination 64° N. It lies half-way between our own pole star, and the bright star α Lyræ.

We may now carry these considerations a little further. When the earth passes through the nodes of the sun's equator, that is

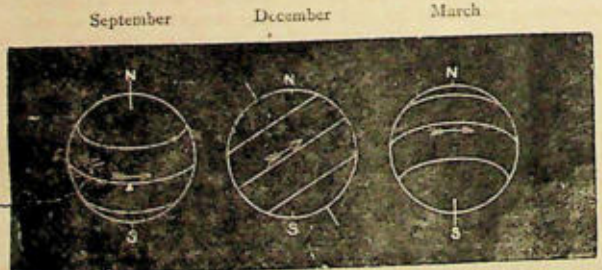


FIG. 2.—Position of the Sun's axis, and apparent paths of the spots across the disk, as seen from the Earth at different times of the year. The arrows show the direction in which the Sun rotates. The inclination of the axis is exaggerated, so that the effect produced may be more clearly seen.

to say, when the axis of the sun is at right angles to the line joining the centre of the sun and the centre of the earth, it will be perfectly clear that the spots will appear to travel straight across the disk. The two times of the year in which this occurs are June 3 and December 5. The two poles of the sun at those times are in fact on the sun's limb, and it is that condition really which makes the path straight (Fig. 2).

From June 3 to December 5 the north pole of the sun is gradually moving earthward. It will be clear, therefore, that during that time the spots, instead of travelling in straight lines across the disk, will gradually have their paths curved with the convexity downwards. When we have got to December, from that time to the next June it is the south pole that will be inclined towards the earth; and therefore the spots will then move with the convexity of their paths upwards.

So far I have said nothing about the period of the rotation of the sun. The question of the sun's rotation is not quite such a simple matter as it might appear at first sight. Here we must be quite honest to the first workers, and I must tell you that the actual facts appear to have been clear to a man who lived three centuries ago—Scheiner—who was the first to observe the spots with any very great and continuous care; he made what appeared to him the extraordinary discovery that the spots which were nearest to the sun's equator appeared to travel at a quicker rate than those which were nearer the sun's poles. The average time in which the spots appear to cross the sun is about 28 days. That you will understand is what we may term the

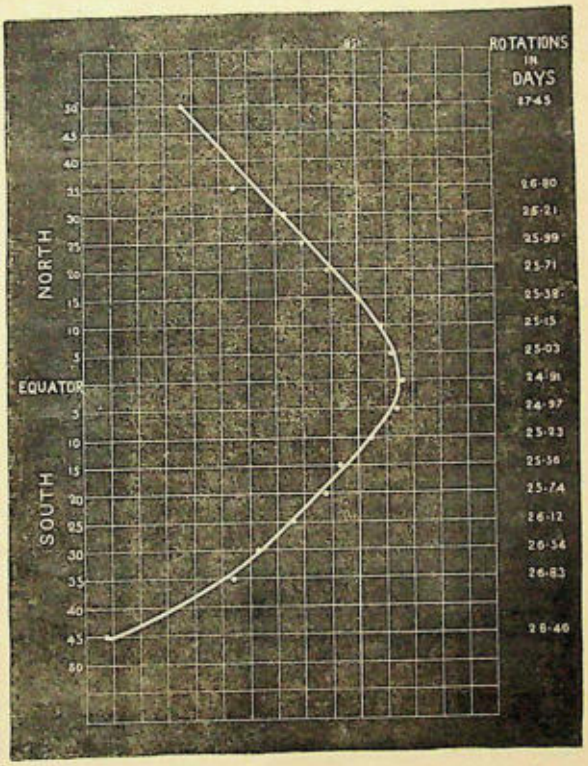


FIG. 3.—Curve showing the period of rotation of the photosphere in different latitudes north and south from Carrington's observations; 851′ of solar longitude per diem = rate of rotation in lat. 15° N. The vertical lines represent differences of 10′ of longitude, + to the right, − to the left, of the line cutting the curve in lat. 15° N.

synodic period, because the observations are made from the earth, which is moving in the same direction as the spots while the observations are being made. Making the correction for the movement of the earth, and getting the actual period, the 28 days have to be brought down to something like 26 for an average spot. Carrington, whose results for the plane of rotation I have already stated, also paid very great attention to this point, and to his work, and also to Spörer's, we owe very much of our present knowledge on this subject.

Carrington, from the observation of some thousand spots, came to the conclusion that the photosphere in which these spots are supposed to float really moves more rapidly at the equator than it does away from it, in the manner that Scheiner had suggested, in such a way that the movement at the equator really takes place in, as near as may be, 25 days, perhaps a little less; but that in latitude 30° there is a slackening off of a day and a half, so that it takes a spot in latitude 30° north or south not 25 days, but 26½ days to make its movement right round; if we go as high as latitude 45°, we have to add on

still another day, and then we find that the rotation takes 27½ days.

Several distinguished men have endeavoured to formulate a law, a mathematical statement, by which, given the movement in one latitude, we may determine it for all other latitudes, and several of them have very nearly succeeded in doing it; but they all confess that it does not amount to much at the end of the chapter; by which I mean that the formula after all contains no physical basis. It is what is termed an empirical formula.

The formulæ to which I have referred may be given in this place. In them all x = daily motion in minutes of solar longitude, and l = latitude. They are as follows:—

Carrington ... ... $x = 865' - 165' \sin^2 l$

Faye ... ... $x = 862' - 186' \sin^2 l$

Spörer ... ... $x = 1011' - 203' \sin (41^\circ 13' + l)$

Zöllner ... ... $x = \dfrac{863' - 619' \sin^2 l}{\cos l}$

Certainly we have here, as I think I shall be able to show you by and by, one of the points in the mechanism of the sun which it behoves those interested in solar physics to work at with the utmost diligence.

We have now got the fact that the sun, like the earth, rotates on its axis; that the inclination of its axis to the plane of the ecliptic is much less than the inclination of our axis; that its node lies in a different longitude; and that the photosphere, instead of being a solid thing like the surface of our earth, is a something which makes its journey round the sun's centre in 2½ days less time in the central portions than it does half-way between the equator and the poles.

The Sun's Density

Now then let us come to another point. We are accustomed, in dealing with the earth and comparing it with other planets, to refer to the density of the various bodies. We say, for instance, that the density of the earth is 5½ times greater than the density of water; that is to say, that the earth put in one scale would weigh down 5½ earths of the same size, if they were made of water, put in the other. And we say, further, that the density of the earth is about the same as the density of Venus and of Mars; but the density of the other planets is very much less. We know on the earth that water is less dense, for instance, than mercury. We know that spirit is less dense than water. We can, indeed, put water in a tumbler, and by proper means add the spirit so that it will float on the top of the water. We do not generally do that. Again, we put lead into water, and it sinks. We put a cork into water, and it floats. All these represent different orders of density. The same thing happens with regard to gases. We know that hydrogen is less dense than oxygen and nitrogen, and so on.

Now, what is the density of the sun? Is the sun denser than the earth? No; according to the books it is just about a quarter as dense as the earth, so that it is a little denser than water. In fact, if we take water as our unit of density, if water equals 1, the density of the sun is 1·444. If we take the density of the earth as 1, then the value is about 0·25—practically, a quarter.

Now, these are the values given in the books, but I think that possibly we must call them in question. They have been determined by taking the volume of the sun as given by the diameter of the photosphere—860,000 miles. Now, we have had to concede 100,000 miles for the height of one atmosphere above the photosphere, and 1,000,000 miles for another, and it is not fair that those atmospheres should be left out of consideration. If we include these atmospheres, though we do not alter the mass, we alter the volume. If we put the same mass into a bigger volume, we naturally reduce the density. Now, if we take the atmosphere of the sun as extending to 100,000 miles above the photosphere, that will give us a radius of 530,000 miles, instead of 430,000 miles, and we shall, as nearly as may be, double the sun's volume. Therefore we shall have halved the density. Instead of being a quarter as dense as the earth, it will only be one-eighth as dense; and, instead of being just denser than water, it will be a little over half the density of water. For my own part, I think that this 100,000 miles is not sufficient. I think that it is the minimum. I think that most students of solar physics would agree that a height for this purpose of 500,000 miles above the photosphere would be probably nearer the mark. That will give us exactly ten times the volume of the sun bounded by the photosphere, so that the densities will be reduced to the tenth; we shall get a density then of about one-eighth of water. This, of course, is the average density; it is the density of the whole volume in which the mass is supposed to be diffused—the mass which is a fact which we cannot get out of, and which has a definite relation to the mass of our own earth. Now if these arguments are of any value we must concede that the density of the sun is very low indeed, much lower than that of any planet or satellite with which we are acquainted; so that we are perfectly justified in saying that it is an enormous globe of gas, by which I do not mean that it is absolutely and completely gaseous to the core. The gases of the centre—gases under very great pressure—may put on the appearance, if they do not put on all the physical properties, of liquids; but be this as it may, in any region that we can get at, unfortunately limited to something like 400,000 miles away from the centre, we are undoubtedly dealing with masses of gas.

The Sun's Heat

Another point in which we find an enormous difference between the sun and any other body that we investigate in the solar system is this—that the sun is an *intensely heated* globe of gas. It is of no use to use any adverbs to tell you how hot it is, and, unfortunately, there are very few available facts; so that I must ask you to give your imagination play, and to believe that it is very, very hot. The values that have been suggested by various men of science vary between 18,000,000° and 3000°. You may take your choice. The fact is, I think, that we are not yet in a position to find out the very best method of determining the solar temperature and then marking it down in an absolutely perfect manner, for the reason that the more one knows about the problem, the more one sees how terribly complicated it is.

No doubt we have here a field of work of the very highest interest. Of course, when men of science have stated that the temperature of the sun is 18,000,000° or 3000°, they have referred to the temperature of that part of the sun which is available to our observation, and to the hottest parts of it. Naturally, if the sun be a heated globe of gas, on the outside it must be cool, so that they do not mean that this globe of gas is equally heated throughout, but that the hottest part of it—the part which sends us the effective heat which we try to measure—is at that temperature.

There is one other very interesting question connected with the remark that the atmosphere must cool to the outside. This time last century the idea was that the sun was a habitable globe just like the earth. An intense heat and light were granted to an exterior envelope, but it was imagined that there was a reflecting stratum inside which sent all the heat away earthward, and planet-ward, and star-ward with redoubled energy, while at the same time it shielded the inhabitants who were below this reflector from the direct light and heat of this envelope. That was Sir William Herschel's idea. We know now that these things cannot be so. If the walls, and ceiling, and floor of this lecture theatre were incandescent, you may depend upon it that, in spite of any number of reflectors we should soon be incandescent too. According to what is now known as Prevost's theory of exchanges, anything inside a heated chamber must, if you give it time, get to the temperature of the walls of that chamber, for the reason that the walls would be giving heat to the object inside, and the object would be sending the heat back again if it had a surplus of it, and you would get this exchange going on until the temperature of everything inside would be the same as the temperature of the envelope; so that we are now perfectly certain that, if the temperature of the photosphere of the sun, let us say, be 3000°, or 30,000°, or 3,000,000°, the temperature of the internal part of the sun will not be less. It may be much more. So that we have to give up all that beautiful idea of the habitability of the sun by creatures like ourselves.

Now, if this mass of gas, a million and a half of miles in diameter, let us say, is coolest outside, and hottest at the centre—which I think you will grant—there must be a gradual increase both of temperature and of pressure towards the centre. The observations which have been made during eclipses indicate with sufficient definiteness that there is an undoubted increase of temperature towards the centre, and that the various appearances which we get at the photospheric level really mean that at this point, where the pressure is greater than at any superior level—as the pressure in London is greater than the pressure on the top of Mont Blanc—the temperature also is higher, as is indicated by the extreme brightness of the objects

seen, as compared with the dimming off of those parts of the solar atmosphere which are farther removed.

Now, can we watch this? Can we study it so that we can find out all about it? Well, not entirely. The photosphere which carries the spots to which I have referred allows us certainly to see the phenomena of the spots, but then it acts as a veil that prevents us seeing anything nearer the centre of the sun, whatever it is. It practically serves as a veil for all the underlying phenomena. Also, as I have mentioned, the outer corona is only visible for a few minutes in each generation; so that, when we attempt to watch the totality of the phenomena from the top of that magnificent radius down to that part of it which cuts the photosphere, there are difficulties of every kind supervening; we can only continuously and effectively study those regions of the atmosphere just above the photosphere, or in other words the phenomena included in the inner corona.

Absorption of the Sun's Atmosphere

But in addition to this there is something else that we can do, though this work is not so valuable, as its results are too general. We can study the general absorptive effect of the whole atmosphere above the photosphere by dealing with ordinary sunlight reflected from a cloud.

The three kinds of absorption which we recognise in spectrum analysis are these. First of all, we have a selective absorption which enables us to determine the presence of the incandescent vapour of any particular metal in the atmosphere of the sun.

Next it was pointed out in the year 1873[1] that the absorption of some elementary and compound gases is limited to the most refrangible part of the spectrum when the gases are rare, and creeps gradually into the visible violet part, and finally to the red end of the spectrum as the pressure is gradually increased. It looks very much as if all the permanent gases, or all gases and vapours at a temperature below that which enables them to give out bright lines or flutings, really possess this kind of absorption, and we know that the absorption of that kind at the sun is enormous, because the blue spectrum of the electric light is very much longer—six or seven or eight times—than the spectrum of the sun, because we get an ultra-violet radiation from the electric light which has been stopped in the atmosphere of the sun. As there are permanent gases in the sun's atmosphere the same conclusion is good for it also. If this absorption both here and at the sun were taken away, it is clear that the sunlight would be much bluer than it is at present. Prof. Langley, of the United States, who seems to be unaware of the results arrived at in 1873, has recently made the same announcement.

There is one other kind of absorption also. We have a general absorption—an absorption working equally upon all parts of the spectrum, which we may call general absorption in its true sense—such absorption, for instance, as we should get by mixing soot with water or smoking a glass and holding it in front of the sun—this would cause a considerable dimming of the light.

We can make this general examination of the atmosphere of the sun by simply observing the spectrum of sunlight reflected from a cloud; but it will be readily understood that, although in that case we shall be able to study the indications of selective absorption and the absorption of the blue end of the spectrum due to such gases as chlorine, and the general absorption of the spectrum due to the existence of solid particles; it will still be an inquiry which will only deal with the matter in its most general aspect, and we shall not be able to localise the exact regions in which these absorptions take place. Further we may say that the result of this study of the absorption of the solar atmosphere taken as a whole is chemical and statical merely. There is nothing dynamical about it. It tells us most important facts concerning the chemical constitution of the sun's atmosphere, taken as a whole, without localising the region in which any particular substance which we find to be absorbing is absorbing; but it does not tell us whether this atmosphere of the sun, which roughly we may accept as about a million of miles high, is in violent movement, or whether it is at rest.

There is, then, very much more to be done before we are fully in presence of the causes of the phenomena to which I have called attention, which stare us in the face every time we look at the sun, either when it is eclipsed, or when it is not.

J. N. LOCKYER

(*To be continued.*)

[1] *Phil. Trans.*, 1873, vol. clxiv. part 2, p. 471.

SCIENTIFIC SERIALS

THE numbers of the *Journal of Botany* for January and February contain no papers of very great importance. Messrs. H. and J. Groves record the addition of two new species to the British Characeæ: *Chara intermedia* and *Nitella capitata*, with figures of both.—Mr. J. G. Baker attempts to trace the relationship between the British and the Continental forms of the difficult genus *Rubus*.—Another addition to the British flora is recorded in *Equisetum litterale*, by Mr. W. H. Beeby.—Most of the other articles relate to descriptive or geographical botany.

THE most important paper in the *Nuovo Giornale Botanico Italiano* for January is an account by Sig. F. Morini of a new disease of cereal crops caused by the attacks of a hitherto undescribed parasitic fungus, *Sphærella exitialis*, allied to *S. graminicola* and *S. Tassiana*.—Sig. Pichi investigates the nature of the reddish-brown spots on the stem of *Bunias Erucago*, which he finds to come under the head of glandular emergences; and Sig. Cavara describes some singular anomalies and monstrosities in the flowers of *Lonicera*.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 14.—"The Coefficient of Viscosity of Air." By Herbert Tomlinson, B.A. Communicated by Prof. G. G. Stokes, P.R.S.

The author employed the torsional vibrations of cylinders and spheres, suspended vertically from a horizontal cylindrical bar, and oscillating in a sufficiently unconfined space. The bar was suspended by a rather fine wire of copper or silver attached to its centre, which, after having been previously subjected to a certain preliminary treatment with a view of reducing the internal molecular friction, was set in vibration.

The coefficient of viscosity of air was obtained from observations of the diminution of the amplitude of vibration, produced by the resistance of the air to the oscillating spheres or cylinders attached to the horizontal bar, arrangements having been made so that the vibration-period of the wire should remain the same, whether the cylinders or spheres were hanging from the bar or not. In deducing the value of the coefficient of viscosity from the logarithmic decrement, the author has availed himself of the mathematical investigations of Prof. G. G. Stokes.[1]

Five sets of experiments were made with hollow cylinders and wooden spheres, in the construction and measurement of which considerable care was taken. When the cylinders were used arrangements were made to eliminate the effect of the friction of the air on their ends. The following are the results:—

Cylinders

Length in centimetres	Diameter in centimetres	Vibration-period in seconds	Temperature of the air in degrees Centigrade	Coefficient of viscosity of the air in C.G.S. units
60·875	2·5636	6·8373	12·02	0·00018171
60·885	0·9636	7·0590	14·63	0·00018122
60·875	2·5636	3·0198	11·69	0·00018024
53·175	2·5636	2·9994	10·64	0·00017845

Spheres

	6·364	2·8801	9·35	0·00017820

Maxwell has proved[2] that the coefficient of viscosity of air is independent of the pressure and directly proportional to the absolute temperature. We can, therefore, calculate from the above data what would be the value of the coefficient of viscosity at 0° C.; and when this is done, in the case of each of the five sets of experiments, we obtain the following values:—

Set of experiments	Coefficient of viscosity of air at 0° C.
1st	0·00017404
2nd	0·00017201
3rd	0·00017284
4th	0·00017359
5th	0·00017230

The mean of these numbers is 0·00017296 with a probable

[1] See Prof. Stokes's paper "On the Effect of the Internal Friction of Fluids on the Motion of Pendulums," *Trans.* Camb. Phil. Soc., vol. ix. Part II., 1850.

[2] *Phil. Trans.*, 1866, vol. clvi. Part I.

error of only 0·14 per cent. The formula for finding μ_t, the coefficient of viscosity of air at the temperature $t°$ C., is therefore—

$$\mu_t = 0{\cdot}00017296\left(1 + \frac{t}{273}\right).$$

The value of the coefficient of viscosity of air at 0° C., given above, though much nearer to that obtained by Maxwell than any which has been got by other observers, nevertheless differs from it by more than 8 per cent.[1]

January 28.—"On Local Magnetic Disturbance in Islands situated far from a Continent." By Staff-Commander E. W. Creak, R.N., F.R.S.

It has long been known that local magnetic disturbance has been found to exist to a considerable extent at St. Helena, Bermuda, and other islands. Observers in the islands adjacent to the west coast of Scotland have also found local disturbance existing in them, and, in order to determine its amount, have obtained normal values from curves of the magnetic elements calculated from neighbouring regions where observations have been made apparently free from magnetic disturbance.

In the case of islands situated far from a continent, however, normal values of the three magnetic elements may be obtained by the method of turning the ship in azimuth and observing on eight or more equidistant points of the compass in the process called "swinging," whereby the effects of the horizontal disturbing forces proceeding from the iron of the ship may be eliminated, and by occasional observations at well-selected land stations known to be free from local magnetic disturbance, the values of the vertical magnetic forces caused by iron in the ship may also be ascertained for all latitudes, and the necessary corrections applied to the observations.

A series of magnetic observations have been made on land in Bermuda, Madeira, Teneriffe, St. Vincent (Cape de Verde), St. Paul Rocks, and Sandwich Islands in the northern hemisphere and Tristan d'Acunha, Ascension, St. Helena, Kerguelen Island, New Zealand, and Juan Fernandez, in the southern hemisphere. The observations made in these several islands have been collected for this paper and compared with the normal values as observed at sea in their neighbourhood.

Throughout the discussion the term "blue" magnetism has been adopted to indicate that kind of magnetism which attracts the marked or north-seeking end of the needle, and "red" for that which repels it.

At Bermuda the most extensive series of observations has been made, and a strong focus of blue magnetism found to exist between Mount Langton and the lighthouse on Gibbs Hill.

The position of this focus was approximately defined by drawing, on a map of the western portion of Bermuda, lines of equal values of the disturbance from the normal for each element, and it was found that at one position eastward of this focus the westerly declination was increased 2° 39′, and at another, westward of it, diminished by 3° 5′. The disturbance of the inclination and vertical force gradually increases as the focus is approached, amounting in the inclination from +0° 11′ to 1° 47′, and in the vertical force from zero to +·314 (British units).

Bermuda may be taken as an example of the results generally found in the other islands under discussion, for the observations show that, north of the magnetic equator, the north point of the compass is invariably attracted inland towards some part of the island, and south of the magnetic equator it is repelled, showing marked divergence of results between observations made on the east and west coasts. The inclination and vertical force are, with rare exceptions, increased in the islands on both sides of the magnetic equator.

On the whole the local disturbances are not very large, but it may be remarked that they render the comparison of observations at different epochs very doubtful in value, unless the precise position of observation be rigidly adhered to.

Before dismissing the question of the actual observation, the results obtained at the Bluff, Bluff Harbour, New Zealand, are worthy of note—

Declination observed	On the summit of the Bluff	...	6 54 E.
	30 feet north	,,	... 9 36 W.
	,, west	,,	... 5 4 E.
	,, east	,,	... 46 44 E.
Normal from sea observations		... ...	... 16 20 E.

[1] Prof. Stokes, in a note at the end of the paper, has shown that a very small deviation from horizontality of the movable disks used by Maxwell would make the value of the coefficient obtained by him 8 per cent. too great.

On the summit of the Bluff there was thus shown to be a strong focus of red magnetism.

The general results tend to show that the magnetic disturbance in islands north of the magnetic equator is due to an excess of blue magnetism, and in those south of it to an excess of red magnetism compared with that due to the respective positions of the islands on the earth considered as a magnet.

In Sir G. Airy's treatise on magnetism, reasons have been given for believing that the magnetism of the earth is not due to sources external to it, nor specially existing on its surface, but that the source of its magnetism lies deep.

With these reasons in view, and the results obtained from the observations discussed, the possible conclusion is drawn that the excess of "blue" and "red" magnetism observed in the islands above-mentioned proceeds from portions of those islands which have been raised to the earth's surface from the magnetised part of the earth, forming the source of its magnetism.

For the numerical data upon which the preceding remarks have been founded, and descriptive map of the Bermuda magnetic disturbances, reference should be made to the original paper.

Linnean Society, February 4.—Sir John Lubbock, Bart., President, in the chair.—Mr. J. Dallas, of the Exeter Museum, exhibited a specimen of the somewhat rare glossy ibis (*Plegadis falcinellus*, L.), obtained from Mr. J. H. Clyde, of Bradsworthy Vicarage, Holsworthy, Devon, in whose possession it had been since killed in that neighbourhood, September 1851.—Mr. F. J. Hanbury showed a series of forms of the genera Hieracium and Carex gathered by him in Caithness and Sutherlandshire, all new to Britain, but representative of the Scandinavian flora.—Mr. C. Bartlett showed a remarkable African (?) caterpillar, 7 inches long, of a steel-gray colour, and abundantly hairy and spiny.—Mr. W. H. Beeby drew attention to an example of *Equisetum littorale* got by him on Bisley Common, Surrey, and hitherto not known as an English plant.—Mr. J. C. Sawer exhibited a sample of a superior sort of the essential oil of lavender and a spike of the plant, a cross-breed of varieties introduced by him from the Continent, and grown at Brighton.—Mr. A. Hammond showed a microscopic section of the integument of the larva of a dipterous insect (*Stratiomys chamæleon*), raising the question as to whether the polygonal areas of the cuticle, described by M. Villiane, were surface-markings only, or, as he held, cellular in character.—Mr. F. Darwin read a paper on the relation between the bloom of leaves and the distribution of the stomata. "Bloom" on leaves is used by him to mean a coating of minute particles of a waxy character, which is removable by hot water or ether. But gradations occur from a distinct and appreciable greasiness throwing off moisture to such as are easily wetted. A large series of leaves of different groups of plants have been studied by him, and for convenience in the analysis of data he has divided them into four classes. Leaves of Class I. are devoid of bloom on both surfaces, and yield 54 per cent. which have *no* stomata on the upper surface. In Class II. bloom is deficient above but present below, whereof 83 per cent. contain stomata on the leaves' lower surface. Class III. possesses bloom on the leaves above, but none inferiorly, and 100 per cent. of these have stomata on the upper surface. Class IV. have leaves with bloom on both surfaces, 62 per cent. of them having stomata above. From such analyses and other facts and data given, Mr. Darwin concludes that the accumulation of stomata accompanies that of bloom, and, other things being equal, that it is functionally protective against undue wetting by rain, and thus injury to the leaf-tissue.—In a communication by Mr. E. C. Bousfield, on the Annelids Slavina and Ophidonais, he criticises Herr Vejdovsky's new genus *Slavina*, and objects to his identification of *Nais appendiculata* and *N. lurida*, while giving a full description of the latter, and observing points of contrast. He also describes touch organs in Ophidonais, similar to those of Clavina, mentioning other points of similarity between the two. He further proposes to do away with the former genus, including its only species under Slavina.—Brigade-Surgeon E. Bonavio, in a paper afterwards read, asserts that the wild *Citrus hystrix*, D.C., is the grandparent of *Lima tuberosus*, *L. agrestris*, *Limonis feri*, *Limonellus auriarius*, and others, while also more distantly the grandparent of the cultivated true limes of India, Ceylon, &c. The reason why the lime has so persistently a winged petiole, according to him, is that this is derivative from the immense winged petiole of its progenitor *Citrus hystrix*.—Prof. Richard J. Anderson communicated a paper on the relative lengths of

the segments of limbs in the chick during development between the sixth and twentieth days. On or even before the ninth day, the bones of the fore-arm and manus are longer than the corresponding segments of the leg and foot. Afterwards the tarso-metatarsus begins to lengthen, and maintains a greater relative size at the end of incubation.

Zoological Society, February 16.—Dr. St. George Mivart, F.R.S., Vice President, in the chair.—Mr. Sclater exhibited a specimen of the new Paradise-bird, *Paradigernis rudolphi* of Finsch and Meyer, lately discovered by Mr. Hunstein in the Owen Stanley Mountains of New Guinea, and pointed out the characters in which it differs from typical *Paradisea*.—The Secretary exhibited, on behalf of Mr. Taczanowski, C.M.Z.S., the skin of an owl from the south-east of the Ussuri country, on the frontiers of Corea, which appeared to be referable to *Bubo blakistoni* of Seebohm.—Mr. E. Gerrard, Jun., exhibited heads and skulls of two African rhinoceroses (*R. bicornis* and *R. simus*), obtained by Mr. Selous in Mashuna-land.—Prof. Ray Lankester exhibited and made remarks on a drawing of a restoration of *Archæopteryx*.—Mr. Oldfield Thomas gave an account of a striking instance of cranial variation due to age, as shown in two specimens of the skull of the Canadian marten (*Mustela pennanti*), which presented extreme differences in the breadth of the zygomata, in the contraction of the interorbital space, and in the development of the occipital crest. Special stress was laid on the fact that such changes as these take place after the animal has attained maturity.—Mr. W. L. Sclater exhibited and described a new Madreporarian coral, which he proposed to call *Stephanotrochus moseleyanus*. The coral had been dredged in the Faroe Channel during the cruise of H.M.S. *Triton* in the summer of 1882. Some account of its anatomy and histology was also given.

Chemical Society, February 4.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following note was read:—The chemical formula for wool keratine, by Edmund J. Mills, F.R.S.—A lecture was delivered on methods of bacteriological research from a biologist's point of view, by Dr. Klein, F.R.S. The object of the lecture was to bring before the Chemical Society the methods used at present by pathologists in the investigations of micro-organisms associated with disease. These methods, thanks to the investigations of Koch, are greatly in advance of those hitherto employed by chemists in the investigation of the activity of bacteria. The enormous amount of work that has been done by chemists since the memorable investigations of Pasteur on fermentation and putrefaction, if viewed in the light of modern bacteriological methods, is in a great measure unsatisfactory and imperfect, more so than will be conceded by chemists. This unsatisfactory state is chiefly due to the imperfect methods employed. Specific chemical action is ascribed to certain organisms, because these were found present in the substances examined, no regard being paid as to whether these organisms were alone active or whether they were only concomitant and dependent on the activity of others. Numbers of instances can be adduced to prove this: amongst them may be mentioned the assertions that alcoholic fermentation is produced by *Mucor racemosus*, and also by a bacillus besides saccharomyces; that the ammoniacal fermentation of urine is due to a bacillus; that the lactic acid fermentation is due to a micrococcus and also to a bacillus. To determine whether a definite chemical process is produced by a definite organism, and which, it is necessary to prove (1) that the substances to be acted upon are at the outset free of any accidental organisms; (2) that the particular organism to which the definite chemical activity is ascribed is the only one concerned in this process. The methods used must fulfil these elementary conditions, that is to say: (1) the materials used must be sterile at the outset, and protected from accidental contamination; (2) the specific organism must be obtained in pure cultivations, and this purified organism must be capable of producing the specific chemical change. Viewed in this light, few of the assertions hitherto made bear criticism. As one of the most striking instances it may be mentioned that, notwithstanding the enormous amount of knowledge gained by chemical research into the changes of proteid bodies during putrefaction, there is no reliable answer yet given to the questions—Which organism or organisms are concerned in this complex process? Which part of the process is due to which organism? Is the analytical process by which proteids are carried down to relatively simple nitrogenous principles done by one or more organisms and by which? Is the production of the alkaloids known as ptomaines due to the same organism or organisms which started the process of putrefaction? Another equally important series of investigations refers to the process of nitrification; here also no definite answer can be given. So also the chemical changes due to the growth of moulds are waiting for investigation. When chemical research begins to adopt such methods as are employed by pathologists, but not till then, its results will be unequivocal. The methods used for sterilising materials, for studying and recognising the morphological characters of organisms, for obtaining pure cultivations, and for inoculating nutritive materials with them were then minutely described.

Physical Society, February 13.—Annual General Meeting. Prof. F. Guthrie, President, in the chair.—Prof. T. H. Huxley and Mr. A. E. Mills were elected Members of the Society.—The President read the report of the Council. The Treasurer, Dr. E. Atkinson, presented his report, which was adopted. The meeting resolved that votes of thanks be accorded to the Committee of the Council of Education, the President and Officers of the Society, and the Auditors of the Society's accounts. The meeting then proceeded to elect officers for the forthcoming year, and a ballot having been taken, the following were declared elected:—President: Dr. Balfour Stewart, F.R.S.; Vice-Presidents: Dr. J. H. Gladstone, F.R.S., Prof. G. C. Foster, F.R.S., Prof. W. G. Adams, F.R.S., Sir W. Thomson, F.R.S., Prof. R. B. Clifton, F.R.S., Prof. F. Guthrie, F.R.S. (the above have filled the office of President), Prof. W. E. Ayrton, F.R.S., Shelford Bidwell, M.A., Prof. H. McLeod, F.R.S., Prof. W. Chandler Roberts-Austen, F.R.S.; Secretaries: Prof. A. W. Reinold, F.R.S., and Walter Baily, M.A.; Treasurer: Dr. E. Atkinson; Demonstrator: C. Vernon Boys; other Members of Council: Conrad W. Cooke, Prof. G. Forbes, F.R.S.E., Prof. F. Fuller, R. T. Glazebrook, F.R.S., Dr. J. Hopkinson, F.R.S., Prof. J. Perry, F.R.S., Prof. J. H. Poynting, Prof. A. W. Rücker, F.R.S., Prof. S. P. Thompson, Dr. C. R. Alder Wright, F.R.S.—Prof. Guthrie, in resigning the position of President, thanked his colleagues for the help they had afforded him since he became President of the Society in 1884; he also congratulated the Society upon the highly satisfactory state to which it had attained.—The meeting then resolved itself into an ordinary meeting. In the absence of the President, Prof. Balfour Stewart, the chair was occupied by Prof. G. C. Foster.—The following communications were read:—On experimental error in calorimetrical work, and on delicate calorimetrical thermometers, by Prof. U. S. Pickering. In conducting a great number of determinations of the heat of dissolution of a solid body in water, the author has had an opportunity of detecting the sources of error incident on such work, and by an examination of the results has not only obtained the mean error of a series of observations, but has been able to apportionate this error to its various causes. In the experimental work it was found that the presence of anything but air between the calorimeter and jacket was most injurious; the space should be entirely open, and no cover of any sort should be used. Before reading the thermometers, as pointed out by Berthelot, the top of the stem should be tapped for some time, otherwise the mercury lags behind the true temperature; but besides this thermometric error, which the author calls the "temporary error," is another effect which may be termed the permanent error, of a similar kind, which no amount of tapping will remove. He has found and verified by special experiments that a thermometer when rising is invariably too low, while when falling it is invariably too high. Error due to this, which varies in amount with different instruments, is avoided by conducting the whole experiment with a rising or with a falling thermometer. The thermometers employed in these experiments had a range of 15° C., and a total length of 600 mm. The experiments were performed at temperatures varying from −1° to 26° C., and as it was important that the same thermometer should be used in different experiments, and even advisable to use the same part of the scale of the thermometer, the following expedient was devised: The thermometer was first heated to the highest temperature required in the experiment, and, by the application of a flame to the mercurial column just below the enlarged space at the end of the tube, that part of the mercury above the flame was broken off and driven into the space, where it remained when the thermometer was cooled. By this means the relative value of a scale division was only inappreciably affected, while the absolute value could be obtained from a single comparison with a standard. From an examination of the results obtained, the

author concludes that for further accuracy in this kind of work we must look for improvements in the methods employed, the instruments having, he believes, attained to a state as near perfection as possible.—On some new forms of calorimeters, by Prof. W. F. Barrett. These instruments were constructed for the accurate and ready determinations of specific heats, notably those of liquids. In the first form the bulb of a thermometer is blown into the form of a cup of about 4 cubic centimetres capacity, which thus acts as a calorimeter. Into this cup the liquid is dropped directly from a burette, its temperature being observed by a thermometer in the burette, the mouth of which is closed by the end of the bulb of the thermometer, which is ground, and thus acts the part of a stopper, so that, on raising the thermometer, the liquid flows from the burette into the cup. The thermometer itself forms a balance, the horizontal stem acting as the beam is supported by a knife-edge, and a pan is attached to the further end by the addition of weights to which the weight of liquid added can be ascertained. In the second form a simple thermometer with a large bulb is used, the latter dipping into a silver vessel, into which the liquid is introduced as before.—Prof. S. P. Thompson exhibited a glass calorimeter, similar in construction to that of Favre and Silbermann; water is used instead of mercury, the great density of which renders it unsuitable for use in so large a glass vessel.

Anthropological Institute, February 9.—Mr. Francis Galton, F.R.S., President, in the chair.—The election of Prof. Otio T. Mason, Prof. J. Ranke, Dr. G. Manouvrier, and Prof. J. Kollmann as Honorary Members, and of the Rev. W. Birks, J. G. Blumer, F. H. Collins, J. Spielman, and T. L. Wall, as Ordinary Members, was announced.—The President read a paper on recent designs for anthropometric instruments, and called particular attention to a number of instruments made by the Cambridge Scientific Instrument Company, and exhibited by Mr. Horace Darwin, who afterwards described them and showed the manner in which they are used.—M. Collin, of Paris, exhibited a traveller's box of anthropometric instruments and Topinard's craniophore.—Prof. A. Macalister read a paper on a skull from an ancient burying-ground in Kamchatka; and Dr. G. Garson read a paper on the cephalic index, in which he proposed a system of nomenclature for international adoption which has already been accepted in principle by several of the leading anthropologists on the Continent.

Royal Meteorological Society, February 17.—Mr. W. Ellis, F.R.A.S., President, in the chair.—Mr. G. Buchanan, Capt. G. H. Leggett, Dr. H. C. Taylor, J.P., and Mr. J. Tolson were elected Fellows of the Society.—The following papers were read:—General remarks on the naming of clouds, by Capt. H. Toynbee, F.R.Met.Soc. The author considers it important to keep to Luke Howard's nomenclature, leaving it to the observers to express by an additional word any peculiarity they notice in a particular cloud.—On the thickness of shower-clouds, by Mr. A. W. Clayden, M.A., F.G.S. From some measurements made by the author during the summer of 1885 he has come to the conclusion that clouds of less than 2000 feet in thickness are not often accompanied by rain; and, if they are, it is only very gentle, consisting of minute drops. With a thickness of between 2000 and 4000 feet the size of the drops is moderate. As the thickness gets greater, the size of the drops increases, and at the same time their temperature becomes lower, until, when the thickness is upwards of 6000 feet, hail is produced.—On the formation of rain, hail, and snow, by Mr. A. W. Clayden, M.A., F.G.S. The author points out that all observations tend to show that, except under quite abnormal conditions, the temperature of the atmosphere falls as the height above sea-level increases; and there seems no reason whatever for assuming that the law does not apply to that portion of the atmosphere which forms a cloud. Hence, if a drop were to be formed at or near the upper surface of a cloud, it would fall down into a region saturated with vapour at a temperature above its own. The result will be further condensation, producing a larger drop; and this process will continue until it leaves the cloud. If its temperature is below the dew-point of the air it falls through, condensation will continue until it reaches the ground. However, it is obvious that this subsequent gain cannot bear any very large proportion to the growth while falling through the saturated cloud, from which the conclusion follows that the size of the drop must increase with the thickness of the cloud. The author suggests that condensation begins on the upper surface of the cloud by the cooling of some of the liquid cloud-particles. If this particle is cold enough it will solidify, and snow will be formed. Should it not be quite cold enough to solidify at once, owing to its minuteness, but remain still below the freezing-point, hail is formed. Finally, if the temperature is not low enough for either snow or hail, rain is produced.—On three years' work, by the "chrono-barometer" and "chrono-thermometer," 1882-84, by Mr. W. F. Stanley, F.R.Met.Soc. The chrono-barometer is a clock that counts the oscillations of a pendulum formed by a suspended barometer. The upper chamber of the pendulum is a cylinder of an inch or more in diameter. By change of atmospheric pressure the mercury in the pendulum is displaced from the bottom to the top, and *vice versâ*. The rate of the clock is accelerated or retarded in proportion to the displacement of the mercury. The chrono-thermometer is a similar clock to the above, and the pendulum is also a barometer; but instead of the lower chamber being exposed to pressure, the whole tube is inclosed in a second hermetically-sealed tube containing air. Atmospheric pressure being thus removed, the expansion of the included air by heat alone forces the mercury up into the vacuum-chamber, and alters the period of oscillation of the pendulum.

Victoria (Philosophical) Institute, February 15. A paper on final cause, by Prof. Dabney, of Texas University, was read.

EDINBURGH

Mathematical Society, February 12.—Dr. R. M. Ferguson, President, in the chair.—Mr. William Harvey communicated several theorems in kinematics with geometrical demonstrations; and Mr. R. E. Allardice submitted a proof, by Mr. T. Hugh Miller, of Lagrange's theorem.

PARIS

Academy of Sciences, February 15.—M. Jurien de la Gravière, President, in the chair.—Discourses pronounced at the obsequies of M. Jamin, by M. J. Bertrand on behalf of the Academy, and by M. L. Troost in the name of the Faculty of Sciences.—Remarks on the 172 tornadoes recorded in the United States during the year 1884, by M. Faye. From the scientific point of view the author considers that it seems definitely established that there is a definite portion of an area of low pressure within which the conditions for the development of tornadoes is most favourable. The special tornado reporters for the Signal Service are now endeavouring still more accurately to determine this "dangerous octant," as it is called in America. February 19, 1884, is mentioned as memorable in the history of these destructive phenomena. On that day no less than forty-five were recorded in the South-Eastern States, attended with a total loss of 800 lives, 2500 injured, 10,000 houses and buildings destroyed, and from 10,000 to 15,000 people left homeless.—Note on a prophylactic means of protecting the vine by destroying the winter egg of Phylloxera, by M. P. de Lafitte. This plan has now been tried with considerable success during the last three years at three different places in the department of Lot-et-Garonne. The State aid granted for the purpose having long been exhausted, growers have been encouraged by these results to continue the experiments at their own expense.—On the periods of the double integrals, by M. E. Picard.—On the theory of reciprocants, by M. R. Perrin. It is shown that the new forms introduced by Prof. Sylvester into mathematical analysis may be considerably simplified by the employment of a few general theorems here communicated to the Academy.—Note on the polhodie and terpolhodie (continued), by M. A. Mannheim.—Spectroscopic observations on the new star discovered by Mr. Gore in Orion, made at the Nice Observatory by MM. Perrotin and Thollon. This star presents a fine line spectrum stretching far into the violet, the red and especially the green being remarkably brilliant, while the yellow appears relatively dull. This suggested a certain analogy with the spectra of comets, only much more complicated, and the idea was confirmed by subsequent comparative observations made on α Orionis, which shows a characteristic continuous spectrum intersected by dark bands and lines. Notwithstanding the faint yellow bands, the new star would therefore appear to be of the same type as α Orionis.—Note on the deviation of the equipotential lines, and the variation of resistance shown by bismuth in a magnetic field, by M. Leduc.—On the electrolysis of the salts: influence of temperature, of the distance and surface of the electrodes, by M. Adolphe Renard.—Observations in connection with M. A. Millot's note on the "Products of Oxidation of Carbon by the Electrolysis of a Solution of Ammonia," by

MM. A. Bartoli and G. Papasogli. To M. Millot's statement that he failed to find mellic acid and its derivatives in the electrolysed ammoniacal solution, it is pointed out that the failure was doubtless due to the fact that his experiments were not conducted under the same conditions as those of the authors.—Note on a combination of acetic ether and chloride of magnesium, by M. J. Allain le Canu.—On the influence of the acid oxalate of ammonia on the solubility of neutral oxalate, by M. R. Engel.—On the γ-bromo and iodobutyric acids, $XCH_2-(CH_2)_2-CO(OH)$, by M. Louis Henry.—Note on the affinities of the Eocene floras of the West of France with those of North America, by M. Louis Crié. The attention of geologists and botanists is here directed to certain fossil plants occurring in the Eocene sandstones of West France, which present evident affinities to several species of the lignitic group described and figured by M. Leo Lesquereux in his "Contributions to the Fossil Flora of the Western Territories" (Washington, 1878). *Pteris Fyensis*, Crié, *Lygodium Fyense*, Crie, *Lygodium Kaulfussii*, Heer, *Asplenium Cenomanense*, Crié, and others are compared respectively with *Pteris pseudopennæformis*, Lesq., *Lygodium Dentoni*, Lesq., *Lygodium neuropteroides*, Lesq., *Gymnogramma Haydenii*, Lesq., &c.—Note on the subject of atmospheric disturbances—M. Faye's theory of whirlwinds, by M. Jean Luvini. It is shown that the slight convergence of the current towards the centre of great cyclones, as appears determined by observation, would be more opposed to the theory of absorption than to M. Faye's gyratory theory. A slight convergence near the ground is in fact a natural consequence of the principles regulating the movement of fluids.

BERLIN

Physiological Society, December 11, 1885.—Dr. Gad spoke of an apparatus executed by him and set up in the demonstrating-room, designed to show the play of the valves of the heart. A short canula of 7 cm. in diameter was tightly fixed into the left auricle of a large bullock's heart, and the free end was closed in a water-tight manner by a plate of looking-glass. At the side of the canula was a short tube connected by an elastic tube with an upright bottle. A similar canula of 3 cm. in diameter was fastened into the aorta close over the semi-lunar valves, and its lateral tube conducted by an elastic pipe into a funnel through which the water flowing from the ventricle reached the bottle. A third canula was fastened into the apex of the heart, and connected with a thick-walled elastic ball, by the compressions and elastic expansions of which the vigorous operations of pressure and expansion required for the circulation of the water filling the apparatus were achieved. In the ventricle was placed a small Edison lamp, the conducting wires to which were, by means of a water-tight tube at the side of the third canula, directed outwards. When the elastic ball was rhythmically compressed, then the alternating play of the cardiac valves was seen through the two first canulæ, and, by means of a suitable mirror before the canulæ, might be exhibited to a large class.—Dr. Goldscheider reported on the results of an investigation into the nerve-endings at the pressure and temperature points, the existence of which he had demonstrated. In the expectation that specific terminal organs of the cutaneous nerves must, if they existed, be met with at the pressure points and points of cold and warmth, Dr. Goldscheider had cut out of his forearm, at the isolated pressure points and temperature points, small wedges of skin, and prepared them with arsenic acid and auric chloride, embedding in paraffin. Of the preparations he made a series of sections which in most cases showed longitudinal sections through the cutaneous nerves. The microscopical examination revealed that no Paccinian or Meissner corpuscles were situated either at the pressure or at the temperature points. On the contrary, the speaker found regularly at the pressure points, which he had previously marked by the prick of a needle, a bundle of medullated nerve-threads approaching close to the boundary of the corium. At this point the bundle split into two branches proceeding in opposite directions, and then further ramifying. These two divisions made their way mostly between the corium and epidermis, and but seldom penetrated as far as the second layer of the epidermis cells. So far as ends of the nerves were visible, they were situated between the cells and were pointed. On the temperature points a bundle of nerve-fibres were likewise seen to rise, but in this latter case they ended in a pretty narrow net of very fine, non-medullated threads, and never reached the epidermis. In the neighbourhood of the nets of the temperature nerves blood-capillaries were regularly met with. Dr. Goldscheider was of opinion that the cutaneous nerves possessed no specific terminal organs, but simply merged into narrower or wider nets, and that the sensitive points for pressure and temperature were situated at the spot where the terminal division of the nerve-bundles occurred.—Dr. Benda supplemented the address he delivered at the last meeting on spermatogenesis by hypothetical considerations regarding the significance of the microscopical figures found by him.

January 15.—Dr. Müllenhoff spoke of his observations respecting the structure of bee-cells. Producing specimens of combs and models, he handled the geometrical figure of the cells, the fact of which had been recognised so far back as the time of the Greek philosopher Pappus, and the measure of which had been taken by Réaumur, the cells forming a hexagonal column bounded on the side turned to the partition wall by a trilateral pyramid, on the other by a plain terminal surface. To account for the great regularity of the cells, Buffon had propounded that they originated in the mutual pressure of the wax-vesicles, and put this explanation to the proof by an experiment in which he filled up a vessel with peas, and stuffed the interstices with water, which caused the peas to swell. In point of fact the round bodies got thereby converted into precisely geometrical figures with trilateral terminal surfaces. They were, however, no hexagonal columns, but regular rhombendodecahedrons. Dr. Müllenhoff had now, by a long series of observations in beehives, studied the structure of the bee-cells, and had established that the bees, which, as was known, worked closely compacted together, first stuck a little thick wax disk to the wall, and then gnawed away at it till the plate had grown so thin that under the all-sided pressure, in accordance with the law respecting equilibrium figures of fluid membranes discovered by Plateau, they assumed the form of a half rhombendodecahedron with trilaterally pyramidal surfaces. The bees then proceeded to build on the six free edges by attaching to them small wax plates, and gnawing away at them till they had grown so thin that under the pressure of the neighbouring cells they took on the form of a hexagonal column. The column was made so long that the queen bee, in laying her eggs, rested with her posterior body on the floor of the cell, and, with her anterior legs, was able to take hold of the free edge of the column. The geometrically-regular figure of the bee-cells was accordingly conditioned by physical laws, and not by any knowledge inherent in the bees of geometrical laws in respect of the greatest economy of space and material. That without the co-operation of the Plateau laws the bees were able to achieve no regular cells was demonstrated by the queen-cells, which, constructed isolatedly, had the irregular form of a thimble.—Prof. du Bois-Reymond gave a short summary view of the investigations he had carried out in the past summer into living torpedoes, by means of which he had pretty well solved all the problems which were at all capable of being submitted to experimental test on the animals of the aquaria, which were very much reduced in strength and exhausted by inanition. Having first ascertained the direction of the cuticular current, he examined the polarisation-phenomena yielded by stripes of the electrical organ under the influence of foreign currents. He learned that homodromous currents, *i.e.* such as were directed in the same way as the direction of the shock, gave always a homodromous polarisation, while heterodromous currents never produced heterodromous polarisation, and only occasionally homodromous polarisation. This fact was capable of explanation by assuming that what appeared as homodromous polarisation was but a shock of the fish caused by the foreign current, a shock which of course could only be homodromous; or that the electrically polar molecules directed by the foreign polarising current were capable of being turned only in one direction. A decision between these two explanations could not be arrived at. Prof. du Bois-Reymond next examined the conductivity of the electrical organ, and ascertained that it conducted homodromous currents almost as well as did the muscle, but that it conducted heterodromous currents much worse, so that the electrical organ was almost half an insulator for heterodromous currents. The conduction power of the electrical organ of the torpedo was consequently irreciprocal. This irreciprocity of conduction obtained only for strong currents and for those of short duration. It was met with, moreover, only in the living organ. The defunct organ conducted considerably better than the living, and was equally good for the conduction of homodromous and heterodromous currents. The irreciprocity, finally, increased with the

length of the organ stripe. This irreciprocity of conduction explained in a most highly interesting manner the powerful effect of the strokes directed outwards of electrical fish. Let us suppose a column of the electrical organ reaching from the back to the belly, then would the electrical currents of the organ diffuse themselves at the positive pole surface of the back, and in accordance with well-known laws respecting the distribution of electrical currents in an endless conductor, betake themselves to the negative pole surface of the belly. Were the organ a good conductor of its currents, then would the most intense threads of currents balance themselves in the organ, and only very faint ramifications of current penetrate into the water. These currents, however, had a heterodromous direction in the organ, and were therefore ill-conducted. The most intense threads of current were forced therefore to penetrate into the water, and were accordingly able to produce vigorous effects outwardly. The speaker had finally examined a phenomenon in the powerful electric nerves of the torpedo, which he had earlier had occasion to observe in other nerves. If a piece of nerve were cut off and the electromotory energy of the two transverse sections determined, then did the electric nerves show that the peripherical cross-section acted in an electromotory sense more powerfully than did the central. If both cross-sections were derived, then was an ascending current received in consequence thereof. This occurred with such regularity that the peripheral and the central nerve could be recognised on any piece whatsoever by the direction of the axial nerve current, which was opposed to the direction of the physiological action. In the sensory nerves Prof. du Bois-Reymond had found a reverse axial current directed from the centre to the periphery. He had the phenomenon then further investigated by Dr. Mendelssohn, and it was quite generally established that centripetal active nerves, such as the nerves of the senses and the posterior roots of the spinal nerves, always showed a descending axial nerve current, whereas centrifugal active nerves, such as the motory and the electric nerves, possessed an ascending axial nerve current. In the case of mixed nerves an axial nerve current could not be decidedly demonstrated.

Meteorological Society, January 12.—Dr. Hellmann laid before the Society in the form of a table, the results of the rain registration at the eleven stations to the west of Berlin for the six months from July to December, and drew attention to the fact that in the winter months the values yielded by the different rain-gauges coincided very closely, whereas in summer differences reaching as much as 50 per cent. occurred.—Herr Opel spoke of the quantities of water discharged by rivers, and in particular by the Elbe. In view of the great difference prevailing in the registrations of the amounts discharged at high water, it deserved to be noted as an indication of important progress that Herr Sasse, on the basis of a careful special investigation of the subject, had formulated the proposition that the curve of the quantities of water discharged formed a parabola to the high-water marks as abscissæ, but that the zero-point of the parabola lay deeper than the zero-point of the water-mark. From a long series of examples the author demonstrated the correctness of the formula, and directed attention to several singularities in the quantities of water discharged by the Elbe at various stations of its course through Germany, singularities which, while in part explicable by the tributaries, demanded further investigation. The speaker then discussed the question of the volumes of water in rivers, on which in quite recent times several scientific investigators had expressed an opinion to the effect that they had diminished in comparison with the volumes of water in the rivers last century. This diminution of volume was in large part attributed to the progress of the denudation of forests in the river districts. Herr Opel was, however, of opinion that these registrations of the rivers were rather related to the present well-ascertained lower state of the rivers at low water. Since at many places the beds of the rivers had, altogether irrespective of their profile, been enormously narrowed, the rivers at high water had, in consequence, dug themselves out a deeper channel, and in this way depressed the mass of waters. Rain returns did not, at all events, testify to any diminution in recent times in the supply of water. The observations on the amounts discharged by the rivers of Prussia have hitherto rested on very unsatisfactory bases. At a number of stations daily observations of water-marks were made. The average of these was then taken, and the monthly and yearly averages of these water-marks were used as a basis for the calculation of the monthly and yearly discharges. Seeing, however, that the amount of water discharged represented a parabola, it was impossible to calculate it from the height of the state of the water alone. The amounts of water corresponding with the average water-marks deviated, as was shown in a number of instances, very considerably from the average of the water volumes corresponding with the several high-water marks. Another source of error lay in the circumstance that the observations of water-marks were made only once a day, from which observations the monthly and yearly averages were deduced. In view, however, of the repeated and often important variations in the states of the water, once-a-day observations were really of little value. Hourly observations even would not suffice. What is required are self-registering gauges of the states of the water, as being the only means whereby to obtain trustworthy values for the amount of the river-discharges. Over and above this, in the case of the larger rivers, measurements of their respective quantities at low, mean, and high water should, every few years, be very carefully made and the parabola determined, from which the quantities discharged could then be calculated from the registered high-water marks with some degree of certainty.

BOOKS AND PAMPHLETS RECEIVED

"Class-Book of Geology": Dr. A. Geikie (Macmillan and Co.).—"Trigonometry for Beginners": Rev. J. B. Lock (Macmillan and Co.).—"Fourth Annual Report of the Board of Control of the New York Agricultural Experiment Station for the Year 1885" (Andrews, Rochester).—"The Co-operative Index to Periodicals," vol. i. No. 4 (New York).—"Hints for Land Transfer and a State Land-Bank": Nemo.—"Revista di Artiglieria e Genio," vol. i. (Roma).—"The Star-Guide": Latimer Clark and Herbert Sadler (Macmillan and Co.).—"The Artist's Manual of Pigments": H. C. Standage (Lockwood and Co.).—"Observaciones Magnéticas y Meteorológicas del Real Colegio de Belen de la Compañía de Jesus," January to March, April to June, 1885 (El Iris, Habana).—"Scientific Results of the Second Yarkand Mission—Aranelida": Rev. O. P. Cambridge (Government Printing-Office, Calcutta).—"The Comparative Anatomy of the Pyramid Tract": E. C. Spitzka (Jenkins, New York).—"Science for Nobleness, for Knowledge, and for Use": Sir H. W. Acland (K. Paul and Co.).

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THURSDAY, MARCH 4, 1886

THE ZOOLOGICAL RESULTS OF THE "CHALLENGER" EXPEDITION

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 under the Command of Capt. G. S. Nares, R.N., F.R.S., and Capt. F. T. Thomson, R.N. Prepared under the Superintendence of the late Sir C. Wyville Thomson, F.R.S., &c., and now of John Murray, one of the Naturalists of the Expedition. Zoology—Vols. XI., XII., and XIII. By N. Poléjaeff, M.A., P. Herbert Carpenter, D.Sc., Frank E. Beddard, M.A., Prof. William C. McIntosh, Edgar A. Smith, Dr. E. Selenka, and Prof. G. O. Sars. (Published by Order of Her Majesty's Government, 1885)

DURING 1885 three new volumes of the Zoological Series of Reports have been published. Of these, Part 32 of Vol. XI., "On the Stalked Crinoidea," by Dr. P. Herbert Carpenter, has already been noticed in our pages (NATURE, vol. xxxi. p. 573). The others we now proceed to notice.

Part 31 is a "Report on the Keratosa," by N. Poléjaeff, M.A., of the University of Odessa. The Keratose sponges do not belong to the deep-sea fauna. It is therefore not to be wondered at that the total number of species collected during the cruise of the *Challenger* should have been only 37. It is, however, a little surprising that of this number 21 should be new. The collection embraced forms belonging to almost all the genera of the Keratine sponges hitherto distinguished, and the specimens were for the most part well preserved.

The Report opens with a chapter on the organisation and classification of the group. The subject of the classification of the group is undeniably a difficult one. In no section of the animal kingdom is there a greater danger of describing individuals instead of genera and species. The student has no palæontological data to refer to; embryological details so far as these are known do not help him much; minute anatomy gives but few distinctive characters, and so he is obliged to depend on general anatomical details. When the author acknowledges, as he freely does, that this is so, one is not surprised to find the writers of the past—Duchassaing and Michelotti, Gray, Hyatt, and Carter—depending for their divisions on the properties of the skeleton; nor does one wonder that in their attempts they so often went astray. The division of the Keratosa into two groups, differentiated by having homo- and heterogeneous skeletal fibres, is characterised as thoroughly artificial. The subject of the presence of filaments is capable of no systematic application (the extremely interesting question of what these filaments are is discussed at length, no definite conclusion being come to; it is strange that they never seem to have been examined by a botanist). The presence of true cells in the walls of the skeletal fibres cannot at present be defined as of systematic value. Dr. Vosmäer's arrangement of a division into families, characterised by the properties of both the skeleton mass and of the soft parts is selected as the best possible for the present.

The history of these families and of the various genera placed therein is written with the greatest care and fairness. In agreeing with Hyatt (1875) that Ceratella and Dehitella of Gray are thoroughly sponge-like forms, and not, as Carter (1873) would have them, "nothing but hydroids or coral-like skeletons," he overlooks the fact that in the *Quarterly Journal of Microscopical Science* for January 1870 it is stated that the Ceratellidæ were undoubtedly a "family of arborescent Keratose sponges." The descriptions of the species are accompanied by ten plates of figures. This able Report concludes with a few pages on the subject of the affinities of the group.

Mr. Herbert Carpenter's "Report on the Crinoidea" forms Part 32, and is followed by a "Report on the Isopoda" (part 1), by Mr. Frank E. Beddard, forming Part 33 of the series. This portion of Mr. Beddard's Report relates to the genus Serolis, which occupies a foremost place among the Isopods collected. Of the 16 species collected nine are new. A discussion of the systematic position of the genus within the order Isopoda is postponed until the next Part of the Report, but with regard to the alleged affinity of the genus and of the Isopods generally to the extinct Trilobites, as insisted on by A. Milne-Edwards, the author has nothing to add to what has already been said; the examination of the species found during the *Challenger* Expedition having brought to light no facts which tend to show any close resemblance between the two groups. Of the 22 known species all but four are found at a depth of from 5 to 150 fathoms. Of the four deep-sea forms one is found at a depth of 675 fathoms, a second at depths between 400 and 1600 fathoms, a third between 400 and 1975 fathoms, and a fourth at depths of 600 and 2040 fathoms. In the two species from the latter depth the genus attains to its greatest size. It has evidently had its origin in the Southern Hemisphere, probably around the shores of the south polar continent. While the great majority of the species live in shallow water, the deep-sea forms are in all cases strongly marked; they also show certain peculiarities, notably in the structures of their eyes, which are often absent, but, when present, show great evidence of functional degeneration; indeed none of the deep-sea species possess well-developed eyes. The eye-structure of some of the species is given in great detail and is well illustrated on Plates IX. and X. Ten plates accompany this memoir.

Part 34 of the Zoological Series forms Vol. XII., a portly volume of over 550 pages illustrated by 93 plates. This valuable Report is by Prof. William C. McIntosh. It is on the Annelida Polychæta, and marks quite an era in the history of this group. In a short notice it is impossible to do justice to this laborious work, and we must content ourselves with briefly marking our admiration of the care and research that have been bestowed upon it. Of the species collected no less than 220 are described as new. It is noteworthy that the formation of no new family was required; all the forms fall into groups already constituted, and which have been so satisfactorily diagnosed by Malmgren that the diagnoses have not here been repeated, but a most useful synopsis of the families, genera, and species described is appended to the Report, with references both to the pages and plates. In many cases the food of the Annelids has been examined, and in the case of abyssal forms, it throws some light on the food-resources of the great depths of the oceans. In the North Atlantic Region a large number of forms

occur, and relatively few range to other areas, but this apparent distinctness in so vast a region is probably due to the comparatively unexplored condition both of it and the other oceans. Most of the genera are cosmopolitan in their range, but the remarkable new genus Buskiella is entirely confined to the abysses (2025 fathoms) of this and the South Atlantic. In the South Atlantic Region the two chief centres for specimens were the coast of Brazil and the Cape. In the South Indian Region one of the most striking features was the large proportion of species pertaining to Kerguelen. The abundance of Annelids in the deep water of the land-locked bays of this island was remarkable, and many new forms are described therefrom. In the Australian Region the types found were in many cases peculiar and novel; here the branched Syllis, one of the most remarkable discoveries of the Expedition, was found. In the Japanese Region a series of remarkable types were found, while comparatively few came from the North Pacific, and the majority of the specimens from the South Pacific came from the confined waters of the Straits of Magellan.

In regard to bathymetrical distribution, the greatest number of species occurred in the shallow water, 10 fathoms and under. The two regions ranging from 10 to 50 and from 50 to 100 fathoms have each about the same number of Annelids, and both are similar in respect to new forms. In the depth between 100 and 200 fathoms the number was less, but the proportion of new forms was much higher; while in depths between 200 and 500 fathoms almost all the forms were new, and many belonged to new and remarkable genera; between 500 and 600 fathoms the number fell to less than half that in the previous group, but the majority were new. The number found between 600 and 1000 fathoms include two known species out of a list of 14. The four species occurring between 1000 and 1200 fathoms are new. Those species found between 1200 and 1500 fathoms are more than five times as numerous as the last, and include only five known forms, most of which, however, are found in shallow water as well as at this great depth; between 1500 and 2000 fathoms all the species were new. The same is true of those between 2000 and 2500 fathoms; while in the lowest depths, between 2500 and 3000 fathoms several known forms occurred. The majority of the deep-sea forms are tube-dwellers.

Vol. XIII. opens with Part 35, Mr. Edgar A. Smith's "Report on the Lamellibranchiata." On the return of the Expedition all the Mollusca were placed in the hands of the Rev. R. Boog Watson for description, but after separating out the different species, and labelling the greater part of the known forms, Mr. Watson, seeing the immense extent of the collection, determined to limit his descriptive work to the Gasteropoda and Schaphopoda, and Mr. Edgar A. Smith then consented to prepare the "Report on the Bivalves." The author apologises for not using the name Pelecypoda for this group, urging that it has not only priority but also is more in conformity with the names in use for the other classes. When in 1824 De Blainville first used the term Lamellibranchs, though it is true the class for which it was used was not characterised, still the genera placed under it were so well-known, that the name itself may be said to carry its own explanation, and this might fairly secure the priority for a well-known and almost universally accepted name, which in part by accident it would seem is used in this important Report.

In many respects the collection of Lamellibranchs was disappointing. Only some 500 species were obtained, and of these five were represented by a long series of specimens, and in many cases the species were represented by only detached or single valves. When great depths were reached some of the forms found were of particular interest, but it is a remarkable fact that only one distinctly new generic type was discovered. The greatest depth at which Lamellibranchs were found was in the mid North Pacific Ocean at 2900 fathoms, but two species, *Semele* (*Abra*) *profundorum*, n.sp., and *Callocardia pacifica*, n.sp., were found. Some of the species are noted as found not only at widely distant localities but also at very different depths. The Lamellibranch fauna of the deepest parts of the Atlantic and Pacific Oceans is not of a very extraordinary and certainly not of a special character, and it would appear clear that the deeper the dredgings the fewer the species found. The memoir is illustrated by 25 plates, executed in a very creditable manner by the Cambridge Scientific Instrument Company.

Part 36 is a "Report on the Gephyrea," by Dr. E. Selenka, the well-known Professor of Zoology in the University of Erlangen. The number of species (28) collected was small, and they belonged to known genera; 10 were undescribed. The habitat and distribution of some are of special interest; forms previously known as littoral have been dredged from great depths; it would appear probable that the tube-inhabiting Gephyrea occur especially at the greater depths, where as yet has been found only a single example of the free-living forms. Four plates illustrate this Report, on one of which the strange male of *Bonellia viridis* is figured, with its till now overlooked curious segmental organs.

Part 37 is a "Report on the Schizopoda," by Prof. G. O. Sars, of Copenhagen. The collection made turned out extremely rich and of very special interest, containing several most remarkable new types, and greatly increasing our knowledge of the morphology and affinities of the group. In an introductory note the subject of terminology is dwelt on; in a note on the morphology of the group the author decides for the present to "assign to this group the rank of a distinct tribe or sub-order of Decapoda." This sub-order occupies as it were the most primitive position within the division of the Podophthalmia; containing apparently the least modified forms, in which the orig[illegible] characters distinguishing the progenitors of the w[illegible] division would seem to exhibit least change.

In an appendix to the Report some interesting details are given of some ecto- and endo-parasites found in the Schizopods; 38 plates, drawn by the author with the aid of the camera lucida, represent all the new species; the drawings are very highly finished, and have been clearly and beautifully printed. It may be noted that the new genera and species described in the Report were briefly characterised by the author in the *Transactions* of the Christiania Scientific Society for 1883.

We have pleasure in again noticing that these splendid contributions to zoological knowledge have been edited and seen through the press with wonderful expedition and accuracy by Mr. John Murray, whose labours as Editor now seem coming to a close.

THE GERMAN NAVAL OBSERVATORY

Aus dem Archiv der Deutschen Seewarte. VI. Jahrgang, 1883. Herausgegeben von der Direktion der Seewarte. (Hamburg, 1885.)

THIS, the sixth yearly report of the German Naval Observatory at Hamburg, of which Dr. Neumayer is the Director, contains much valuable information as to the increasing and successful application of scientific methods and results to the safe navigation of the German Imperial and Mercantile Navies, in addition to the usual details as to the *personnel* and working of the whole establishment.

The volume contains four papers, but the first is that in which the most general interest is likely to be taken, the other three referring to special reports on subjects connected with one or other of the four departments into which the work of the Observatory is divided.

Commencing therefore with the first paper, there will be found a general report showing much activity in the collating and distribution of information on the important subjects of meteorology, magnetism, and geography, and describing the arrangements for making the observations in the head Observatory at Hamburg, and the affiliated stations on the coast. It may also be noticed that one of the principal additions to the Observatory in 1883 was an instrument for the systematic observation of refraction, but the description is deferred to another report.

Following the general report is an account of the work accomplished in each of the four departments before mentioned.

Department I. is devoted principally to maritime meteorology, and it will be found that the system adopted ollows closely on the lines of our own Meteorological Office in the collection of observations on the coast and at sea, and publication of results.

In Department II. the work resembles in some particulars that which is now making Kew Observatory such a valuable aid to the nautical world in the testing of sextants, barometers, and thermometers. At the Hamburg Observatory, however, they also prove compasses, compensating magnets, log-glasses, and position lanterns for ships' use.

It may be remarked in passing that the production of a novel form of compass by Sir William Thomson in 1876, and the full explanation by him of the principles involved in its construction in several lectures, accompanied by the subsequent success of that instrument in its later form, has had a world-wide influence in modifying the previously conceived ideas of the best form of compass for navigational purposes. For example, at p. 32 of the first paper there will be found the announcement of a new compass constructed in 1882 under the supervision of the Director of the Observatory in which all the principles of the Thomson compass have been carefully retained, but with certain changes securing greater strength in the compass card. These changes were introduced in view of the consideration that the Thomson card was too fragile to stand the rough handling it might be subjected to on board ship. This new compass has been patented in Germany, and after considerable trial in their mercantile marine has proved successful.

But this department has also turned its attention to the instruction of officers in the magnetism of iron ships by approved teachers of navigation, and at pp. 32 and 33 information is given as to the number of ships swung for deviation of the compass by the officials of the Observatory, and their compass arrangements scientifically treated, also of the large number of ships' compass journals sent to the Observatory for discussion. When the journals have been examined, instructions for the future guidance of the captains of the several ships are given as to the probable deviations of their compasses in the ensuing voyage.

As a useful aid to this scientific examination of ship's compasses, the terrestrial magnetic elements with the annual change are given for certain ports on the German coast.

In Department III. the important work relating to weather forecasts, coast meteorology, and storm warnings is carried on, and tables are given showing the number of days on which forecasts were given for inland and the coast, and of the degree of accuracy attained.

In 1883 the first attempt in establishing a limited night service for issuing storm warnings at night was commenced, a lantern showing a red light being hoisted as the signal.

Department IV. conducts all matters relating to the trial of chronometers, and an account is given of the trial of several descriptions of those valuable instruments, as well as of an apparatus for simulating the action of a ship in a seaway upon them, the effect of temperature being observed at the same time.

Six chronometers of the German Navy have been tried in this apparatus, but the results are not reported. It may be a matter of curiosity to hear how far this apparatus has been a success, but long and varied experience in England has shown that if the rate of a chronometer due to the elements of time and temperature are properly ascertained and furnished to the seaman, he will soon find out the effects of the ever-varying motion of his ship at sea with a precision which an apparatus on shore is not likely to attain in advance.

At p. 43 some useful information is given respecting the scientific work carried on independently by the several departments of the Observatory.

Paper No. 2.—This has been written as a guide for popular instruction in the nature of the deviations of the compass in iron ships by means of a model. A woodcut of the model is given, and the results of some twenty-seven experiments recorded. Models of a similar kind are in use in England and America, and are found very useful in imparting practical information concerning the causes and correction of the deviations of ships' compasses.

In Paper No. 3 there is a discussion of a series of observations of the magnetic declination in Barth, made during the years 1881-2-3-4, a period of time which should render them interesting to magneticians.

The fourth and last paper consists of a special report on the trials of marine chronometers sent in by different makers, and of varied construction, during the three years 1880-83. The results of these trials are here mathematically discussed, and chiefly by the use of M. Villarceau's formula for rate, in which the rate g of a chronometer is considered to be a function of the two independent variables—t, the time, and θ, the temperature. The tables of rates recorded resemble very closely those published by the Greenwich Observatory, with the

exceptions that, instead of weekly sums of the rates being given, the sums are given for every ten days, and the Centigrade thermometer is used. The chronometers are also kept in a constant temperature for each ten days of the period of trial, commencing with 15° C., then with the temperature raised 5° for each decade until the maximum, 30°, is reached. The trials are continued in the same manner with decreasing temperatures until 5° is reached, and lastly with temperatures increasing to 30° as before.

From what has been said it will be seen that at the Naval Observatory in Hamburg a wide range of subjects is taken under its supervision, and it may be added that the volume now under review is a full and able exponent of its work and aims.

VARIATION IN DOMESTICATED ANIMALS

Fancy Pigeons. By J. G. Lyell.
Poultry for Prizes and Profit. By J. Long.
Book of the Goat. By H. Holmes Pegler.
British Cage-Birds. By R. L. Wallace. (London: L. Upcott Gill, 1885.)

WE have grouped the above-named works together inasmuch as they all treat of the varieties existing in domesticated animals, and are moreover serials in course of publication by the same publisher.

Previous to the issue of Darwin's great work on "Variation in Plants and Animals," the subject was treated with undisguised contempt by biologists generally, and thought to be worthy of consideration only by florists and fanciers, not even its importance in reference to the food supply of man being properly estimated. The origin of this opinion was no doubt correctly given by the late Dr. Gray, when, in reply to the question put to him by the writer of this notice, "Why naturalists ignored the existence of varieties, a variation, however abnormal or monstrous it might appear, being as real as the most normal species," he answered, "The reason, my dear sir, is that they know nothing at all about them."

Nor is this ignorance extinct at the present day. In the Museum of the College of Surgeons may be seen the skull of a crested fowl, with the peculiar bony growth supporting the crest, and the accompanying hour-glass-shaped cavity of the cranium, which are characteristic of the entire race, described as the result of disease in the catalogue compiled by Sir Richard Owen. Nor need we go further than our own unrivalled zoological vivarium to see specimens which every breeder of domestic animals believes to be mere varieties, such as woolly cheetahs and black-shouldered peacocks, exhibited as "good species."

How many naturalists even now care to ascertain what are the limits of variation in any given species, or to what extent the characteristics of allied animals or groups of animals may be reproduced by what Darwin termed "analogous variation."

By careful selection, aided by great practical experience, the skilled breeder can produce almost any pattern of plumage or any disposition of colour he pleases, limited only by the range of colours and markings natural to other animals of the family to which the species belongs on which he is experimenting Thus all the markings of the wild Felidæ can be reproduced in the domestic cat; those of the Columbidæ in the pigeon; but the feline markings cannot be produced in the dog, nor the distribution of colour seen in the Australian pigeons be implanted in the domestic fowl.

It unfortunately happens that the peculiar bent of mind which makes a man a "good fancier" does not necessarily tend to constitute a good naturalist, and it is rare for the two pursuits to be combined in the same person; the zoologist despising the fancier and his monstrosities, which are the result of artificial selection, and the fancier, on the other hand, if he has even a slight acquaintance with zoology, laughing at the naturalist who manufactures what he calls "good species" out of a slight variation of plumage, which he, the fancier, would breed to order without the slightest difficulty. For examples of this proceeding, we need only turn to recently manufactured species of the genus Phasianus.

To those ornithologists who would wish to note the almost infinite variety of pattern, colouration, and marking to which the descendants of *Columba livia* can be bred, we would recommend the "Fancy Pigeons" of Mr. Lyell; it contains a more detailed and fuller account of the numerous breeds than any book in the language, although some of the theories of the writer will not meet with the support of ornithologists. The work, moreover, has a sufficient number of engravings, both coloured and plain, to render the descriptions easy to follow; and these are not, as is too often the case in works written by a fancier for fanciers, grossly exaggerated.

"Poultry for Prizes and Profit" treats, as far as it has proceeded, of the characteristics of the various breeds of fowls, of which, as of pigeons, new varieties are being constantly produced. Of the manner in which fanciers confound species and varieties a strong example is given, the author describing the very distinct and strongly characterised species, *Gallus furcatus*, as a variety of the domestic fowl.

The "Book of the Goat" contains a very good description of the various breeds of goats found in different parts of the world, and most valuable and practical directions for the management of the animal in a domestic state as a useful milk-producer.

"British Cage-Birds," the last of the serials on our list, deals more with wild species than with varieties. It gives the mode of capture, treatment in captivity, &c., of British birds that are kept in confinement for the sake of their song or beauty of plumage. This work is also largely illustrated, but the engravings in many instances are capable of improvement.

W. B. TEGETMEIER

OUR BOOK SHELF

Differential and Integral Calculus, with Applications. By A. G. Greenhill, M.A. Pp. xi. and 272. (London: Macmillan and Co., 1886.)

WITHIN the limits of 267 pages it is not easy to make improvement in so vast a subject as that of this treatise. The chief novelty is the concurrent treatment of differential and integral calculus. A great step in perspicuity has been made by the use of the *complete* notation of hyperbolic trigonometry (sinh, cosh, &c., and $\sinh^{-1}$, $\cosh^{-1}$, &c.), which shows the perfect analogy of the

circular and hyperbolic functions in both differentiation and integration. The gain is for mathematicians; its use to practical men may be doubted, as the numerical calculation of these functions is (at present) best done by the familiar logarithms. In the older treatises the applications were chiefly algebraic and geometric; the author's system is to introduce the student at once to a wide scope of applications in both geometry and physics, including some of the higher branches (*e.g.* central orbits, harmonic vibration, Fourrier's and Green's theorems, &c.). It is clear that the account of each must be very brief. In some cases (*e.g.* the article on "Curve-Tracing," Art. 127) it amounts to merely a sketch of procedure and results with scarcely any proof. In an "introductory" work this seems a defect. It is, however, a masterly introduction to the subject, and the wide scope of the applications is well fitted to interest the student.

It remains to notice some defects (in our judgment). About ten pages are devoted to *ordinary* trigonometric relations and tables of mere trigonometric formulæ. This seems too much space (being 4 per cent. of the whole) to such elements. No definition is given of a maximum or minimum, and the treatment of maxima and minima is made to depend wholly on geometry.

On p. 189 it is stated that Taylor's theorem is one "by means of which any function whatever can be expanded"—an obvious slip, corrected lower down (pp. 193, 201). The necessity for the subject-functions, and in many cases also their differential coefficients, being continuous and generally also finite within the limits of any question is not stated. This is, unfortunately, a not uncommon omission in elementary works. ALLAN CUNNINGHAM

Elementary Algebra. By Charles Smith, M.A., Fellow and Tutor of Sidney Sussex College, Cambridge. (London: Macmillan and Co., 1886.)

IT is a pleasure to come across an algebra-book which has manifestly not been written in order merely to prepare students to pass an examination. Not that we think Mr. Smith's book unsuitable for this purpose; indeed, with its carefully-worked examples, graduated sets of exercises, and regularly-recurring miscellaneous examination-papers, it compares favourably with the most approved "grinders'" books. The real want of the present day is a text-book logically arranged and logically written. Apparently no author cares to risk the chance of the financial ruin of his book by going thoroughly to the root of the evil. A policy of "safety" is the most we can expect. This is Mr. Smith's policy, and although we think he might have made fewer concessions to custom and yet have been safe, we welcome his effort very cordially, trusting that, when his book has gained the success which it well deserves, he will see his way to introduce further improvements. He shows to great advantage as a teacher, his style of exposition being most lucid: the average student ought to find the book easy and pleasant reading. The second set of exercises on the binomial theorem is worth specially noting; in many other mathematical books the sets of exercises proposed to the student might well be, as in this instance, *collections of really useful theorems.*

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Pleomorphism of the Schizophyta

SOME students of natural history are content, when the explanations of phenomena which they have advanced and the arguments by which they have supported those explanations are appropriated by other observers, to remain silent, trusting to the justice of future generations for the vindication of their claims. So far as my own experience goes, an active observer who should trouble himself to obtain honest treatment from all his contemporaries in regard to the significance of his published writings, might abundantly employ the latter half of his life in struggling with new writers for that just recognition of his efforts in earlier years in advancing the knowledge of this or that subject, which is the one reward desired above all others by most men who have not attained to the heights of philosophic contempt for the regard and sympathy of fellow-labourers. I do not intend to largely employ my leisure in this pursuit, but there is one subject on which I am anxious once for all to establish the significance of my observations and reasonings published twelve years ago in relation to similar views advanced and accepted at this moment.

That subject is what is now spoken of as the pleomorphism of the Schizophyta or Bacteria.

The view that the genera then recently established by Cohn, viz. Micrococcus, Bacterium, Bacillus, Vibrio, Spirillum, and Leptothrix, are form-phases, or variations of growth of a number of "Protean" species of Bacteria, each of which may exhibit, according to undetermined conditions, all or some of these forms, was definitely and precisely formulated by me in my memoir on "A Peach-coloured Bacterium," published in the *Quart. Journ. of Microscop. Science* in 1873. I distinctly recognised the existence of true species of Bacteria or Schizophyta, but I pointed out that these must be characterised, not by the simple form-features used by Cohn, but by the *ensemble* of their morphological and physiological properties as exhibited in their complete life-histories. I illustrated my conception of the Protean or pleomorphic character of Bacterian species by a reference to the similar character of the species of Calcareous Sponges, and I had in my mind also the closely parallel facts established by Carpenter in relation to the endless variety of forms of the Protozoic Foraminifera.

My view was no merely speculative suggestion, but was based upon a careful study of a remarkable peach-coloured Bacterium, which exhibited a wide range of forms, connected by intermediate forms, growing together in the same vessel, and linked to one another most unmistakably by the fact that they all were coloured by a special pigment which I studied with the spectroscope, and to which I gave the name "Bacterio-purpurin." I observed this organism on many different occasions from various localities; I figured and described its various form-phases; I obtained some modifications of form by cultivation, but chiefly depended upon the association of the different forms, the presence of completely transitional forms, and the common bond of the pigment, for the view as to their nature which I put forward. I gave the name *Bacterium rubescens* to this pleomorphic, or, as I termed it, "Protean," species. I gave an account of further observations on this organism in the *Quart. Journ. Mic. Sci.*, 1876, pp. 27-40.

Cohn opposed my view as to the genetic connection of the various forms associated by me under this name, and, contrary to the established laws of nomenclature, substituted a manuscript name in one of Rabenhorst's collections (viz. "*roseo-persicina*"), for the duly-published name applied by me to this organism. He further described some of its form-phases, already figured by me, as *Monas okeni*, *Monas vinosa*, and *Rhabdomonas warmingii*.

On the other hand, two years later, Dr. Warming of Copenhagen (*Vidensk. Meddelser. naturhist. For. i. Kjöbenhavn*, 1875), after studying the same organism and figuring many of its form-phases, adopted my view as to their nature, and the extension of that view to the Schizophyta generally. He says: "Les bactéries sont douées en réalité d'une plasticité illimitée, et je crois qu'il faudra renoncer au système de M. Cohn." In 1883 Dr. Neelsen, in his "Studien über die blaue Milch" (Cohn's *Beiträge*, vol. iii. p. 241) cites my views and their confirmation by Warming, and rightly contrasts them with the later views of Nägeli and Billroth, and with that of Lister, who conceived that certain Bacteria were developed from a filamentous fungus (*Dematium fusisporum*). As the result of his investigation of the *Bacterium cyanogenum* of blue milk, Neelsen says: "Viel eher würde für unsern Fall der Ausspruch Lankesters zutreffend erscheinen, von dem Proteus-ähnlichen Organismus, dessen einzelne Erscheinungs-formen eine Serie von Adaptationen vorstellen."

In 1884 Prof. de Bary of Strasburg, in his "Vergleichende

Morphologie der Pilze," p. 511, says, in regard to the question of species among the different forms of Bacteria :—"There exist two views on this subject which are, at any rate in appearance, totally opposed to one another. The first is, as I think erroneously, ascribed to Cohn. . . . Cohn distinguishes merely what we have above spoken of as form genera and form-species. The other view in its most extreme form amounts to this, that all distinction of species among the Bacteria is denied, and all forms are regarded as modifications of a single species or whatever else it may be called, and these modifications can be transformed by cultivation into one another reciprocally. This view was (if we leave out of consideration older intimations of a similar nature) set up in opposition to Cohn's classification by Lankester in 1873, and by Lister; and in 1874 carried to such a length by Billroth, that he united all the forms of Schizomycetes known to him under one collective species, his *Coccobacteria septica*. It received later a support through the views which Nägeli (1877) expressed in the words, 'I have investigated during the past ten years many thousands of Bacterian forms, and I could not maintain (if I except Sarcina) that there was any need for a separation into even two specific forms.' Nägeli, however, adds that he by no means maintains that all forms belong to one single species: it were a bold thing in his opinion to express a definite conclusion in a matter in which morphological observation and physiological experiment leave the investigator so much in the lurch. He expresses himself again in the same sense in 1882. He nevertheless is, when carefully considered, in agreement with Cohn's fundamental conception, since Cohn erected his form-genera and his form-species (the latter based on physiological properties) primarily in order to gain a provisional survey, and irrespective of the question (as he distinctly states) as to whether as thus distinguished they correspond to natural species.

"Nageli's words above-cited contain a pregnant criticism of the whole controversy, so far as it had then gone. Both parties failed to bring forward (as is especially the case in Billroth's book) the only certain basis for their opinions, namely, the strict observation of the continuity or the non-continuity of the forms or species in question. In the absence of this, our judgment could only remain suspended, more especially since the forms in question are minute, very like to one another, often mixed together, and consequently easily to be mistaken for one another in the absence of quite strict observation. Lankester certainly came somewhat nearer towards establishing a special case of strictly-observed continuity, since the forms of his *Bacterium rubescens* (*Beggiatoa roseo-persicina*) gave evidence of their connection with one another more clearly by their characteristic coloration. Strictly-made morphological and developmental researches are now to hand. They have demonstrated that the forms known as Cocci, Rods, Threads, &c., are phases of growth (*Wachstformen*)."

Thus writes Prof. de Bary in 1884. To some extent I have reason to thank him for the recognition which he gives to my position in this matter. But I cannot think that he has given a correct statement of my relation to the conclusion which he finally adopts when he associates me with Lister, who derived Bacteria from Fungi, with Billroth, who massed all Bacteria under one collective species, and with Nageli, who declared that he did not see grounds for distinguishing as many as two.

The view which I put forward in 1873 is *precisely* that which Prof. de Bary now espouses, and I think I may very rightly object to its being confounded with the extreme and exploded theories of other naturalists. As to the "strict morphological and developmental researches" which now have made my doctrine of the pleomorphism of the Schizophytes acceptable to Prof. de Bary, I beg to point out that they do not differ in *character* from my own researches on *Bacterium rubescens*. Prof. de Bary very properly cites the later researches of Cienkowski, Neelsen, Hansen, and Zopf as the chief amongst those which have tended to establish that view as to the forms and species of Schizophyta which I promulgated in 1873. They have done so, *not* by affording us any stricter evidence of actual observation of change of form taking place under the observer's eye, but by multiplying cases similar (in regard to the kind of observation made) to that published by me in 1873, viz. observations of the juxtaposition and structural continuity of different forms, and of the co-existence with extremely divergent forms of abundant intermediate forms.

In relation to the attitude taken up by one of the above-named observers, I have something further to say. Dr. Zopf has made valuable researches on various Bacteria and on the Mycetozoa, and has published the best systematic account of each of these groups which has appeared. In his quarto memoir (Leipzig, 1882) on the Schizophyta, as well as in the smaller hand-book which he has since produced, Zopf gives a reference to my memoir on "A Peach-coloured Bacterium." He has himself repeated my observations on that organism, but he has entirely abstained from pointing out in the text of his work how far his observations are simply repetitions of those published eleven years previously by me (which they are almost entirely), and he has in the most exact details adopted the view as to the pleomorphism of Bacteria which I then put forward, and on precisely the same grounds, without stating that he had been anticipated by me in this respect.

Not only this, but Zopf actually goes out of his way to ascribe to me a view differing from his own, and one which I have never suggested. Either Zopf is writing about my views without having troubled himself to ascertain what they are, or he is purposely misrepresenting them, when he says ("Morphologie der Spaltpflanzen," 1882, p. v.): "Die Annahme Billroth's und Lankester's dass alle Spaltpilzformen nur Einer einzigen naturhistorischen Art oder Gattung zugehören, lässt sich nicht aufrecht erhalten."

I think Dr. Zopf will find it difficult to bring forward a citation from any writing of mine in which I have hinted, even in the remotest way, that "all the forms of Schizophyta belong to a single natural species." Billroth's declaration on this subject was published a year after my statement of the pleomorphic nature of the numerous natural species of Schizophyta, and never appeared to me to have any foundation in a general botanical experience, but to be the result of the restricted observations of a pathologist.

To remove all possibility of further misapprehension, I may be allowed to quote my own words ("A Peach-coloured Bacterium," *Quart. Journ. Mic. Sci.*, 1873, p. 410):—

"The series of forms which I have found in the growth of *Bacterium rubescens* leads me to suppose that the natural species of these plants *are* within proper limits 'Protean.' . . . The natural species among the Calcispongiæ have been shown by Haekel not to correspond at all with the series of *forms* distinguished by his predecessors. . . . It seems exceedingly probable that the same manner of regarding the Bacteria will have to be adopted, Cohn's tribes and genera taking the position of an artificial or formal system, whilst the natural species must be based upon some of those more profound characteristics which Cohn has himself indicated to us in his divisions—saprogenous, chromogenous, pathogenous. The indications of natural species do not lie under our hands in the case of the Bacteria, but have yet to be sought out."

I have now, I think, sufficiently pointed out the position of my publication on *Bacterium rubescens* in the history of the modern doctrine of the pleomorphism of the Bacteria. It will accordingly be readily understood that I cannot contentedly see this doctrine referred to, as it was recently in your columns by my friend Dr. Klein, as "Nägeli's theory of the pleomorphism of the Schizophyta," since Nägeli's view was announced four years after my publication, and is not identical with that at present accepted by De Bary, Zopf, and others, which is, in fact, *precisely* that put forward by me in 1873.

Equally objectionable as falsifying the history of knowledge by assigning to one individual the property of another is a statement in your review of Mr. Crookshanks's "Practical Bacteriology" (NATURE, February 18, p. 361). The reviewer quotes and apparently indorses a statement by Mr. Crookshank, whose book I may observe, though useful in many ways, is wanting in accuracy and in references to original sources. The passage to which I allude is as follows :—"'Researches,' writes our author," "by competent observers have quite recently clearly de-" "monstrated that several micro-organisms in their life-cycle" "exhibit successively the shapes characteristic of the orders" "of Cohn. This had as early as 1873 been observed by" "Lister in a Bacterium in milk. Lister detected forms of" "Cocci, Bacteria, Bacilli, and Streptothrix genetically con-" "nected.' Recent observers also have obtained similar" "results, so that the very foundation of Cohn's classifica-" "tion has been shaken, and we are left without possessing" "a sound basis for classification into genera or species." In the original work of Mr. Crookshank (p. 110) I find the names of Cienkowski, Neelsen, Zopf, Van Tieghem, and others of my successors in this field cited, but no reference is made to

the memoir published by me in 1873. Lister's observations led him to quite different conclusions, which he has since abandoned. I am sure that those who are at present busy in this country with the study of Bacteria, and who undertake to write hand-books of the subject, can have no desire to do otherwise than give a just statement of the history of knowledge of the organisms of which they treat. Hence it is with no unfriendly feeling that I offer to Mr. Crookshank and other writers similarly engaged the statement contained in this letter.

February 20 E. RAY LANKESTER

Notes on the Volcanic Phenomena of Central Madagascar

MADAGASCAR is as yet almost a *terra incognita* to the geologist; nothing, so far as I am aware, but notices of the most vague and fragmentary kind ever having appeared in regard to its geological features. Nor indeed may we expect to have other than the most general descriptions until the island is surveyed by thoroughly competent men. In the absence of something more complete, I hope that the following notes on the volcanic phenomena of Central Madagascar may not be unacceptable to your readers, and may prove a contribution, however slight, to our knowledge of the geology of this great island. And first let me mention the volcanic cones, of which there are many scores, probably hundreds, in the part of the island of which we are speaking. These volcanic cones are situated in [illegible] localities especially: in Mandridrano, on the western side of Lake Itasy, and in the neighbourhood of Betafo in Vakin' Ankaratra; the former being from 50 to 60 miles west, and the latter from 70 to 80 miles south-west, of Antananarivo, the capital. Both localities are about 130 miles from the sea on the eastern side of the island, and 150 on the western side. It is hardly necessary to say that all these volcanoes are extinct, and that there are none in activity at the present time in any part of Madagascar.[1] On the west side of Itasy the volcanic cones exist in great numbers, and these, therefore, shall be first described.

The extinct volcanoes of this district of Mandridrano extend for a distance of about 20 miles north and south, and perhaps 3 or 4 east and west. They are, for the most part, scoria cones. The cones are thickly studded over the district, in some parts clustering together more thickly than in others. There is no single large volcano to which the others are subsidiary, or upon which they are parasitic. Occasionally there is a series of cones which have evidently been heaped up by the simultaneous ejection of scoriæ from different vents situated on the same line of fissure, but so that the cones have run one into the other, leaving a ridge, generally curvilinear, at the summit. None of these extinct volcanoes reach the height of 1000 feet. Kasige, which is probably the highest, I found by aneroid to be 863 feet above the plain (5893 feet above the sea). Andranonatoa is perhaps next in height to Kasige. Kasige is a remarkably perfect and fresh-looking volcano, whose sides slope at an angle of about 40°. The scoriæ on the sides have become sufficiently disintegrated to form a soil on which are found a by no means scanty flora; for among other plants growing here I found an aloe (*A. macrociada*), and clematis (*C. trifida*), two or three Composite herbs (*Senecio cochlearifolius*, *Helichrysum lycopodioides*, *Laggera alata*, &c.), some grasses (*Imperata arundinacea*, &c.), a species of Indigofera, and an orchid. On its top is an unbreached crater, which measures, from the highest point of its rim, 243 feet in depth. It may be mentioned in passing, that on the very summit, in a hollow "cinder," there were found a small piece of money, perhaps of the value of a halfpenny, and a small bead, as also a portion of a banana leaf, with a few pieces of a manioc, and two or three earth-nuts placed upon it these had been deposited there by some of the heathen inhabitants of the place as a votive offering either to their ancestors or to the Vazimba (the aborigines of Central Madagascar). Continuous with Kasige, and adjoining its south side, though not so high, there is another volcano, Ambohimalala, and dozens of others are to be seen near by.

One thing with regard to these volcanic piles soon strikes the observer, which is, that they are frequently lop-sided, one side of the crater being higher than the other. The higher side varies from north to north-west and west. This is undoubtedly accounted for by the direction of the wind during the eruption, causing the ejected fragments to accumulate on the leeward side of the vent. Now we know that the south-east trades blow during the greater part of the year in Madagascar, hence the unequal development of the sides of the cones. The same thing may be also observed in the volcanic piles in the neighbourhood of Betafo. This phenomenon, as is well known, occurs also in other parts of the world.

A very large number of the cones have breached craters, whence lava has flowed in numerous streams and floods, covering the plains around. These streams and floods consist in every instance, I believe, of black basaltic lava; a sheet of this lava, the mingled streams of which have flowed from Ambohimalala and some other vents, has covered the plain at the foot of Kasige to such an extent as almost to surround the mountain. Similar sheets are to be seen in other parts of the district, but they are so much alike that a description of one will suffice for all. Amboditaimamo (or Ambohidratrimo?) is a small volcano to the north of Lake Itasy, and at the northern confines of the volcanic district. It possesses a breached crater turned towards the east; from this has issued a stream of lava which, following the direction of the lowest level of the ground, has swept through a small valley round the northern end of the mountain, and spread out at its west foot. This sheet of lava, which is horribly rough on the surface, occupies but a small area of some two or three square miles. It has been arrested in its flow in front by the side of the low hills. It is cut through in one part by a stream which, in some places, has worn a channel to the depth of 80 or 90 feet. Its surface, which is slightly cellular, is covered by some hundreds of mammiform hillocks, which must have been formed during the cooling of the liquid mass. The hillocks are mostly from 20 to 30 feet high, and apparently are heaped-up masses of lava, and not hollow blisters. The lava itself is black, heavy, and compact, being porphyritic with somewhat large crystals of augite. As yet it is scarcely decomposed sufficiently to form much of a soil, though grass grows on it abundantly, and a few other plants are to be seen.

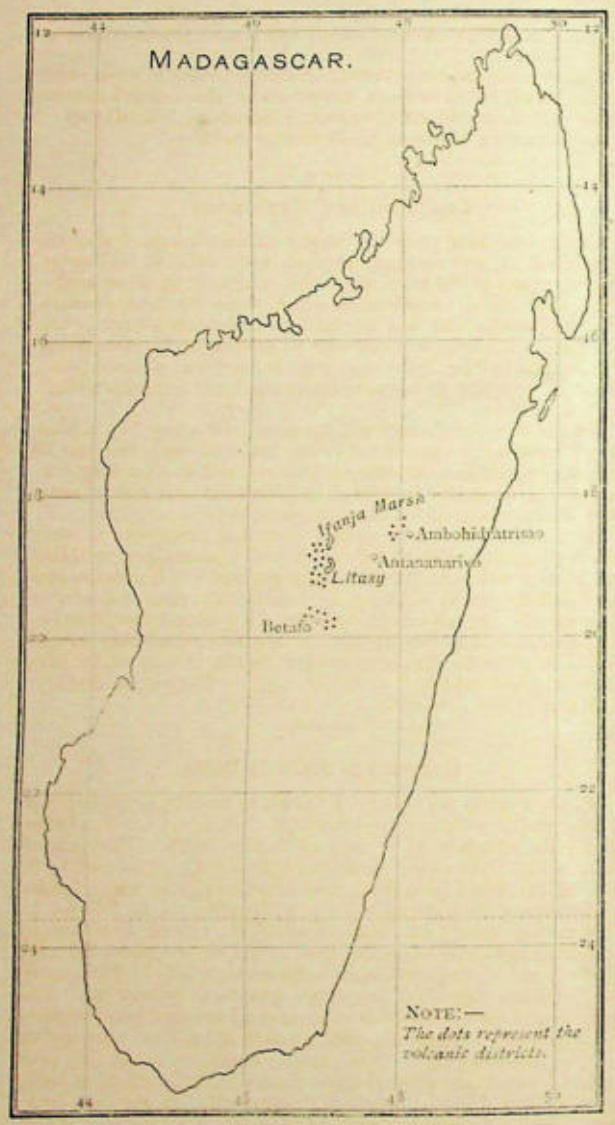
A little to the south of Amboditaimamo there is another volcano, known by the name of Andrarivahy. It is situated on the summit of a ridge of hills—astride of it, so to speak—and from its crater there has been an outflow of what must have been very viscid lava, for, though the sides of the volcano and the ridge of hills form an angle of from 30° to 40°, the ejected matter has set or "guttered" on the slope, only a small portion of it having reached the valley below. This ridge of hills, through which the volcanic orifice has been drilled, is composed entirely of gneiss; and indeed it may be here stated that the whole of these volcanoes, as is the case also with those about Betafo, rest upon a platform of gneiss, chiefly garnetiferous.

Throughout the district numerous fragments of basic lava, trachyte, trachytic tuff, and basaltic conglomerate lie scattered about in abundance. The trachyte is of various shades of yellow and gray, and frequently porphyritic with large crystals of sanidine. Pumice, obsidian, and pitchstone do not seem anywhere to be found.

In addition to the numerous scoria-cones, there may be seen here and there in the district some half-dozen or more bell-shaped hummocks of trachyte. They are for the most part composed of a light-coloured compact rock. This rock, having originally had a highly viscid or pasty consistency, has evidently accumulated, and set immediately over the orifice through which it was extruded: such hummocks are Ingolofotsy, Beteheza, Angavo, Ambasy, Isahadimy, Ambohibe, Antsahondra, &c. Ingolofotsy, situated to the north-west of Itasy, is perhaps the most striking in appearance of these trachytic hummocks. It bears some resemblance to a bell or Turkish fez, except that its sides are furrowed with water-channels and its truncated summit is notched in a remarkable manner. Its height above the plain is 665 feet (5258 feet above the sea); the inclination of its sides averages probably 50° Adjoining Ingolofotsy on the south-

[1] Scrope, in his "Volcanoes," second edition, p. 428, says of Madagascar, "There is some reason to believe in the existence of active volcanic vents in this great island:" and Dr. Daubeny, in the second edition of his "Volcanoes," p. 432, in referring to the islands on the eastern coast of Africa, says: "The principal of these are the great Island of Madagascar, the Isle of Bourbon, and the Mauritius, the first of which has been too little explored to allow of my announcing with certainty anything respecting its physical structure;" and in a note he adds: "Madagascar is stated by Daubuisson to contain volcanoes, on the authority of Ebel (*Bau der Erde*, tome ii. p. 289), who reports that in this island there is a volcano ejecting a stream of water to a sufficient height to be visible 20 leagues out at sea." What remarkable eyesight those from whom Daubuisson heard the story must have had to see an invisible phenomenon so far away! Dr. Daubeny continues: "Sir Roderick Murchison, December 1827, exhibited at the Geological Society some specimens of a volcanic nature, said to have come from this island, but the locality was not mentioned."

west is Beteheza, a large mass of trachyte which has probably welled out from an orifice on the same line of fissure from which Ingolofotsy was extruded. Angavo is another of these trachytic domes. One singular feature in this mountain is its numerous shallow water-channels, which make their way down from the summit in a surprisingly regular manner (at least on the north side), giving the appearance of an opened umbrella with numerous ribs. From one point of view I counted as many as thirty-four of these channels. It may be mentioned in passing that, in a valley at the west foot of Angavo, there is a small crater whose lips are level with the surface of the ground. This may perhaps be accounted for by supposing that the ejected materials from this and other craters near have so accumulated



as to raise the level of the valley between up to the rim of the crater, and so obliterate the cone, probably never of any great height.

It is hardly necessary to say that these extinct volcanoes of Mandridrano must have been in activity in comparatively recent times. Possibly they belong to the historic period, though no tradition lingers with regard to their being in a state of eruption.[1] That they are, at any rate, of recent date, is shown by the almost perfect state of preservation in which most of the cones are still found, and by the undecomposed (or but slightly decomposed) character of the lava-streams that have issued from them. There have been no terrestrial disturbances or modifications of any magnitude since the days of their fiery energy; the conformation of hill and dale was the same then as now, for, in every instance, the lava-streams have adapted themselves to the form of the existing valleys.

Another feature worthy of mention in this volcanic district is the lakes and marshes which occupy many of the valleys. Itasy is the largest of the lakes, and Ifanja the largest of the marshes. Now most of these lakes and marshes have been doubtless formed by the sinking in of certain portions of the district, a fact made evident by the two following circumstances:—(*a*) On the south side of Kasige the gneiss may be seen distinctly to take a sudden dip beneath the volcanic pile, showing that, as the matter has been discharged from below, there has been a settling down of the cone, a fact made further evident by the existence of a small sheet of water, known as Bobojojo, in the immediate vicinity. But (*b*) on the western side of Ifanja marsh there is a small pond known as Mandentika. In the time of King Andrianampoinimerina, about a century ago, so the people say, there was a headland projecting into this pond, upon which was situated a small village of two or three houses. On a certain unhappy day the foundations of this headland suddenly gave way, and down it sank with the village and its inhabitants, only one of the latter escaping. From that time the pond has been appropriately termed Mandentika ("[illegible]ing"), but previous to the catastrophe it was known as [illegible] parihimboahangy. There is no doubt as to the truth of this story, as I have myself seen traces of the submerged headland and village appearing just above the surface of the water. The natives of the place say that the sinking was caused by a Fananimpitoloha, a seven-headed, mythical, serpent-like monster that is supposed to live beneath the water.

Ifanja Marsh is some four or five miles from one end to the other, and perhaps a mile or more wide in its greatest width. It runs in a northerly and southerly direction, with its southern end bending round towards the west, at the foot of which is the volcano of Amboditaimamo, mentioned above. The marsh is 3700 feet above the sea, forming a considerable depression below the surrounding country, which is about 5000 feet in altitude. At its south-eastern corner there are some hot springs which are much resorted to by sick folks.

Lake Itasy covers ground, roughly speaking, to the extent of about 25 square miles. It may not improbably occupy an area of depression due to volcanic action;[2] but be this as it may, there is a cause at its outlet sufficient to account for its formation. Here, lying in the river-bed, may be seen numerous blocks of gneiss, many of them blackened with a covering of oxide of iron; and beneath this gneiss lava may be seen. Several volcanoes cluster round the outlet; but there is one—an inconsiderable hill—situated on the southern margin of the outflowing river, just above the rapids. There distinctly enough may be seen a low and much-worn crater, with its breached side facing the outlet; and gneiss blocks may be traced from the bed of the river all up the hill-side to the crater. There has apparently been first an ejection of volcanic matter, followed probably by an explosion tearing up and flinging out the gneiss through which the vent was bored, hence the gneiss blocks are superimposed upon the lava. Thus the water has been ponded back. The river has now cut its way several feet through the barrier thus thrown across its course; and by this continual erosion at its outlet, and the accumulation of sediment, and the growth of vegetation at its head, the lake is slowly, though surely, decreasing in extent year by year.

It seems that the lava also occupies the bed of the river further down, as Mr. W. Johnson says: "Went down the Lilia as far as the waterfall at Ambohipo. A more beautiful fall I think I never saw. The river, broken into three streams, falls in foaming white masses over an edge of black lava some 50 feet deep. The whole bed of the river for a mile above is of the

[1] I was told by a native that near the village of Ambohiriana, north of Angavo, and not far from Ingolofotsy, there is an emission of gas (? "fofona"), and that the people say that formerly fire was to be seen. The place is named Afotrona ("afo," fire; and "trona," grunting or hard breathing).

[2] Mr. W. Johnson says: "I am told here that Itasy was once a huge swamp, and that its becoming a clear lake is within the knowledge, or perhaps the traditions, of the people." If this be really true, it can only be explained on the supposition that there has been a recent subsidence of what is now the bed of the lake, as in the case of Mandentika, mentioned above.

Mr. Sibree says: "The natives say that the lake Itasy . . . was formed by a Vazimba chieftain, named Rapeto, damming up a river in the vicinity and so the rice-fields of a neighbouring chief with whom he was at variance were flooded, and have ever since remained under water."—"The Great African Island," p. 136.

same black character, the lava broken in innumerable blocks, and setting out in vivid colour the verdure of the river banks."

A good deal of what has been said respecting the volcanic district of Itasy also holds good in regard to that of the Betafo valley and neighbourhood, where, however, the volcanic cones are fewer, and where trachytic domes do not appear to exist. One of the volcanoes in the Betafo valley, Iavoko, is of greater dimensions, and has a much larger crater than any to be found about Itasy. From this volcano a large sheet of basaltic lava has issued, upon which are to be found in abundance various species of plants, notably a Euphorbia and a stonecrop (*Kitchingia*). Almost all the plants growing on this lava-bed, however, are of a succulent character, and can dispense with soil, requiring merely a foothold. On the sides of Iavoko may be picked up fragments of calcined gneiss, which have been torn from the sides of the vent in t'e passage upward of the volcanic matter. On some of the cones numerous crystals of augite as large as marbles may be found among the volcanic debris. There is one volcano, Tritriva, near Betafo, which, inasmuch as it is different in character from any others mentioned above, deserves a few words. It is one of those volcanoes off which the summit has been blown by explosive action, leaving what is known as a crater-ring, which is now the site of a small lake. The lake is not more than 100 or 2 0 feet in diameter, perhaps not as much as that; but there is reason to suppose that it is of very great depth. The inner sides are steep for the greater part of the circumference, but on one side the lake is easily accessible.

It is possible that, when the country is more thoroughly explored, it may be found that the volcanoes near Itasy and those in the Betafo valley are connected by intermediate ones; indeed, on Dr. Mullens's map several craters are shown somewhat west of a straight line drawn between these two volcanic districts.

About 25 or 30 miles to the north-east of Antananarivo I discovered, a couple of years ago, several small volcanic craters. These also seem to belong to the class of crater-rings or explosion craters. Although fragments of volcanic matter have been ejected from them, they are not in such quantity as to form a cone; and the craters, none of which exceed 100 yards in diameter, and 30 feet in depth, have been formed probably by a single explosion of the pent-up forces below. With the exception of scoriæ and lapilli, which are sparingly scattered about, there is no visible sign of volcanoes, and one may come to the very verge of the craters before being aware of their existence. Two of the largest craters consist of saucer-shaped depressions, but are rather elliptical than circular in form; the others consist mostly of small cavities, deep in proportion to their width. Several of the craters are occupied by sheets of water, with rushes and other aquatic plants growing around their margin.

Besides the volcanic phenomena mentioned above, thermal springs occur in various localities in the interior of Madagascar. The following is an analysis by Dr. Parker of water from springs in the district of Antsirabe:—

"On evaporation, one pint (20 oz.) of water from each spring yielded the following quantities of solid salts:—

Spring No.	1	yielded	40	grs.	of salt,	or	2	grs.	to	1 oz. of water.
,,	,,	2	,,	38	,,	,,	1·9	,,	1	,, ,,
,,	,,	3	,,	42	,,	,,	2·1	,,	1	,, ,,
,,	,,	4	,,	28	,,	,,	1·4	,,	1	,, ,,

All these springs contain the same ingredients, viz. lime, magnesia, soda, and potash, in combination with chlorine, iodine, sulphuric acid, and carbonic acid, with the addition of free carbonic acid gas."

At Antsirabe there is a deposit from one of these springs of carbonate of lime, which is occasionally used for building purposes in the capital. Bubbles of carbonic acid may be seen rising from the surface of the deposit, and at one point, where there is a small spring, a mass of calc-sinter has been formed which, speaking from memory, is probably 12 feet high by 18 feet long.

In one of the valleys in the vicinity of the crater-rings of Ambohidratrimo, spoken of above, there is a deposit of siliceous sinter. It appears in one or two places, scarcely rising above the surface of the ground, in a valley of rice-fields, and has been deposited by springs which have long since ceased to flow. The sinter is exceedingly hard and compact, and is used by the natives for fire-flints. In some portions of it numerous fossils of a species of Equisetum are embedded. The longitudinal striæ leave no doubt as to the nature of the plant. The fistular stem has been filled in, and the vegetable substance entirely replaced, by silex. The stems of some of these fossil plants are quite half an inch in diameter. Now, the only Equisetum found in Central Madagascar at the present time is *E. ramosissimum*, but this never attains to such a thickness as the Equiseta in the sinter; so that the fossil species have become extinct since the springs which deposited the geyserite were in a state of activity.

So little is known respecting earthquake phenomena in Madagascar, no scientific observations ever having been instituted, that it is scarcely worth while to refer to the subject. However, it may be stated that scarcely a year passes without one or more shocks being experienced in Central Madagascar, though they are never severe or of long duration; and the destruction caused by these earth-waves in some parts of the world is entirely unknown here. The natives, I may say in passing, strangely imagine that earthquakes are caused by a whale (Trozona) turning on its back.

Extinct volcanoes and thermal springs exist also in other parts of the island, but so little is known about them that I can do no more than merely allude to their existence. R. BARON

Antananarivo, Madagascar, December 2, 1885

Coal-Dust and Explosions

THOSE who have given the labours and conclusions of workers antecedent to, and contemporaneous with, Mr. W. Galloway, on the subject of the part played by coal-dust in mine explosions, the careful consideration which these merit in common with the results and writings of that zealous exponent of the question, will hardly feel disposed to concur in his conclusion that, except by him, "the very simple, and yet all-important, element" to which he refers in his recent letter has been treated with neglect.

On the other hand, they will consider that when Mr. Galloway "goes the length of crediting coal-dust with the *rôle* of principal agent (in coal-mine explosions), and of relegating fire-damp to a secondary position," he altogether loses sight of some very obvious facts which forbid so sweeping a conclusion.

Any one who is led, by special interest in the subject, to study the forthcoming Repo t of the Royal Commission on Mine Accidents, will find that the important part which may be, and no doubt frequently is, taken by dust in coal-mine disasters is recognised to its full extent, and that, in a careful consideration of the accumulated knowledge on this subject, all due weight has been given to the experimental results arrived at by Mr. Galloway and others. FREDK. A. ABEL

March 3

Deposits of the Nile Delta

PERMIT me to say that Prof. Judd is in error in supposing that I intended to withdraw my statement that desert sand underlies the Nile alluvium at a very moderate depth. The general succession of the newer deposits of Lower Egypt, according to the information I have been able to obtain (and which I have endeavoured to state as plainly as possible) is as follows, in descending order: (1) Modern alluvium, varying from zero to about 40 feet, and of course more in old eroded channels. (2) Desert sand of the Post-Glacial continental period. (3) Pleistocene or Isthmian deposits, lacustrine, estuarine, or marine. The question is not whether this succession exists—that I am prepared to argue on other grounds—but whether it appears in any or all of the recent borings. It is scarcely necessary to say that such general succession admits of alternations at the junctions of beds, and of local absence of some of its members. On finding, however, that the recent borings had been stopped by quicksand at the depth of about 35 feet, and that this quicksand consisted of the rounded grains of desert sand, and was mixed with gray clay or marl, and concretions like those of the Isthmian formation, I naturally concluded that the succession above referred to was distinctly indicated. Prof. Judd now affirms, as I understand, that, in all the Delta borings, mud of "precisely similar mineral character" to that of the surface extends to the bottom. The evidence of this, as well as the promised consideration of the other points to which I have alluded, I am content to wait for till the report appears in full. J. WM. DAWSON

Montreal, February 18

On the Intelligence of Dogs

When reading in Nature of November 12, 1885, the abstract of Sir John Lubbock's paper "On the Intelligence of Dogs," I called to mind an incident of a little Blenheim spaniel which belongs to my mother.

The readers of Nature may perhaps be a little tired of stories relating to the intelligence of the dog, especially when these are illustrations of the effects of training. My excuse for troubling you now is that the following incident seems to indicate a singular power of *reasoning*.

"Middy" was about nine months old when he was picked off the streets of Melbourne, and he had many traits of the "larrikins," as the human waifs there are called. He had been three months in our family, and we had almost begun to despair of breaking him in to civilised life.

One Sunday my sisters set off for Sunday-school, and were surprised, on nearing the church, to find "Middy" at their heels. He was told to "go home," and he was found at the house on their return. Nothing more was said on the subject, which was forgotten by the next Sunday. But when my sisters entered the school-room on that day, great was their amusement to see the little dog seated calmly as a scholar in one of the classes! He behaved quite quietly during the lessons, and then left with the children, and trotted home alone. To prevent constant repetitions of this behaviour, he had to be caught hours before school-time and shut up. He was very clever in evading capture—crept into hiding early in the day, and bolted when we were off guard. On these occasions he was certain to be found in his place at school.

It perhaps should be especially noted that "Middy" had never been to the church before, and that a whole week had elapsed between his first and second attempts.

Mary Knott

7, Kaga Yashiki, Tokio, Japan, January 20

Frost in Devonshire

The Rev. A. D. Taylor, Rector of Church Stanton, a parish in Devonshire, some 900 feet above sea-level, writes me under date of the 22nd inst. :—

"We have had for three days the most wonderful rime. The trees have been covered, every twig and bud, with ice, on the average an inch at least in depth. I have measured several pieces, and have found them 1¼ to 1½ inches from base to edge. The whole place has been like fairy-land, or a silver country. To-day it has all fallen, with a continuous rushing and rattling on the bushes for four hours. The very leaves of the laurels were so frozen that you could take off each leaf a perfect *ice-leaf*—an exact reproduction in transparent ice, of about twice the thickness of this (ordinary letter) paper, of the laurel leaf—every vein and unevenness of edge distinct and clear. The children collected scores of them, and very lovely they looked. I have never seen anything of the sort which would compare with it. The people call it *rangling* (phonetic spelling), a queer word of which I never heard before."

Keen frost in an excessively moist air no doubt sufficiently explains the beautiful phenomenon itself; but can any Devonshire man explain the country people's word?

Bregner, Bournemouth, February 24 Henry Cecil

"Pictorial Arts of Japan"

In my review last week of Mr. Anderson's "Pictorial Arts of Japan" I inadvertently wrote the "eight Nirvanas" of Gautama instead of the "eight incidents (more properly 'features'—*ya siang*) of the Nirvana."

F. V. Dickins

University of London, Burlington Gardens, W., March 1

DISCOVERY OF A NEW ELEMENT BY CLEMENS WINKLER[1]

In the summer of 1885 a rich silver ore was found at Himmelsfürst, near Freiberg; it was pronounced by A. Weisbach to be a new mineral, and was named *Argyrodite*. T. Richter examined its behaviour in the blow-pipe flame, and found that it consisted chiefly of sulphur and silver together with a little mercury, which latter element has never before been found at Freiberg.

[1] From the *Berichte* of the Berlin Chemical Society, No. 3.

The author has analysed the new mineral, and finds that the amount of mercury only amounts to 0·21 per cent., whilst silver is present to the extent of 73-75 per cent., and sulphur to the extent of 17-18 per cent. He also finds a very small quantity of iron, and traces of arsenic. However often and however carefully the analysis was conducted, a loss of 6-7 per cent. always remained unaccounted for. After a long and laborious search for the source of this error, Clemens Winkler has at length succeeded in establishing the presence of a new element in argyrodite. *Germanium* (symbol Ge), as the new element is called, closely resembles antimony in its properties, but can, however, be sharply distinguished from the latter. The presence of arsenic and antimony in the minerals accompanying argyrodite, and the absence of a method of sharply separating these elements from germanium, made the discovery of the new element extremely difficult.

The author, having a more detailed communication in view, confines himself to the following particulars:—

When argyrodite is heated out of contact with the air, which is best effected in a current of hydrogen, a black crystalline and moderately volatile sublimate forms, which melts to brownish-red drops, and which consists principally of germanium sulphide, together with a little mercury sulphide. Germanium sulphide dissolves readily in ammonium sulphide, and, on the addition of hydrochloric acid, is thrown down again in a pure state as a snow-white precipitate, which is immediately dissolved when treated with ammonia; the presence of arsenic or antimony colours the precipitate more or less yellow.

On heating germanium sulphide in a current of air, or on warming it with nitric acid, a white oxide is produced which is not volatile at a red heat and which is soluble in potash solution; when the alkaline solution is acidulated and submitted to the action of sulphuretted hydrogen, the characteristic white precipitate is produced.

The oxide is readily reduced by hydrogen, whilst the sulphide on account of its volatility is more difficult to reduce. The element, like arsenic, has a gray colour and moderate lustre, but is volatile only at a full red heat, and is decidedly less volatile than antimony. Its vapour condenses to small crystals recalling those of sublimed iodine; these show no tendency to melt and could not be confounded with antimony.

When germanium or its sulphide is heated in a current of chlorine it yields a white chloride which is more readily volatile than antimony chloride; its acidulated aqueous solution yields a white precipitate with sulphuretted hydrogen.

The author intends to undertake the determination of the atomic weight of germanium, even if it can be decided only approximately, as this will show whether the new element is to occupy the vacant position in the periodic system between antimony and bismuth.

THE STORY OF BIELA'S COMET[1]

II.

Brandes, one of the two German students spoken of, was riding in an open post-waggon on the night of Dec. 6, 1798, and saw and counted hundreds of these shooting-stars or meteors. At times they came as fast as six or seven a minute. These meteors which Brandes saw that night we know now were bits from Biela's comet. In November 1833 occurred the famous star-shower, which some of you saw. The facts of that shower gave to two New Haven men, Profs. Twining and Olmsted, the clue to the true theory of the shooting-stars. From that date

[1] A Lecture delivered by Prof. H. A. Newton, on March 9, 1874, at the Sheffield Scientific School of Yale College, U.S. From the *American Journal of Science*. Continued from p. 395.

shooting-stars have belonged to astronomy. The November meteors were admitted a new constituent of the solar system. Three years later, M. Quetelet, of Brussels, found that shooting-stars are to be seen in unusual numbers about August 10 of each year. A few months afterwards Mr. Herrick made independently the same discovery; but he also told us of star-showers in April and January. What Brandes had seen in December 1798 led Mr. Herrick, moreover, to expect a like shower in other Decembers, and he asked that shooting-stars be looked for on December 6 and 7, 1838. This shrewd guess was justified, for on the evenings of those days hundreds of these meteors were seen in America, in Europe, and in Asia by persons thus induced to look for them. These shooting-stars also had once been parts of Biela's comet, though this fact was not dreamed of at that time.

In the course of time we came to know more about the meteoroids: that in general they moved in long orbits like comets, rather than round ones like planets; that some of them were grouped in long, thin streams, many hundreds of millions of miles long, and that it was by the earth's plunging through these that we have star-showers; that the space travelled over by the earth has in it everywhere some of these small bodies, probably the outlying members of hundreds of meteoroid streams.

Also the periodic time and the path of the stream of November meteoroids were found out. Then came the interesting discovery that in this stream, and in that of the August meteoroids, lay the paths of two comets. Then Dr. Weiss of Vienna showed that the meteors seen



Fig. 9.

by Brandes in 1798, and by Herrick in 1838, as well as many meteors seen near December 1 of other years, and the Biela comets, all belonged to each other.

It is then properly a part of my story to show you the behaviour of one of the streams of meteoroids. Standing several hundreds of miles away, see them enter the upper atmosphere. They are entirely unseen until they strike the air. They then come down like drops of fiery rain a few miles, in parallel lines, burning up long before they reach the ground (see Fig. 9). The air is in fact a shield, protecting the men below from a furious bombardment. The region of the luminous tracks is many miles above that of the highest mountains.

Go farther away. Parallel lines may show the paths of the meteoroids (Fig. 10), though the bodies themselves are too small to be seen. They strike a little way into the air, to some persons coming from the zenith, to some coming obliquely, to some skimming through the upper air—and unseen by all upon one whole hemisphere. I need hardly remind you that sunlight, and twilight, and clouds often come in to prevent the seeing of the star-flights by persons below.

Go still farther away. From outside look in toward the sun upon the earth and meteoroid stream. The meteoroids in fact are not to be seen. The stream is of unknown depth, perhaps millions of miles deep. Its density increases in general toward the centre. We cross the densest part of the November stream in 2 or 3 hours, and the whole of it in 10 or 15 hours, while the passage of the August stream requires 3 or 4 days. The Biela stream is crossed obliquely, the meteoroids overtaking the earth. The August stream is nearly perpendicular, and the November stream meets the earth.

Again go still farther away, out to the point from which we first looked down upon the earth and comet. We then see (by the mind's eye) the meteoroids strewn along the elliptic orbit of the comet for hundreds of millions of miles, forming a stream of unknown breadth, but in the

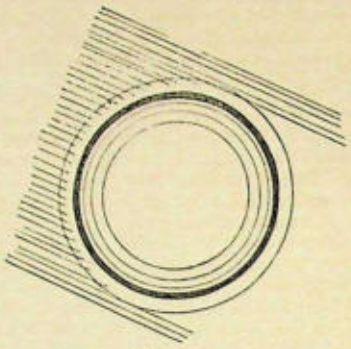


Fig. 10.

scale of the first figure shown you about $\frac{1}{30}$ of an inch in thickness.

Come back now and stand inside the stream, at its densest part. You in fact see nothing; but the meteoroids are all about you scattered quite evenly, and distant each from its nearest neighbours 20 or 30 miles. They all travel the same way and with a common motion.

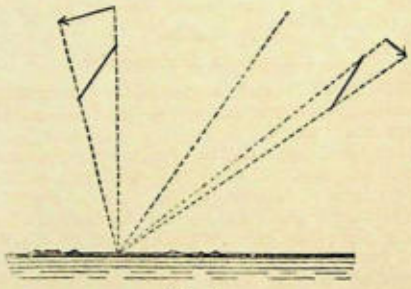


Fig. 11.

Once more change your place and look up from the earth's surface. The meteoroids can now be seen, for when they strike the air they burn with intense light, becoming shooting-stars. As it is from this position only that we ever see them, note their behaviour with more care. A shooting star coming toward you appears only as a bright stationary point in the sky. That point is a

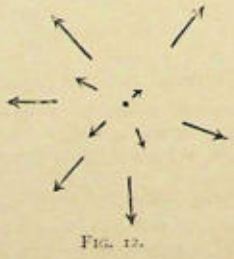


Fig. 12.

marked one in every star-shower, and is called the radiant. The meteors to the right and left of the stationary one are, in fact, moving in the common direction, but they seem to move in the sky away from the radiant (Fig. 11). In other words, the tracks produced backward will all meet in one point in the sky (Fig. 12). This radiant-point may be in the horizon, or in the zenith, or at any place

between. It will in general rise in the east and set in the west, like the sun or a star, keeping always its fixed place among the stars.

Need I tell you how much we would like to have some of these bits from the meteoroid streams to handle, to try with the blowpipe and under the microscope, perhaps thus to learn something of their history? We do have something like this. At times large meteor masses come crashing into the air. They burn with a light bright enough to be seen over several States. Coming down usually a little lower than the shooting-stars, most frequently to a height of 25 or 30 miles, they break up with a noise like the firing of heavy artillery, to be heard over several counties. Fragments scattered in every direction fall to the ground over a region 10 or 20 miles in extent. I can show you several such fragments. There are over a hundred of them in our College Cabinet, one of which weighs nearly a ton.

Between these stone-producing meteors and the faintest shooting-star I cannot find any clear line of division. We have meteors that break with a loud detonation, but no fragments are seen to fall. One such was seen in 1860 from Pittsburgh to New Orleans, and from Charleston to St. Louis. It exploded over the boundary line of Tennessee and Kentucky. We have others which are only seen to break into pieces, no noise being heard. Then we have those which quietly burn out. Like the larger ones, these may leave smoky trains that last for minutes. One such I have seen for 45 minutes as it slowly floated away in the currents of the upper air.

Thus through the whole range, from the meteors that give us these stones and irons for our museums, down to the faintest shooting-star hardly seen by a person watching for it, we pass by the smallest differences. They differ in size, in colour of flame, in direction, in train, in velocity. But in astronomical character all seem to be alike. They move in long orbits like comets, and like comets at all angles to the earth's orbit. In fact, a meteoroid is a small comet, not having, however, the comet's tail.

Let us turn from this long digression again to the story of Biela, and tell you what we saw of it in November 1872. We of course looked for a few fragments from the comet the last week in November, but not quite as early as the 24th. But on that evening they came, in small numbers it is true. Before midnight we saw in New Haven about 250 shooting-stars, three-fourths of them from Biela. Very few of them were to be seen the next morning and evening. Then for a day or two it was cloudy. But in the early part of the evening of the 27th they came upon us in crowds. Over 1000 were counted in an hour. By 9 o'clock the display was over. But we saw only the last few drops of a heavy shower. Before the sun had set with us the shooting-stars were seen throughout all Europe, coming too fast to be counted. At least 50,000, perhaps 100,000, could have been seen then by a single party of observers.

Notice what was really seen. Here is a chart of the paths of the shooting-stars as actually seen on that evening, and drawn with care at the time upon maps of the stars (Fig. 13). You see a few stray flights cutting wildly across the others. These are strangers to the system.

You see also that the paths do not, as we had reason to expect, all meet in one point. This is not due to errors of observing, for we see it in every star-shower. It is probably because the small bodies glance as they strike the air, just as a stone skips on the water. In fact, we often see the meteors glance in the air—the paths being crooked.

The meteors came from the northern sky. A German astronomer, Prof. Klinkerfues, at once thought that if this was the main body of the comet it ought to be visible as it went off from us. For this, however, we must see the southern sky. He telegraphed to Mr. Pogson at Madras in India: "Biela touched earth Nov. 27. Search near Theta Centauri." Mr. Pogson looked for the comet and found it. On two mornings he saw a round comet with decided nucleus, and having on the second morning a tail 8' long. But clouds and rain returned the next day. This is the last that has been seen of Biela's comet.

Was this Pogson comet one of the two parts of Biela seen in 1845 and 1852? This is yet an open question among astronomers. It may have been, but I think it was not. The Biela comets should have been nearly 200,000,000 miles away. Their orbits had been computed with care. The comets, as single or double, had been observed for 80 years, that is 12 revolutions, and we knew well their orbits. All known disturbing forces had been allowed for. It could hardly be that they should have gone so large a distance out of the way. It is much more probable that this was a third large fragment, thrown off centuries ago. The two observations made by Mr. Pogson were not enough to compute an orbit from, but they do

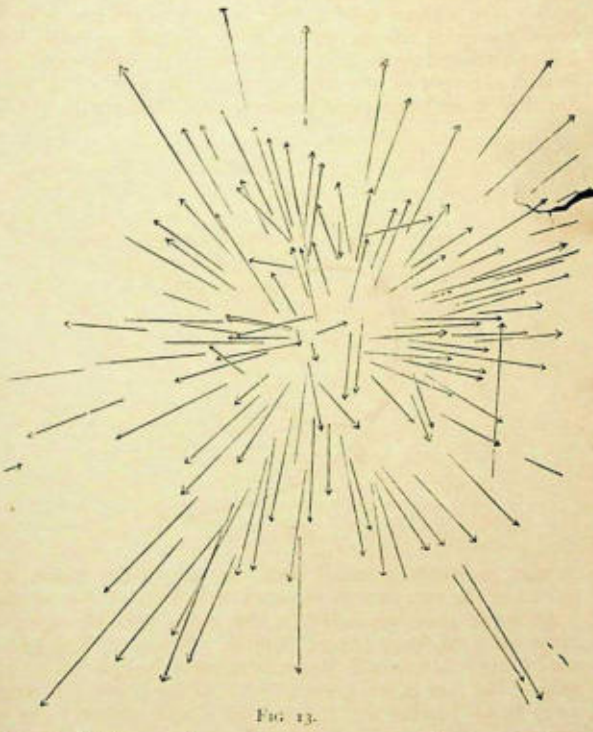


Fig. 13.

show that his comet was very near us, and were such as one travelling in the Biela stream might give. But they also show that the earth did not pass through the Pogson comet centrally.

Orbit of the Biela Meteors.—In 1798, when the earth was at N, and Brandes saw the fragments from Biela, the comet was at C (Fig. 14). In 1838 Mr. Herrick and others saw such fragments of the comet at N, 300,000,000 miles ahead of the main body at A, and in 1872 we met like fragments at N, 200,000,000 miles behind the main body, which should have been at B. Thus the fragments are strewn along the comet's orbit, probably in clusters, for at least 500,000,000 miles.

My story of Biela's comet and of its fragments has covered 100 years. Do we get any glimpses of its earlier life, and can we guess how it grew into its present shape? Yes, we may make our hypothesis. But we must not forget that to tell others how God must have made the world is bewitching to many minds, and that of the thousands of trials at world-building almost all have been grievous failures. With this caution let me give you a plausible form of this early story of Biela.

Once upon a time, hundreds of thousands of years ago, this comet was travelling in outer space, among the fixed stars, too far away to be attracted by the sun. What I mean by this outer starry space may be told by the help of the pictures I have shown you. In them the earth's distance from the sun is 10 inches, and the comet's longest range about 5 feet. Upon the scale of these figures only a few of the nearest fixed stars, perhaps two or three only, would be in the State of Connecticut. In this starry space the comet was travelling. What had happened before I do not try to guess. How, when, by what changes, its matter came together, and had become solid, I do not know, nor whether, in fact, it had not always been solid.

In the course of time its path and the sun's path through space lay alongside of each other, and the sun drew the comet down toward itself. If the comet had met no resistance as it ran around the sun, whether from the ether that fills space, or from the sun's atmosphere, and if it had not come near any of the planets, it would have gone off again into outer space whence it came. Some such cause robbed it of a little of its momentum, and it could not quite rise out of the sun's controlling force, but it came around again in an elliptic orbit to remain thenceforth a member of the solar system. It may or it may not then have been a great comet, like Donati's (in 1858).

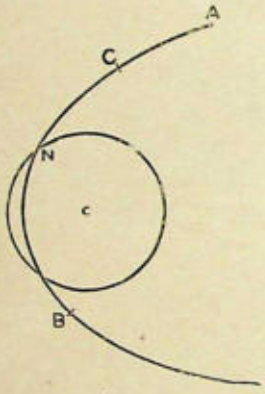


Fig. 14.

It was probably a small one. It may have made its circuit of the sun in tens of years or in tens of thousands.

At some time, probably in the early historic ages, it came near the huge planet Jupiter. When it had gone out of his reach it had just momentum enough left to go around the sun in its present orbit of 6¾ years. It went away from Jupiter an entire and single comet. As it came near the sun, his burning heat acting upon the cold rocky body of the comet cracked off and scattered in every direction small angular bits. At the same time a very thin vapour, shining by its own light, was set free. To this vapour both comet and sun had an unaccountable repulsion. It was driven off first by the comet every way. But soon that which was sent toward the sun was driven back again, and it went streaming off into space to form the comet's tail, a process ably set forth by Prof. Norton.

This matter which made the tail of the comet never got back. It had, moreover, nothing whatever to do with the meteoroid stream. The meteoroids are solid fragments. To them the sun, at least, had little repulsion. The comet was so small that perhaps the force with which a boy can throw a stone would have sent the bits of stone entirely off the comet, never to come back. Those which were shot forward from the comet near P (Fig. 1) went up along the orbit with greater velocity and rose higher from the sun than the comet did near D. Having a longer road to travel, they took a longer time to come around to P in each circuit. On the other hand, those bits which were shot backward followed the comet with less velocity and could not quite rise to D, and so having a shorter road to go over came sooner back to P, gaining on the comet at each circuit. Thus the stream grew longer slowly, and new fragments being thrown off at each circuit, the meteoroid stream grew in length to its hundreds of millions of miles. At times, the main comet has broken into two or more parts, giving us the double comets of 1845 and 1852, the Pogson comet of 1872, and the double meteor stream of November 1872.

THE NAVIGABLE BALLOON[1]

M. RENARD, captain of the Chalais-Meudon navigable balloon, has presented to the French Academy of Sciences a report of the experiments made with that balloon last year. Before starting on a fresh campaign in 1885, it was found necessary to make certain modifications in the construction of the balloon, affecting the ventilator, voltaic piles, commutators, &c. To measure the velocity of the balloon, an anemometer, the registrations of which would be too strong, seeing that the spiral is placed in front, was impracticable. There was no inconvenience, on the other hand, in the use of an aërial log. A balloon of gold-beater's skin, 120 litres in capacity, was accordingly filled in part with common gas, so as to keep exactly in equilibrium in the air. This balloon was attached to the central extremity of a bobbin of silk thread just 100 metres in length. The slightest effort is sufficient to unroll this bobbin when the central thread is drawn. The other extremity of the thread is wound round the finger of the operator. To obtain a measurement of speed the balloon is let go, when it quickly flies to the rear, and, on reaching the end of its line, conveys a perceptible indication of the fact in the finger holding the thread. The instant of its departure and that of the twitching sensation in the finger at its terminus are marked on a chronometer counting tenths of a second. Although the force transmitted to the small balloon during the unwinding of the thread is very slight, it is yet necessary to take account of it. Repeated trials in a closed place showed that the little balloon swerved 7 metres per minute, or 0·117 metre per second, under the influence of this light effort. If, then, *t* be taken as the time in seconds elapsing in the process of unwinding, the way traversed by the navigable balloon during the opera-

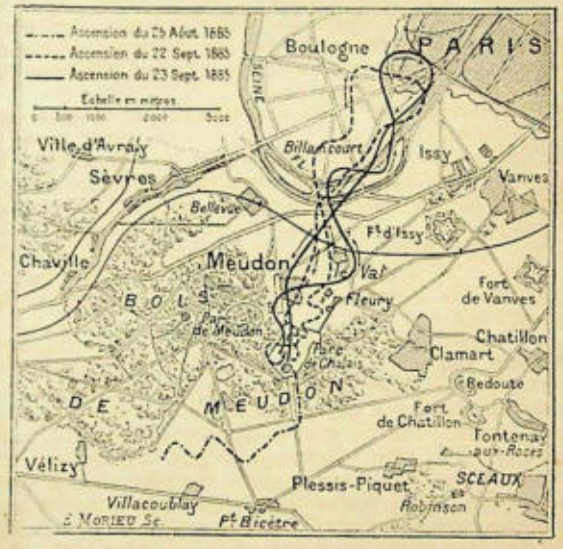


Fig. 1.—Map of the journeys of the *La France* balloon.

[1] From *La Nature*.

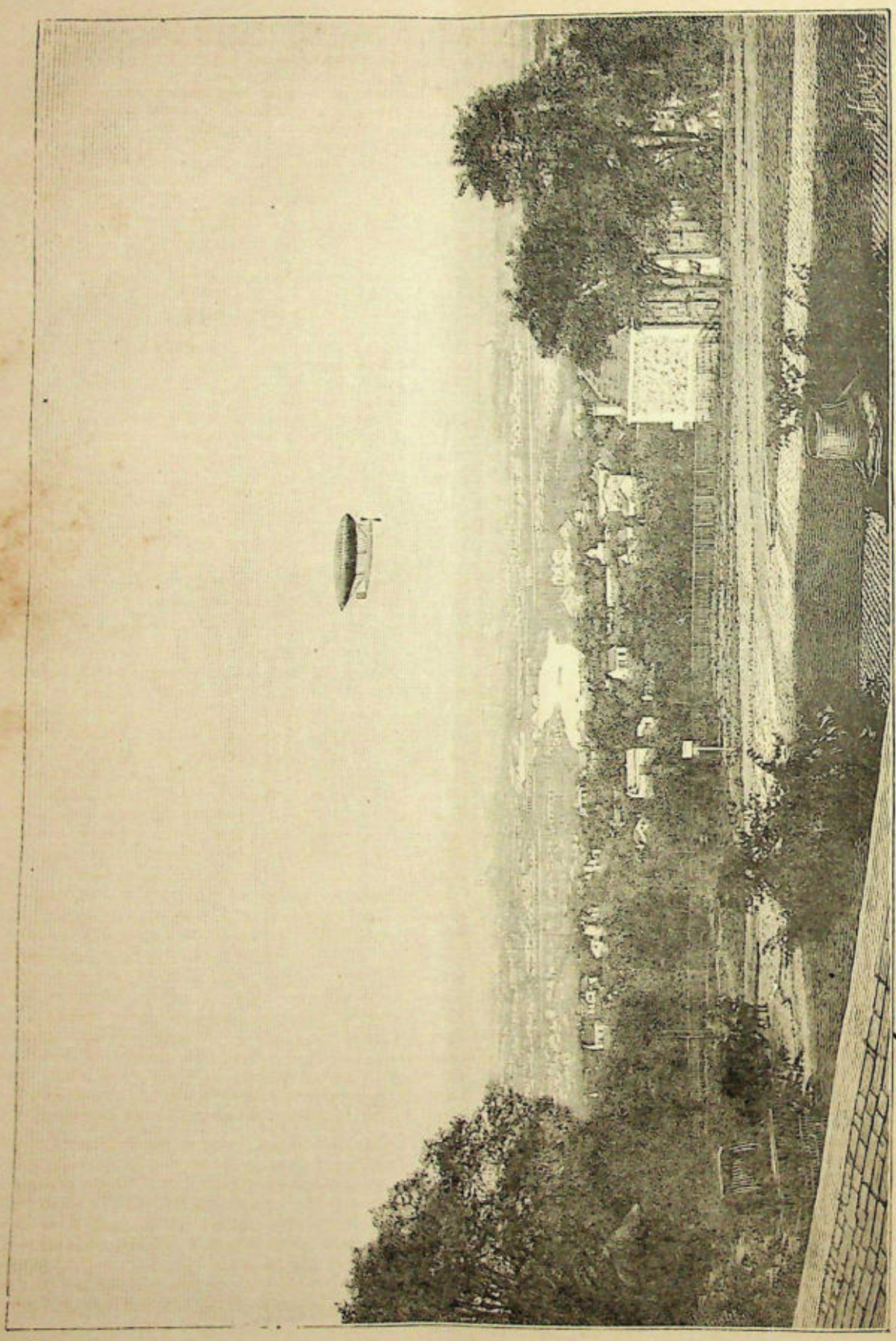


FIG. 2.—The *La France* above the Pont-du-Jour, Paris. Facsimile of an instantaneous photograph executed at the Observatory of Phys al Astronomy, Meudon.

tion of unwinding will be $100 + 0{\cdot}117\,t$, and the speed of the balloon will be given by the formula—

$$S = \frac{100}{t} + 0{\cdot}117.$$

The preparations above referred to having been all completed, on the first fine day thereafter, August 25, the new mechanism was put on its trial, and behaved in a manner leaving nothing to be desired.

The balloon, which had been already filled for a certain *time*, having lost a considerable portion of its ascending force, M. Renard was under the necessity, on this occasion, of dispensing with the services of a third aëronaut, and mounted in the company solely of his brother, Capt. Paul Renard. The wind blew from the east. The speed measured at a low height by means of small balloons, appeared to be no more than 5 metres a second. Taking as a basis the approximate values of the preceding year, they calculated on obtaining a proper speed of nearly 7 metres per second, and were greatly surprised at being unable to gain the aërial current which prevailed at 250 metres above the valley of Chalais. The spiral, launched at fifty-five rounds per minute, proceeded with perfect regularity, yet they fell back—slowly, indeed, but continually. Desiring, nevertheless, to continue the experiment, and fearing to be carried away above the woods of the Chaville quarter, M. Renard turned the head of the balloon a little to the right, and soon, under the combined action of the wind and its own speed, it took a southern direction, and, the backward movement continuing, alighted after a voyage of 50 minutes close by the farm of Villa Coublay, whither he had directed it.

By reason of the bad weather the second definitive experiment did not come off till September 22, when the wind was blowing from the north-north-east—that is, from Paris, and its velocity in the lower strata varied from 3 to 3·50 metres per second. This time the aëronauts had their full complement of three: Capt. Renard at the helm and the motory machine, Capt. Paul Renard taking measurements and various observations, and, in addition, M. Duté-Poitevin. They started at 4.25 p.m. in a moist and foggy atmosphere. The spiral was set in motion and the head directed towards Paris. Though at first inclined to yaw, the course of the balloon soon righted itself, and, crossing the railway line above the station at 4.55, the balloon reached the Seine towards the western extremity of the island of Billancourt at 5 o'clock. Here, a measurement being taken, the progress of the balloon was found to be precisely 6 metres per second (time of unwinding = 17″, whence

$$S = \frac{100}{17} + 0{\cdot}117 = 5{\cdot}882 + 0{\cdot}117 = 5{\cdot}999\text{ m}).$$

At 5.12 p.m., after an excursion of 47 minutes, the balloon entered the enceinte by the bastion 65. It was only the increasing damp and fog which induced the aëronauts to cut short their voyage and make for home. The turning of the balloon was easily effected, and, aided this time by the aërial current, it approached its point of departure, which was entirely concealed by the fog, with surprising rapidity, retracing in 11 minutes the road it had taken 47 minutes to cover in going. The aërostat tacked about at first to keep its head to the wind, and in 10 minutes the little skiff touched the sward, whence it had ascended. During this voyage the balloon mounted to only 400 metres above the ground.

The next day before Gen. Campenon, Minister of War, and Gen. Bressonnet, President of the Committee of Fortifications, the balloon, *La France*, performed a fresh ascent with a success equal to that of the previous day. The itinerary of this voyage was much the same as that of the 22nd. The wind was weaker and bore the balloon to Paris. The time of the passage was 17 minutes going, 20 returning. The landing was very easy, and the balloon returned to the precise spot of its departure. The voyage could not be further prolonged for lack of ballast, the previous ascent having cost the balloon a partial loss of its ascending force.

On the valid basis of the experiments above described, M. Renard lays down some fundamental formulæ for calculating the resistance of balloons of construction analogous to that of *La France* with network and car.

Let R be the resistance in kilogrammes of the balloon *La France*, moving by the point; S, its speed per second in metres; θ, the work of direct traction (motory work in kilogrammetres); T, the work of the propelling screw shaft (in kilogrammetres); T', the work at the limits of the motive power in kilogrammetres); then

$$(1)\quad \begin{cases} R = 1{\cdot}189\,S^2. \\ \theta = 1{\cdot}189\,S^3. \\ T = 2{\cdot}300\,S^3. \\ T' = 2{\cdot}800\,S^3. \end{cases}$$

At the rate of 10 metres, which would suffice for having the direction in most cases, we get

R = 118·9 kilogrammes.
θ = 1189 kilogrammetres.
T = 2300 kilogrammetres, or 31 horse-power.
T' = 2800 kilogrammetres.

In general for a balloon of D diameter (in metres) we would get

$R = 0{\cdot}01685\,D^2\,S^2.$
$\theta = 0{\cdot}01685\,D^2\,S^3.$
$T = 0{\cdot}0326\,D^2\,S^3.$
$T' = 0{\cdot}0397\,D^2\,S^3.$

It may be added that out of seven voyages, from August 9, 1884, to September 23, 1885, the aërostat has in five returned to its point of departure.

NOTES

With much regret we announce the death of the eminent Belgian botanist, Prof. C. J. E. Morren, of Liége, at the early age of fifty-three years.

At a meeting of the Managers of the Royal Institution, held on Monday, March 1, the Actonian Prize of one hundred guineas was awarded to Prof. G. G. Stokes, P.R.S., for his lectures on Light, in conformity with the Acton Endowment Trust Deed. The following alteration has been made in the lecture arrangements before Easter:—Prof. Dewar, F.R.S., will begin a course of four lectures on Electro-Chemistry, on March 25, in place of Prof. Tyndall, F.R.S., on Light.

Dr. Julius von Haast, C.M.G., F.R.S., the eminent geologist and Director of the Canterbury Museum, New Zealand, who is charged as Commissioner with the exhibits from that colony for the Colonial and Indian Exhibition, has arrived in London, and is busily at work in carrying out all the preliminary arrangements of the extensive court allotted to New Zealand. Dr. von Haast has been exceedingly successful in his journeys through the colony in obtaining large and valuable collections illustrating the fauna, flora, and geology, as well as collections of the art and industry of the Maori tribes. The food and other fishes, the birds, the timbers, as well as other native products and local industries will be well represented.

M. Pasteur, at the last sitting of the Paris Academy of Sciences, stated that out of 325 cases of inoculation for hydrophobia, only one had failed—namely, that of the youth Pelletier, who came too long after being bitten, and under very unfavourable conditions. He advocated the establishment of an international hospital, to which patients would come from all parts of the world; and he suggested a discussion as to the locality and the fund for its support. At the close of the meeting Prof. Pasteur announced that he should next investigate whether diphtheria could not be treated by a similar process to that which he had found so successful against hydrophobia.

M. Chevreul caught a cold a few days ago, and some anxiety was entertained for his health, owing to his great age rather than to the gravity of the indisposition. We are glad to learn that he has since improved. His 101st birthday will take place on August 31 next.

It is probable that the Observatory of Montsouris will be discontinued as an independent establishment. M. Marie-Davy will be placed on the retired list, and the credits paid in support of Montsouris suppressed entirely. It will become the head-quarters of the Central Bureau of French Meteorology.

The *Colonies and India* states that it is the intention of Mr. Morris, on leaving Jamaica to take up his appointment at Kew, to make a tour of the West India Islands for the purpose of becoming personally acquainted with their circumstances and resources, and with the view of being able afterwards to give them advice and assistance in the development of new industries. Several of the islands have already been visited by him, but it is said to be his intention to make now a careful study of their circumstances, to be afterwards embodied in a special report, or utilised in directing the resources of Kew to the amelioration and improvement of West Indian industries.

At the Scottish Geographical Society on Tuesday afternoon, March 9, at 4 o'clock, a paper will be read by Prof. James Geikie, F.R.S., Vice-President of the Society, entitled "The Evolution of Europe."

The Department of Public Works in Japan having recently been abolished as a separate office of State, much interest is felt, especially by scientific Europeans in the Japanese service, as to the future fate of the Imperial College of Engineering, which, since its establishment, has been under the control of the Minister of Public Works. It has been attached now to the Education Department, but it is uncertain whether it will remain a separate College or will be incoporated with the University of Tokio. In the latter case a considerable readjustment of the staff would take place, as the University has already professors of most of the subjects taught at the Engineering College, and a number of holders of Chairs of scientific subjects would be redundant. Commenting on this subject, the *Japan Mail* says that graduates of the College are found doing useful work in every part of the empire, and so high is the esteem in which they are held that to have been educated there is a certain passport to employment. It possesses the handsomest buildings and the most perfectly-equipped laboratories and museums of any educational institution in Japan, the University not excepted, and hence it would be a pity to destroy the individuality of an institution which has been so markedly successful. Accordingly it is suggested that the wisest plan would be to affiliate it to the University, and to transfer the engineering classes of the latter to its care. If any Japanese institution may be said to be British, the Engineering College may be said to be so from its foundation until the present moment. Its Chairs have all been held by English men of science, and are still held by them.

The administration of the Ethnological Section of the Royal Museum at Berlin has commenced the publication of a periodical having for its object the description of the contents and additions to the collection. It is published by Spemann of Berlin. The first number contains an account of Dr. Nachtigal's ethnological collections, of those from Easter Island, a description of the burials of the Pelew Islands by Herr Kubary, also one of the ourney of the collector, Herr Rohde, in Matto Grosso and the Indian tribes of this region. Dr. Grube describes a collection of Taoist pictures; Dr. Grünwedel contributes notices of the iconography of the Lamas of Tibet and Mongolia, and Bishop Thiel supplies a vocabulary from Costa Rica. Some of the papers are illustrated by plates.

The Christiania University has received a valuable collection of ethnographical objects from East Greenland from the Danish Government, as a mark of appreciation of the services rendered by Dr. Knutsen, a Norwegian naturalist, to the expedition under Lieut. Holm, of which he was a member.

The well-known Norwegian *savant*, Dr. Rausch, makes in the Norwegian press an appeal respecting meteors and earthquakes which is not without interest. Respecting the former, he points out the scientific value of these objects, and describes their outward appearance when reaching the earth, with a request that a better look-out may be kept by people than has hitherto been the case. Only two meteorites have hitherto been found in Norway, viz. one in 1848 and one in 1884. Dr. Rausch is, however, of opinion that a great many more have fallen. Respecting the belief prevalent among the peasants that a stroke of lightning is preceded by a stone, said to be dark and burnt in appearance, the so-called "Thorelo," *i.e.* "Thor's wadding," and which are kept on farms as a kind of "household medicine," he ventures to suggest that they are meteorites, and begs those who may possess such to send him a small sample of the same. With regard to earthquakes he begs that a closer attention be given to their duration, extent, and the exact number of shocks, &c., than has hitherto been the case, remarking that only the most minute details will enable us to discover the origin and laws of these important phenomena.

A letter from Bagamoyo, published in *Cosmos*, describes a shower of stars seen there on November 27 last year. There were at the time neither moon nor clouds; the firmament was of a sombre blue. The phenomenon commenced at 7 o'clock, and the writer watched it until 9. Again he observed it at 11, and he was informed that it lasted all night. Bagamoyo is situated at 6° 23′ south, and 36° 30′ east of the meridian of Paris. Putting the average fall at eight per second, which he believes to be below the actual number, the number for the twelve hours of the night would be about 350,000 asteroids. They came from all points of the heavens, but they appeared to increase sensibly as one ascended from the horizon towards the zenith. Usually they fell singly, but sometimes a single constellation of five, eight, and ten at a time fell. Their luminous course was uniformly directed towards the south, south-east, and south-west. They did not appear to form curves, but rather to advance rapidly in straight lines. Many were like ordinary shooting-stars, but others left behind them a luminous trail of extraordinary vividness and beauty. White was the commonest colour in the train, but many had a red, yellow, and orange tint. Each lasted about a second, but some persisted for five and even ten seconds. No sound or smoke was perceived, and the phenomenon was followed by no notable change in the atmosphere. Two days after some thunder was heard and a few drops of rain fell. It is noted as curious that an old wise man on the coast had predicted shortly before that fire would fall from heaven shortly; possibly he had recognised a certain periodicity in the shower.

We have received the first part of vol. i. of the *Annalen* of the Imperial Natural History Museum of Vienna, edited by the Director, Baron von Hauer. This part contains an account of the year's work of the Institution, the organisation of which and the arrangement of the new buildings were described in a recent number of Nature. As the Museum includes all departments of natural history in its widest sense—geology, zoology, botany, anthropology—it will be evident that the year's work will be full of interest. This part is the first of what promises to be a series of papers issued at frequent intervals. In the next number will be papers on new species of fish from the Orinoco and Amazon, by Dr. Steindachner; on new and rare antelopes in the Museum, by Dr. Kohl; and on the flora of South Bosnia and neighbouring regions, by Dr. G. Beck.

WE referred in a previous number to ova having been artificially spawned from sea-trout, *S. trutta*, at the South Kensington Aquarium, which had been retained in captivity for three years, and had therefore not visited the sea. The ova have since become incubated, and the fry, which are hybrids, appear to be in a healthy state. The mortality amongst them is heavier than with those produced from ordinary fish, especially at the period when emerging from their shell. There is an abnormal number of monstrosities amongst them, which never live beyond a few days. The ova produced from fish in captivity occupy a longer time in hatching out than those spawned from wild fish. Owing to the severity of the weather this season, hatching operations have been greatly retarded, but the fry seem to be more vigorous and healthy in consequence.

TO show the value attached to the *S. fontinalis*, or brook-trout of America, when first introduced into this country some few years since, it may be mentioned that, according to the price-lists issued by pisciculturists at the time, 100*l.* per thousand was charged for them. The same amount was mentioned for whitefish, which, until last year, were not successfully acclimatised to our waters. The price charged at the present day for the same fish is about 2*l.* per thousand.

DR. J. P. LICHERDOPOL writes under date February 23 from Bucharest (Roumania):—"Yesterday at 3.40 p.m. a slight shock of earthquake was noticed here, followed by two others strong enough to make objects hung on the walls move. Atmosphere calm, but covered with fog. No damage."

THE telephone system of Stockholm is developing rapidly: on January 15 it had 3164 subscribers, against 2335 in the beginning of 1885, and 865 in the previous year. Last year there were over 4½ million communications, of which 85,000 were by night. The subscription is about 7*l.* a year. Stockholm is connected by telephone with several neighbouring towns, the furthest being Trosa, 50 miles distant.

AT a recent meeting of the Paris Medico-Psychological Society, M. Rey (who was intrusted with documents, &c., left by Broca) gave the results of 347 observations by that eminent man on the weight of the three cerebral regions (*a*) the frontal lobes, (*b*) the occipital lobes, and (*c*) the parietal regions. In men the ratio of these parts to the brain is (*a*) 1 : 2·33, (*b*) 1 : 10·66, (*c*) 1 : 2·12. In females (*a*) 1 : 2·32, (*b*) 1 : 9·88, (*c*) 1 : 2·13. In men the left frontal lobe has more weight than the right; but the difference between the two diminishes with the weight of the whole organ. In the case of the occipital lobes and the temporal regions the right side preponderates over the left. In old men the loss of weight in the parieto-frontal regions is more sensible than that in the frontal and occipital lobes. It is still more pronounced in women; so that, while in adult age men have proportionally more in the frontal lobes, this proportion is reached by women in old age. In men the frontal lobes only attain their greatest weight at 35 years of age; but at 25 the parieto-temporal regions have their maximum weight. In women, with regard to the anterior lobes, there is little difference between 25 and 35 years of age.

MR. VAN VOORST has in the press and will very soon publish a new and enlarged edition of Prof. Mills' "Manualette" of the destructive distillation of petroleum, rosin oil, coal-tar, and kindred industries, with illustrations of shale retorts.

THE February number of *Petermann's Mittheilungen* contains a paper by Dr. Andries on the causes of the increasing number of accidents by lightning. As to the fact of the increase itself, he shows from statistics that this has, in the last fifty years, been three- to five-fold. In Bavaria the proportion is 1 to 5, and between 1854 and 1877 it has risen from 1 to 2·75 for all Germany. The question now is: Whence arises this striking increase? Various hypotheses have been advanced to account for it. Bezold refers it to varying maximum and minimum periods, the present being one of the former; Karsten attributes it to the decrease of forests, which made houses more and more the prominent points of a neighbourhood; others again allege the increase of lofty buildings, factories, and such like as the cause. Dr. Andries observes that although these may account for some of the increase, they cannot do so for all. Nor do they adequately explain the enormous and sudden increase in such a short period. He states the problem thus: "How can the electrical tension during thunderstorms be so increased that a greater number of bolts strike the earth than formerly? For it is not so much the increasing number of storms as their increased violence that causes the accidents by lightning." The main cause is said by him to be the enormous increase in the last half century in manufactories, locomotives, &c., filling the air with smoke, steam, and particles of dust of all kinds, the increase of population adding likewise to the impurity of the atmosphere. Having arrived at this point, viz. the enormous increase of foreign particles in the atmosphere, and their wide distribution by various currents of air, Dr. Andries describes at some length experiments made by himself and others on the subject, which showed that all the electrical phenomena of the air increased in intensity with the increase of dust in it, and to the same cause he attributes the increased appearances of the aurora borealis. Accidents by lightning in the southern half of the globe should, if this be correct, be much less frequent than in the other half; and this, he says, really appears to be the case. At any rate, he thinks, the southern lights are not visible nearly so frequently as those of the north.

THE additions to the Zoological Society's Gardens during the past week include eight Viscachas (*Lagostomus trichodactylus*) from Buenos Ayres, presented by Mr. E. Vere Dashwood; four American Hares (*Lepus americanus*) from North America, presented by Mr. F. J. Thompson; six Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, presented by the Hon. Sir Julius Vogel, K.C.M.G.; a Macaque Monkey (*Macacus cynomolgus*) from India, fifteen Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, deposited; two Yucatan Blue Jays (*Cyanocitta yucatanica*) from Yucatan, two Great Barbets (*Megalæma virens*) from the Himalayas, purchased; a Red Kangaroo (*Macropus rufus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE BINARY STAR γ CORONÆ AUSTRALIS.—Mr. J. E. Gore has recently computed elements of the orbit of this binary, fixing the periastron passage at 1886·53 and the period at 81·78 years. These elements differ widely from those deduced three or four years ago by Mr. Downing, who, by determining corrections to Prof. Schiaparelli's orbit, from a considerably larger number of observations than have been utilised by Mr. Gore, found the epoch of periastron passage to be 1883·203 with a period of 54·985 years. The position-angles computed from these two sets of elements now differ enormously, as is seen from the following tabular statement:—

Epoch		Angle		Distance	Computer
				"	
1886·0	...	51·3	...	1·28	Downing
1886·53	...	48·5	...	1·44	
1886·0	...	200·7	...	1·20	Gore
1886·53	...	196·7	...	1.13	

We venture to express the hope that those astronomers who can observe this object will not fail to do so in the present interesting stage of its physical history.

THE NEBULA ROUND MAIA.—Prof. E. C. Pickering states, in the *Astron. Nach.*, No. 2712, that the announcement of the discovery of the nebula near Maia by means of photography recalled to him the circumstance that certain peculiarities had been noticed in a photograph of the Pleiades taken at Harvard College Observatory on November 3, 1885. These were supposed at the time to be merely photographic defects, but it

now appears that one of the markings corresponds to the Maia nebula. The other irregularities seem to afford indications of the Merope nebula. There is also a faint narrow streak of light projecting from Electra on the following side.

PROF. LANGLEY ON THE EMISSION-SPECTRA OF BODIES AT LOW TEMPERATURES.—Prof. Langley having traced the solar spectrum in the infra-red so far as $\lambda = 0{\cdot}0027$mm., where it suddenly ceased, has since examined the emission-spectra of various terrestrial substances at temperatures from that of fusing platinum to that of melting ice, and more particularly of temperatures corresponding to the ordinary conditions of the soil. The result of his observations has been to show that the maximum of heat from cold and black bodies has in every case a wave-length greater than 0·0027mm.,—greater, that is to say, than that of the lowest solar heat which reaches us; and that further, that part of these spectra which has a greater wave-length than that of the point of maximum, represents a larger total amount of heat than the part with shorter wave-length. Prof. Langley believes that he has been able, by means of his bolometer, to trace out the emission-spectra of cold bodies so far as $\lambda = 0{\cdot}0150$mm., a wave-length more than twenty times as great as that which Newton found for the lower limit of the spectrum, viz. $\lambda = 0{\cdot}0007$mm.

FABRY'S COMET.—Dr. H. Oppenheim has computed the following fresh elements and ephemeris for this comet:—

T = 1886 April 5·5398 Berlin Mean Time

$\omega = 126^\circ\ 50'\ 27''{\cdot}6$
$\Omega = 36\ 19\ 54{\cdot}0$ 1886·0.
$i = 82\ 11\ 15{\cdot}0$
$\log q = 9{\cdot}804021$

Ephemeris for Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log. r	Log. Δ	Brightness
March 7	23 19 34	31 19·6 N.	9·9441	0·1621	8
11	23 18 54	32 29·8	9·9171	0·1424	10
15	23 18 11	33 42·0	9·8904	0·1191	12
19	23 17 29	34 54·6 N.	9·8650	0·0916	16

The brightness on December 2 is taken as unity.

BARNARD'S COMET.—The following ephemeris by Dr. A. Krueger is in continuation of that given in NATURE for February 18, p. 376:—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log. r	Log. Δ	Brightness
March 6	1 54 54	22 35·8 N.	0·1229	0·2415	4·10
10	1 53 55	23 45·9	0·1001	0·2390	4·61
14	1 53 6	24 58·9	0·0757	0·2352	5·25
18	1 52 26	26 14·9 N.	0·0497	0·2299	6·07

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 MARCH 7-13

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 7

Sun rises, 6h. 34m.; souths, 12h. 11m. 10·0s.; sets, 17h. 48m.; decl. on meridian, 5° 11′ S.: Sidereal Time at Sunset, 4h. 49m.

Moon (two days after New) rises, 7h. 16m.; souths, 13h. 21m.; sets, 19h. 36m.; decl. on meridian, 0° 28′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 54	12 49	18 44	1 47 S.
Venus	5 1	10 30	15 59	6 48 S.
Mars	17 23*	0 15	7 7	9 24 N.
Jupiter	19 10*	1 15	7 20	0 16 N.
Saturn	10 54	19 5	3 16*	22 46 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
8	B.A.C. 408	6½	18 11	near approach	54 —
9	64 Ceti	6	17 31	18 38	118 342
9	ξ Ceti	4½	18 35	19 39	156 310
13	130 Tauri	6	16 49	18 1	91 253

Saturn, March 7.—Outer major axis of outer ring 43″·0; outer minor axis of outer ring 19″·3; southern surface visible.

March h.
10 ... 2 ... Venus stationary.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h.	m.	
T Cassiopeiæ	0 17·1	55 10 N.	Mar. 10,	0	0	m
U Cephei	0 52·2	81 16 N.	,, 8,	20	30	m
			,,	20	16	m
V Tauri	4 45·4	9 42 N.	,, 12,			M
ζ Geminorum	6 57·4	20 44 N.	,, 10,	0	0	m
δ Libræ	14 54·9	8 4 S.	,, 11,	22	10	m
R Coronæ	15 43·9	28 30 N.	,, 12,			M
U Ophiuchi	17 10·8	1 20 N.	,, 9,	2	22	m
			,, 9,	22	30	m
X Sagittarii	17 40·4	27 47 S.	,, 10,	0	0	m
			,, 12,	21	30	M
U Sagittarii	18 25·2	19 12 S.	,, 9,	22	30	m
			,, 12,	22	30	M
S Vulpeculæ	19 43·7	27 0 N.	,, 11,			m
η Aquilæ	19 46·7	0 7 N.	,, 8,	4	50	m
S Aquilæ	20 6·4	15 17 N.	,, 13,			m
δ Cephei	22 24·9	57 50 N.	,, 12,	2	30	m

M signifies maximum; m minimum.

Meteor Showers

Two showers may be looked for on March 7, viz near γ Libræ R.A. 233°, Decl. 18° S.; and near γ Herculis, R.A. 244°, Decl. 15° N. Other showers of the week:—Near ε Cassiopeiæ, R.A. 36°, Decl. 67° N.; from Virgo, R.A. 193°, Decl. 1° N.; from Cepheus, R.A. 300°, Decl. 80° N.

Stars with Remarkable Spectra

Name of Star	R.A. 1886·0 h. m. s.	Decl. 1886·0 ° ′	Type of spectrum
124 Schjellerup	9 45 48	22 29·0 S.	IV.
132 Schjellerup	10 31 54	12 47·6 S.	IV.
D.M. +68°·617	10 37 9	68 0·6 N.	IV.
136 Schjellerup	10 46 5	20 38·8 S.	IV.
56 Leonis	10 50 5	6 47·7 N.	III.
R Crateris	10 54 58	17 42·8 S.	III.
ω Virginis	11 32 35	8 45·9 N.	III.
145 Schjellerup	12 19 24	1 24·1 N.	IV.
152 Schjellerup	12 39 46	46 3·8 N.	IV.
155b Schjellerup	12 51 57	66 36·6 N.	IV.
40 Comæ Ber.	13 0 49	23 13·8 N.	III.

THE SUN AND STARS[1]

II.

First Conclusions

THE view of the solar constitution, which was based upon the early work to which I have referred—work which dates from about the year 1860, and is therefore about a quarter of a century old—the view which grouped together, and endeavoured to make a complete story of all the facts which were known then, was this: the chemical substances which had been found to exist in the sun's atmosphere existed quite close—relatively quite close at all events—to the photosphere. When subsequent work demonstrated the existence of hydrogen to a considerable height above this photospheric envelope, as I shall show presently, the idea was suggested that these chemical substances existed in the atmosphere, not pell-mell, not without order, because Nature is always full of the most exquisite order, but in the sequence of their vapour-densities, so that a very heavy vapour would be found low down in the atmosphere, and a very light one like hydrogen would be high up.

It was at first suggested that gaseous diffusion would prevent such a sorting out, until it was pointed out by an American mathematician, Prof. Pierce, that it was a good deal to ask that diffusion should act along a radius something like a million of miles long, and indeed he showed that it would not.

Before we go farther, I give tables of the different substances which so far have been traced in the sun's atmosphere by means of their spectral lines. The first gives the substances according to the results obtained by Kirchhoff,

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 403.

Ångström, and Thalèn, who were the first workers in this field of inquiry.

TABLE A.—*Elements present in the Sun according to Kirchhoff, Ångström, and Thalèn*

Kirchhoff	Ångström and Thalèn
Sodium	Sodium
Iron	Iron
Calcium	Calcium
Magnesium	Magnesium
Nickel	Nickel
Barium	—
Copper	—
Zinc	—
	Chromium
	Cobalt
	Hydrogen
	Manganese
	Titanium

Another gives the substances which were added to the preceding list by taking a special consideration into account. Some time after the first work on the chemical composition of the solar atmosphere was accomplished, a method was introduced by which it was easy to determine the existence of a small quantity of any particular vapour in a mixture of vapours, so that the substances indicated in the second table are those substances which possibly exist in the sun's atmosphere in a small quantity only.

TABLE B.—*Elements the Longest Lines of which coincide with Fraunhofer Lines*

Certainly coincident	Probably coincident
Aluminium	Indium
Strontium	Lithium
Lead	Rubidium
Cadmium	Cæsium
Cerium	Bismuth
Uranium	Tin
Potassium	Silver
Vanadium	Glucinum
Palladium	Lanthanum
Molybdenum	Yttrium or Erbium

It is important to call special attention to the fact that Ångström and Thalèn, who followed Kirchhoff, did not agree with regard to barium, or copper, or zinc, and they added chromium, cobalt, hydrogen (a very notable addition), manganese, and titanium, the existence of which Kirchhoff had not discovered in the solar atmosphere.

A detailed study of the facts recorded by Ångström gives a good idea of the immense difficulty of the research, and also of the doubts and of the difficulties which were suggested in the very first part of the inquiry. For instance, in the case of sodium, what Ångstrom did, of course, was to get the vapour of sodium incandescent in the laboratory, and he got the eight familiar lines. He then observed whether there were dark lines corresponding with all of them. He found that there were. With regard to cobalt he got nineteen lines, and he found nineteen lines in the sun coinciding with them. But when he studied the spectrum of barium in his laboratory he got twenty-six lines, but of these in the solar spectrum he found only eleven. When he came to aluminium, of the fourteen lines seen in the spectrum of the metal only two existed among the Fraunhofer lines. In zinc it is not yet quite decided whether we even have two out of twenty-seven; so that we see it was not all perfectly plain sailing.

A New View

So much, then, for the chemistry of the solar atmosphere, taken as a whole. Two observations suggest themselves: the first is, that it is perfectly clear that if we have in the sun's atmosphere incandescent iron vapour, and calcium vapour, and magnesium vapour, and the incandescent vapours of many other substances which we generally know here as solid bodies, there must be tremendously strong convection-currents somewhere; for were these vapours at rest they must cool on the outside, and if they get up high enough they will condense, first into liquid particles, and then into solid particles, and then they are bound to go down. So that we see there is a new world of motion in full front of us the moment we are driven to the conclusion that we are really dealing with a mixed mass of gases so intensely hot that its constituents exist in it, except in the coldest parts of it, in a state of vapour. To enable us to think this out a little, let us consider a small part of the sun where we will imagine that the statical condition is as nearly secured as possible, and that then we suddenly upset the temperature equilibrium. When we get any solid particles, say of iron, falling into a region where they will be gradually melted, and then driven into iron vapour, the vapour is bound to reascend—it will not continue in its downward flight; whereas if vapours, by ascending, gradually get cooler and cooler, they must afterwards redescend, falling first, as I have said before, as mist and then in big liquid drops, and finally as solids—as meteorites, if you like: they are bound to go down. To put this in the most general form, we may say that in the sun's atmosphere complex molecules are bound to go down, and simple molecules are bound to go up; so that we shall have convection-currents, as I have already hinted, produced in this kind of way, and these convection-currents must exist wherever the temperature equilibrium is broken. Of course we must assume that these more or less vertical convection-currents may be modified to a certain extent by the rotation of the sun, in the same way as the up and down currents of our own air, and even the currents pole-wise and equator-wise are modified by the rotation of the earth.

The other observation which suggests itself is as follows:—We need not limit ourselves to the general chemical ideas we have acquired; the chemistry of each part of the sun (always above the photosphere) can be examined bit by bit. The photosphere has spots in it; it has the chromosphere above it with the included prominences, the inner corona above that, the outer corona above all. As a matter of fact, all these have now been examined, bit by bit, by the spectroscope—that is from the chemical point of view.

The next point of importance to urge is that a view of the solar constitution has been arrived at in consequence of this new wealth of facts, on which something must be said before we go further.

The old view put the absorbing atmosphere above the photosphere, the various chemical substances being arranged in the order of their vapour-densities, so that hydrogen would be highest, then sodium, then magnesium, till finally we arrive at iron and platinum, and so on.

Now, if that view were correct, it would be perfectly easy to prove it at once by the new method of local examination. We have only during an eclipse, or even without an eclipse, to put the slit of a spectroscope on the edge of an image of the sun thrown by an object-glass, and observe the spectrum from each part of the sun; from the photosphere to as far above the photosphere as we can get. If that view were true, we should get, as short bright lines close to the photosphere, the lines of substances having a high atomic weight. Then higher and higher we should get longer lines indicating the existence at greater heights in the solar atmosphere of those substances which have a smaller atomic weight. Further, as we have evidence to show that the spots exist in a low part of the sun's atmosphere (how low we shall see by and by, when we come to consider them in detail), we should expect in those spots to find all the familiar lines of the substances having a high atomic weight to be affected. When we examine the chromosphere and the base of the prominences which arise out of it, we should find that at the same height or about the same height where the spots give us lines of the substances of high atomic weight, the chromosphere itself should be full of the same substances of high atomic weight.

Now the fact that not one of these expectations is realised—that none of these things are so—has necessitated the putting forward of the new view to which I have referred.

This can be stated in a very few words. It is that the temperature of the sun is not only sufficient to drive all our most refractory metals into vapour, as we can do in our laboratories on the earth, but that it goes very much further; it continues the work of our laboratories, and drives them into something else altogether finer than anything that we can separate with our terrestrial conditions. According to that view, what would happen would be this:—If we could lay hold of a solar meteorite, say a hundred thousand miles from the photosphere, and watch it in its downward flight, the solid would first become liquid, it would then be vaporised, and we should have the spectrum with which we are familiar in our laboratories; but after that the vapour would still

go through a series of simplifications of which we can take no count in our laboratories, because we have not the same temperature. What would happen in that view is that obviously we should know nothing whatever of the spectrum of the lower part of the atmosphere open to our inquiries. Now that is practically the fact. The spectrum of the region just above the photosphere is one of the strangest things in solar physics. Almost everything there is strange. The lines which we see are lines either altogether unknown to us, or are seen without their usual terrestrial companions. Many are found in none of the maps prepared in any of our laboratories, and whether we read this story from the facts presented by spots, or those observed in prominences, we get the same apparently inexplicable riddle.

All this, then, by way of introduction. There will be a good deal to be said as to details in the sequel. What we have next to do is to commence our detailed examination of each portion of the sun.

Description of the General Surface

To do this it is proper that we should begin with that part with which we are most familiar: I mean the photosphere—the bright shining surface which represents to most of us the actual veritable sun.

When we look at the sun by means of an ordinary telescope, taking proper precautions,—it will never do to look straight at the sun with an ordinary telescope unless we wish to be instantly blinded,—what one sees is first a bright disk, which is slightly dimmed at the edge; here and there, it may be, will be seen dark objects, the *spots*, although it may happen that no spots will be visible; on examining the disk carefully, what we further see is a strange mottling of the whole surface. The mottling is very often very delicate; but everywhere, in all parts of the sun, near the poles, near the solar equator, and universally, we get this strange mottling. These fine mottlings sometimes take certain directions, in consequence of the existence of powerful currents. Here and there we get cyclonic swirls, and here and there there is an appearance of smudginess, apparently produced by tremendous overhead currents, so to speak, that is, currents between us and that part of the sun on which they appear.

Some photographs of the sun taken of late years by Dr. Janssen at the Physical Observatory at Meudon, near Paris, have thrown great light upon the general arrangement of this mottling.

An attentive examination of his photographs shows that the surface of the photosphere has not a constitution uniform in all its parts, but that it is divided into a series of figures more or less distant from each other, and presenting a peculiar constitution. These figures have contours more or less rounded, often very rectilinear, and generally resembling polygons. The dimensions of these figures are very variable; they sometimes attain a minute and more in diameter.

While in the interior of the figures of which we speak the grains are clear, distinctly terminated, although of very variable size, in the boundary the grains are as if half effaced, stretched, strained; for the most, indeed, they have disappeared to make way for trains of matter which have replaced the granulation. Everything indicates that in these spaces, as in the penumbræ of spots, as we shall see, the photospheric matter is submitted to violent movements which have confused the granular elements.

In these investigations the sun's appearance can be better studied by these photographs than by means of the eye and telescope. This is what Dr. Janssen says on this point:—

"The photospheric network cannot be discovered by optical means applied directly to the sun. In fact, to ascertain it from the plate, it is necessary to employ glasses which enable us to embrace a certain extent of the photographic image. Then, if the magnifying power is quite suitable, if the proof is quite pure, and especially if it has received rigorously the proper exposure, it will be seen that the granulation has not everywhere the same distinctness; that the parts consisting of well-formed grains appear as currents which circulate so as to circumscribe spaces where the phenomena present the aspect we have described. But to establish this fact it is necessary to embrace a considerable portion of the solar disk, and it is this which it is impossible to realise when we look at the sun in a very powerful instrument, the field of which is, by the very fact of its power, very small. In these conditions we may very easily conclude that there exist portions where the granulation ceases to be distinct or even visible; but it is impossible to suppose that this fact is connected with a general system."

Independently, then, of the phenomena of spots (about which presently), the verdict of minute examination is that the whole photosphere is riddled by convection-currents; because I shall have to show that each of those dark markings which we will call *pores*, is the seat of a downrush, and each of those *domes*, as we will call the intervening brighter portions, is, in all probability, a dome produced by the very same cause that gives us the grand domes of our cumulus clouds on a summer's day.

The Cause of the Photosphere

In discussing any subject, especially such a subject as the sun, it does not do to avoid difficulties, and therefore I may very frankly say that one of the greatest difficulties which students of solar physics have met with up to the present time has been the absence of an easy and satisfactory way of explaining the existence, and the sharp boundary, and the intense brilliancy of the photosphere.

The photosphere, as already stated, is about 400,000 miles—in round numbers—from the sun's centre. If we take the average density of the sun at a pretty low figure, as we found reason to do in the last lecture, we note that the photosphere, assuming it to be a shell, exists in a region of low pressure, and we see in a moment that, unless we suppose the photosphere, or something immediately inside the photosphere, to be solid, there is no reason for supposing any very great increase of pressure at the photosphere itself. In fact, there are a great many reasons for regarding this as improbable, not to say impossible.

Now, if that is so, we are driven to another line of inquiry, and it is this. If there can be no sudden increase of pressure at the photospheric level to account for the sudden luminosity, to what other cause must we look? Driven to our supports, it is fair to ask whether any sudden increase of temperature will help us?

In an ordinary gas-jet we have coal-gas burning. When we examine the coal-gas flame in an ordinary fish-tail burner, with the spectroscope, what we find is this: Up to the part where the luminosity—the white light—suddenly begins, about half-way up, we get the flutings of acetylene and marsh-gas, and above that we get nothing whatever except a continuous spectrum; therefore, according to the books, we have now either a solid, or a liquid, or a densely gaseous substance to deal with. That is an obvious suggestion, and one apparently in harmony with all the facts. I think that is the general opinion now. Hence in a flame, in the non-luminous portion, we have got hydrocarbons ascending. So long as they are not dissociated they are feebly luminous. The light which they give is chiefly a fluted light, by which I mean that if we observe it with the spectroscope we do not get much continuous spectrum. When the hydrocarbons reach a certain height in the flame, their dissociation becomes possible, the solid particles of carbon are set free; these solid particles of carbon when free give a continuous spectrum totally different from that which they gave when they were associated with the hydrogen in its various proportions in the lower part of the flame.

Now, it is obvious that, generally, everything above the photosphere must be cooler than the photosphere itself. Have we then a relatively non-luminous gas going down, which at a distance of 430,000 miles from the sun's centre finds a region where chemical combination is destroyed, the effect being exactly the same—different in degree, but not different in kind—from that which we watch in a candle or gas-flame, imagining the gas-flame to be inverted for the sake of simplicity? That is the question. Is it along such a line as this one is to look for the solution of the mystery of the sudden brightening of the photosphere, rather than along that other one which attributes the increase of brilliancy to the sudden increase of pressure, for which really one sees no physical basis at all?

The Faculæ

It was stated that the pores were supposed to be the seats of downrushes, and that the domes between the pores were the equivalents of our cumulus clouds.

The brighter portions of the photosphere, called *faculæ*, consist of domes heaped up together, or arranged in certain directions. We shall find by and by that they are associated with a certain stage in the history of every spot. But they are by no means limited to the vicinity of spots. We may have some develop-

ment of these faculæ in parts of the sun where there are no spots at all.

Those who are familiar with this class of observations will remember that it is much easier to see the faculæ near the sun's limb than in the centre of the sun. Also it is easier to get a photograph of the faculæ using a collodion or a dry plate which works very far up in the blue, than it is with a collodion or a dry plate which works in the green or the blue-green; this latter fact proves to us quite conclusively, as it was pointed out a good many years ago now,[1] that the difference between the light at the top of a dome, so to speak, or the bottom, or between the top of the cumulus and the base of the pore, is a difference chiefly of that kind of light which writes its record by means of the absorption of the blue end of the spectrum.

The reason that we see the sun red at sunrise and sunset frequently is not that there is anything different in our air at that moment, but because we are looking at the sun through a greater thickness of the air; and the redness of the sun is the balance left after our atmosphere has done all it can in the way of absorbing the blue. We do not expect to get the sun red at midday. Of course a London fog will do anything; but I am talking of our ordinary atmosphere; and the fact that we do not get the sun red in the middle of the day is one of the same kind as the other one that we do not so easily see the faculæ on the centre of the sun as we do at the edge of it. There is absorption going on between the top of a facula and the bottom of a pore; and, as you know, to get that out in its greatest vigour and quantity we must take the greatest possible thickness of atmosphere. We see in a moment that the only way to have a considerable thickness of solar atmosphere to work this for is to make observations near the sun's limb.

These faculæ exist on an enormous scale. It is quite common to see reaches of them tens of thousands of miles long, lasting for days, and perhaps weeks; we get in that fact an indication of the enormous amount of energy which may still be changing places in the solar atmosphere, even though we do not get other phenomena which appear to us to be more important. By "other phenomena" of course I mean the spots.

J. NORMAN LOCKYER

(To be continued.)

[1] In 1872; see "Solar Physics," p. 404.

BARK BREAD

MOST travellers in Norway have probably had more than sufficient opportunities of becoming acquainted with the so-called "Fladbröd," flat bread, of the country. Few, however, among them who have partaken of this dry and insipid food may possibly be aware that in many districts, more especially in Hardanger, the chief ingredient in its composition is the bark of trees. This substitution of an indigestible product for *bonâ fide* flour is not necessarily a proof of the scarcity of cereals, but is to be ascribed rather to an opinion prevalent among the peasant women that the bark of young pine branches, or twigs of the elm, are capable of being made into a thinner paste than unadulterated barley or rye-meal, of which the Norse housewife, who prides herself on the lightness of her "Fladbröd," puts in only enough to make the compound hold together.

The absence of any nutritive property in bark bread, whether made with elm or pine bark, and the positive injury it may do the digestive organs, has of late attracted much notice among Norwegian physiologists, and the editor of *Naturen*, with a view of calling the attention of the public to the subject, has, with the author's permission, reprinted some remarks by Dr. Schübeler on the history and character of the bark bread of Scandinavia. From this source we learn that the oldest reference to the use of bark bread in Norway occurs in a poem, ascribed to the Skald Sighvat, who lived in the first half of the eleventh century. In the year 1300 the annals of Gothland record a season of dearth, in which men were forced to eat the bark and leaf-buds of trees, while then, and during the later periods of the Middle Ages, the frequent failure of the crops in all parts of Scandinavia led to the systematic use of the bones and roe of fishes, as well as the bark of trees as a substitute for genuine flour; and so extensively was the latter substance used that Pastor Herman Ruge, who in 1762 wrote a treatise on the preservation of woods, has drawn attention to the almost complete disappearance of the elm in the Bohus district, which he ascribes to the universal practice in bygone times of stripping the bark for the preparation of bread.

In Nordland and Finmark the root of *Struthiopteris germanica* and other ferns, as well as the leaves of various species of Rumex, have been largely used with barley-meal in making ordinary bread as well as "Fladbrod." In Finland the national "pettuleipa" (bark bread), which was in former times almost the only breadstuff of the country, still ranks as an ordinary article of food in Kajana, and in the forest-regions of Oesterbotten, and Tavastland. Here it is usually made of the inner layers of the pine-bark, ground to a meal, which is mixed with a small quantity of rye-flour to give the requisite tenacity to the dough. The Finlanders of an older generation showed marvellous ingenuity in composing breadstuffs, in which scarcely a trace of any cereal could be detected in the mixture of bark, berries, seeds, bulbs, and roots of wild plants, which they seem to have accepted as a perfectly legitimate substitute for corn-bread. In the interior of Sweden, according to Prof. Säve, the *best* bread of the peasants consisted till the middle of this century of pease, oats, and barley-meal in equal proportions, while in the ordinary daily bread the husks, chaff, and spikes of the oats were all ground down together. In bad seasons even this was unattainable by the Dalekarlian labourer, who had to content himself with pine-bark bread.

DILATANCY[1]

THE principal object of this lecture was to show experimental evidence of a hitherto unrecognised fact of fundamental importance in mechanical philosophy. This newly-recognised property peculiar to granular masses (named by the author "Dilatancy") would be rendered clear by the experiments. But it was not from these experiments that it had been discovered. This discovery was the result of an endeavour to conceive the mechanical properties a medium must possess in order to act the part of the all-pervading ether—transmitting waves such as light, but not such as sound, allowing free motion of bodies, causing distant bodies to gravitate, and causing forces like cohesion, elasticity, and friction between adjacent molecules, together with electricity and magnetism.

As the result of this endeavour, it appeared that the simplest conceivable medium, a mass of rigid granules in contact with each other, would answer not only one but all of these requirements, provided such shape or fit could be given to the grains that, while these rigidly preserved their shape, the medium should possess the apparently paradoxical or anti-sponge-like property of swelling in bulk when its shape was altered.

This required that the grains should so interlock that, when any change in the shape of the mass occurred, the interstices between the grains should increase. Having recognised this property as a necessity of the ether, the next question became, What must be the shape and fit of the grains so that the mass might possess this unique property? At first it seemed that there must be something special and intricate in this structure. It would obviously be possessed by grains shaped to fit into each other's interstices: this was illustrated by a model of bricks arranged to bond as in a wall; when the pile was distorted, interstices appeared. Subsequent consideration revealed this striking fact—that any shape of grains resulted in a medium possessing this property of dilatancy so long as the medium was continuous, or so long as precautions were taken to prevent rearrangement of the grains, commencing at the outside. All that was wanted was a mass of smooth hard grains, each grain being held by the adjacent grains, and the grains on the outside being so controlled as to prevent rearrangement. This was illustrated by a model of a pile of shot, which, when in closest order, could not have its shape changed without opening the order and increasing the interstices. The pile being brought from closest to most open order by simply distorting its shape, the outside balls being forced, those in the interior were constrained to follow, showing that in no case could a rearrangement start in the interior.

Considering the generality of this conclusion, it was necessary to explain how it was that dilatancy was not a property of ordinary atomic or molecular matter. This was owing to the elasticity, cohesion, and friction which rendered molecules in-

[1] Abstract of a Lecture delivered at the Royal Institution of Great Britain, on Friday evening, February 12, 1886. By Prof. Osborne Reynolds, LL.D., F.R.S.

capable of acting the part of independent grains whose only property was to keep their shape. This was not inconsistent with dilatancy in ether, for these physical properties were possessed by the molecules of matter in consequence of the presence of the ether, and hence it was not logical that the atoms of ether should possess these properties.

If evidence of dilatancy were to be obtained from tangible matter, it was to be sought on the most commonplace, and what had hitherto been the least interesting, form, that of hard, separate grains—corn, sand, shot, &c.

That an important geometrical and mechanical property of a material system should have lain hid for thousands of years, even in sand and corn, was such a striking thought that it required no small faith in mechanical principles to undertake the search for it; and, though finding nothing but what was in accordance with previous conclusions, the evidence obtained of this long-hidden property was as much a matter of surprise to the lecturer as it could be to any of the audience.

To render the dilatancy of a mass of grains evident, it was necessary to accomplish two things: (1) the outside grains must be controlled so that they could not rearrange, and this without preventing change of shape or change of bulk; (2) it was necessary to adopt means of measuring the change of bulk or volume of the mass or of the interstices between the grains as its shape was changed. A very simple means—a thin india-rubber bag—was found to answer both these purposes to perfection. The outside grains indented themselves into the india-rubber, which prevented their changing their places, while the impervious character of the bag allowed of a continuous measure of the volume of its contents by measuring the quantity of air or water necessary to fill the interstices.

In these experiments neither the bag nor the fluid had anything to do with the dilatancy of the contents considered as forming part of a continuous medium, the bag merely controlling the outside members as they would be controlled by the surrounding grains, and the fluid merely measuring or limiting the volume.

India-rubber football cases were then shown full of dry sand, shot, corn, and glass marbles, shaken down into their densest form. The bags could not be distorted, as by squeezing between two plates, without enlarging the interstices between the grains, and hence the volume of the bag. Such increase of bulk was not, owing to the change of shape, evident to the eye; but by connecting the mouth of the bag to a pressure-gauge, it appeared as the squeezing began, the pressure of the air within the interstices began to diminish, and as the squeezing went on diminished as much as 6 inches of mercury, which showed that the interstices had increased a third. These experiments were introduced mainly to prevent the impression that the character of the fluid within the interstices had anything to do with dilatancy. Water affords a more definite measure of volume than air. This was shown. A bag holding six pints of sand full of water without air, connected by a tube with the bottom of a vessel of water, drew, on being squeezed, about a pint of water from the vessel into the bag. This was the maximum dilation; for further squeezing the water ran back into the vessel, and then again, for still further squeezing, was drawn back again, showing that, as the change of form proceeded, the medium passed through maximum and minimum dilations.

The most striking evidence of dilatancy is obtained from the fact that, since dilatant material cannot change its shape without increasing in volume, by preventing change of volume all change of shape is prevented. By closing the communication between the bag and the vessel of water, and thus preventing further increase of volume, further change of shape was instantly prevented. Starting with the sand at its densest, and the communication closed, a pinch of 200 lbs. was put on the planes without producing the smallest apparent change in the spherical shape of the bag.

Communication with the pressure-gauge was then opened, which showed that, so far from the water in the bag being at a greater pressure than the atmosphere, it was less by 20 inches of mercury, so that a little more pressure on the planes and a vacuum would have been formed. On opening communication with the water the bag instantly responded by change of shape, and again instantly stopped when the supply was cut off.

That the thickness of the envelope was of no importance so long as it was impervious to air, was shown by using india-rubber balloons, so thin that the sand could be seen through them; one of these, which was soft and yielding when the water was in excess, became hard like a cannon-ball when the excess of water was drawn off, maintaining any shape it had when the bag was closed, supporting 200 lbs.

In this way a cast was taken from a mould, into which the bag was shaken with water in excess till it took the form of the mould; the excess of water was then drawn off, and the mould removed, leaving an image which preserved its shape loaded with 200 lbs.

The firmness and softness of the sand by the sea was shown to be due to these causes; as the tide falls it leaves the sand apparently dry, but in reality full of water, the surface of which is kept up to the surface of the fine sand by capillary attraction. This saturated sand cannot yield to the tread without dilating, and cannot dilate until it has had time to draw more water, the first effect of the foot being to draw down the capillary surface, leaving the sand apparently dry round the foot. This was shown by experiment.

The lecturer then indicated how the property of dilatancy in a continuous medium would render it capable of causing an attraction between bodies at a distance, like gravitation, and cohesion, and elastic forces between bodies close together; how the ability of the grains to rearrange at a free surface would allow bodies to move freely in the medium which, if in a state of agitation by transverse waves in all directions, would transmit waves like those of light, but not like sound, and which if consisting of grains of two different sizes or shape, would give rise to phenomena resembling those of electricity.

In conclusion, it was remarked that, promising as this dilatant hypothesis of ether was, it could not be taken as proved until it had been worked out in detail. This would take long; and in the meantime it was put forward to add interest to the property of dilatancy, to the discovery of which it had led. The property of dilatancy once recognised was, however, independent of any hypothesis, and seemed to have opened up a new field for philosophical and mathematical research quite independent of the ether.

SOCIETIES AND ACADEMIES

LONDON

Royal Microscopical Society, February 10.—The President, Rev. Dr. Dallinger, F.R.S., in the chair.—The President referred to the loss sustained by the death of Mr. P. H. Lealand, to whom microscopists were so largely indebted for the optical productions which were so well known and appreciated.—The Report of the Council was read and adopted.—Dr. Dallinger then gave his annual address, in which he detailed the results of his later researches into the life-history of minute septic organisms as carried on by means of the improved lenses constructed for him by Messrs. Powell and Lealand. Four forms were selected for study. Each of these septic organisms terminate a long series of fissions with what is practically a generative act of fusion. The two last of a long chain of self-divided forms fuse into one, become quite still, and at length the investing sac bursts, and a countless host of germs is poured forth. The growth of these germs into forms like the parent was continuously watched, showing gradual enlargement, and ultimate, but as to time somewhat uncertain, appearance of the nucleus, and the somewhat sudden appearance of the flagella or thread-like motor organs, the latter being found in each instance to arise in the nucleus. Very soon after the adult stage is reached the act of self-division commences, and is kept up for hours in succession. The delicate plexus-like structure becomes aggregated at one end of the nucleus, leaving the rest perfectly clear, except that a faint beading is seen in the middle line, with two or three finer threads from it to the plexus. Then occurs the commencement of partition of the nucleus, followed by a slight indication of division of the body-substance. Quickly afterwards the nucleus becomes completely cleft, and the body-substance follows suit. Then the plexus-like condition is again diffused equally over the whole nucleus. When the generative condition is approached by the last generation of a long series of dividing forms, it is remarkable that the organism becomes amœboid, showing how far-reaching is the amœboid state. In this condition, when two such forms touch one another they coalesce and fuse into each other almost as though two globules of mercury had touched, until nucleus reaches nucleus and the two melt into one, and the blended bodies become a globular sac, which ultimately emits an enormous number of germs. Previous to the blending it is now made out that all

traces of plexus-like structure are lost in the nucleus, which becomes greatly enlarged and assumes a milky aspect, and shows no trace of structure throughout the process of fusion. Afterwards it begins to diffuse itself radially through the body-sarcode, until every trace of the nucleus is gone, and the still globule of living matter becomes tight and glossy, but no trace of structure can be anywhere found in it. In this condition it remains for six hours, when it emits the multitude of germs. After giving similar details about several other organisms, Dr. Dallinger summed up thus:—"One thing appears clear; the nucleus is the centre of all the higher activities in these organisms. The germ itself appears to be but an undeveloped nucleus, and when that nucleus has attained its full dimensions there is a pause in growth, in order that its internal development may be accomplished. It becomes practically indisputable that the body-sarcode is, so to speak, a secretion, a vital product of the nucleus. From it the flagella originally arise; by it the act of fission is initiated and in all probability carried to the end; the same is the case with fertilisation and the production of germs. We are thus brought into close relation with the behaviour of the nucleus in the simplest condition. No doubt far profounder and subtler changes are concurrently proceeding. We of course are no nearer to the solution of what life is. But to come any distance nearer to a knowledge of how the most living part of the minutest organisms acts in detail has for me, and for most biologists, an increasing fascination." The address was illustrated by the aid of the oxy-hydrogen lantern.—The new Council was elected, Dr. Dallinger being elected President for a third term.

BIRMINGHAM

Philosophical Society, February 11.—On Resistance at surfaces of electrodes in electrolytic cells, by G. Gore, LL.D., F.R.S. This paper is a purely experimental one, and contains new proofs of some of the chief results of an extensive research on "transfer-resistance," communicated to the Royal Society, March 2, 1885 (*Proc.* Roy. Soc., 1885, No. 236, p. 209). In it the author shows conclusively that the phenomena discovered by him, and to which he applied that term, are not due to polarisation, some kind of electromotive force, or any other form of opposing difference of electric potential, because they still remain when those causes are entirely absent. He selected various cases of voltaic inversion, in which a pair of different metals in an exciting electrolyte produced no difference of electric potential and no voltaic current, and examined them for "resistance" and differences of "resistance" at the immersed surfaces of the two metals. He first tested them by a "bridge" method, and then by a "condenser" one, also described, and gives the results; and in every case he found that the "resistance" still existed, and was different in amount at the two plates. In each case the plates were of equal sizes. He also took several cases in which a pair of plates of the same metal, but of different sizes, were immersed in an exciting electrolyte, a combination which it is well known produces no difference of electric potential and no voltaic current, and tested them similarly, and found abundant evidence of "resistance," different in amount at the two plates in each instance. By the condenser method he also measured the amounts of such "resistance" at the surfaces of the two different metals, of several voltaic elements at their inversion-points, during absence of difference of electric potential, and gives the quantities. He asks: "Is the phenomenon I have discovered really of the nature of ordinary electric conduction-resistance? If it is, its characters will agree with the most essential ones of that influence. It agrees in several important points with that resistance: first, it is not able to produce a current; second, it is usually small with those liquids in which ordinary resistance is small; and third, it is considerably reduced in liquids by rise of temperature, it also, when overcome by current, evolves heat" (*Proc.* Roy. Soc., 1885, No. 236, p. 209; *Phil. Mag.*, vol. xxi. 1886, pp. 130-148). It differs, however, from such resistance in the less important circumstance that it varies in amount with the strength and density of the current; it is also usually much larger in amount than the ordinary conduction-resistance of a short section of the same liquid. "From these various fundamental truths respecting it, 'transfer-resistance' is a retarding influence essentially similar to ordinary conduction-resistance, but modified, increased in amount, and rendered more complex by taking place at the surfaces of mutual contact of two heterogeneous bodies instead of in the mass of a homogeneous substance." He concludes by remarking that "it performs an important part in the action of all voltaic batteries and electrolytic cells," and calls attention to the circumstance that "one important practical application" of it "has been made in the electro-metallurgical parification of copper on the large scale, where a great saving has been effected by arranging the depositing vats in multiple series, and thus diminish the 'transfer-resistance.'" It was in the year 1831 that the first attempt to discover this kind of resistance was made by Fechner.

PARIS

Academy of Sciences, February 22.—M. Jurien de la Gravière, President, in the chair.—Observations of the small planets made with the great meridian instrument of the Paris Observatory during the fourth quarter of the year 1885, communicated by M. Mouchez.—Determination of the elements of refraction: examination of the general geometrical conditions required to be fulfilled in the practical solution of the problem, by M. Lœwy. The question is treated under the three following heads:—(1) Given the positions of two stars, at what time of the day must the conjugated operations be effected in order to attain the greatest variation of refraction? (2) What angle of the double-mirror is most suitable for obtaining this maximum value? (3) What are the co-ordinates of the two stars enabling the observer to arrive at the maximum effect of the refraction in the minimum of time?—Experimental verification of Verdet's optical law in the directions near those that are normal to the magnetic lines of force, by MM. A. Cornu and A. Potier.—Specific determination of the imprint of fossil plants in the Carboniferous formations of the Gard, with a view to determining the sequence of the vegetable species and of the stratified rocks in this basin, by M. Grand'Eury.—On the equivalent of the turbines, by M. Lecoq de Boisbaudran.—Remarks on M. Jean Luvini's note on the subject of the conflicting theories advanced by M. Faye and his opponents to explain the action of water-spouts, whirlwinds, and analogous atmospheric phenomena, by M. Léon Lalanne. The author mentions two authentic cases which occurred on the west coast of France many years ago, and which seem inexplicable except on the supposition of *a transverse ascending movement*.—Note on the employment of dynamometric machines for the transmission of force at the marine cannon foundry of Ruelle, communicated by M. Jurien de la Gravière.—Observations of Barnard's comet made at the Imperial Observatory of Rio de Janeiro, by M. L. Cruls. These observations, made with the 0·25m. equatorial, extend over the period from July 15 to August 8, after which date the comet became invisible.—Observation of the nebula in Andromeda made at the same Observatory during the period from September 10 to December 18, 1885, by M. L. Cruls. The angle of position between the *nova* and the central nucleus of the nebula, as well as the angular distance, was measured on two separate occasions, with the following results:—

	Angle of position	Estimated distance
September 17 ...	80°·9 ...	15"·0
October 28	79°·1 ...	12"·1

—Observation of the meteoric display of November 27, 1885, made at the same Observatory, by M. Cruls. The total number of meteors observed between November 26-29 was 1792, the maximum being on November 27, when 73 were seen in five minutes and 1145 during the whole night.—Results furnished by the observation of the solar protuberances at the Roman Observatory during the year 1885, by M. P. Tacchini. The great protuberances were never seen in the neighbourhood of the Poles, but nearly always between the equator and ± 40°, corresponding almost invariably with solar regions free from spots and faculæ. As regards the protuberances, solar energy may be considered as having been more active in 1885 than during the previous year.—Phosphorographic studies for the photographic reproduction of the stars, by M. Ch. V. Zenger. The author describes what he hopes may prove to be an improvement even on MM. Henry's process, which has already yielded such surprising results. He uses the phosphorescence of the sulphurets of the alkaline earths instead of the fluorescence in the preparation of his photographic plates, thereby securing greater sensitiveness and power to reproduce the invisible as well as the visible stars.—Determination of the remainder in Gauss's quadrature formula, by M. P. Mansion.—Note on a geometrical interpretation of the differential equation—

$$L\left(x\frac{dy}{dx}-y\right)-M\frac{dy}{dx}+N=0,$$

in which L, M, and N denote functions of x and y at once homogeneous, algebraic, entire, and of the same degree, by M. G. Fouret.—On the coefficient of contraction of elastic solid bodies, by M. Gros.—Analysis of some specimens of the air taken at Cape Horn by the Mission sent to observe the transit of Venus, by MM. A. Muntz and E. Aubin. The mean result of the analysis gave 20·864 as compared with 20·960, Regnault's mean for the atmosphere of Paris. The proportion of oxygen appears to be also very nearly equal to that of the air in various other parts of the globe, so that the variations in the quantities of nitrogen and oxygen in the whole terrestrial atmosphere seem to oscillate within very narrow limits, as was already shown by Regnault in the course of his memorable researches.—Action of gaseous hydrochloric acid on iron, by M. F. Isambert.—Fresh researches on the earthy alkaline manganites, by M. G. Rousseau.—On the reduction of compounds optically inactive by the process of compensation, by M. E. Bichat.—Observation in reference to M. Joly's note on the titration of the phosphoric acids by means of various indicators, by M. R. Engel.—Note on the formation of monatomic alcohols derived from the essence of turpentine, by MM. G. Bouchardat and J. Lafont.—On the action of the alcoholic chlorides on ammonia at a low temperature, and on the methylic amines, by MM. Camille Vincent and Chappuis.—Note on lesions of the alcoholic nevrite, by M. Gombault.—On the *Balanoglossus sarniensis*, by M. R. Kœhler.—On the morphology of the ovary in insects, by M. Ad. Sabatier.—Note on the nervous system of *Echinus acutus*, by M. Henri Prouho.—Note on *Diplosoma Kahleri*, a new species of Diplosomian recently found in Guernsey, by M. F. Lahille.—On the quantities of heat liberated and absorbed by plants, by M. Gaston Bonnier.—Note on a nephelinic tephrite from the valley of the Jamuna, kingdom of Shoa, by M. A. Michel Lévy.—Note on the basaltic rocks of the county of Antrim, Ireland, by M. A. Lacroix.—On the Egyptian decans, by M. Omont.

BERLIN

Physical Society, December 18, 1885.—Dr. Schulze-Berge spoke on the conduction of electricity in dielectric media, a subject which had hitherto been examined in most cases only from a technical standpoint, in order to determine the insulating power of gutta-percha sheathings for telegraph wires and cables. If it were assumed that the resistance of the dielectrics differed with the thickness of the layer according to the same law as prevailed in metals, then—seeing that the resistance of a cubic centimetre of gutta-percha was, in accordance with Jenkin's determinations, equal to 25×10^{12} ohm—the thickness of a layer, the resistance of which amounted to about 100 ohm, and ought to be measurable, must be so small as to be incapable of being produced. It might possibly be the case, however, that in dielectrics the resistance varied in another relation to the thickness, and in point of fact the speaker had found that a gutta-percha layer of 1/13 mm. thickness, and a superficies of 175 square c.m. inserted between two metal plates into the circuit of a Daniell's element connected to earth, produced a very rapid discharge. Measurements executed by the speaker by means of a quadrant-electrometer on thin layers of gutta-percha, sulphur, paraffin, and sealing-wax between two metal plates, yielded resistances very well capable of being measured, and which in the case of gutta-percha amounted on an average to about 200 ohm. In the case of sulphur the values varied between 20 and 2000 ohm, and just as varied and irregular were the resistances in the case of the two other substances. The layer offering resistance was produced by placing rubber tissue or purest flowers of sulphur on a heated plate of zinc, and thereupon pressing the second heated metal plate, after which the whole was allowed to cool. In the course of time the resistance changed. In the case of sulphur it increased, in the case of paraffin and sealing-wax, however, the resistance abated; in the case of gutta-percha the resistance continued pretty equal. If the cells supplying the current were disconnected, and the dielectric brought into conjunction alone with the electrometer, then the latter showed no deviation, whence it was inferred that the dielectric did not conduct electrolytically, and that it was no electrolytic polarisation which caused the change of resistance. The measurements of resistance were also taken with the aid of the Wheatstone bridge, and, after the former results had been confirmed by this method likewise, the influence of the electromotive force on the resistance of the dielectrics was determined. If the bridge system was in equilibrium, then must it remain unaltered when the intensity of the current was varied by the insertion of a changeable resistance into the circuit of the current. The experiment, however, showed that with the change in the strength of the current the needle of the galvanometer indicated a deflection. This change of resistance with the change in the strength of the current was, as the speaker had become convinced, by means also of the bridge combination, through disconnecting the chain, not caused by an electrolytic polarisation, but probably by a dielectric polarisation, which would have to be further investigated after other dielectrics, besides the four mentioned, had been tested. The most important results of his experiments were formulated by the speaker as follows:—(1) The resistance of the dielectrics varied in relation to the thickness of the layer in a different way from metals. (2) The conduction of the dielectrics was not electrolytical. (3) The resistance depended on the electromotive force.—In the discussion following this address, Dr. Schulze-Berge further stated that the sensitiveness of his electrometer was so great that a Daniell gave a deflection of 120°.—Prof. Schwalbe gave a full report of the two volumes on "Geophysik," by Herr S. Günther, published last and this year.

BOOKS AND PAMPHLETS RECEIVED

"Gurina im Obergailthal (Kärnthen)": A. B. Meyer (Hoffmann, Dresden).—"Das Gräberfeld von Hallstatt": A. B. Meyer (Hoffmann, Dresden).—"The Chemistry of the Coal-Tar Colours": R. Benedikt, translated by E. Knight (Bell and Sons).—"Der Schall": Dr. Elsas (Freytag).—"Photo-Relief Map of Scotland": H. F. Brion and Rev. E. McClure (S.P.C.K.).—"Flowers, Fruits, and Leaves": Sir J. Lubbock (Macmillan and Co.).—"Les Aérostats Dirigeables; leur passé, leur présent, leur avenir": B. de Grilleau (Dentu, Paris).—"Führer f. Forschungsreisende": F. F. von Richthofen (Oppenheim, Berlin).—"Tourist's Guide to the Flora of the Alps": Prof. K. W. v. Dallatorre (Sonnenschein and Co.).—"Hand-book of Mosses": J. E. Bagnall (Sonnenschein and Co.).—"The Laws [illegible] S. Cockburn (Sonnenschein and Co.).—"The Elements of Eco[illegible] ii. part 1: H. D. McLeod (Longmans).—"Manual of Music": R. [illegible] (Hughes).—"Meteorologische Beobachtungen in Deutschland, 1883," Jahrgang vi (Hamburg).—"Bulletin of the U.S. Geological Survey," Nos. 7 to 14 (Washington).—"Annual Report of the Comptroller of the Currency U.S., December 1, 1885" (Washington).—"Report of the International Polar Expedition to Point Barrow, Alaska": Lieut. P. H. Ray (Washington).—"On the Structure of the Brain of Sessile-Eyed Crustacea": A. L. Packard (Washington).

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THURSDAY, MARCH 11, 1886

THE SCIENTIFIC RELIEF FUND

A TIME in which so many heartrending calls are being made upon the benevolent seems but ill-adapted for pressing any schemes not immediately connected with any specially urgent distress. There is, however, at present an appeal being made by the Royal Society to all who are in any way interested in science, which, though on behalf of a permanent fund, and not connected with any ephemeral distress, has long been felt to be necessary, and which peculiar circumstances render it imperative now to press forward without delay.

For some years past the Scientific Relief Fund administered by the Royal Society has been found insufficient properly to meet the numerous claims made upon it, and the Committee in charge of the Fund has been frequently hampered in its action in consequence. Of course the demands upon it are variable in their character and extent, being chiefly dependent on what may be called the chapter of accidents; but there are few years that pass without some one of greater or less scientific repute being carried off by an untimely death without having made due provision for those whom he leaves behind him; and perhaps fewer years still in which some earnest worker is not laid low by sickness, and finds himself reduced by an unforeseen chain of circumstances to a condition in which a grant from a fund administered by his scientific brethren is of inestimable value both materially and morally.

The income of the Scientific Relief Fund has not hitherto exceeded some 250*l.* per annum, its capital at the close of last year being about 7500*l.* With the view of increasing this capital sum to at least 20,000*l.* a most munificent offer has been made by Sir William Armstrong, who was among the original founders of the Fund. It is that he will present 6500*l.* to the Fund provided certain conditions are fulfilled, the principal of which is that an equal amount be raised from other sources within the current year. We earnestly hope that there may be no difficulty in accomplishing this, and, with the view of making the scope and character of the Fund more fully understood, we annex a few explanatory particulars.

It was in the year 1859 that the idea of creating a Scientific Relief Fund occurred to the minds of the late Mr. Gassiot and some other Fellows of the Royal Society, and the regulations under which it was to be administered were carefully considered, and, having been adopted by the Royal Society, have remained practically unchanged until the present day. The object of the Fund is defined to be for the aid of such scientific men or their families as may from time to time require and deserve assistance. Cases, however, can only be entertained on the recommendation of a President of one of the chartered Societies, it being understood that he consults the Councils over which he presides as to the person whom he intends to recommend for relief. The Committee administering the Fund, though Fellows of the Royal Society, are not members of its Council, and the senior member of its body retires annually, another Fellow being appointed in his place. It will thus be seen that every reasonable precaution has been taken for the impartial and judicious administration of the Fund; and since its foundation nearly a hundred recipients of well-timed grants have had reason to bless its existence.

It may perhaps be said that men of science ought to be able to foresee what is coming, and be prepared to meet all the changes and chances of this mortal life, and possibly as a class they are more than usually exempt from those reverses of fortune to which all are liable. It is, however, the unforeseen that constantly occurs, and the temporary aid which, by means of such a Fund, a man can receive from a committee of his fellow-workers may be accepted with all gratitude, and without that humiliation which would be felt did the relief proceed from any more ordinary source of charity.

But although men of science may as a rule be prudent, it can hardly be said that they are as a class rich. Their researches may aid others in the acquisition of material wealth, but the cases are exceptional where the pursuit of science has brought large pecuniary gains to the student. Where it has, we are confident that others besides Sir William Armstrong will aid those less fortunate in this particular than themselves by contributing liberally to this Fund.

There is, however, another and important class of persons whose ample fortunes have been the result of the judicious application of science in economic pursuits, and we may be sure that the wants of the Fund have only to be brought under their notice to assure ready and efficient aid in raising the amount necessary to meet Sir William Armstrong's munificent offer. Already we see on the list a noble subscription of five hundred guineas from Mr. Ludwig Mond, and we venture to hope that by thus giving publicity to what is at present being done to enlarge the scope of this most useful Fund, others directly and indirectly interested in science may be led to follow so generous an example.

Looking at the extent to which the material welfare of this country has now for many years been intimately connected with its scientific progress, the debt due from all to the workers in science must at once be appreciated, and a more practical manner of acknowledging this indebtedness can hardly be suggested than that of contributing to the Scientific Relief Fund.

THE BOTANY OF THE ROCKY MOUNTAIN REGION

Manual of the Botany of the Rocky Mountain Region, from New Mexico to the British Boundary. By John M. Coulter, Ph.D., Professor of Botany in the Wabash College. (New York and Chicago: Ivison, Blakeman Taylor, and Co, 1885.)

THE object of this manual, as stated in the preface, is to do for the range of country in which the plants it describes are found, what has for a long time been so admirably done for the North-Eastern States of the Union by Asa Gray's manual. It hence affords a means of comparison between two distant areas, each of such considerable dimensions as to throw much light on the flora of temperate North America. And not only with the flora of the Eastern States does it compare, for, the botany of the great Western area included in California

having also been recently worked out, the three floras together enable a fairly accurate estimate to be formed of the nature and extent of the vegetation of the middle regions of temperate North America from ocean to ocean. Thus Gray's manual takes in the States between the Atlantic and Mississippi, which lie north of Tennessee and North Carolina; that is, approximately between lats. 36½° and 46° N., and is essentially the vegetation of a wooded region with high-lands towards the coast. The Rocky Mountain manual occupies a rather smaller area, comprising the States of Colorado, Wyoming, Montana, Western Dakota, Western Nebraska, and Western Kansas. Its southern and northern limits are on the same parallel as those of Gray's "Flora," and its eastern limits (the 100th meridian) is nearly parallel to and as long as Gray's western, and distant from it about 400 miles. Its western frontier is a very irregular one, following the north-western and south-eastern direction of the great mountain plateau; and borders the Pacific States of Washington and Oregon, and the interior ones of Nevada and Utah. It is essentially an Alpine and prairie vegetation; probably most or all of it is above 4000 feet of elevation, with mountains attaining a maximum of over 14,000 feet (Mount Gray). The Californian flora, again, does not occupy half the area of either of the others. It extends rather further south, to lat. 35°, and only to 45° N. Though only 200 miles in average breadth, it is infinitely richer than both the others combined, having a mountain flora—the Sierra Nevada—throughout the length of its eastern boundary, a coast flora along the Pacific, a hill flora along a coast range, and a valley flora between the latter and the Sierra Nevada.

Comparing the areas thus limited with that of the whole breadth of what may be regarded as temperate North America (in contradistinction to the cold British possessions to the north of 48° and the hot ones to the south of 35°), it will be seen that they together cover nearly four-fifths of the breadth of the continent, of which 1200 miles are in the limits of Gray's "Flora," 700 in Coulter's, and (though not in the same parallel) 200 in the Californian. The strips of country not included are, the wooded region west of the Mississippi, and the prairies between the latter and the 100th meridian, and the region of the Great Basin, between the Rocky Mountains and the Sierra Nevada. Neither of them can, however, be expected to add much to the sum of the three floras now under consideration, for on the one hand the western wooded region of the Mississippi cannot add much to Gray's flora or the eastern prairies to Coulter's; and on the other hand, as the Rocky Mountain flora takes in the plants of the western fringe of the Great Basin, and the Californian its eastern fringe, the intermediate region cannot add very much to what these two floras contain.

Dr. Gray[1] has in various essays admirably discussed the characteristics of the three longitudinal zones of North American vegetation, and clearly indicated their composition and relations. In no region of the northern hemisphere, nor perhaps anywhere on the globe, can three parallel meridional floras so different in their aspect and elements be found within such narrow limits, as the middle unforested zone of North America separating two heavily forested ones, the latter differing from one another by hundreds of genera and thousands of species.

The richness of the three floras as expressed by genera and species is, in round numbers—

	Genera	Species	(European)
Rocky Mountain Flora ...	500	1750	(300)
Eastern United States ...	660	2150	(370)
Californian	764	3786	(225)

A striking difference between the Pacific and Atlantic floras is in the relative numbers of the two primary groups of Dicotyledons: the Polypetalæ and Monopetalæ, which in California are as eighteen to ten, but in the Eastern States nearly equal. In both the Incompletæ amount to about one-third of the Monopetalæ, in which respect the Rocky Mountain flora assimilates to the Eastern one. But the most remarkable difference between the three floras is in the relative proportion of Monocotyledons and Dicotyledons, which is about 1 : 2·18 in the Eastern United States; 1 : 3 in the Rocky Mountains; and 1 : 4·9 in California. This is mainly due to the greater number of Junceæ, Cyperaceæ, and Gramineæ in the Rocky Mountains and Eastern States, and the abnormal excess of various Dicotyledonous families in California. So too with the proportion of genera to species: it is nearly the same in the Rocky Mountains and Eastern States (1 : 3·5 and 1 : 3·3), but in California, owing very much to the number of monotypic genera, it is nearly as 1 : 5.

Regarding the composition of the Rocky Mountain flora, the most remarkable facts are the number of Compositæ, amounting to one-fifth of the Phanerogams, thus far exceeding the proportions in the Eastern United States (about one-seventh), and in California (about one-eighth). Of this order nearly forty genera do not occur in the Eastern States. Leguminosæ come next in order of number of species, as they do in California, where, however, they are fewer in proportion to the whole flora. These, with Gramineæ, Cyperaceæ, Scrophularineæ, and Rosaceæ, which follow next in order of numbers (six families in all), embrace half the Rocky Mountain Phanerogamic flora. In the Eastern United States half of the flora consists of seven families, of which the five first are the same as in the Rocky Mountain flora; but Scrophularineæ are replaced by Ericeæ, and Ranunculaceæ are to be added. In California, on the other hand, species of no fewer than thirteen families must be added together to embrace half the flora.

But the most conspicuous difference to the eye between the vegetation of the Rocky Mountains and the Eastern States consists in the absence in the former of almost all the Coniferæ and Cupuliferæ of the latter, together with the whole Orders of Magnoliaceæ, Tiliaceæ, Juglandeæ, Platanaceæ, and Droseraceæ, and the rarity of Hypericineæ, Rubiaceæ, Lobeliaceæ, Ericeæ, Labiatæ, and Orchideæ, and of water-plants generally. On the other hand, there is in the Rocky Mountains a much greater abundance of Cruciferæ, Portulaceæ, Loasaceæ, Cactaceæ, Polemoniaceæ, Borragineæ, Solanaceæ, Chenopodiaceæ, Polygoneæ, and Nyctagineæ, — all show-

[1] "Statistics of the Flora of the Northern United States" (*American Journal of Science and Arts*, vol. xxiii.); "Remarks concerning the Flora of North America" (*American Journal of Science and Arts*, vol. xxiv.); "Vegetation of the Rocky Mountain Region" (*Bulletin* of the United States Geological and Geographical Survey, vol. vi. No. 1, 1881); "Characteristics of the North American Flora" (*British Association Reports*, Montreal, 1882, and *American Journal of Science*, vol. xxviii. 1884).

ing the flora to partake far more of that of the Pacific than of the Atlantic coast. It differs, however, notably from the Californian flora in the paucity of Papaveraceæ, Rhamneæ, Hydrophyllaceæ, Labiatæ, Cupuliferæ, Coniferæ, and Liliaceæ.

The distribution in the United States of America of the 480 indigenous European species,[1] which form an integral part of their flora, offers some very interesting matters for consideration. Of these there are indigenous to the

Rocky Mountain Flora	about	300
Eastern United States	„	370
Californian	„	225
Common to all	„	135

The following list of some of the Rocky Mountain species not found either in the Eastern Alps or Sierra Nevada of California is a very instructive one. No doubt some occur in the northern continuation of the Sierra Nevada, in Oregon, and Washington, &c.; such are therefore plants of the Pacific States, though not Californian:—

Ranunculus hyperboreus, nivalis, pygmæus, and affinis
Thalictrum alpinum
Papaver nudicaule
Draba stellata, incana
Viola biflora
Cerastium alpinum
Sagina nivalis
Elatine triandra
Astragalus hypoglottis
Potentilla nivea
Saxifraga Hirculus, flagellaris, cæspitosa, cernua, adscendens, punctata
Chrysosplenium alternifolium
Epilobium latifolium
Adoxa Moschatellina
Hieracium umbellatum
Campanula uniflora
Androsace Chamæjasme
Gentiana frigida, glacialis, prostrata
Swertia perennis
Lloydia serotina
Juncus triglumis, castaneus
Kobresia caricina
Carex microglochin, rupestris, obtusata, frigida, ampullacea, nardina, gynocrates, incurva, stenophylla, elongata, leporina
Alopecurus alpinus
Deyeuxia lapponica
Catabrosa aquatica

These it will be seen are for the most part Arctic plants, whose presence might be expected on any range of mountains of sufficient elevation in America; but they are absent both in the Sierra Nevada and the White Mountains of the Eastern States. On the other hand, it is not easy to account for the absence in the Rocky Mountains of an even greater number of European species which are found in the Eastern States or in California, or both, and of which some occur in most other meridians of the globe. Such are especially

Caltha palustris
Nuphar lutea
Cardamine bellidifolia and pratensis
Arabis petræa
Drosera (all the 3 European species)
Arenaria peploides
Montia fontana
Oxalis Acetosella
Oxytropis campestris
Rubus Chamæmorus
Circæa lutetiana and alpina
Lythrum Salicaria
Lobelia Dortmanna
Ericeæ (12 species, nearly all Arctic, and both European and Asiatic)
Menyanthes trifoliata
Trientalis europæa
Euphrasia officinalis
Prunella vulgaris
Armeria vulgaris
Myrica Gale
Salix herbacea
Betula alba
Taxus baccata
Rhynchospora alba and fusca
Carex (24 species, chiefly boreal)
Tofieldia palustris
Narthecium ossifragum
Luzula arcuata
Hierochloe alpina
Aira atropurpurea
Glyceria fluitans

[1] In Gray's "Vegetation of the Rocky Mountain Region," cited above, will be found an exhaustive table of comparison of all the Alpine plants of the Atlantic, Pacific, and Rocky Mountain regions as then known. Coulter's "Flora," however, introduces considerable modifications in its details.

Neither the climate of the Rocky Mountain region, its elevation, its geological structure or its physical features, appear to present obstacles to the migration into it of these common plants of the colder north temperate zone from Canada or from the Eastern United States. It is still more difficult to understand how those that occur in all three adjacent American regions should have become excluded from the fourth, which they may be said to bound.

It remains to add that Dr. Coulter's manual is well got up, and though claiming in the preface to be no more than a compilation, it is really a very useful work. The only important omission observed, and it is a very serious one, is that of the elevations at which the plants grow. It is a great advance on the fragmentary "Synopsis of the Colorado Flora" by Porter and Coulter, which was welcome in its day; and though there is no doubt that a good many more species will be found in a future edition, and that some of the data extracted above will be thereby interfered with, there is no reason to suppose that these will clash with the main facts, which so amply confirm all the conclusions that Asa Gray drew years ago from the comparatively imperfect data then at his disposal.

J. D. H.

MORLEY'S "ORGANIC CHEMISTRY"

Outlines of Organic Chemistry. By H. Forster Morley, M.A., D.Sc. (London: J. and A. Churchill, 1886.)

THE faults into which the writer of a text-book of organic chemistry for students is apt to be led are, as Dr. Morley points out in his preface, that of over-elaboration on the one hand, to which the material too readily lends itself, and that of unintelligent abridgment on the other. Dr. Morley adopts a satisfactory compromise by selecting for treatment a relatively small number of typical compounds, giving, however, "as much consideration to each compound as it would receive in a large treatise." Some departures from this rule are, as he candidly confesses, due to the necessity of taking into account "the requirements of students working for examinations."

Dr. Morley's arrangement of his subject is new—so far at least as it has not been anticipated in Prof. Remsen's "Organic Chemistry," which, however, did not appear until after the completion of the present work in manuscript. "I have endeavoured," he says, "to describe compounds in the order in which they may be synthetically produced, so that each compound should be a product of the one before and a producer of the one after." We must confess to having doubts as to how far, save in the interests of very young students, such an entire sacrifice of the symmetry of the ordinary classification as is involved in this arrangement is judicious.

Most text-books of organic chemistry contain, prefixed to each class of compounds, preliminary chapters dealing with the general modes of preparation, the properties and the reactions of the entire class. This arrangement finds no favour in the author's eyes. "Not until he (the student) finds that a series of reactions can be grouped together under some general expression should he be allowed to mention a general law." The principle is doubtless, within its proper limits, sound; but we should

be sorry to lay down a hard-and-fast rule. The order of educational exposition is not necessarily identical with that of scientific discovery. Facts are more readily remembered if the principle connecting them is known beforehand. And if a teacher, by offering a few preliminary generalities, can peptonise a rather indigestible mental nutriment, why should he, on purely *doctrinaire* grounds, be forbidden to do so? Did Dr. Morley ever read a novel, and if so, did he never yield to the human temptation of anticipating the course of the narrative by looking at the end?

Dr. Morley has distributed the general reactions throughout the text, calling attention to them, however, by printing them in spaced type. The theoretical sections are as a rule brief, but to the point. An excellent account of the benzene theory is introduced; but we would point out that Hübner has given a simpler proof of the existence of the symmetrical *meta* pair of hydrogen atoms than that of Wroblewsky quoted by Dr. Morley: this proof is based upon reactions of the two nitro-salicylic acids.

The selection of facts is judicious, and, inasmuch as Dr. Morley's plan demanded that each compound should be treated of with considerable fulness, the student can hardly turn to any section of the book without learning all that is of real importance under that head.

Several inaccuracies have crept into the book, although they are not sufficiently numerous to interfere seriously with its usefulness. In his preface Dr. Morley acknowledges his indebtedness to Beilstein's treatise in his search for facts, and we fear that he has not always been sufficiently careful to ascertain how far Beilstein's statements are traversed by more recent experimental results.

Thus on p. 136 the author introduces glycerin ether—formerly dear to classification as the only example of the ether of a trihydric alcohol. But Tollens and Loë have shown that, whatever this compound may be, it is certainly not an ether of glycerin.

On p. 389 it is stated as a universal rule, that, in the conversion of diazo-compounds into substituted azo-compounds, "where nitrogen becomes attached to an atom of carbon in a benzene nucleus, the nitrogen takes up a para-position with regard to one of the groups already present." Mazzara, Witt, Liebermann, and Griess have shown that the nitrogen may also take up the ortho-position.

Following Beilstein the author has altered Wertheim's formula for conhydrine, $C_8H_{17}NO$, into $C_8H_{19}NO$. This has of course been done in order to bring Wertheim's statement, which Dr. Morley gives, that conhydrine may be broken up into water and coniine, into harmony with Hofmann's formula for coniine. But Hofmann has shown that Wertheim's conhydrine formula is correct, and that it is his experimental fact which is wrong: conhydrine does not yield coniine. In this connection it is strange that Dr. Morley makes no mention of Ladenburg's synthetic optically-inactive coniine (α-isopropylpiperidine).

Under piperidine (p. 434) Königs's assertion that pyridine can be reduced to this compound by treatment with tin and hydrochloric acid is given. Dr. Morley must have overlooked Ladenburg's criticism of this work.

In the indigo group we find isatin (p. 386) represented as a lactam instead of as a lactim, and the so-called nitrosooxindol (in reality isotoxim) formulated as a true nitroso-compound, instead of as an isonitroso-compound. It is of course conceivable that in these two cases Dr. Morley does not share the views put forward in Baeyer's later work on the indigo-compounds.

In the foregoing instances the information is, as already stated, merely not up to date. But there are one or two statements in the book, the source of which we are quite unable to trace. Thus we are told (p. 339) that "anthraquinone forms a compound with bisulphite of soda." If there is one thing that distinguishes anthraquinone from the quinones of the other hydrocarbons with complex nuclei—from phenanthraquinone, chrysoquinone, &c.—it is the fact that it does *not* form a compound with bisulphite of soda.

Again, under the head of ultimate analysis of organic compounds, we read:—

"Many mixtures have been suggested from time to time as substitutes for oxide of copper; the latest is a mixture of potassic chromate and precipitated binoxide of manganese proposed by Dr. Perkin."

Dr. Perkin would indeed have much to answer for if he had proposed such a substitute for oxide of copper. The mixture was proposed as a substitute for *reduced* copper, to absorb the oxides of nitrogen formed during the combustion of nitrogenous organic compounds.

The equation for the action of trichloride of phosphorus on acetic acid (p. 47) is an instance of the strange vitality which symmetrically-constructed and plausible but quite erroneous chemical equations sometimes display. We do not blame Dr. Morley for introducing the equation: it is given in all organic text-books, ancient and modern, from the time of Gerhardt to the present day, and will probably continue to be employed, translated into the notation of the distant future, at a time when our present formulæ have become as unintelligible as cuneiform inscriptions. The correct equation may however be found, by the curious in such matters, in a paper by Dr. Thorpe, (*Chem. Soc. Trans.*, 1880, p. 186), who was at the trouble to work out the reaction quantitatively.

An excellent feature, unusual in an elementary work of this kind, is to be found in the copious references, designed to encourage in students the habit of reading original papers for themselves.

F. R. JAPP

THE SPRINGS OF CONDUCT

The Springs of Conduct; an Essay in Evolution. By C. Lloyd Morgan. (London: Kegan Paul, Trench, and Co., 1885.)

THIS is a thoughtful and extremely well-written little book on psychology and ethics, regarded from the standpoint of evolution. There is not much in it that is strikingly original; but the material is so well arranged, and the views so lucidly expressed, that the work constitutes a most interesting epitome of modern thought upon the subjects of which it treats. The author is a man well informed as to his facts, while his ability as an analyst may be remembered by the readers of this journal, in the pages of which it was well displayed a year or two ago in a criticism upon the work of the present writer. On that occasion Mr. Morgan took exception to the study of animal intelligence and mental evolution in animals, on the ground that it is impossible to obtain any verified

knowledge of the psychology of brutes, seeing that we cannot directly interrogate them upon the nature of their feelings or mental states. The discussion which followed appears to have had the effect of somewhat modifying his original views; for these, as now stated in his book, are not so severely sceptical as they were when stated in these columns. That is to say, he now appears to recognise the possibility of comparative psychology as a science, although its subject-matter is necessarily restricted by the inadequacy of our "ejective" knowledge of animal intelligence.

We are in such full agreement with the whole essay that our only criticisms upon it refer to matters of comparative detail. These are as follows:—

Mr. Morgan gives it as his opinion that we cannot conceive of matter apart from motion (p. 94), for, in order to do so, we should require to conceive of matter as absolutely cold, "and of such absolutely cold matter we have no knowledge." The fact, however, that we have no knowledge of absolutely cold matter is no proof that we are not able to conceive of matter as absolutely cold. The so-called absolute zero of temperature surely admits of conception as definite as it would were it possible to take an actual reading of its occurrence.

Mr. Morgan's use of the word "instinct" appears to us equivocal. At one time instinctive actions are expressly affirmed to mean adaptive actions of an involuntary and unconscious kind (pp. 226-7); while at another time it is said "Mr. Darwin clearly shows that the satisfaction of any instinctive emotion carries with it a subdued form of pleasure; while, on the other hand, if those instinctive emotions be not satisfied, there results a still more marked feeling of uneasiness, which is a subdued form of pain" (p. 259). Now, clearly, there can be no such thing as an unconscious emotion, an unconscious form of pleasure, or a "still more marked [unconscious] feeling of uneasiness." Mr. Morgan thus appears to have fallen into the inevitable confusion which is the fate of all writers who fail clearly to distinguish between instinct and reflex action, or expressly to include the former term within the territory of consciousness. For these reasons we cannot follow the author's analysis where it leads up to the conclusion that volition is coextensive with consciousness (p. 226 *et seq.*). We may be conscious of the sudden anguish of neuralgia: can it be said that this consciousness is due to, or accompanied by, any act of volition? Mr. Morgan would answer that with the pain there arises a desire that it should cease (p. 229). But, in the first place, a desire is not a volition; and, in the next place, even the desire has here no time to arise before the pain is past.

In one place where Mr. Morgan refers to the views of the present writer, he represents them as differing from those of Dr. Bain, while in reality no difference obtains. First, he quotes the following passage from "Mental Evolution in Animals":—

"What is the difference between the mode of operation of the cerebral hemispheres and that of the lower ganglia which may be taken to correspond with the great subjective distinction between the consciousness which may attend the former, and the no-consciousness which is invariably characteristic of the latter? I think the only difference that can be pointed to is a difference of rate or time, which clearly implies that the nervous mechanism concerned has not been fully habituated to the performance of the response required. . . . Reflex action may be regarded as the rapid movement of a well-oiled machine, consciousness as the heat evolved by the internal friction of some other machine, and psychical processes as the light which is given out when such heat rises to redness. Consciousness is but an adjunct which arises when the physical process, owing to infrequency of repetition, complexity of operation, or other causes, involves what I have before called ganglionic friction."

Now, on this passage Mr. Morgan remarks that he does not consider such ganglionic friction so important a factor in the evolution of consciousness as is "the diffusion of nerve-disturbance" enunciated by Dr. Bain. But surely the former principle includes the latter. For it is only due to this internal friction that the diffusion of nerve-disturbance can be supposed to take place. If all the paths of nervous discharge were freely open, the nervous disturbance would course rapidly and easily along the habitual channels, with comparatively little diffusion as a result. It is only in cases where no one set of paths are more readily open than other sets that alternative directions are offered to the flow of nervous disturbance, with diffusion as a result. The resistances thus encountered—or the ganglionic friction thus created—finds its measurable expression in the delay of eventual response. But although ganglionic friction may arise from such "complexity of operation" (so leading to diffusion), it may also arise from "infrequency of repetition or other causes." Therefore the term ganglionic friction includes all that is expressed by the term diffusion, and differs from it only in being more comprehensive, or in recognising other conditions of cerebral action leading to consciousness, the occurrence of which is always expressed by delay.

GEORGE J. ROMANES

OUR BOOK SHELF

Spectrum Analysis. Six Lectures delivered in 1868 before the Society of Apothecaries in London. By Sir Henry E. Roscoe, F.R.S. Fourth Edition, Revised and Considerably Enlarged by the Author and by Arthur Schuster, Ph.D., F.R.S. (London: Macmillan and Co., 1886.)

THIS is a fourth edition of a well-known book, and the joint authors have evidently taken some trouble to bring the present edition up to date. To this end, the arrangement of the book, which is rather peculiar, lends itself very well. The peculiarity of the arrangement to which we refer is this. At the time that the lectures were first delivered, now nearly twenty years ago, the literature of the subject was so restricted that Prof. Roscoe found it easy and convenient to reinforce the subject-matter of each lecture by reprinting, immediately after it, the particular memoirs on which it had been based. Hence the first edition was a very precious boon to two classes of people: there was an excellent popular account of the new science, and there were the complete memoirs conveniently brought together for those who wished to go more deeply into the subject.

In the present edition an attempt has been made, as we have said, to bring the lectures more or less up to date, and considering the volume of the work which has been done since 1868, one can understand that this has been no easy task. When we pass, however, from the lectures to the appended memoirs so much cannot be said; indeed the interest of this part of the book is now chiefly antiquarian, if we except reprints of Dr. Schuster's own papers, which are given, we believe, *in extenso*,

while Prof. Young's observations on the sun, now fifteen years old, is the latest information we get in the appendixes on any solar matter, English and foreign work being ignored with a magnificent impartiality. In the same manner Vogel's work on the spectra of stars, the most extensive which has been accomplished by any one single individual up to this time, is also passed over, as is also Birmingham's work on the red stars.

We give these as instances of the treatment adopted. No doubt, had the initial idea of the book been carried out in its entirety by the insertion of the most important parts of these memoirs, the size of the volume would have been greatly increased, and this perhaps may be one reason for the violently selective treatment adopted; but it may be urged on the other hand that the value of the book would have been increased much more than its size, and further, that space might easily have been gained for some of the best modern work by the omission of those papers which, as we have said before, are now purely of antiquarian interest.

There was one feature in the third edition which we also regret very much to see dropped in the present one. This was a bibliography running over twenty pages, in perhaps its most convenient form, namely, a list of authors and a complete reference to their memoirs, arranged under the larger groupings of the subject-matter.

Trigonometry for Beginners, as far as the Solution of Triangles. By the Rev. J. B. Lock, M.A., Senior Fellow of Gonville and Caius College. (London: Macmillan and Co., 1886.)

THIS book covers exactly the same ground as Pinkerton's, which we noticed in NATURE, vol. xxxi. p. 148. The two have many good points in common, and we should be well satisfied to use either of them as a text-book. Mr. Lock's great advantage is preceptorial skill in arrangement and exposition. On this score he deserves much credit indeed. There are very few points on which it is possible to suggest improvement. The retention of the expression "circular measure" in all its former importance, notwithstanding the introduction and constant use of the term "radian," is regrettable but not of much consequence: the mode, however, which he employs for indicating the word "radian," *e.g.* writing π^c for π radians, is most unfortunate, and we should hope altogether unacceptable. It is surprising too to find so skilled a teacher following the multitude in condescending to recognise those unnecessary nuisances, "tabular logarithmic sines," &c. Their existence, Mr. Lock says, is due to a typographic difficulty—a statement we hesitate to give assent to; but, be their history what it may, they serve no purpose nowadays whatever, except to roughen the learner's path. Writers require to give them a foolish name and a special symbol, to alter the formulæ for solution, and to burden the learner with additional cautions,—and all for less than nothing. It seems almost malicious indeed to force on a "beginner" such gratuitous absurdities as "natural sines," "logarithmic sines," and "tabular logarithmic sines," when the entities to be dealt with are simply *sines* and *logarithms of sines*. If Mr. Lock in a succeeding edition could see his way to inaugurate the necessary reform here, many teachers would be grateful to him.

The Apparent Movements of the Planets and the Principal Astronomical Phenomena for the Year 1886. Illustrated with Charts showing the Paths of the Eleven Principal Planets among the Stars. By William Peck, F.R.A.S. (Edinburgh: Archibald and Peck, 1886.)

BEGINNERS in astronomy will find this little compilation useful. Just the kind of information is brought together in it which persons interested, though not learned, in celestial phenomena want to be supplied with. Technical language, too, is as much as possible avoided, while sufficient exactness for the purpose in view is usually preserved. Not, however, invariably; the statements regarding the two solar eclipses visible in 1886 are so loose as to be misleading. Eleven miniature maps, showing the paths through the constellations during the present year of seven primary and four minor planets, are neatly executed, and ought to prove acceptable to casual observers. Exception must be taken to the introductory assertion that Copernicus swept away all the "complicated machinery of the heavens." His reform of the Ptolemaic system was by no means so complete as Mr. Peck's expression implies. The retention by the Frauenburg astronomer of the old hypothesis of equable circular motion necessitated, in fact, the employment still of no less than thirty-four circles, by which to make plain, as he said, "the entire structure of the heavens"—that is, the revolutions of the moon and of the six known planets.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

An Earthquake Invention

IN NATURE of July 2 last, p. 213, I was accused by Prof. Piazzi-Smyth and Mr. D. A. Stevenson of having attempted to appropriate an invention of Mr. David Stevenson. The invention referred to was the joint introduced by Mr. Stevenson beneath the lamp-tables in certain lighthouses in this country.

In my reply (NATURE, vol. xxxii. p. 573) I pointed out the fact that the aseismatic joint had been independently invented by several investigators of earthquake phenomena, and so far as I was aware Mr. Mallet had appeared to have the prior claim to this invention. My reason for attributing the invention to Mr. Mallet is that when speaking of Japanese lighthouses he says: "I was consulted by Mr. Stevenson as to the general principles to be observed, and these edifices have been constructed so that they are presumedly proof against the most violent shocks likely to visit Japan; not perhaps upon the best possible plan, but upon such as is truly based upon the principles I have developed" (Palmieri's "Vesuvius," p. 43). As the aseismatic joints were portions of the lighthouses especially designed to render them proof against earthquakes, I naturally assumed that Mr. Mallet might be the first inventor of the ball-and-plate joint.

The only occasion on which I have posed as *the* author of the aseismatic joint in question, was when Messrs. Stevenson and Smyth promoted me to that *quasi*-enviable position.

Had these gentlemen recognised the fact that they were only reading a *brief note* about ball-and-plate joints, intercalated in a collection of notes on other subjects, and had they been well acquainted with the recent literature relating to aseismatic tables, they would certainly have refrained from the objectionable accusations made on July 2.

On *more than one* occasion I have referred to Mr. Stevenson's work in Japan. As an example of such a reference, Messrs. Stevenson and Smyth may turn to the *Times* of May 26—*a date which it will be observed is prior to the date of their unwarrantable attack*. In that paper there is a long letter on "Buildings and Earthquakes" signed with my name. When speaking of my house on shot, I there say, "*This experiment was very similar to one carried out by Mr. David Stevenson with regard to the lamp-tables in several of the lighthouses on the coast of Japan.* For several reasons, among which were the movements produced by wind, I abandoned the balls, and now have my house resting at each of its piers upon a handful of cast-iron shot. These shot, which are about the size of buckshot, have so increased the frictional resistance to rolling, that the house is practically astatic, and the motion in the house is in most earthquakes only about one-tenth of what it is outside."

I make especial reference to the *Times*, first because it is a

paper which many Englishmen have often the opportunity of seeing; and second, because the article in question occasioned considerable discussion.

With this reference to the relationship of my experiments to those of Mr. David Stevenson, and I will furnish others if required, I think it would only be just for Prof. Piazzi-Smyth and Mr. D. A. Stevenson to withdraw their accusation of July 2.

I must now refer to a second point which Mr. Stevenson has raised. In your issue of August 6 Mr. Stevenson appeals to the results of my experiments as showing the value of his aseismatic tables. All my experiments with aseismatic tables, whether used for seismographs or buildings, when approximating in form to Mr. Stevenson's joint were, for a variety of reasons, unsatisfactory. Under compulsion I have stated that Mr. Stevenson's joint itself, as applied to the lighthouses of Japan, has been unsatisfactory. I did so for the following reasons:—

(1) Shortly after erection the free motion of the tables occasioned so much inconvenience, that the European engineers then on the Japanese service had them clamped. For this reason Mr. Stevenson's arrangement was not adopted in lighthouses which were subsequently erected (see Brunton on "The Japan Lights," Institute of Civil Engineers, No. 1451, p. 9).

(2) I learn from the Lighthouse Department that in 1882, wishing to give Mr. Stevenson's tables another trial, several of them were put in working order. The result has been that on March 11, 1882, at Tsurgisaki, a number of lamp-glasses on the burners on the aseismatic tables were overthrown.

Some time afterwards a second shock produced a similar effect. At neighbouring lighthouses, of which there are several (two being within 8 miles), not provided with aseismatic tables, no damage was sustained.

The shock of March 11, 1882, which was felt for at least 300 miles along the coast, was severe, and its effects at Yokohama and Tokio, which are no great distance from Tsurgisaki, were carefully recorded. I am not aware that any small articles like lamp-glasses, bottles, vases, &c., were overthrown inside ordinary houses (see *Trans. Seis. Soc.*, vol. vii. part ii. pp. 41–44). The fact that no ill effects occurred at other lighthouses provided with Mr. Stevenson's tables, like those on the Inland Sea and near Kiushiu, must not be regarded as an argument in favour of the tables, inasmuch as the earthquake referred to was not felt in those districts.

I may here remark that several of the aseismatic tables are at places where earthquakes are almost as rare as they are in Britain. Mr. Stevenson tells the readers of NATURE (June 26) that his lighthouses suffered when the aseismatic tables were *not* in working order. I have shown that they suffered when they were in good working order.

Speaking generally about Mr. Stevenson's descriptions of his aseismatic arrangement, he invariably refers to it as a great success. Where it was applied, earthquakes have produced no effect, but where it was suppressed, evil effects have resulted. After inquiries at the Lighthouse Department, which is a branch of my own department, I find that the facts adduced by Mr. Stevenson are exactly the reverse of the facts which have been placed at my disposal; and from what I learn, and from my own experiments, I conclude that thus far Mr. Stevenson's tables have been a failure.

As a further support to my conclusions I will quote the following translation of a report from the chief lightkeeper at the Tsurgisaki Lighthouse:—

"Sir,—On October 15, 1884, at 4.16 a.m., very severe shocks of earthquake were felt. The aseismatic table was in working order, but the shocks were so violent that fifteen lamp-glasses out of twenty-one in use were upset and broken. The lamps thus stripped of glasses began to smoke. The milled heads of the wick-holders being shaken off, and besides the revolving machine being in motion, we had some difficulty in replacing the glasses promptly; however, we managed to put them all in proper order again by 4.21 a.m.—I am, Sir, your obedient servant, &c., &c."

The only form of aseismatic joint that I have found at all practical is one where something more like a layer of cast-iron sand rather than a bed of cannon-balls is used to break the continuity between a structure and its foundations. I arrived at this after spending much time and, I may add, a considerable sum of money, and although the method involves the same *principle* as Mr. Stevenson's tables, I hardly think he is justified in claiming my successes to back up what I cannot but feel have been his failures.

If the ways and means permit, I hope to make experiments upon a small building resting on a bed of sand or fine gravel. Should results of any value be obtained, surely Mr. Stevenson will not expect me to do more than I have done already—namely, to state the relationship which may exist between these experiments and those which he carried out at the expense of the Japanese Government.

If everything connected with earthquake investigation which involves the same *principles* as are involved in Mr. Stevenson's lighthouse tables are to be regarded as his creations, he cannot avoid claiming the rolling sphere seismograph, the rolling cylinder seismograph, the horizontal pendulum seismograph, the conical pendulum seismograph, and in short, a very large proportion of the work accomplished by the Seismological Society of Japan. To this I cannot assent. All that Mr. Stevenson can be accredited with is a particular *method* of applying a principle, and this method has to my mind been a failure.

The question of the *principle* involved in Mr. Stevenson's device is one that has been *repeatedly* discussed in Japan. As an example of these discussions I will refer to the *Transactions* of the Seismological Society of Japan, vol. iii. p. 9, where Prof. J. A. Ewing is speaking, amongst other things, about a rolling sphere seismograph, the invention of Mr. Thomas Gray. Prof. Ewing says that Mr. Gray's contrivance was an application of "the method of supporting a mass by a movable piece in such a manner that the connection with the earth was at the centre of percussion of the movable piece, the mass being at the corresponding centre of instantaneous rotation, while at the same time the supporting piece was arranged so that its movements did not introduce any disturbing force due to the action of gravity upon the mass. This kinetic property, common to all these instruments, he believed he might fairly claim to have introduced into seismometry."

If Messrs. Stevenson and Smyth see fit to comment upon these notes, I trust that they will distinctly state whether they yet consider that I have attempted "to get round the letter" of Mr. David Stevenson's invention, and whether they were justified in publishing the objectionable personalities about "a B.A. man" on July 2.

This is the main point at issue, and if they choose to neglect it, the discussion may be considered as ended.

In conclusion I may remark that it was not I who commenced this controversy.

JOHN MILNE

Tokio, January 6

On the Velocity of Light as Determined by Foucault's Revolving Mirror

A FEW years ago Lord Rayleigh raised an interesting question as to the quantity actually determined by our experiments and observations on the velocity of light. There can be no difficulty as long as the medium transmits different wave-lengths with the same velocity, but whenever the medium possesses the property of dispersion the velocity with which any one crest of a wave travels (V) is different from the velocity with which a group of waves is propagated (U); hence the question arises in each particular case, whether it is V or U or something depending on both quantities that we measure.

In his first article on the subject (NATURE, vol. xxiv. p. 382) Lord Rayleigh states that, in experiments with Foucault's revolving mirror, the group-velocity, U, is determined; but subsequently (vol. xxv. p. 52) he corrected this statement and gave V^2/U as the quantity measured. A paragraph was added, however, in which the remark is made that, if a convex lens is interposed so that an image of the slit is formed on the fixed mirror, the rotation of wave-front, caused by the different velocities of different wave-lengths, and acquired on the outward journey, is neutralised during the return, so that in this case we should measure V.

Gouy (*Comptes rendus*, ci. p. 502, 1885) dissents from Lord Rayleigh's second view, and gives U as the quantity determined; without, however, giving sufficient reason in support of his opinion.

Finally, Michelson has performed the experiment with bisulphide of carbon, and obtained a result in close agreement with U. In a discussion of Michelson's measurements in the *American Journal of Science*, by J. W. G., his result is said to give "no countenance" to the theory which would make the velocity observed V^2/U.

It is the object of this communication to support Lord Ray-

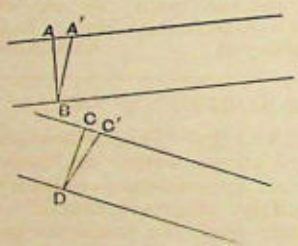
leigh's value V^2/U for the arrangement considered by him, but to point out that, if only one revolving mirror is used, the experiment cannot be performed in this way. The lens spoken of in Lord Rayleigh's second note is, then, a necessary condition of the experiment. When the lens is used it seems to me, however, that the result ought not to be a neutralisation of effects, but rather an equal rotation in the opposite direction. I have Lord Rayleigh's authority for stating that he agrees with this conclusion.

The method of Foucault's revolving mirror thus measures neither V nor U, nor V^2/U, but $V^2/(2V - U)$. As V and U differ by a small amount only, the last expression becomes nearly equal to U, so that Michelson's experiment is in complete agreement with theory.

In Foucault's experiment, it is well known, the displacement of an image is measured which is due to the rotation of a reflecting mirror in the time of passage of the light from the mirror to a fixed mirror and back again. But in order that this quantity should be capable of measurement, it is necessary that a displacement of the mirror should not by itself alone cause a displacement of the image.

The following consideration will show what conditions this imposes on the arrangement of the experiment.

In the accompanying figure let A B be the position of a wave-front as it leaves the mirror (supposed fixed). Let C D be the position as it returns to the mirror. I have drawn the wave-surfaces plane, for the sake of simplicity, but the argument remains the same if they are curved. The point A may correspond to the point C on the returning front or to the point D. If now the mirror is displaced through a small angle, the wave-front takes a different position, A' B. If this displacement shall not change the position of the image after reflection from the mirror, the returning wave must turn through the same angle and take up the position C' D. But it is easily seen that, in order that this may be possible, the point A must correspond to D and B to C, for the optical length along any ray between two wave-



fronts remains the same; also, owing to the maximum-minimum property, we can still measure optical lengths in the displaced position along the original paths; and the length of the ray leaving A having been shortened by a distance A A', the ray leaving B must be shortened by an equal amount, C C'—that is to say, the ray arriving at C must be the one leaving B, and the ray arriving at D must be the one which left A. We may then express the condition of a stationary image thus: The wave-surface must be inverted by the optical arrangement interposed, and the magnifying power of this optical arrangement must be equal to one. The last part of the condition is rendered necessary by the fact that the width of beam must remain the same; otherwise A A' could not be equal to C C'. If both conditions are fulfilled, the image will remain distinct in the rotating mirror, otherwise it would be drawn out into a band.

But an arrangement is possible, at any rate theoretically, in which the wave-surface is not inverted. We might have a second mirror rotating in such a way as to neutralise the effect of displacement. For this purpose the second mirror ought to rotate twice as fast as the first, the light being sent on to this second mirror on its way back only, after reflection from the first revolving mirror. As the angular velocity of the two mirrors must have their velocity accurately adjusted, the experiment would be difficult to perform, but it is important to point out that it is theoretically possible.

Returning now to Foucault's arrangement, consider two successive wave-fronts as they leave the revolving mirror. The distances between them will be larger on the receding than on the preceding side of the mirror. That part of the wave-front which is on the receding side will thus be propagated more quickly in a medium having dispersion, and whatever happens to the wave-front on its journey, whether it is refracted, reflected, or inverted, that side of it which left the receding part of the rotating mirror will always gain on the other. When the wave-front returns to the revolving mirror, it will have rotated through the angle given in Lord Rayleigh's second note; but we have to consider the direction of rotation.

If that part of the wave-front which left the receding half of the mirror will return again to the receding half, the final rotation of wave-front will be in the same direction as the rotation of the mirror; and the displacement of the image which depends on the relative rotation of mirror and wave-front will be diminished. In this case, however, as I have shown, we want a second revolving mirror, otherwise the image of the slit will be drawn out into a band.

In the experiments hitherto performed, the wave-front is inverted an odd number of times between the two mirrors, and hence that part which left the receding side of the revolving mirror will now be on the preceding side. The relative rotation being increased, the observed displacement of the image will be increased.

The total observed rotation will thus, with Lord Rayleigh's notation, be

$$\frac{4Dw}{V}\left(1 + \frac{d\log V}{d\log\lambda}\right),$$

or the velocity of light calculated will be $V/\left(1 + \frac{d\log V}{d\cos\lambda}\right)$. As $U = V\left(1 - \frac{d\log V}{d\log\lambda}\right)$, the apparent velocity becomes equal to $V^2/(2V - U)$. If $\frac{d\log V}{d\log\lambda}$ is small compared to unity, we may write the expression for the apparent velocity approximately

$$V\left(1 - \frac{d\log V}{d\cos\lambda}\right) = U.$$

In the case of bisulphide of carbon, J. W. G., in the passage quoted above, gives for the green rays $K/V = 1{\cdot}637$, $K/U = 1{\cdot}767$, K being the velocity *in vacuo*. From this we get for the theoretical value of the quantity observed in Michelson's experiment 1·758, being identical with the value 1·76 actually observed.

If a second rotating mirror is used, as described, Lord Rayleigh's value V^2/U remains true.

We have then as a final result, that, while the aberration of light measures V, and the eclipses of Jupiter's satellites and Fizeau's experiments measure U: Foucault's revolving mirror measures either $V^2/(2V - U)$, or V^2/U.

ARTHUR SCHUSTER

Variable Stars

IN the last number of NATURE (p. 397) Prof. Seeliger, of Munich, is represented as thinking "it not improbable that the blazing forth of the *Nova* may have been due to a collision which caused an enormous development of heat and light." It appears to me that the collision hypothesis is not necessary, and that the variability of a star is a physico-chemical consequence of mere cooling. This conclusion is based on considerations relating to the formation of the chemical elements.

If we suppose a mass of primitive matter, say gaseous, to be cooling down, it will from a chemical point of view undergo a series of changes such as are indicated in the known transformations I to I_2, NO_2 to N_2O_4, &c.; in short, it will produce a succession of polymers. When, however, each stage of polymerisation is exactly reached, the formation of each new polymer being attended with an increase of density, will, from a physical point of view, lead to an evolution of heat. This evolution of heat will occur periodically as polymerisation goes on; and if the heat be sufficiently intense, there will be a corresponding periodic development of light. The number of such periods will doubtless depend on the nature of the primitive matter, and the difference between its temperature and that of its environment. I cannot recall an instance where, in the laboratory, more than three polymeric periods have been attained; but celestial events have a wider range and greater possibilities.

The evolution of heat which necessarily occurs at the point of polymerisation involves of course a partial reversal of the polymerisation. Elements therefore will be formed which may be regarded as derived from successive polymers by virtue of such reversal.

In the *Philosophical Magazine* for November 1884, and for February 1886, I have shown that the numerical value y of the symbol of an element within the common system is given with great accuracy by the equation

$$y = 15p - 15(\cdot 9375)^t,$$

where p is the number of the period, and t is a whole number, easily approximated to, on the scale of celestial temperature. Our ordinary elements—that is to say, all that are known to us with the exception of hydrogen—are thus seen to correspond to what might be expected from a law of polymerisation affected by the inverse of Dulong and Petit's law of cooling. They appear to be comprised within sixteen periods only.

These considerations lead to the inference that a variable-star is one that is engaged in making "elements." All stars, therefore, either are, or must at one time have been, variable-stars.

Glasgow, March 1 EDMUND J. MILLS

Do Young Snakes take Refuge in the Stomach of the Mother?

THE letters of Messrs. Middleton and Creole (NATURE, vol. xxxiii. pp. 176 and 269) in relation to the above-indicated reputed habit of serpents, directed my attention to some considerations and facts bearing upon the question at issue.

It has long been a popular belief—in relation to the European viper, as well as the American rattlesnake—that when the female is suddenly surprised she opens her mouth and permits her young to *run down her throat*. Some of the English viper-catchers deny that any such thing ever happens; and for a long time I was disposed to ascribe the origin of the popular opinion to the fact that, these serpents being *ovo-viviparous*, they are sometimes found with the young in the *oviduct*; which might lead persons to suppose that they were in the *stomach*. But the following account, given by the well-known French naturalist and traveller, M. Palisot de Beauvois, is so *direct* and *positive*, that my faith in the above explanation has been seriously shaken.

He asserts "that he saw a large rattlesnake, which he happened to disturb in his walks, coil itself up, open its jaws, and instantly receive five small ones which were lying by it and instinctively rushed into its mouth. M. de Beauvois retired and watched the snake, and, about a quarter of an hour after, he saw her discharge them. He approached a second time, when the young retired into its mouth with greater celerity than before, and the snake immediately moved off among the grass and escaped" (*vide* Rees' "Cyclopædia," vol. x., Article "Crotalus," cited from the *Transactions* of the American Philosophical Society). Testimony so clear and distinct from a scientific man is hardly to be gainsaid. JOHN LE CONTE

Berkeley, California, February 17

The Coal-Dust Question

SIR FREDERICK ABEL has not fortified his statement by even one quotation from the writings of one of those workers "antecedent to and contemporaneous with" myself, who, according to his letter in the last number of NATURE (p. 417), have taken the variable specific heat of air into account in drawing comparisons between experimental effects obtained in practically closed apparatuses and the corresponding effects to be expected from a great explosion taking place in the practically closed space represented by the workings of a mine.

Secondly, I am entirely at a loss to know what are the "very obvious facts" which forbid the conclusion at which I have arrived, namely, that coal-dust plays the principal part in most great explosions in mines. They have not yet been pointed out by any author so far as I have been able to learn.

Lastly, Sir Frederick's statements, to which I called attention in my letter in NATURE of December 31 (p. 197), were made for the most part before popular audiences, very few of whom will probably take the trouble to wade through the Report of the Royal Commission on Accidents in Mines in order to verify his concluding remarks for themselves. W. GALLOWAY

Permanent Magnetic Polarity of Quartz

To my letter in NATURE for February 25 (p. 391) you have added an editorial note, quoting a passage from Tumlirz's paper which has no bearing on any of the points at issue.

In your original note you stated that Tumlirz has discovered a permanent diamagnetic polarity of quartz. To this I objected, saying that the permanent polarity was paramagnetic, not diamagnetic, and you reply by a quotation stating that quartz is a diamagnetic body showing permanent polarity, a very different statement indeed from your original one.

A permanent diamagnetic polarity could only mean that quartz placed between the poles of a magnet should show permanent north polarity at the end placed opposite the North Pole. Tumlirz is perfectly distinct and explicit that this is not the case, but that the permanent polarity acquired is in the same direction as it is in iron. There is no room for two opinions as to the meaning of Tumlirz's words.

ARTHUR SCHUSTER

[Our correspondent who furnished us with the original note informs us that Prof. Schuster was entirely right in the definition of the term diamagnetic polarity, and that his informant in Vienna had been misled in using the phrase permanent diamagnetic polarity for permanent polarity of a diamagnetic body. The sentence which we quoted from Dr. Tumlirz's now-published paper we quoted because it is the one in which he points out the essential novelty of his discovery, which we and our correspondent regarded, and still regard, as one of very great importance. Our thanks are due to Prof. Schuster for pointing out the ambiguity.—ED.]

The "Muir Glacier" of Alaska

IN Mr. G. W. Lamplugh's interesting article on "The 'Muir Glacier' of Alaska," published in your issue for January 28 (p. 299), appears the erroneous statement that Glacier Bay opens into Chilcoot Inlet. Chilcoot Inlet is at the head of Lynn Canal, the approximate latitude and longitude being 59° 20′ N., and 135° 20′ W. Glacier Bay opens into Cross Sound (or Icy Strait) about latitude 58° 30′ N., and longitude 135° 50′ W. Lynn Canal is an extension of Chatham Straits, both running nearly north and south. Cross Sound connects the latter with the Pacific Ocean, and runs nearly east and west, entering Chatham Straits south of the southern limits of Lynn Canal.

Washington, February 25 CHAUNCEY THOMAS

THE SURVEY OF INDIA[1]

IT has been well said that "l'exacte connaissance topographique qui est un facteur de l'avancement des sciences et de leurs applications pratiques, est aussi un élément constitutif du progrès national."[2] India is a country which, ever since the establishment of British dominion in the east, has been prolific of surveys of very various degrees of exactitude, ascending from the rough and rude reconnaissances which were needed for the speedy acquisition of some knowledge of the general geography, to, first, a fairly close representation of all topographical features, and, finally, to an exact delineation of the boundaries of all properties—of private individuals as well as of the State—in the richer and more densely populated portions of the British districts. Commencing at the coast lines, with the primary object of furnishing charts for the guidance of navigators, with a view to the rapidly-increasing traffic between India and Europe, they were extended inland, here and there, as different parts of the country became subject to British influence. Astronomical determinations of the latitude and longitude were employed in the first instance as a general basis for the geography, but not proving satisfactory, they were abandoned at the commencement of the present century, when the Great Trigonometrical Survey was originated, which has been of such value for geodesy, as well as geography. The survey work may be broadly classified as non graphical and graphical, the former trigonometrical and geodetic, the latter delineative of the configuration of the ground and of whatever has been raised on its surface.

[1] "General Report on the Operations of the Survey of India Department, administered under the Government of India during 1883-84." Prepared under the direction of Col. G. C. De Prée, S.C., Surveyor-General of India.

[2] "Importance de la Cartographie officielle." C. D. Carusso. Genève, 1886.

For many years survey operations of various kinds were carried on independently by distinct agencies. Of these the most notable were the Revenue and Settlement Departments under the Governments of the Madras and Bombay Presidencies and of the several provinces of the Bengal Presidency, and the Great Trigonometrical, the Topographical, and the Revenue Departments under the Supreme Government. The three last were amalgamated, in 1878, into a single department, styled the Survey of India, the report of which for 1883-84 we are about to review.

The survey year in India is invariably divided into the two periods of the field season and the recess, which are mainly governed by climatic conditions, and vary greatly in different parts of the country according as the monsoons set in or terminate early or late. For the surveys under the Supreme Government it is held to commence on October 1, when most of the survey parties are preparing to leave their recess quarters and return to the field. The annual reports are prepared for the survey year, as distinct from both the calendar and the official year. This one has been issued somewhat tardily, fully a year after the close of the period it embraces.

The operations were mainly geographical, topographical, and cadastral.[1] The principal triangulation having been completed in 1882, it is now only necessary to construct occasional minor triangulations. A chain was carried along the coast of Orissa and Gaujam to establish beacons for the use of the Marine Survey. Another was contemplated in extension of the principal triangulation terminating below Mergui and Tennasserim, at the southernmost point of the British-Indian territories on the Malayan Peninsula, to connect the Straits Settlements and Malacca; but it had to be held in abeyance in view of financial exigencies; thus Singapore still remains unconnected geographically with India, though Bangkok, the capital of Siam, has been well connected by a chain of triangles carried eastwards from Tavoy. And now that Upper Burmah has been annexed to the dominions of the Queen-Empress, the triangulation to Singapore must give way to what is more urgently required for the geography of the newly-acquired provinces.

Some idea of the variety and extent of the topographical operations is afforded by the following statement of the out-turn of area surveyed on different scales during the year:—

4034	square miles	on the scale of	1 inch = 1 mile
3225	,,	,,	½ ,, ,,
7437	,,	,,	1 ,, ,,
12074	,,	,,	2 inches ,,
692	,,	,,	4 ,, ,,
110	,,	,,	6 ,, ,,

in addition to which areas of 875 and 310 square miles were surveyed on the 4-inch scale, the former to supply working plans for the Forest Department, the latter to enable village boundaries to be relaid in riverain tracts, where they had been swept away by floods. The topography was carried on simultaneously in widely distant regions, in Biluchistan and in Burmah, in the Andaman Islands of the Bay of Bengal, and in the Native States of Rajputana and Cutch in Western India; also in the Guzerat and Deccan provinces of the Bombay Presidency. It may excite surprise that these last, which are among the oldest of the British possessions in India, should now be under regular topographical survey, and for the first time; but as a rule more attention has been paid to the topography of our later than our earlier acquisitions of territory. Good maps were prepared for the Punjab and Oudh as soon as possible after their annexation, under instructions from Lord Dalhousie and Lord Canning, at a time when very inferior ones were forthcoming for the North-West Provinces and Bengal: and to this day some of our oldest possessions have no better topography than was acquired by reconnaissance on the ½-inch scale early in the present century. These tracts are taken in hand as the requisite agency becomes available on the completion of surveys elsewhere.

Indian topography is entirely executed by the method of plane tabling on a trigonometrical basis, which, though well known on the Continent, is but little practised in England, and is not adopted by the Ordnance Survey. When a plane table is employed, all the details of the ground may be "fixed" by direction intersections laid off on the table, and all instruments for direct linear measurements may be dispensed with; this is a great advantage in surveys of tracts of mountains where chains cannot be conveniently employed, and in native States where they are objectionable for political reasons, raising a suspicion that lands are being measured with a view to annexation; and it has the further advantage of enabling the details of the ground to be drawn on the spot, whereby field-books are dispensed with and the rate of progress is much accelerated. In accuracy it cannot compete with the Ordnance Survey system of triangle-chaining; but it is better suited for ordinary topography in India, and best of all for rapid geographical reconnaissance everywhere; and it may be supplemented by chaining to any extent that may be desired for cadastral and other large scale surveys.

The out-turn of the work of the Cadastral Survey parties was as follows:—

	Square miles		Fields
In the North-West Provinces...	1747	comprising	1,863,000
,, Burma	1749	,,	1,608,000
,, Central Provinces ...	31	,,	40,000
,, Assam	228	,,	148,000
Total ...	3755	,,	3,659,000

Of the total area, 11 square miles were surveyed on the 32-inch scale, and the remainder on the 16-inch scale; the average areas of the fields ranged from ·12 to ·98 of an acre in different districts, the general average of all being two-thirds of an acre.

Cadastral Survey operations have hitherto been mainly carried on conjointly by the Survey and by the Settlement Departments, with the double object of furnishing correct maps of all properties, and records of the rights of every individual proprietor and tenant. Such maps and records are obviously of enormous value in the administration of the country; but they are necessarily costly, and therefore it has long been, and is still, a moot point whether they are absolutely necessary. Records of rights and liabilities to taxation were constructed at each of the successive periodic settlements of revenue under the Asiatic Governments anterior to the British, but no maps were made. During our first settlement an attempt was made to obtain accurate maps; so an attempt was made to ascertain the areas of the fields by fair approximation by measures of lengths and breadths with poles and ropes of a length regulated by that of the forearm of the measurer, obviously a very variable and indifferent standard unit; and from these measures rude outline sketches were constructed which were serviceable as furnishing a graphical index to the record of rights of each village, but of course were not true maps showing all boundaries of property correctly. In the modern Revenue and Settlement Survey of the Bombay Presidency accurate map construction was deliberately set aside, lest it might interfere with the classifications of soils and the investigations of tenures and rights which were deemed of greater importance. In the Madras Presidency its advantages were recognised, and good maps were made from the first, but the results were costly. In Northern India there has been a continuous endeavour

[1] The term "cadastral" is applied in India to a field-by-field survey which gives an outline-map of all properties and statistical information relating thereto; it is derived from the French word "cadastre" = rental book, which comes from "capitastrum," a register for taxation of individuals.

on the part of the settlement officers to improve the field survey and construct good maps: but it has been attended with varying success, indifferent at best; for though a theoretical knowledge of the first principles of surveying, which are very simple, is readily acquired, a practical knowledge of their application in the combination of a vast number of mutually interdependent measures, with all the desirable accuracy, is not so easy to acquire; it needs much skill and judicious organisation; the ground measurements are necessarily made by the cheapest agency procurable; many measurers have to be employed simultaneously, and they have to be systematically supervised in order to guard against both accidental mistakes and intentional falsifications. Thus in the Bengal Presidency the Survey Department has long been called on to co-operate with the settlement officers to some extent. All village or parish boundaries have been carefully surveyed, and plane-table sketches of the interior have been made, distinguishing the cultivated from the uncultivated lands; and the areas of the entire village, the cultivation, and the waste thus determined have been employed as a check on the gross areas derived from the field measurements of the settlement officers. The results thus obtained were long considered sufficient for practical purposes, though the maps were still far from accurate, for it was merely the areas that were checked, not the mapping of the fields and boundaries of property. But as the country grows in [illegible] and civilisation, the want of accurate cadastral maps is more and more felt; and the question has arisen, How are they to be obtained in the future? whether wholly by the Professional Survey, or by the Settlement Department, as formerly, but with greater assistance from the surveyors, by getting the latter to subdivide the village area into several accurately-outlined blocks, each no greater than the field-measurers can be expected to fill in with accuracy? The merits of the two rival systems are hotly contested; the Governments of the Punjab and the Central Provinces have declared in favour of the modified settlement system, whole those of the North-West Provinces and Burmah are in favour of the professional survey; and the surveyors and the settlement officers are each declared by their respective backers to be the fittest to survive in what has come to be regarded, in some quarters, as a struggle for existence.

There are three essential requirements for administrative purposes, a correct map, a classification of soils, and a record of individual rights, and at first sight it would seem desirable to have each of these performed by a separate class of experts. Thus, when the professional surveyors were called on to undertake the field measurements, it was intended that they should simply make a survey of the ground, and leave the business of classification and recording rights to others; but, though in most instances this would have sufficed to secure what was wanted, in very many it would have failed to do so, in a great several boundaries of property are either quite unmarked on the ground, or so faintly marked that they must be specially pointed out to the surveyor; while, on the other hand, many prominently-marked divisions of land are not boundaries of property. If, then, the surveyor simply made a survey of what he saw, assigning a number to each plot of land on his map for ready identification, the settlement officer following him had sometimes to break up, sometimes to combine, his plots, and institute a new series of numbers for the record of rights, all which caused trouble, expense, and delay, and might necessitate the construction of a second map. Thus, it was found that the surveyor had to survey not what he saw, but what was wanted by the settlement officer, and this necessitated his entering into communication with all the landed proprietors and tenants and squatters.

Now in India and Asiatic countries generally there is this standing objection to any invasion of a district by Government officials, more particularly when made with a view to inquiries about rights of proprietorship and occupancy, that the inhabitants invariably consider it a judicious precaution in their own interests to conciliate the officials and win their favour by substantial presents, even when they have no rival claimants to fear, and when they have, the conciliatory gifts are liable to merge into bribes of ruinous magnitude. Thus every district is invariably impoverished more or less by the passage over it, and still more the protracted residence in it, of a body of native officials, and the less it is subjected to such invasions the better for its welfare. In this respect there is a decided advantage in having the survey, the classification, and the record of rights executed simultaneously by the officials of a single department working under a single officer; and there is the further advantage that the presence of the villagers in attendance on the officials is required much less frequently when all three investigations are made simultaneously than when each is conducted separately. Thus in some of the districts in which cadastral operations are now being carried on, the survey officers have been called on to undertake, in addition to their ordinary duties, the classification of soils and the entry of all *undisputed* items in the record of rights, and to furnish a list of all disputed items, with the requisite information to enable the disputes to be settled either by an officer specially appointed to do so, or by one of the higher courts of justice. This new system has not been long on trial, but it is expected to be very satisfactory in being less costly to the Government and less oppressive on the people of the country. The Survey Department has the great advantage of a staff of European subordinates to control the accuracy of the field measurements; its system of operation is cheap native agency closely supervised; its officers can control the classification of soils and the preparation of the record of rights as well as the ground measurements; and close supervision is a *sine quâ non* wherever subordinate native agency is largely employed.

The question of the best system of cadastral survey is one of especial importance at the present time, for the Government of Bengal contemplates carrying out such a survey in the districts which were permanently settled by Lord Cornwallis in 1792. When that settlement was effected the Government ceased to have any direct interest in the land so long as the annual payments of revenue were made with punctuality. The land has greatly increased in value, and the lightly assessed revenue has been paid with ease and without demur; but meanwhile great changes have taken place in proprietary rights, and of these there is little official record; lands have changed hands, and the settlements of zamindars with ryots, or landlords with tenants, have not by any means been of the permanent and easy nature of the one made by the Government with the landlords; on the contrary, rents have been raised to the utmost, and disputes between the zamindars and the ryots are constantly coming before our Law Courts, which have no record of rights and no map to guide them to a correct decision. When the permanent settlement was effected, nearly a century ago, it was provided that a "patwari," or village accountant, should be maintained to keep the record of rights, and correct it up to date on all occasions of subdivision or clubbing of land; but no steps were taken to carry out this provision, and in Bengal the "patwari" has long become extinct, doubtless to the great advantage of the rich and the strong over the poor and the weak. And now the former are crying out that they do not want a survey, while the latter have not as yet commenced to ask for what they have not yet learnt to understand and appreciate. But many of the higher officials of Government think it imperatively necessary for the just administration of the country.

One of these officers maintains that there can hardly

be two opinions as to the abstract desirability of a cadastral survey; that it would be difficult to conceive a greater boon to the province than would be the existence at the present moment of a complete series of cadastral maps, with their accompanying detailed records of possession and of title; that to measure the extent to which such a record would facilitate administration and promote economic progress, it is only necessary to realise the vast quantity of interminable litigation, more or less connected with the land, that burdens the civil and criminal courts, and drains the resources of the agricultural population. Out of the many criminal cases, true or false, that are brought to determine questions of title or possession in village fields—out of the concurrent and still more harassing civil litigation on the same subject—a very great proportion would certainly never have arisen at all, but for the lack of survey records, and in the remainder the same lack places equity and justice at an extreme disadvantage, and prevents the decisions arrived at from being accepted as definitive. The criminal courts decide at most the question of actual possession at the moment: the parties accept the situation for the time, and go away poorer, but not wiser, to renew the contest when opportunity and resources offer. The civil courts work in the dark, sending out "amins" to perform straggling fragments of mapping—the outcome of hearsay and village tradition rather than of any scientific process—which barely serve as precarious foundations for the court's decree, and do not secure the ready identification of the site when the litigation is in course of time reopened. There is nowhere any stand-point of knowledge or certainty, and every transaction in connection with land is either a litigation or a compromise, in which the strongest wins.

But the cleansing of this Augean stable is expected to be a work of extreme magnitude and difficulty. A Commissioner, who is entirely in favour of the experimental introduction of cadastral survey operations, reports that both zamindars who continue to levy rates which have been actually disallowed in courts of justice, and ryots who for years have taken advantage of the absence of a record to hold more land than they pay rent for, are interested in many instances in preventing the truth from being found out, and the appearance of the survey party in any estate will awaken all sorts of fraud and chicanery, all that procrastination, evasion, and quiet opposition at which both zamindars and ryots are such great adepts. To this must be added the opposition which will be offered by interested middlemen of all grades. The cadastral survey will be an opening up of all the sores of the country, a probing of old wounds, and an invitation to all and sundry to come forward and join in the great game of scrambling for rights; for in Bengal there is next to nothing to go upon.

Thus a cadastral survey will not be an unmixed blessing, and there are not a few of the higher officials who think it likely to be exceedingly mischievous, and deprecate its being undertaken. It is strongly opposed by all the more powerful zamindars. Still it is probably more alarming in prospect than it will prove to be in reality. With a view to the acquisition of practical experience on the subject, the Government has ordered a cadastral survey of the district of Mozuffurpur, which lies to the north of Patna, to be immediately undertaken as a tentative measure.

J. T. W.

(To be continued.)

AËRIAL NAVIGATION

THE account given in NATURE (p. 421) of the late experiments of the French Government with their "dirigible" balloon is very interesting and important, and in order to give it its full significance I will ask leave to offer a short explanation of the general state of the question.

In 1875 I had occasion, in writing an article on balloons for one of our leading Reviews, to call attention to the fact that some skilful and, so far as they went, successful attempts had been made not long before by two French engineers, MM. Henri Giffard and Dupuy de Lôme, to show the possibility of propelling and guiding balloons through the air.

At that time a general and strong opinion prevailed in England against such a possibility. This opinion was enunciated by various classes of people. In the first place, some writers, taking upon themselves to speak in the name of science, declared that the thing was physically impracticable. The Duke of Argyll, for example, the President of the Aëronautical Society of Great Britain, wrote:—[1]

"A balloon is incapable of being directed, because it possesses no active force enabling it to resist the currents of the air in which it is immersed, and because, if it had such a force, it would have no fulcrum or resisting medium against which to exert it. It becomes, as it were, part of the atmosphere, and must go with it wherever it goes."

Then another class of objectors were the aëronauts, who necessarily and properly commanded respect as experts in the practice of ballooning. The cleverest of these, Nadar, declared it was impossible to control the direction of balloons, on account of their lightness and large surface, and he laid down what he considered an important principle, that "pour lutter contre l'air il faut être plus lourd que l'air." One of our most esteemed and experienced English aëronauts, Mr. Coxwell, held the same view; and another (now, alas! lamented) expert, Col. Fred. Burnaby, wrote in the *Fortnightly Review* of May 1884, an article on the "Possibilities of Ballooning," for the express purpose of asserting that the power of guiding them was not one of these possibilities. He professed to show that we were not "one whit nearer" the solution of this problem than when De Rozier and the Marquis d'Arlandes made the first ascent; he denied the truth of the French reports of what had been done; and he offered a present of 100*l.* to any one who, in a free balloon, would after travelling a certain distance return to his starting-point. And I may mention that so strong was the feeling in favour of Col. Burnaby's assertion, that the editor of the *Review* refused to insert a short and respectful remonstrance against it which I tendered to him. Then there were the host of writers in the general Press, the *Times* at their head, who argued that, as in the century since balloons had been invented nothing had been done, it was clear nothing could ever be done, and that the idea of guiding them must be a delusion, which was accordingly ridiculed unmercifully.

All this had an important practical effect; for our military authorities, who wished to make use of balloons in war, totally ignored all possibility of directing them, and confined their attention to using them captive for observing stations, as had been done in the battle of Fleurus nearly a century ago.

As it appeared to me that this opposition and incredulity were very ill-founded, and that the matter was worth more serious investigation, I sent to the Institution of Civil Engineers "A Study of the Problem of Aërial Navigation, as affected by Recent Mechanical Improvements," which they did me the honour to publish in the volume of their *Proceedings* for the session 1881-82. I attempted to show, in the first place, that the problem was perfectly amenable to mechanical reasoning, and that its successful solution involved nothing inconsistent with the teachings of mechanical science; secondly, I pointed out various reasons to account for the failure of early attempts to guide balloons; and thirdly, I showed that the result of the recent French experiments, when treated on ordinary mechanical principles, gave fair data for forming an approximate estimate of what might hereafter be done.

[1] "Reign of Law," London, 1868, p. 130.

They had sufficiently established the general practicability of the attempt, and they had obtained an actual speed through the air of about 6 miles an hour, and it was easy to argue that by suitable provisions this might be increased to 10, 20, or perhaps even 30 miles an hour.

Meantime the French, who had no insular prejudices to restrain them, continued their experiments. M. Gaston Tissandier, an eminent man of science as well as a skilled aëronaut, conceived the possibility of applying electrical power for balloon propulsion; he exhibited a working model at the Paris Electrical Exhibition of 1881, and afterwards made, at his own expense, a large balloon, with which in 1883 he obtained a velocity of 9 miles an hour. But the French military authorities (wiser in their generation than ours) here stepped in, and, with their greater resources, carried the trials still further. They commissioned two of their engineer officers, Messrs. Renard and Krebs, to construct a balloon with which the problem might be thoroughly worked out, and the result is now given. The experiment has been a perfect success; an independent velocity through the air has been attained of upwards of 13 miles an hour; the balloon has been managed, steered, and guided with the greatest ease, and it has, in defiance of the wind, been made to return to its starting-point, the test proposed by Col. Burnaby.

But the most valuable part of the communication to the Academy of Sciences has been the investigation of the bearing of the experiments on the scientific conditions of the problem. There were two points especially which, from the want of actual experience, had in former calculations to be estimated by analogy from water navigation: the resistance which a balloon would encounter at different speeds in its passage through the air, and the efficiency of the screw propeller in overcoming this resistance.

First, as to the resistance. M. de Lôme estimated this by the midship section, but in a vessel much elongated the length has also to be taken into account. Prof. Rankine has given a rule for ships according to the wetted surface, and also another dependent on the displacement. Adapting these to air, and making certain additions which M. de Lôme estimated as special to the balloon, I obtained for the resistance in lbs., the diameter and length being in feet, and the velocity in feet per second—

$$\text{By the skin friction } R = 0{\cdot}0000477 dl v^2;$$
$$\text{By the displacement } R = 0{\cdot}0000886 (d^2 l)^{\frac{2}{3}} v^2.$$

Now, taking the proportion of MM. Renard and Krebs's balloon at $l = 6d$, these equations become—

$$R = 0{\cdot}000286 d^2 v^2,$$
$$\text{and } R = 0{\cdot}000292 d^2 v^2.$$

The result of the latest French experiments is, when put in English measures—

$$R = 0{\cdot}000320 d^2 v^2.$$

This is a little higher than the estimation by the former methods, but it corresponds sufficiently well to give confidence in the general mode of inquiry.

Secondly, as to the efficiency of the screw propeller. This has been often investigated for water navigation, and it may be said that an efficiency of 70 per cent. is fairly borne out by experience. MM. Renard and Krebs obtain for their screw an efficiency of only about 50 per cent.

It is, I should think, highly probable that by further experience both these elements may be considerably amended; but even taking the facts as they are, they show the attainment of considerably higher speeds to be perfectly practicable. A balloon of 50 feet diameter, for example, would carry power sufficient to give a speed of upwards of 20 miles an hour, and still leave a considerable buoyancy disposable.

At any rate, let us hope that we may have no more quasi-scientific declarations of the impossibility of propelling and guiding balloons, and no more sneers at those who attempt to solve the problem. The capabilities of aërial locomotion of this kind must (as I have fully shown elsewhere) be necessarily limited, but its utility in certain situations would be incontrovertible. The President of the Institution of Civil Engineers, Sir F. Bramwell, speaking in January 1885, said:—

"There may undoubtedly be particular circumstances in which this mode of locomotion would be useful, such, for example, as the exploration of new countries, or as the present Egyptian campaign. I strongly suspect that if our lively neighbours, instead of ourselves, had been invading the Soudan, they would long before this have had a dirigible balloon looking down into Khartoum."

And we have now a curious comment on his words, as we know that at that very time there was, lying in its shed near Paris, a balloon which, though perhaps it could not have saved Gordon, might certainly have saved poor Burnaby, and otherwise have been of incalculable benefit to our military operations. WILLIAM POLE

MEDICAL STUDY IN OXFORD

STATUTES for the regulation of the qualifications of Candidates for Degrees in Medicine and Surgery, and for creating a Faculty of Medicine in the University of Oxford, have after prolonged discussions been approved by Congregation in their definitive form. The Statute which places the medical studies of the University under the control of the new Board of the Faculty of Medicine recently received the final sanction of Convocation, and the other statutes will soon follow. The interest which these Statutes have excited could certainly not be attributed to the radical nature of the changes which they will initiate. It must be rather due to the circumstance that the establishment of the new Faculty is regarded as an indication that Oxford, which has hitherto stood alone as the only University in the United Kingdom which has no mdeical students, and in which there is no organisation for medical instruction, now intends to undertake this function.

It is well known that the Oxford Medical Degree is one of the most coveted professional distinctions, but it does not, like that of Cambridge or Edinburgh, mean that the possessor of it has been trained either in science or in medicine at Oxford. In future there is reason to hope that it will be otherwise—that the University will no longer confine itself to the giving of degrees, but will teach all those branches of medical knowledge which come within the range of University studies.

Chemistry, human anatomy, and physiology, are the three subjects which constitute the scientific foundation of medical education, the last-mentioned being itself founded on the other two. For the instruction of medical students in human anatomy, the University has lately imported from Edinburgh an accomplished and experienced teacher, Dr. Arthur Thomson, who has already as many pupils as he can find room for; and the completion of the new laboratory has rendered possible the development of practical work in physiology. But the mere providing of the means of instruction in these subjects is insufficient, unless the lectures and laboratory work are so systematised as to enable the student to learn all that he needs to learn within the limited time at his disposal, and at the same time each branch of teaching is sufficiently specialised to adapt it to his requirements.

The bearing of the new statutes on medical education in the University can be best understood in relation to the course of scientific training which an intending student of medicine will, if they are passed, be able to follow. Hitherto the Oxford graduate who has obtained

honours in biology, has been in no better position as regards his medical curriculum than he would have been had he taken an ordinary pass degree. For the statute now in force, which we hope in a week or two will be replaced by a better, does not permit him to present himself for his medical examination in anatomy and physiology until two years after his degree. In future it will be possible for him to do this at the same time with his examination in the Honour School in the same subjects; the practical effect of the change being that two years will be saved, and that he will be enabled and encouraged *as an undergraduate* to study human anatomy and physiology in their relation to medicine.

In Oxford, as is well known, every man who intends to take a degree in Arts, which is a necessary precursor to that in Medicine, must have passed the examination in classics and mathematics, which is known as "Moderations," and inasmuch as he is not permitted to present himself for this examination until the fourth term after matriculation, it is obvious that he is practically precluded (supposing him to have Medicine in view) from beginning his scientific education until after this period. Consequently, of the four years which intervene between matriculation and his final examination in the Natural Science School, only three at most are at his disposal for the study of physics, chemistry, anatomy, and physiology.[1] Of these three years one at the very least is occupied in acquiring a sufficient knowledge of the four subjects to pass the very thorough and practical "Preliminary Examination." In the scanty remainder of time which is thus left to him he has to get through the most important part of his Oxford work. He has to acquire such proficiency in physiology as will enable him to obtain a class in the Natural Science School, in addition to a very detailed knowledge of human anatomy and a limited acquaintance with organic chemistry. Under present conditions this can only be accomplished by men of exceptional power of work. The rest find it to their advantage to defer their anatomy and chemistry for another year, and consequently are not in a position to enter on their hospital studies until five years after matriculation. As this is more time than men of moderate means can spare, our system cannot be considered satisfactory until the medical student is enabled to devote the four years of University residence entirely to scientific education. The occupation of the first year in studies which, however excellent in themselves, do not fit him for the hard work before him is a grievance of which he may justly claim to be relieved. As, however, the exemption of natural science students from Moderations has already in principle been accepted by Congregation, there can be little doubt that, in the course of a year or two, the desired change will be carried into effect.

The great success of the School of Medicine at Cambridge, although no doubt chiefly due to the ability and energy of the men who are at the head of it, affords evidence that the conditions under which medical education is there conducted, are in themselves well adapted to the requirements of students. It is therefore of interest to compare our own proposed arrangements with those of Cambridge. Assuming that, with the aid of the new Faculty of Medicine, we succeed in giving effect to the views above indicated, there will still be fundamental differences between the two schools.

The first of these is that whereas here every aspirant to the degree in Medicine must have first graduated in Arts, the Cambridge student becomes from the moment that he has passed the "Previous Examination" free to devote himself exclusively to medicine. This of course means that, whereas in Oxford at least four years must intervene between Matriculation and the first examination in medicine, in Cambridge the corresponding point is reached in three years, or even in two,—a loss of time which is chiefly due to the circumstance already referred to, that the year which intervenes between Responsions and the First Public Examination, is by the Cambridge medical student devoted to physics, chemistry, and biology. It is not, however, in this way only that our Oxford system tends to lengthen the course of medical study. Our "Preliminaries," which are adapted to the requirements of an Honour School, are at Cambridge represented by a pass examination in the same subjects, specially intended for medical students, and therefore presumably easier. But it is a point of much more importance that our medical candidate is required, before he presents himself for any medical examination, to have obtained a class in one of the branches of biology. On general grounds there seems reason for thinking that this is disadvantageous, for it does a man harm to compel him to pass an honour examination for, if one may so express one's self, pass purposes. Of the two subjects open to him, the medical student naturally chooses physiology, not only because it is more closely related to medicine, but because he may hope, by obtaining a first or second class, to exempt himself from further examination. In that subject the schedules are framed for the purpose of affording first or second class candidates the opportunity of showing their knowledge. Consequently, in attempting to prepare for it, the medical student who studies physiology specially for the sake of its applications to medicine, acquires a knowledge of wider range than he requires, but of imperfect quality. The evil is a serious one, but happily not difficult to remedy—either by establishing a pass examination in physiology, or, more simply, by marking off in the schedules those subjects which are of less importance to the medical student than the rest.

Enough has been said to show that, however insignificant the position of medicine in Oxford may seem to be at present, it is not likely to remain so. One of the difficulties in the way of medical study here—the non-recognition by the licensing bodies of Oxford teaching—was removed a year ago. The other is the occupation of time, of which the student requires every moment for his preliminary training in physics, chemistry, and elementary biology, with studies which, excellent in themselves, are not conducive to his purpose. From the moment that we are relieved from this drawback, we shall have everything in our favour, and success or failure will depend on our own exertion. In the meantime, it is not too soon to proceed with the organisation of our system of studies, so that, when the opportunity is offered for efficient action, we may be prepared to take advantage of it.

J. B. S.

[1] For more detailed information as to the course of study in Oxford see an article by the writer in the *Oxford Magazine* for January 27, 1886.

CHARLES WILLIAM PEACH

AT the ripe age of eighty-six this genial and enthusiastic naturalist has at last passed away. Never was there a more notable example of the irrepressible instinct of a true lover of nature. Born in Northamptonshire, he eventually joined the Coast-Guard service, and was stationed at various parts of the coast where smuggling went on apace and where his shrewdness and tact were often more than a match for the daring spirits who defied the revenue laws. But in the intervals of his duties he found time for close observation of the living things he met with along the shores and of the plants, insects, birds, and fishes he saw inland. Working in the pre-Darwinian days, when the adding of new species to the known list was one of the chief aims of natural history students, his zeal was early enlisted on behalf of the species-makers. Some twenty species and several genera of sponges were first made known by him as inhabitants of our seas. He considerably augmented our list of native hydrozoa and polyzoa. Among the naked-eyed medusæ, echinoderms, mollusks, and fishes he also materially increased our know-

ledge. One of his distinguishing characteristics was his readiness to tell everything he knew to any naturalist engaged in the investigation of the departments of zoology in which he himself had worked. He was a keen observer rather than a trained naturalist. He published little himself, but he contributed rich materials to those who knew how to make the best use of them. He was consequently a valued correspondent of many of the leading naturalists of his day, who gladly acknowledged their indebtedness to his generous aid. Nor were his observations confined to the living things of the existing creation; he searched the rocks around him for traces of former plants or animals, and found them in places where no one had ever seen or suspected them before. His keen eye detected the first relics of fossil fishes in the Devonian rocks of Devonshire, and when, after his transference to the north of Scotland in 1849, he had an opportunity of looking at the limestones of Durness, he soon brought to light a series of fossils which, in the hands of Murchison and Salter, proved of the utmost value in fixing the geological age of the rocks of the North-West Highlands. After his retirement from the public service he went to reside in Edinburgh, and devoted himself with all his old enthusiasm to the exploration of the fossil flora of the Carboniferous rocks of that neighbourhood. Nothing seemed ever to escape his notice, and hence even from the quarries and sections where many a practised eye had preceded his own he was able to glean materials which none but himself had noticed. In recognition of his important services to the cause of natural history, the Royal Society of Edinburgh in 1875 awarded to him the Neill Gold Medal. His health has for some time past been failing, and he has now gone to his rest with the affectionate regrets of all to whom the progress of natural science in this country is dear. His son, Mr. B. N. Peach, of the Geological Survey, with all his father's enthusiasm and more than his father's range of acquirement, will, we hope, for many a long year, preserve among the naturalists of this country a family name that is familiar as a household word.

PROFESSOR EDWARD MORREN

CHARLES JAMES EDWARD MORREN, whose death on the 28th ult. we announced in our last issue, was the son of Charles Morren, a Professor in the University of Ghent, and was born in that city in 1833. Shortly afterwards the father removed to Liége as Professor of Botany. The son, Edward, as he was usually called, was educated for the law, but evincing a strong tendency towards the natural sciences and chemistry, took his degree in the Science Faculty with much distinction. Owing to the ill health of the father, Edward Morren was early called on to undertake the professorial duties, but the continuation of his licence to teach was made conditional on his undergoing a "special" examination for the Doctorate. This was the occasion of the publication of his dissertation on green and coloured leaves, by which he first became known to the botanists of Europe. After the death of Charles Morren, in 1858, the son was appointed in the father's stead, and from that day to this, the aim of the son seemed to be to walk in the steps of his father, and to complete and extend his work. Both devoted themselves not only to botany but to chemistry, and in particular to horticulture and agronomy. Both were imbued, as so many of the Belgian *savants* are, with an ardent patriotism which led them to devote their science to the practical good of the nation, and to hold up to honour and respect the work of their celebrated predecessors. Hence, from father or son, or both, we have memoirs of Dodoens, of de l'Obel, of de l'Escluse, of Fuchs, and other worthies of Flemish nationality.

Both were impressed with the necessity of extending and adapting to the necessities of the times the system and the means of botanical education. The Botanical Institute of Liége, which Edward Morren lived to found and to see completed, was but the modified outcome and extension of the plans and schemes originally proposed by the father. The result is that Liége is now equipped with a compact and well-ordered laboratory for botanical tuition and research, such as some of our own Universities might envy. In order to perfect this institution Morren availed himself of his frequent travels to study the method of instruction followed in the Universities of Germany, and the organisation of the scientific establishments of Holland, Paris, London, and other centres. With his professorial work, his ceaseless duties in connection with official horticulture and the publication of the *Belgique Horticole*, Edward Morren necessarily found little time for the preparation of any separate work, but his memoirs and academic dissertations are numerous. The most important of them, as may be gleaned from what has been said, referred to questions of chemistry and vegetable physiology. A paper published in this country in the Report of the London Botanical Congress, 1866, comprises a most elaborate investigation into the action of sulphurous acid and other vapours on plants.

His academical discourses and popular lectures were remarkable both for their method and their matter. With the fluency and elegance of style of a practised orator, Morren combined the fulness of knowledge and accuracy of exposition of a man of science. Botanists, however, were looking forward with expectancy to a monograph of the Bromeliaceæ from his pen. It was known that the Professor had been accumulating for many years material for this purpose. His collection of living examples is, we believe, the largest and best selected in existence, and the materials in his herbarium and very extensive library (the most complete of its kind in Belgium) are in their way equally remarkable. Beyond detached fragments, however, Morren published little on this curious family.

Death has overtaken him, as it did his father, when little or not at all beyond the prime of life, and it has caused a void which only those who knew the warm-hearted, genial, liberal-minded Professor can fully appreciate.

THE WEATHER

OVER the greater part of the British Islands last month was one of the coldest Februarys on record, the mean temperature at Greenwich being only 33°·8, or 6°·8 below the average of the month. Throughout Great Britain generally, from the Grampians to the Channel, temperature was from about 5°·0 to 7°·0 below the means of the stations. But in the northern and western divisions of these islands temperature was only from about 2°·0 to 3°·5 below the monthly averages. This difference was mainly occasioned by the distribution of temperature during the second week of the month, owing to the higher temperature in the north and west accompanying the storms which prevailed in the far north during the time. Thus during the week ending February 13, the mean temperature of Parsonstown was 43°·5, whilst at Oxford it was so low as 33°·8, or nearly 10° lower.

From the middle of February, however, to the memorable snowstorm in the beginning of March, the weather-maps of Europe presented several remarkably persistent noteworthy features. The commencement of the period was marked at the Ben Nevis Observatory by forty-eight hours of singularly dry clear weather, such as occurs in connection with anticyclones and the settled weather attendant on them. Eastern and Northern Europe was now even more pronouncedly than it had been in the earlier part of the month the theatre of a widely-extended anticyclone, which slowly shifted its position from day to day, and sent out from its central regions winds in all

directions, differing much in their climatic qualities. On the other hand, Western and Southern Europe was marked by an atmospheric pressure persistently and greatly lower, with an absence of anything approaching a cyclone—usually a characteristic feature of the weather at this season—if we except a cyclone, not very decidedly marked, that appeared in the Bay of Biscay on February 25, and thence passed slowly eastwards across Italy and Greece, towards Asia Minor, which was reached on March 2.

The inevitable consequence of this distribution of atmospheric pressure was a prevalence of calms and of easterly and northerly winds over the Continent, with low temperatures. For five days, ending February 19, the anticyclone had its centre near Moscow, during which time the barometer, at 32° and sea-level, rose to 30·965 inches. Meanwhile temperature steadily fell, and −7°·6 was recorded at Moscow on the morning of the 19th. The anticyclone thence advanced northward to the White Sea and westward to the Gulf of Bothnia, a pressure of 30·961 inches being recorded at Haparanda on the 22nd, and 30·922 inches at Uleaborg, in Lapland, on the 24th; and thereafter southward to Stockholm with a pressure of 30·603 inches on the 28th, to Riga with a pressure of 30·742 inches on March 1, and to Charkow with a pressure of 30·398 inches on the 2nd. The central regions of the anticyclone were throughout, as happens at this season, marked by unusually low temperatures, the lowest being −16°·8 on the 23rd and −18°·8 on the 24th at Archangel, and −15°·5 on the following morning at Haparanda, these temperatures being about 30°·0 below the average for this time of the year at these places.

The weather-maps show that an important change had already set in on the morning of the last of February, the curvings of the isobaric lines pointing to a cyclone to the north-east of the White Sea, and to another cyclone advancing to the south-west of the British Islands. The anticyclone was thus now surrounded by three cyclones, located respectively near the White Sea, to the south-west of the British Islands, and in the Mediterranean. On the morning of March 1 the most northern of the cyclones had travelled somewhat to westwards, and the other two to eastward; and these respective movements were continued on the following day. In the meantime the anticyclone had greatly shrunk in breadth, and by the morning of the 2nd, when the snowstorm raged most fiercely over an unusually extensive breadth of country, it lay as a narrow tongue of high pressure westwards over Scandinavia, and, meteorologically considered, perilously close on to the cyclone whose centre was then about the Humber. It necessarily followed, from the contiguity of the high-pressure area to the cyclone on its north side, that the storm passed across the British Islands with uncommon slowness, thus prolonging its continuance in Great Britain; and that the steepest gradients were formed in the north-east quarter of the cyclone,—a rather unusual feature of the storms of North-Western Europe,—thus exposing North Britain to one of the worst easterly gales of recent years.

Some snow fell in a few places on Sunday, but on Monday it fell in almost all parts of England, the fall being particularly severe in North Wales and the northern counties. The Furness and Wigtownshire railway lines were blocked and traffic suspended, a circumstance that has not occurred since these railways were opened, which as regards the Furness line is twenty-seven years ago. In the more southern counties the storm was not quite so severe, and as the day advanced the snow changed to sleet and at last to heavy rain. On the Tuesday the storm spread northwards over all Scotland, and raged with a fury altogether unexampled. Owing to the fineness of the snow-particles and the force of the wind, snowdrifts in many places accumulated in a degree quite unparalleled, and all transit was seriously paralysed. The most serious railway block occurred on the East-Coast line, and it was computed that thirty trains of various sorts were snowed up between Newcastle and Berwick. Letters carried by the London Monday mail were not delivered in Edinburgh till Friday morning. The sensation produced by the rapidly-driven snow-particles on the face resembled the sharp pricking of a shower of needles; and it was remarked that the effect of the snow-drift on the eyes gave the feeling which would be produced by the spray of dilute nitric acid. As respects the singular character of the snowfall, it may be suggested that it was in some way connected with the remarkable meteorological conditions described above as having overspread Eastern and Northern Europe during the fortnight preceding the storm, and the proximity of North Britain to the anticyclone when the storm raged in all its fierceness.

It is remarkable that, while the snowfall was large in many western as well as in eastern districts, it was comparatively light over the higher midland parts of Scotland, and that on Ben Nevis and surrounding mountains little snow fell. It is to be noted, however, that at the Ben Nevis Observatory the wind blew, not as is usual on such occasions, from a different direction, but from precisely the same direction as at lower levels, with a force, however, very greatly diminished, the mean wind-force for the day being estimated by Mr. Omond at only 4 of the Beaufort scale. For the week preceding the storm the mean pressure and temperature of the air at the Observatory were respectively 25·482 inches and 14°·9; at sea-level at Fort William, 30·154 inches and 33°·2. This mean pressure at the Observatory is 0·046 inch in excess of what previous observations show to be the mean when the sea-level pressure and temperature of the air is as above. On the morning of the storm the excess was double that of the previous week. It is these departures from the average in their relations to the cyclones and anticyclones of this part of Europe that give the Ben Nevis observations their great significance.

NOTES

It will be remembered that the Paris Academy of Sciences on Monday week, after hearing Prof. Pasteur's account of the cases he has treated, appointed a Committee to consider the question of the establishment at Paris of a vast international hospital. On Monday last M. Vulpian communicated to the Academy the following proposals, unanimously agreed upon by the Committee:—(1) An establishment for the treatment of rabies shall be founded at Paris under the name of l'Institut Pasteur. (2) This Institution shall be open both to French subjects and to foreigners bitten by dogs or other rabid animals. (3) A public subscription is opened in France and abroad for the foundation of this establishment. (4) The employment of the funds subscribed shall be made under the direction of a Committee, consisting of Admiral Jurien de la Gravière, President of the Academy of Sciences; M. Bertrand, M. Vulpian, M. Marey, M. Paul Bert, M. Bichat, M. Charcot, M. Hervé Mangon, M. de Freycinet, M. Camille Doucet, M. Wallon, Vicomte Delaborde, M. Jules Simon; M. Magnin, Governor of the Bank of France; M. Christophile, Governor of the Crédit Foncier; M. Alphonse de Rothschild; M. Beclard, Doyen of the Faculty of Medicine, and Perpetual Secretary of the Academy of Medicine; M. Brouardel, Professor to the Faculty of Medicine, and President of the Consultative Hygienic Committee of France; M. Gaucher, Professor to the Faculty of Medicine of Paris. (5) The subscriptions shall be received at the Bank of France and its branches, at the Crédit Foncier and its branches, and at the Public Treasury Offices. The names of all subscribers shall be inserted in the *Journal Officiel*.

THE Stockport people have a pleasantly hearty way of testifying their appreciation of the services of scientific men. A series of popular science lectures has been given this winter under the auspices of the local Society of Naturalists and the directors of the Mechanics' Institution. The fourth of the series was on "The Life of Pasteur," and on the conclusion of the lecture it was proposed from the body of the hall that an address of thanks should be sent to the illustrious Frenchman. In accordance with the resolution an illuminated memorial has been prepared for transmission to M. Pasteur.

M. CHEVREUL has so far recovered that he has been able to walk out in spite of the low temperature prevailing in Paris.

SIR JOHN LUBBOCK has been appointed Rede Lecturer to the University of Cambridge for the ensuing year.

M. CORNU, member of the Paris Academy of Sciences and Professor in the Polytechnic School, has been appointed a member of the Bureau des Longitudes.

THE Council of the St. Petersburg University has awarded Prof. P. A. Tlienkoff's premium of 500 roubles to Prof. P. T. Brounoff of the same University for his work on "The Laws of the Movement of Cyclones and Anticyclones, especially in Russia." For the next year's competition the same premium is offered for the best work on the Compositæ of European Russia.

THE late Dr. Davidson had a world-wide reputation as one of the most eminent of British palæontologists, and freely gave his life-long services for the advancement of science. He also rendered, for a series of years, great and valuable services to Brighton; chief amongst which may be mentioned the arrangement of the Brighton Free Museum in its present *locale*, the presentation to it of a fine series of volcanic products, and of his collection of rocks and fossils from the Paris Basin—one that is unique of its kind and of very great value because it was obtained whilst the fortifications of Paris were being constructed, an exceptional circumstance not likely to recur; in addition to these the late Dr. Davidson acted as Chairman of the Museum Committee for several years, and filled that office at the date of his death. Whilst holding this position his attention to and care over the best interests of that institution were unremitting, and he was always ready, at his own expense, to purchase specimens for the public benefit, whenever he thought it desirable to fill up gaps in any series in the museum, on behalf of which his scientific influence was always freely exercised. It is felt that such disinterested and valuable services should be permanently commemorated in the museum in which Dr. Davidson laboured so assiduously and which he loved so well. With this end in view, the Mayor of Brighton, Mr. E. J. Reeves, on behalf of the members of the Pavilion Committee of the Town Council, and of the Museum, Fine Arts, and Library Committees, invites his fellow-townsmen and Dr. Davidson's personal and scientific friends to contribute towards the raising of a fund to be devoted to the placing in the museum of a memorial to the late Dr. Davidson.

THE Royal Meteorological Society's Exhibition of Barometers will be held at the Institution of Civil Engineers, 25, Great George Street, Westminster, on Tuesday and Wednesday next. The Exhibition will be a most interesting one, as a large number of various forms of barometer have been brought together, many of them being of great value, and some being the only specimens known to exist. At the meeting of the Society on Wednesday evening, the President, Mr. W. Ellis, will give an historical account of the barometer. Any persons, not Fellows, wishing to visit the Exhibition or to attend the meeting, can obtain tickets on application to the Assistant Secretary, Mr. W. Marriott, 30, Great George Street, S.W.

OF the three colleges—Columbia, Harvard, and University of Pennsylvania—that received the benefit of the Tyndall Fund, Columbia has been the first to act, we learn from *Science*. Her trustees have recently drawn up a series of regulations in regard to the John Tyndall Fellowship. The Fellow, who is to be appointed on the recommendation of the President and Professors in the Scientific Department, must pursue a course of study and research in experimental physics for the term of one year, and he may be reappointed. The first incumbent of the Fellowship is Michael Pupin, who graduated at Columbia in 1883 with honours, and has since his graduation been studying mathematics and physics at Cambridge, England.

M. GUERAULT, the well-known electrician and secretary of the *Lumière Électrique*, has died, at the age of forty, from consumption. He was well known in England, where he stayed during some years to learn engineering.

A VERY interesting entomological conference took place recently at Odessa; it was organised by the Zemstvos of nearly all the southern provinces of Russia. It appears from the reports read by the respective representatives, that nearly all the southern districts of Russia suffer more or less from different obnoxious insects and other animals, but principally from the Hessian fly and marmots. The latter are especially destructive to the corn-fields, and the Zemstvos found themselves compelled to encourage the extermination of the plague by offering a reward of from one to three kopeks (one to three farthings) for each animal killed. During the year 1885 alone the Zemstvo of Kherson thus paid over 100,000 roubles, this sum corresponding to 6,600,000 animals killed, while in 1883 over 2,000,000 of these animals had been killed.

MR. WESTWOOD OLIVER, with the assistance of Messrs. E. W. Maunder, F.R.A.S., W. F. Denning, F.R.A.S., T. E. Espin, F.R.A.S., A. Cowper Ranyard, F.R.A.S., T. Gwyn Elger, F.R.A.S., J. E. Gore, F.R.A.S., J. Rand Capron, F.R.A.S., Howard Grubb, F.R.S., F.R.A.S., W. S. Franks, F.R.A.S., T. W. Backhouse, F.R.A.S., and other well-known observers, has in preparation a practical manual of "Astronomical Work for Amateurs," the aim of which is to help the possessors of limited instrumental means to turn their attention to astronomical researches of real scientific utility, special attention being directed to the comparatively new fields of spectroscopy and celestial photography. The book will be published by Messrs. Longmans and Co. Mr. Oliver invites suggestions from practical workers, which may be sent to him at Lochwinnoch, Scotland.

WE have received Parts I. and II. of "British Petrography, a Description of the Ordinary Rocks of the British Isles," by J. J. Harris Teall, F.G.S. The publishers are Watson Brothers and Douglas, Birmingham.

ON March 15, 22, and 29, Prof. Bonney lectures at the London Institution on the "Making of Mountains."

THE Arago Laboratory created by M. de Lacaze-Duthiers in France is attracting much attention on the Continent. This laboratory serves as a counterpart to that formed at Roscoff, and is performing an excellent work. It is constructed in such a manner as to be capable of resisting excessive heat, which always militates considerably against the operations carried on at this and all similar laboratories.

THE artificial reproduction of the sole is being energetically carried on in France, where a laboratory was established so far back as 1881 by Dr. Joussett of Belleyme especially for this purpose. Since that time the ova of the sole have been regularly incubated with success, notwithstanding the numerous difficulties attending the process.

THE French Consulting Committee of Hygiene recently advised the prohibition of the use of vaseline for butter in food preparations. The effects of vaseline on the system, however, seemed to require fuller examination, and Dr. Dubois has made some experiments in regard to it. Two dogs were fed exclusively on soup in which the usual fat was entirely replaced with vaseline; one of them absorbed 25 grammes of vaseline a day for ten days, the other 15 grammes (this would correspond in the case of an average man to 100 grammes and 60 grammes respectively). With this diet the animals even slightly increased in weight. Their general state was good: there was no loss of appetite, nor vomiting, nor diarrhœa. In general it may be said that the carburets of hydrogen forming vaseline, though they favour neither oxidation nor saponification like fats, are readily tolerated in the alimentary canal, at least in the case of dogs. Further experiments will show if a prolonged use of the substance is equally innocuous.

IT is estimated by the Marquis de Nadaillac (*La Nature*), that Europeans can endure temperatures as widely apart as 130° C. at least. Thus, on January 25, 1882, a temperature of − 65° C. was recorded on board the *Varna* and *Dijmphna*, when blocked by ice in the Sea of Kara, east of the Straits of Waigatz. On the other hand, M. Duveyrier, in the country of the Touaregs, in Central Africa, has seen the thermometer rise to 67°·7 C.

A RECENT number of *Globus* contains an article by Prof. Nehring, on an interesting prehistoric discovery made in the neighbourhood of Madgeburg. At the village of Westeregeln, between that city and Halberstadt, in the course of some work the labourers came on the remains of an ancient grave, containing parts of the skeleton of an unburned human body, near which were about 112 bored dogs' teeth, two decorated shells of a river shell-fish now only found in Southern Europe, the *Unio sinuatus*: two pieces of an easily-burnt resin, the remains of one or more clay vessels, and a small highly-oxidised bronze ring, which appears to have been used as a finger ornament. The teeth, from their formation, must have been collected from twenty dogs at least, and they were all bored through the root portion, and were evidently meant to be hung on a string. With reference to the shell, it is noticeable that here and there in the Rhine provinces similar shells are found with Roman remains. Dr. Nehring is inclined to look for an explanation of this circumstance rather to an importation from Southern Europe than to the theory that the *Unio sinuatus* has died out since the Roman period in the Rhine provinces. Ornaments of the teeth of Carnivora for the neck, waist, arms, &c., have been found in prehistoric mounds or graves elsewhere in Germany; and even now they are in use for a similar purpose amongst certain primitive peoples. The Igorrotos of Luzon use them for necklets and earrings; so also do the inhabitants of the islands in Torres Straits.

AT the annual meeting of the London Sanitary Protection Association the Report stated that the number of members is now over 1000, and the total number of inspections made during the year 1264; a large number having been made in the suburbs of London and several in the country, including that of Eton College and other large public institutions. Unfortunately the general character of the houses inspected was as insanitary as ever, only 5 per cent. being found in perfect order, and 9·5 per cent. in fairly good order; whilst in 60 per cent. foul air was escaping directly into the house, and in 24 per cent. sewage was partly retained underground by leakage or choking of pipes.

DR. SCHLIEMANN, who has been busy at Berlin for the last few days arranging in the new Ethnological Museum the fruits of his recent excavations, intends to return to Athens shortly. The doctor promises that Berlin shall be the ultimate inheritor of all his archæological treasures.

A TELEGRAM from Catania announces Mount Etna to be in a state of eruption. Cinders and stones are being continually thrown up, and it is supposed that lava is coming out of the crater, but as it is covered by a dense mist no proper observations can be taken. Slight shocks of earthquake have been felt at the foot of the mountain.

A VIOLENT shock of earthquake was felt at 7.30 on Saturday morning at Cosenza. Several houses were thrown down. One person was killed.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas* ♀) from West Africa, presented by Master Eric Blind; a Toque Monkey (*Macacus pileatus*) from Ceylon, presented by Mr. C. Brown; a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Lieut. W. H. Duffin, King's Own Regiment; a Serval (*Felis serval* ♂), a White-tailed Ichneumon (*Herpestes albicauda*) from West Africa, presented by Mr. F. J. Jackson; a Canada Goose (*Bernicla canadensis*) from Canada, presented by Mr. J. E. Kelsall; a Rough-billed Pelican (*Pelecanus trachyrhynchus*) from Mexico, a Hutchins's Goose (*Bernicla hutchinsi*), from Arctic America, purchased.

OUR ASTRONOMICAL COLUMN

LUNAR INEQUALITIES DUE TO THE ACTION OF JUPITER.—Some years ago Prof. Newcomb, discussing certain discordances between the observed and tabular places of the moon, was led to the conclusion that there existed a hitherto undetected inequality with a coefficient of 1″·5 in the longitude, and having a period of about 17 years as regards its effects on the eccentricity and longitude of the perigee. Shortly afterwards Mr. Neison announced that he had found in the action of Jupiter the explanation of this inequality. Using Delaunay's notation, his expression for the inequalities in longitude is—

$$\delta V = -1''\cdot163 \sin(2h + 2g + l - 2h'' - 2g'' - 2l'') + 2''\cdot200 \sin(2h + 2g - 2h'' - 2g'' - 2l'').$$

Now, the coefficient of the second of these inequalities is, theoretically, a quantity one order higher than that of the first; the first having the simple power of the eccentricity as factor, while the second has the square. Hence we should naturally expect to find the latter coefficient the smaller. On the grounds, therefore, that there is reason to think that Mr. Neison's value of this coefficient is possibly too large, Mr. G. W. Hill has investigated the lunar inequalities arising from the action of Jupiter, and has computed afresh the values of the coefficients of the resulting perturbations in longitude. His final result is—

$$\delta V = -0''\cdot903 \sin(2h + 2g + l - 2h'' - 2g'' - 2l'') + 0''\cdot209 \sin(2h + 2g - 2h'' - 2g'' - 2l'') - 0''\cdot118 \sin(l - 2h'' - 2g'' - 2l'' + 2h'' + 2g'' + 2l'').$$

It will be seen that the coefficient of the second term is only about one-tenth of that found by Mr. Neison. It is not possible at present to determine the cause of this discordance, as Mr. Neison has not published the details of his investigation. It is to be hoped that he will now do so, in order to afford the means of deciding this interesting matter.

SPECTROSCOPIC DETERMINATION OF THE MOTION OF THE SOLAR SYSTEM IN SPACE.—The *Astronomische Nachrichten*, No. 2714, contains a brief note by Herr Hans Homann, giving the result of a discussion he has recently made of the spectroscopic observations of the motions of stars in the line of sight made at the Royal Observatory, Greenwich. He finds the position of the apex of the solar motion as derived from these to be R.A. 320°·1, Decl. 41°·2 N., and the speed of translation to be 39·3 ± 4·3 kilometres per second. He has likewise discussed the similar observations made by Dr. Huggins, and at the Temple Observatory, Rugby, by Mr. Seabroke, although these two latter series embraced too few stars, and these insufficiently observed to furnish adequate grounds for any satisfactory conclusions. The results derived from these three series, though differing very considerably from each other, yet show a certain rough correspondence which was perhaps all that could be expected.

and Herr Homann considers that the velocity of translation may be taken as not greatly differing from 30 kilometres a second. The results from Dr. Huggins's and Mr. Seabroke's measures are as follows:—

Observer	Velocity of Translation km. per sec.	Apex of Solar Motion
Huggins	48·5 ± 23·1	R.A. 309°·5, Decl. 60°·7 N.
Seabroke	24·5 ± 15·8	R.A. 278°·8, Decl. 13° 6 N.

These results all differ very considerably from those obtained by Struve, Airy, Galloway, and others, from a consideration of the proper motions of stars as observed with the telescope, *i.e.* in a direction at right angles to the line of sight, the most probable mean value of the co-ordinates of the apex from all these discussions being about R.A. 260°, Decl. 35° N., whilst Struve found the velocity of translation to be about 7 kilometres per second. This speed was, however, based upon the assumption that the average annual parallax of stars of the first magnitude is about 0″·25, and it should be borne in mind that Airy obtained (*Mem. R.A.S.*, vol. xxviii. p. 161) from the discussion of 113 stars with large proper motions a speed of translation nearly six times as large as that of Struve. Plummer also (*Mem. R.A.S.*, vol. xlvii. p. 341), from a rediscussion of Galloway's data, found for the co-ordinates of the apex R.A. 276° 8′, and Decl. 26° 31′ N., a result which differs considerably from the earlier ones above referred to, and in the direction of greater accordance with those obtained by the spectroscopic method. It may, however, be doubted whether the spectroscopic results are yet ripe for satisfactory discussion; the preliminary investigation undertaken by Plummer some time ago gave distinctly disappointing results, and, so recently as last May, Maunder (*Observatory*, vol. viii. p. 165) stated that but "some fifty stars in all had been observed a sufficient number of times for us to be able to deduce their speed to the nearest ten miles per second." He considered, however, that the results, so far as they went, "indicated a motion towards α Aquarii rather than towards any point in Hercules." This would agree well with Herr Homann's calculations in R.A., but not in Decl.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *MARCH* 14-20

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 14

Sun rises, 6h. 17m.; souths, 12h. 9 m. 19°·2s.; sets, 18h. 1m.; decl. on meridian, 2° 26′ S.: Sidereal Time at Sunset, 5h. 30m.

Moon (one day after First Quarter) rises, 11h. 20m.; souths, 19h. 14m.; sets, 3h. 6m.*; decl. on meridian, 18° 14′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 39	13 6	19 33	4 33 N.
Venus	4 40	10 3	15 26	7 57 S.
Mars	16 35	23 32	6 29*	10 27 N.
Jupiter	18 37*	0 44	6 51	0 37 N.
Saturn	10 26	18 38	2 50*	22 47 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Mar. 18,	19 55	*m*
Algol	3 0·8	40 31 N.	,, 18,	4 18	*m*
ζ Geminorum	6 57·4	20 44 N.	,, 15,	0 0	*M*
			,, 20,	4 50	*m*
S Cancri	8 37·4	19 27 N.	,, 17,	1 10	*m*
T Ursæ Majoris	12 31·2	60 7 N.	,, 14,		*M*
δ Libræ	14 54·9	8 4 S.	,, 18,	21 44	*m*
U Coronæ	15 13·6	32 4 N.	,, 16,	4 46	*m*
W Scorpii	16 5·1	19 50 S.	,, 16,		*M*
U Ophiuchi	17 10·8	1 20 N.	,, 14,	23 15	*m*
		and at intervals of	20	8	
X Sagittarii	17 40·4	27 47 S.	Mar. 17,	0 0	*m*
			,, 19,	21 40	*M*
W Sagittarii	17 57·8	29 35 S.	,, 18,	21 30	*m*
δ Lyræ	18 45·9	33 14 N.	,, 18,	21 40	m_2
η Aquilæ	19 46·7	0 7 N.	,, 17,	19 10	*M*
T Cephei	21 8·0	68 2 N.	,, 14,		*M*
δ Cephei	22 24·9	57 50 N.	,, 19,	2 20	*M*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
14	B.A.C. 1930	6½	0 40	1 28	152 279
15	1 Cancri	6	22 15	23 12	70 327
18	37 Sextantis	6	17 25	18 17	11 240
20	B.A.C. 4043	6½	1 38	2 34	119 239

March	h.	
15	6	Mercury at least distance from the Sun.
20	..	Sun in equator.
20	8	Jupiter in conjunction with and 0° 13′ north of the Moon.

GEOGRAPHICAL EDUCATION AND NATURAL SCIENCE[1]

ONE of my claims to address you on the subject of geographical education is that I have been a traveller. In my opinion nothing can better bring home to the mind the value of good geographical instruction, or make more keenly felt the disadvantages of the lack of it, than a scientific journey round the world. It is naturally the scientific side of geography which interests me most; and it is on the importance and prospects of physical geography as a subject of education that I have now to speak.

To the naturalist a knowledge of physical geography is becoming yearly more and more essential. The geographical distribution of plants and animals is one of the most important and fascinating of all the branches of his subject, presenting an immense field for research, full of problems of the utmost interest. Such problems can only be approached, with hope of success in elucidating them, with a clear comprehension of the principles of physical geography, and a power of entering into the utmost details whenever required. The distribution of organisms, and often their very forms and existence, are the result of the relative positions of the various climatic and other physical barriers on the earth's surface. On the land surfaces, where these barriers present most sharply defined and serious obstacles to migration, the complexity of the distribution of the terrestrial fauna and flora is most remarkable. On the shores, where the barriers are less complete, the isolation and geographical restriction of the littoral fauna and flora is less developed. Whilst in the ocean, with no absolute land-barriers, the pelagic fauna shows little more than a distribution of animal and vegetable forms, according to climatic zones. In the depths of the ocean, which the effects of climate do not reach, the distribution of the animal inhabitants almost approaches universality.

It is, however, scarcely necessary to insist on the especial importance of the study of physical geography as one of the bases required for the scientific pursuit of zoology; and I am sure no one will be more ready than my friend Sir Joseph Hooker, to whom our knowledge of the geographical distribution of plants, and its meaning, is so largely due, to testify to its immense importance in the case of botany. It is obvious that it is equally indispensable in the cases of geology, astronomy, and meteorology.

Far more important is the question, Ought not physical geography to form part of every liberal education, as being a subject specially adapted for purposes of general learning, and as the only true basis on which can be founded a knowledge of what is termed political geography? Political geography may be regarded to some extent as the geographical distribution of mankind; and its various features of importance—its boundaries, its lines of migration and commerce, its cities and battle-fields—have their positions determined by the physical conditions and conformation of the earth's surface, as much as in the case of the distribution of the lower organisms.

In Germany and Austria, and many other parts of Europe, the necessity of physical geography as a subject of general education and of higher University study seems to be thoroughly accepted. There can be little doubt that it is an excellent subject of general education. I have become more and more convinced of this from my own experience as an examiner in the subject, and especially when examining for the Public School medals of this Society.

[1] Abstract of Lecture by Prof. H. N. Moseley, F.R.S., at the Royal Geographical Society's Exhibition of Geographical Appliances, Sir Joseph Hooker, K.C.S.I., V.P.R.S., in the chair.

Dr. Archibald Geikie, than whom no one can speak with higher authority, has expressed a most decided opinion on the peculiar value of physical geography in education. He writes, in a letter published in Mr. Keltie's excellent Report, that he knows of no other subject "that lends itself so effectively to the teacher who wishes to inspire his pupils with some appreciation of the nature and value of scientific education and reasoning." He has long been of opinion that, in this sense of the term, geography (that is physical geography), should form an essential part of education.

It seems generally conceded that the teaching of geography in this country is at present in a very unsatisfactory condition, and far behind that existing over a great part of the Continent of Europe. It is most remarkable, and much to be regretted, that in England, of all countries where advanced education prevails, with her world-wide possessions and interests, such a condition should exist. There can be no doubt about the matter. The fact that it is not found by English publishers to pay to issue first-rate maps and works on physical geography, equivalent to those published in Germany, is striking evidence of its correctness. The present movement is founded on a conviction that it is so. The reasons for this condition of things are probably not far to seek. When we find that geography, whether in lower or higher schools, or at military training colleges, is best taught and provided for in such countries as Germany and Austria, where the subject is represented by special professors and systematically taught at the Universities, whilst at no British University is there any professor of geography at all, it is surely not unreasonable to conclude that the lack of professors and higher teaching of the subject at our Universities is the main cause of the inferior position of the subject here.

The present energetic effort of the Society to promote geographical teaching cannot but yield considerable results in improving the position of the subject in this country, but it is most important that a further attempt to introduce the subject in any form, as a University one, should be made.

Possibly, although at the present moment it may not be feasible to secure the representation of geography as a whole, because of the apparent vagueness of its bounds and the attacks on all sides to which it is in consequence liable, there may be a chance of success if the attempt be made to press the claims of physical geography. It is, however, scarcely possible that the establishment of physical geography at the Universities can ever be effected without the cordial co-operation of the leading geologists of this country. I know that several of these, including Prof. Bonney, to whom I am indebted for much advice in the present matter, believe that the time has come when special chairs of physical geography should be established, regarding the question as one of, as it were, splitting the subject of geology into two parts. Prof. Archibald Geikie expresses himself as of a similar opinion in his letter published in Mr. Keltie's Report. That there is a necessity for lectures on the higher branches of physical geography is shown by the fact that courses of lectures nearly relating to this subject are now being given by Prof. Hughes at Cambridge and Prof. Boyd Dawkins at the Owens College, and I venture to suggest to the Council of the Society that it would be well to make an attempt to secure the co-operation of the Geological Society in a joint endeavour to induce the Universities to establish professorships of physical geography. There are many reasons why success may attend an effort to establish the representation of physical geography rather than the wider subject. It is obvious that any professor who could hold such a chair must be a geologist, the two subjects of physical geography and geology being most closely allied and overlapping. I am not going to attempt to define physical geography as a subject. The term geography is, no doubt, a somewhat unfortunate one, and a great deal of serious opposition has been raised to the advancement of the subject on such grounds as that it is a "graphy" and not a "logy." But the Germans have not only practically separated geology and geography as subjects of University study with the highest success, but find no difficulty in the use of the term physical geography to cover such knowledge as is represented in Peschel's excellent work, "Allgemeine Erdkunde."

Regarding physical geography as a part of geology to be separated from it:—The reason why such a separation should be effected is that there is thus formed and brought together for special treatment a subject which is far more necessary and suitable for general educational purposes than the whole of geology itself, which will attract far more students and act as a lever for promoting the study of other branches of science as special subjects, as well as of geology itself.

The principal argument that is always brought against the establishment of professorships of physical geography at the Universities, is that the subject is already covered by the professors of geology; but Prof. Geikie evidently does not take that view, and points out in his letter already referred to, "Geology is every day increasing in its scope, which is already too vast for the physical powers of even the most indefatigable teacher." It is already impossible for one teacher to cover all which may be supposed to be included under the name geology. When both physical geography and geology are represented by a single professor in a University they must needs be inadequately covered, or one branch must receive but meagre treatment in proportion to the other; or the period covered by a course of lectures is too long for any one student to attend the whole. Convinced that it is a matter of the utmost importance for the progress of geography here to show that the two subjects, geology and physical geography, can be taught with perfect harmony and advantage by different professors at the same time at a University, I asked Mr. Keltie to write to some of the German professors of geography, and request them to express their views on the matter, and to ask for copies of the syllabuses of courses of lectures on geography and geology delivered at the same time within their Universities. He has handed me the following most interesting letter from Prof. Kirchhoff, Professor of Geography at Halle:—

"Unfortunately, I cannot send you syllabuses of the University lectures in geology like those of my own lectures on general geography, and on the countries of Europe, which I placed in your hands, since such do not exist.

"However, the question now being raised in England is already practically settled in Germany. All the Universities in Northern Germany, and now those in Austria also, possess geographical as well as geological professors, and it is not found in any instance that the two interfere with each other, or are superfluous to each other, but, on the contrary, they have proved to afford mutual support.

"It is, no doubt, correct that geology, in just the same way as geography, is concerned with the earth and all its various parts. But the point of view on either side is different. For example, whilst I am delivering in Halle during four successive semestres the course on geography, with the nature of which you are acquainted, Prof. von Fritsch and two colleagues are lecturing to almost entirely different audiences on mineralogy, crystallography, geology, and palæontology. In summer, Prof. von Fritsch arranges excursions for geological purposes, and many of the students attending my lectures take part in these, because a problem of great geographical importance is able to be solved during these excursions, namely, the explanation of the form of the land surface as resulting from its composition, and by means of the history of its development.

"The two sciences do, indeed, touch one another in what is termed superficial geology, but from this zone of contact they stretch wide apart from one another. Geology discusses not only the developmental history of the earth in the Quaternary period, a matter which concerns the geographer quite as much as the geologist, but it discusses also that of the most remote periods of the earth's antiquity, investigates the petrographic structure and the organic life of every formation, subjects which hardly concern the geographer at all.

"On the other hand, geography has to deal not only with the land surface and the waters, but also with climate, the flora and fauna, and human inhabitants, both of the earth as a whole and of each separate country, confining its view to the present only, that is to say to the Quaternary period. It might as well be said that the existence of history as a subject at Universities rendered geography unnecessary, because it also has to do with the entire earth's surface.

"In reality, geography embraces all facts relating to the earth, borrowing them often from other sources. The geology of the British Islands, for example, together with their history since the time of Cæsar, does not by any means represent the geography of the islands."

Prof. Wagner, of Göttingen, Professor of Geography in that University, a most eminent authority on geographical education, has sent a note, in which he gives a syllabus of his

own lectures and those of Prof. von Koenen, Professor of Geology.

From this it is evident, as Prof. Wagner concludes, "that there is no connection whatever (*gar kein Konnex*) between my lectures and those of the geologist."

Can any one doubt that the establishment of such a system of teaching geography and geology, side-by-side, as set forth in these two communications, would not be of the utmost benefit to our country and its education generally, if established in our Universities also? It will be impossible to obtain adequately trained teachers of physical geography until such courses of instruction are open; and until adequately trained teachers are produced for higher schools and training colleges, no real progress in the teaching of physical geography can be made throughout the country.

There can scarcely be a doubt that the establishment, at our Universities, of such a condition as that at the German ones, would be in every way to the advantage and advancement of geology, and to the increase of the numbers of its students; it would also advance the cause of all other branches of natural science, and all interested in the teaching of these subjects ought to support a movement in favour of its adoption warmly. No doubt the adoption of the system is merely a question of time,—England cannot lag behind in the study of geography for ever.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Mr. J. E. Marr, M.A., Fellow of St. John's College, has been appointed University Lecturer in Geology.

It is estimated that the ethnological collections now displayed in the Antiquarian Museum are worth at least 2000*l.*, and with a little additional accommodation objects valued at 1000*l.* more can be displayed. These series are of inestimable value to the student of anthropology, and from the labours of Baron von Hügel in their arrangement the University is reaping a rich harvest. The baron contemplates illustrating them by a full series of maps and drawings.

The honorary degree of M.A. is to be conferred on Mr. C. Todd, Government Astronomer, Postmaster-General, and Director of Telegraphs in South Australia.

The Open Entrance Scholarships for Natural Science to be competed for in the ensuing months include those of Peterhouse, Chemistry and Physics, October; Clare, Natural Science, March 24; Downing, Natural Science, June 1; Non-Collegiate Students, Physical Science, July.

Mathematical Scholarships will be given at each College mentioned above (except Downing), and at Trinity Hall, March 17; Corpus Christi, March 23; Queens', April 27; St. Catherine's, May 11; Magdalene, March 17. Further information will be given by the Tutors of each College.

AT the City and Guilds of London Institute, Central Institution, Exhibition Road, S.W., Prof. Ayrton, F.R.S., will give a course of six lectures on some of the industrial applications of electricity, from 5 p.m. to 6 p.m. Friday afternoons, March 12, 19, 26, April 2, 9, and 16. The lecture on March 12 will be on Electric Lighting; March 19, Electricity as a Motive Power; March 26, Electric Storage of Energy; April 2, Electric Transmission of Power; April 9, Electric Meters; April 16, Electric Locomotion.

AT Clifton College a Scholarship of the value of 30*l.* per annum, tenable for three years at the Central Institution of the City and Guilds of London Institute for the Advancement of Technical Education, is offered by the Committee of the Institute, and will be awarded, on the nomination of the headmaster, in July next. The candidate so nominated will be required to pass the Entrance Examination of the Institution, to be held in the following October. It is the intention of the Committee of the Institute to offer this Scholarship annually for six years, beginning with 1886. The object of the Central Institution is to provide advanced instruction in those kinds of knowledge which bear upon the different branches of industry, whether manufactures or arts.

It is intended that a subdivision of the Military and Engineering Department of Clifton College shall have its studies specially, though not exclusively, directed with a view to prepare for entrance to the Central Institution and similar Engineering and Technical Colleges.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 4.—"On the Polarisation of Light by Reflection from the Surface of a Crystal of Iceland Spar." By Sir John Conroy, Bart., M.A. of Keble College, Oxford. Communicated by Prof. G. G. Stokes, P.R.S.

In the year 1819 Sir David Brewster communicated to the Royal Society (*Phil. Trans.*, 1819, p. 145) an account of some experiments he had made on the polarisation of light by reflection from the surface of double-refracting substances, and showed that Malus's statement with regard to Iceland spar was incorrect.

Malus said that Iceland spar behaves towards the light it reflects like a common transparent body, and that its polarising angle is about 56° 30', and that, whatever be the angle comprehended between the plane of incidence and the principal section of the crystal, the ray reflected by the first surface is always polarised in the same manner ("Théorie de la Double Refraction," pp. 240, 241).

Some years later Seebeck made a number of very accurate observations on the same subject, and in 1835 and 1837 Neumann published an account of further experiments that he had made on the reflection of light by Iceland spar.

He begins his second paper by a brief summary of the results obtained by Brewster and Seebeck. "Brewster found that the angle of complete polarisation for calc-spar depends on the position of the reflecting surface relatively to the axis, and upon the position of its principal section to the plane of reflection; he also found that when the reflecting surface is covered with a liquid the plane of polarisation of the completely polarised ray does not coincide with the plane of reflection, but makes a smaller or greater angle with this; when a cleavage-face of calc-spar is covered with oil of cassia this deviation may amount to 90°. The knowledge of these phenomena has only been further advanced in recent times. Dr. Seebeck has so followed out, by means of most accurate determinations, the influence of optically uniaxial crystals upon complete polarisation that the angle of incidence at which this occurs can be determined as accurately beforehand as it can by Brewster's law in the case of uncrystallised bodies. Seebeck also discovered that the deviation of the plane of polarisation from the plane of reflection, which Brewster had observed, also occurs when the ray of light falls directly from air on to the surface of the crystal."

Seebeck's observations having been mainly directed to the determination of the angle of polarisation, Neumann's object was to determine the azimuth of the plane of polarisation of the reflected light.

Seebeck and Neumann only repeated a portion of Brewster's experiments, and no one except Sir David Brewster appears to have made any determinations of the angles and azimuths of polarisation when the spar was in contact with media other than air.

Prof. Stokes very kindly called my attention to these experiments of Sir David Brewster, and pointed out that, as they had never been published in detail, and had not been repeated by any one else, it was desirable that further observations should be made on this subject. The experiments, the results of which I have the honour of submitting to the Royal Society, were undertaken at Prof. Stokes's suggestion, and in carrying them out I had the benefit of his advice.

The apparatus used was essentially the same as that employed by Seebeck; the divided circle of the goniometer was, however, horizontal, and not vertical, as in Seebeck's instrument, and the arrangement for keeping the reflected ray constantly in the axis of the observing-tube, whilst the angle of incidence was varied, differed from that employed by him.

The measurements were made by altering the angle of incidence and the azimuth of the observing Nicol until the light reflected by the Iceland spar was reduced to a minimum, the position of the crystal remaining fixed.

In order to obtain anything like accurate results with observations of this kind it is necessary to make a large number of determinations and take their mean: it was obvious that there were two ways in which any given number of observations might be grouped, either by making a good many separate determinations for a few positions of the crystal, or by making a few observations at a number of different azimuths; the latter alternative being the one adopted, two readings were made at seventy-two different azimuths of the crystal.

Two complete series of observations were made with cleavage-

faces of Iceland spar in air, water, and tetrachloride of carbon, the water and tetrachloride of carbon being contained by a nearly cylindrical thin glass vessel (a chemical beaker), which stood on the horizontal stage of the goniometer, the tetrachloride being prevented from evaporating by a layer of water floating on its surface.

The position of the crystal in which the principal section was in the plane of incidence and the obtuse summit nearest the observer was considered the zero position; when the principal section was in the plane of incidence, and the obtuse summit towards the side from which the light was incident upon it, was therefore azimuth 180°. The crystal was rotated clockwise, and the same direction of rotation was considered the positive direction for the Nicol.

It had been intended to make similar measurements with artificial surfaces cut perpendicular and parallel to the axis of the crystal, and three pieces of Iceland spar cut respectively parallel to a natural face, and perpendicular and parallel to the axis, and all polished with "whiting" were obtained.

Seebeck states (*Pogg. Ann.*, vol. xxi. 290) that Iceland spar polished with rouge or putty powder differs in its optical properties from the natural substance, but that an artificial surface polished with chalk behaves very nearly, if not exactly, like a natural one.

Seebeck's measurements were all made with the crystal in air, and as the changes in the azimuth of the plane of polarisation, and in the value of the polarising angle, for different azimuths of the crystal, when such is the case, are small, it seemed desirable, before making any measurements with the artificial surfaces cut perpendicular and parallel to the axis, to make some determinations with an artificial surface parallel to a natural face of the crystal when the crystal was immersed in water; this was accordingly done.

These results differed considerably from those obtained previously with a natural face in water, and it therefore did not appear worth while to make any further experiments with artificial surfaces, as it seemed certain that the results would be untrustworthy.

The difference between the results obtained with this artificial surface and with a natural surface of the crystal is too great to be explained by supposing that the artificial surface was not cut absolutely parallel to the direction of the cleavage, and must therefore be attributed to some change produced by the polishing, possibly due to the pressure employed (conf. Seebeck, *Pogg. Ann.* vol. xx., 1830, 27).

Prof. Stokes pointed out to me that the experimental results which had been obtained were well suited for reduction by means of the harmonic analysis, and not only explained the method but himself reduced the first set of observations made with a cleavage-face in water. All the observations were accordingly reduced by this method.

Owing to the fact that the principal section of the crystal is a plane of symmetry, the periodic series for the development of the azimuths of the planes of polarisation can contain sines only, and that for the polarising angles cosines only, including the constant term; therefore the coefficients of the cosines in the former case, and of the sines in the latter, were not calculated, except with the observations made with the artificial surface; it seemed possible that the process of polishing might occasion some want of symmetry, and that therefore it was desirable to calculate the values of the coefficients in both sines and cosines.

Omitting the terms which we know from theoretical reasons ought not to appear, and which at any rate are extremely small, we obtain as the final result the following approximate expressions—

Azimuths of the Plane of Polarisation of Light Polarised by Reflection

Cleavage surface in air	$-2^\circ 10' \sin\theta + 1^\circ 49' \sin 2\theta + 0^\circ 2' \sin 3\theta + 0^\circ 1' \sin 4\theta$.
Ditto, in water	$-9^\circ 27' \sin\theta + 5^\circ 29' \sin 2\theta + 0^\circ 47' \sin 3\theta - 0^\circ 10' \sin 4\theta$.
Ditto, in tetrachloride of carbon	$-23^\circ 47' \sin\theta + 10^\circ 25' \sin 2\theta + 4^\circ 17' \sin 3\theta - 0^\circ 24' \sin 4\theta$.
Artificial surface in water	$-3^\circ 52' \sin\theta + 5^\circ 11' \sin 2\theta + 0^\circ 33' \sin 3\theta - 0^\circ 21' \sin 4\theta$.

Polarising Angles

Cleavage surface in air	$58^\circ 17' - 1^\circ 15' \cos 2\theta + 0^\circ 2' \cos 4\theta$.
Ditto, in water	$52^\circ 2' - 3^\circ 14' \cos 2\theta + 0^\circ 13' \cos 4\theta$.
Ditto, in tetrachloride of carbon	$53^\circ 9' - 8^\circ 54' \cos 2\theta + 1^\circ 12' \cos 4\theta$.
Artificial surface in water	$48^\circ 53' - 2^\circ 9' \cos 2\theta + 0^\circ 1' \cos 4\theta$.

From these expressions the values of the ordinates of the curves representing the phenomena were calculated, and the curves plotted from the values so obtained.

These curves correspond very closely with the smooth curves drawn from the points given by the observations, the values of the ordinates for those portions of the curve corresponding to azimuths 0°–40° and 320°–360°, being rather greater than the values given by the smooth eye-drawn curve. The curves for the artificial surface in water show clearly, when compared with the corresponding curves for the natural surface, how nearly these two surfaces differed in their optical behaviour.

Brewster, in his paper in the *Philosophical Transactions* for 1819, says:—"In any given surface when A and A'' are the maximum and minimum polarising angles, viz. in the azimuths of 0° and 90°, the polarising angle A' at any intermediate azimuth α may be found by the formula $A' = A + \sin^2\alpha(A'' - A)$."

This expression is the same as that given by the harmonic reduction of the observations set forth in this paper, if we assume that the smaller terms are due to errors of observation, as in that case the expression for the polarising angle in air (B) becomes $58^\circ 17' - 1^\circ 15' \cos 2\theta$.

Brewster's formula also appears to hold good for the case of Iceland spar in water, as the harmonic series for the value of the polarising angle (D) may be taken as $52^\circ 02' - 3^\circ 14' \cos 2\theta$. But with the spar in tetrachloride of carbon the agreement no longer holds, as the coefficient of $\cos 4\theta$ becomes too large to be neglected, being 1° 12'. The determinations made in this strongly refracting liquid were less satisfactory than the others, but there is hardly sufficient ground for assuming that the value of the coefficient of $\cos 4\theta$ is merely due to errors of observation.

The experiments, of which an account had been given, confirm the accuracy of Brewster's observations made with a surface of Iceland spar in contact with media other than air, and show moreover that, as Seebeck pointed out, the change in the value of the azimuth of the plane of polarisation of the reflected light also occurs, though to a far less extent, when the crystal is in air, and further, as the refractive index of the medium increases, the change in both these values is greatly augmented.

The harmonic analysis affords a means of expressing approximately at least both these changes as functions of the azimuth of the principal section of the crystal, and further shows that, when the crystal is in air or water, Brewster's formula for the angle of polarisation expresses the facts of the case.

Linnean Society, February 18.—Dr. St. George Mivart, F.R.S., in the chair.—Prof. H. Macaulay Posnett, N.Z., was elected a Fellow of the Society.—Mr. W. Joshua exhibited over 130 species of Lichens from Jamaica, collected by Mr. J. Hatt in the Blue Mountains near Gordon Town, and afterwards determined by Dr. J. Müller (Arg.) of Geneva; many of these were of great interest.—Mr. T. Christy exhibited some flowers preserved by a new chemical process; he also called attention to a hitherto unknown Cinchona bark from South Africa; and besides showed a living plant of *Erythoxylon coca* in fruit.—Mr. H. Goss made remarks on specimens of the Wild Parsnip (*Pastinaca sativa*) gathered by him on the Thames side, Moulsey, Surrey.—Mr. A. D. Michael read a paper on Acari of the genus *Glycyphagus*, discovered in moles'-nests. In *G. platygaster* the male, although slightly differing from the female, as is usual in the genus, still can easily be recognised as of the same species; but in *G. dispar*, while the female closely resembles that of *G. platygaster*, the male, on the contrary, is totally unlike in size, form, markings of body, and arrangement of the legs, &c. *G. dispar* also affords evidence of the retro-anal position of the bursa copulatrix, and its being the posterior median projection characteristic of the females of the genus. Mr. Michael speculates wherefore the above divergence of the male form of *G. dispar*, seeing that its habitat and other conditions are the same as its female, and the closely-allied species.—Mr. John Ball gave a communication on the botany of Western South America. He introduced the subject with reflections on the climatal relations of the western seaboard, which have such a remarkable influence on the development of vegetable life. He then describes his collection of plants from Buena Ventura in Columbia, from Payta in Northern Peru, from Caldera in Northern Chili, and Lota in Chili, from the neighbourhood of the Channels of Western Patagonia, and Straits of Magellan, throughout interspersing reflections and brief summaries of the peculiarities of the floras in each of the districts in question. He infers

that the vast region including the warm and moist parts of South and Central America should be regarded as a single botanical province, in which the same generic types are represented by species of which a large proportion are endemic, and confined to comparatively small areas. Along with these we find, in various parts of the same region, a few forms so distinct as to be ranked as separate genera, mostly represented by one, or very few, species, and nearly allied to types of wide distribution. He assumes that, in a broad sense, the most natural divisions of the vegetation of the earth are wide areas of low country, over which, with more or less modification, a limited number of types have extended, with islands of high land, which are the original homes of special types that form the characteristic features of different regions.

Zoological Society, March 2.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—Mr. J. G. Millais, F.Z.S., exhibited an adult specimen of the Ivory Gull, shot by himself near Thurso, in December 1885; also a young example of the same species, obtained in Scotland in 1879.—Mr. T. D. A. Cockerell exhibited a living Slug of the genus *Parmacella*, obtained at Tangier, and probably referable to *P. valenciennesi*.—A communication was read from Prof. R. Collett, C.M.Z.S., containing an account of a new Pediculate fish from the sea off Madeira, belonging to the family Ceratiidæ, which the author proposed to call *Linophryne lucifer*.—Mr. P. L. Sclater read a note on the external characters of the head of *Rhinoceros simus* as compared with those of *R. bicornis*.—Mr. F. E. Beddard read a note on the air-sacs of the Cassowary.—A second paper by Mr. Beddard treated of the syrinx and some other points in the anatomy of certain forms of Caprimulgidæ.

Entomological Society, March 3.—Mr. Robert McLachlan, F.R.S., President, in the chair.—Mr. J. M. C. Johnston was elected a Fellow, and Cavaliere Piero Bargagli, of Florence, was elected a Foreign Member.—Mr. Pascoe exhibited a curious larva, probably of a *Papilio*, from Pará; and also a pupa-case of *Anosia plexippus* (*Danais archippus*), from the same locality.—Mr. W. J. Williams exhibited, on behalf of Mr. C. Bartlett, a gigantic hairy and spiny larva, perhaps allied to *Gastropacha*, from Madagascar.—Mr. C. O. Waterhouse exhibited *Rutela rufipennis*, *Doryphora haroldi*, and some other (undescribed) species of *Coleoptera*, from Colombia.—Mr. Billups exhibited a specimen of *Cholus forbesi*, found alive in a horticultural sale-room in London.—Mr. Eland-Shaw referred to the exhibition at the last meeting of *Tettix australis* from New South Wales, and called attention to the fact that the aquatic habits of certain species of the genus *Tettix* in India had been previously recorded.—Dr. Fritz Müller communicated a paper on fig insects from Itajahy, South America; and Prof. Meldola exhibited, on behalf of Dr. Fritz Müller, a number of specimens of the insects described in the paper.—Mr. E. B. Poulton read further notes upon lepidopterous larvæ and pupæ, including an account of the loss of weight in the freshly formed pupa.

DUBLIN

University Experimental Science Association, January 27.—Prof. Cathcart in the chair.—Prof. Fitzgerald showed his new galvanometer. This instrument was constructed, and exhibited in the Inventions Exhibition last year, by the Cambridge Scientific Instrument Company. Its peculiarities are (1) the arrangement by which the coils can be measured in their place, which is an advantage when practical classes are working, and should measure their instruments; (2) the arrangement by which the circle is read with a microscope by reflection-mirrors attached to the magnet, when the instrument is used either as a sine or tangent galvanometer; (3) an arrangement by which a spot of light reads the tangents of deflection. The first advantage is secured by having the two pairs of short and long coils wound in grooves closed in, outside, by a glass plate through which they can be seen, and the external and internal diameter of each layer of wire measured; the transverse diameter, by seeing through small holes left in the ring that covers the coils outside. The reading is effected by viewing a scale engraved on the inside of a horizontal ring surrounding the needle by reflection in two right-angled prisms attached to the needle which reflect opposite sides of the scale. The corresponding lines in the two maps, which differ by exactly 180°, is the line at right angles to the line of intersection of the reflecting planes of the prism. The exact position of that line can be read by means of a micrometer in the eye-piece of the microscope. The horizontal graduated ring is attached through the vertical axis on which the coils, &c., turn to the base of the instrument, and so the same circle does for reading when the instrument is used as a sine galvanometer. By means of a small mirror attached to the needle at 45° to the line of suspension, a spot of light can be reflected through the glass side of the instrument to a scale, and then a uniform scale represents the tangents of the deflections.—Mr. J. Joly, B.E., gave an account of a method of finding the specific gravity of small heavy bodies. The substance, whose specific gravity is required, which may only be a few milligrammes in weight, is melted into a small dish of paraffin of known specific gravity. The paraffin and substance is then floated in a specific gravity solution, and from the formula

$$S = \frac{W}{\frac{w_1}{s_1} - \frac{w_2}{s_2}}$$

the required specific gravity of the body can be obtained. In the above equation W is the weight of the solid, w_2 that of the paraffin, w_1 the sum of these weights; s_2 is the specific gravity of paraffin, s_1 the specific gravity of paraffin and substance together. This method is extremely useful in dealing with porous bodies, owing to the capability of paraffin, when in a molten state, of entering the pores and expelling air. Mr. Joly gave details of a number of experiments which show excellent results.—The next paper was read by Mr. Gerald Stoney, on the dynamics of bicycling. He described experiments made by him, in conjunction with his father, Dr. G. Johnstone Stoney, F.R.S., by which the energy required to propel a bicycle was obtained. They found that it required, when the velocity was 9 miles per hour, about 5500 foot-pounds per minute, and that it often rose higher than 10,000 foot-pounds per minute, which was the highest the apparatus used was capable of recording. Their results were higher than those of other experimenters on the power a man can exert. This shows that the bicycle or tricycle is probably the most economical way of using human muscles. The experiments were made by attaching an indicator-diagram-apparatus to the lever of the safety-bicycle, known as the "Extraordinary," and also by observing the reduction in speed due to friction, when the bicycle was running free. The experiments also showed that the resistance varied almost as the velocity, and that the pressure on the pedal was not constant, but was at a maximum at the centre of the stroke.

PARIS

Academy of Sciences, March 1.—M. Jurien de la Gravière, President, in the chair.—Results of the application of the new method for preventing rabies after the bite of a mad dog, by M. Louis Pasteur. Since October 26, 1885, when his process was first announced to the Academy, 350 patients of all ages and both sexes have been treated with perfect success in every case except one. The eminent biologist considers his prophylactic method established, and expresses a hope that a hospital may now be founded for the regular treatment of patients by this process of inoculation. This suggestion met with general approval, and a Commission was appointed to give it effect, including the names of MM. Vulpian, Marey, P. Bert, Jurien de la Gravière, Bertrand, and De Freycinet.—Direct formulas for calculating the momenta of flexion in continuous girders of constant or variable section, by M. Maurice Lévy.—Note on the comparative results of direct astronomical observation with those obtained by MM. Henry's photographic process, by M. Wolf. Discrepancies are pointed out between the photographs of the Pleiades and the author's observations of that constellation in 1874. He adds: "The chart of the heavens now obtained by photography is different from that drawn from direct observation, and it also differs from that which will be obtained twenty years hence by the photography of the future, whose processes will certainly be different from ours. The human eye, on the contrary, is an organ which is always the same; consequently its observations are always capable of being compared together. . . . Celestial photography must work hand in hand with the observer's eye, which it can never replace."—Reply to M. Lalanne's note of February 22, on the mechanical effects of tornadoes, by M. Faye. M. Lalanne's facts are not questioned, but they are shown to be perfectly in accordance with M. Faye's well-known theory.—Remarks on the various theories of tornadoes, by M. Lecoq de Boisbaudran. While admitting the descending movement as the general law, the

author suggests that a secondary movement in the opposite direction may perhaps occasionally be produced, which would serve to explain many phenomena difficult to account for on any one theory.—On the equivalent of the terbenes; explanatory note, by M. Lecoq de Boisbaudran.—On the employment of the azimuthal co-ordinates in geodetic surveys, by M. Hatt.—Communication on the approaching centenary of Arago, by M. Mouchez. It was announced, on behalf of the Committee, that the intended banquet in the Hôtel de Ville has been abandoned, and that it has been decided to erect a more lasting monument to the memory of the illustrious astronomer, to take the form of a colossal statue to be raised by national subscription on the Boulevard bearing his name.—Remarks on the *Year-book* of the Imperial Observatory of Rio de Janeiro, presented to the Academy on behalf of the Emperor of Brazil, by M. Faye.—Position of telescopic stars in the constellation of the Pleiades, by M. G. Rayet. A complete list is given of 143 stars observed with the 14-inch equatorial of the Bordeaux Observatory during the winters of the years 1884-85 and 1885-86.—Observations on Fabry's comet made at the Observatory of Algiers with the 0·50 m. telescope, by M. Ch. Trépied.—Orbit and ephemeris of the same comet, by M. Lebeuf. From the observations taken at Algiers, Hamburg, Nice, and Paris, the elements of the new orbit have been determined as under:—

T = 1886 April 5·9580 Paris Mean Time

ω = 126° 36′ 6″·7
Ω = 36 22 32·0 } Equinox 1886·0.
i = 82 36 34·9
log q = 9·807626

On the angle of the line of depression below the horizon at sea, by M. E. Perrin. The observations of depression here published were taken in 1884-85 on board the *Galissonnière* in the Chinese seas by means of a Lorieux reflection circle furnished with Daussy's additional small mirror. The mean value of apparent depression was determined at 5′ 31″·5. The corresponding geometric depression being 5′ 46″·8 for an altitude of 9 metres, about 1/23 was fixed for the coefficient of geodetic refraction at sea.—Calculation of mechanical regulators; the proper course to follow in practice in order to establish a regulating apparatus with indirect action, by M. H. Léauté.—Note on the articulated hyperboloid and the application of its properties to the demonstration of De Sparre's theorem, by M. A. Mannheim.—On Deprez d'Arsonval's aperiodic galvanometer employed as a ballistic galvanometer, by M. Ledeboer.—On the spectrum of erbine, by Prof. W. Crookes. The phosphorescent spectrum of this earth, of which a comparatively pure specimen has recently been obtained by the author, showed four green bands coinciding with none of those of the spectra of yttrium and samarium.—On the crystallisation of the paratartrate of soda and ammonia, by M. J. Joubert.—On the relations existing between the variations of terrestrial magnetism and the protuberances and other phenomena observed on the sun, by M. H. Wild. As far as the question has hitherto been studied the author considers it well-nigh established that the great movements of the solar atmosphere are revealed on the globe by corresponding disturbances of the magnetic needle.—Actinometric observations made at Montpellier during the year 1885, by M. A. Crova.—On the hygroscopic properties of tobacco, by M. Th. Schlœsing, jun.—On the isomeric states of the sesquichloride of chromium, green sesquichloride, by M. A. Recoura.—On some immediate principles of the peel of the bitter orange, by M. Tanret.—On the respiratory centres of the spinal marrow, by M. E. Wertheimer. Numerous experiments made on dogs show that in the spine there exist nervous centres, some determining inspiration, others expiration.—On the character of an anomalous rock in the Aspe Valley, Lower Pyrenees, by MM. E. Jacquot and A. Michel Lévy. This rock, by Charpentier called *compact feldspar*, is interstratified at the base of the Carboniferous formations, its age coinciding with the end of the granulite and beginning of the microgranulite eruptions. Although soft and oily to the touch, like the steatites, its dust scratches glass. Chief constituents: silica, 76·33 per cent.; alumina, 14·30; potassa, 3·33; lime, 0·90.—On the stratigraphic relations existing between the miliolite limestones and the *Micraster tercensis* formation in the department of the Haute-Garonne and the canton of Sainte-Croix (Ariège), by M. J. Roussel. The new facts determined by the author show that in the Pyrenees the relations of the Chalk and Tertiary formations are sometimes of an extremely complicated character. But in his remarks on this paper M. Hébert was unable to accept the view that the *Micraster tercensis* of the Pyrenees, essentially a Cretaceous rock, was contemporary with the Tertiary formations containing *Cerithium ladevezi*, *Ostrea uncifera*, and similar fossils.

STOCKHOLM

Royal Academy of Sciences, February 10.—On Binuclearia, a new genus of Confervaceæ, by Prof. V. B. Wittrock.—On the biology of some Arctic plants, by Prof. E. Warming.—Contributions to the anatomy of the cotyledons of the monocotyledonous plants, by Miss M. Lewin.—On the amount of the rainfall on bare and wooded ridges in the North of Halland, by Dr. H. Hamberg.—Insects collected in the Cameroon Mountain, by G. Waldau and H. Knutson: I. Coleoptera, Cetoniidæ, described by Prof. Chr. Aurivillius.

BOOKS AND PAMPHLETS RECEIVED

"Across the Jordan," by G. Schumacher (Bentley).—"Marvels of Animal Life," by C. F. Holder (Low).—"Japanese Homes," by E. S. Morse (Low).—"Highlands of Cantabria," by Ross and Cooper (Low).—"The Rain-Band," by J. R. Capron (Stanford).—"Lessons in Elementary Chemistry," new edition, by Sir H. E. Roscoe (Macmillan).—"Rotifera," part 2, by Hudson and Gosse (Longmans).—"Bees and Bee-keeping," part 7, by F. R. Cheshire (Gill).—"The Western Pacific and New Guinea," by H. H. Romilly (Murray).—"British Petrography," part 2, by J. J. H. Teall (Watson, Birmingham).—"Indian Meteorological Memoirs," vol. ii. part 5 (Calcutta).—"Report on the Administration of the Meteorological Department of the Government of India in 1884-85."—"The Monthly Weather Report," Oct. and Nov., 1885.—"Proceedings of the Linnean Society of New South Wales," vol. x. part 3 (Cunninghame, Sydney).—PAMPHLETS.—"La Sensibilité et la Motilité des Végétaux," by E. Morren (Hayez, Bruxelles).—"Une Expérience sur l'Ascension de la Sexe chez les Plantes," by L. Errera.—"Freundländische Zierfische, mit Abbildungen," by B. Dürigen (P. Matte, Berlin).—"The Fixed Idea of Astronomical Theory," by A. Tischner (Fock, Leipzig).—"Report on the Action of the Sheffield Water on the Lead Communication Pipes," by S. White.

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THURSDAY, MARCH 18, 1886

A TEXT-BOOK OF POLITICAL ECONOMY

A Brief Text-Book of Political Economy. By Francis A. Walker. Pp. iv.-415. (London: Macmillan and Co., 1885.)

PROFESSOR WALKER'S "Text-Book," for the most part an abridgment of the larger work published in 1883, deserves to be received with the highest commendation as supplying a much-felt want in English literature of the subject. An introductory treatment of so complex a study as political economy, written with due insight into the theoretical difficulties of the subject, and at the same time with adequate notice of the practical problems which these involve, can hardly be said to be given in any of the smaller manuals in current use in this country. The praiseworthy work of the late Prof. Fawcett, with its condensation by Mrs. Fawcett, kept on the whole too rigidly to the lines prescribed by Mill's classical treatise, and remained unaffected by many discussions which had shown the need of altering or amending the cardinal doctrines so forcibly stated by Mill. There is hardly any portion of the theory of political economy which has not received attention since the date of Mill's exposition, while the pressure of new practical problems has of itself been sufficient to render necessary some revision of the general theory. Prof. Walker, while retaining on the whole Mill's general conception of the limits and divisions of economical science, has incorporated many results of recent research, and has in addition so keen an eye for practical issues that his exposition, even when remaining within the lines of the older doctrine, gains peculiar freshness and interest.

Of the six parts into which the work is divided, the first contains a brief statement, mainly based on Cairnes, of the character and logical method of Political Economy. Parts II., III., IV., on Production, Exchange, and Distribution, contain an admirable *résumé* of the current doctrine, with certain important modifications. As excellent specimens of the way in which the author's keen appreciation of practical conditions enables him to state economical principles in a novel and forcible manner, I would instance the chapters on labour and productive capacity (Part II., Chapters 2 and 4), that on the reaction of exchange upon production (Part III. Chapter 7), and the treatment of market prices. Opinions must differ in regard to what should be included for purposes of elementary instruction under the three staple heads of production, exchange, and distribution, as also in regard to the most suitable order of treatment. Generally Mr. Walker's choice is wise, and his exposition clear of the more thorny theoretical difficulties. It appears to me, however, that much greater expansion might have been given to the section which follows out division of labour into its concrete form—the specialisation of industries, employments, and localities, and in particular the separation of industrial functions. Without a descriptive basis of some such kind, the student finds far too wide a gap between his hypothetically deduced theory of exchange and distribution and the facts of practical life. More might with advantage have been said on the way in which this social development affects competition, and so some more concrete view of capital obtained than is contained in the chapter on that subject. Justice is barely done to the theoretical notions involved in the determination of normal value, and I think that most useful illustrations of a quite elementary kind are to be had from the treatment of local and temporary variations of price, and of cost of transport or circulation. I am unable to persuade myself that the treatment of seignorage, on which Prof. Walker lays unusual stress, is the best or even a good introduction to the discussion of inconvertible paper money, and generally the sections on money seem to me to leave much to be desired. Possibly the problem of the determination and the variation of general prices is too hard for an introductory treatise, but, if it be omitted, unusual caution is required in laying down abstract propositions regarding demand and supply of money. I do not know how Prof. Walker, usually very careful in his use of terms, will reconcile the statements about "inflation" in §§ 164 and 186. On certain points in the treatment of distribution a remark will later be made.

In Part V. a very interesting and instructive treatment is given of some portions of the theory of Consumption. Prof. Walker seems to me justified in all he says of the importance of this part of the subject. But it has peculiar difficulties, and tends to bring before one rather forcibly the often-recurring doubts as to the economical statics which have preceded it. Perhaps political economy is hardly yet in a position to take the important step of regarding its statics as but a special case of the more general, more important, but less easily formulated dynamical principles.

Part VI.—"Some Applications of Economic Principles"—contains interesting but, on the whole, over-brief treatments of some mixed problems of economics and politics, ranging from usury laws to protection. So far as the book is designed for students beginning the subject, nearly the whole of this part might with advantage have been omitted; it does not seem possible to deal satisfactorily in the compass of a few pages with such involved problems as bi-metallism, progressive taxation, and protection.

The treatment of distribution is the portion of Prof. Walker's work in which he deviates most widely from the current doctrine as laid down in Mill's treatise, in which he tends more towards the view of certain French and German economists. The tendency seems to me to be in the right direction, but not to have been allowed sufficient development, and although I attach high value to this portion of Mr. Walker's work, both in its abridged and its larger form, I cannot think that he has been entirely successful in threading the labyrinth of distribution. It is in the province of distribution that the abstraction by the aid of which the economist proceeds to develop his theorems becomes at once most necessary and most dangerous—most necessary, for there is absolutely no single fixed significance attached to the fundamental terms employed; most dangerous, because the attempt to sever may reduce living reality to a mere economical *caput mortuum*. In the theory of production it is comparatively easy to form the *schema* or general picture of the elements, their relations and movements, which constitute the fact to be analysed; nothing is

harder than to form any one self-consistent *schema* of the line within which distribution falls. The common complaint that the fundamental categories of rent, interest, wages, and profits, have in popular usage a meaning not that assigned to them by the economists, only expresses a small part of the difficulty. There is hardly an economical treatment of the subject which altogether evades the consequences of the peculiar difficulty that these terms are indifferently employed to mark the remuneration which, in a hypothetical or actual state of society, falls to distinct industrial functions, and the shares which, in like circumstances, are enjoyed by distinct industrial classes. Hardly anywhere is there sufficient recognition of the important distinction between the proximate and the ultimate conditions through which the distribution of produced wealth comes about. Illustration of these difficulties can be given only from Prof. Walker's excellent and most instructive treatment of profits. Here, following, or at all events coinciding with, some of the best Continental economists, Prof. Walker develops the notion of the *entrepreneur* and his industrial function, and assimilates the remuneration of the *entrepreneur* to rent, from which follow certain important general propositions. Profit, apparently, is regarded as the title of the share falling to the *entrepreneur*. Now, undoubtedly there is a portion of the share falling at any given time to the *entrepreneur* which in its origin and laws is identical with rent, for rent is a quite general consequence of any inequality, howsoever arising, in productive sources at any moment needed for the satisfaction of social wants. But it is impossible to identify this with profit at large,—an identification which Prof. Walker appears to reject in § 255, but which he accepts without qualification in the proposition that there is a class of no-profit *entrepreneurs*. There is doubtless a class of no-profit *entrepreneurs*, but the immediate inference is that the term profit is not equivalent to remuneration of the *entrepreneur*, while it is a further consequence that, in quarters where it has not generally been looked for, there is precisely the same rent-element, in wages *e.g.*, and in payment for the use of capital. What conceals it from us in many cases, and makes it disappear in particular conditions, is the greater perfection of the market for services, which tends to remove the inequalities out of which rent essentially emerges. Prof. Walker's analysis of the *entrepreneur* remuneration seems thus to be far from adequate, though it is on the right track. He has not sufficiently recognised that, if we take *entrepreneurs* as a class, then, by whatsoever name we describe it, their remuneration will be a complex quantity, proximately determined by the conditions under which the exercise of the *entrepreneur* function at any moment meets a social want, ultimately breaking up into a number of distinct remunerations, each having its own natural origin and laws. So with wages. To begin the analysis of wages with the conception of the hired labourer, though it keeps one closer to practice, is only to make a first step, and ought not to conceal from us the essentially complex character of the payment so-called. I believe that fundamentally I am in agreement with Prof. Walker in his view of the ultimate condition determining wages, but I cannot assign such importance to it as he seems to do, and I wish that he had observed his own prudent caution (§ 9) regarding the word property, and not thought it necessary to say (§ 273) that, after deduction of rent, profits, interest, "the whole remaining body of wealth daily or annually created is the property of the labouring class"! This is either one of the many truisms that abound in theoretical economics, or it is a dubious, ambiguous, and incautious rule for practice. It is to be added, however, that Prof. Walker's practical observations about wages in §§ 278–289 are excellent and to the point.

R. ADAMSON

ALGÆ

Till Algernes Systematik. Nya bidrag af J. G. Agardh (Fferde afdelningen). VII. "Florideæ." *Lunds Univ. Årsskrift*, tom. xxi. 4to. (*Proceedings* of the University of Lund, Sweden, 1886.)

FOR more than forty-five years the venerable author—now a septuagenarian—of the work mentioned at the head of this notice, has continued to produce, at brief intervals, a succession of standard works on Algæ. We hope this will not be the last. The present work is a fourth instalment of Dr. Agardh's "Contributions to the Systematic Classification of Algæ." The three preceding parts have been already reviewed in NATURE.[1]

The recent part, which consists of 117 pages, is devoted to the Florideæ. Besides observations elucidating many genera and species already partially known, it contains descriptions of three new genera and between fifty and sixty species. Of the new genera, Titanophora, which belongs to the Nemastomeæ, contains two species—*T. incrustans*, J. Ag. (*Halymenia incrustans*, J. Ag.), and *T. Pikeana* (*Galaxaura Pikeana*, Dickie)—both from Mauritius. The other new genera belong to the Rhodymeniaceæ, namely, Glaphyrymenia, of which there is one species—*G. pustulosa* (see Fig. 4)—and Merrifieldia, which also contains one species—*M. ramentacea*. The last-mentioned alga is one among several instances where the algologist has had to wait many years before he had amassed sufficient material to enable him to give an accurate description of the plant, and to decide on its place in the system. Every one who has collected algæ must know how frequently it happens that plants are dredged or cast ashore in an imperfect state. In some the lower part may be absent; in others the apices of the ultimate branchlets may be broken off; in others, again, the plants may be sterile; or, in the case of the Florideæ, they may bear but one species of fruit. Until, therefore, perfect plants, bearing ripe cystocarps, and others bearing sphærospores, have been thoroughly examined, neither the genus nor the species of the plant can be accurately determined. *M. ramentacea* was first partially described by C. Agardh, in the "Systema," upwards of sixty years ago, under the name of *Chondria ramentacea*, and afterwards by his son, Dr. Agardh, in the "Epicrisis" (p. 661), as *Hypnea ramentacea*. The examination of subsequent examples, with fruit of both kinds, has induced Dr. Agardh to consider this alga as the typical species of a new genus.

[1] The first part, containing a revision of (1) Caulerpa, (2) Zonaria, and (3) certain groups of Sargassum, was published in 1872, in vol. ix. of the *Proceedings* of the University of Lund; the second part, containing (4) Chordarieæ, and (5) Dictyoteæ in vol. xvii.; and the third part, containing (6) Ulvaceæ in vol. xix. of the *Proceedings* of the same University.

In Fig. 5 the cystocarps and sphærospores, in different degrees of development, are represented.

Two other genera at present but little known, namely, Marchesettia (Hauck) and Melanoseris (Zan.), are also commented on. The former is a most singular alga, in appearance much more like a branched sponge than a plant, and, except for the little deep-red fruit-leaflets, it might readily be taken for one. The discovery of the fruit shows that its affinities are with Thamnoclonium. One of the several new species of this genus, described in the present work, so much resembles Marchesettia, that it has been named *T. Marchesettioides*.

The other genus, Melanoseris, is nearly related to Pollexfenia, from which it is distinguished by the fruit in the former being marginal, instead of on the disk, as in the latter, and by its smaller size.

Halymenia saccata (Harv. and H. "Fl. Tasm.") has long been a puzzle to algologists. Dr. Agardh now refers it to Bindera, supporting his opinion by a comparison of the structure and fruit with those of *Bindera splachnoides* (see pp. 41–46, and Fig. 3).

Another plant, *Amansia? Marchantioides*, first mentioned in the "Flora of New Zealand," had not, hitherto, been accurately determined. Dr. Agardh now considers it to be a Placophora.

Among the more interesting of the new species is *Cliftonea imbricata*, of which one specimen only has yet been discovered. This was also the case with *C. semipennata*, of which one example only is known to exist.

The present work is illustrated by one plate. The eight figures are printed in a red ink, which is somewhat dazzling to the eyes.

In conclusion, we venture to suggest that *Gracilaria Millardetii* (p. 64) should be *G. Maillardetii*, the plant having been named by Montagne *Rhodymenia Maillardetii*, in honour of M. Maillard, the author of "Notes sur l'Ile de Réunion."

OUR BOOK SHELF

Practical Chemistry, with Notes and Questions on Theoretical Chemistry. By William Ripper, Assistant Professor of Mechanical Engineering, Sheffield Technical School. Second Edition. (London: Isbister and Co., 1885.)

TRULY the number of little books coming into existence, presumably to aid students to do the Science and Art Department's examinations, is very great, and they are not by any means always good. The evil of a big book has evidently been well seen by chemical teachers, and more especially by teachers connected with the Department's examinations, many little books springing up intended originally for the class or school to which the teacher is attached only. In some, the greater number of cases perhaps, this is a very happy thing for students in general. When a book of this kind passes through two editions in a reasonably short time there is some cause for its survival. The book before us has evidently fulfilled its mission in a fairly satisfactory manner. It is still decidedly one of the cramming class, but it contains an amount of matter simply and well arranged which, with the aid of a teacher, or demonstrations, should enable any ordinarily industrious student to "pass" the first stage of the "Department's" examinations.

The first part contains descriptions of experiments on the non-metallic elements, reactions for metals and acids, and tables for the examination of a simple salt. The second part, called "Theoretical Chemistry," is mostly equations, and questions and problems.

Free Public Libraries; their Organisation, Uses, and Management. By Thomas Greenwood, F.R.G.S. (London: Simpkin, Marshall, and Co., 1886.)

IF in Her Majesty's dominions there is a spot where newspapers do not penetrate and where free libraries are only known by name, *and yet* where some pioneering spirit only requires a spark to set aflame the desire to start such an institution, this book will be a fitting flint and steel for the purpose. But as such a combination is to be found in very few places, we cannot encourage the writer to hope that many will read his 500 pages of newspaper cuttings with much satisfaction. To any *reader* who is within measurable distance of earnestly considering that "most interesting question of the day—how to work a free library in a small community"—nine-tenths of this book, commencing its survey as it does at the British Museum, will be provokingly irrelevant; he will grudge the time taken up in finding where the practical information is scattered. As a missionary book, crying in the wilderness the advent of knowledge, it is less likely to make its way than the newspapers from which it is compiled, and it is thoroughly wanting in the eloquent earnestness of the prophet.

Still there is much excellent advice to those who know nothing about the matter; and since it seems to have been written, as the compiler says, "with the earnest hope of increasing the number of free libraries" (there are 133 now open in Great Britain) we gladly call to it the attention of any to whom such a book as we describe may be useful. The combination in the writer of librarian and newspaper editor has made easy to him much that would have been a considerable labour to others who might have gone more deeply into the subject, and his information is brought down to marvellously recent date.

The hasty way in which it has been put together is illustrated by an account on p. 83 of "first failures," which apparently apply to Sheffield, and are not discovered to belong to Newcastle-upon-Tyne till three pages further on there comes a full-page engraving of the important building opened there in 1884 by the Prince of Wales. A puzzled reader may guess that a short paragraph on p. 100 should have introduced its history, but that it found its present place among the author's notes through confusion of the name with that of Newcastle-under-Lyme. The same haste appears in more important matters. Mr. Greenwood very properly urges the importance of the librarian as the "vocal key to the catalogues," and gives a touching illustration of the value of knowledge and sympathy in that officer. "Wives and children come for books, and make the request, 'Please pick me a nice one, sir, for if I take home an interesting book, my husband (or father, as the case may be) will stop in during the evening and read it to us.'" We must point out the inconsistency between this and the unqualified advice he gives to the librarian not to stand "at the desk entering out and taking in the books, and so uselessly employed in doing the work of a boy." It will be found that as such a librarian stands at the counter and hears the wants expressed of the class for whose benefit chiefly these libraries are considered to be established, the circulation of books will increase; while if it is left to a boy to do the work, the popularity, the circulation, and to a far greater extent the good work, of a free library will fall off. The same consideration also should qualify the zeal with which the use of indicators is urged, which, though theoretically very simple, and to the library officials very time-saving things, yet practically do not work where any attempt is made to accommodate the class just referred to, or an unlearned public who, it will be found, *won't* use catalogues. For one minute, however, which they save the librarian, they hinder five

minutes of the borrower of the more intelligent class; to whom, also, the most recent catalogue (and hence the indicator) is generally deficient of three-fourths of the books he most wants, viz. the new ones.

Nothing is better than the advice given here to secure a good librarian even at a higher cost than some may consider proportionate to the income. But the committee having taken that advice, there is little in this book which will be of value to either him or them. W. ODELL

Les Aérostats dirigeables. Par B. de Grilleau. (Paris: Dentu, 1884.)

THIS little book does not add anything to the scientific data regarding the direction of balloons which we have lately published; indeed it was written before the best and most conclusive trials were made. It is a popular view of the subject only; but it is useful as combating the ignorant prejudice existing thereon in the public mind. It points out to whom the successful solution of the problem is due; it states the results that have been obtained, and it shows what may be expected to be done in the future. It also explains clearly some of the conditions affecting the question, which are often misunderstood, such as the effect of the wind, the effective speed obtainable, the nature of the propelling action, and so on.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Clifford's "Mathematical Fragments"

A SHORT time since I lent the originals of this work to Mr. A. B. Kempe, F.R.S., as he has been working on the subject of "graphs." Some remarks he made on returning the "Fragments" led me to compare them with the lithographed work, and I propose to supply what is, I think, a defect in the published book.

The "Mathematical Fragments" are reproduced on xxii. pages of a *uniform* size which in the original manuscript is that of the first 5 pages only. The paper of these pages is blue, and has ruled lines. Page vi. corresponds to *two* pages of manuscript, indicated by a break, two other pages being blank. Page vii. corresponds to two *distinct* pages of manuscript. Page viii. is made up of three parts, the first six lines on one page of manuscript, the next thirteen of another page of manuscript. These last pages of plain white paper are approximately 4½ inches wide by 5½ inches deep. The page is filled up with a fragment on plain blue paper approximately 5¼ by 8 inches. Page ix. is on stout plain white paper, app. 7 inches by 9 inches. The last five lines of book are written on the back of the paper. Pages x.-xvi., xviii.-xxi. are written on thin white paper of the same material as page vi., size 9 inches by 11 inches; the pages are all *detached*; page 15 is on back of page 14, and page 19 on back of page 18. Page xx. is made up of two distinct pages of manuscript, the second commencing at the defaced word which is clearly in the manuscript "Degree." Page xvii. is written in pencil on stiff white paper, folded in half, the lower fragment in the manuscript being in the lower half of the page, and at right angles to the upper—size of full page, app. 7 inches by 10 inches. Page xxii. is made up of three pages of manuscript: the uppermost fragment is on white paper, 6 inches by 4 inches; the immediately following four lines of writing are given on the back of this page. The next three lines are on paper 7 inches by 10 inches, and the last four lines on precisely similar paper. The time notes at the side have, of course, nothing to do with "graphs."

These "Fragments" have been circulated (see "Papers," p. 86) chiefly amongst libraries; if the details I here supply are indicated in the copies, their value will, I believe, be greatly increased, and much trouble may be saved by students when they know how slender a connection there is in some cases between consecutive pages of the text. In the manuscript there is no indication of the order in which the pages should be read beyond what I have pointed out above. The manuscripts are now deposited in the Library of University College, Gower Street. R. TUCKER

The Upper Wind Currents in the South Indian Ocean and over the N.W. Monsoon

AFTER sending a brief account to NATURE of my observations on the upper wind currents over the Atlantic doldrums, I started from Natal for some journeys across various portions of the Indian Ocean, to investigate the circulation of the higher atmosphere in that region.

I first went to Mauritius. During the whole passage from Natal, at the end of December, we sailed in the S.E. Trade, with an almost constant movement of high cirrus from the N.W.

Though I was disappointed in not meeting with a cyclone in those seas, still I succeeded in obtaining much valuable information about the details of hurricane weather, which could only be learnt on the spot. One point relating to upper currents is very important. The cirrus which appears five or six days before the arrival of a hurricane follows the normal course from N.W. or S.W., and is no guide to the path of the cyclone. But on the outskirts of the hurricane, low clouds afford valuable information. If the cloud over the S.E. surface-wind inclines towards E. the centre of the cyclone will pass to the N.; if on the contrary the low cloud inclines towards S. the centre will pass to the S. of the observer.

Though Meldrum, and Bridet of Réunion, both agree on this point, the subject requires further elucidation, for such a rotation of upper currents is contrary to all analogy of what is supposed to hold round cyclones in the northern temperate regions. I am certain from my own investigations that the general character of tropical and extra-tropical cyclones is identical. In Mauritius hurricanes I find the same oval form, the same squall at the turn of the barometer, the same halo in front, and hard, detached cloud in rear, which characterise European cyclones. Mr. Harris has recently traced a cyclone from its easterly course as a typhoon in the China Seas, across the Pacific, United States, and Atlantic into Western Europe. Like every other long-lived cyclone, this one received accessions of strength by fusion or coalescence with others which had formed outside the tropics. It is perfectly certain that cyclones which revolved on different systems could not unite, and I think that the motion of the lower layers of cloud over the northern side of our own cyclones should receive special attention. At present we are led to believe that the cirrus in front of a cyclone, both right and left of the path, comes from S.W. or S.

Be this as it may, cloud motion forms a useful adjunct to a valuable and successful system of hurricane forecasting that is carried out by Mr. Meldrum, who, in the absence of telegraphs, has to rely entirely on his own instruments and above all on his own experience and judgment. Another interesting feature of this system is the care which must be taken to allow for the diurnal motion of the barometer during the slow diminution of pressure which always precedes the arrival of a hurricane.

From Mauritius I sailed to Adelaide, so as to examine the Polar limit of the S.E. Trade. Though we steered a great circle course which took us fully into 39° S. latitude, we experienced constant S.E. and E. winds. These must have been due to some extra-tropical anticyclone, and every observation of low or middle layers of cloud showed a current practically in the same direction as the surface-wind.

At Adelaide I learnt that the normal direction of the highest currents is from N.W. In that city the direction of the surface-wind is much influenced by land and sea breezes. Through the kindness of the acting chief of the Observatory, Mr. W. E. Cooke, I was able to confirm what I had previously suspected from my investigations in Melbourne last year, that sometimes at least the characteristic "southerly bursters" of Australia, are due to that class of V-shaped depression in which the rain occurs in rear of the disturbance. Other times the sudden irruption of S. wind appears due to the shift of wind at the passage of the trough of a cyclone.

From Adelaide I came here to Colombo so as to repeat a section of Indian Ocean very nearly at the same season and in the same straight line as last year. The results of the former voyage were communicated to NATURE, vol. xxxii. p. 624, when I announced the fact that the highest currents over the

N.W. monsoon came from points of E., and not from W., as might have been anticipated.

In this journey I found the clouds at the Polar side of the S.E. Trade coming constantly from a point either side of the surface-wind, that is, from S.S.E. to E.S.E. When well in the Trade, the middle clouds always came from some point more east than the surface-wind, or in accordance with the usual circulation of the southern hemisphere. No high cirrus was ever observed.

We found no doldrum, but ran straight from the Trade, under a bank of cloud, into the N.W. monsoon, in about 12° S. latitude. In that monsoon the low and middle clouds always came a little more from the N. than the surface N.W. wind, or in the manner of the upper winds of the northern hemisphere. All the high cirri moved from E. or N.E., except on one occasion, when they came from S.

The N.E. monsoon which we picked up on the equator was so clear that I only obtained one observation of cirrus which came from N.E. when the surface-wind was N.N.E. The lower layers of cloud usually drove from the same direction as the surface-wind, though on one or two occasions they came from a point more N. than the surface.

The above results entirely confirm the observations described in my previous letter of a deep S.E. Trade and of an easterly current over the N.W. monsoon. RALPH ABERCROMBY

Colombo, February 15

Glacier Bay in Alaska

[redacted]ANK your correspondent, Mr. Chauncey Thomas, for [redacted]g out my error in describing Glacier Bay as opening into Chilcoot Inlet, and for more exactly indicating its position. When I visited this region I was provided only with a small and inaccurate pocket-map, in which I found it difficult even to trace the course of the steamer, and I was under the impression that the whole of the fiord northward from Chatham Strait was known as Chilcoot Inlet, though my statement would still not be quite correct.

It may be well to add that my object in arranging my rough field-notes for publication was not to describe the glacier as a whole, but to draw attention to some uncompleted observations of special geological interest which it seemed to me ought to be made known as indications for future explorers; and it should be borne in mind that my estimates of heights and distances were only estimates based on opinion, and not on any system of actual measurement. The very limited time at my disposal, and my desire to get over as much ground as possible in that time, precluded the use of more satisfactory methods.

Bridlington Quay, March 13 G. W. LAMPLUGH

A Correction, and the Distribution of Appendicularia

(1) THE specimen which I referred to in NATURE (Jan. 7, p. 221) as being probably a new species of *Chætoderma*, has turned out on a more detailed examination not to be Chætoderma at all. Therefore I must withdraw the statement that that genus has been found in British seas.

(2) Can any of your readers who have been using the tow-net round our coasts give me information in regard to the occurrence of the Appendicularidæ? Forbes and McAndrew found *Appendicularia* off the north coast of Scotland in 1845. Allman found [redacted] the Firth of Forth in 1858, and Sanders at Torquay, [redacted]nd it has been taken by Huxley on the English coast. [redacted] seen in quantity by Sorby off the south coast of England [redacted]uple of summers ago, and I obtained it in Lamlash Bay in 1880 and 1884, in Loch Fyne in 1883, and off the Mann coast in 1885. Apparently it is much commoner and more generally distributed than is usually supposed. I would be glad to hear of any additional records of the occurrence of the Appendiculariidæ in our seas. W. A. HERDMAN

University College, Liverpool

Morley's "Organic Chemistry"—Correction

IN my notice of Dr. Morley's "Organic Chemistry" in this week's NATURE, the reference to "Ladenburg's synthetic optically-inactive coniine (α-isopropylpiperidine)" (p. 436) contains an inaccuracy. Instead of "coniine" it should read "coniine-base." F. R. JAPP

Normal School of Science, March 11

"Peculiar Ice-Forms"

IN NATURE, vol. xxxi. p. 5, you allowed me to describe, under this heading, a curious and beautiful form of fibrous ice met with near Chamonix, which I, and other of your correspondents who discussed the matter, thought to be very unusual, though later communications seemed to show that it is commoner than we had supposed.

It may be interesting to note that a day or two ago I came upon the same form of ice in considerable quantity in a very unexpected locality, viz. on the path leading from Gerozano to Lake Nemi, in the Alban Hills. Attention was drawn to the circumstance by the crackling of the ice under foot, otherwise there was no visible indication of its presence except that, where it existed, the path was slightly damp (which was not the case on other parts of it), the dampness being evidently due to the partial melting of the upper stratum of the ice, which was everywhere covered with a layer of earth. The ice was almost exactly similar to that found at Chamonix, but only an inch and a half to two inches deep, and in three layers, easily detached from one another, and evidently the result of successive frosts.

We afterwards found that a bank beside the road between Albano and Frascati was covered with the same formation for several hundred yards; but it would certainly have escaped detection, being everywhere covered with earth, if our previous discovery had not led us to recognise it. This proves that it may often exist unnoticed.

The conditions were precisely similar to those under which this particular form of ice has been observed before—viz. a northerly aspect—a very porous soil (in this case volcanic), bright, sunny days, and clear nights with a low temperature.

Rome, March 12 B. WOODD SMITH

REMARKABLE DISCOVERY OF RARE METALS IN DILUVIAL CLAYS[1]

DR. STROHECKER, of Frankfort, has carefully examined and analysed the clay which is found in the neighbourhood of Hainstadt, near Seeligenstadt, and he has made the remarkable discovery that this clay, which has been largely used for building purposes, contains considerable quantities of some of the rare metals, and more especially cerium. The beds are extensive, and consist of layers differing considerably in appearance and composition.

The composition of picked samples of the two upper layers is as follows:—

	No. 1	No. 2
SiO_2	47·5444	58·3331
TiO_2	trace	—
Al_2O_3	24·5937	11·7607
BeO	6·4399	5·3833
Fe_2O_3	0·9190	0·6356
$Ce_2(OH)_6$	13·4214	9·4012
DiO	—	0·8474
LaO	0·8576	2·6536
YO	—	1·6949
MgO	1·5901	1·8659
$CaCO_3$	0·8878	—
$CaSO_4$	0·1361	0·2015
CaO	—	0·5883
P_2O_5	trace	2·0691
K_2O	2·3236	0·5648
Na_2O	1·2137	0·5838
NH_4Cl	—	0·0529
Loss on ignition	—	4·1057
	99·9273	100·7418

The cerium and yttrium oxides appear to be derived from orthite, which is known to occur in the syenite at Weinheim. The upper layer (No. 1) of the clay varies in colour from a bright flesh-colour to a dark cinnamon-brown, indicating that the cerium hydroxide, which is the colouring substance, varies in amount at different points. The bricks made from this clay vary in colour according to the temperature at which they are burnt, the lightly-burnt bricks having an orange-yellow colour, whilst those

[1] *Journal f. prakt. Chemie*, 1886, pp. 132 and 260.

burnt at a white heat are leather-coloured, and have a silver-gray appearance.

The second layer (No. 2) is divided into two varieties, *a* and *b*, the former of which is black from the presence of lignite, and yields lemon-yellow bricks; this colour is due to the conversion of the cerium oxide Ce_2O_3 into the lower oxide Ce_3O_4 by the action of the carbon which is present. The *b* variety is blackish-gray, and yields orange-red to orange-yellow bricks.

The third layer contains less cerium than the other two, and the bricks made from it are of a fainter orange colour.

The amount of glucina present is very characteristic of the Hainstadt clay. Ammonium chloride, which occurs only in traces in some portions of the clay, exists in quantity in others; and in one piece which crumbled to pieces a crystal of sal-ammonia was found measuring about 2 centimetres in length and 1·5 centimetres in thickness.

It will be seen from the above that the oxides of cerium which were hitherto of only theoretical interest, are now of technical importance. They have long served as colouring substances in building materials without the fact having been known, and from the large amount present in the Hainstadt clay there are prospects of their being brought into use as paints.

The variation in the colour of the bricks, already mentioned as being produced according to the degree of heat to which they are submitted in the process of burning, does not appear to be due to any action of the silicate on the ceric oxide, as the latter substance can itself be made to assume either colour by igniting it at a suitable temperature. The small amount of iron present in the clay is found to have no influence on the colour of the bricks, which however is affected by the admixture of larger quantities of iron. Dr. Strohecker mentions a number of streets in Frankfort in which houses constructed of the different sorts of cerium bricks are to be seen; the leather-coloured bricks occur in Palmstrasse, Bergerstrasse, Schleidenstrasse, Schillerplatz, Goetheplatz, &c.; the orange-red bricks at the police-station, the law-courts, and in the walls of the zoological garden, &c, and the lemon-yellow bricks at a villa near the west station at Hanau, and at a house in the Verlängerte Zeil at Frankfort. The houses of the peasants near Hainstadt are built of lightly-burnt bright flesh-coloured and yellow bricks.

The somewhat remarkable fact that chemists have so long failed to recognise anything other than ferric oxide as the cause of the colours in these bricks may probably be explained by the large number of shades of colour produced by iron in its various stages of oxidation, by the presence of manganese, and by the employment of mixed clays containing the oxides of both cerium and iron.

HARVARD COLLEGE MUSEUM REPORT

PROF. AGASSIZ' Report, dated October 1885, has just reached us, and, as usual, it presents several topics of interest. Since the first section of the Museum was inaugurated in November 1860, the establishment has passed through many changes, and from being, at its origin, a State institution, it has gradually assumed that of an independent department of the Harvard College. While it has thus lost the immediate support of the State, it has gained the good will and interest of the students of the College, the class upon whom it must in a very great measure depend not only for its maintenance, but for its being a source of intellectual and scientific good.

During the first decade of its existence the resources of the Museum were spent in forming collections which, in some branches of science, have made it a great scientific centre. During this period of ingathering the teaching powers of the place were interfered with. Now this period has so far passed that the resources of the place will be chiefly expended on its teaching, its original investigations, and its publications.

The foundation of this Museum dates from the publication of the "Origin of Species." The powerful movement effected by this work on the scientific thought of the age has not failed in modifying the problems which this institution was intended by its original founder to illustrate and to solve; and rightly does the son write that, if the synoptic, systematic, faunal, or palæontological collections should cease to bear the interpretation given to them by his father (the founder), their interest and importance for the advocates of the new biology would not be one whit lessened.

It is pleasant to note that the plans of Prof. Louis Agassiz—the founder of the Museum—have been, it is known, realised, and indeed beyond his most sanguine expectations, and that his son and successor now sees the establishment of a prosperous School of Natural History, amply provided with laboratories, connected with a University, and recognising in the administration of its trusts the claims of the College and of the advanced students, as well as those of the original investigator, and giving to both the latter ample opportunity of publishing their theses or researches. It has not even forgotten the specialists, for whom it has collected vast stores—stor- in every way available, as most of the specialists in will gladly testify.

Very truly writes Prof. A. Agassiz in reference to original investigation, that such is always best promoted in connection with educational institutions, and we would that the fact were more recognised in these countries; and in regard to museums belonging to such he suggests that they should grow so fast, and no faster, as the demand for such growth arises, otherwise they become mere unwieldy and meaningless accumulations. We may add that in countries where large museums are kept up by the State, University or College Museums on an extensive scale are a vast mistake. The college student's needs are very limited, and the money spent on adding to and keeping up collections would be infinitely better expended as aid to original research. All experienced teachers know how small is the stock of material required for their demonstrations, and how comparatively easy nowadays it is to procure such.

Prof. Agassiz hints that it would be desirable if, in connection with the Laboratory of the United States Fish Commission, the Universities of the United States should found a sea-side laboratory, which would render unnecessary, unless for special work, the various establishments already being established along the American coast. The hint should not be lost on our own Universities and Colleges, which should be urged to assist in the establishment of the British Biological Station. A long list of donations and purchases, an account of the work done, memoirs published or assisted by the loan of collections, conclude this very interesting Report.

TECHNICAL EDUCATION IN NEW SOUTH WALES

THE progress of technical education during the last few years in this country has been watched with great interest by some of our more important colonies which are desirous of not lagging too far behind the mother country in their arrangements for giving special instruction to artisans in subjects allied to the industries in which they are engaged. The Report of the Minister of Public Instruction of New South Wales recently issued contains some interesting particulars as to the establishment of a Technical College in Sydney and the organisation of trade classes in the colony. The present

Technical College of Sydney, like many similar institutions in this country, has grown up out of the Sydney School of Arts. From 1873 to 1877 plans for the extension of the school were carefully considered, and in 1878 the Colonial Parliament granted 2000*l.* towards the inauguration of a Technical College. In 1883 the Government decided to establish a State system of technical education in New South Wales, and having carefully examined the scheme of the City and Guilds of London Institute, and compared it with what was being done on the continent of Europe, they decided that the course of study and system of instruction to be adopted in their college should "accord with the practice of the City and Guilds of London Institute, with such modifications as seemed necessary to meet local requirements and appliances." "Following out the principle laid down by the City of London Guilds for their own guidance, the Board of Technical Education resolved that the object of technical instruction in the colony would be to improve the industrial knowledge of workmen by teaching the sciences and principles underlying their handicraft, and that such teaching should be illustrated by the best apparatus and machines that can be obtained, and by visits to workshops, manufactories, &c." No sounder views than these could be expressed. In 1884 the Parliamentary vote for technical education had increased to 17,093*l.* 3*s.* 4*d.*, and more than forty classes were in operation at the College. These figures show the great advance that has been made. As now organised, the College contains thirteen departments, viz., Agriculture, Applied Mechanics, Art, Architecture, Geology, Chemistry, Commercial Economy, Mathematics, Music, Elocution, Pharmacy, Physics, and Domestic Economy. Some of these subjects are outside the curriculum of our own Technical Colleges; but there is much to be said in favour of the introduction of some non-scientific subjects into a technical course; and where statesmanship is almost a profession the study of elocution in early youth is of distinct advantage. The average number of students in the College during the past session has been 917, and the fees paid by the students amounted to 1838*l.*

For the benefit of artisans engaged in the building-trades, classes have been established in decoration, plumbing, bricklaying, wood-carving, carpentry, and joinery; and in many of those classes the syllabus of instruction is identical with that in use at the Finsbury Technical College. Recently, the Council of the City Guilds Institute have received an application to extend their technological examinations to the colony, and to award certificates and prizes on the results. This application is at present under the consideration of a Committee of the Institute. There can be no doubt that all efforts to bring the colonies and mother country into closer relationship should be encouraged, and the more the colonial system of education is assimilated to our own, the greater will be the sympathy between the colonists and the inhabitants of the United Kingdom. This sympathy is of greater advantage to our commercial interests than is generally supposed; for it tends to link together the colonies and the mother country into one vast empire, the several parts of which will depend upon one another rather than upon foreign markets for the supply of their various wants.

It is to be hoped that the example of New South Wales will be followed by Victoria, and may extend to New Zealand and to other parts of our colonial empire. The advancement of technical education in our colonies is to us a matter only second in importance to the improvement of the means of technical instruction in our own manufacturing towns: and it must be a source of satisfaction to the City and Guilds of London Institute that the influence of its operations is being felt, not only in the centres of our home industries, but already in one of the most flourishing of our colonies.

SEEBOHM'S HISTORY OF BRITISH BIRDS[1]

SINCE our last notice of Mr. Seebohm's book (NATURE, vol. xxviii. p. 120) the author has brought it to a successful conclusion, and has fully sustained his reputation as an original and painstaking writer. The great defect in our standard works on British birds has been a want of originality, as one author after another, and one editor after another, have compiled books on the subject, each one founded on the labours of their predecessors, so that the best books have been but compilations. Mr. Seebohm has started on quite a different principle, and the greatest charm of his book consists in the account of the life and habits of the birds, drawn from his own actual experience of the species in their native haunts. And before giving to the world his varied experiences, he has, as is well known, travelled extensively in Europe and Northern Asia, and has become celebrated as the discoverer of the breeding-places of many species of European birds, previously unknown. In this respect he resembles the late John Wolley, for whom a fellow-feeling of sympathy is expressed by Mr. Seebohm throughout his work, but, more fortunate than that well-known naturalist, our author has survived to record in his own books the results of his successful expeditions. It must not, however, be supposed that Mr. Seebohm, in giving us detailed accounts of the life of the birds, has neglected in any way the scientific portion of his task. On the contrary, he has grappled with this difficult subject in a manner which is highly creditable, and however divided opinions may be as to the advisability of some of the changes of nomenclature which he introduces, there can be no question as to the greater simplicity which he has once more attached to the names of the British birds, and we believe that he will be largely followed. Some revision of the code of rules proposed by the British Association appears to us to be necessary, and we trust that ere long Mr. Seebohm or some other ornithologist will draw out a scheme for their modification, in order to bring them into harmony with the more advanced state of science of the present day; and an attempt to arrive at a definite understanding with our Continental and American brethren as to the employment of a uniform system of nomenclature ought soon to be made. The opportunity may probably come when the authoritative "List of North American Birds" is promulgated by the American Ornithologists' Union, a work which is anxiously awaited by naturalists in this country, and it will then be competent for us to consider the merits and demerits of the trinomial system of nomenclature which is gaining ground considerably on this side of the water, but which cannot be adopted without the utmost consideration. Mr. Seebohm does not hesitate to adopt it, but how far he will be followed remains to be seen.

We can cordially recommend this book to all lovers of ornithology, both at home and abroad, and to young and old alike, for they will find ample material for study, and a very great deal that is new. It is by far the best introduction to a knowledge of British birds that we are acquainted with, and a great deal of the subject-matter is very original. The criticisms of contemporary ornithologists are occasionally somewhat hard, but no one can complain of a want of candour on the author's part, and as he no doubt expects equally hard hitting in return, he must have counted the cost before striking at the authors who so often arouse his ire. One thing we do not clearly understand, and that is the constant odium thrown by Mr. Seebohm upon the "Ibis List of British Birds" compiled by a Committee of the B.O.U., of which the author was himself a member. A long time was spent by this Committee in investigating the subject, and as its conclusions were carried by a majority of votes, all the members

[1] "A History of British Birds: with Coloured Illustrations of their Eggs." By Henry Seebohm. Vols. I. to VI. (London: R. H. Porter, 1883 to 1885.)

of the Committee ought to acquiesce in its decisions. We ourselves do not agree with every point of the Committee's work, but at the same time the "List" supplied a great want in ornithology in this country, and it will, no doubt, be greatly improved in a second edition.

Oologists in this country have in Mr. Seebohm's work a thoroughly good hand-book, the figures of the eggs being highly satisfactory, while as to the information concerning the nesting-habits and life of the birds, we believe this "History of British Birds" to be by far the most complete yet published in this country. R. B. S.

NOTES

THE collection of funds for the Pasteur Hospital is proceeding rapidly. The total of the first list is a little under 10,000*l*.

IN reply to a recent letter from the Russian Minister of Education, M. Pasteur has written offering to receive Russian doctors for instruction, and suggesting that Russia should contribute towards the establishment of his proposed Institution at Paris. A small establishment for the application of M. Pasteur's method against rabies has already been started in St. Petersburg, on the initiative and at the expense of Prince Alexander of Oldenburg, where experiments on rabbits and dogs are now being made, preparatory to the treating of persons in danger of hydrophobia.

IN the House of Commons, last week, in reply to a question by Sir Henry Roscoe, Mr. Chamberlain stated that his attention had been called to the reported discovery by M. Pasteur of a cure for hydrophobia. The recognised eminence of M. Pasteur as a scientific investigator, and the great interest and importance which attach to the subject of his recent inquiries, seemed to him to justify a careful and impartial examination of the results obtained. At present the information on the matter in the possession of his department was too vague and incomplete to afford materials for a full appreciation of M. Pasteur's process. Mr. Chamberlain promised to consider how such an inquiry can be most satisfactorily conducted, and to confer with the Chancellor of the Exchequer with reference to the question of the expense. He hoped to be able to arrange for such an investigation as may enable a just estimate to be formed as to the reliability of M. Pasteur's method and its applicability to this country.

THE French Minister of Public Instruction has applied to the French Parliament for a grant of about 150,000 fr. for the building of an equatorial-coudé according to the Lœwy system. The total sum required will be 100,000 fr. more.

AT the last meeting of the Berlin Anthropological Society Prof. Virchow stated that the German Colonial Society had sent circulars to all European colonies situated in the tropics requesting observations to be made regarding the question of the acclimatisation of Europeans in the tropics, the result of this inquiry to be communicated to the German Naturalists' Association at their next annual meeting in September. An exhibition of objects required in fitting out scientific travellers for their journeys will also be held at the same time as the meeting of German naturalists.

THE Ben Nevis Weather Reports chronicle an extraordinary dryness of the air in the end of last week. From 3 a.m. of Thursday the air became so dry that a humidity of about 15 per cent. was maintained for some time, and the dew-point fell to − 24°·0. On Friday the humidity was about 13 per cent. till 3 p.m., when the air became still drier, and at 9 p.m. the humidity was only 8 per cent., the readings at this hour being: dry bulb, 19°·2, and wet bulb, 13°·0. The great dryness ceased at midnight, when the air suddenly became saturated. The snow lying at the Observatory at present is not much more than half the quantity of the two previous winters at this season.

IT is reported that on Sunday night, about 11 o'clock, a sharp shock of earthquake, lasting seven seconds, caused a panic at the theatre in Granada. The audience rose, and rushed into the streets. The inhabitants, awakened by the shock, poured out of their houses, and many persons remained in the streets and squares part of the night. Very little material damage was done to the houses, and none to the public buildings, for the preservation of which the authorities have adopted precautions. The shocks were oscillatory from west to east, and accompanied by a rumbling noise. The shock was felt also in the districts which were the scene of the earthquake of 1884. The villagers were terribly alarmed, and some houses were injured.

A VIOLENT shock of earthquake was felt at Wiesbaden at twenty-eight minutes past midnight on Sunday.

THE fourth volume of Dr. M. C. Cooke's "Illustrations of British Fungi" is just completed, bringing the total number of coloured plates up to 622, illustrating 790 species and varieties of *Agaricus*, or more than double the number figured by Fries in his "Icones," and nearly as many as there are in the combined works of Sowerby, Hussey, Bolton, Bulliard, and Krombholz. It is estimated that the two volumes yet to be published, if the author receives sufficient support, will contain about 400 additional species, making a total of nearly 1200 species and varieties of the gill-bearing *Fungi*, or nearly three times as many as in any other work in existence. The four volumes accomplished represent five years' laborious work and a great expenditure of money by the author, who is publishing at his own sole cost; yet we are assured that he has not only derived no profit therefrom, but has suffered a loss, and this in spite of his having saved the expense of an artist. Surely there must be a sufficient number of persons in this country interested in botany to render such a work self-supporting, if not remunerative; especially as the price is about half that of contemporaneous Continental works on the same subject. Dr. Cooke, in response to numerous solicitations, also proposes issuing a volume of coloured plates of British Desmids as a supplement to his "British Fresh-Water Algæ," provided a sufficient number of subscribers come forward.

NEAR the village of Dorndorf (Prussian province of Nassau) considerable alarm has recently been caused by the repeated appearance of extensive fissures in the surface of a hill. Quite lately the main fissure has advanced to within 100 metres of the village, at which point it, however, turned aside, seemingly returning to its starting-point. Subsidence of the soil has also been noticed in several parts of the circumscribed area, which measures about a mile in diameter.

THE climate of Lucerne has been described by Herr Suidter (in a recent address there) on the basis of five years' observations at Mariahilf. Lucerne, he says, is in the föhn-climate but on the outer edge of its zone (the föhn being, it is known a strong, warm, descending wind of southerly direction in Switzerland). The former is proved by the preponderance of warm winds and the large rainfall (average 1275·8 mm. in 1879-83) compared with Central Switzerland, the latter by the low mean annual temperature (8°·284 C.), and by a much less rainfall than places near the source of the föhn, such as (in descending order) Rigikulm, Vitznau, Schwyz, and Engelberg; where the föhn blows much oftener and more continuously and strongly. A peculiar green tinge of the sky's blue over the Uri or Obwaldner Mountains tells the Lucerners of the föhn's coming, some 12 to 24 hours in advance. Drenching rain nearly always comes with it. The lowest temperature in those five years was − 17° C. (in 1879); but years often pass without

the thermometer going down to −10° or −15°. In the cold winter of 1879 the arm of the lake never became unnavigable from ice, and the robust exotic plants in the open gardens were scarcely damaged at all. The vegetation of Lucerne is much more southerly than the mean annual temperature of 8°·284 would lead one to expect. It is an interesting fact that as early as 1598 there was in Lucerne a small botanic garden (formed by Renward Cysat), where many exotic plants, such as tobacco, were grown, and from which issued the best methods for cultivating fruit-trees, &c.

THE curious phenomenon of "lake-balls" is to be met with on the Sils Lake and others in the Upper Engadine. They are composed of larch-leaves felted together. Three samples (the largest over a foot in diameter) were recently exhibited by Herr Coaz at the Berne Naturalists' Society, and he stated that these balls are formed in small bays into which the prevailing south-west winds blow. The water acquires a whirling motion, and the larch-leaves involved in it, together with pieces of moss, &c., are worked into balls. There is no cementing with mud. Sometimes, on shallow banks—not in bays—sausage-like forms are met with. Prof. Fischer made reference to another kind of lake-balls formed of a filamentous alga in the lakes of Sweden and other countries; also to the marine balls, formed of fragments of [illegible]erogamic sea-plants (Zostera, Cymodocea, &c.) which were at one time used medicinally.

AT the last meeting of the Seismological Society of Tokio, Prof. Milne read a paper describing the results obtained from a seismic survey of the ground in the neighbourhood of his house. By the seismic survey of a district he meant an examination of the different parts of that district with regard to the effects which were produced upon them by earthquakes. After describing local peculiarities of the ground, he said that he placed at different places, but in similar positions, similarly constructed seismographs. These had been proved to give diagrams which were practically absolute measures of the movements of the ground, and, when any of these instruments were placed side by side, they gave similar results. The result of observing many earthquakes was that all the instruments, the positions of which would be included in a triangle the sides of which were 800 or 900 feet in length, gave different indications as to direction, amplitude, maximum velocity, and intensity. So that, had these instruments been in the hands of different observers, each observer would have given a different account of the same earthquake. Thus, comparing the average maximum velocities at a station, C, on hard ground, with that at a station, E, on soft ground, they were found to be 1 : 5. The maximum accelerations at these two stations were 1 : 2·4. It might therefore be concluded that a building at C would withstand a disturbance which would be sufficient to shatter a similar building placed at E. Prof. Milne also described further experiments made with a seismograph placed in a pit 10 feet deep, and with a wooden building the foundations of which at first rested on 10-inch cannon-balls, and subsequently on cast-iron shot 6 mm. in diameter.

ALL these experiments were made with a view to discover the best method of constructing buildings which would stand earthquake shocks with least damage. The practical conclusion of the investigation was that there were three ways by which residents could escape from very much of the motion which disturbs an ordinary building. These were (1) by a seismic survey they might select a site where there was relatively little motion; (2) they might build up from the bottom of a pit, which might be utilised as a cellar, the walls of the houses not touching the sides of the pit; (3) when obliged to build on soft ground, when a pit could not be excavated, a light one-storied building of wood or iron might be rested on a layer of cast-iron shot.

WE have received from Dr. D. J. Macgowan, whose name has for many years been well known to all students of China, a copy of a curious paper by him on the movement cure in China, contributed to the *Medical Reports* of the Chinese Customs. In form the paper (which contains several interesting illustrations of the *modus operandi* of the cure) is a notice of successive writers on the system of therapeutics, which was actually practised on the late Empress by a high official who was supposed to be an adept in the art. The notion that supernatural power was imparted to the human frame, and that the latter was rendered invulnerable to disease and death, by breath-swallowing, or accumulations of air in the system, is a very old one. About the sixth century before our era a celebrated writer recommended a mild form of exercise to effect this, and this exercise, with breath-gulping, now constitutes the Chinese movement cure. After tracing the fluctuations of the practice and their causes, Dr. Macgowan comes to a work published in 1858 by the high official already mentioned. Life, it is taught, depends on the existence of a primary aura; so long as a particle of it is retained in the system, death cannot occur. A deficient supply is the cause of disease; and when it duly permeates the system, every ailment is averted. The object of the postures, motions, and frictions is to promote the due circulation of that vital air. One writer illustrates the state of the system that is thoroughly saturated with air by that of a drunken man who falls from a cart without sustaining injury, because of intoxication; so a man permeated with the vital aura is invulnerable. Disease appears only when the vitiated air can find entrance, when the circulation of the vital air is defective. The air starts in its circulatory movement from the "little heart," which is situated in the pubic region; air-vessels convey it thence upward anteriorly to the forehead, where these vessels become continuous with a similar system that returns the air posteriorly to the "little heart." Without fire this aura is the source of animal heat; without water it lubricates the viscera. Fate, indeed, determines longevity as it does birth, yet disease may be averted by employing the movement cure, which is preferable to delaying until disease sets in, when the art is comparatively useless. These are the principles on which the cure rests.

THESE curious searchings into the mysteries of life and death are followed by a description of the details of the process. These are too numerous and complicated to be mentioned at length. They deal with the periods of air-swallowing and friction, the time for inhaling the sun's air and the moon's air, the time and modes of friction, the implements for shampooing (amongst them being a bag filled with water-worn pebbles, and a pestle or round bat for pounding the abdomen), and the various muscular movements, many of which are exceedingly comical. In gulping air the east should be faced, and twelve of the various operations described should be gone through each forty-nine times. In going through the exercises there is to be no thinking, for the mind must be absolutely quiescent. Reference to this air-swallowing is made in the earliest extant Chinese medical treatises, but regular practitioners have always regarded the exercises as charlatanism.

MR. HOWARD GRUBB, F.R.S., will give the first of two lectures on the Astronomical Telescope on Saturday (March 27), at the Royal Institution; and on Friday (April 2) he will give a discourse on Telescopic Objectives and Mirrors: their Preparation and Testing.

M. GASTON TISSANDIER has issued the prospectus of a large work which he is preparing on the great aeronauts. The work

will be in two volumes, the first of which is to appear next October.

THE additions to the Zoological Society's Gardens during the past week include a Silky Marmoset (*Midas rosalia*) from Brazil, presented by Mr. Percy Bewick Bewick; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, presented by Mrs. Dunn; a White-crowned Mangabey (*Cercocebus æthiops*) from West Africa, presented by Mr. N. King; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. W. A. Rooff; a Black-backed Jackal (*Canis mesomelas* ♀) from South Africa, presented by Mrs. E. Thomas; a Grey Ichneumon (*Herpestes griseus* ♀) from India, a Demoiselle Crane (*Grus virgo*) from North Africa, presented by Mr. T. W. Proger; a Moor Monkey (*Semnopithecus maurus* ♀) from Java, deposited; a Talapoin Monkey (*Cercopithecus talapoin* ♀) from West Africa, received in exchange.

OUR ASTRONOMICAL COLUMN

DARK TRANSITS OF JUPITER'S FOURTH SATELLITE.—Prof. Davidson, of the U.S. Coast Survey, has communicated to the Californian Academy of Sciences some interesting notes of observations of "dark" transits of Jupiter's satellite IV. made by Mr. Burckhalter with a 10½-inch reflector. Mr. Burckhalter's observations on May 21, 1885, suggest the possibility that the satellite has an area of white surface and also an area of dark surface. When the satellite approached the planet it appeared bright, the white area being then the visible part; but when it had advanced some way on the disk, this white part was (on this supposition) lost in the superior brightness of the planet, and the dark area became visible. Prof. Davidson thinks it might even lead to the determination of the rotation period of the satellite if it were watched throughout the whole transit, and the different phases noted. Again, observing on June 7, 1885, Mr. Burckhalter saw the satellite as a dark spot on the edge of the north dark belt. But as soon as the satellite was clear of the planet's disk, it was noted to be north of this belt; so that it would appear from this observation also as if the satellite were divided into bright and dark areas, the south pole being the dark one. Prof. Davidson also observed the transit of June 7 with a 6·4-inch refractor, and confirms generally the appearances noted by Mr. Burckhalter.

NOVA ANDROMEDÆ OF 1885, AND NOVA SCORPII OF 1860.—With reference to Prof. Seeliger's researches on the subject of the Nova in Andromeda (NATURE, vol. xxxiii. p. 397), Herr Auwers draws attention in the *Astronomische Nachrichten*, No. 2715, to the great similarity of this outburst to the phenomenon observed by him in 1860 in the nebula 80 Messier in Scorpio. He considers that the probability that, in an interval of twenty-five years, two variable stars of so exceptional a character should be projected on the central part, in one case of a close star-cluster, in the other case of an object which appears to be, in part at least, a close star-cluster, is so small that the identity of the circumstances attending the phenomena of 1860 and 1885 makes it almost necessary to refer both outbursts to physical changes in the nebulæ in which they respectively appeared. As Prof. Seeliger makes no mention of this (in Herr Auwers' opinion) very strong argument in favour of his supposition respecting the cause of the outburst in Andromeda, Herr Auwers is induced to do so, and takes the opportunity of publishing the details of his observations of the Nova of 1860, an account of the discovery of which was printed in the *Astronomische Nachrichten*, No. 1267. Herr Auwers states that having turned the Königsberg heliometer on 80 Messier on the evening of May 21, 1860, he saw a 7th magnitude star in the nebula, a little following the central part, which it quite outshone in brilliancy. By June 16 this star had degraded to magnitude 10·5. It will be remembered that the "new" star in Scorpio was independently discovered in this country by Mr. Pogson, whose attention was arrested on May 28, 1860, "by the startling appearance of a star of the 7·6 magnitude in the place which the nebula had previously occupied." On June 10, according to this observer, the stellar appearance had nearly vanished, but the cluster still shone with unusual brilliancy and a marked central condensation.

FABRY'S COMET.—The following ephemeris, by Dr. H. Oppenheim (*Astr. Nach.* No. 2711) is in continuation of that given in NATURE for 1886 March 4:—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log r	Log Δ	Brightness
March 23	23 16 58	36 5·6 N.	9·8421	0·0589	20
27	23 16 57	37 12·4	9·8233	0·0203	26
31	23 17 59	38 11·5	9·8102	9·9744	34
April 4	23 20 55	38 58·9	9·8043	9·9198	45
8	23 27 4	39 28·7	9·8062	9·8547	61
12	23 38 33	39 31·4 N.	9·8157	9·7767	83

The brightness on December 2 is taken as unity.

BARNARD'S COMET.—The following ephemeris, by Dr. A. Krueger (*Astr. Nach.* No. 2710), is in continuation of that given in NATURE for 1886 March 4:—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log r	Log Δ	Brightness
March 22	1 51 49	27 34·3 N.	0·0217	0·2230	7·12
26	1 51 13	28 57·0	9·9917	0·2144	8·51
30	1 50 34	30 23·2 N.	9·9594	0·2036	10·38

The brightness on December 5 is taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 MARCH 21-27

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to ... is here employed.)

At Greenwich on March 21

Sun rises, 6h. 1m.; souths, 12h. 7m. 15·4s.; sets, 18h. 13m.; decl. on meridian, 0° 19′ N.: Sidereal Time at Sunset, 6h. 10m.

Moon (one day after Full) rises, 18h. 50m.*; souths, 0h. 53m.; sets, 6h. 45m.; decl. on meridian, 2° 35′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	6 19	13 12	20 5	9 40 N.
Venus ...	4 23	9 43	15 3	8 37 S.
Mars ...	15 54	22 55	5 56*	11 11 N.
Jupiter...	18 4*	0 13	6 22	0 59 N.
Saturn ..	9 59	18 11	2 23*	22 48 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° ′
23	γ Libræ	4½	23 19	23 58	93 167
24	η Libræ	6	4 18	5 34	75 285

March	h.	
21	19	Jupiter in opposition to the Sun.
22	2	Mercury at greatest elongation from the Sun, 19° east.
25	—	Venus at greatest morning brilliancy.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Mar. 23,	19 35	*m*
Algol	3 0·8	40 31 N.	,, 21,	1 7	*m*
			,, 23,	21 56	*m*
R Aurigæ	5 8·1	53 27 N.	,, 22,		*m*
ζ Geminorum	6 57·4	20 44 N.	,, 25,	4 50	*M*
U Monocerotis	7 25·4	9 32 S.	,, 21,		*M*
δ Libræ	14 54·9	8 4 S.	,, 25,	21 18	*m*
T Libræ	15 4·2	19 35 S.	,, 24,		*M*
U Coronæ	15 13·6	32 4 N.	,, 23,	2 29	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 24,	4 40	*m*
		and at intervals of	20	8	
X Sagittarii	17 40·4	27 47 S.	Mar. 24,	0 0	*m*
			,, 26,	21 30	*M*
W Sagittarii	17 57·8	29 35 S.	,, 22,	2 20	*M*
T Herculis	18 4·8	31 0 N.	,, 24,		*M*
β Lyræ	18 45·9	33 14 N.	,, 22,	2 20	*M*
R Cygni	19 33 8	49 57 N.	,, 22,		*M*
η Aquilæ	19 46·7	0 7 N.	,, 25,	0 0	*M*
δ Cephei	22 24·9	57 50 N.	,, 22,	19 10	*m*

M signifies maximum; *m* minimum.

BIOLOGICAL NOTES

THE PELAGIC STAGES OF YOUNG FISHES.—The memoirs by Alex. Agassiz, on the young stages of osseous fishes, have been noticed from time to time in our pages. In connection with C. O. Whitman, he has quite recently published, as the first part of vol. xiv. of the *Memoirs* of the Museum of Comparative Zoology at Harvard College, an account of the pelagic stages of young fishes, which is illustrated with nineteen very beautifully-executed plates. This memoir is devoted to descriptive sketches of the different fish-eggs which have come beneath the notice of the authors, and of the early stages of the fish after their escape from the egg. In a second portion of the memoir it is proposed to treat of the earlier stages of cleavage, the formation of the embryonic ring, the formation of the various portions of the embryo, and so on. The pelagic eggs, so far as the authors' experience goes, may be divided into—(1) those without oil-globules, and (2) those with one or more oil-globules. But this, while a convenient, is not an accurate division, because, if eggs apparently without oil-globules are carefully examined, the yolk-mass will be found permeated with minute fatty bodies, but these are never seen to coalesce to form conspicuous oil-globules. Some pelagic eggs are laid singly—this seems to be the most common condition—and are left to float at the mercy of the waves and winds, while others are laid in an investing gelatinous mass. The single eggs seem to have the best chance of escape from their numerous enemies, while as to those laid in masses the chances seem all against them. When first laid, pelagic eggs are usually perfectly transparent; little by little, with the formation of the embryo, chromatophores are formed, generally on the surface of the yolk-mass close to the embryo, or upon the embryo itself. These chromatophores, at first colourless, soon become pigmented, and while the young embryo is still within the egg, the characteristic colour-pattern is often clearly indicated. All the eggs described in the memoir, except when confined in masses, float with the embryo downwards. The resorption of the yolk-mass differs greatly in the different species. The rate of resorption also varies, and would seem to be correlated with the degree of development of the structural features of the embryo. The chromotaphores very rarely become dendritic before the embryo is hatched, and as a rule not till then does the black eye-pigment make its appearance. The first fins formed are the pectorals, traces of which appear in very early stages within the egg. The closing of the blastopore and the disappearance of the vesicle of Kupffer are followed by the growth of the tail and the formation of an embryonic caudal fin. Usually at the time of the resorption of the yolk-mass the pectorals are well developed, and have become powerful limbs; then, too, the intestinal tract lengthens, and a swim-bladder and larger alimentary canal appear. In the very youngest stages, immediately on leaving the egg, the embryo depends mainly upon its embryonic dorsal and ventral (its leptocardial fin) fin for locomotion. The propelling powers are proportionally very large, and at no time of its life is the young fish better provided with both means of locomotion and sense-organs. With growth the young fish depends, however, more and more for locomotion upon the use of its pectoral fins. The comparatively large size of the chorda in the earlier embryonic stages is a marked feature of all young fishes. The regularity with which the same stages of development of identical species appeared in successive years was very striking, and the authors note that this regularity was not peculiar to young fishes, but that they also found the spawning of the majority of marine animals and their rate of development practically identical year after year; as instances of the latter they refer to embryos of Agalma, Balanoglossus, Plagusia, &c. To facilitate the identification of the different pelagic stages of fish and fish-eggs, a table is given, in which we find the most characteristic features of the eggs and young fish so far as these have been observed, the date of their occurrence, the distinctive features at time of hatching, with references, so far as the forms described in this memoir are concerned, to its pages and its figures, and for the rest to authorities where they have been described. The figures on the plates are from sketches from life made by A. Agassiz and Whitman. We trust soon to be able to notice the second portion of this important memoir.

DANAIS ARCHIPPUS—AN ENTERPRISING BUTTERFLY.—As an instance of a species extending its geographical area under our observation, perhaps there is none more remarkable than the case of a beautiful and noteworthy butterfly whose natural history is so pleasantly written about in the *Entomologist's Monthly Magazine* for March 1886 by Mr. James J. Walker, R.N. We would that our British Navy had many more such excellent observers. This butterfly, which, according to the rules of zoological nomenclature, is called *Anosia plexippus*, L., is perhaps better known by its synonym, *Danais archippus*, F. The original home of this insect is the American continent, where, including some well-marked varieties, it now enjoys a vast range, extending from the Hudson's Bay Territory and Canada to the region of the Amazons, Bolivia, and the estuary of the Rio de la Plata. Nearly everywhere through this vast area it is common, and in some places it occurs in vast swarms. Thus Mr. Riley says that at Missouri the air is sometimes filled with these butterflies to a height of from 300 to 400 feet. These swarms appear in autumn, and some of them seem to migrate southwards to warmer regions at the approach of winter. The caterpillar is singularly hardy, handsome, and easy to rear; it feeds on various species of Asclepias, a genus belonging to one of the most interesting families of plants known. All the species of the genus are peculiar to the New World—and to the northern portions of it, just that area which seems to have been the birth-area of our butterfly—or to tropical Africa. Many of them are hardy even in this country, and are easily increased, taking care, as a gardener would say, of themselves. *A. tuberosa* is a fine border plant; *A. cornuti* has sweet-scented flowers; while *A. curassavica*, though bearing showy flowers, has a fœtid perfume, like its congeners, the Stapelias, those African Asclepiads so attractive to the carrion-flies; this last species is the one so fully described by H. Müller as fertilised through the agency of Lepidoptera. The chrysalis of *D. archippus* is described as very beautiful, being of a bright, translucent, emerald-green colour, with some transverse black ridges, brilliantly-gilded lines, and minute spots of a bright gold hue, and the duration of the pupal condition is from fourteen to twenty days. Insect-eating birds do not touch either larval or perfect forms, which are free even from Ichneumon guests. It is interesting to note that Mr. Riley has found the larva attacked by a Dipteron, this group of insects being intimately connected with the life-history of Asclepiads. The longevity of the imago is most remarkable. Taking all these facts into consideration, we find this butterfly well outfitted for the battle of life: the perfect insect strong on the wing, with from twelve to fifteen months of a life; eggs soon hatching, after being laid on the food-plants, these themselves spreading like weeds; larvæ not molested by destructive parasites. The first great march westwards was over 2350 miles to the Sandwich Islands, and remembering that the appearance of the insect here is subsequent to commerce with these islands, the probability is that it was helped across this expanse of ocean, and then it in a wonderfully steady and rapid manner spread across the whole breadth of the Pacific Ocean, and far into the Malay Archipelago. Carrying on its course round the world, we may soon expect to hear of it in Asia. Southwards and westwards it has appeared in New Zealand and Australia. After enterprise like this, it does not seem surprising that eastward it should have flown to the West Indies, and at least one or two examples to the Azores; and within the last ten years it has put in an appearance and been speedily captured in South Wales, Devon, Isle of Wight, Dorset, Sussex, and Kent. In 1879 a specimen was even taken at La Vendée. While as garden plants species of Asclepias are fairly common in Britain, in Europe other food-plants might be found in *Vincetoxicum officinale* and *Cynanchum acutum*. With such a startling phenomenon in distribution, which in so gay and fine an insect cannot easily be overlooked, a great light is thrown on the diffusion under perhaps even more favourable circumstances as to the distribution of less conspicuous species. We should have welcomed some remarks from Mr. Walker's pen about the varieties that may have arisen from the very varied surroundings that environ the butterfly; one of these, *D. erippus*, seems by some entomologists almost to take rank as an independent species; that is to say, that it has passed too far away from the type to be easily recognised as such.

GEOGRAPHICAL NOTES

THE following medals have been awarded by the Geographical Society of Paris for 1886:—The principal gold medal to MM. Capello and Ivens for their three journeys across Africa; gold medal to the Pandit (name not specified, but doubtless A——K) for his journey in Tibet; the Lagerot prize to M. Morsche for his explorations in the Philippines; a silver medal to M. Moyet

for his topography of Eastern Africa; and the bronze medal to M. Mager for his *Atlas Colonial*, published by M. Bayle.

ETHNOLOGISTS will be glad to know that the February number of the *Bollettino* of the Italian Geographical Society contains a full descriptive account of the objects forwarded to Europe by Romolo Gessi after his return to East Central Africa in 1877. These objects have now been added to the rich collection which he had already presented to the Geographical Society, and which has found a permanent home in the Prehistoric and Ethnographic Museum in Rome. Amongst the objects specified by Dr. G. A. Colini, to whom the public is indebted for this paper, mention is made of a stool from the Bongo tribe (Upper White Nile) with feet made exactly like the boots usually worn by European ladies. This object was locally known as "the lady," and it is suggested that the native artist took for his model the boots belonging to Miss Tinné. The artistic talent of the Bongos is, however, better illustrated by the figure of a man 0·69 metres high, wearing a girdle of cylindrical glass trinkets, and with upper lip and ears pierced for the insertion of the iron rings commonly worn by this tribe. From the Latuka people on the opposite or east side of the Nile come ivory trumpets, wooden clubs with iron heads, curious knives with slightly curved blade and wooden handle inlaid with iron plaques, and a very fine helmet decorated with shells, red and blue glass beads and a triangular brass plate in front. The A-Zandeh (Niam-Niam) and Mangbuttu (Monbuttu) objects are distinguished by their number, variety, and richness, including articles in wood, iron, and ivory: arms, ornaments, utensils, and musical instruments. The ivory carvings often display great taste in the designs and technical skill in the execution, fully bearing out the accounts of Schweinfurth and other travellers regarding the great artistic talent of these cannibal tribes. Archæologists will be interested to know that amongst the Mangbuttu objects is a splendid polished stone hatchet 0·25 metres long, with circular section, and terminating above in a point, which must be classed with the prehistoric hematite weapons supposed by the natives to have fallen from the clouds. Nearly all the tribes of the Upper Nile Valley, and even several of the equatorial lake region, such as the Waganda and Wanyoro, are represented in this very valuable ethnological collection, probably the most complete yet brought together from that quarter of the globe.

AT the meeting of the Paris Geographical Society of the 19th ult. Vicomte de Brettes described the results of an exploration made by him during last year in the southern Grand Chaco. Since the commencement of the sixteenth century forty-three expeditions have attempted to discover a communication between the regions on the eastern slope of the Andes with those on the left banks of the rivers Paraguay and Parana. These expeditions have constantly followed the courses of the Pilcomayo and Vermejo, and have ultimately demonstrated the impracticability of these routes by reason of the numerous rapids, as well as of the shallowness of the water. The route so actively sought for three centuries by the Argentine Republic, Bolivia, and Paraguay, which would increase their trade tenfold, has never yet been sought by land, and since the Spanish conquest the interior of the southern Grand Chaco has remained wholly unknown. M. de Brettes undertook this exploration, and entered the region accompanied only by two Chenupis Indians. He discovered three rivers and an immense salt lake, on the banks of which he marched 113 miles, when ague and fever compelled him to return to Corrientes after a journey of 436 miles in a hitherto-unexplored region. The country traversed by him is absolutely flat, mimosa-trees and palms grow in abundance, and there are vast prairies and swamps, inhabited by the Chenupis, Mocovis, Velelos, and Matacos—all tribes still in an extremely barbarous state. The lecturer referred to various unpublished documents respecting these tribes, including a grammar of the Topii language, which is in the press. He also announced his intention of returning to the Chaco to continue the work which was arrested by illness. He appears to have received the most cordial assistance from the Argentine authorities.

ON February 12 General Prjevalsky gave a lecture on his fourth journey to Central Asia before a distinguished audience at St. Petersburg. He entered into details on the sources of the Yellow River, and described the environs of Lob-nor, dwelling upon the peculiar features of the population of the surrounding country. Then the lecturer passed to the orographic outlines of the Alpine country, the numerous chains of which had been first traced by himself, and finally concluded his account by describing the valley of the River Tarim. The lecture was very well illustrated.

THE March number of the *Proceedings* of the Royal Geographical Society has for its leading paper an account, by Col. Stewart, of the Herat Valley and the Persian border, from the Hari-rud to Sistan. It contains a large amount of interesting information respecting a region which appears destined to play a larger part in the public eye of England in the future than even in the past. The discussion which followed adds much to the paper, and this is especially the case with the remarks of Surgeon Aitchison, the naturalist to the Afghan Delimitation Commission, who read an account of the botany of the region. Major Greely's lecture on Arctic exploration with reference to Grinnell Land is also published. The number also contains summaries of two lectures, and the subsequent discussions, at the Exhibition of Appliances used in Geographical Education, the lecturers being Profs. Bryce and Moseley.

THE March number of the *Scottish Geographical Magazine* commences with a paper by Col. Stewart on a visit to Badghis in 1883, and to the Herat Valley in 1885. It also contains a paper by Prof. James Geikie on mountains—their origin, growth, and decay; and a brief account of Dr. Boas's recent journeys in Baffin Land. The geographical notes are very comprehensive; amongst them is one, taken from the *Geographischer Jahrbuch*, 1885, containing statistics of the geographical societies of the world. It is somewhat humiliating to find Great Britain and her colonies only third on the list in point of members, and fifth in the number of societies. France has 26 societies with 18,000 members; Germany 24, with [illegible] members; while the British Empire has 5 societies, with [illegible] members. The United States is even worse, for it has only 2 societies, with 1500 members.

AT the last meeting of the Geographical Society of Paris, M. Hansen-Blangsted read a note on the disagreement between geographers as to the highest peaks in Denmark. According to the maps of the general staff at Copenhagen, the highest hills were in the south-west of the department of Aarhus. Himmelberg was long regarded as the principal eminence in Denmark; it is 147 metres in height. But in the forest of Ky, in the south of the commune of the same name, there are several unnamed heights, one of which is 163 metres high. Himmelberg is now only the third in height, and possibly it will have on examination to take even a lower place. Communications were read from Gen. Annenkoff on the Transcaspian Railway and the region it traverses, from M. Thouar on his exploration on the Pilcomayo, and from M. Duveyrier on some Sahara longitudes.

IN the last number of the *Transactions* of the Halle Verein für Erdkunde, Herr von Brandis describes some curious observations which he made during a year's residence in 1861-62 on the slope of the active Java volcano Merapi, which has lately been in eruption. From the crater two perfectly straight white columns of steam (not smoke), of equal thickness above and below, ascended. For some weeks the colour was of an equal degree of whiteness throughout; both were of equal height, and from measurements made this varied from 320 to 450 metres. The upper ends were cut off sharply like the ends of two tapers, and the thickness of one varied from 5 to 15 metres, while the other was only about half this. The distance between the two appeared to be about 20 metres. The colour of the smaller of these pillars appeared to alter occasionally, but the wind did not seem to have any effect in causing them to deflect from the perpendicular. At first the observer thought there must be perpetual calm at this altitude; but this is not so, for others have found that a south-east wind blows constantly there. The effect of a current of air blowing from this direction would have been readily perceptible to Herr von Brandis in the position his residence occupied. This curious phenomenon was observed in 1836 by Junghuhn, of Madgeburg, who ascended the mountain, but the conditions of the summit do not appear to have been sufficiently investigated to enable a positive explanation of it to be made.

IT is stated that M. Rogozinski, who is at present in Cracow, is preparing a dictionary and grammar of the idioms of the Cameroon tribes.

M. ROLLAND has been charged by the French Minister of Public Instruction with a mission to Madagascar, to study its mineralogy, botany, zoology, and anthropology.

THE SUN AND STARS[1]

III.

The Spots

IN the large photographs now secured at Meudon and in India, and smaller ones now received from India, the Mauritius, and Australia, showing the spots as they are photographed there, I am glad to say almost every day now, on a scale of 8 inches to the sun's diameter, we get wonderful records of what a spot really is, and how it changes.

In a normal spot the exterior shade is called the *penumbra*. The inner darker one is called the *umbra*, and very often there is a deeper shade still, which is called the *nucleus*. In some spots there are many umbræ for one penumbra; and very likely, if one had examined them carefully with the telescope at the time, one would have found that each had its interior nucleus. The idea is that we have at the edge of the penumbra, where the penumbra joins the photosphere, the greatest height of the spot; that the penumbra is an incline going down as gradually as you like, but still down, so that the level of the photospheric stuff, whatever it is, at the edge of the umbra, is below what it is at the edge of the penumbra.

In the penumbra the domes seen on the general surface are drawn into elongated shapes, hence we speak of the "thatch" on the penumbra. Visually the part of the penumbra adjoining the umbra seems brighter than that adjoining the photosphere. In photographs this is not so.

Now, if the view that the spots are cavities be correct, and the appearances they put on in travelling over the sun are sufficient to prove it, it will be clear that there ought to be occasions when a spot going over the limb should show as a depression. The idea that sunspots are cavities is a very old one. It was first put forward by Wilson of Glasgow in the last century; but it was not so easy to demonstrate it to a large audience in the days when one had no photographs.

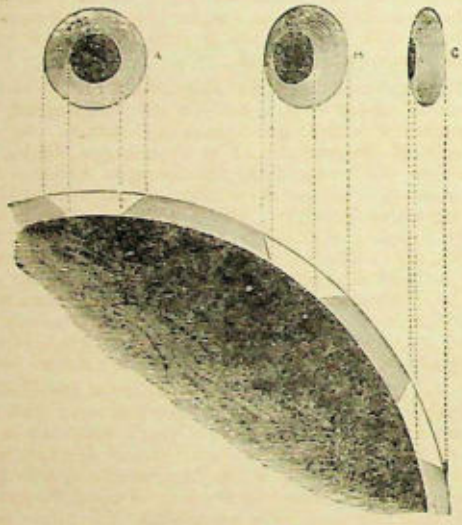


FIG. 4.—Appearances presented by spots. A is the centre of the disk; B between centre and limb; C, near the limb.

Here is a photograph showing the retreat of a sunspot over the edge of the sun in 1884. We see that it writes its record as an unmistakable notch at the limb of the sun (Fig. 5).

In other photographs we can conveniently study the connection between the faculæ and the spots, especially if the spots be near the limb; the neighbourhood of spots in this position is rich in faculæ.

When we come to examine these spots carefully, we find there are apparently in the main—(I want to speak as carefully as I can)—two different kinds. Some spots seem to be pretty regular, and to undergo no very violent commotion. In them that the penumbra and the umbra are not so tremendously contorted and mixed up as sometimes happens; and, again, the ridge of facula round the spot is not so honeycombed by convection-currents and the results of convection-currents. On the other hand, as representing the other class where we get violent action, there seems to be no limit to the enormous energies indicated, and the areas over which these energies hold their sway. I believe that one spot, or at least a spot system, was observed in 1858, of 140,000 miles or eighteen earth-diameters in length. Telescopic examination of each minute part of these enormous disturbances indicates that the most violent changes

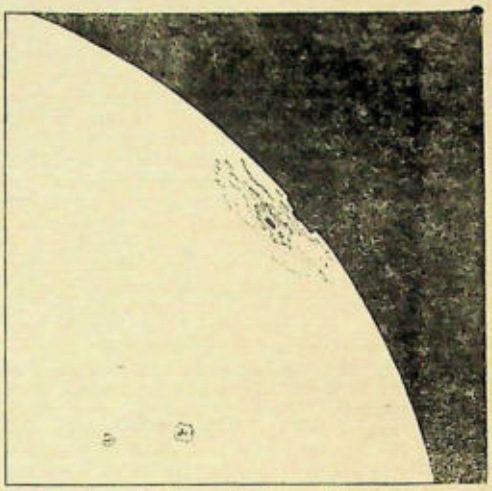


FIG. 5.—Copy of part of a photograph taken at Dehra Dun in 1884, showing a sunspot passing over the Sun's edge.

are going on—changes which the eye can detect, after a few minutes' interval, in different parts of the spot (see Fig. 6).

The History of a Spot

A spot seems to be the first disturbance of the photosphere in the region where it is formed. I mean *the facula follows, and does not precede, the spot.* On this point I first quote Dr. Peters,[1] one of our highest authorities:—

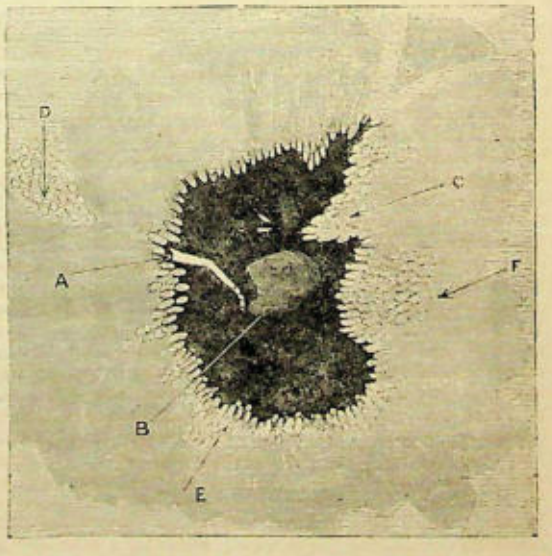


FIG. 6.—Sunspot showing details of the penumbra. The dark portion in the centre is the umbra, the surrounding half-tone is the penumbra. A, a "bridge" or tongue of facula being carried over the umbra; B, clouds forming at the end; C, part of the penumbra being driven over the spot (the domes are drawn out); D, domes on photosphere; F, "thatch" on penumbra.

"The spots arise from insensible points, so that the exact moment of their origin cannot be stated; but they grow very

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 429.

[1] *Proceedings* of the American Association for the Advancement of Science, vol. IX.

rapidly in the beginning, and almost always in less than a day they arrive at their maximum of size. Then they are stationary, I would say in the vigorous epoch of their life, with a well-defined penumbra of regular and rather simple shape. So they sustain themselves for 10, 20, and some even for 50 days."

I next quote the Rev. S. J. Perry, one of the most constant of modern solar observers:—

"And, to begin with spot-formation, we find almost invariably that large solar spots start life as little dots, frequently in groups, and then grow at once with enormous rapidity. A spot will often attain its full size in 5 or 6 days, although exceptionally large ones occasionally occupy a longer time in their first development. If no remarkable increase is noticed in a spot within 2 or 3 days from its birth, it will in all probability never attain to any considerable size. The solar surface has repeatedly been examined with the greatest care, in regions where considerable spots have broken out on the following day, without detecting any marked disturbance or other sign announcing a probable outburst. No satisfactory exceptions to this have as yet been noticed."

The second state of a spot's history presents us with phenomena of reaction, as if the material carried in the first instance below the upper level of the photosphere had produced a disturbance in the lower regions, indicated by the increase in the quantity and brilliancy of the faculous matter and its separation into small masses, while at times the umbra of the spot becomes distinctly coloured.

I again quote Dr. Peters:—

"The notches in the margin, which, with a high magnifying power, always appear somewhat serrate, grow deeper, to such a degree that the penumbra in some parts becomes interrupted by straight and narrow luminous tracts,—already the period of decadence is approaching. This begins with the following highly interesting phenomenon. Two of the notches from opposite sides step forward into the area, over-roofing even a part of the nucleus; and suddenly from their prominent points flashes go out, meeting each other on their way, hanging together for a moment, then breaking off and receding to their points of starting. Soon this electric play begins anew and continues for a few minutes, ending finally with the connection of the two notches, thus establishing a bridge and dividing the spot into two parts. Only once I had the fortune to witness the occurrence between three advanced points. Here from the point A a flash proceeded towards B, which sent forth a ray to meet the former when this had arrived very near. Soon this seemed saturated, and was suddenly repelled; however, it did not retire, but bent with a sudden swing toward C; then again, in the same manner, as by repulsion and attraction, it returned to B; and, after having thus oscillated for several times, A adhered at last permanently to B. The flashes proceeded with great speed, but not so that the eye might not follow them distinctly. By an estimation of time and known dimension of space traversed, at least an under limit of the velocity may be found; thus, I compute this velocity to be not less than 200,000,000 metres [or about 120,000 miles] in a second.

"The process described is accomplished in the higher photosphere, and seems not to affect at all the lower or dark atmosphere. With it a second, or rather a third, period in the spot's life has begun, that of dissolution, which lasts sometimes for 10 or 20 days, during which time the components are again subdivided, while the other parts of the luminous margin, too, are pressing, diminishing, and finally overcasting the whole, thus ending the ephemeral existence of the spot.

"Rather a good chance is required for observing the remarkable phenomenon which introduces the covering process, since it is achieved in a few minutes, and it demands, moreover, a perfectly calm atmosphere, in order not to be confounded with a kind of scintillation which is perceived very often in the spots, especially with fatigued eyes. The observer ought to watch for it under otherwise favourable circumstances when a large and ten- or twenty-days'-old spot begins to show strong indentations on the margin."

The scintillation referred to by Dr. Peters is perhaps associated with a phenomenon which has been described by M. Trouvelot,[1] who has observed the faculous masses to subdivide into small flakes which vibrate rapidly, producing the effect of a snow-storm above the umbra, when these dissolve into blue or violet vapours.

It happens sometimes also near groups of spots which are endowed with great activity that perturbations are observed which are so violent that the adjacent photosphere is shaken to its foundations, cracks, and, on opening, forms sinuous crevasses which extend to considerable distances, sometimes connecting the most distant spots with each other.

From the instant of their apparition the crevasses—even those which are the narrowest—show a striated and filamentous structure, which presents the greatest analogy with the penumbræ of spots; only, instead of inclining and forming a sort of slope like that on the penumbra, the filaments which form entirely the sides of the crevasses are vertical, and are all directed towards the centre of the sun.

When these crevasses have a certain duration they widen sometimes here and there, especially when they bifurcate and send branches in another direction. In this case it is not rare to see forming a strait and lengthened umbra when, at the same time, the vertical filaments having now more room raise their lower extremities.

We have seen that the last act in the history of a spot is its invasion by the faculæ. These faculæ remain long after the spot has entirely closed up, and in this connection it is important to remark that new spots very often break out in the old place. These of course, unlike the first spot in that position, will appear to be preceded by faculæ.

There is a great deal more that I might say about spots. It is a very tempting subject, but there is so much more to be referred to. The papers which have recently been printed by the Rev. S. J. Perry[1] and M. Trouvelot represent some of the most careful modern examination of the solar surface, and there is really a very great deal to be learnt from them; and fortunate it is that much which this new work has brought out in the plainest way has reference to a region of fact of very great importance to any one who wants to be able to answer for himself, as well as he can, the question, What is a sun? For instance, M. Trouvelot discovered about ten years ago that, although, as we shall see presently, ordinary sunspots have a very definite place of their own on the sun, there is a kind of spot which is not so confined. These he calls veiled spots; and I gather from his description that his opinion is that the photosphere is driven down there to a certain extent, but not driven down sufficiently to give us the dark appearance which we get in the other cases.

Spots caused by Descent of Cooled Material

It has already been suggested in preceding paragraphs that in the spot region we cannot really be dealing with any violent changes of pressure, but we may be dealing with very violent changes of temperature. We can see that it is the most natural thing in the world to suppose that in an atmosphere like the sun's, seeing that there is enormous radiation, and therefore cooling at the exterior, there must be a descent of solid particles into the interior heated region. Now, can we associate this with spot phenomena?

Yes, we can, and we are absolutely driven to it. We have already seen that the spot, when it travels over the limb, is a hollow. We also find when we examine a spot with the spectroscope that certain vapours get very much denser, as if they were being crushed together into a certain limited region either by an upthrust or a downfall. Which? Well, the spectroscope answers that question for us quite perfectly, because it shows that the vapours are absorbing, and therefore that they are cooler than the photospheric material immediately underlying them, and that they have not an excess of radiation, as they would have if they came up from below; the spectroscope then certainly justifies the view that a spot is really the result of a downrush; the vapours there are *cooler*, as they should be if they come from a cooler place; they are *denser*, as they should be if they are descending rapidly into a place which is more confined; and, more than all, the change of the refrangibility of certain lines enables us to determine roughly the rate at which these descents take place. A very common velocity is 30 miles a second—not 30 miles a minute or 30 miles an hour, but 30 miles a second.

Our final idea with regard to the spots then is that they are depressions, that in fact we may regard them as shallow saucers or cups filled with the cooler vapours brought from the upper regions of the solar atmosphere. This is merely a physical conception. What we have next to do, if possible, is to add a little

[1] *Bulletin Astronomique*, vol. ii.

[1] In the *Astronomical Register*.

chemistry, to make a more or less detailed examination of the materials—of the various chemical substances—in them.

The Chemistry of the Spots

Now from what has been already said we at once see that if we get a downrush of solid bodies, such as cooled iron masses which are derived from the condensation of the iron vapour, and which we may regard as solar meteorites, from the top of the sun's atmosphere down to the photosphere, we shall have, if that quantity be great enough in the spot region, a considerable dimming of the sun's light, by reason of the fact that we have an infinite number, or a very large number, of solid bodies stopping the light from that particular part of the sun. We shall have in that way then a continuous absorption of the sun's light; that is to say, the red light, the yellow light, the green light, the blue light, and so on, will all be more or less stopped, and that part of the sun will, from that cause alone, look dimmer. Further, if we have any vapour approximating in molecular structure to the chlorine vapour to which I drew your attention before, we shall have an absorption of another kind; we shall have a special stopping of the blue light of the sun, making, therefore, the sunlight yellower than it otherwise would be. Again, if we have other substances associated with these spots in the state of fine vapour in a state of incandescence, we shall have such absorption indicated by the darkening of certain of the Fraunhofer lines, and by the widening of them as well as the darkening of them if the quantity of any particular vapour is considerable, and we shall also get new lines if new substances are produced or their existence revealed by these conditions.

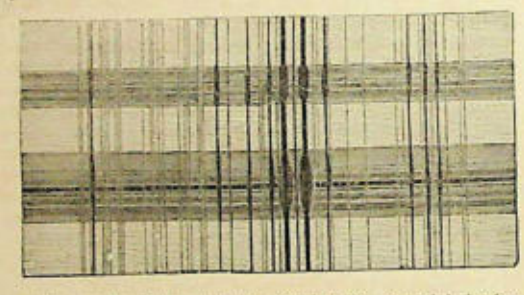


FIG. 7.—The spectra of two sunspots, showing the general darkening, and that certain lines are widened while others are not.

Now, I propose with regard to this point, seeing that our time is limited, to confine myself to the observations that have been made on the sun's spots at South Kensington since the year 1879. From that period some 700 spots have been observed. Of that number some 200 have been discussed; that is to say, maps have been made, and we have endeavoured to see along which line it was best to push on the work. But this climate of ours is not a particularly good one for observations of this kind, especially in London, because there is a good deal of smoke, and it is almost as difficult to see through a smoke cloud as it is through one of the ordinary kind. Still, in that time a considerable number of observations have been made altogether; and, to guarantee us as far as possible against bad climatic conditions, what has been done in the case of each spot has not been to observe all the lines which are specially affected, but to content ourselves with getting the results with regard to twelve lines, six in the green and yellow, and six in the blue. In that way, as these observations can be recorded in about an hour, all the observations made from 1879 to the present time are strictly comparable.

Before I state exactly what results we did get it is worth while for one moment to consider what results we should get if the old view of the chemical structure of the solar atmosphere were correct. This view is that most of the absorption which produces the Fraunhofer lines in the solar spectrum, especially those due to the absorption of the vapours of chemical substances of high atomic weight, takes place close to the photosphere, which is practically the place where the spots live. Therefore we should expect to see:—

(1) The same lines constantly thickened, as the ordinary solar spectrum is constant.

(2) The same lines of a substance widened in all spots, in which we have evidence that that particular substance is present, or the lines thinning out in all cases in the same order.

(3) No lines but those visible in the general spectrum.

(4) Motion indicated by one line of a substance indicated by all.

If the old view were true, that we have iron vapour among the other vapours in the atmosphere of the sun—nickel vapour, magnesium vapour, and so on, it would not be at all out of the way to suppose that some spots might chiefly consist of iron vapour, whereas another spot might be chiefly filled with nickel vapour, or with magnesium vapour, and so on.

With reference to (2) it may be explained that in the case of a spot which we can imagine to contain a very large quantity let us say of iron vapour, and a very small quantity of magnesium vapour; by a laboratory process which had been worked out before this work was commenced, it was easy to make a rough, but still a very useful, quantitative guess as to their relative proportions, because it has been found in laboratory work that if we only have a very small quantity of one vapour, let us call it vapour *a*, in a mixture of other vapours, *b*, *c*, and *d*, then we shall not get all the lines of *a*; we shall only get some of them, the longest lines; and if the quantity *a* is very small indeed, then we shall only get one line—the longest, in the spectrum of the vapour.

The method of mapping adopted may next be stated. In order to get as much light as we could out of the work, first of all the Fraunhofer lines were mapped in a manner which enabled anybody who took the trouble to look at the map to see which was darkest. In addition to those Fraunhofer lines information is given showing the origin of them.

I should tell you that it has been found since Kirchhoff's first researches that it does not do to talk about the spectrum of a substance as if it were an unchangeable thing. To be precise we must refer to the spectrum at the temperature of the arc; or at the temperature of the electric spark with a jar or without a jar; or at the temperature of the oxy-hydrogen flame. These spectra are very different indeed, not with regard so much perhaps to the actual lines which we see in any case, but chiefly with regard to the intensity of the lines as seen in one spectrum and in the other.

Thus it was useful to compare the lines of a substance as seen in the arc and spark with that seen in the spots, and that, so to speak, formed the ground-plan of the maps. The work to be done was to observe all the lines most widened in a region of the spectrum, and see whether they were absolutely unchangeable or whether they were not.

The diagram shows a part of one of these maps dealing with the first 100 observations. The Fraunhofer lines are at the top; the lengthening of the lines representing the intensity, that is to say, the longest line is the darkest. Below are the lines of the substance being specially studied seen in the electric arc, the longest being the brightest; and lower still the lines seen in the electric spark, the longest line also being the brightest.

We observe in the first place that there is a very considerable difference in these two spectra. We have a considerable number of lines seen in the arc, and seen in the solar spectrum among the Fraunhofer lines, which are not seen in the spectrum of the spark, the temperature of which of course is assumed to be very much higher than the temperature of the arc.

Again we may have a very faint line at the temperature of the arc, which is considerably intensified when we pass to the temperature of the spark. There are, again, other lines seen nearly of the same length both in the arc and in the spark.

Now, when we first mapped the spot observations, the maps did not indicate the origin of the lines, and when there was a great variation in the lines discovered it was a fair thing to say that the explanation lay in the fact that some of the lines belonged to one substance, and some to another. Let us call those two substances *a* and *b*. In some spots we have more of *a* and in other spots we have more of *b*. That of course was very good reasoning, so good that it was necessary to undertake a complete discussion in the case of each element. In this case the spot lines studied are not all the lines which were seen in spots, but the lines of one substance. Now the moment this work was begun strange results appeared, and the matter became difficult, because we should have imagined *a priori* that if the same substance were always present in the spot we should always have got the same spectrum, or, at all events, a spectrum along that line to which I have already referred, viz., that if the relative quantity of the vapour were less the number of its lines would be reduced, and at last when the quantity was the least possible the number of lines would be the least possible. I must call

your attention to the fact that we found *inversions*, as they are now called; that is to say, to take an instance, if we represent three lines of a spectrum by *a*, *b*, and *c*, we have found among the most widened lines in spots *a* without *b* and *c*, *b* without *a* and *c*, and *c* without *a* and *b*. Now that is a condition of things impossible to understand or explain on the old view.

We next continued the discussion over another region of the spectrum, and we found that the result held absolutely good, that is to say, in other regions we got these same inversions. If we look at a map belonging to another period, although the lines change, the inversions remain, and the lines behave very much in the same way as the other. This result is quite constant for all regions of the spectrum examined. Hence, finally, we learn that these inversions hold good for different periods, and for different parts of the spectrum; and we have found that spectroscopically any one vapour in the spots behaved in exactly the same way as various mixtures of many vapours would be bound to do.

The result of this inquiry with regard to chemical substances which have been most carefully worked out, is indicated in the accompanying table, giving the result of the work for two years from 200 spots.

Statistics of the most Widened Lines seen in 200 *Sunspots at Kensington*

	Total number of lines in part of spectrum discussed	Total number of lines widened
Iron	172	72
Titanium	120	38
Nickel	24	9
Zinc	19	5
Cobalt	17	3
Calcium	17	7
Chromium	15	9
Molybdenum	14	1
Tungsten	14	2
Manganese	13	4
Platinum	12	1
Barium	10	1
Copper	10	1
Sodium	7	2

In these 200 spots out of 172 lines of iron which we might have seen only 72 were observed altogether; out of 120 lines of titanium which we might have seen only 38 were seen; and then the number goes on decreasing: 24 in the case of nickel, of which 9 were seen; 19 in the case of zinc, of which 5 were seen; 13 of magnesium, of which 4 were seen; 12 of platinum, of which 1 was seen, and so on.

The final upshot is, therefore, that at the spot-level we do not see the Fraunhofer spectrum, as we ought to do on the old theory. What we do see is a small percentage of the lines, and we see them under conditions which are entirely unexpected. No one, I think, who knew anything about spectrum analysis would have anticipated the result which we have got at Kensington in these 700 observations.

These, though the earlier results, are not the only results which we may hope to get by going on with the work. At present we have limited ourselves to recording the dates of the spots. But this is not enough; we must know the actual positions of the spots on the sun. We must note whether each particular spot is in the northern hemisphere or in the southern hemisphere, with the view of determining whether there is any chemical difference between the north part of the sun and the south part; and then again we shall have to compare the latitudes of spots, with the view of determining whether there is any difference in the chemistry of the spots according to the latitude. I may tell you that we are working at that particular point just now, and it really does look as if the sudden changes in the spectra recorded may have been due to the fact that the spots compared were spots varying very considerably in latitude, and it would not surprise me to find that spots which are very like each other in their spectra will be found to be situated more or less in the same degree of latitude,—whether the same degree of latitude north or south we do not know. And there is another question, too. I pointed out that there is a considerable number of lines seen in the spectrum of the arc which are left out of the spectrum of the spark. Now, will that help us at all in our inquiries? I think perhaps it may. Everybody assumes that the electric spark is hotter than the electric arc. If that be so, the lines which we see at the temperature of the arc, and which we do not see at the temperature of the arc only, may represent the lines due to cooler vapours—more complex molecular groupings it may be, which can exist in the cooler temperature, but which entirely break up on the application of a higher one. If that be so we shall be able to sort out the spots more or less according to their temperature.

Though the results have not been shown on the map, the lines visible in the spectrum of some substances at the temperature of the oxy-hydrogen jet have been observed. Everybody assumes that the temperature of the oxy-hydrogen jet is lower than the temperature of the electric arc or spark; so that, if we can get a spot which gives us those lines thickened only which we see at the temperature of the oxy-hydrogen jet, we should be perfectly justified, I think, in saying that that was a relatively cool spot; whereas, if we saw a spot which only had those lines thickened which are intensified on the passage from the temperature of the arc to the temperature of the spark, we should be justified in saying that that spot was very much hotter. I only throw this out as an indication of the kind of result which probably future working and future thought will bring out, and that we are by no means at the end of the work yet.

J. Norman Lockyer

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Oxford.—The new Medical Statute was finally approved by Convocation on March 16. The scope of the new Statute and its bearing on the study of medicine at Oxford were so clearly described by Prof. Burdon-Sanderson in last week's Nature, that it is unnecessary to refer further to them. One point insisted on by the Professor, that the present student of medicine wastes his first year over Pass Moderations, has not yet been corrected. The Moderations Committee are still deliberating, but there seems little doubt that students of Natural Science in Oxford will receive substantial relief under the new scheme.

The present year is one of reform. While the Moderations question is still under debate, a new and much-needed reform has been sprung upon the University. The old Examination in the Rudiments of Faith and Religion has by common assent become out of date. Last week the preamble of a new Statute was passed *nemine contradicente* in Congregation. We must wait till next term to learn the fate of the Statute itself. It seems time that the University should grant degrees without demanding an intimate knowledge of the Thirty-nine Articles.

Cambridge.—It has been decided to establish a Tripos Examination in Engineering, to be combined with the present Natural Sciences Tripos. The general basis is that, as an alternative to the present First Part of the Tripos, an examination in certain mathematical subjects useful in engineering, physics, chemistry, and theory of structures shall be held, to be followed by a practical examination. Those who pass this will be entitled to a degree in honours. A later examination, concurrent with the second part of the Natural Sciences Tripos, is to consist of advanced papers in Physics, Chemistry, and Engineering, distinction in one or more of which is to entitle a student to a first class. When the complete scheme is published we shall give full details.

SCIENTIFIC SERIALS

The Journal of Physiology for November 1885, vol. vi. No. 6, contains:—On a double differential rheotome, by Dr. W. D. Samways (plate 7). The instrument is described and figured.—On the blood of Decapod Crustacea, by Dr. W. D. Haliburton (plate 8). Assisted in part by a grant from the British Medical Association, the author has studied the blood in the lobster, the edible crab, the crayfish, Astacus, and *Nephrops norvegicus*; and he treats of its colour, constituents, and coagulation. He ascribes the clot as due to the formation of a body scarcely to be distinguished from the fibrin of vertebrate blood, and believes that its formation is due to a ferment action, which latter is derived from the amœboid corpuscles of the blood. At the close of the memoir the author treats of the comparative aspects of crustacean

blood, and gives a table of the invertebrates in which hæmocyanin and hæmoglobin have been found.—On the nature of papain and its action on vegetable proteid, by Dr. Sidney H. C. Martin. The proteids present in papain are globulin and albumin, and two forms of albumose. No peptones were found.—Regarding the influence of the organic constituents of the blood on the contractility of the ventricle, by Dr. Sydney Ringer (plate 9). He infers that the arrest of contractility with a saline solution is not due to the removal of pabulum to support the contractions, but that lime and potassium salts are necessary ingredients in a circulating fluid to supply the conditions essential to the change occurring during a contraction, there being stored up in the muscular tissue a material to carry on contractions which cannot be washed out by a fluid circulating in the heart cavities.—On the nature of glomerular activity in the kidney, by J. G. Adami. It would seem that the glomerular epithelium has properties of a definite secretory nature; they may even be regarded as (in the dog) having powers of a selective secretory nature.—Plethysmographic and vaso-motor experiments with frogs, by Dr. Fred. W. Ellis (plates 10 and 11).—On some vaso-motor functions of the spinal nerves in the frog, by W. Horsecraft Waters.

The Journal of Anatomy and Physiology for January 1886, vol. xx. part 2, contains:—Prof. Macalister, morphology of the arterial system in man, part i.—R. Austin Freeman, the anatomy of the shoulder and upper arm of the mole (plate 5).—Dr. Hans Gadow, on the reproduction of the carapax in tortoises (plate 6). In the case experimented on, the dermal armour was cast off, after injury, down to the soft cutaneous layers; the bulk of these produced cutis, which then underwent the normal process of ossification, until at last a new complete armour was formed. The author cites, as an analogous case, "the reproduction of bark from the *whole surface of the cambium* laid open after the destruction of the old cortex." Is this so?—Dr. A. M'Aldowie, on the development and decay of the pigment-layer in birds' eggs.—Dr. D. J. Cunningham, the connection of the os odontoideum with the body of the axis.—Dr. R. W. Shufeldt, on the skeleton of Geococcyx (plates 7-9); a very full account of the skeleton of this rare bird.—Dr. Noël-Paton, relationship of urea-formation to bile-secretion; part ii. of these important experimental researches. The formation of urea in the liver bears a very direct relationship to the secretion of bile by that organ.—Dr. W. Hunter, recent histological methods.—Prof. W. Turner, the sacral index in various races of mankind; makes two classes—where the sacral index is below 100 (Dolichohieric), and where it is above 100 (Platyhieric).—Dr. J. L. Gibson, the blood-forming organs and blood-formation, part ii.

Zeitschrift für wissenschaftliche Zoologie, Band xliii. Heft 1 (Leipzig, December 31, 1885), contains:—Prof. A. Kölliker, histological studies of Batrachian larvæ (plates 1 and 2). Almost forty years ago Prof. Kölliker published his first account of the development of the Batrachian tissues, but the improvement in methods of research and the expansion of knowledge as to nerve-bundles and other endings have caused him to alter his opinions on several matters, and in this memoir we find his latest views on the structure, development, and terminations of the nerves; also some general considerations of the structure of the nerve-fibre and on the development of the blood- and lymph-vessels.—W. Schwarze, on the post-embryonal development in Trematodes (plate 3). These researches were made on *Cercaria armata* and *C. echinata* from *Limneus stagnalis*, and on *C. ornata* and *C. spinifera* from *Planorbis corneus*. A useful bibliography of the literature is appended.—Hermann Uhde, on the dorsal pore of the terrestrial Oligochæts: a contribution to the histology and classification of the Lumbricidæ (plate 4). In this memoir, in addition to a very detailed list of the literature of the subject and to a chapter on anatomical details, we have an account of the various species, based on materials collected from various parts of the world.—Dr. Deichler, on Protozoa parasitic in the sputa of whooping-cough.—Dr. E. Witlaczil, on the morphology and anatomy of the Coccidæ (plate 5).

Morphologisches Jahrbuch (Gegenbaur's), Band xi. Heft 3 (Leipzig, 1885), contains:—Dr. Béla Haller, researches on the marine Rhipidoglossa (plates 17-24), part ii. The first part of Haller's researches appeared in vol. ix. The present part treats of the structure of the central nervous systems and their envelopes. The material operated on was obtained at Trieste from Fissurella, Haliotis, and Turbo, and the conclusion is arrived at that without doubt the nerves throughout this group of Mollusca have a double origin.—Dr. H. Virchow, on the form of the plicæ of the ciliary body in mammals (plate 25). These folds, so comparatively small in the human eye, are largely developed in the rabbit.—Dr. W. Pfitzner, on the division of the nucleus in Protozoa (plate 26). These observations were chiefly on the nuclei in *Opalina ranarum*, and show the general similarity of the kariokinesis in this Protozoon with that in Metazoa.—Dr. G. Baur, notes on the "astragalus" and the "intermedium tarsi" in mammals (plate 27). As introductory to these notes a very copious account of the literature of the subject is given.—Among the short notices are: on the nerve-canal in the humerus of the Amniota, by Prof. U. Fürbinger; and on the rudiment of a septal nasal gland in man, by Prof. Gegenbaur.

Rendiconti del Reale Istituto Lombardo, January 21.—On the grape-vine mildew; observations and remedies, by Prof. Gaetano Cantoni. Although usually supposed to have been for the first time introduced into Europe from America about 1877, the writer quotes a correspondent in the *Bulletin* of the French Agricultural Society, who states that this disease was known in Alsace under the name of *mildau* over forty years ago. From Alsace it passed to America, where the name became Anglicised, recently returning to Europe under the designation of grape-vine mildew. The best prophylactic remedies hitherto discovered are the sulphate of copper and milk of lime, applied either separately or in combination about the beginning of June, and repeated, if necessary, towards the end of August or beginning of September.—On the formation of dew, by Prof. Giovanni Cantoni. It is shown that the theory recently communicated by Prof. Aitken to the Edinburgh Royal Society and described in NATURE for Jan. 14 (p. 256), agrees with the conclusions already arrived at by Fusinieri, Melloni, and other Italian meteorologists.—Summary of the meteorological observations made at the Brera Observatory, Milan, during the year 1885, prepared by E. Pini.

Mittheilungen der Naturforschenden Gesellschaft in Bern, Nos. 1092-1132 (1884-85).—Wind and precipitates in Bern (from records of Bern Observatory during fifteen years), by Herr Benteli.—On a case of rapid hole-formation in rock, by Herr Baltzer.—On lake-balls, by Herr Coaz.—On the theory of trisection of angles, by Herr Moser.—On the termination of nerves in striped muscles of man, by Herr Flesck.—On a case of loess in Canton Bern, by Herr Baltzer.—On the oldest map of Switzerland of Ægidius Tschudi, by Herr Graf.—Mathematical researches on the colour of thin gypsum plates in polarised light, by M. Jonquière.—On the poisoning with *Amanita phalloides* in Bern in 1884, by Herr Studer, jun.—On the occurrence of the vascular wave in the carotid-curve, by Herr Mützenberg.—Contributions to a comparison of the brain-fissures in Carnivora and Primates, after examination of a lion's brain, by Herr Familiant.—On the chemistry of food-stuffs, by Herr Fueter-Schnell.—On a new occurrence of rock-crystal in Switzerland, by Herr von Fellenberg.

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft in Lucerne, September 1884.—We note here the President's (Herr Suidter-Langenstein) opening address, dealing with the Lucerne region in geological, meteorological, and biological aspects; also two interesting reports on prize competitions—one relating to a climatology of Switzerland, the other to the deep-water fauna of Swiss lakes.

Journal de Physique, February.—On refrigerating mixtures and the principle of maximum work, by M. Potier.—On the critical temperatures and the pressures of some gases, by MM. Vincent and Chappuis.—Researches on the freezing temperature of solutions, by M. Raoult.—On the formula of plane gratings, by M. Branly.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 10, 1885.—"On the Magnetisation of Steel, Cast Iron, and Soft Iron." By John W. Gemmell.

In this paper the author describes and gives the results of a series of experiments upon particular specimens of iron and of steel. The specimens consisted of wires of "soft Scotch iron," "common wire," "charcoal iron," and "soft steel," with bars of cast iron and malleable iron; and the object of the investiga-

tion was to find the difference between these, with respect to the intensities of their total and residual magnetisation, due to different degrees of magnetising force.

The apparatus was arranged, and the experiments made, according to a simple magnetometric method fully detailed in the paper. The magnetising currents were derived from a battery of Thomson's tray Daniells, so arranged that any number of cells could readily be placed in the circuit.

The results represent the effect of a current gradually increased from 0 to the maximum, gradually diminished to 0 again, and of the same process repeated with a negative current. They are shown in curves, the abscissæ of which are proportional to the magnetising forces, and the ordinates to the magnetisation produced. Figures are given by which to reduce these values to absolute measure.

It has been found that the "charcoal iron" has the highest magnetisability, and the "soft steel" the lowest; while that of the "soft Scotch iron" approaches the former. With regard to retentiveness, the "charcoal iron" shows the least, and the "soft steel" the greatest. Annealing the latter, however, has the effect of bringing it very near the "common wire," both in respect of magnetisability and retentiveness. The two specimens of cast iron differ considerably. The malleable iron bar shows a very much higher magnetisability than the cast iron ones, and its residual magnetisation was so low that it could not be observed with the same arrangement of apparatus.

These curves also present certain anomalies which are worth investigation. The space about the zero on an enlarged scale is affixed to each set to show its peculiarities more clearly.

In the curves representing the residual magnetisation we find a loop between the direct and return curves, more or less marked in all the diagrams. A similar feature presents itself in the curves of total magnetisation in two of the diagrams, and there seems to be a tendency always to form this loop.

In that part of the return curve which represents the effects of the small magnetising forces, the residual magnetism is seen first to take a greater value, and then to diminish again just before the zero of magnetising force is reached. This may be observed also in the negative return curve.

January 21.—"On Radiant Matter Spectroscopy: Note on the Spectra of Erbia." By William Crookes, F.R.S.

I have recently succeeded in getting the earth erbia in a sufficiently pure state to allow me to examine its phosphorescent spectrum without the interference which might be produced by the presence of yttria, samaria, holmia, thulia, Yα, or ytterbia. As in the case of yttria,[1] the spectrum is best seen when erbic sulphate is heated to redness and submitted to the electric discharge in a high vacuum. The addition of calcic sulphate interferes with the purity of the spectrum. In this respect erbia differs from samaria, as the latter earth seems to require the presence of some other metal to develop its phophorescent properties.

The phosphorescent spectrum of erbia consists of four green bands, of which the following measurements have been taken:—

Scale of spectroscope	λ	$\frac{1}{\lambda^2}$	Remarks
9·750	5564	3230	Approximate centre of a wide band, shading off at each side.
9·650	5450	3367	Approximate centre of a band, narrower and somewhat fainter than the first band.
9·525	5318	3536	Approximate centre of a narrow band, bright and moderately sharp on each side.
9·400	5197	3702	Approximate centre of a band, similar in appearance to the first band, but brighter.

These bands do not correspond in position to any in either the yttrium or samarium spectrum. The nearest approach to a coincidence is between the first erbia green and the samarium green, but when the two spectra are examined one over the other it is seen that the samarium band is less refrangible than the erbium band.

[1] *Phil. Trans.*, part iii., 1883, p. 923 (par. 71).

The first green of Yα occurs midway between the first and second greens of erbia, and the second Yα green comes between the second and third erbia greens.

Pure erbia is of a beautiful rose-pink colour. When illuminated by sun or electric light and examined in the spectroscope it gives a spectrum of black lines and bands as sharp and distinct as the Fraunhofer lines. It is strange that this most characteristic property has been recorded by so few observers. Indeed, the only notice of it I have come across is a passing remark of Prof. Clève's that "the light reflected by dry erbia shows absorption bands."

The absorption spectrum given by a solution of pure erbic chloride differs in some respects from the drawings mapped from older observations, as the absorption lines of holmia and thulia are absent. The fine group of lines in the green of the reflection spectrum is also absent in the absorption spectrum.

The spectrum of bright lines emitted when erbia is rendered incandescent in the blow-pipe flame has been often observed, but the lines in this case are luminous on a fainter continuous background, and are not particularly sharp, whilst the reflection spectrum consists of black lines sharply defined on a continuous spectrum.

February 4.—"A Further Inquiry into a Special Colour-Relation between the Larva of *Smerinthus ocellatus* and its Food-plants." By Edward B. Poulton, M.A., of Jesus and Keble Colleges, Oxford. Communicated by Prof. J. S. Burdon-Sanderson, F.R.S.

The object of the paper was to give an account of the investigation upon this subject which had been undertaken in 1885, having been continued from the previous year (described in *Proc. Roy. Soc.*, No. 237, 1885, p. 269). The points which had been raised, and upon which evidence was desired, were as follows:—(1) The larvæ are generally uniformly coloured on the same food-plant, but sometimes there are exceptions; can any of these be due to the hereditary transmission of the influence of food-plants upon the parent larvæ? (2) Is the colour of the larva influenced by the colour of the environment which, acting upon some sensory surface, directs the kinds and amounts of pigments deposited, or absorbed from the food? (3) It was also important to test the effects of certain new food-plants and of others about which the evidence was conflicting; and (4) to look out for any indications which would throw light upon the red-spotted varieties, or upon the existence of individual variation of any kind, under similar conditions of parentage and food; and (5) to inquire into the periods during which the larvæ are most susceptible to the colour-influence.

Experiments in 1885.—These were divided into five series, as the larvæ came from five batches of eggs. The differences between the larvæ are expressed in five degrees: white, whitish-intermediate, intermediate, yellowish intermediate, and yellow. *Series I.* Eggs were laid by a moth bred from a larva which had been a typical whitish variety (as was also the case with the male parent). The resulting larvæ were whitish (5) upon *Pyrus Malus* (var. *acerba*), intermediate (1) upon *Populus tremula* and another species of poplar, intermediate (1) upon *Salix babylonica*, and whitish (2), although they did not become adult, upon *S. rubra* and other similar species of sallow. In this series the hereditary influence on the side of white is seen to be strongly marked on comparing the effects with those shown in the other series and in the parent larvæ (see former paper). *Series II.* Eggs were laid by a moth bred from a whitish-intermediate larva, without any act of coitus having been witnessed (although male moths were present). Most of the eggs shrivelled up, but a few hatched, and form the larvæ of this series. Subsequently coitus was induced (artificially), and a large number of fertile eggs were laid which are considered under the next series. The larvæ of Series II. were whitish (4) upon *Salix viminalis*, although not to such an extent as upon apple, and yellowish-intermediate (1) upon *S. Smithiana* and another sallow with similar leaves. These results are rather irregular, for the former larvæ were whiter than the parents, the latter yellower than it is probable that the parents would have been on the same tree. But the results were not unusual in themselves. *Series III.* The female parent was the same as in Series II.; the male parent was bred from a typical whitish larva. The resulting larvæ were whitish (6) upon ordinary apple, and upon the same with the leaves sewn to expose the under sides (1), and to expose the upper sides (3) (none of these reached maturity, and the last lot were especially young when they died); whitish (4) but immature upon crab (var. *acerba*); whitish-intermediate

(5) upon *Salix viminalis*; white (1) but immature upon *S. viminalis*, sewn to show the under sides; yellowish-intermediate (2) but immature upon *S. alba*; whitish-intermediate (4) but mostly immature upon *S. Smithiana* and similar leaves; intermediate (1), yellowish-intermediate (5), and yellow with traces of the red spots (1) upon *S. cinerea*; intermediate (1) upon *Populus nigra*; intermediate (6) and yellowish-intermediate (2) upon *S. triandra*; yellowish-intermediate (10) upon *S. triandra* without the bloom on the under sides of the leaves; yellowish-intermediate (4) upon *S. babylonica* (when the larvæ were young and more numerous, one of them in the fourth stage possessed traces of the upper row of rust-coloured spots, and was a whitish variety: it was put upon apple and died as an intermediate variety when advanced in the last stage); intermediate (1) and yellowish-intermediate (3) upon *S. rubra*. The results of these experiments were mostly what might have been anticipated from the colour of the leaves. The especially interesting results were: the effects produced by the sewn leaves of *S. viminalis* and the bloomless leaves of *S. triandra* as compared with the normal leaves in both cases, and the occurrence of red spots on two larvæ—one, the only yellow variety obtained, and the other an intermediate variety. The indications of individual variation in the *S. cinerea* larvæ were also interesting. *Series IV.* All these larvæ died before trustworthy observations could be made; they had been reserved for experiment: the ocelli of many were covered with a harmless opaque layer (lamp-black and McGuilp) in the attempt to isolate the sensory surface which is affected by the colour of the environment. Others were fed upon apple and *S. rubra*, and a certain number were changed [illegible] stage, so as to find the periods during which the larvæ [illegible]t susceptible to the surrounding colour. The failure of all these was due to the season and not the conditions of the experiment. *Series V.* The female parent was bred from a yellowish-intermediate larva, the male parent from a yellow larva. The resulting larvæ were, intermediate (1) upon *S. viminalis* sewn to show the upper sides of the leaves; intermediate (1) and yellowish-intermediate (1) upon *S. cinerea*. The first result was interesting, but the second shows that the larvæ did not tend much towards yellow. The hereditary influence towards yellow in this case depends chiefly on the male parent, and how far this element asserts itself in opposition to the other sex is quite unknown in this class of experiment.

Results of the Experiments.—The existence of hereditary influence is, on the whole, demonstrated. The parent larvæ tended towards white, and out of the 75 larvæ of the next generation, there was only one yellow variety. Yet the latter were, on the whole, rather more influenced in the direction of yellow than the parents, when the plants tended this way. The results were the same as in the parents when very powerful white influence was used (apple, &c.) The comparison of the different series was less satisfactory, but the hereditary differences were mostly delicate, except between V. and the other series.

Series I. and III. compare favourably, while in II. the parentage is very obscure. There is conclusive proof that it is the colour of the leaf, and not its substance when eaten which influences the larval colours.

Conflicting evidence as to the effect of plants is cleared up. *S. triandra* produces yellow; and Mr. Boscher's white larvæ, said to have been found upon this plant, occurred upon the very similar, but much whiter, *S. alba*. Previous conclusions as to *S. Smithiana* and *S. babylonica* are confirmed. The existence of individual variation with similarity of parentage and conditions is now proved, although it is rare and slight (8 out of 75 in 1885, 0 out of 23 in 1884). Thus it cannot explain the extreme differences met with in the field (1884), *e.g.* yellow upon apple, &c. The colours of the larvæ are determined by (1) the food-plant; (2) hereditary influence; (3) individual variation. Slight differences may be caused by the latter; extreme differences by the two former. The uncertain action of (1) will be shown later. The two red-spotted larvæ were very interesting, showing how the character tends to appear on the yellow varieties (the only yellow one produced), and yet that it may appear upon the other varieties (which is a new experience).

Observations in the Field in 1885.—(1) White variety upon ordinary apple; (2) white and (1) intermediate upon *S. viminalis*; (1) yellowish-intermediate upon *S. lineiris* (Forbes); (1) yellow upon *S. incana* in Switzerland; (1) white upon *S. alba* (ordinary) in Switzerland; (1) yellowish-intermediate upon var. *S. alba* (? *vitellina*) in Switzerland; (2) yellow upon var. *S. alba* in Switzerland; (1) whitish-intermediate upon *S. Smithiana*; (4) yellow and (1) whitish-intermediate upon *S. cinerea*; (4) yellow upon *S. triandra*; (1) yellowish-intermediate upon *S. babylonica*; (12) yellow and (3) yellowish-intermediate upon *S. rubra*. All, except the five in Switzerland, were found at Oxford.

Conclusions from Captured Larvæ; Reconciliation of Conflicting Evidence.—The results recorded above were very uniform. Only in the case of *S. cinerea* was there any great difference between the larvæ on the same tree, for the Swiss varieties of *S. alba*, which produced yellowish larvæ, had leaves resembling *S. rubra* rather than the ordinary English *S. alba*, with one exception (which produced the white larva). At the same time there were two instances which perplexed me for a long time, and finally suggested the explanation which clears up the greatest difficulty in the way of the theory—the conflicting evidence (Mr. Boscher's and my own) with regard to the action of *S. viminalis*. These instances were, the yellowish intermediate larva upon *S. lineiris* and the yellow one upon *S. incana*. Both the trees had small narrow leaves with very white under sides, and yet the larvæ were not white. *S. lineiris* is whiter than apple or any sallow that I have seen. Then I remembered that the single yellow larva I had found upon *S. viminalis* (in 1884) was upon a tree with very small leaves; finally, I had the opportunity of looking at twigs from the trees upon which Mr. Boscher had found about eighteen yellow larvæ. These, too, bore very small leaves, although they were as white as usual on the under sides. This association of yellow larvæ with small leaves (although white) suggested the following explanation. It is the *immediate* environment almost in contact with the larva which has the greatest effect upon it, and the longer it acts the more extreme will be the result. The larvæ habitually rest upon the under sides of the leaves, until their size and weight render it impossible for them to do so longer; then they retire to the stem. Hence the larvæ rest for a much longer period of their lives upon large and strong leaves than upon small ones, and therefore, in the former case, the effect of the white under sides is much more powerful, for after the larva has reached the stem the immediate environment is less exclusively white, and may be largely formed by the green or yellowish upper sides of the leaves (depending upon the arrangement of the latter). This completely explains the conflicting results upon *S. viminalis*, for there is an immense difference in size between the leaves of the two forms upon which the two varieties of larva have been found; and the arrangement is also different, tending to produce a white environment after the larva has gone to the stem in the case of the large-leaved trees, but not in the small-leaved forms. This explanation is valid for other food-plants in exact proportion to the difference in colour between the two sides of their leaves. Thus it is probable that it explains in a great measure the yellow effect of the small-leaved *S. cinerea*, and the much whiter effect of the large-leaved *S. Smithiana*; both having very similar leaves with white under sides. It also explains the very powerful effect of apple, with its large strong leaves, which are arranged so as to give a maximum white effect after the larva has retired, very late in life, to the stem. Another difficulty is also cleared up by this suggestion—the fact that bred larvæ in 1884 and 1885 became intermediate upon large-leaved *S. viminalis*, although they tended towards white (as shown by the effect of other plants). The long leaves were disarranged when crowded into the glass cylinders in which the larvæ were kept, and so the immediate environment of the larvæ was artificially altered when they were on the under sides of the leaves, and also on the stem. Furthermore, they were often disturbed by changing the food, and so did not rest upon the white surfaces for such long periods as in the natural state. The larvæ found in the field upon *S. rubra* and plants tending towards yellow were much more extreme varieties than those produced by breeding. This is partly due to the hereditary influence towards white in the latter case, but also probably to the white muslin which was tied over the breeding cylinders, and to the less amount of direct sunlight obtainable indoors and among the crowded leaves. In the field the larvæ habitually rest on the most exposed and tallest boughs, of which the colours are most brightened by sunlight, and such an environment therefore produces a very strong influence upon them. Such considerations suggest that it will be very interesting to breed the larvæ under coloured light, and I intend to make the experiment this summer.

Conclusion.—The whole evidence for the theory of colour-relation advanced in the present paper consists of 204 instances,

of which about half were bred and the rest found in the field. Such is the evidence for the conclusion that the larva of *Smerinthus ocellatus* maintains a colour-relation with the food-plant upon which it was hatched, adjustable within the limits of a single life, and that the predominant colour of the food-plant itself is the stimulus which calls up a corresponding larval colour. This is an entirely new resource in the various schemes of larval protection by resemblance to the environment, and one which stands on a very different level from all others. In the latter the gradual working of natural selection has finally produced a resemblance, either general or special, to something which is common to all the food-plants of the larva or to some one or more of them, the larva being less protected upon the remainder. But in the former case the same gradual process has finally given the larva a power which is (relatively) immediate in its action, and enables the organism itself to answer with corresponding colours the differences which obtain between its food-plants. This action is very different from the much more rapid changes of colour in other organisms (amphibia, fish, &c.), for in them the changing colours of the environment act as stimuli, which, through a nervous circle, modify the condition of existing pigments; while in the larva the influence makes itself felt in the absorption and production of pigments rather than their modification when formed; and such a method of gaining protection is, as far as we yet know, unique in the animal kingdom. And the power is not confined to the species in which its existence has been to some extent completely proved. There are already proofs that many other larvæ can maintain a similar colour-relation, and careful observation will doubtless reveal many slight and protective differences among larvæ of the same species when found upon differently-coloured food-plants, and will prove that this power is not at all uncommon among the great body of lepidopterous larvæ which adopt the methods of protective resemblance.

February 11.—"On the Theory of Lubrication and its Application to Mr. Beauchamp Tower's Experiments, including an Experimental Determination of the Viscosity of Olive Oil." By Prof. Osborne Reynolds, LL.D., F.R.S.

The application of the hydrodynamical equations for viscous fluids to circumstances similar to those of a journal and a brass in an oil-bath, in so far as they are known, at once led to an equation [1] between the variation of pressure over the surface and the velocity, which appeared to explain the existence of the film of oil at high pressure.

This equation was mentioned in a paper read before Section A at the British Association, at Montreal. It also appeared from a paragraph in the Presidential Address (p. 14, B.A. *Report*, 1884) that Prof. Stokes and Lord Rayleigh had simultaneously arrived at similar results. At that time the author had no idea of attempting the integration of this equation. On subsequent consideration, however, it appeared that the equation might be so transformed [2] as to be approximately integrated by considering certain quantities small, and the theoretical results thus definitely compared with the experimental.

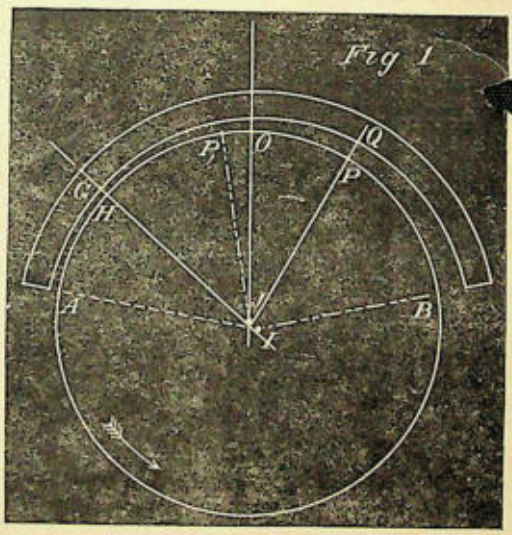
The result of this comparison was to show that with a particular journal and brass the mean thickness of the film would be sensibly constant for all but extreme values of load divided by viscosity, and hence if the coefficient of viscosity were constant the resistance would increase approximately as the speed.

As this was not in accordance with Mr. Tower's experiments, in which the resistance increased at a much slower rate, it appeared that either the boundary actions became sensible, or that there must be a rise in the temperature of the oil which had escaped the thermometer used to measure the temperature of the journal.

That there would be some excess of temperature in the oil film on which all the work of overcoming friction is spent is certain, and after carefully considering the means of escape of this heat, it appeared probable that there would be a difference of several degrees between the oil-bath and the film of oil.

This increase of temperature would be attended with a diminution of viscosity, so that as the resistance and temperature increased with the velocity there would be a diminution of viscosity, which would cause the increase of the resistance with the velocity to be less than the simple ratio.

In order to obtain a quantitative estimate of these secondary effects, it was necessary to know the exact relation between



the viscosity of the oil and the temperature. For this purpose an experimental determination was made of the viscosity of olive oil at different temperatures as compared with the known viscosity of water. From the result of these experiments an

No. of equation in the paper

$$\frac{dp}{dx} = \frac{6\mu U\,(h - h_1)}{h^3} \quad . \quad . \quad . \quad . \quad . \quad (31)$$

in which p is the intensity of pressure, μ coefficient of viscosity, x the direction of motion, h the interval between the journal and the brass, h_1 being the value of h for which the pressure is a maximum, U the surface velocity in the direction of x.

[2] If the journal and brass are both of circular section, as in Fig. 1, and R is the radius of the journal, R + a radius of brass, J the centre of the journal, I the centre of the brass, JI = ca, HG the shortest distance across the film, IO the line of loads through the middle of the brass, A the extremity of the brass on the off side, B on the on side, P_1 the point of greatest pressure

putting

$$\text{OIH} = \phi_0 - \frac{\pi}{2}$$
$$\text{OIP}_1 = \phi_1$$
$$\text{OIP} = \theta$$
$$h = a\left\{1 + c\sin(\theta - \phi_0)\right\}$$
$$h_1 = a\left\{1 + c\sin(\phi_1 - \phi_0)\right\}$$

the equation (31) becomes

$$\frac{dp}{d\theta} = \frac{6R\mu c\left\{\sin(\theta - \phi_0) - \sin(\phi_1 - \phi_0)\right\}}{a^2\left\{1 + c\sin(\theta - \phi_0)\right\}^2} \quad . \quad (48)$$

if $\frac{a}{R}$ is small. This equation, which is at once integrable when c is small, has been integrated by approximation when c is as large as 0·5.

The friction is given by an equation

$$f = -\tfrac{1}{2}R\frac{d\theta}{dp}a\left\{c\sin(\theta - \phi_0)\right\} - \mu\frac{U_1 - U_0}{a\left\{1 + c\sin\theta_0 - \phi_0\right\}} \quad . \quad (49)$$

This is also approximately integrated up to $c = 0{\cdot}5$.

ϕ_0 and ϕ_1 and c have to be determined from the conditions of equilibrium, which are

$$\int_{-\theta_1}^{\theta_1}\left\{p\sin\theta - f\cos\theta\right\}dp = 0 \quad . \quad . \quad . \quad . \quad (44)$$

$$\int_{-\theta_1}^{\theta}\left\{p\cos\theta + f\sin\theta\right\}d\theta = \frac{L}{R} \quad . \quad . \quad . \quad . \quad (45)$$

$$\int_{-\theta}^{\theta} f\,d\theta = \frac{M}{R^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (46)$$

where $2\theta_1$ is the angle subtended by the brass, L the load, and M the moment of friction.

The solution of these equations may be accomplished when c is small, and has been approximately accomplished for particular values of c up to 0·5, the boundary conditions as regards p being

$$\theta = \pm\theta_1 \qquad p = p_0,$$

whence substituting the values of ϕ_1, ϕ_0, c in (45) and (49), and integrating, the values of the friction and values of the pressure are obtained.

empirical formula has been deduced for the viscosity of olive oil at all temperatures between 60° and 120° F.[1]

Besides the effect on μ the temperature might, owing to the different expansion of brass and iron, produce a sensible effect on the small difference a in the radii of the brass and journal, *i.e.* on the mean thickness of the film. E was taken for the coefficient of this effect, and since, owing to the elasticity of the material, the radius would probably alter slightly with the load, m was taken as a coefficient for this effect, whence a is given by an equation[2] in terms of a_0, its value with no load and a temperature zero.

Substituting these values in the equations, the values of the pressure and friction deduced from the equations are functions of the temperature, which may be then assumed, so as to bring the calculated results into accord with the experimental.

There was, however, another method of arriving, if not at the actual temperatures, at a law connecting them with the frictions, loads, and velocities. For the rise in temperature was caused by the work spent in overcoming friction, while the heat thus generated had to be carried or conducted away from the oil film. Consideration of this work and the means of escape gave another equation between the rise of temperature, the friction, and velocity.[3]

The values of the constants in this equation can only be roughly surmised from these experiments, without determining them by substituting the experimental values of f, U, and T, as previously determined, but it was then found that the experiments with the lower loads gave remarkably consistent values for A, B, E, m, and a_0, which was also treated as arbitrary. In proceeding to the higher loads for which the values of ϵ were greater, the agreement between the calculated and experimental results was not so close, and the divergence increased as ϵ increased. On careful examination, however, it appeared that this discordance would be removed if the experimental frictions were all reduced 20 per cent. This implied that 20 per cent. of the actual friction arose from sources which did not affect the pressure of the film of oil; such a source would be the friction of the ends of the brass against flanges on the shaft commonly used to keep the brass in its place, or by any irregularity in the longitudinal section of the journal or brass. A coefficient, n, has therefore been introduced into the theory, which includes both the effect of necking and of irregularity in longitudinal section. Giving n the value 1·25, the calculated results came into accordance with all Mr. Tower's results for olive oil, the difference being such as might well be attributed to experimental inaccuracy, and this both as regards the frictions measured with one brass, No. 1, and the distribution of the pressure round the journal with another, No. 2.

Not only does the theory thus afford an explanation of the very novel phenomena of the pressure in the oil film, but it also shows, what does not appear in the experiments, how the various circumstances under which the experiments have been made affect the results.

Two circumstances in particular which are brought out as principal circumstances by the theory seem to have hitherto entirely escaped notice, even that of Mr. Tower.

One of these is a, the difference in the radii of the journal and of the brass or bearing. It is well known that the fitting between the journal and its bearing produces a great effect on the carrying power of the journal, but this fitting is supposed to be rather a matter of smoothness of surface than a degree of difference in radii. The radius of the bearing must always be as much larger than that of the journal as is necessary to secure an easy fit, but more than this does not seem to have been suggested.

It now appears from this theory that if viscosity were constant the friction would be inversely proportional to the difference in the radii of the bearing and journal, and this although the arc of contact is less than the semi-circumference; and taking temperature into account it appears from the comparison of the theoretical frictions with the experiment on brass No. 1 that the difference in the radii at 70° F. was

$$a = 0{\cdot}00077 \text{ (inch)},$$

and comparing the theoretical pressures with those measured with brass No. 2,

$$a = 0{\cdot}00084 \text{ (inch)},$$

or the difference was 9 per cent. greater in the case of brass No. 2.

Another circumstance brought out by this theory, and remarked on both by Lord Rayleigh and the author at Montreal, but not before suspected is, that the point of nearest approach of the journal to the brass is not by any means in the line of load, and, what is still more contrary to common supposition, it is on the *off*[1] side of this line.

This point H moves as the ratio of load to velocity increases; when this ratio is zero, the point H coincides with O, then as the load increases it moves away to the left, till it reaches a maximum distance $\frac{\pi}{2} = \phi_0$, being nearly $-\frac{\pi}{2}$. The load is still small, smaller than anything in Mr. Tower's experiments, even with the highest velocities. For further increase of load, H returns towards O, or $\frac{\pi}{2} - \phi_0$ increases. With the largest loads and smallest velocities to which the theory has been applied this angle is about 40°. With a fairly loaded journal well lubricated it would thus seem that the point of nearest approach of brass to journal, *i.e.* the centre of wear, would be about the middle of the off side of the brass.

This circumstance, the reason of which is rendered perfectly clear by the conditions of equilibrium, at once explains a singular phenomenon, incidentally pointed out by Mr. Tower, viz. that the journal having been run in one direction for some time, and carrying its load without heating, on being reversed began to heat again, and this after many repetitions always heating on reversal, although eventually this tendency nearly disappeared. Mr. Tower's suggested explanation appears to the author as too hypothetical to be satisfactory, even in default of any other; and particularly as this is an effect which would necessarily follow in accordance with the theory, so long as there is wear. For the centre of wear, being on the *off* side of the line of loads, this wear will tend to preserve or diminish the radius of the brass on the *off* side, and enlarge it on the *on* side, a change which will, if anything, improve the condition for producing oil pressure while running in this direction, but which will damage the condition on which the production of pressure in the film depends when the journal is reversed and the late *off* side becomes the new *on* side. That with a well-worn surface there should be sufficient wear to produce this result with such slight amounts of using as those in Mr. Tower's experiments before reversal seems doubtful, but supposing the brass new and the surface more or less unequal, the wear for some time would be considerable, even after the initial tendency to heat had disappeared. Hence it is not surprising that the effect should have eventually seemed to disappear.

The circumstances which determine the greatest load which a bearing will carry with complete lubrication, *i.e.* with the oil film continuous between brass and journal throughout the entire arc, are definitely shown in the theory, so long as the brass has a circular section.

The theory shows that the ultimate limit to the load will be the same with the oil-bath and with partial lubrication as Mr. Tower found it to be.

The effect of the limited length of bearings, and the escape of the oil at the ends, is also apparent in the equations.

Although in the main the present investigation has been directed to the circumstances of Mr. Tower's experiments, namely, a cylindrical journal revolving in a cylindrical brass, the main object has been to establish a general and complete theory based on the hydrodynamical equations for viscous fluids. Hence it has been thought necessary to proceed from the general equations, and to deduce the equations of lubrication in a general form, from which the particular form for application has been obtained. It has been found necessary also to consider somewhat generally the characters of fluid friction and viscosity.

The verification of the equations for viscous fluids under such extreme circumstances affords a severe test of the truth and com-

[1] An inch being unit of length, a pound unit of force, and a second unit of time, for olive oil

$$\mu = 0{\cdot}00004737\epsilon^{-0{\cdot}0221T} \quad \ldots\ldots (8)$$

[2] $$a = (a_0 + mL)\epsilon^{ET} \quad \ldots\ldots (117)$$

[3] $$f = \left(A + \frac{B}{U}\right)T + EAT^2. \quad \ldots\ldots (120)$$

A + ET represents the rate at which the mechanical equivalent of heat is carried away per unit of temperature; B represents the rate at which it is conducted away.

[1] *On* and *off* sides are used by Mr. Tower to express respectively the sides of approach and recession, as B and A, Fig. 1, the arrow indicating the direction of motion.

pleteness of the assumptions on which these equations are founded; and the result of the whole research is to point to a conclusion (important to natural philosophy) that not only in cases of intentional lubrication, but wherever hard surfaces under pressure slide over each other without abrasion, they are separated by a film of some foreign matter, whether perceptible or not; and that the question as to whether the action can be continuous or not turns on whether the motion tends to preserve the foreign matter between the surfaces at the points of pressure, as in the almost if not quite unique case of the revolving journal, or tends to remove it, and sweep it on one side, as in the action of all backward and forward rubbing with continuous pressure.

The fact that a little grease will enable any surfaces to slide for a time has tended doubtless to obscure the action of the revolving journal to maintain the oil between the surfaces at the point of pressure, and yet, although only now understood, it is this action that has alone rendered machinery or even carriages possible. The only other self-acting system of lubrication is that of reciprocating motion with intermittent pressure and intermittent separation of the surfaces to draw the oil back or to draw a fresh supply. This is important in certain machinery, as in the steam-engine, and is as fundamental to animal mechanism as is the continuous lubricating action of the journal to mechanical contrivances.

Mathematical Society, March 11.—Mr. J. W. L. Glaisher, F.R.S., President, in the chair.—Mr. L. J. Rogers was admitted into the Society.—Prof. Sylvester, F.R.S., read a paper on an instantaneous proof of the expression for the number of linearly independent invariants or seminvariants of a given type, and also of the corresponding expression for reciprocants.—Mr. E. B. Elliott read a paper on ternary and n-ary reciprocants, and Mr. L. J. Rogers read one entitled "Homographic, Circular, and Projective Reciprocants."—Capt. P. A. Macmahon, R.A., communicated a proof of Cayley's fundamental theorem of invariants, and Mr. Leudesdorf communicated a note by Mr. Griffiths, on the invariantisers of a binary quantic.—Mr. Tucker (Hon. Sec.) called the attention of the Society to a paper read before the Royal Irish Academy (January 26) by Dr. Casey, F.R.S., entitled "On the Harmonic Hexagon of a Triangle," in which properties established by himself for a harmonic quadrilateral were beautifully generalised and extended to the harmonic hexagon and other harmonic polygons. The harmonic hexagon is thus defined:—ABC is any triangle, AA', BB', CC' its symmedian lines, which meet the circumcircle in $A'B'C'$; the figure $AB'CA'BC'$ is the harmonic hexagon. Dr. Casey calls the triangles $A'B'C'$, ABC cosymmedian triangles.—Mr. Tucker then communicated, for the Rev. T. C. Simmons, the following extensions:—Let K' be the inverse point of the symmedian point K with respect to the circumcircle, and let $K'A$, $K'B$, $K'C$ meet this circle in $A''B''C''$; then $A''B''C''$ may be called the inverse cosymmedian triangle of ABC. What Dr. Casey has proved for cosymmedian triangles, Mr. Simmons shows also for these inverse triangles, and the result is that the three sets of triangles have the same Brocard points, symmedian point, Brocard, "T. R.," sine and cosine circles.—Mr. Simmons also sent a construction for finding a triangle whose Brocard points and angle are given, whence he proves that *any* triangle inscribed in a certain circle and circumscribed to the Brocard ellipse has the given Brocard points for B. points.

Linnean Society, March 4.—Sir John Lubbock, Bart., F.R.S., President, in the chair.—Messrs. Gilbert C. Bourne, William H. Catlett, and Thos. A. Cotton were elected Fellows of the Society.—One of nine volumes of water-colour drawings of British plants, by the late Miss Mosely of Great Malvern, was exhibited for Miss Onslow.—A paper on *Strongylus Arnfieldi* and *S. tetracanthus*, by Prof. Spencer T. Cobbold, was read, and specimens illustrating the encysted stage of the latter exhibited. Of Arnfield's strongyle he drew attention to the morphology of the hood and its rays, the position of the vulva, and the structure of the embryo, contrasting these with those of allied forms. Regarding his observations on the four spined strongyle these may be summarised as follows:—(1) The eggs are expelled from the parent in a state of fine yolk-cleavage; (2) embryos are formed after egg expulsion, and a few days subsequently escape from the envelopes, undergoing a primary change of skin in moist earth during warm weather; (3) thereafter they live many weeks as rhabditform nematoids; (4) in all likelihood an intermediary host is unnecessary; (5) the rhabditform larvæ are passively transferred to their equine bearers either with fresh-cut fodder, or while the animals are grazing; (6) transferred to the intestinal canal they enter the walls of the cæcum and colon, encyst themselves, and undergo change of skin; (7) their presence in the intestinal walls is associated with certain pathological conditions, frequently fatal to the bearer; (8) ordinarily the young worms perforate their cysts and migrate to the lumen of the bowel, and indications of sex appear at this the "Trichonema stage"; (9) they next form cocoons by agglutination of vegetable debris within the gut, and undergo a third skin-casting, with intestinal metamorphosis; (10) lastly, their internal sexual organs and the completion of definite form are acquired within the colon of the host.—A paper was read by Mr. G. Murray on a new species of *Rhipilia* from the Mergui Archipelago. This was collected by Dr. J. Anderson (of Calcutta Museum) in 1882, and recently presented to the British Museum. It was found growing on mud flats at King's Island Bay. The genus *Rhipilia* was established by Kützing for the reception of two species—*R. tomentosa* and *R. longicaulis*—collected by Sonder in the Antilles. To these Prof. Dickie added *R. Ransoni* from Barbadoes. The new species, *R. Andersoni*, differs from the two former in the frond being completely sessile on the mass of rhizoids, and from the latter in the sessile frond being entire. A hitherto unidentified, imperfect specimen brought by Cumming from the East (Philippines?) is now found to be identical with Dr. Anderson's example, which is well preserved in spirit, and thus the Oriental habitat of the genus is corroborated. The author describes minutely and illustrates the remarkable rhizoid filaments of *R. Andersoni*.—A second paper was read by Mr. G. Murray, viz. on two new species of *Lentinus*, one of them growing on a large *Sclerotium*.—Mr. J. G. Baker afterwards gave orally the gist of a communication on a collection of ferns made in North Borneo by the Bishop of Singapore and Sarawak.

Physical Society, February 27.—Dr. J. H. Gladstone in the chair.—Dr. Sydney Young and Mr. D. E. Jones were elected members of the Society.—The following communications were read:—The relations of pressure, temperature, and volume in saturated vapours, by Prof. W. C. Unwin. In the first part of this paper certain formulæ given by Messrs. Ramsay and Young in a recent communication on some thermodynamical relations are criticised. The most important of these is the statement that for different saturated vapours at the same pressure $p\frac{dp}{dt}$ is constant. Prof. Unwin finds, however, that $t\frac{dp}{dt}$ is less constant than $t^2\frac{dp}{dt}$, while $\frac{t^2}{p}\frac{dp}{dt}$ is nearly a constant quantity for all saturated vapours under any conditions. This result suggested that

$$\frac{t^{n+1}}{p}\frac{dp}{dt}$$

might be more nearly constant, and the integration of this gives

$$\log p = a - \frac{b}{t^n},$$

a formula to the examination of which the second part of the paper is devoted. From it may be derived the following relations in which for convenience in calculation the logarithms given are to the base 10.

$$t = \left(\frac{b}{a - \log p}\right)^{\frac{1}{n}}$$

$$\frac{1}{p}\cdot\frac{dp}{dt} = 2{\cdot}3025\,\frac{nb}{t^{n+1}}$$

$$= 2{\cdot}3025\,n\,\frac{(a - \log p)^{\frac{n+1}{n}}}{b^{\frac{1}{n}}}$$

$$\frac{t}{p}\cdot\frac{dp}{dt} = 2{\cdot}3025\,\frac{nb}{t^n},$$

&c. These formulæ have been examined in the case of steam from − 30° to 230° C., and with pressures varying from ·4 to 20,000 mm. The constants were found to be

$$a = 7{\cdot}5030 \quad \ldots \quad b = 7579 \quad \ldots \quad n = 1{\cdot}25,$$

and the differences between the calculated results and the obser-

vations of Regnault and Zeuner rarely exceeded 1 per cent., while generally much smaller. a, b, and n have also been found for some other substances, with the following results:—

Alcohol	$a = 7{\cdot}448$	... $b = 8784$	... $n = 1{\cdot}29$
Ether	$a = 6{\cdot}9068$	... $b = 3047$	... $n = 1{\cdot}153$
Mercury ...	$a = 9{\cdot}8651$	... $b = 597{\cdot}5$	... $n = {\cdot}69$
Carbonic acid	$a = 8{\cdot}4625$	... $b = 302{\cdot}8$	... $n = {\cdot}77$

Prof. Perry offered some criticisms upon this paper, and believed that for practical purposes the expressions given would not be found superior to Rankine's formula

$$\log p = a - \frac{b}{t} - \frac{c}{t^2},$$

which gives p in terms of t, and and a quadratic expression for obtaining t in terms of p. He also observed that the chief aim of Ramsay and Young's paper was to obtain relations between the pressure and temperature of different saturated papers, so that the connection between temperature and pressure having been observed and recorded for one vapour, that for any other vapour could be at once deduced from it.—On a map of the world in which the proportion of areas is preserved, by Mr. Walter Baily. The author had devised a method for constructing such a map, but has subsequently found that one precisely similar was employed by Flamsteed in 1729 for charting the stars in his "Atlas Cœlestis." The construction applied to the earth is briefly as follows. Draw a straight line to represent the meridian that is to occupy the centre of the map. Divide this line into equal parts representing upon a convenient scale the distance between the parallels of latitude, and through these points draw a series of lines at right angles to the original line; these are the parallels of latitude. Mark off on these the actual distances at which the meridians cut them; through the points so found the meridians may be filled in, and the map constructed. From the method of construction it is evident that, although the outlines in the map are distorted, the amount of distortion increasing with the distance from the central meridian, the proportionality of areas is preserved, a fact which the author believes will render the map useful for recording rainfall, depth of sea, ocean currents, &c.—On a delicate calorimetric thermometer, by Prof. S. U. Pickering.

EDINBURGH

Royal Society, February 1.—Mr. J. Murray, Vice-President, in the chair.—Several obituary notices were read.—Dr. Thomas Muir read the second part of a paper on the theory of determinants in the historical order of its development.—Mr. G. Brook communicated a paper on the origin and formation of the germinal-layers in the Teleostei.—Mr. A. C. Mitchell described the results of experiments on the thermal conductivity of ice. A method involving periodic variation of temperature was used.

February 15.—Mr. R. Gray, Vice-President, in the chair.—Mr. W. Durham read a paper on chemical affinity and solution.—Mr. J. T. Cunningham, of the Scottish Marine Station, read a paper on the reproductive elements of *Myxine glutinosa*.—Dr. J. R. Buist communicated a paper on the life-history of the micro-organisms associated with Variola and Vaccinia.—Mr. A. P. Laurie discussed the probable heats of formation of zinc-copper alloys, as determined by observations on the E.M.F. of constant voltaic cells with the alloys as negative elements. His results indicate the formation of a compound of the formula $CuZn_2$ with an evolution of heat producing a fall of E.M.F. equal to 0·5 volt.—Prof. Tait, in a paper on the mean free paths in a mixture of two systems of spheres, generalised his results as given in previous papers.—Prof. Duns read a paper on two shrunk human heads from South America.

March 1.—Prof. Douglas Maclagan in the chair.—Sir W. Thomson read a paper on the magnitude of the mutual attraction between two pieces of matter at distances of less than 10 micro-millimetres.—Prof. Tait read a paper on a theorem in the science of situation.—Mr. John Aitken communicated a paper on radiation from snow, and also a paper on thermometer screens.—Mr. J. H. Pollok discussed the relation between the volume of an aqueous solution of a salt and the sum of the columns of its constituents.—Mr. W. Peddie read a paper on the increase of electrolytic polarisation with time.

Mathematical Society, March 12.—Mr. W. J. Macdonald in the chair.—Mr. Harry Rainy read a paper on bifilar suspension treated by the method of contour lines, and Mr. J. S. Mackay gave an abstract, with notes, of a paper of Euler's, entitled "Solutio facilis problematum quorumdam geometricorum difficillimorum."—A conversation took place regarding work to be done under the auspices of the Society by groups of members, with the result that investigations were undertaken on linkages, projective geometry, and the bibliography of mathematical periodicals.

PARIS

Academy of Sciences, March 8.—M. Jurien de la Gravière, President, in the chair.—Foundation of a hospital for the treatment of rabies. The following articles have been adopted by the Commission appointed by the Academy to promote this object:—(1) An establishment for the treatment of rabies after the bite of a mad animal shall be founded in Paris under the title of "Institut Pasteur"; (2) this Institute shall admit Frenchmen and foreigners bitten by dogs or other mad animals; (3) a public subscription shall be opened in France and abroad for the foundation of this establishment; (4) the funds thus raised shall be applied under the direction of a Committee appointed for the purpose; (5) subscriptions received by the Bank of France and its branches, the Crédit Foncier and its branches, the Treasury, and public receivers. Names of all subscribers to be inserted in the *Journal Officiel*. Amongst the Committee are the names of MM. Jurien de la Gravière, Pasteur, Bertrand, Vulpian, Marey, Paul Bert, de Freycinet, Magnin (Governor of the Bank of France), Baron Alphonse de Rothschild, and the Perpetual Secretaries of the Academies of Sciences, Inscriptions et Belles Lettres, Beaux Arts, and Moral and Political Sciences.—Determination of the elements of refraction: the most convenient practical solution of the problem, by M. Lœwy. Compared with the older methods here passed in review, the new process enables the observer to obtain in a single month a greater precision than was formerly possible after fifteen years of observations and researches of all sorts required to determine the instrumental constants.—Remarks on the danger of fire arising from the use of nitric acid in the manufacture of certain industrial objects, and especially of explosive substances, such as gun-cotton and dynamite, by M. G. Lechartier. Several instances are mentioned of straw and other organic substances when heated, and even at a low temperature, taking fire by accidental contact with this acid.—Equatorial observations of Brooks's, Barnard's, and Fabry's comets, made at the Observatory of Bordeaux in February 1886, by MM. G. Rayet and Courty.—Observation of the nebula in Maia, by M. Perrotin. In a letter addressed from Nice to M. Mouchez the writer states that by masking Maia he was able distinctly to observe the nebula discovered by MM. Henry, first on February 28, and again, in company with MM. Thollon and Charlois, on March 3 and 4.—On the construction of objectives for instruments of precision, by M. Léon Laurent. The objectives here described and illustrated have been executed by practical methods, which, according to the author, yield the best possible results. They have a diameter of 70 mm. with focus 735 mm.—On the isomeric states of the sesquichloride of chromium: gray hydrated chloride; anhydrous chloride, by M. A. Recoura. The author's researches have led to the determination of two isomeric varieties—a gray chloride and a green chloride, with which latter is connected the violet anhydrous chloride. Dissolved in water, both varieties constitute two extreme states capable of being transformed one into the other by passing through all the intermediate states, the gray-blue solution constituting the stable state of the extended solutions, the green solution the stable state of the highly-concentrated solutions. In another paper it will be shown that these are not the only varieties of chloride.—Note on a combination of methylic alcohol and sulphate of copper, by M. de Forcrand.—On the action of ammonia and water on chloroform, by M. G. André. Some details are given regarding the use of ammonia in aqueous solutions, with indications of the relative proportions of the products resulting from this reaction.—Note on the action of picric acid on terebenthene and on thymene, by M. Lextreit.—On the histogenesis of the elements contained in the ovaries of insects, by M. J. Perez.—On the anatomy of the reproductive organs of Pontobdella (*P. muricata*, Leach), by M. G. Datilleul.—A contribution to the study of the Miocene palms of Brittany, by M. Louis Crié.—On the distribution of inverted formations in the region of the Jura comprised between Geneva and Poligny, by M. Bourgeat.—Note on a method of direct analysis of rocks by means of their physical properties, by M. Thoulet. The physical properties of which the author avails himself in this process are weight, specific heat, density, and the coefficient of

cubic expansion (variation of density with temperature), the two last being easily determined even with small samples by means of the fluid of iodides already recommended by him.—Remarks on M. Mushketoff's orographic and geological description of Turkestan, by M. Daubrée. Of the three volumes of explanatory text to the map of Russian Turkestan (scale 1 : 1,250,000), the first has now appeared. It contains a summary of the explorations of Turkestan from the remotest times down to the year 1884, and a geological description of the Aralo-Caspian steppes, with a small geological map of Turkestan.

BERLIN

Physical Society, January 22.—Dr. König spoke of some photometers he had quite recently tested in respect of their precision. The simple Bunsen photometer, consisting of a screen of fine writing-paper smeared with a grease spot, laboured under the drawback that it was not possible to contemplate simultaneously the two sides it was desired to compare. There were several modifications of this apparatus planned with a view to overcoming this defect. First, there was the application of two mirrors inclined at 45°, by means of which both surfaces were seen in juxtaposition. Other contrivances for the same purpose were the application of a prism, the edge of which lay in the plane of the screen, the use of two prisms, and, further, the use of two totally reflecting prisms with lenses. The last-named description of photometer, as also the mirror-photometer, were very exact, but it now appeared that it was not possible to cause the spot of grease wholly to vanish from view. For such precise photometers there would, on the contrary, have to be found two substances which reflected and transmitted the light differently, but yet absorbed it with equal strength and possessed the same structure. Weber's photometer was constructed according to an entirely different principle. It consisted in the main of a small benzene lamp, which was placed in a tube in front of a mirror and which illumined a milk-glass plate displaceable in the tube. From the illumined milk-glass the light was carried to a totally reflecting prism, and thence into the eye-piece, where it lighted up the half of the field of vision. The other half received light from a milk-glass plate standing in the direction of the eye-piece behind the prism. This milk-glass plate was illumined by the light which was to be measured. In the case of like-coloured light the registrations of the Weber photometer were very exact, but in the case of different-coloured lights such precision was not obtained. Of the means employed by Herr Weber to measure different-coloured lights with his photometer, that which consisted in bringing first a red, then a green, and thereafter a blue glass before the eye-piece, and taking the average of the three measurements, was still at this day the most approximately exact, but was yet inadequate. A great advantage belonging to the Weber photometer, on the other hand, was that by means of it the scattered daylight could be measured. The readily available Weber photometer would prove itself particularly useful for the purpose of testing the conditions of illumination in school-rooms.—Dr. Grunmach reported on the barometric investigations carried out by him in the Normal Gauging Office. He described at length the arrangement of the normal barometer, the vacuum of which was measured in an electrical way. A combination of the barometer-vacuum with a Geissler tube permitted the attenuation to be examined even beyond the limits of the pressures measurable by the cathetometer. The occurrence of the phosphorescence light in the spectral tube was a standard for the highest degrees of attenuation, in which the vacuum was filled with quicksilver vapour of the tension of only 0·01 to 0·02. A still better vacuum would be achieved when the quicksilver vapour was made to be absorbed, a condition which the speaker had in vain tried to effect with selenium. With this barometer was compared a large number of normal barometers according to a method described at large by the speaker, and with the application of the developed formulæ of reduction. Under these comparisons it appeared that the impurity of the free quicksilver-cup heightened the meniscus, and thereby the registrations also of the barometer. In the case of older barometers, a series of other disturbing influences likewise showed themselves, which would have to be further investigated. In the discussion which followed this address, Dr. Goldstein proposed for the electrical measurement of the vacuum, instead of Geissler's spectral tube, the employment of a wide tube which let the fluorescence light pass more obviously into the phenomenon; and for the gradu ations of these highest degrees of attenuation the thermometer would, he maintained, be better adapted than were the optical phenomena. Let, namely, a thermometer be brought into a vacuum-tube whose positive pole was a point, but whose negative electrode was a steel plate nearly filling out the tube in front of the cathode: then the thermometer, when the attenuation reached such a degree that the cathode light appeared would mount 80° to 90° above the temperature of the room. At the positive pole the thermometer rose only about 3°. This rise of temperature in the cathode light occurred in connection with the degree of attenuation, and might be utilised for the measurement of these degrees.

BOOKS AND PAMPHLETS RECEIVED

BOOKS :—"Schriften der Naturforschenden Gesellschaft in Danzig," Neue Folge, Sechsten Bandes, Drittes Heft (Danzig).—"The Construction of Harbours," 3rd edition, by Thos. Stevenson (A. and C. Black).—"Three Years of Arctic Service," 2 vols., by A. W. Greely (Bentley).—"The Quarterly Journal of Microscopical Science," February (Churchill).—"Fractional Electricity," by T. P. Treglohan (Longmans).—"Hand-Book of the History of Philosophy," by E. Belfort Bax (Bell).—"Treatise on Statics," vol. ii., 3rd edition, by J. M. Maclean (Clarendon Press).—"Analisi delle Ipotesi Fisiche," by C. Zanon (Tondelli, Venice).—"Proceedings of the American Academy of Arts and Sciences," May to October 1885 (Wilson, Boston).—"Transactions of the Anthropological Society of Washington," vol. iii.—"Proceedings of the Academy of Natural Sciences of Philadelphia," part 3 (August to December 1885).—Memoirs of the Geological Survey of India: "Palæontologia Indica," ser. x.; "Indian Tertiary and Post-Tertiary Vertebrata," vol. iii. parts 7 and 8; "Siwalik Crocodilia, Lacertilia, and Ophidia, and Tertiary Fishes," by R. Lydekker (Trübner).—"Hong Kong Observatory Reports," May to November 1885.—PAMPHLETS :—"On the Movement Cure in China," by D. J. Macgowan.—"The Present Position of the Museum and Art Galleries of Glasgow, 1886" (Anderson, Glasgow).—"Twenty-ninth Annual Report on Free Public Libraries and Museum of Sheffield."—"Les Crânes dits Déformes," by J. Ignaciode Armes (Havane).—"Cellulose," by C. F. Cross and E. J. Bevan (G. Kenning).—"Separatabdruck aus dem Repertorium der Physik," by Dr. F. Exner.—"The Typhoons of the Chinese Seas in the Year 1885: Essay on the Atmospheric Variations in the Far East during January 1885," by R. P. Marc Dechevrens (Kelly and Walsh, Shanghai).

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THURSDAY, APRIL 22, 1886

INJURIOUS INSECTS

Reports on Insects Injurious to Hop Plants, Corn Crops, and Fruit Crops in Great Britain. Prepared for the Agricultural Department, Privy Council Office, by Charles Whitehead, F.L.S., F.G.S. No. II., "Insects Injurious to Corn, Grass, Pea, Bean, and Clover Crops." (1885.)

Reports of Observations of Injurious Insects and Common Farm Pests during the Year 1885, *with Methods of Prevention and Remedy.* By Eleanor A. Ormerod, F.R.Met.Soc., &c. (London: Simpkin, Marshall, and Co., 1886.)

THE first of these works, a Government Report issuing from the press of Messrs. Eyre and Spottiswoode, and bearing the announcement that it was "Presented to both Houses of Parliament by command of Her Majesty," forms the second of the series, and is a very valuable contribution to the knowledge of the insects destructive to crops mentioned above. It will be of great service to agriculturists, whether scientific or otherwise, as the whole Report from beginning to end is written in a clear and concise manner, without losing any of its accuracy. The Report occupies seventy pages, and of these, forty-nine pages are devoted to "Insects injurious to corn and grass crops." From p. 50 to 56 "Insects injurious to corn in store" are treated of, and from p. 57 to the end "Insects injurious to pea, bean, and clover crops" are dealt with. Each insect has a separate article devoted to it, uniformly treating first of the habits of the creature, the manner and extent of its devastations, then under separate heads the life-history is given, prevention, and remedies.

The crane-fly, or more popularly the daddy-long-legs (*Tipula oleracea*, L.), comes in for a considerable share of attention. Mr. Whitehead reminds us that "It is the larvæ or grubs that injure plants of corn and grass, by attacking them with their strong jaws and eating into them just beneath the surface of the ground, so as either to kill them or make them weak and sickly. In the early spring, if wheat plants which show signs of failing are examined, large ash-grey grubs or maggots will often be found close to the affected plants. Oats and barley are equally liable to harm from these grubs, not perhaps quite to such an extent as autumn-sown wheat, and especially wheat sown after clover leys."

Mr. Whitehead gives the following estimate of loss occasioned by these insects:—"A field of oats sown on March 1, after clover, was attacked by these grubs. Although it was an even strong plant, it was soon nearly half devoured, and, instead of nine quarters per acre being obtained, as might have been expected from the state of the land, and the circumstances of its cultivation, and the produce of other land hard by, only about four quarters per acre were grown. It is computed that the loss in this case amounted to 80*s*." As an illustration of Mr. Whitehead's manner of treating the life-history of the several insects, the following quotation from that of the daddy-long-legs will suffice:—"The life-history of the crane-flies, both of the *Tipula oleracea* and its close congener *Tipula maculosa*, is simple. The eggs are small, oval, conical grains, shining and black as ebony (as Curtis writes), forming a mass which occupies nearly the whole of the abdomen. As many as 300 have been found in one female. These are deposited, in the autumn, upon grass and herbage, and more frequently in the ground. Wet, undrained meadows and marshy and damp places are preferred by these insects, and the conditions of such spots are probably favourable to the preservation and the ultimate hatching of the eggs. This hatching takes place in the early spring, directly the weather becomes mild. . . . After hatching, the maggots or larvæ grow fast until they become an inch in length. Labourers call them 'leather jackets' because of their tough skins. Their colour is of the earth, with a slight dash of grey or ash colour in it. Although they have no legs, they are able to move rapidly from place to place, and burrow in the ground. It is in this grub form that they do mischief to crops, and they remain in this stage of their existence until the beginning of July, at which period they change into pupæ under the surface of the soil. After a while the pupæ work their way up to the light by means of hooks or recurved spines, and in a short time the crane-flies appear, and soon unfold their long wings and fly away to commence a new series."

After some further notes descriptive of the insects, some instructions are given under the heads of Prevention and Remedies.

It will be seen that the mode of imparting information is of the simplest and clearest description, and in this as well as in the manner of treatment the author has followed Miss Ormerod in her well-known manual, and moreover he frequently quotes her views and opinions expressed throughout her valued reports.

Just as we are finishing this notice Miss Ormerod's ninth annual "Report of Observations of Injurious Insects and Common Farm Pests during the Year 1885, with Methods of Prevention and Remedy," comes to hand. Like its predecessors, it is full of interesting and valuable records. Miss Ormerod has still something more to say on that general pest referred to above—the daddy-long-legs. It is, perhaps, not generally known how difficult the grubs are to kill, but Miss Ormerod's experiments, as recorded in a previous Report, proved that they could endure almost any amount of freezing and yet come to life as the season returned. Speaking of the grubs, one correspondent, in the Report before us, says:—"In my experience, any chemicals applied for their destruction when they begin to make their ravages must destroy the grain. I have had them covered with salt and soot over night, and they have been alive in the morning." Miss Ormerod here notes that "This observation quite agrees with the result of the experiments of Mr. Ralph Lowe (noted p. 26 of Report for 1884), in which grubs covered respectively with quicklime, soot, household salt, and superphosphate, and also some placed in earth mixed with one-fourth of white arsenic, were not at all the worse, excepting those that had been in the arsenic, and even these recovered before the following day. But nitrate of soda had much more serviceable effects."

It is satisfactory to find that the cases of injurious insects which were exhibited for so long a time in the Bethnal Green Museum are being thoroughly overhauled.

Miss Ormerod remarks in the preface to her Report that the rearrangement of these cases, in which are shown insects injurious to crops, fruit, and timber, is now in progress, and promises to be of practical service. "The insects exhibited are for the most part those which are serious in their ravages, and, as far as is possible, they are shown in their various stages (either by specimens, drawings, or models), with samples of injury caused by them accompanying."

Appended to the Report are some special observations on the warble-fly or ox-bot-fly.

ACROSS THE JORDAN

Across the Jordan: Being an Exploration and Survey of Part of Hauran and Jaulan. By Gottlieb Schumacher, C.E. With Additions by Laurence Oliphant and Guy Le Strange. (London: R. Bentley and Son, 1886.)

THIS volume is the last of several recently published by the Committee of the Palestine Exploration Fund, following quickly on the steps of Conder's "Heth and Moab" and Hull's "Mount Seir," and describes with great accuracy a district lying to the east of the Sea of Galilee not often visited; or, if visited, only hastily skirted, by travellers on the road from Jerusalem to Damascus. How little is known of its geographical details may be gathered from a comparison of the excellent map which faces the title-page of the book with any of the best maps now published. The district described embraces the eastern part of the Jaulan and the western of the Hauran, and is remarkable for the number and variety of its works of ancient art, dating from the time of the dolmen-builders to those of the Crusaders, and including structures referable to Jewish, Greek, Roman, and Christian times. How this region came to be explored is narrated by Mr. Walter Besant in the preface. It appears that about a year ago a firman was granted by the Porte for the survey of the district lying between Haifa on the Mediterranean and Damascus, with a view to the construction of a railway. For the western part of this route, namely, that between Haifa and the Jordan Valley, the maps of the Palestine Exploration Society afforded the necessary details; but from the Jordan to Damascus the line of country had to be specially surveyed, and this work was intrusted by the *concessionnaires* to Herr Gottlieb Schumacher. In the course of his work Herr Schumacher was able to make many scientific observations, as well as maps and drawings of villages, structures, and works of art, which he afterwards embodied in the memoir forming the greater part of the present volume. A ready means of publication was found in the active Society which has done so much in elucidating, and embodying in maps and memoirs, the topographical details of Palestine and its borders.

To the geologist, as well as to the antiquarian, the region of the Jaulan and Hauran is full of interest, and the author has added some details on its geological structure which are very acceptable. The best and most recent observations on this subject are those of Prof. L. Lartet, and contained in his work on the geology of the Dead Sea.[1] The country, as is well known, is volcanic, and is largely covered by sheets of basalt, scoriæ, and ashes which have been erupted from numerous vents, some of which lie in the district here described. Several of these, such as Tell-ej-Jabiyeh and Tell-ej-Jemûʻah, reach an elevation of considerably over 2000 feet above the Mediterranean, and therefore of nearly 3000 feet above the surface of the Sea of Galilee. The southern margin of the Jaulan region, as well as of the basaltic formation, is marked by the deep gorge of the Yarmûk (Hieromax of Pliny), to the south of which the soft *Cretaceo-Nummulitic* limestones reach the surface and afford a genial soil to forests of oak. The Yarmûk receives several tributaries from the north, now correctly mapped for the first time, which lay open on their banks fine sections both of the volcanic rocks and of the underlying chalky limestones; and these streams, which are large and swift, are often precipitated over cliffs of basalt, forming fine cascades. One of these in the Wady Seisûn, a tributary of the Rukkad, has a fall of 100 feet, and then, pursuing its course by a succession of cataracts, unites with the larger stream after falling 517 feet in 420 yards. The Rukkad rises at the foot of Mount Hermon Jebel-esh-Sheikh), a little above the village of 'Ain-el-Berbab, and, upon the melting of the snows in early summer, sends a large flood of water into the Yarmûk It is remarkable, however, that none of these streams depend altogether on surface drainage for their permanent supplies, as they have their sources in springs; and the combined volume of these waters goes to form a river of equal volume with that of the Jordan itself where it leaves the Lake of Galilee. There are clear indications of the existence of large underground reservoirs of water in the basaltic and calcareous formations. The winter snows and "the former and latter rains" of autumn and spring rapidly sink into the fissured and broken strata, and are pent up, either in the mass of the rock itself, or in caverns which have been formed in the limestone by the solvent action of percolating water. These waters probably accumulate under the tracts sloping towards the south from the base of Hermon to the north of the Yarmûk Valley, and when a vent is formed rise to the surface with force. One of these springs, that of Râs-el-'Ain at the village of El Mezeirîh, fills a considerable basin, and is two to three yards across and about two feet deep at its source; others are of nearly equal copiousness and more or less thermal.

The physical phenomena connected with the district described by Herr Schumacher have their counterpart in the volcanic district of Central France, with this exception, that there do not appear to be any examples of the highly silicated class of lavas, such as domite, trachyte, &c., which we generally find associated with the basic varieties. As regards the geological age of the volcanic outbursts, the question is brought within narrow limits by their relations to the Cretaceo-Eocene limestones. Both these formations appear to have been not only deposited, but subsequently upraised and largely denuded, before the volcanic lavas issued forth from their subterranean reservoirs. As this movement and denudation of the strata took place in the Miocene epoch, the volcanic eruptions may be referred, with little uncertainty, in the main to the succeeding Pliocene; an epoch remarkable for outbreaks of vulcanicity over large portions of the globe. At

[1] "Voyage d'Exploration à la Mer Morte," par M. le Duc de Luynes; tome 3me, "Géologie" (Paris).

the same time it is not improbable that the first outbursts may be dated back to the later Eocene, and the last to the period when the waters of the great Jordan-Valley Lake had receded from their original limits to those within which they are now restricted.

The physical details form but a small part of the volume, which contains a large number of carefully drawn figures of works of art and architecture, accompanied by descriptive text, showing that the region, now the abode of Fellahin—or of migratory Arabs—was one of importance during long centuries of successive dynasties and races. The book cannot fail to be of value to students of Biblical and ancient history, and we are promised by Herr Schumacher descriptive drawings and maps of another section of the Hauran country.

HARBOURS

The Design and Construction of Harbours. A Treatise on Maritime Engineering. By Thomas Stevenson, P.R.S.E., &c. Third Edition. Pp. xiv. + 355. Twenty-four Plates. (Edinburgh: A. and C. Black, 1886.)

THIS work is a reprint, with large and valuable additions, of the article "Harbours" in the Encyclopædia Britannica." Its importance may be gauged from its acceptance in successive editions of that "Encyclopædia, and from its having passed into three editions in the separate and enlarged form.

An important feature is the attempt to lay down general principles, and to discuss and reduce as far as possible to calculation the effect of the great forces of wind and water, and to regulate both the general design and the details of constructions thereon. To the earlier engineers this was mere guesswork, *e.g.* Smeaton is said (p. 41) to have described these forces as "subject to no calculation." Many striking instances of the maximum effect of wind and waves are given, *e.g.* at the top of Whalsey Skerries (Zetland), at a height of 74 feet above high water, large blocks up to 13½ tons were found to have been lifted and transported by the waves (p. 45). Again, two blocks of 1350 tons and 2600 tons were shifted bodily at the Wick breakwater in two storms in 1872 and 1877. At Dunbar, pressures of 3½ tons per square foot for the direct wave-action (p. 56), and of 1 ton per square foot for the back-wash (p. 131), were recorded upon a dynamometer of the author's invention; and, by use of two instruments at different levels, it was found that the pressure at the upper level may (exceptionally?) be twice that at the lower level (p. 56). It is much to be wished that extensive and systematic observations of this kind were made, as instances are quoted wherein only 80, 144, and 70 lbs. per square foot had been assumed in the design of lighthouses and harbours (p. 58). Scott Russell's opinion is quoted (p. 106), and accepted, that the most violent action on sea-works is from those waves which form ground-swell or rollers, and are "waves of translation," *i.e.* vast masses of solid water moving horizontally with great velocity; and that the only way of opposing them is by masses too heavy for them to move.

A useful feature of the work is the presentation of 28 cross-sections of quay-, dock-, and harbour-walls, and breakwaters, beginning with the jetty of old Dunkirk (1699); also of 10 cross-sections of lighthouses, beginning with Winstanley's Eddystone (1699).

A chapter (47 pp.) is devoted to materials. A good deal is said about their decay under water. No ordinary material seems free from this. All timber is eventually destroyed by borers (oddly termed *insects* in this work!) of different sorts; even greenheart and creosoted timber, till recently thought borer-proof, have now given way to their special borers. Most stone, and even rock *in situ*, has its own special borer. Iron gives way by rusting, perhaps at a rate of three-quarters of an inch in a century. Bronze alone seems to stand sea-water, but is too expensive to be extensively used.

Ten pages are given to the use of Portland cement concrete, and some remarkable instances of its use are detailed, *e.g.* the concrete cylinder foundations (12 feet diameter, 30 feet length) of the Plantation Quay at Glasgow, and the use of 350-ton blocks (say 5000 cubic feet) laid in 24 feet of water at Dublin (1885).

Attention is drawn to a new and seemingly very promising American cement styled "carbonite," which is said to stand an ultimate pressure of 8000 lbs. per square inch, or *eight times* as much as Portland cement. Trial of this cement in England is much to be wished. Its preparation is apparently a secret, as though four pages are devoted to its use and properties, its main ingredients are only hinted at as being various hydrocarbons.

Two chapters (39 pp.) are given to the difficult subjects of training works for preserving the outfall of harbours and rivers, and preventing silting in estuaries. An interesting instance of the great commercial advantage of even a small increase of depth in a harbour is that of Leith, where an addition of only 2 feet of depth at the Albert Dock gave 296 tides yearly of 23 feet depth against 102 tides of that depth at the Victoria Basin.

Attention is drawn to the disadvantage of harbours being constructed as local instead of as national works. Want of funds has thus repeatedly led to harbours being designed too small for future wants, and being afterwards enlarged at greatly increased cost, the whole works having to be destroyed to make way for the new.

One of the least satisfactory parts of this work is the formulæ, the range of applicability of several of the empirical ones being very doubtful. One (which should have been definite) on strength of lock-gates (p. 191) is misprinted

$$S = \tfrac{1}{2} W \sec\phi + \tfrac{1}{20} \operatorname{cosin}\phi.$$

By reference to the original (*Trans.* Inst.C.E., vol. i. p. 67) it is seen to be

$$S = \tfrac{1}{2} W \sec\phi + \tfrac{1}{20} W \operatorname{cosec}\phi.$$

Moreover, the meaning of W is misquoted as "pressure on the length of the gate, &c.," instead of "pressure on the length l, &c." (l being only the half-breadth of lock), and the meaning of the result S is given, in words which are barely intelligible, as "whole transverse strain at angle ϕ": the context of the original shows that this should be "whole transverse strain applied at middle of gate" (strain being understood to mean pressure). These defects occur in the "Encyclopædia Britannica" (9th ed.) as well as in the separate work (3rd ed.).

On p. 243 a table of values of a "constant" of strength of various timbers is given without explanation of the meaning of the "constant."

Space might have been saved by the exclusion of special subjects, *e.g.* lighthouse apparatus, &c., which could not be treated at adequate length.

A short glossary of uncommon terms would have been decidedly useful, *e.g.* alveus, bollard, kant, pawl, scend, staith.

These blemishes are, however, small compared with the great merit of the work as a whole, which deals with the difficult and important subject of harbours in a thoroughly masterly manner.

ALLAN CUNNINGHAM, (Major, R.E.)

OUR BOOK SHELF

A First Course of Physical Laboratory Practice. By A. M. Worthington, M.A., late Assistant Master at Clifton College. (London: Rivingtons, 1886.)

PROBABLY no one has so successfully carried on practical science teaching in schools as the author whose excellent work at Clifton College has done so much to gain for that institution an enviable reputation. He therefore is specially fitted to write a "First Course of Physical Laboratory Practice" which shall contain just that which the schoolmaster who is endeavouring to supplement mere lectures with the necessary practical work requires.

In the introduction the author explains the system of science teaching at Clifton. He insists on the importance of from the first making boys themselves measure and experimentally confirm geometrical, mechanical, and physical laws, not necessarily with expensive and elaborate apparatus, such as may be best suited for making determinations of the greatest accuracy, but by the most simple and obvious methods, which are likely to lead to results quite accurate enough to show the truth of the law being examined. The pupil is thus from the first taught to learn the value of simple and often extemporised apparatus, instead of acquiring the very general distrust in anything that has not been highly finished by the professional instrument maker.

Here much that is of great value to those intending to introduce practical science teaching into schools will be found, such as descriptions of fittings, original and working cost, and the time that the several courses of instruction should occupy.

The book is divided into nine parts as follows:—1, Mensuration, 23 experiments; 2, Hydrostatics, 15 experiments; 3, Barometer and Boyle's Law, 3 experiments; 4, Mechanics, 39 experiments; 5, Elasticity, 20 experiments; 6, Heat, 42 experiments; 7, Magnetism, 55 experiments; 8, Statical Electricity, 57 experiments; 9, Current Electricity, 16 experiments. The two branches of physics, light and sound, are not included.

The first part is especially valuable as an introduction to laboratory practice of any kind. It is full of examples in which a good way of observation is contrasted with one or more bad ways, so that the pupil soon learns, or ought to learn, method in observation, to choose that way in which error of observation shall least affect the result.

If it is possible to point out any parts as being more excellent than the rest, the chapters on mechanics and elasticity may be mentioned. It is shown how, by means of one or two boxwood scales, a few weights, some pieces of catapult india-rubber (but for sufficient reasons it is not called catapult india-rubber), and some other equally simple and easily obtained articles, a course of experiments of the utmost value can be performed. A pupil must, if he gives his mind to the subject, learn more of the principles of mechanics, of the reasons of things—not the mere "pulley, wedge, and lever" mechanics of the ordinary text-books—than as yet the majority of people have ever acquired.

There is only one sentence which might with advantage be modified as being not strictly correct, though any false impression which it would produce might be removed by the more exact statements five pages later. Having shown that the bending of a lath depends on its length, the author proceeds to show that thickness affects the bending. He says:—"Now take a lath of double the thickness, or, what is the same thing, lay on the first lath a second similar one, and put on the same weight, . . . This would be a serious blunder to make if the effect of depth were not well shown later. As the fact that the stiffness of a beam is directly proportional to its width is explained by considering it as equivalent to beams side by side, the opportunity is lost, when the effect of depth is considered, of showing that a beam is *not* equivalent to beams lying above one another, and why.

As a text-book for school use, Worthington's "First Course of Physical Laboratory Practice" is highly to be recommended.

Lectures on Heat, Sound, and Light. By Richard Wormell, D.Sc., M.A., Head Master of the City of London Middle-Class Schools. (London: Thomas Murby.)

THE distinguishing feature of this book is its gradually progressive character. The subjects are supposed to be taken in the order in which they are given. "*Heat* being far simpler in itself, and so much easier to explain, is placed first, while *Light*, being essentially more intricate than either *Sound* or *Heat*, is placed last." The lectures on *Heat* are adapted to the minds of pupils when first receiving instruction in a scientific subject; as the mind develops the lectures advance in character, so as to make full use of the increased intelligence of the pupil, and ultimately, when light is reached, the perfection of the undulatory theory can be presented with some hope of its being appreciated.

After each of the three parts questions are given, and, what is far more valuable, a few pages of instruction in laboratory practice.

The book is illustrated by many figures, which are often explanatory diagrams rather than pictures. Such diagrams have far more educational value than cuts from photographs of apparatus, but the want of proportion may be carried so far as to give a misleading idea of what a thing is really like—thus, the gridiron pendulum is shown nearly as wide as it is long.

There is a curious slip in Fig. 30, which shows how waves travelling along paths differing by half a wave-length come together again in opposite phases, and so neutralise one another; while, if there is a difference of one or more complete wave-lengths, the phase is the same, and they reinforce one another. The slip—it can hardly be called more than a slip—consists in showing the *same* number of wave-fronts in the longer as in the shorter path.

That the book should contain much that is excellent is only to be expected of an author of such experience, while the necessity for turning to such trivial details for criticism is sufficient to show that fault of a serious kind cannot be found.

Une Expérience sur l'Ascension de la Sève chez les Plantes. Par Léo Errera, Professeur à l'Université de Bruxelles. *Comptes rendus* de la Société Royale de Botanique de Belgique, tom. xxv. 2ième partie, 1886.

THIS paper contains an interesting contribution to the question of the course taken by the sap of vascular plants on its way from the roots to the leaves. The view taken by Sachs, that the current passes through the substance of the lignified cell-walls, has, as is well known, been disputed by Böhm, Elfving, and many others, who maintain that it ascends through the cavities of the vessels and tracheides. Various observers have endeavoured to bring the question to an experimental decision by stopping up,

in one way or another, the cavities of the water-conducting elements, and then observing whether the current is interrupted. Sachs and Dufour endeavoured to attain this result by sharply bending the stems of actively-transpiring plants, but this method is obviously unsatisfactory, owing to the difficulty of proving that the cavities are completely closed. Elfving attacked the problem in a different way. He injected portions of the stem of woody plants with cocoa-butter, melted at a temperature of 30° C., and satisfied himself that the cavities were really filled up when the injected material had solidified. Under these conditions he found that a pressure of 60 cm. of mercury failed to force any water through the wood, though before the injection 1 cm. of water had sufficed to cause filtration.

To Elfving's experiment two objections have been made. On the one hand, Dufour urged that the absence of the action of transpiration, rather than the closure of the cavities, might well explain the result of the experiment. On the other hand, it was objected by Scheit that the action of the fatty cocoa-butter on the membranes would probably render them impermeable to water, and thus account for a negative result. Prof. Errera has succeeded in modifying Elfving's method in such a way as to meet both these objections.

In the first place, actively transpiring branches were employed for the investigation, *Vitis vulpina* being selected for experiment on account of the large diameter of its vessels. Secondly, instead of cocoa-butter, a solution of gelatine melting at 33° C. was used as the injecting material. This was coloured with Indian ink, so that its presence in the vessels might be easily demonstrated. The action of transpiration was in most cases assisted by the pressure of a column of water 50 cm. in height. The experiments were carried out with all possible precautions, and the result in every case was that the injected branches took up no water, and faded in a few hours, while, under precisely similar conditions, uninjected branches remained perfectly fresh for three days at least, and during that time transpired many cubic centimetres of water. For details and numerical results we must refer to the original.

Prof. Errera's experiments certainly add greatly to the already strong probability that the cavities of the tracheal elements of the wood constitute the channels through which the sap ascends. D. H. S.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

The Lost Found—Boole Justified and Monge Reinstated in His Rights by Prof. Beman of the University of Michigan, U.S.

In the report of my public lecture on Reciprocants, published in NATURE of January 7 (p. 222), mention is made of a formula, given by Boole in his book on "Differential Equations," which he ascribes to Monge.

Endeavours were instituted in London, Cambridge, and Paris to ferret out the passage in Monge in which it occurs, and very diligent search was made, as well in the printed works as in the manuscripts of Monge in the library of the Institute, to accomplish this object.

But all these researches were fruitless, and the opinion was come to by the compatriots of Monge that Boole had made a misquotation, and that the formula ascribed by him to Monge was not to be found in his works. The formula is one of very great interest, as being the first instance on record of a multinomial projective reciprocant.

Knowing how scrupulous and painstaking Boole was, and the least likely of all men to make a quotation at random, I never acquiesced in this belief, but entertained little or no hope that any one would ever succeed in unearthing a reference which had defied all the endeavours of Monge's own countrymen to verify.

But fate had designed otherwise, as will be seen from the subjoined letter. In addition to the satisfaction of a controverted point being settled and Boole's character freed from a rash imputation of inaccuracy, it is to my mind, and will probably be so to many of the readers of NATURE, a peculiar source of pleasure to contemplate the occurrence as an illustration or note of the unity not merely of occupation, but of feeling also, which binds together mathematical workers in all parts of the world.

To think that a task found impossible in London and Paris should have been accomplished in the most satisfactory manner at Yale and Michigan!

Without further comment I submit the letter in its entirety as written, for the insertion which it so well merits in the world-wide-diffused columns of NATURE, and think that all its readers will join with me in according a cordial vote of thanks to Prof. Beman for his valuable contribution to mathematical history.

University of Michigan, Ann Arbor, Michigan, April 3, 1886

PROF. J. J. SYLVESTER, Oxford, England

DEAR SIR,—You will find Monge's form of the differential equation of the conic in his memoir, "Sur les Équations différentielles des Courbes du Second Degré" (Corresp. sur l'École Polytech. Paris, ii., 1809-13, pp. 51-54), and in *Bulletin de la Soc. Philom.*, Paris, 1810, pp. 87, 88; the first as having been contributed directly by Monge, and the second as having been copied from the first.

I have not *seen* the journals myself, but the references have been *verified* for me at the Yale College Library. The actual form is "$9q^2t - 45qrs + 40r^3 = 0$."

The term "Mongian" can now be used without hesitancy by you.

I remember noticing this form when I began reading Boole's "Differential Equations," and I also noticed Halphen's method in Jordan's "Cours d'Analyse." It never occurred to me that Halphen considered the *form* original with himself; I thought that his *method*, probably, of deducing it was different from Monge's.

With kind recollections of having met you at Johns Hopkins once upon a brief visit when Prof. Cayley was there,

I am yours very sincerely,
W. W. BEMAN,
Assoc. Prof. Math.

Since writing the above, in fact this very afternoon, I have received a letter from the Universal Knowledge and Information Office containing the same references as those given by Prof. Beman, which will speak for itself, and cannot fail to draw the attention of the readers of NATURE to the important service which this Society is capable of rendering to all engaged in research of whatever nature in enabling them to discover the origins and hunt up the authorities of any subject on which they may desire to obtain information.

It is certainly a singular coincidence that after the lapse of four months the desired information in this case should have reached me from such widely distant sources at an interval of less than forty-eight hours. The letter, which I inclose, is well deserving of setting out in full. The reference made to the circle at the end is extremely interesting, as it contains an example of a non-homogeneous mixed reciprocant, which in the notation now in use might be written $(1 + t^2)b - 3ta^2$. Or rather, adopting the improved notation, in which $t, a, b, \ldots$ represent

$$\frac{dy}{dx}, \frac{1}{1.2}\frac{d^2y}{dx^2}, \frac{1}{1.2.3}\frac{d^3y}{dx^3}, \ldots$$

it takes the form

$$(1 + t^2)b - 2ta^2.$$

London, April 15, 1886

DEAR SIR,—I am instructed by the management to send you the following in reference to your question relating to the attribution of the differential equation

$$\left(9\left(\frac{dy}{dx^2}\right)^4 - 45\frac{d^2y}{dx^2}\cdot\frac{d^2y}{dx^3}\cdot\frac{d^1y}{dx^4} + 40\left(\frac{d^3y}{dx^3}\right)^3 = 0\right)$$

to Monge by Boole in his "Differential Equations."

In the *Nouveau Bulletin des Sciences, par la Société Philomathique de Paris*, tome ii., Paris, 1810, occurs this passage:—

"Mathématiques.—Sur les Équations différentielles des Courbes du Second Degré, par M. Monge. L'équation générale des courbes du second degré étant

$$Ay^2 + 2Bxy + Cx^2 + 2Dy + Ex + 1 = 0,$$

dans laquelle A, B, C, D, E sont des constantes, M. Monge donne l'équation différentielle débarrassée de toutes ces constantes, et il parvient à l'équation suivante, du cinquième ordre,

$$(A) \qquad 9q^2t - 45qrs + 40r^3 = 0,$$

les quantités r, s, t, étant définies par les équations suivantes:

$$\frac{dy}{dx} = p, \quad \frac{dp}{dx} = q, \quad \frac{dq}{dx} = r, \quad \frac{dr}{dx} = s, \quad \frac{ds}{dx} = t.$$

"Il faut ensuite voir l'usage de l'équation (A), pour trouver l'intégrale d'une équation d'un ordre inférieur qui satisfait à cette équation (A); ainsi étant donnée l'équation différentielle $(1 + p^2)r = 3pq^2$, il parvient à l'intégrale $(x - a)^2 + (y - b)^2 = c^2$, qui est l'équation d'un cercle.

"La même méthode pourroit s'appliquer aux équations des courbes d'un degré supérieur au second."

A note is added to the effect that "Cet article est extrait de la Correspondance de l'École impériale Polytechnique, rédigée par M. Hachette: 1r cahier du 2e volume, 1810." The press mark of this work at the British Museum is PP. 1543.

Trusting that this is the reference you are in search of, and that the long delay in the discovery of it may be excused when the difficulty of identifying a particular passage (known perhaps only in its full extent to those whose chief work is concerned with such matters) is considered.

I remain, Sir, faithfully yours,
H. Fisher

Prof. J. J. Sylvester, &c., &c.

New College, Oxford, April 19 J. J. Sylvester

On the Velocity of Light as Determined by Foucault's Revolving Mirror

It has been shown by Lord Rayleigh and others that the velocity (U) with which a group of waves is propagated in any medium may be calculated by the formula—

$$U = V\left(1 - \frac{d\log V}{d\log\lambda}\right),$$

where V is the wave-velocity, and λ the wave-length. It has also been observed by Lord Rayleigh that the fronts of the waves reflected by the revolving mirror in Foucault's experiment are inclined one to another, and in consequence must rotate with an angular velocity—

$$\frac{dV}{d\lambda}\alpha,$$

where α is the angle between two successive wave-planes of similar phase. When $dV/d\lambda$ is positive (the usual case), the direction of rotation is such that the following wave-plane rotates towards the position of the preceding (see Nature, vol. xxv. p. 52).

But I am not aware that attention has been called to the important fact, that while the individual wave rotates the wave-normal of the group remains unchanged, or, in other words, that if we fix our attention on a point moving with the group, therefore with the velocity U, the successive wave-planes, as they pass through that point, have all the same orientation. This follows immediately from the two formulæ quoted above. For the interval of time between the arrival of two successive wave-planes of similar phase at the moving point is evidently $\lambda/(V - U)$, which reduces by the first formula to $d\lambda/dV$. In this time the second of the wave-planes, having the angular velocity $\alpha dV/d\lambda$, will rotate through an angle α towards the position of the first wave-plane. But α is the angle between the two planes. The second plane, therefore, in passing the moving point, will have exactly the same orientation which the first had. To get a picture of the phenomenon, we may imagine that we are able to see a few inches of the top of a moving carriage-wheel. The individual spokes rotate, while the group maintains a vertical direction.

This consideration greatly simplifies the theory of Foucault's experiment, and makes it evident, I think, that the results of all such experiments depend upon the value of U, and not upon that of V.

The discussion of the experiment by following a single wave, and taking account of its rotation, is a complicated process, and one in which it is very easy to leave out of account some of the elements of the problem. The principal objection to it, however, is its unreality. If the dispersion is considerable, no wave which leaves the revolving mirror will return to it. The individual disappears, only the group has permanence. Prof. Schuster, in his communication of March 11 (p. 439), has nevertheless obtained by this method, as the quantity determined by "the experiments hitherto performed," $V^2/(2V - U)$, which, as he observes, is nearly equal to U. He would, I think, have obtained U precisely, if for the angle between two successive wave-planes of similar phase, instead of $2\pi\lambda/V$, he had used the more exact value $2\pi\lambda/U$.

By the kindness of Prof. Michelson, I am informed with respect to his recent experiments on the velocity of light in bisulphide of carbon that he would be inclined to place the maximum brilliancy of the light between the spectral lines D and E, but nearer to D. If we take the mean between D and E, we have—

$$\frac{K}{U} = 1{\cdot}745, \qquad \frac{K(2V - U)}{V^2} = 1{\cdot}737,$$

K denoting the velocity *in vacuo* (see *Amer. Jour. Sci.*, vol. xxxi. p. 64). The number observed was 1·76, "with an uncertainty of two units in the second place of decimals." This agrees best with the first formula. The same would be true if we used values nearer to the line D.

J. Willard Gibbs

New Haven, Connecticut, April 1

The Effect of Change of Temperature on the Velocity of Sound in Iron

I venture to draw attention to an error relating to the above subject, which, originating with Wertheim, still holds a place in some of our modern books on science. According to Wertheim, the velocity of sound in iron and steel is *increased* by rise of temperature not extending beyond 100° C. Now in no sense whatever is this statement correct. It is true that the longitudinal elasticity of iron, as determined by the static method, will be found greater at 100° C. than at 0° C., provided *we begin with the lower temperature first and the wire has not, after the original annealing, been previously raised to* 100° C.; but the apparent *temporary* increase of elasticity is really a *permanent* one (*Phil. Trans.*, part i., 1883, pp. 129–131), and if the wire be repeatedly heated to 100° C. and afterwards cooled, subsequent tests will always show a *less* elasticity at the *higher* temperature than at the lower, if *sufficient rest after cooling be allowed*. When, however, we come to such small molecular displacements as are involved in the passage of sound through a wire, even the apparent increase of elasticity mentioned above vanishes. I have been able to prove that, when an iron or steel wire is thrown into longitudinal vibrations, so as to produce a musical note, the pitch of this note becomes *lower* as we *raise* the temperature, *even when the wire is heated for the first time* after it has left the maker's hands.

It seems rather strange that this error should have so long been allowed to remain uncorrected, for it has been known for many years that the pitch of a tuning-fork made of steel is lowered by small rises of temperature, and the main part of this lowering must be due to the *decrease* of elasticity of the steel.

Herbert Tomlinson

King's College, Strand, April 10

Sound-producing Apparatus of the Cicadas

With regard to the above subject, treated of in an article by Mr. Lloyd Morgan in February last (Nature, February 18, p. 368), I may mention that some time ago I examined the drum of the common cicadas found plentifully in the Himalaya near Simla, and which in the evenings send forth a deafening roar from the rhododendron-trees like the whirr of large machinery. Generally the arrangement of the drum and the powerful muscles was as figured by Mr. Morgan, but I also noticed the following particulars not mentioned by him.

The chitinous rods in the membrane of the drum were not parallel, but converged slightly towards one point of the mem-

brane. The effect of this when the sound-producing motion set in was to cause the membrane to wrinkle sharply towards the point of convergence; and, by experiment on the dead insect with the point of a pencil, it was easy to see that the sound was simply produced by this sharp wrinkling of the membrane. If a piece of stiff paper or parchment be held in the fingers, and the thumb be made to play sharply and rapidly upon it in succession, so as to produce a "kink" or wrinkle each time, a very fair representation of the sound of the insect will be produced. A captive insect, when the motion is slowing down, can be advantageously watched; it will then be seen that, as the sound divides up into separate clicks, the membrane becomes alternately wrinkled and flat. Beyond doubt the sound is no humming.

C. S. MIDDLEMISS

North-West Himalaya, March 14

Ferocity of Animals

I HAVE read with interest the article by Prof. Lloyd Morgan "On the Study of Animal Intelligence" in the present number of *Mind*, in which he touches upon the subject of entangling fact and inference which attracted my attention when reading "Mental Evolution in Animals" some time since.

I write to call Prof. Morgan's attention to the excellent example of "ejective inference" given by Dr. Romanes in his letter in NATURE for April 1 (p. 513), where he says of a rat that he "perfectly understood my object." Would it be troubling Dr. Romanes too much to ask him to explain the appearance a *wild* rat presents on "perfectly well understanding" the object of a human being's actions?

Churchfield, Edgbaston, April 5 F. H. COLLINS

Tropical Dew

HAVING had occasion to lay out a large quantity of iron hoes and picks, without handles, on the hard ground of an open inclosure in one of the driest districts in India (Bellary), where, in fact, these implements had been collected in the face of a scarcity, it was found, after they had lain a couple of months, that a thick, weedy, but luxuriant vegetation had sprung up, enough, though there had been no rain, to almost hide the tools.

The effect depositing tools on grass has had in stimulating its growing the writer has observed in the tropics before, but was at a loss to account for it, except upon some irresolvable theory of radiation or magnetism.

The whole phenomenon is cleared up by Mr. Aitken's paper on "Dew" in NATURE of January 14 (p. 256), dew being proved deposited, not, as generally thought, from the air above, but rising and conden ing from the soil below; and the ground in India is always hygroscopic. The outer surfaces of the iron tools radiate of course quickly at night, and the stratum of air inclosed between the metal under surfaces and the earth is therefore saturated with condensing moisture.

That iron gratings laid on bare ground will raise a rank vegetation in places with only 10 or 15 inches of annual rainfall, and exposed to tropical heat, is a not unimportant fact, as being a readily availab'e substitute for irrigation water, worth further investigation.

A. T. FRASER

India, March 26

The Climbing Powers of the Hedgehog

I AM advised by some of my friends to send you a notice of the mode in which hedgehogs may frequently escape from confinement, and of their habits.

I obtained a hedgehog last week, and put it in my kitchen. Every day it is placed in a small back area, about 12 feet square, during the day-time. The waste-pipes from the cisterns discharge into this area, and the animal frequently lies under these, and, as my servant says, "wallows in the trough like a pig." If he hears any noise he at once runs to a corner and rolls himself up. On Wednesday the servant found him on the top of the partition wall between my area and the next. This wall is vertical, and about 6 inches. The top course but one projects 1 inch, which he have climbed over this.

No one watched in the operation. He climbs by the projecting bricks, which are rather rough, looking about him frequently when he is watched. He climbs up the house wall beside the corner—an ordinary iron rain-pipe; but from the shoulder of the pipe, where it passes through the wall, to the top of the partition wall, there is a distance of 9 inches without any pipe, so up this portion and over the projecting brick course he must have climbed by clinging to the wall of the house or the partition wall.

Yesterday (Thursday) he repeated the ascent, and descended into the next area, where he was found this morning.

ROBERT H. SCOTT

6, Elm Park Gardens, April 16

STARS WITH BANDED SPECTRA[1]

THE spectroscopic survey of the northern heavens, undertaken conjointly by MM. Vogel and Dunér in 1879, has already progressed so far that its general results can be fairly anticipated—its immediate results, that is to say; for it is ultimately designed, not so much for a collection of statistics, however valuable and interesting, as for a criterion of change. This effect, however, must wait for the future—perhaps a remote future—to develop; we can in the meantime gather much present knowledge through labours inspired by still unfolded possibilities.

The first instalment of the first spectroscopic star-catalogue systematically executed, was published by Vogel in 1883 (*Publicationen* des astrophysikalischen Observatoriums zu Potsdam, No. 11). It covers a zone of the heavens extending from $-2°$ to $+20°$ of declination, and includes 4051 stars down to 7·5 magnitude. M. Dunér now sends us from Lund, in a catalogue of 352 stars fully ascertained to possess spectra of the fluted and zoned types, a work of special and extreme importance.

Stars with banded spectra fall into two perfectly distinct classes, of which the first is well exemplified in α Orionis (Betelgeux), the second in a 5·5 magnitude star close behind the Great Bear, numbered 152 in Schjellerup's Catalogue of Red Stars (*Astr. Nach.*, No. 1591), and called by Father Secchi "La Superba," from the extraordinary vivacity of its prismatic rays. The spectrum of Betelgeux (Fig. 1) shows a series of seven or eight well-marked dark bands (besides minor shadings) all abruptly terminated towards the violet, and dying out by insensible gradations towards the red. The impression upon the eye resembles that of a colonnade thrown into strong relief by a vivid side-illumination. Only three conspicuous dark spaces, on the other hand, interrupt the beams of 152 Schjellerup (Fig. 3); but their breadth is fully twice that of the flutings in the spectrum of α Orionis; and, still more remarkable, they *face in the opposite direction.* Their obscurity deepens slowly downwards towards their less refrangible sides, then suddenly, by a sharp transition, and with a singular and splendid effect of contrast, gives place to unclouded light.

The stars characterised by these two different qualities of absorption, respectively constituted Father Secchi's third and fourth spectral orders. M. Vogel, however, saw fit in 1874 (*Astr. Nach.*, No. 2000) to modify the arrangement by grouping the two varieties together as subdivisions of a single class. Nor was this a mere arbitrary change. It was the outcome of a far-reaching speculation regarding the course of development taken by the great army of suns marshalled in the profundities of space.

Secchi's classification involved no hypothesis of any kind; it was founded simply on appearances. But the idea that the colours, consequently the spectra of stars, may guide us to a knowledge of their comparative "ages," thrown out in a crude shape by Zöllner in 1865, had, meantime, made its way. Vogel's adoption of it as a means of rationalising observed particulars, gave it (perhaps prematurely) a recognised scientific status.

According to this view, the white stars forming Secchi's first order (of which Sirius and Vega may be taken as

[1] "Sur les Etoiles à Spectres de la Troisième Classe." Par N. C. Dunér. Mémoire présenté à l'Académie Royale des Sciences de Suède, le 11 Juin, 1884. (Stockholm, 1884.)

representative), are in the initial stage of their life as suns. Their energy is still unwasted; their temperature is enormously high; their light is not sensibly modified by absorption, hydrogen being the only constituent of their atmospheres capable of strongly intercepting their radiations. But with the lapse of ages, this early fervour cools down, and absorption gains strength. Hydrogen no longer stamps itself predominantly upon their spectra; metallic rays deepen and multiply; a dusky veil is drawn across each photosphere, stopping preferentially its more refrangible emissions, and thus imparting a yellowish tinge to the resulting light. The condition of our sun, as well as of Capella, Pollux, and Dubhe, is, in short, reached. Down to this point the history of all ordinary stars is the same. Here, however, a bifurcation in the path of development is reached. Two roads to extinction are now open to them. For, according to Vogel, the two varieties of banded spectra mark co-ordinate, not successive, stages in stellar existence. The choice, so to speak, once made, is definitive. Migration from one type to the other is impossible. Hence Vogel's abolition of Secchi's fourth type, and his distribution of such stars as Betelgeux and α Herculis on the one hand, and 152 Schjellerup and 19 Piscium on the other, into two alternative branches of his third. But let us look a little more closely at facts before admitting conjecture.

M. Dunér's Catalogue includes 297 entries under the heading Class III. *a* (type of α Orionis), to which in all 475 stars are so far known to belong. A particular description of each spectrum, from his own and others' observations, is appended; so that ample materials are provided for some few safe generalisations.

The first point to be noted is that the positions of the leading bands in *all* spectra of this kind are absolutely unchanging. The series is repeated with varying degrees of intensity from star to star, almost as if in stereotype. The shadings are, it would seem, in reality made up of fine lines very closely grouped. D'Arrest and Huggins, at least, repeatedly succeeded in thus resolving them, although to Vogel, even when employing most powerful optical means, they persistently maintained a nebulous appearance. Now a glance at the accompanying figures will show a symmetry in the arrangement of these bands suggesting that they result from the rhythmical vibrations of one highly complex molecular system. In other words, they betray the absorptive action of a single substance; particular identification is awaited; nor is it easily attainable. Great difficulty attends inquiries into the direct spectra of compound bodies, since the very means employed to render them luminous, also tend to destroy, by forcing them asunder into their constituent elements.

Besides this unknown substance, however, metallic vapours exist abundantly in the atmospheres of Betelgeux and its congeners. The grooved spectrum distinguishing them might in fact be regarded as superposed upon a modified Fraunhofer spectrum. Not only in its bright spaces, but even across its dusky flutings, a crowd of significant dark rays can be perceived. Their number, as disclosed by the 27-inch Vienna refractor in September, 1884, in the spectra of β Pegasi and α Herculis, took Vogel altogether by surprise (*Publicationen*, Potsdam, No. 14, p. 22). Yet he and Dr. Huggins had already measured no less than 95 such in the analysed light of Betelgeux. Some of these can be identified with terrestrial substances. Sodium, iron, magnesium, calcium, and bismuth, are without doubt incandescent above the photosphere of that star. Lines of hydrogen have also been made out, and its presence is certified by Dr. Huggins's photographs. Its absorption is, however, inconspicuous in all, and imperceptible in most spectra of this description.

One of their most singular features, as yet unexplained, is that dark metallic rays form the sharp boundary of many of the flutings. Thus calcium-lines (wave-lengths 616·4 and 585·6) respectively terminate, on their more refrangible sides, the bands numbered 2 and 3 in the figure; strong contiguous lines of calcium and iron limit band 4; band 5 ends with the well-marked iron lines of wave-lengths 545·0 and 544·4, and band 8 with that of 495·8; band 7 with the solar group *b*; band 9 with a deep furrow of unknown origin. These coincidences are extremely puzzling; for, as M. Dunér remarks, they can scarcely be accidental.

Stars with fluted spectra are all more or less deeply tinted with orange, owing to the stoppage, by a general absorption, of by far the greater part of their blue rays. Their actual emissions must then be very greatly in excess of those reaching outer space. Stripped of its surrounding atmosphere, our sun, it is computed, would leap up to some three or four times its present lustre; but in stars like Betelgeux, absorption must at least quadruple its solar effects. This consideration is of fundamental importance in any estimate of the relative luminous power of the stars.

Fifty-five members of Class III. *b* find a place in the Lund Catalogue. These are all that have hitherto been discovered. Yet exploration, in their case, is more complete than with the previous type, the broad, deep zones of their spectra being distinguishable in objects much too faint to show the narrower groovings of Class III. *a*. No star of this kind is as bright as the fifth magnitude, while eight between ninth and tenth are included in M. Dunér's list. Thus, although the fluted spectra already examined outnumber those in zones (as we may call them for the sake of distinction) scarcely nine times, M. Dunér considers that the real proportion of their excess is at least fifty to one.

The rare objects constituting Class III. *b* are amongst the most interesting in the heavens. For they exhibit in their spectra the unmistakable signature of that substance which, more than any other, deserves to be called the material basis of life. Father Secchi (their original discoverer) regarded them from the first as "carbon-stars;" but Dr. Huggins in 1872 tested the supposition (for it was then little more), and rejected it as disproved. There is now no doubt that the Roman observer was in the right. The three conspicuous bands of dense absorption visible in such spectra agree in position quite closely with the emissions of carbon-vapour glowing in the electric arc. Dr. Huggins gives scanty details of his observation (see Schellen's "Spectrum Analysis," ed. 1872, p. 504); he is rarely in error; but on this occasion was perhaps misled by the facile emergence of acetylene-bands, of which the blue one falls just in the intermediate position indicated by him as fatal to the suggested identity.

Besides carbon, sodium is without doubt present in the atmospheres of these remarkable bodies; and there are signs of further metallic absorption, notably by iron. Their rays being, however, too faint to bear scrutiny with a narrow slit, the finer features of their spectra remain, for the present, unrecognisable. Yet we cannot avoid being struck with the circumstance that their most prominent constituent elements are precisely those which kindled in the great comet of 1882 as it approached the sun.

The "zoned," like the "fluted" stellar spectrum, is, in general outline, invariable, though capable of endless individual modifications of tone and detail. It is as if one fundamental sketch-plan were filled in with the most diverse depths of shading.[1] Another point on which all these stars agree, is the redness of their light. The violet end of their spectra is, uniformly, all but obliterated, necessarily through original deficiency. The [illegible] frangible emissions of 152 Schjellerup may

[1] See Figs. 4, 5, and 6; the last a supposed example [illegible] spectrum given by a star in course of passing from Class [illegible] Class III. *b*.

can tell, be as copious as those of Sirius or Vega. But they are intercepted in a deeply-laden atmosphere, which can indeed be escaped by only a small per-centage of their entire radiations. This explains at once the uniform inconspicuousness of such objects. A star of this class should possess, say, a hundred times the radiating surface of Vega, to send us, from an equal distance, the same quantity of light.

No star of those yet known to show banded spectra of either kind has an ascertained parallax. This is not wonderful, since the stars at measured, or perhaps measurable, distances from the earth, constitute a scarcely perceptible fraction of the whole. Still, the fact remains that all members of the two classes under consideration are indefinitely remote. We are accordingly without the means of estimating, even in the most general way, the real quantities of matter contained in, or of light emitted by, them. We can only say that their dimensions must be very great in proportion to their apparent magnitudes.

The question of their distribution is of much interest, as involving their relations to the vast ground-plan of the sidereal system. And one circumstance connected with it becomes immediately evident. This is, their largely predominant occurrence in and near the plane of the Milky Way. M. Dunér, it is true, considers that they merely obey the general law of stellar condensation. But this law applies more and more closely to the lesser orders of stars; and we have just seen that, physically, characterised by strong absorption should rank with optically by many degrees their superiors. The hypothesis, then, of some special connexion with the galactic streams and rugosities is by no means excluded; and it is countenanced by statistics as to the distribution of red stars in the southern hemisphere, recently afforded by M. Pechüle ("Expédition danoise pour l'Observation du Passage de Vénus," 1882, p. 38).

One of the most assured peculiarities of stars with banded spectra is their marked tendency to fluctuations of light. Amongst innumerable examples of this connexion may be cited "Mira" Ceti, and Gore's "new star" in Orion, both of which display brilliant prismatic flutings. Nearly all variables, in fact, save the few which complete their cycle of change in a few days, belong to one or other of the subdivisions of Class III. Whatever may be the secret of their constitution, it is indissolubly bound up with the still mysterious cause of stellar variability. We can scarcely penetrate the one without divining the other. Already something is gained by the mere fact of the connexion being established. We learn from it that the steadfast shining of a sun or star is conditioned by the quality of its surrounding gaseous envelope. Continuous study, then, of the spectra of variables affords probably the best chance of progress in knowledge of their nature. M. Dunér's incidental observations show that the reinforcement and extension of banded absorption apparent at minima, do not sufficiently explain the diminution of light, which must accordingly be in part due, either to a failure of emissive power, or to an increase of general absorption. The analogy of sun-spots favours the latter alternative.

M. Dunér concludes his valuable memoir with the admission that the order of stellar development postulated by Vogel, and advocated by himself, may, after all, be the reverse of that pursued in nature,—a possibility surely worth thinking about.

Suns are no longer in our eyes "incorruptible." Observation alike lead us to seek for symptoms of decrepitude in their bright inmates. Not alone "the old order changeth, yielding" but the subject is one on which we are apt to lose of experience, and can scarcely allow, regard being had to the almost infinite between our hurried notions of time, and the unimaginable leisureliness of cosmical progression. Caution is then all the more needful, if we would avoid wide wandering from the truth.

Now it has to be objected to Vogel's scheme, that it gives no account whatever of suns in process of becoming. Yet they must be as numerous, one would think, as suns in process of decay. From the summit of brilliancy and vigour, the course of decline is traced downward towards the final quenching. But what of the other branch of the curve? Stars now at their acme of splendour must have passed through long periods of preparation. Sirius and Canopus, we are fully assured, did not all at once blaze out in their present radiance. What, then, we cannot abstain from asking, was their anterior condition? What quality of light did they emit? How were their atmospheres constituted? What kind of spectra, in short, would they then have afforded? A system of classification, based on the supposed order of stellar development, in which no account is taken of this wide branch of the inquiry, must be regarded as essentially incomplete.

A. M. CLERKE

THE INSTITUTION OF NAVAL ARCHITECTS

THE twenty-seventh annual session of the Institution of Naval Architects, held at the rooms of the Society of Arts, was one of the most successful of the series. The meetings began on the 14th inst. and concluded on the 17th. There were seven sittings, averaging from three to four hours each, and no less than eighteen papers were read and discussed. As on previous occasions, too much was attempted to be done in the time available, with the result that some important matters received scant notice. This may be to some extent inevitable in a Society embracing such wide and varied interests, yet meeting but once a year. But it may be anticipated that the autumn meetings in the outports which are now contemplated may somewhat relieve the congestion in future.

Lord Ravensworth presided as usual, and delivered a Presidential Address, in which various matters of interest were touched upon, *inter alia* the use of liquid fuel instead of coal in steamships, the development of triple-expansion engines, the prospects of shipping and the statistics of shipbuilding, including the extended use of steel. It may be hoped, although the immediate future scarcely justifies the expectation, that before the next meetings a change in circumstances may enable the President to speak more cheeringly. On the other hand, it is an undoubted fact that the period of depression through which the country is now passing is forcing into prominence inquiries into possible economies in the construction and propulsion of ships which might otherwise have been neglected.

No less than seven of the papers read had relation to the propulsion of steamships. The first on the list—"On the Speed Trials of Recent War-Ships"—was read by Mr. W. H. White, Director of Naval Construction. It contained a succinct account of the remarkable advances made during the last quarter of a century in the speeds and propelling machinery of war-ships. The fact that huge battle-ships carrying enormous weights of armour and guns are now driven at speeds of 17 to 18 knots—20 to 21 miles per hour—is sufficiently remarkable. Yet the fact that such a ship, weighing 10,000 tons, can be driven 9 knots in an hour with an expenditure of only 1 ton of coal is no less striking. Much has been learnt, too, of late years as regards the influence of *form* upon the resistances of ships; thanks, in great measure, to the researches of the late Mr. Froude, whose work received the substantial support of the Admiralty. In the paper above mentioned it was shown that by suitable selection of form, the *Howe*, a vessel of 9600 tons, 325 feet long and 68 feet broad, was driven as easily as the *Warrior*

up to the highest speed reached by the latter, although she was 380 feet long, 58 feet broad, and of 8350 tons only. The *Warrior* reached 14½ knots only; the *Howe* attained 17 knots. Improvements in marine engineering made this tremendous speed possible in the *Howe*. In her each ton weight of propelling apparatus corresponded to 10 indicated horse-power; in the *Warrior* 6 indicated horse-power required 1 ton. This economy of weight in the propelling apparatus was shown to be due to several causes, including a higher steam-pressure, quicker-running engines, the use of forced draught in the stoke-holds, and the introduction of wrought iron, steel, and gun-metal instead of cast iron.

Two papers dealt with the interesting subject of "forced draught" from different points of view. Mr. Sennett described at some length the Admiralty system of "closed stoke-holds," by means of which air is delivered into the boiler-rooms by powerful fans, and at a sensible pressure. The stoke-holds being thus *in plenum*, the air can escape only through the furnaces, and combustion is quickened greatly. With the best *natural* draught, about 10 indicated horse-power per square foot of furnace (or grate area) is considered a good performance: with forced draught and closed stoke-holds, this may be increased from 60 to 80 per cent. It will be seen therefore that for war-ships, which only require to steam occasionally and for comparatively short periods at full speed, the system is admirably well adapted. And it has been proved to be not nearly as wasteful of fuel as might have been supposed; while it certainly makes the stoke-holds cooler and more comfortable to work in. For the mercantile marine the conditions are different: ships have to steam ordinarily at practically their full speed; the restrictions of weight and space are not so great as in war-ships; and economy in coal consumption is of primary importance. Still even here forced draught promises to supplant natural draught, and to enable large economies to be made in weight and size of boilers concurrently with savings in coal. Mr. Howden described his system of forced combustion, which has b en tried at sea over a long period, and promises to be successful. He does not close in the stoke-holds, but delivers air under pressure from fans direct into the furnaces and ash-pits, this air having been heated by passing through a special apparatus placed in the up-takes. Great economy is claimed for this system, and it was well spoken of by competent authorities in the discussion which followed. Competing plans are also being tried, so that more will certainly be heard of forced draught in the mercantile marine. Hitherto economy has been sought in higher pressures and in the *use* of steam in the engines: now engineers are turning attention to the boiler, and the means of generating steam with a minimum expense.

Hard times in the mercantile marine have led to a wholesale conversion of compound engines into engines of the triple or quadruple expansion type. Mr. Cole read a thoughtful and well-considered paper on this subject, which is of general interest to shipowners just now. It may prove a very desirable thing to reduce the coal-bill by 20 per cent., even at the cost of converting the machinery to the more highly expansive type.

It is a natural transition from the propelling machinery to the propellers of steamships. Mr. R E. Froude, who has succeeded his father in the superintendence of the Admiralty model-experimental works, contributed one of the most valuable and scientific papers read at the meetings, on "The Determination of the most Suitable Dimensions for Screw Propellers." He attempts from experiments with models of ships and screws to ascertain the resistance experienced by a ship moving at a given speed, and the "augment" of that resistance produced by the action of the propeller behind her. By means of a lengthy series of experiments with model screws he further attempts to fix the best diameter and pitch for a given number of revolutions of the engines. And finally, the results are thrown into a form adapted for practical use. The paper is in all respects admirable, but we are bound to say that it can be regarded only as another step forward on a very difficult road, and may be treated as provisional rather than conclusive. Some of the inferences do not accord, either, with the results of general experience. It is to be welcomed, however, for as yet the theory of the screw propeller is not in a satisfactory condition; and it is well known that very remarkable economies are frequently realised by changes in propellers. In the course of the discussion Mr White mentioned a case of recent occurrence, where, by a change of screw only, the speed of a ship was raised from 12 to 13¼ knots per hour.

M. Marchal, of the French Génie Maritime, contributed an interesting paper, in which the results of a number of experiments, made by order of the Government, were described. It was desired to obtain data for guidance in deciding on the relative advantages of two or three screws as applied to an ironclad of 10,000 tons. A model steamer of 10 tons was built, and tried at "corresponding speeds," with two screws and with three. The publication of this paper marks a distinct change of policy in France, and it places before English designers a mass of valuable facts, which may prove very useful hereafter as the speeds of ships are increased.

Mr. Hall read a paper on "Flexible Shafting for Screw Steamers," describing a plan by which he h[ope] reduce the number of breakages or serious accide[nts] the screw shafts of ocean-going steamers. His contention was that in not a few cases there is a want either of accuracy in the line of shafting and shaft-bearings, or of rigidity in the hulls of steamships; so that, by special joints between the various lengths of shafting, a certain amount of flexibility might advantageously be secured. Experience will prove whether he is correct or not in the anticipation that his plan will reduce accidents or breakages—serious matters in single-screw ships carrying large numbers of passengers and having very small sail-power.

Another important group of papers are those dealing with the use of rolled and cast steel for shipbuilding. It is well known that steel is rapidly gaining upon iron, and Mr. Martell (of Lloyd's) stated some very interesting facts as to the extension of its employment in the mercantile marine. War-ships are now all steel-built. Seven years ago only 4470 tons of steel ships were built as against 518,000 tons of iron ships. In 1885 over 165,000 tons of steel ships were built as against 290,000 tons of iron. Confidence in steel was expressed by Mr. Martell in his paper, echoed by Mr. Ward in another excellent paper recording eight years' experience in building steel ships, and indorsed by all who took part in the discussion. Incidentally the question arose of the introduction of steel made by the "basic" process for shipbuilding purposes; as yet this "make" of steel has not found much favour, but the Admiralty authorities are now about to undertake a series of experiments from which much m[ay] be learnt. Every one agrees that thorough and systemat[ic] testing has done much to secure the excellent qualities [of] steel now made by both the Bessemer and the Siem[ens] processes; and even the manufacturers are in favour [of] maintaining the full severity of the tests in order to [pre]vent any deterioration in quality. Of more recent [date] than the use of "mild-steel" plates and bars is th[e] duction of mild-steel castings in lieu of iron [for] Mr. Warren, who had been chairman of [a] appointed by the Admiralty to look int[o] gave to the meeting an excellent st[ate]m[ent] of their inquiries. There can be no [doubt] heavy iron forgings are doomed to [be] castings, which can be produced ra[pidly] sound and ductile quality, and in fi[ne]

costly machine-work. As a record of experience up to date, Mr. Warren's paper will have a permanent value.

The remaining papers on the list are of a miscellaneous character, but all of considerable interest. Mr. Heck described a "Mechanical Method of Finding the Stability of a Vessel," by means of a simple model. This is a very ingenious and labour-saving device, likely to prove of great assistance in ordinary ship-yards, where a staff of trained calculators may be wanting. Mr. Stromeyer described a "Strain Indicator" which he has invented. This instrument is extremely simple in its construction: the essential parts consisting of two flat plates between which is inserted a "rolling-pin" of fine steel wire. Relative motion of the two plates causes the rolling-pin to rotate, and its rotation is the means of measuring the strain to which the material is subjected in any portion of a sample or a structure to which the indicator may be attached. If this instrument answers as well as it promises to do, much will be learnt from its indications as to the strains brought upon ships under various conditions and more especially at sea. Such information carefully compiled and collated ought to prove of value in determining the structural arrangements of ships.

Admiral Paris, the venerable Curator of the Naval Museum at the Louvre, long known for his eminence as a scientific naval officer and as an archæologist in shipbuilding, attended the meetings, and contributed an interesting paper on the "Rolling of Ships," exhibiting an instrument designed to represent the relative movements of ships and waves. His reception was deservedly cordial.

Capt. Colomb described, in a well-written paper, some of the more important results of recent measurements of turning powers of ships in the Royal Navy. These trials are now systematised, and much has been learnt from them which will be of value to future naval tactics, as well as useful to shipbuilders in designing rudders and steering-appliances. A novel steering-gear was described by Mr. Maginnis, who also laid before the Institution some valuable autographic information on the obscure subject of the strains brought upon a rudder when it is "put over" to various angles in a ship moving at speed.

Mr. Read's contribution, "On the Strength of Bulkheads" in ships, was seasonable, the recent loss of the *Oregon* having again drawn public attention to the necessity for water-tight subdivisions as a means of safety from foundering. Mr. Read put into a mathematical form the principles which should regulate the construction of bulkheads if they are to successfully withstand the water-pressure which must come upon them when the compartments are "bilged" and sea-water enters. He did not deal with the principles which should govern the disposition of bulkheads; but these principles are well understood, and more generally acted upon now than formerly.

Another paper by Mr. Benjamin described a "Proposed Steam Lifeboat" which had been designed to be practically uncapsizable; and for that purpose, among others, made of a very peculiar form. The only other paper on the list described the improved methods of working anchors and cables devised by the author, Mr. Baxter. This was a paper of a practical and historical character, on a subject of undoubted importance.

From this hasty summary it will be seen that the Institution of Naval Architects maintained at its recent gatherings its old reputation for widely diversified topics of discussion. And it is to be added that the papers as a whole, numerous as they were, were also of more than average merit.

ON THE USE OF MODELS FOR INSTRUCTION IN THE MAGNETISM OF IRON SHIPS

THE deviations of the compass produced by the iron used in the construction of wooden ships was a source of considerable perplexity to the navigators of the last and early part of the present centuries; and no sooner were these difficulties fairly overcome than the building of ships entirely of iron commenced.

With the introduction of iron ships, prolonged investigations into their magnetism and the resulting deviations of the compass on board were undertaken by some of the most eminent philosophers and mathematicians of the day, the subject being still one which occupies the attention of many observers, from the increased use of iron in the equipment, as well as construction, of the hulls and decks. These investigations were much facilitated by the increased knowledge of the earth's magnetism, which received such notable additions from magnetic surveys made by travellers on land and navigators at sea during the years 1819-45.

Moreover, as time rolled on, these observations were embodied in trustworthy graphic representations of the declination or variation, the dip or inclination, and the horizontal force, which have done such good service in the work of obtaining a clear understanding of the cause of the magnetism of iron ships, and the changes to which such magnetism is liable when the vessel's position is altered either geographically or in respect to the magnetic meridian.

It is not here intended to enter into any historical *résumé* of the names of the several investigators in this branch of science, nor of the results which each obtained, but to indicate at once where the physicist and mathematician may find the theory and examples of its application; also, how the practical results of this elegant theory may, by the use of models, be made intelligible and available to the seaman and other inquirers who have neither the time nor the opportunity for abstruse studies requiring considerable mathematical knowledge.

The text-book which is now generally accepted in all countries is the "Admiralty Manual for the Deviations of the Compass," in Appendix No. 1 of which will be found the three fundamental equations of Poisson, which form the whole theory of the deviations of the compass, and the expressions of these equations "in terms of the quantities which are usually given and required," written by the late Archibald Smith, M.A., F.R.S.

The whole of the action of the soft iron of a ship is represented in these equations by the parameters a, b, c, d, e, f, g, h, k, and in a model by nine soft iron rods fixed in definite positions, distinguished by the same letters.

The effects of the magnetism of the hard iron of the ship are represented in these equations by the parameters P, Q, R, and in the model by two permanent magnets held horizontally in definite positions, and a third permanent magnet held vertically under the compass.

One of the most important contributions to magnetical science as regards iron ships was made by Sir George Airy (late Astronomer-Royal) in a paper published in the *Phil. Trans.* Royal Society for 1839. After making a series of experiments in certain iron-built ships, he discussed the results mathematically with the purpose of discovering a correction for the deviation of the compass. He concluded his paper with the announcement of his invention of the system of correction by magnets and soft iron, which is universally practised in the present day, always with advantage, and often as a matter of necessity in ships of certain types, where to find a suitable place even for the standard compass is a matter of no small difficulty. This system of correction, coupled with the analysis described in the "Admiralty Compass Manual," provides the means of correcting a compass even in position on the 'tween decks of our armour-plated ships of war.

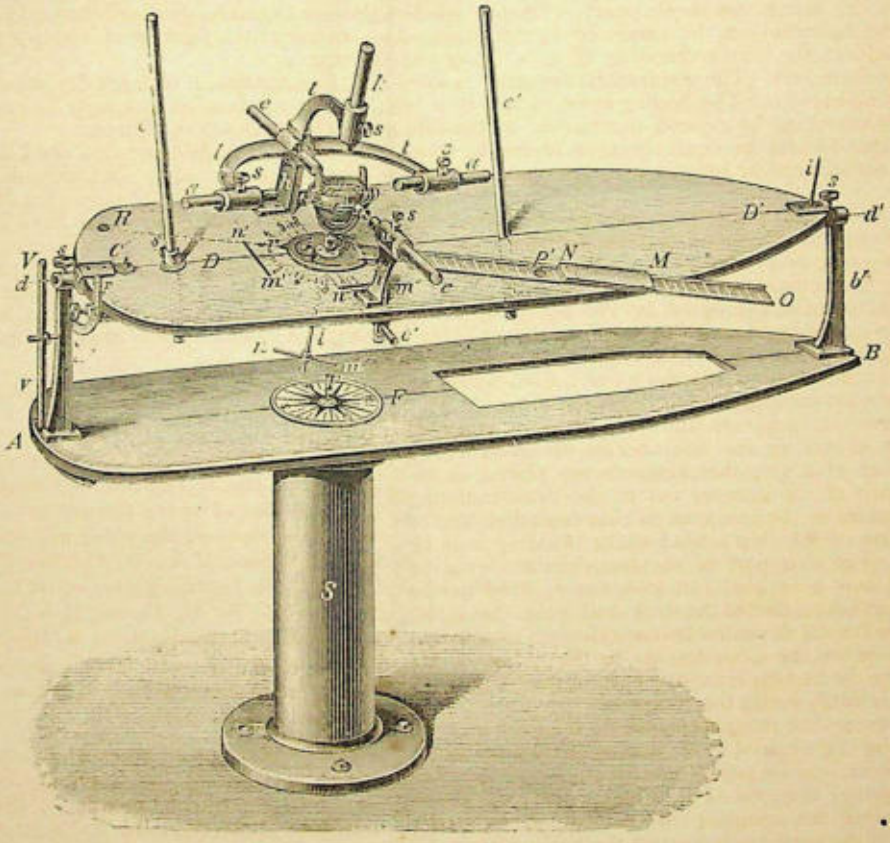
With these preliminary remarks, the description of some different forms of models will be given, and their uses for instruction in the magnetism of iron ships considered.

One of the first of these instructive models was that constructed for Sir George Airy, and used during his lectures to illustrate his method of correction of the deviations of the compass. It consisted of a model of the wooden hull of a vessel. In the centre of the deck a compass was mounted, disturbing magnets and pieces of soft iron being concealed underneath it, producing semicircular and quadrantal deviations as in an iron ship. These deviations were then corrected by placing the model ship with its bow alternately on the north and south magnetic points, when the compass was made to indicate the same directions by means of transverse magnets on the deck; and then on the east and west points magnetic, the correction of the semicircular deviation being completed by longitudinal magnets on the deck. Lastly, with the model placed in a north-east and south-west direction magnetic, scrolls of soft iron were placed on either side of the compass—an imaginary line transverse to the model passing horizontally through the centre of the scrolls and compass-card—until the compass pointed correctly.

Of more recent models there are three which are of an instructive character: one designed by Dr. Neumayer of the German Naval Observatory at Hamburg; the second in England by an official of the Board of Trade; and the third, which is the most complete both for experiments and purposes of instruction, by the United States Navy Department.

The accompanying woodcut on the scale of one-twentieth of the original model is taken from Paper No. 2 of the *Archiv der Deutschen Seewarte*, VI. Jahrgang, 1883, where an account of the experiments to be made with it is given in full detail. The following is a description of the several parts shown.

S is a pillar fixed in the floor of the room, upon which pivots the wooden board A B, with the line of its central



axis marked. At the point T, a compass-card is fixed to S, with its north and south points adjustable in the magnetic meridian.

Supported by the two brass uprights *a' b'*, is the second board in the form of a ship's deck pivoting at *d d'*, so that it can be inclined sideways, as when a ship inclines under pressure of sail or when rolling, but kept horizontal as required by the screws *s s*. An arc, *o p*, marked to degrees, shows the angle of inclination. A gimballed compass, C, with sight vanes, is mounted on the deck; and when the lubber's point and the pin *i* are in line, as seen through the vanes, the compass support is secured by the clamping-screw. O P' is a graduated arm revolving round the base of the compass stand, grooved to receive a bar-magnet, and with a pointer, *r*, showing the number of degrees the arm has been turned in azimuth. *h* and *h'* are brass bearers for carrying the rods of soft iron used in disturbing or correcting the compass, with screws, *s*, for clamping the rods at any required distance.

The model, as described thus far, is entirely free from any magnetic body external to the compass, and may, by means of the latter, be placed with its marked axis in the magnetic meridian, the compass card at T being fixed in that direction for future reference. The means for producing the disturbing forces on the compass similar to those found in iron ships are these. M N is a magnet, which may be so adjusted in the groove that, by moving the arm O P' in azimuth, semicircular deviation of any desired form may be produced. In the figure the magnet M N is placed to produce the semicircular deviation of a ship built with her head north-north-west, and the resulting south (or blue) pole is found in the point R. The soft iron rod V *v* in its vertical position represents the stern-post of a ship, producing that part of the semicircular deviation in compasses placed near it, which

changes as the ship moves into fresh magnetic latitudes. *c c'* are soft iron rods, intended to represent iron masts.

Quadrantal deviation of the form generally observed is produced by the soft iron rod *c'*, extending from side to side under the deck D D' like a deck beam, the rods *a a* also conspiring with *c'* in increasing the quadrantal deviation. That part of the heeling error caused by the magnetism of the hard iron of a ship is produced by a small vertical magnet in the position of the rod *l* when removed; that from soft iron by the vertical soft iron rod *k* and the horizontal rod *c'*.

The compass C having been disturbed by magnetic forces of the usual type in an iron ship, may now be corrected: *m" n"* is a magnet with its north or marked end, *n"*, towards the stern of the model, and near enough to the compass to correct the deviation on the east and west points: *m' n'* is a second magnet with its north or marked end, *n'*, towards the port side, correcting the deviation on the north and south points. Or the whole semicircular deviation may be corrected by one magnet, *m n*, placed exactly in the direction of R, *n* being the marked or north end. The quadrantal deviation is corrected by the rods *e e*. The heeling error caused by *c'* is also nearly corrected by *e e*, and that caused by the sum of the effects of *k* and the vertical magnet under the compass by another vertical magnet with the opposite pole uppermost.

Thus it will be seen that any component part of the instrumental deviation usually found at the standard compass of an iron ship may be produced in the model and the corresponding corrector provided.

The portable model adopted by the Board of Trade has a compass mounted on a ship's deck, as in the figure; but the deck, which rests on a central metal support, revolves round a pivot in the centre of a fixed board, an arrangement for inclining the model being provided.

The disturbing magnets and soft iron are arranged thus. For producing the semicircular deviation due to the hard iron of a ship thin magnets are placed as required in any of the grooves cut in the deck radiating from the centre of the compass, so that deviations due to any direction of the ship's head whilst building may be produced. For that part of the semicircular deviation due to soft iron a vertical soft iron bar is fixed in the central longitudinal line of the deck and near the stern. For the quadrantal deviation hollow cylinders of soft iron are placed under the deck similar to the rod *c'* of the figure. For the heeling error due to hard iron a magnet is placed vertically under the compass.

The correctors are magnets placed on the deck as *m'n'*, *m"n"* in the figure, and soft iron spheres—on brass brackets which may be turned in azimuth round the compass—instead of the rods *e e*; a Flinder's or vertical soft iron bar before the compass; a vertical magnet under the centre of the compass to correct the heeling error.

This model is exceedingly well adapted for instruction and examination in the causes of the deviations generally found at standard compass positions in the mercantile navy, and the method of correction adopted in that service.

There remains now only the model made for the Bureau of Navigation of the United States Navy Department to be noticed. It consists of a miniature vessel of which the stem, keel, and stern-post are of bronze cast in one piece, with three wooden decks supported by bronze screws. This model, called the *Scoresby*, is pivoted at the stern by a socket in the floor, with a bronze wheel fitted under the bow, so as to be easily turned round in azimuth. The disturbing magnetic forces are produced by magnets and hollow wrought-iron tubes of soft iron, whilst wrought-iron plates can be attached to the sides of the vessel.

The *Scoresby* was designed with the object of proving by experiment the mathematical theory already noticed. Experiments were consequently made as to the effects of hammering the plates of the model with the bow in different directions, a magnetic survey being made after the hammering to determine the polarity in different sections, and its degree of permanency or otherwise. The model was next swung both when upright and inclined, for the deviations of the compass produced by a magnet or soft iron tube representing each parameter singly, combinations being made afterwards as desired. These experimental results proved satisfactorily the correctness of the mathematical theory.

This general description of the *Scoresby* will serve to show that the Americans have taken considerable pains in making valuable experiments in proof of theory, and for instruction to the seaman. Before parting with her, however, a quotation from the American professional paper on the subject of the *Scoresby* seems worthy of a place, as sounding a fresh warning note to those who ruthlessly distribute iron *ad libitum* and in any form round the position of a ship's standard or guiding compass.

"Compensation of large deviations by means of magnets is at the best but a remedy for an ailment; better not sow the seeds of the disease."

The three models just described have been selected as being the most modern specimens of these useful aids to knowledge, but there are others for the instruction of officers in the Royal Navy which have been in use for some years past. It will be gratifying to the many who take interest in maritime affairs to note the increasing anxiety for the spread of a sound knowledge of the principles of the magnetism of iron ships and the deviations of their compasses which the construction of these models manifests.

NOTES

THE total number of candidates for election into the Royal Society this year is sixty-two. Of these the following fifteen have been selected by the Council to be recommended to the Society for election; the voting will take place on June 4:—Shelford Bidwell, M.A., W. Colenso, F.L.S., H. B. Dixon, F.C.S., E. R. Festing, Major-Gen. R.E., Prof. A. R. Forsyth, M.A., Prof. A. H. Green, M.A., Prof. Victor Horsley, F.R.C.S., T. R. Lewis, M.B., R. Meldola, F.R.A.S., P. H. Pye-Smith, M.D., H. C. Russell, B.A., Prof. W. C. Unwin, B.Sc., R. Warington, F.C.S., Capt. W. J. L. Wharton, F.R.A.S., and H. Wilde.

THE following are the probable arrangements for the Friday evening meetings of the Royal Institution after Easter:—May 7, Mr. Frederick Siemens, "Dissociation"; May 14, Prof. John Millar Thomson, F.C.S., "Suspended Crystallisation"; May 21, Sir John Lubbock, Bart., M.P., F.R.S., "The Forms of Seedlings: the Causes to which they are due"; May 28, Prof. Oliver Lodge, D.Sc., "Electrical Deposition of Dust and Smoke"; June 4, Walter H. Gaskell, M.D., F.R.S., "The Sympathetic Nervous System"; June 11, Prof. Dewar, M.A., F.R.S.

THE editor of the *Sidereal Messenger* (U.S.) writes in his April number:—"We are glad to learn from private advices that a small observatory will soon be fitted up with the necessary instruments for continuous solar and local magnetic observation, in which daily solar photographs of the sun will form an important part of the work done by the observers. We are not aware that work of this kind is now anywhere systematically undertaken in the United States."

THE Congress of French Sociétés Savantes will take place as usual at the Sorbonne, and the final ceremony under the chairmanship of M. Goblet, the present Minister of Public Instruction. It is

expected that this ceremony will have an unusual interest, M. Goblet having sent a circular to the various learned Societies, announcing his intention of altering the date of the Convocation of French *savants* in Paris.

ALTHOUGH the Association Française and the Société Scientifique de France have passed a vote for their fusion into one compact body, the resolution has not been carried into effect, owing to some legal difficulties resulting from the very peculiar state of French law relating to Societies of public interest, which are considered as so many infants, whose properties are always in the hands of a lord chancellor for protection.

THE Report of the Committee of the Mitchell Library at Glasgow (where the Public Libraries Act was rejected by a moderate majority during the past year), while showing a largely-increased usefulness of that institution, forces attention to the very great cost of working even a reference library only. Out of an expenditure of 2770*l.*, only the odd 770*l.* can be employed in the combined purchase and cost of binding of both books and periodicals. Of this, 450*l.* is all that was spent in the purchase of 4500 publications; which does not suggest costly works for a reference library from which fiction is excluded. Nevertheless, the crowded state of the present rooms has led to an earnest effort to expend nearly fifty times that amount in a new site and "inexpensive" buildings, although the Committee are well aware that "a new and large building would imply a larger annual expenditure of every kind." The present premises have been much more economically, though not sufficiently, supplemented by the addition of two small houses adjoining, in one of which a reading-room for ladies has been fitted up, while the remaining rooms are well utilised by being shelved and filled with the less-used classes of literature. Complete sets of the 268 periodicals taken would be a valuable part of such a library if indexed in the American way, so that all the most recent information would be found there directly or indirectly. A presentation of 283 volumes from the Lords of Her Majesty's Treasury is specially acknowledged, and suggests that a gift from Government Offices of sets of their publications to all free libraries up to a certain time, which would be willing to properly house them, would be no very great cost to the nation, while it would be a reward to the enterprise of those towns which have organised free libraries and an encouragement to others to do so quickly.

THE Fish Commission steamer *Albatross*, *Science* states, arrived at Nassau, New Providence, March 19, after a most successful trip. The ship was chiefly engaged in making soundings. Two naturalists were landed at Watling's Island, San Salvador, where much valuable scientific material was gathered during a stay of two weeks. But little dredging has been done, so that few accessions of marine life have been made. At Rum Cay, Conception Island, Cat Island, and Great Exuma Island, the naturalists of the expedition obtained many valuable specimens of fish, lizards, birds' nests, eggs, cave relics, pottery, and about 500 bird-skins. These islands are very small and thinly populated. Vegetation is scarce, and the islands themselves are formed almost entirely of rock. Cocoa-nut trees and bananas are abundant, but oranges and apples rather scarce. The *Albatross* is now at Key West, and will spend some time dredging in the Gulf of Mexico and vicinity.

GENERAL HAZEN said recently, in his testimony before a U.S. Congressional Committee, that foreign signal stations were a necessity, and the establishment of a station in the West Indies had fully demonstrated this fact. It is quite probable that Congress will authorise the establishment of stations at important foreign points.

AN interesting discussion is just now being carried on between Scandinavian and German anthropologists as to priority in the theory of three great prehistoric periods—the ages of Stone, Bronze, and Iron. Dr. Sophus Müller, for the former, claims that the theory was first enunciated in 1837 by the Danish Thomsen, and that it was ridiculed for forty years by the Germans. To this Prof. Virchow, in the last *Zeitschrift für Ethnologie*, replies that Dr. Müller confounds two different things. The priority of the Stone Age to the others was never disputed in Germany; it certainly was denied that any epoch deserved especially the title of the Bronze Age, and he thinks that this was due to the propensity of the Scandinavians to exaggerate the extent of this epoch. But he contends that two Germans, Lish and Danneil, discovered the three ages simultaneously with Thomsen. In support of this he quotes a memoir by the former, published in 1837, but in large part printed in 1836, before Thomsen's work appeared, and when it was wholly unknown to him, expounding a similar theory. In 1835 Lish had actually arranged prehistoric objects in the Museum in Mecklenburg according to the three ages. Prof. Virchow therefore proposes that in future Danneil (whose share in the discovery does not appear so pronounced), Lish, and Thomsen should be regarded as the earliest propounders of the theory of the three prehistoric ages.

ON March 28, at about 9 p.m., a magnificent meteor was observed in several places between Trondhjem and Molde, the north-west coast of Norway. An observer at the former town states that his attention was first attracted to the phenomenon by the street in which he was walking becoming suddenly brilliantly illuminated, and on looking up he saw a bright meteor, with a somewhat faint trail, going in a direction S.S.W. to N.N.W. The light from the body itself was an intensely bluish-white, and that of the trail grayish, with a red tint at the end. During its passage the meteor passed behind some light clouds, and was still visible through them, but not the trail. The meteor disappeared from view behind mountains, but a brightness could still be observed in that direction for some time afterwards. Another observer at Christiansund (about 130 kilometres south-east of Trondhjem in a straight line) states that he saw the meteor at that place at 8.45 p.m., going in a direction S.E. to N.W. It was about 40 centimetres in diameter, with a purple-coloured trail of about 1½ metre in length, and its passage was accompanied by a whizzing sound like that of a flight of birds. The meteor illuminated the whole town brightly for some seconds, and burst with a report like that of a big gun. The light was so intense that even people in well-lighted rooms were attracted by the sudden brightness without. At Molde (about 60 kilometres further south) the meteor was also seen, and its bursting was so loud that the Romsdal Mountains returned a thundering echo.

IN the twenty-ninth issue of the Medical Reports of the Chinese Customs, published half-yearly, besides the reports of the medical officers at the various Treaty ports, which are probably of much professional and local interest, there are two special papers. In one of these the character and uses of the so-called "black-lime" of China are noted by Dr. Peek of Tientsin. This substance is generally stated (Dr. Williams even falls into the error) to be a kind of bitumen; it really is amorphous graphite, and it is used when mixed with lime to make a very hard and durable plaster, and it is also employed in dyeing cloth. The second special paper is Dr. Macgowan's on the movement cure in China, which has been already noticed in these columns.

THE Norwegian Meteorological Office is making an appeal to Norwegian sea-captains with reference to the total eclipse on August 29 next, viz. that any one who on that day happens to be in the locality where the eclipse is total shall make obser-

vations of the barometer and thermometer every quarter of an hour from 10 a.m. to 4 p.m. (Greenwich time), with a view to ascertain what the effect of the eclipse is on the atmosphere during totality, a point on which our knowledge is very limited. Proper forms for recording the observations, and full details of instructions, are issued gratis by the Office.

AT a recent meeting of the Russian Physical Society, M. B. Sreznewski pointed out some remarkable oscillations of the barometer during the series of atmospheric storms which had passed over Western Europe and Russia from December 12 to 17 last; namely, the sudden appearance on December 12 in Western Europe of a considerable barometric minimum in a region of very equally spread high atmospheric pressure; secondly, the very low range of the barometer at Nicholaistadt in Finland, as low as 717·6 mm.; and thirdly, the remarkable occurrence of a barometric minimum in Western Russia, which brings the author to conclusions similar to those which served M. Brownoff as a basis for his recently published theory of the movement of cyclones.

IN the month of January shocks of earthquake were felt in several parts of Sweden and Norway. The shock which we reported as having been felt in several parts of Central Norway on January 2 was also felt in several parts of Central Sweden. On January 21, at 9.55 p.m., another shock was felt in and around the town of Hernösand, on the Baltic, going in a direction east to west, and shaking houses and fixtures. On the following morning, at about 5 o'clock, another but fainter shock was felt in the same district. In one place two shocks were felt in quick succession.

A REPORT has been received from Tschembar, in Siberia, giving an account of some remarkable phenomena observed at that place on the night of January 3-4 last. At about 1 a.m. a meteor was suddenly seen rushing across the town, being accompanied by sudden gusts of wind, and bursting with a terrific report near the high-road outside the town, and killing a horse before a cart. The peasant who was driving it was so frightened that he was unable to give any details of the occurrence, believing that it was a "fire-dragon" which had slain his horse. Ten minutes later a loud report as of an explosion was heard, on which the commander of the garrison in the town ordered a patrol to proceed at once to the gunpowder magazine, as he believed it had been blown up. This official had hardly issued the order when a second and more terrific report was heard, accompanied by a violent vibration of the earth, which lasted half a minute. During the shock several houses fell in, and the thick ice on an adjacent lake was broken, the blocks being piled one upon the other. A shock and a similar report were observed at the same time at a town twenty versts distant.

ARRANGEMENTS are being made by the Canadian Commissioners at the forthcoming Colonial and Indian Exhibition to hatch and rear large numbers of Salmonidæ and other fish indigenous to the waters of Canada. Consignments of trout and whitefish ova have already arrived at the Exhibition, and are rapidly becoming incubated.

THE *Journal* of the Asiatic Society of Bengal, vol. liv. part ii. No. 3 (December 1885) contains two valuable papers on Indian entomology. Mr. E. T. Atkinson enumerates fifty-one species of Fulgoridæ (including the Indian lanthorn flies), of which several are indicated as new, and there are copious local (and other) notes on already known forms. Prof. A. Forel, who has paid so much attention to ants in general, enumerates twenty-six Indian species contained in the collection of the Calcutta Museum, with one or two new forms. The only other paper in the part is of a thoroughly practical nature, viz. by Mr. A. Pedlar "On the Cause of the Corrosion of Indian Tea Chests." The author sums up by stating that tea if properly cured has no power to corrode lead, but the corrosion is usually due primarily to acetic acid derived from the unseasoned wood of which the chests are too often made.

DR. MEYER has recently issued an "Album of Philippine Types" (Dresden, 1885), containing thirty-two photographic plates, with altogether about 250 figures of natives of Luzon and Mindanao, the two largest islands in the Archipelago. Some of these were originally taken by Dr. Meyer himself in the year 1872, when he spent some time in the Philippines; for the others he is indebted to Herr C. Heinszen, of Hamburg, Dr. W. Joest, of Cologne, and Dr. A. Schadenberg, of Glogau. Two plates with nine figures are devoted to the little-known Bagobos tribe of South Mindanao; all the rest to the motley populations of Luzon. Here are figured a large number of Negritos (Aetas) and half-caste Malayo-Negritos; Tinguianes, and Igorrotes from the northern and western districts; Ibilaos; Ilongotes from the province of Nueva Vizcaya, and Tagalas of every variety (pure, and half-caste Spanish, Chinese, and Negrito Tagalas) from Manilla and other districts. The accompanying letterpress gives a brief description of the several figures, the reader being referred for fuller information to Prof. F. Blumentritt's valuable treatise on the ethnography of the Philippines, which appeared in *Petermann's Mittheilungen*, Ergänzungsheft 67, 1882.

THE library of the Conservatoire des Arts et Métiers is to be lighted by electricity. It is the first Parisian library which will enjoy this advantage. The inauguration will take place next week, on the occasion of the meeting of the several scientific Congresses, which generally assemble in Paris during the week following Easter.

AT the January meeting of the Russian Chemical Society, Prof. Mendeléeff communicated some results of his investigation into the thermic effects of dilution of sulphuric acid with water. The maximum evolution of heat and the maximum contraction of 100 parts of the solution both correspond to the solution containing from 65 to 75 per cent. of H_2SO_4, which is very near to the hydrate $H_6SO_6 = S(HO)_6$. Together with some other observations this leads the author to the conclusion that there exist at least five more or less constant hydrates of sulphuric acid, as H_2SO_4, H_4SO_5, H_6SO_6, and two more containing a large amount of water, as $H_2SO_4 + 100H_2O$.

CONSIGNMENTS of grayling ova have been received by the National Fish Culture Association and the Buckland Museum. Considering the present period of the year, the fry are unusually late in becoming incubated, but this may be accounted for by the fact that, the past winter being very severe, it has greatly retarded the development of fish life. The ova are fully-eyed, however, and in some instances a few newly-born fish are issuing therefrom.

THE additions to the Zoological Society's Gardens during the past week include a Pudu Deer (*Pudua humilis*), five Chilian Sea-Eagles (*Geranoaetus melanoleucus*), two Siskins (*Chrysomitrit barbata*), a Diuca Finch (*Diuca gritea*), two Auriculated Doves (*Zenaida auriculata*) from Chili, a King Vulture (*Gypagus papa*) from Tropical America, five Capoeira Partridges (*Odontophorus dentatus*) from Brazil, two Barn Owls (*Strix flammea*) from America, an Antarctic Skua (*Stercorarius antarcticus*) from the Antarctic Sea, presented by Mr. Harry Berkeley James, F.Z.S.; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*), a Barnard's Broadtail (*Platycercus barnardi*) from Australia, presented by Lord Braybrooke, F.Z.S.; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. W. Woods; six Field Frogs (*Rana arvalis*) from Breslau, presented by Mr. G. A. Boulenger, F.Z.S.; four Californian Quails

(*Coturnix californica*) from California, a Scarlet Ibis (*Eudocimus ruber*) from Para, deposited; a Roan Kangaroo (*Macropus erubescens*) from South Australia, an Eroded Cinixys (*Cinixys erosa*) from West Africa, a Merrem's Snake (*Liophis merremi*) from South America, purchased; an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

Relation of Asteroid Orbits to that of Jupiter.—Prof. H. A. Newton, in the *American Journal of Science*, April 1886, points out that the orbits of the asteroids should have a relation to that of Jupiter. For supposing the orbits of the asteroids to be distributed in any manner whatever, provided only that they make small angles with the plane of Jupiter's orbit, the action of Jupiter would give to each orbit a motion of its node which would differ for the different orbits, and eventually the orbits would come to be distributed somewhat symmetrically about the orbit of Jupiter. And as a matter of fact, the centre of gravity of the poles of the 251 known asteroid orbits, computed as for points of equal weight, lies only 30′ from the pole of Jupiter's orbit; so that the plane of Jupiter's orbit lies nearer to the mean plane of all the asteroid orbits than any single asteroid orbit does, the nearest orbits being those of Medusa and Euterpe, inclined to it 46′ and 49′ respectively.

In the same periodical Dr. H. Geelmuyden, of Christiania, remarks, relative to Prof. Searle's deduction that the plane of the zodiacal light has some relation to the asteroid orbits (Nature, February 11, p. 350), that "the most northerly point of Jupiter's orbit has the heliocentric longitude 188°, or with 60° east elongation 178°; and for matter in the same plane, but nearer the sun, the approximation to coincidence with 160° is still greater."

The Proposed Change in the Astronomical Day.—M. Raoul Gautier has recently published in the *Archives des Sciences Physiques et Naturelles* of Geneva an account of the proceedings of the International Meridian Conference held at Washington in October 1884. Remarking that the resolutions passed at Washington are similar in many respects to those of the Roman Conference of the preceding year, M. Gautier goes on to point out how they differ in the important particular of the manner of reckoning universal time, and that on this account a large number of astronomers have expressed their reluctance to conform to these recommendations, more especially to the sixth resolution (which proposed that the astronomical and nautical days should be arranged everywhere to begin at mean midnight of Greenwich), the adoption of which would involve considerable changes in the astronomical and nautical ephemerides, which are used by all observers and navigators. Astronomers, M. Gautier states, as well as sailors, begin the day at noon; the former to avoid changing the date in the middle of the night during a series of observations, the latter because they find it convenient to commence the day at the moment when they observe the sun on the meridian. Why then, he asks with some force, oblige them to modify their habits, now of long standing, considering that the fourth resolution passed at the Washington Conference expressly stipulates that the universal day ought not to interfere with the use of local or other standard time where the latter appears desirable?

The Pleiades as Seen and as Photographed.—MM. Henry have recently compared their beautiful photographic map of the Pleiades with the map so carefully laid down by M. Wolf in 1873-75, and published in vol. xiv. of the *Mémoires de l'Observatoire de Paris*, and find that the photograph possesses the following advantages over the map made by direct eye-observation. The photograph shows faint objects which are lost to the eye through their proximity to bright stars; thus the Maia nebula, and another near Electra, have been made evident, as well as details recognised hitherto only by Mr. Common in the Merope nebula. A number of faint companions have also been detected close to several of the brightest stars of the group, and in several cases where M. Wolf had detected a faint companion to a bright star, the photograph has shown that the magnitude of the former was under-estimated. Many more stars are seen on the photograph than are given in M. Wolf's map, the former showing 1421 stars, the latter 625; the aperture of the instrument employed being about the same in both cases. A yet more striking instance of the superior sensitiveness of the plate is seen in the fact that M. Rayet, in his revision of M. Wolf's map in the pure air of Bordeaux, and with a much more powerful instrument, added only 151 stars in a region where the photograph gave 338. All the stars observed by M. Wolf are seen in the photograph but ten, and these cannot be found in the sky.

The Brothers Henry, whilst laying stress on these facts as showing how indispensable a weapon photography has now become to the astronomer, disclaim the idea of criticising M. Wolf's great work, and completely assent to his opinions expressed in the *Comptes rendus*, vol. cii., No. 9, that the eye of the observer must continue to work at the same time as the sensitive plate; the latter can never supersede the former.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 APRIL 25—MAY 1

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 25

Sun rises, 4h. 45m.; souths, 11h. 57m. 51·4s.; sets, 19h. 10m.; decl. on meridian, 13° 15′ N.: Sidereal Time at Sunset, 9h. 25m.

Moon (at Last Quarter April 26) rises, 0h. 57m.; souths, 5h. 28m.; sets, 10h. 2m.; decl. on meridian, 17° 22′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	4 16	10 37	16 58	3 29 N.
Venus ...	3 25	9 6	14 47	4 21 S.
Mars ...	13 19	20 21	3 23*	11 16
Jupiter ...	15 20	21 37	3 54*	2 3
Saturn ...	7 51	16 3	0 15*	22 51 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

April	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
28 ...	ϵ^1 Aquarii ...	6	3 38	4 42	42 288
29 ...	78 Aquarii	6	2 49	3 8	139 175

April	h.	
28 ...	6 ...	Mercury at greatest distance from the Sun.
29 ...	17 ...	Venus at greatest elongation from the Sun, 46° west.
30 ...	5 ...	Venus in conjunction with and 0° 19′ north of the Moon.

Positions of the Comet Fabry

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Brightness.
April 25 ...	1 45 25 ...	31 18 N. ...	9·420 ...	315
27 ...	2 29 43 ...	24 51 ...	9·355 ...	400
29 ...	3 20 22 ...	15 22 ...	9·309 ...	465

Positions of the Comet Barnard

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Brightness.
April 25 ...	1 39 50 ...	39 53 N. ...	0·047 ...	67
27 ...	1 38 41 ...	40 19 ...	0·023 ...	80
29 ...	1 38 8 ...	40 31 ...	9·997 ...	94

The comet positions are for Berlin midnight.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
R Leporis ...	4 54·4 ...	14 59 S. ...	Apr. 26,	0 0	*m*
δ Libræ ...	14 54·9 ...	8 4 S. ...	,, 25,	3 26	*m*
U Coronæ ...	15 13·6 ...	32 4 N. ...	,, 30,	1 53	*m*
U Ophiuchi ...	17 10·8 ...	1 20 N. ...	,, 25,	1 31	*m*
		and at intervals of		20 8	
X Sagittarii ...	17 40·4 ...	27 47 S.	Apr. 28,	2 20	*m*
			May 1,	0 0	*M*
W Sagittarii	17 57·8 ...	29 35 S. ...	Apr. 25,	21 40	*m*
			,, 29,	2 25	*M*
U Sagittarii ...	18 25·2 ...	19 12 S. ...	,, 26,	2 30	*m*
			,, 29,	2 20	*M*
β Lyræ ...	18 45·9 ...	33 14 N. ...	,, 29,	21 35	*M*
η Aquilæ ...	19 46·7 ...	0 7 N. ...	,, 29,	21 40	*M*
R Vulpeculæ	20 59·3 ...	23 22 N. ...	,, 25,		*m*
δ Cephei ...	22 24·9 ...	57 50 N. ...	May 1,	0 0	*M*

M signifies maximum; *m* minimum.

Meteor Showers

The principal shower of this week is that of the *Aquarids*, radiant R.A. 326°, Decl. 2° S. It is a strong shower, visible just before daybreak, from April 29 to May 2.

GEOGRAPHICAL NOTES

THE Geographical Society of Paris held last Friday its first general annual meeting. M. de Lesseps was in the chair, and delivered an address on the Panama Isthmus and Canal. Amongst the gold medallists are MM. Capello and Ivens, the Pandit Krishna, and Alfred Marche.

M. PELLET, a French explorer belonging to the cavalry, was murdered by an unfaithful guide on his way to Timbuctu, before reaching Insalah, the capital of Tuat.

THE Portuguese Legislature has, at the initiative of the Geographical Society of Lisbon, passed an act relating to MM. Capello and Ivens, of which the following are the main provisions:—(1) They are to receive a pension of 600,000 *reis* (135*l.*) per annum each, in addition to a similar pension granted to them after their first journey; (2) exemption from all taxes; (3) the Treasury is to bear the expense of printing an edition of the account of their last African journey, of which 5000 copies will be given to them, and the copyright will be their property; (4) confirmation of the rank conferred on them, and dispensing with the condition of serving the remainder of the term in Africa in consideration of which the rank was granted to them by law. Portugal, it would thus appear, knows how to honour officially, as a nation, her sons who have done honour to her. MM. Capello and Ivens's work is in the National Press at Lisbon, and the volume is expected to be published in two months.

THE current number (Band v., Heft 1) of the *Mittheilungen* of the German African Society is full of interesting matter. The contents are divided into two parts: (1) the reports of the Society's explorers in the Congo region, and (2) those in the Western Soudan. The first part contains Dr. Büttner's diary of his journey during July, August, and September last year. Leaving Arthington Falls on July 3, he travelled eastward to the Quango, at its junction with the Quilo, which point he reached on the 21st of the same month. He then turned south along the right bank of the Quango for seven days, as far as Muene Putu, where he stayed for a fortnight, again returning northward, and crossing to the left bank near the spot where the Quilo joins it. Leaving this on August 21, he continued down the left bank to Kiballa, whence he turned westward to Stanley Pool. A map compiled by Dr. R. Kiepert accompanies the diary, and also tables of various measurements calculated by Dr. von Danckelman. The reports from the Expedition in the Western Soudan are written by Dr. Flegel (from Bakundi, on the Tarabba) and Dr. Semon.

THE last number of the *Mittheilungen* of the Geographical Society of Vienna, like so many similar publications just now, is mainly devoted to African geography. It contains, with a description, route-, &c., a map of the neighbourhood of Ango-Ango, by Herr Baumann, a member of Dr. Lenz's Austrian Congo Expedition. The topographical material was collected during a stay at Ango-Ango, and was put together in Vienna. Two further letters from Dr. Lenz are also published: the first describes the journey from Ngombe to Stanley Pool, and the second the journey to the Equator Station on the Upper Congo. It is satisfactory to learn that the Expedition reached this point in excellent health, and that the Free State officials gave it every assistance. The only other paper in the number is the conclusion of Dr. Diener's contribution to the geography of Central Syria. At the end he confesses that it is at present impossible to say whether the physical features of a great part of this region have altered since the days of the Romans. There are facts, historical, climatic, and geographical, which tend in favour of both sides, and the problem is one for solution in the future.

ACCORDING to a recent communication of M. Venukoff to the Geographical Society of Paris (to which we have already referred), the results of a survey of the basin of the Neva, executed in 1884-85, show that hitherto the levels generally accepted by geographers here have been totally incorrect. The following is a comparison of the levels now ascertained with those given by M. Reclus in his "Géographie Universelle" for Lakes Ladoga, Onega, and Ilmen:—

	New Survey	M. Reclus
Ladoga ...	5·01 metres ...	18 metres
Onega ...	34·97 ,, ...	72 ,,
Ilmen ...	17·97 ,, ...	82 ,,

These figures, and others which might be quoted, show that the region watered by the Neva and its tributaries is much lower than was generally supposed. The new figures refer to the normal zero of Cronstadt, which is itself 0·66 m. above the level of the Baltic at Revel. The absolute heights of the lakes is thus slightly increased, but still the differences between the old and the new figures are very great. As the results of the new survey appear unquestionable, the former hypsometric details respecting the basin of the Neva must be dismissed as wholly incorrect.

THE French Topographical Society proposes that an International Exhibition of Topography should take place in the Palais de l'Industrie next year, under the patronage and with the assistance of the Government. The Committee of Organisation which has been appointed has addressed a circular to French topographers, geologists, geographers, and explorers, asking for their co-operation. The Society, the circular says, has for its aim the popularisation of the science of topography, especially by means of gratuitous lectures, and it is anticipated that an exhibition will give a spur to this work.

SOME RESULTS OF OBSERVATIONS WITH KITE-WIRE SUSPENDED ANEMOMETERS UP TO 1300 FEET ABOVE THE GROUND IN 1883-85

SINCE I had the honour of reading a paper on the first series of observations taken in 1883-84 before the Association in Montreal last year, I have made twenty-five fresh observations at heights above the ground varying from 300 to about 1300 feet, or double the greatest height before attained. I had hoped in have been able to make a greater number and variety of observations, but a pressure of private and other work has stood to the way.

Since, however, in ten of the new observations the upper anemometer was suspended at a height of over 1000 feet above the ground, or 1500 feet above the sea, I trust the results may be thought sufficiently novel and valuable to merit the brief discussion to which I have subjected them.

In dealing with the observations I have included fifteen of those made in 1883-84, and have thus been able to utilise forty observations in all. As the observations were intentionally made as nearly as possible at certain desired heights, so as to afford a regular progression upwards in the scale of height, I have been able to arrange forty-two pairs of observations at two different levels in six groups.

In order to present the results in a form in which they can be readily compared, as well as to exhibit the law of change of the velocity with the height, I have computed for each observation the value of the corresponding exponent in the empirical formula $\frac{V}{v}=\left(\frac{H}{h}\right)^x$, where V, v, H, h, are the velocities and heights of the upper and lower instruments respectively. The several groups, together with their corresponding heights, mean velocities, and exponents, are given in the following table:—

TABLE I.

Group	No. of observations	Mean height of upper instrument above ground, in feet	Mean height of lower instrument above ground, in feet	Mean height of both	Mean velocity at both heights in feet per minute	Mean upper and lower velocities: Upper	Mean upper and lower velocities: Lower	Mean value of x
*1	7	250	102	176	1395	1617	1174	0·372
2	3	322	128	225	1955	2232	1679	0·307
*3	8	407	179	293	1545	1705	1385	0·275
4	5	549	252	400	1940	2107	1773	0·237
5	9	795	481	638	2074	2192	1957	0·250
6	10	1095	767	931	2166	2236	2096	0·194

The general and obvious conclusion to be drawn from this table, as well as from the individual observations (in which a reverse case has never occurred), is that the velocity of the wind

* These two groups comprise observations made in 1883-84 only. The other groups those made in 1884-85 only.

TABLE II.—*Exponents in Formula* $\frac{V}{v} = \left(\frac{H}{h}\right)^x$ *arranged for Different Mean Velocities in all 6 Groups. Groups and Values of x with the Corresponding Mean Resultant Directions D**

Range of mean velocities in feet per minute	1	D	2	D	3	D	4	D	5	D	6	D
700 to 1100	·422 (1)	N. 85 W.	—	—	·343 (2)	N. 39 W.	—	—	·576 (1)	N. 43 W.	·279 (1)	N. 43 W.
1100 to 1500	·345 (5)	S. 83 W.	—	—	·376 (2)	S. 14 W.	·290 (1)	N. 59 E.	·235 (1)	S. 26 W.	—	—
1500 to 1900	·440 (2)	S. 22 W.	·286 (1)	S. 63 E.	·156 (2)	N. 61 W.	·290 (2)	S. 22 W.	·214 (1)	N. 39 W.	·290 (1)	N. 71 W.
1900 to 2300	—	—	·317 (2)	N. 19 W.	·225 (2)	S. 21 W.	—	—	·212 (2)	N. 24 W.	·196 (5)	S. 80 W.
2300 to 2700	—	—	—	—	—	—	·158 (2)	N. 53 E.	·237 (3)	N. 16 E.	·239 (1)	N. 40 E.
2700 to 3100	—	—	—	—	—	—	—	—	·091 (1)	N. 57 E.	·077 (2)	N. 57 E.
Mean range of exponent for 400 feet of velocity. + if it varies directly with − ,, inversely velocity	+ ·009		+ ·031		− ·039		− ·033		− ·097		− ·040	

TABLE III.—*Exponents in Formula* $\frac{V}{v} = \left(\frac{H}{h}\right)^x$ *arranged for the Different Hours of the Day during which the Instruments were suspended, together with the Mean Velocities (V′) and Directions (D) of the Wind†*

Hours	Group 1 x	D	V′	Group 2 x	D	V′	Group 3 x	D	V′	Group 4 x	D	V′	Group 5 x	D	V′	Group 6 x	D	V′
11 to 12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	·058 (1)	N. 57 E.	2703
12 to 1	·360 (1)	S. 8 E.	1447	—	—	—	·163 (1)	N. 48 W.	1635	—	—	—	—	—	—	·174 (2)	N. 7 W.	2286
1 to 2	·360 (1)	S. 8 E.	1447	—	—	—	·163 (1)	N. 48 W.	1635	—	—	—	—	—	—	·154 (3)	N. 31 E.	2286
2 to 3	·360 (1)	S. 8 E.	1447	—	—	—	·163 (1)	N. 48 W.	1635	—	—	—	·235 (1)	S. 26 W.	1368	·087 (2)	N. 60 E.	2494
3 to 4	—	—	—	·307 (3)	N. 45 E.	1956	·257 (5)	N. 75 W.	1589	·119 (1)	N. 39 E.	2378	·163 (4)	N. 61 E.	2183	·116 (4)	N. 41 W.	2479
4 to 5	·386 (4)	S.	1521	·332 (2)	S. 17 W.	1889	·263 (6)	S. 89 W.	1546	·183 (2)	N. 36 W.	1945	·240 (8)	N. 22 W.	1997	·185 (7)	N. 70 W.	2129
5 to 6	·335 (5)	S. 34 W.	1348	·286 (1)	S. 63 E.	1609	·342 (4)	S. 18 E.	1460	·237 (5)	N. 78 E.	1940	·252 (8)	N. 13 W.	2162	·192 (8)	N. 41 W.	2188
6 to 7	·315 (3)	S. 45 W.	1284	·286 (1)	S. 63 E.	1609	·414 (2)	N. 82 E.	1203	·237 (5)	N. 78 E.	1940	·251 (7)	N. 13 E.	2194	·215 (6)	N. 48 W.	2099
7 to 8	—	—	—	—	—	—	·458 (1)	S. 23 E.	1402	·204 (2)	N. 49 E.	1884	·328 (1)	N. 49 E.	2691	—	—	—
Ranges of exponents and velocities	− ·071		− 237	− ·046		− 280	+ ·295		− 233	+ ·118		− 438	+ ·165		+ 508	+ ·128		− 395

+ if increasing, − if decreasing, towards evening ; = sig maximum, minimum.

* The resultant wind directions when calculated from more than two observations have been derived by means of Lambert's fo

† The tant wind directions are calculated by Lambert's formula.

always increases from the surface of the ground up to 1800 feet above sea-level, and that the ratio of the increase steadily diminishes up to that height. The only exception to the steady decrease in the value of x occurs in Group 5, and this is evidently due to the inclusion in that group of an abnormally large value of x (0·576), corresponding to an equally abnormally small velocity of 789 feet per minute, which is little more than a third of the mean velocity of the stratum corresponding to that group. The mean velocities of each group are also seen to increase with some degree of regularity with the height, but this is, of course, partly accidental. In estimating the value of the exponent x for strata of the atmosphere at different heights above sea-level, it must be remembered that the place of observation is 500 feet above sea-level, and therefore that at a certain height above the ground the motion of the air in all probability approximates to what it would have at its real height above the sea. Where this state of things *actually* occurs, we have no ready means of determining, but at a height of 1000 feet above the ground we may assume that the influence of the subjacent tableland is almost obliterated, and the motion of the air *approximates* to what it would have at its real sea-level height. On this assumption, if we add the full 500 feet to each height in Group 6, we get the following value for the exponent :—

	Upper sea-level height	Lower sea-level height	Value of x
Group 6	1595	1267	0·28

If more reasonably we add 400 feet only, we get $x = 0{\cdot}26$, or almost identically the same value as 0·25, which I found agree best on the average with Dr. Vettin's cloud observations at Berlin, ranging from 1600 to 23,000 feet above sea-level (NATURE, January 11, 1883). I think, therefore, that the results of the present series of observations may be taken to add strong confirmation to the general agreement of the empirical formula $\frac{V}{v} = \left(\frac{H}{h}\right)^{0\cdot25}$, with the average motion of the air at heights over 1600 above sea-level.

One great advantage which results from the representation of the observations in the form of exponents is that we are thus enabled to compare observations differing from one another, both as to height and velocity, in a manner which would otherwise be almost impossible.

There are four principal variables which have been observed, and which are likely to affect the value of these exponents, viz. (1) the mean velocity at the upper and lower elevations ; (2) the direction of the wind ; (3) the time of day ; and (4) the month of the year. I have, so to speak, differentiated the exponents with respect to each of these variables in turn, and have in each case placed the corresponding values of the other variables alongside, in order to see how much of the resulting variation of the exponent is independent, or dependent on accidental collocations of the other variables. The results I find most curiously involved, owing to apparently accidental groupings of some of the variables.

One or two variations can, however, be shown to arise from the influence of one factor alone, after that due to the co-existence of others is allowed for. One of these is that due to the change of mean velocity, and the other is the diurnal change with the hour of the day. These are shown in the accompanying Tables II. and III. respectively.

In Table II. the exponent is found, on the whole, to increase with an increase in the velocity in the two lowest groups (1 and 2), and to decrease in the four upper groups, the maxima in each of these groups occurring at the lower velocities, and the minima at the highest ones.

This latter result is what might have been expected *a priori*, and though the first two groups would appear at first sight to present an anomaly, it must be remembered that in these groups the lower instrument is hardly above the influence of surrounding trees, so that in high winds, while the upper instrument might be feeling the full force of the wind, the lower one might be unduly sheltered from it by adjacent trees or buildings.

In Table III. the diurnal variation in the value of the exponents, reaching its minimum from 2 to 3 or 3 to 4, and its maximum between 6 and 8 (as far as the observations go), is most clearly and regularly shown in each of the four upper groups, and as these last are well beyond the influence of local obstructions, I regard the uniformity with which they exhibit this variation as a strong proof in favour of its physical existence independently of any similar variation caused by the parallel march of other factors. Even if part of the variation in groups 3, 4, and 6 is due to the equally regular decrease in the mean velocity from midday to evening, it can be shown from Table II. that this only accounts for a portion of the observed variation.

Thus, taking the ranges of the exponents in Table III., and adding to or subtracting from them the proportional ranges of the exponents for the corresponding opposite range of velocity (deduced from the mean range of the exponents for 400 feet range of velocity in Table II.), we get the following results :—

Ranges of exponents from diurnal minimum to diurnal maximum ; + increasing towards evening ; − decreasing towards evening.	Groups	1	2	3	4	5	6
		−·065	−·025	+·273	+·083	+·296	+·088

that is to say, for Group 5 the variation is increased, and for the rest not materially diminished.

The opposite variation in the two lowest groups (1 and 2) may be capable of an explanation somewhat analogous to the similar anomaly presented by these two groups in Table II., but in any case it cannot be said either to sensibly corroborate or invalidate the physical existence of the variation so statistically marked in all the four upper groups.

This diurnal change in the value of the ratio of the velocity of the upper to the lower strata which is here shown to occur for the afternoon hours, is confirmed by various other casual observations, and is in complete accord with the results afforded by anemometrical observations on Ben Nevis and other lofty mountain observatories, as well as with Dr. Köppen's theory of the diurnal period in the surface-wind alluded to in my former paper.

Since at stations near sea-level the diurnal wind-velocity reaches its maximum at midday and its minimum at midnight, while at lofty stations about 4000 feet above sea-level the critical epochs are reversed, it is evident that somewhere between these levels a neutral plane exists where the diurnal variation is *nil*. The ratio of the upper velocity to the lower for a given difference of height would, however, continue to vary diurnally all the way up (unless some unknown law intervene), reaching its minimum value about midday and its maximum about midnight.

Indications of other laws have been noticed in the value of the exponents, such as a maximum for west winds and a minimum for east winds in five out of six of the groups, and also a maximum in the autumn, minimum in the winter, and maximum again in the summer in all the groups, but the observations are too few and the factors too involved to establish these with any certainty. I trust on a future occasion to be able to go into these questions more in detail, and also to supply the morning half of the diurnal variation, which I consider to be the most certain and valuable result I have as yet obtained in addition to the law of the general progressive decrease in the value of the exponent up to 1800 feet above sea-level in the *free* atmosphere.

E. DOUGLAS ARCHIBALD

BASIC CINDER[1]

THE interest of this report centres principally around the question of the manurial value of undissolved phosphates present in basic steel slag or cinder. The basic cinder is the effete and broken up basic lining of the converters used in the Thomas and Gilchrist process for dephosphorising iron, and is made in very large quantities as a by-product of steel manufacture. It contains from 16 to 19 per cent. of phosphoric acid in union with lime and other bases in combinations insoluble in water.

At the request of the North-Eastern Steel Company Prof. Wrightson and Dr. Munro undertook field experiments in order to test the manurial value of this substance. These experiments were carried out last summer on the College farm at Downton, and at East Howle, Ferry Hill, county of Durham, upon dissimilar soils, and under different climatic conditions. The results as given in the very concise report before us are remarkable, and certainly must be highly satisfactory to those who are interested in the future of basic cinder. The value of this substance as a fertiliser for swedes and turnips, as well as for grass, is placed beyond reasonable doubt by a most remarkable unanimity of results obtained at both experimental stations. Each series

[1] "Report on Experiments made to test the Manurial Value of Basic Cinder from the North-Eastern Steel Works." By Prof Wrightson and Dr. Munro, of the College of Agriculture, Downton, Salisbury. Middlesbrough : *Daily Exchange* Offices, 1886.

was composed of thirty-five plots of one chain square, or of one-tenth of an acre each, and comprised forty drills or rows of plants. The plots were arranged to form five rows of seven plots each, and a rectangle of three and a half acres. They were so disposed within this area that every manured plot was adjacent to an unmanured plot, with the object of obtaining repeated confirmations of any differences which might be indicated in favour of the dressings. Every trial was made in duplicate in both series, and the results are graphically shown by tinted plans, on which the number of the plot, the manurial dressing used, and the number and weight of roots grown are printed.

Not only do these experiments prove ground basic cinder to be a valuable fertiliser, but they assign it a higher position than ground coprolite, and place it only slightly below "superphosphate" in value. This remarkable result is, we find, supported by statements resting on the authority of Dr. Biedermann *Centralblatt* (vol. xiv. part 2), in which the phosphoric acid in basic cinder is asserted to be more readily appropriated by growing plants than is the phosphoric acid contained in coprolites.

The subject is full of interest as bearing upon the positive profits of steel manufacture, and also upon the manufacture of superphosphate and upon agricultural practice. It has attracted the attention of M. Grandeau, of the Faculty of Science of the French University, who contributed a review of the pamphlet before us occupying over three columns of *Le Temps* newspaper. In the course of his remarks he says:—"Les résultats obtenus en Angleterre confirment pleinement, on le voit, ceux que les agronomes allemands ont publiés et que j'ai précédemment analysés. Les scories de déphosphoration sont appelées à jouer un rôle considérable dans la fumure du sol. Des négociants ont déjà traité avec quelques-unes des importantes usines de l'Est (Alsace-Lorraine notamment) pour l'achat de toute leur production de scories."

The experiments conducted at Downton and Ferry Hill were not only instituted to ascertain the positive value of ground basic cinder in comparison with unmanured plots. In them the ground cinder was compared with ground coprolite, with ordinary superphosphate, with a rich superphosphate, with a superphosphate made direct from the basic slag, and with a superphosphate to which green vitriol was added. The subject is likely to arouse a very considerable amount of attention.

AN IMPROVED FORM OF TEMPERATURE REGULATOR

IN 1882, at the request of the Board of Trade, the Royal Society appointed a Committee, consisting of Sir G. Airy, Col. Clark, and Prof. Stokes, to advise on the question of improving the existing means of the comparison of standards of length at the Standard Office. In their report the Committee suggested improvements in the arrangement for securing greater uniformity and steadiness of temperature in the bars under comparison. As a first step in this direction, the Cambridge Scientific Instrument Company were requested to investigate the subject of temperature regulators, and to consider the general design of a comparing apparatus. They proposed that the standards, some hours before they were observed, should be placed in metal cases and immersed in a bath containing water; and that they should not be disturbed during the process of observation. If the uniformity of temperature of the water could be ensured, it would secure the equality of temperature of the standards and remove one of the greatest difficulties in the construction of a satisfactory comparing apparatus.

After some preliminary trials a regulator was constructed similar to that used at the Bureau International des Poids et Mesures at Sèvres.[1] Its action depends on the variation of pressure of a saturated vapour, caused by a change of temperature. The pressure on the volatile liquid and vapour is due to the atmosphere, as well as to a column of mercury; consequently the regulated temperature will vary with any change in the atmospheric pressure. In the following experiments the corresponding change of temperature for one inch alteration of the barometer was about 0°·37 C. The accuracy of the regulator therefore depends on the constancy of the atmospheric pressure,

[1] See "Travaux et Mémoires du Bureau International des Poids et Mesures," tome i. p. C. 10.

and to overcome this serious disadvantage an arrangement was devised for maintaining a constant pressure on the volatile liquid.

An iron bath, D (Fig. 1), containing water, was placed in a wooden box. The intermediate space was filled with sawdust; this was done to minimise the unequal cooling due to the varying temperature of the room. The two ends of a U-shaped tube were fixed into the bottom of the iron bath and passed through holes in the side of the wooden box. The water was kept warm by means of two gas-flames placed under a part of this tube. One of the gas-flames was connected to the regulator and the other direct to the gas-main. The object of the second flame was to re-light the regulated gas-jet in case it should have been extinguished by the regulator.

The water in the bath was kept thoroughly stirred by air forced through it by means of bellows. These were placed inside the box in order to keep them warm, and also for the more important reason of avoiding the currents of air which would otherwise be produced at each stroke. The air used for

Fig. 1

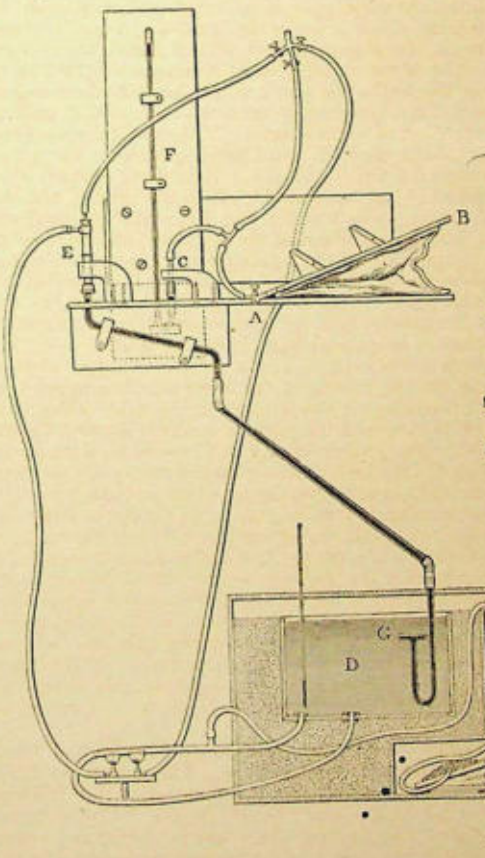


Fig. 2



stirring was thus saturated with aqueous vapour, and did not cool the water in the bath by absorbing moisture from it. The nozzle of the bellows was connected to the U-shaped tube by a branch inserted just above the point where the gas-flame was applied. The air thus pumped through the upper part of the U-tube caused a rapid circulation of water through it. This method has the advantage of applying the heat in a manner which does not tend to make the water in one part of the bath perceptibly hotter than the rest.

The volatile liquid in the regulator was a mixture of methyl-chloride and ethyl-chloride, boiling at about 2½° C. under the normal atmospheric pressure. It was contained in a flat bulb, G, blown at the end of a glass tube, and was under a head of mercury. The glass tubes containing the mercury were connected by short lengths of canvas-lined india-rubber tube. A double brass tube was secured to the open end of the regulator, E; this is shown enlarged in

Fig. 2. The gas entered by the inner tube, which passed down to the surface of the mercury, and the outer tube was connected with the gas-burner placed under the U-shaped heating-tube. Thus a rise of mercury in the regulator reduced the supply of gas to the burner. The cross-section of the flat glass bulb at the common surface of the mercury and volatile liquid was large compared with the cross-section at the upper end of the regulator; thus nearly all the increase in height due to expansion of the volatile liquid and vapour takes place at the upper end of the regulator, and the level of the common surface of the mercury and volatile liquid remains nearly constant.

The most interesting part of the apparatus is the arrangement for compensating for the variation of atmospheric pressure. With this object a barometer in the form of a bent tube is fixed at F. To simplify the explanation we will suppose that the atmospheric pressure diminishes by an amount equal to a head of one inch of mercury; this will cause the mercury in the open end of the barometer to rise half an inch. If the regulated gas-flame is to be extinguished when there is a constant pressure on the volatile liquid, then the tube E must be raised one inch; thus it must move in the same direction as and twice the amount of the exposed surface of the mercury in the barometer. To accomplish this the upper part of the regulator was attached to a board turning about a horizontal axis, A. A gas-bag was placed between the projecting end of this board and a fixed board, B. The board turning about A was so weighted as to tend to close the bag. The nozzle of the bag was connected to the gas-main, and a branch pipe led to a small tube, C, passing down the open end of the barometer. This small tube was fixed by a bracket to the movable board half-way between the upper end of the regulator and the pivot A. Now if the mercury rises in the open end of the barometer it closes the tube C, and the gas from the main passes into the bag, forces the boards apart, and raises both the upper end of the regulator and the tube C, until the escape restores the equilibrium. The flexible india-rubber connections in the glass tubes allow the necessary movement to take place. This arrangement is of interest, as the pressure of the gas-supply is the motive-power for automatically moving a piece of mechanism in a required manner.

The apparatus was kept in action for fourteen days without readjustment, but the stirring of the water was discontinued at night. The thermometer was read about ten times a day, and from July 18 to August 1 the extreme readings were 30°·90 C. and 30°·86 C. The greatest change of temperature during any day was 0°·04 C., the least observed change during any day was 0°·01 C., and the longest period during which no change was observable was from 12.30 p.m. on July 20, to 1 p.m. the following day. At night, when the stirring was discontinued, the variation of the temperature was greater, but it settled down to its normal amount shortly after the stirring began. In a properly-constructed comparing-room the change of temperature would have been less. On one occasion the barometer rose rapidly, nearly half an inch in twenty-four hours, and during this time the temperature of the water did not vary perceptibly. If the barometer had not been attached to the regulator, this change of pressure on the volatile liquid would have produced a change of 0°·14 C. in the bath.

The apparatus was roughly made in an experimental form, but the results were highly satisfactory. There were no doubt errors in the readings of the thermometer. Sir William Thomson, in his article on "Heat" in the "Encyclopædia Britannica," describes an error which may be introduced owing to the mercury in the stem of a thermometer remaining at rest whilst slight changes of temperature are occurring, and then moving suddenly into a new position, where it again remains at rest. This phenomenon was observed in the very delicate thermometer used.

The variation of temperature due to the expansion of the mercury in the barometer and regulator was perceptible, and agreed roughly with the amount arrived at by calculation. Very small errors were also probably introduced by the following causes: the sticking of the mercury in the regulator and the barometer; variation of the gas-pressure; imperfections in the mechanism and of the vacuum in the barometer. There can, however, be little doubt that the errors produced by these and other causes could be reduced to an inappreciable amount, and if the apparatus were placed in a room of fairly constant temperature, remarkable results could be obtained.

HORACE DARWIN

SCIENTIFIC SERIALS

Journal of the Russian Chemical and Physical Society, vol. xviii., fasc. ii.—On the analysis of platinum ores, by F. Willm. All former methods of the separation of noble metals, though sufficient for technical purposes, are considered not exact for the scientific determination. Electrolytic method is recommended.—On the thermic effects of the replacement of hydrogen by bromine in the aromatic compounds, by E. Werner.—On cholanic and bileanic acids, by P. Latchinoff. Both having been obtained from cow's bile and formulæ proposed for the former $C_{25}H_{38}O_7 + \frac{1}{2}H_2O$, and for the latter $C_{25}H_{36}O_6 + \frac{1}{2}H_2O$.—Contribution to the theory of the influence of the decomposition of a body due to heat or to mechanical influences, on its magnetism, by P. Bakmetieff.—Thermo-electrical researches, by the same author. The starting-point for these researches being the fact observed by the author, that the thermo-electro generative force in the metal rods, which serve as thermo-elements, undergoes variations under the influence of the contraction or expansion of the rods parallel to those of magnetism in the same metals and from the same causes.

Rendiconti del Reale Istituto Lombardo, February 18.—State of public instruction in Italy, by Prof. A. Amati. In general the results here tabulated of an inquiry into the present state of instruction throughout the peninsula show that the number of unlettered is in direct proportion with that of the criminal classes.—On a phenomenon of intermission in the sense of hearing, by Prof. A. Raggi. It is shown that under certain conditions regularly recurring sounds strike the auditory faculty in rhythmically recurring waves of greater and less intensity. The phenomenon is regarded as the direct result of perception, the reflex act represented by the awakened attention not being produced with a uniform degree of energy continued throughout the duration of the stimulus, the lack of uniformity being itself due to the feeble degree of excitement.—Note on a simple and obvious, but not hitherto noticed deduction from Taylor's formula in infinitesimal analysis, by Gian Antonio Maggi.—Remarks on a normal metamorphosis of the scented violet due to the presence of the larva of *Cecidomyia destructor*, by Dr. S. Calloni.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 25.—"On the Changes produced by Magnetisation in the Length of Iron Wires under Tension." By Shelford Bidwell, M.A., LL.B. Communicated by Prof. F. Guthrie, F.R.S.

In a paper communicated to the Royal Society about a year ago, the author discussed the results of certain experiments made by Joule in relation to the effects of magnetism upon the dimensions of iron and steel bars.

It is well known that the length of an iron rod is in general slightly increased by magnetisation. Joule enunciated the law that the elongation is proportional in a given bar to the square of the magnetic intensity, and that it ceases to increase after the iron is fully saturated. The author's experiments, made with a greater range of magnetising forces and with thinner rods than those used by Joule, showed that if the magnetising current were gradually increased after the so-called saturation point of the iron had been reached, the elongation, instead of remaining at a maximum, was diminished, until, when the current had attained a certain strength, the original length of the rod was unaltered, and if this strength were exceeded, actual *retraction* was produced.

Joule also found that when the experiment was performed upon an iron wire stretched by a weight, the magnetic extension was in all cases diminished, and if the weight were considerable, magnetisation caused retraction instead of elongation. From these facts he appears to have formed the conclusion that, under a certain critical tension (differing for different specimens of iron, but independent of the magnetising force), magnetisation would produce no effect whatever upon the dimensions of the wire. In one of his experiments a certain iron wire loaded with a weight of 408 lbs. was found to be slightly elongated when magnetised; the weight was then increased to 740 lbs., with the result that magnetisation was accompanied by a slight retraction. In both cases the magnetising currents varied over a considerable range, and the smaller ones were without any visible effect. Commenting upon these results, Joule conjectured that "with a tension of about 600 lbs. (which number is roughly

the mean of 408 and 740) the effect on the dimensions of the wire would cease altogether in the limits of the electric currents employed in the above experiments."

In reference to this surmise the author in his paper of last year expressed his belief that, if Joule had actually made the experiment, he would have found that the length of the wire was increased by a weak current, that a current of medium strength would have had no effect whatever, and that one of his stronger currents would have caused the wire to retract. He had, in fact, reason to believe that the effect of tension was to diminish the "critical magnetising force" (which produces maximum elongation), so that the retraction which is found to occur in all iron rods when a sufficient magnetising force is employed, is observed with smaller magnetising currents when the rod is stretched than when it is free, but want of suitable apparatus prevented him from submitting this idea to the test of direct experiment.

	Commercial iron wire, diam. 1·2 mm.				Charcoal iron strip, section 3 mm.				Hard wire, diam. 2·6 mm.		Soft wire, diam. 3·25 mm.	
	Amperes											
Stretching load ...	3 lbs.	7 lbs.	10 lbs.	14 lbs.	3 lbs.	7 lbs.	10 lbs.	14 lbs.	3 lbs.	14 lbs.	3 lbs.	14 lbs.
Smallest current producing sensible elongation	0·043	0·064	0·084	...	0·033	0·020	0·029	0·064	0·12	0·15	0·064	0·033
Current producing maximum elongation	0·49	0·39	0·23	...	0·44	0·33	0·27	0·15	0·70	0·58	0·70	0·58
Current by which original length is unaffected ...	0·99	0·73	0·47	0·23	1·30	0·99	0·77	0·53	0·99	0·94	1·24	1·09
	Scale divisions											
Maximum elongation in scale divisions	2	1·5	0·5	...	10	6	4	1	2·5	2·5	6·5	4·5
Retraction with current of 1·6 ampere	6	9·5	11	11	9	15	18	20	11	11	8	11

The magnetic field at the centre of the coil = current × 92.
One scale division = one five-millionth part of the length of the wire.

He has lately modified the instrument, which was described in his former paper, in such a manner that it can be used for observing the effects of magnetisation upon rods and wires under traction, and the results of a series of experiments made with it are presented in a synoptical form in the above table. Four specimens of iron were used. The first was a wire of commercial iron, 1·2 mm. in diameter, which had been softened by heating in a gas flame; the second was a strip of annealed charcoal iron, 5·5 mm. wide and 0·55 mm. thick, its sectional area being about 3 mm.; the third was a piece of hard unannealed wire, 2·6 mm. in diameter; and the last was a wire of very pure soft iron, 3·25 mm. in diameter, which had been carefully annealed. These were successively fixed in the apparatus, and loaded with weights varying from 3 lbs. to 14 lbs. While under the influence of each load, four observations were made in the case of each wire:—(1) A determination was attempted of the smallest magnetising current which sensibly affected the length of the wire in the direction of elongation or retraction. (2) The current producing *maximum* elongation (if any) and the extent of such maximum elongation were found. (3) A determination was made of the critical current which was without effect upon the original length of the wire, *i.e.* the current of such strength that a weaker one would cause elongation and a stronger one retraction. (4) The retraction produced by a fixed current of 1·6 ampere was measured.

The figures recorded in the table disclose the following facts:—

(1) The effects produced by magnetisation upon the length of an iron wire stretched by a weight are in general of the same character as those which have been shown in the former paper to occur in the case of a free iron rod. Under the influence of a gradually increasing magnetising force such a wire is at first elongated (unless the load be very great), then it returns to its original length, and finally it contracts.

(2) The maximum elongation diminishes as the load increases according to a law which seems to vary with different qualities of iron. If the ratio of the weight to the sectional area of the wire exceeds a certain limit, the maximum elongation (if any) is so small that the instrument fails to detect it.

(3) The retraction due to a given magnetising force is greater with heavy than with light loads.

(4) Both maximum elongation and neutrality (*i.e.* absence of both elongation and retraction) occur with smaller magnetising currents when the load is heavy than when it is light; retraction, therefore, begins at an earlier stage. Thus the anticipation expressed in the author's former paper is justified.

(5) The phenomena, both of elongation and of retraction are, as might be expected, greater for thin than for thick wires, and for soft than for hard iron.

Linnean Society, April 15.—W. T. Thiselton Dyer, C.M.G., Vice-President, in the chair.—The following gentlemen were nominated auditors, viz., J. Jenner Weir and F. Victor Dickins, as representing the Fellows, and Thos. Christy and F. B. Forbes for the Council; afterwards Mr. Rochfort Connor was elected a Fellow of the Society.—Specimens of so-called Madrepore marble from Iowa (U.S.) were exhibited for Mr. G. A. Treadwell. These contained abundance of a species of *Stromatopora*.—Mr. E. A. Heath showed living examples of *Dendrobium densiflorum* and *D. suavissimum*, and Mr. J. G. Baker drawings of new and remarkable ferns in illustration of the Roraima report.—A paper was read on new African genera and species of Curculionidæ by Mr. F. P. Pascoe. These were obtained from Monteiro, a missionary station north of Lake Nyassa, from Landana, a new settlement on the Congo, and Mayotte, one of the Comoro Islands off Madagascar. The author remarks that the inadequate descriptions, without reference to affinities or diagnostic characters as given by some entomologists, ought to be disapproved. The great diversity of appearance among the same genus of Curculionidæ is somewhat remarkable; secondary characters, therefore, have to be taken into account, but these, after all, may be quite as natural. On the other hand, species quite like each other in appearance are found to belong to widely different groups. For these and other reasons the correlation of stable characters is perplexing, and definite classification difficult.—The third part of Mr. C. E. Broome's series of fungi from Brisbane, Queensland, was read in abstract.—Mr. Everard F. im Thurn then gave the gist of a long report on the plants collected by him during his recent ascent of Mount Roraima, British Guiana. Among these, 3 new genera and 54 new species had been determined. The country of Guiana was described by him as consisting of three marked ascents from the Atlantic on the east to the central table-land west. The groups of vast sandstone columns, of which Roraima is the best known, really abut or overlap on to Brazil territory, and from their summit pour down

streams which flow in diverse directions to feed the rivers Orinoco, Essequibo, and Amazon. Roraima is therefore a probable centre whence peculiar vegetable forms may have originated and distributed themselves over a wide area. Regarding the flora of Guiana as a whole, three distinct zones of vegetation may be distinguished: one, the cultivated strip of coast-land; another, the forest which clothes the upward slopes of the country; and, third, the high savannahs of the interior. Within each of these zones plant species are evenly distributed, though occasionally on the savannahs uniformity is interrupted by small tracts of peculiar vegetation. Sometimes these tracts are marked by the occurrence of only one peculiar species—"areas of localised species"; sometimes by a large number of peculiar species—"areas of distinct vegetation." These latter have notable representatives in the savannah above Karetem Fall and Roraima itself; where, so to say, the more common plant species are excluded. This, then, gives them quite a separate and independent botanical facies.

Entomological Society, April 7.—Mr. Robert McLachlan, F.R.S., President, in the chair.—The following were elected Fellows:—Dr. Capron, Dr. J. W. Ellis, Messrs. F. D. Wheeler, M.A., J. B. Bridgman, F.L.S., T. D. Gibson-Carmichael, F.L.S., J. Rhodes, F.R.M.S., A. C. Horner, J. T. Harris, Evan John, Martin Jacoby, J. A. Clark, G. Elisha, and A. S. Olliff.—Mr. Crowley exhibited a large number of *Lepidoptera* from Accra, West Africa, including long series of *Charaxes* and *Rhomalæosoma*, and a number of specimens of *Saturnia* from Natal.—The Rev. W. W. Fowler exhibited four Coleoptera belonging to the family *Carabidæ*. Three of them had been taken twenty years ago on the banks of the Clyde, and had lately been identified as *Anchomenus sahlbergi*, a species new to Europe, having hitherto been only found in Siberia. The remaining specimen was *Anchomenus archangelicus*, a North European species, nearly related to *A. sahlbergi*.—Mr. J. W. Slater exhibited a spider belonging to the genus *Galeodes*, a Lamellicorn beetle belonging to the genus *Cetonia*, and an undetermined species of *Curculionidæ*, all from Port Elizabeth, South Africa.—Mr. Billups exhibited a specimen of *Bassus vicinarius*, an Ichneumon new to Britain, taken at Peckham in 1885; also a series of another parasite, *Dimeris mira*, taken in Headley Lane, Surrey, in March last.—Mr. White exhibited preserved larvæ of two species of *Catocala*, for the purpose of calling attention to some hitherto undetected processes on the under side; and Prof. Meldola and Mr. J. J. Weir made some remarks on them.—Mr. H. Goss exhibited two remarkable varieties of the male of *Argynnis paphia*, taken in Sussex and Hampshire respectively.—Mr. S. Edwards exhibited an unknown exotic spider found in his Orchid House at Blackheath.—Mr. A. G. Butler communicated a paper entitled "Descriptions and Remarks upon Five New Noctuid Moths from Japan."—The Rev. W. W. Fowler read a paper on new genera and species of *Languriidæ*, chiefly from specimens in the collections of the British Museum, the Cambridge Museum, Mr. G. Lewis, and the Rev. H. S. Gorham; and Dr. Sharp and Mr. Champion made remarks thereon.—Dr. Sharp read a paper on "Some Proposed Transfers of Generic Names," the subject of a pamphlet recently published by M. Des Gozis, in which that author transposed many of the most familiar generic names. Dr. Sharp pointed out the extreme confusion caused by this practice, and showed that the theory on which the system was based was as unsound as the practice itself was objectionable. A long discussion ensued, in which Mr. Fowler, Mr. Waterhouse, Mr. Pascoe, Mr. McLachlan, Dr. Sharp, and Mr. Dunning took part. The last-named gentleman said that the discussion reminded him of a similar one on the application of the law of priority, which took place at a meeting of the Society nearly twenty years ago. The project was then condemned as unanimously as that of M. Des Gozis had been that evening, and he trusted that entomologists would hear no more of it.

Anthropological Institute, April 13.—Prof. A. H. Keane, Vice-President, in the chair.—Mr. H. Ling Roth read a paper on the origin of agriculture. He commenced by briefly reviewing the ideas entertained by savages as to the origin of agriculture among them; then, criticising the views held by scientific men of the present day on the subject, he discussed the conditions generally accepted as necessary to be fulfilled wherever agriculture is to flourish. He laid special stress on the fact that with savages the want of food could not possibly be an inducement to cultivate the soil, but considered that, from the social condition of women in barbarous life and their connection with the soil, they probably originated the first steps which ultimately led whole nations to become agriculturists. He then described what he thought might have been the first step, the rotation in which plants became domesticated, the three homes of agriculture and its spread amongst the uncivilised, and wound up with a few words on the development of agricultural implements.—A paper on the Sengirese, by Dr. Hickson, was read.—The election of Mr. Abraham Hale was announced.

PARIS

Academy of Sciences, April 12.—M. Jurien de la Gravière, President, in the chair.—Complementary note on the results of the application of the prophylactic method against rabies after the bite, by M. L. Pasteur. As many as 726 patients from every part of Europe, and even from North America and Brazil, have now been treated, of whom 688 were for dog-bite and 38 for wolf-bite. Of the first class all are doing well except the already-reported case of the girl Pelletier, and over half of the number have passed the critical period. Of the second class—all Russians—three have succumbed, the others, so far, progressing favourably. An essential difference is pointed out between the nature of bites by wolves and dogs, the former being regarded in Russia as always absolutely fatal. Hence the proportion of victims under the new process must be considered extremely low, more especially considering the severity of the wounds and the long time that elapsed before the treatment could be applied.—On the origin of the electric discharge in thunderstorms, by M. Daniel Colladon. The paper contains a more detailed statement of the author's views, already reported in previous numbers of the *Comptes rendus*, supplemented with remarks suggested by two violent thunderstorms observed by him in the Swiss Alps during the summer of 1885. In the latter an important feature was the *stationary* character of the thunder-clouds, inexplicable according to M. Faye's well-known theory.—Remarks on the second volume of the "Cours de Machines" presented to the Academy by M. Haton de la Goupillière. This volume treats of hydraulics and all kinds of hydraulic machinery, with a special chapter on accumulators and their various applications.—Note on a photographic map of the Pleiades group, by MM. Paul and Prosper Henry. This chart is an engraved reproduction of a proof on paper of the impression obtained on November 16, 1885, by means of the 0·33m. photographic equatorial twice enlarged. It shows, besides the interesting nebula near Maia, another near Electra, of which a very faint impression was obtained. It also indicates the existence of several new companions to Merope, Alcyon, and some other brilliant stars. The discrepancies between this map and Wolf's tables are most pronounced in the case of the small stars in the vicinity of brighter constellations. One of the 10th magnitude in Wolf's list is resolved in the photographic into two of the 13th magnitude. It is also pointed out that where direct observation gives only 625, the photographic process reveals 1421 stars in a somewhat smaller space.—On some remarkable spectroscopic phenomena, by M. A. Riccò. While recently observing on a very bright protuberance the inversion of the sodium rays D and D_2, the author was surprised to notice that the very vivid chromospheric ray D_3 seemed double, being divided by a very fine black line. The same effect was afterwards observed on the chromospheric rays C and F, and it is suggested that these and other double inversions noticed from time to time on the sodium and magnesium rays may be connected with the phenomenon of diffraction.—On the origin of M. Janssen's "solar photospheric network," by M. G. M. Stanoiewitch. From his studies of the photosphere the author concludes that, whatever be the origin of the solar granules, the "photospheric network," as presented by the photographic plates, does not exist on the surface of the sun. It is produced by the irregular refraction of a transparent body with irregular molecular constitution interposed between the granular solar surface and the photographic objective. This irregular refraction is caused by the gaseous envelope of the sun, which, being agitated by currents in all directions, presents as a whole a body of extremely irregular molecular constitution. This view was not accepted by M. Janssen, who made some remarks after the paper was read.—On the equilibrium of a fluid mass in rotation, by M. Matthiessens. The author claims priority of discovery of the annular figures which M. Poincaré lately stated had first been observed by the English geometricians Tait and Thomson. He refers to a series of papers ranging from 1845 to 1883, in which he describes the two rings and discusses the whole theory of these forms and of the ellipsoidal figures.—On a general theorem

relating to the propagation of motion, by M. Hugoniot. The method employed by the author in studying the propagation of motion in fluids is here generalised and extended to all movements regulated by the same system of mathematical formulas.—On the thermo-electric properties of iodide of silver, phosphuret of zinc, sulphuret of tin, and some other chemical compounds, by M. G. Chaperon.—On the density and compressibility of gases and vapours, by M. Antoine. The compressibility of atmospheric air is shown to approach that of nitrogen, whence an important induction is drawn for the use of automatic torpedoes in marine warfare.—On the optical phenomenon known as simultaneous contrast, that is, the tendency to produce the sensation of a complementary colours in the neighbourhood of any coloured surface, by M. Aug. Charpentier. From his researches the author infers that this phenomenon of contrasting colours produced in a region not directly excited is simply a case of *induced colours* in the literal and figurative sense of the expression.—Transformation of the protochloride of chromium into a sesquichloride: molecular states of the oxides of chromium, by M. Recoura.—On monochloruretted vinylethylic ether, trichloruretted, pentachloruretted, and some other chloruretted ethers, by M. L. Godefroy. The first-mentioned of these ethers, discovered by the author, has enabled him to prepare six other ethers, some already known, some new, and forming two distinct series with almost opposite general characteristic properties.—A study of the isomeric naphthylphenylcarbonyls, by M. Rospendowski.—On the eleven genera of the land Lumbricus established by Kinberg, by M. Edm. Perrier. Most of these so-called genera are shown to be mere species, and all the genera known in the time of Kinberg, or down to the year 1872, are now reduced to four. To these are here added eleven others, making fifteen at present known.—On the food of turtles, by MM. G. Pouchet and J. de Guerne. Although usually supposed to be herbivorous, the stomach of some turtles captured in the Azores waters yielded remains of *Hyalæa tridentata*, *Lepas anatifera*, besides Medusæ and small fishes.—Note on the discovery of a Cenomanian deposit at Pech de Foix, containing *Pygaster truncatus*, *Rhynchonella grasiana*, and other fossils of the same epoch, by M. J. Roussel.—Experimental essay on the toxic properties of febrile urines, by M. V. Feltz.—Note on the project of a railway from the coast of Syria to the Persian Gulf, by M. A. Dumont. The projected Euphrates Valley scheme connecting the Mediterranean with the Persian Gulf is favourably discussed from the engineering and economic standpoints. This alternative overland route is declared to be a necessity in the near future, in consequence of the continually increasing traffic through the Suez Canal. At the conclusion of the paper M. de Lesseps also spoke in favour of the scheme, which might be carried out for about 10,000,000*l*.

GOTTINGEN

Royal Society of Sciences, Aug. 1, 1885.—On the theory of liquid jets, by W. Voigt.—The spectrum of the brush discharge, by E. Hoppe. The lines showed a certain correspondence to those of aurora.—On the pyro-electricity of tourmaline, by E. Riecke. The method was to heat a tourmaline a given time in a space of high constant temperature, then hang it by a cocoon fibre to cool near the knob of a gold-leaf electroscope, whose behaviour was then noted. In cooling, the maximum of electric charge occurs if the tourmaline has first taken throughout the temperature of the heating space. The charge corresponding to a regular heating is nearly the same as that with an irregular, if the mean temperature of the latter be equal to the constant temperature of the former.—On Crinoids, by H. von Könen.

November 7.—On a representation of elliptic modulus functions, by infinite products, by H. von Mangoldt.—On Maccullagh's theory of total reflection for isotropic and anisotropic media, by P. Volckmann.

STOCKHOLM

Academy of Science, March 12.—Report on a visit to the Continent for the study and research of chemical-, by Dr. J. M. Lovén.—On Biunclearia, a new genus of Confervaceæ, by Prof. Wittrock.—On *Erythræa exsiccata*, V. B. Wittrock.—Report on a visit to the province of Jemtland (Sweden) for the prosecution of mycological studies, by Herr C. J. Johansson.—Report on a visit to the province of Scania for the prosecution of bryological studies, by Dr. A. L. Grönvall.—On the formation of zoo-pores and quiescent spores in some species of the genus Conferva, by G. Lagerheim.—On the "Herbarium Ruborum Scandinaviæ" of Dr. C. J. Lindeberg, by Prof. Wittrock.—Report on a visit to Ireland, the North of France, Holland, and Westphalia, in order to study the Cretaceous formations of these countries, by Dr. J. C. Moberg.—On a discussion with a view to prove the stability of the planetary system, by Prof. H. Gyldén.—Sur une formule dans la théorie des fonctions, by Prof. Pincherlè of Bologna.—Annotations on the mathematician Petrus de Dacia, and on writings (third part), by Dr. G. Enestrom.—On a geological map of Scandinavia, Denmark, and Finland, exhibited and commented upon by Prof. O. Forell.—On the classification of tourmaline with the group of the rhombohedric tetartohedric forms of the hexagonal system, by Dr. W. Ramsay.

BOOKS AND PAMPHLETS RECEIVED

"The Fresh-water Fishes of Europe," by H. G. Seeley (Cassell).—"Traité de la Détermination des Orbites des Comètes et des Planètes," by A. Oppolzer (Gauthier-Villars).—"Templeton's Workshop Companion," enlarged by Hutton (Lockwood).—"Report of the Mitchell Library, Glasgow, 1885" (Anderson).—"Il Grande Ipnotismo," by Dr. G. Campili (Bocca, Turin.)—"Sound, Light, and Heat," by C. Bird (Relfe).—"Gardens of Light and Shade" (Stock).—"Encyclopædia Britannica," vol. xx. (Black).—"On Asthma," by Dr. H. Dobell (Smith, Elder, and Co.).—"Journal of the Royal Microscopical Society," April (Williams and Norgate).—"Mechanics and Faith," by C. T. Porter (Putnam).—"Systematische Übersicht der Fossilen Myriopoden Arachnoideen und Insekten" i. Abth., Bd. ii., by S. Scudder (München).—"Journal of the Society of Telegraph-Engineers and Electricians," vol. xv. No. 60 (Spon).—"Verhandlungen der Naturhistorischen Vereines," second year, part 2 (Max Cohen, Bonn).—"The Auk," April (Foster, New York).—"Journal of the Asiatic Society of Bengal," vol liv. part 2, No. 3, 1885 (Calcutta).—"American Museum of Natural History," Annual Report of the Trustees, &c., for the Year 1885-86 (Martin, N.Y.).—"Johns Hopkins University: Studies from the Biological Laboratory," vol. iii. No. v.—"The Influence of Sewerage and Water Supply on the Death Rate in Cities," by E. T. Smith.—"What is Materialism," by L. Stephen (E. W. Allen).—"Charles Darwin," by H. W. S. Worsley-Benison (Seers, Bath).—"Les Orages au Sud de la Russia," by A. Klossovsky (Odessa).

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, MAY 6, 1886

HOMER'S SENSE OF COLOUR

Le Sens des Couleurs chez Homère. By Dr. Alb. de Keersmaecker. Part I., xii. + 152 pp. (London: Trübner, 1885.)

THIS appears to be Part I. of a monograph on the colour-sense developed in ancient times, although chiefly based on the language of the Homeric poems. It is to a large extent a criticism of the essays of Mr. Gladstone and Dr. Magnus (of Breslau) on this subject. It is generally admitted that the colour-nomenclature of the Homeric poems is far less copious and less precise than that of modern times. Various theories have been proposed about this. The author represents (p. 22, &c.) Mr. Gladstone's view to be that Homer's *perception* of colour was ill-defined, and that his so-called colour-terms are often really descriptive of luminosity rather than colour. And he describes (p. 6, &c.) that of Dr. Magnus similarly, with the addition that the human eye was in those days less perfect in colour-perception than now, and has gradually improved to its present state.

After a lengthy criticism of these and other theories, the author's conclusions are briefly that there is no evidence of any improvement in the human eye itself during these ages, and that the progress that had taken place is solely one of human knowledge of colour: also that Homer's colour-terms are probably often vague, but not more so than is admissible in poetry.

As to evolution, however, the author goes much further: he lays down broadly (p. 32) that no change has taken place in any organ in any species, and most certainly not in man. It is strange that he also expresses himself as a follower of Darwin. After this it will not seem strange that the general argument is not particularly convincing: the mode of argument, too, is not pleasant; in fact the author pleads guilty to a certain sharpness of manner (*acescence de la forme*) in his criticism of persons.

Waiving however the form, there is much in the matter that is interesting. A short account (9 pages) is first given of what is known of Homer's life, and it is argued that Homer—as being an illegitimate child—was constitutionally liable to the infirmity of blindness traditionally ascribed to him: it is fairly urged by some that this blindness, coupled perhaps with *colour-blindness*, may itself be responsible for some of the uncertainty attached to Homer's colour-terms; but the conclusion is that there is no evidence of colour-blindness.

As to the misuse (?) of colour-names sometimes ascribed to Homer, the author points out (with numerous quotations) that the usage of modern French and English poets is often, to say the least, inexact, so that it is absurd to expect exactitude of application in ancient poetry.

Among the detailed criticisms on Mr. Gladstone's essays may be noticed the following:—Exception had been taken to the use of the word φοῖνιξ (usually translated *red*) as descriptive of a horse; hereon it has been urged (by Mr. Prior in NATURE) that this word should here be translated *Phœnician;* but, if this be really a colour-term in this place, why not translate it as a *bay* or *chestnut* (horse) if the term *red* jars on the English ear? Again, surely a poet may describe a (mythical) serpent as διαφοινός (red?), and the (mythical) ambrosia as ῥοδόεις (rosy?) without being called to account. In one case (Odys. B. VI. v. 163), where the use of φοῖνιξ as a colour-term had been objected to, the author explains that its other meaning, *palm-tree*, makes sense of the passage. Special exception is taken to Mr. Gladstone's interpretation of αἴθοψ, which the author considers to be not a colour-term but a word descriptive of combustion, so covering a wide range of meanings, *e.g.* fiery, glowing, smoky, golden, &c.

The Homeric expression οἶνοψ applied to the sea—hitherto far from clear—receives a new explanation from a traveller in the Ægean, viz. that that sea has at times a blood-red appearance with a red horizon all round. In commenting on the word χλωρός, which seems to mean both *green* and *fresh* or vigorous, the author endeavours to connect the syllable ι with the meaning of vigour, *e.g. harit* (Sanskr.), *sairit* (Zend), ἴφι (Greek), *vi* (Lat.), (to which may surely be added the English *might*), but the connection seems very slight; in fact the syllable ι recurs in many terms expressing weakness or smallness, *e.g.* μικρός, *minimus, slight, schlimm, weich, faible.*

The remarkable fact is brought to notice that the term *sky-blue* is almost unknown in the ancient writings of any Asiatic people, *e.g.* in the Vedic hymns, in the Zend-Avesta, in the Old Testament, in Hebrew writings generally, and in Homer and Hesiod; the epithets applied to the sky being expressive of its vastness, depth, purity, brilliancy, &c., but not of its colour. A similar want of a precise colour-term is shown to exist in many modern barbarous languages. But it does not seem warrantable to conclude that sky-blue was a colour unknown to these peoples; indeed sky-blue pigments have been found (p. 37) at both Memphis and Thebes.

A part of Dr. Magnus's theory of the evolution of the colour-sense is that the eye acquired the power of recognising different colours in the order of their luminosity: but the order which he seems to assign (p. 71), viz. red, yellow, &c., is certainly not that of their luminosity. The physiological and emotional effects of colours on men and animals are noticed in this connection. Thus red is known to excite bulls and turkeys: the experiments of M. Paul Bert on the small crustacean Daphnia are quoted; when placed in a solar spectrum they congregate most thickly in the orange to green region, which is also the most luminous region. Goethe's speculations on the effects of colour on the emotions of mankind are noticed at length. A curious "colour-treatment" (chromo-photothérapie) proposed for the insane is also mentioned, which consists in placing the patients amidst surroundings of a tint supposed to be capable of exciting healthful effects: thus red is said to excite, blue and violet to sadden, green to soothe. The results of this treatment do not seem to have been very definite (pp. 78, 79).

The comparative philology of colour-terms takes up—as might be expected—much of the work: the author has spared no pains in endeavouring to trace out the meanings of Homer's colour-terms by the help of the related words in other languages. As to the uncertainties of this process, take the words related to *blue* as an instance. Mr. L. Geiger's opinion is quoted (p. 50) that the modern European words *blue*, *blae*, *blau*, *blâ*, *bleu*, &c. (English, Scotch, German, Danish, French), now meaning *blue*, meant *black* in early Europe, whilst another (p. 101) connects them with words conveying the idea of brightness, *e.g. briller*, *blanc*, *blink*, *bleach*, *blank*.

The author promises a further instalment of this essay, in which the evidence from the fine arts, pottery, and dyers' work, and that from morphology and physiology are to be set forth; also a full statement of conclusions.

ALLAN CUNNINGHAM (Major, R.E.)

OUR BOOK SHELF

The Journal of the Engineering Society of the Lehigh University, March, 1886.)

THE practice of forming engineering societies in universities where engineering is taught is an exceedingly good one, and should receive every encouragement and help from the authorities. In fact every college should have its society. The meetings give the students an opportunity of discussing interesting engineering works, and give them a greater interest in the subject-matter taught in the class-room. These junior engineering societies, if I may so call them, ought not to be only found in colleges, but all large engineering works should have a society of their own, the members of which should include those of the pupils, apprentices, and men who are anxious to improve themselves by the reading and discussing of papers prepared in rotation by the members themselves. Visits to other works might also be arranged. No doubt the formation of such societies may seem very hard to accomplish, but in most works there will be found men willing and anxious to form such societies and to keep them going until their utility is recognised.

The *Journal* before us contains several articles of an interesting nature, the first being by Prof. Merriman on "The Internal Work and the Deflection of Beams"; the second article gives an account of "Boring the Big Aqueduct" for the New York water-supply from Croton Lake. We next have a short notice on technical education in Mexico, followed by a very good account dealing with "The Requisites of a Successful Engineer.'

After notices on "Mine Water Formations" and "The Foundations of the Washington Monument," the *Journal* concludes with a condensed report dealing with the measurements necessary to ascertain "the velocity and discharge of the Lehigh River about Bethlehem."

Taken as a whole the contents of this *Journal* are disappointing from a professional point of view, Prof. Merriman's article on the deflection of beams being excepted. The descriptions are much too general and popular; the subjects are not treated with that accuracy demanded by an engineering article, and are written in a style more fitted for the columns of a daily paper than a journal published by an engineering society.

N. J. L.

Fresenius's Quantitative Analysis. Parts I. and II. Vol. II Translated by C. E. Groves, F.R.S. From New Edition of Fresenius commencing in 1877. (No date)

IT is a great pity these books cannot be pushed forward much faster. The plan adopted by many German authors of sending out books in "Lieferungen" has some advantages, but generally these are more than balanced by the time allowed to elapse between each part. This slowness on the part of authors makes it somewhat unpleasant for a translator, who must of necessity be still somewhat later. In this particular instance, however, the translator has improved on the time by introducing or referring to methods not in the original, but it might have been carried further. The original does not contain anything about Victor Meyer's methods of vapour-density determination, and the translator has also refrained from noticing these methods. There may be some reason for this, but we think at least the methods might have been mentioned, as they are simpler to perform than any other, and do not fall behind any in accuracy.

The whole of Part I. and a small portion of Part II. is taken up with analysis of organic bodies; the remainder of Part II. is on the analysis of potable and spring waters, &c. If an index or table of contents had been added, it would have rendered the English edition more practical.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Protective Influence of Black Colour from Light and Heat

IN NATURE, vol. xxxiii. p. 559, a correspondent refers to the effect of blackening the skin round the eyes as a protection against the glare of strong sunlight. Probably the practice has good scientific grounds.

The shape of the orbit at once suggests the reflecting cone of a thermopile, with the eyeball centred on its axis in the position of the pile, but of course much less deeply placed. The cone is, in this case, oblique, the maximum slant side being internal, *i.e.* towards the nose, and the minimum slant side external. A plane through the outer orbital angle, and perpendicular to the axis, will be pretty nearly coincident with the tangential plane of the eyeball at the anterior end of its antero-posterior diameter, and there will be a considerable part of the nasal surface of the cone in front of that plane. This part will act as a reflecting surface, and concentrate the rays upon the eyeball. Probably variations of complexion will not much affect the reflecting power of this surface, seeing that the difference in the skin of black and of white races is mainly a difference in the amount of pigment in the rete mucosum, and not in the superficial parts of the epidermis.

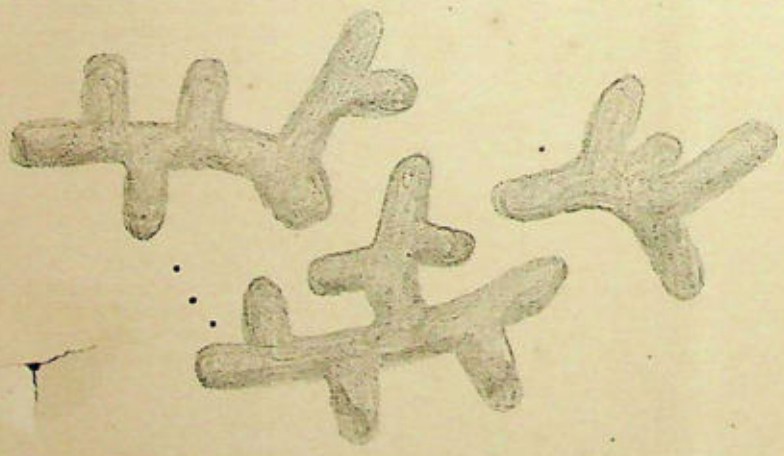
It is evident that rays reflected from the ground, and from objects of no great altitude, are the rays which will have the greatest chance of striking the eye after reflection from the sides of the orbital cone. The direct rays of the sun in tropical countries will, during the hottest part of the day, be too nearly vertical to take this course. Now it would seem that it is in the case of intense light reflected from rocks, snow, &c., that the blackening has been found useful.

Whether to any appreciable extent the amount of light entering the eye is increased by the shape and projection of the orbit is a different question. For here it is not enough that the rays should be concentrated upon the eyeball. They must enter the pupil. Nevertheless, it would seem from observations made for another purpose upon the pupil-reflex, that the diameter of the aperture is increased by blackening the skin round the orbit, say by means of a piece of black cloth with an elliptical hole in it for the eye, the light of course being kept of constant intensity.

April 19 G. N. S.

On the Form of Mole-Hills Thrown up under Snow

MOLES must have an opportunity of getting to the surface here and there to dispose of the results of their excavations. When they meet with a deep-laid hard road they come out and cross it. When frost has bound the soil into an impenetrable cake they sometimes come out of the ground, and, travelling away to seek a place more suitable for their operations, are unable to find their way back or to burrow into the frozen soil in another place,



and so they get killed in considerable numbers. When there is a little snow on the ground, protecting it from the frost, the moles come to the surface as usual, and throw up mounds of earth under or through the snow. But, when deep-drifted snow has covered the ground, the mole-hills under it are found to be arranged in more or less symmetrical ridges of uniform height and breadth, as represented in the sketch. It would appear that the moles in these circumstances make galleries about the size of their own bodies on the surface of the turf in the bottom of the snow, into which they push the earth to be disposed of, finding it easier to make these small tunnels than to raise the usual mound of earth under the superincumbent snow-drift. The severe winter just over has caused the snow-drifts to lie long in the north of England, where examples of this peculiar form of mole-hill may be commonly seen on the Fells.

Cambridge THOS. MCKENNY HUGHES

Protective Imitation

I HAVE been watching for hours with great interest what I believe to be a very curious instance of protective imitation. A large old thrush has been, all that time, trying to make itself look like a serpent, and succeeding remarkably well. The object appears to be to frighten away a smaller and more active thrush—no doubt younger and with sharper ears—which seems to be getting all the worms. It appears afraid to attack its young rival, but runs towards it as if it meant to do so, and when the young one turns round and faces it, the old one crouches down so that nothing of it is seen but a crest-like back, two glaring eyes, the spotted throat, and a dark line formed by the front view of the beak and the lines at the corners of the mouth, which look very much like a serpent's mouth. If I saw the creature protruding from a bush or from the grass, I should certainly take it for a snake of some kind. The young bird looks alarmed and retreats, though just before it was ready to attack the other. No sooner has it recovered its courage and advanced to attack than the old one retreats, and resumes its serpent-like mask. There has been a little sparring in the air occasionally, just enough to show the nature of the feeling, but if allowed to do so the young one evidently would be content to feed quietly. The old thrush (I know it by a small white feather on one wing) is very much at home on this lawn, and seems to consider it as its own private domain, at all events as far as thrushes are concerned. A short time ago, when the ground was for a long time hard from frost and drought, this thrush moped about and seemed nearly starved, and at last fell upon two great clumps of yellow crocuses, and not only tore them to pieces, as if in a rage, but devoured them entirely, returning again and again to them, and gobbling up the yellow petals as a rabbit does a lettuce. At that time many birds that are usually too shy came down from the hills and strolled about the fields and lawns—snipes, plovers, &c. Two exquisite crested plovers (I think they are called) stalked about with graceful dignity for some days in a garden close by, and roosted in an old hen-house. The thrush touched no crocuses but the yellow ones, and no other bird did so. I should be glad to know if the resemblance to a serpent has been observed by any one else. J. M. H.

Sidmouth, April 19

P.S.—It may be thought that the crouching is only a preparation for a spring, but it does not suggest that to the eye, and it is not followed by a spring. If it really is a fact and not a fancy, the instincts of imitation and of fear in this case must be a very ancient inheritance indeed.

Iridescent Clouds

THIS evening at sunset there was here a fine instance of iridescent clouds. About 7 I drew the attention of my companion to some remarkable clouds; three long arms of stratus of peculiar texture, like pulled-out cotton-wool, and of striking colour, blue-black and silver, stretched nearly to where the sun had gone down behind a hill. At 5 minutes past 7 a detached portion of this cloud assumed lovely iridescent colours like bright mother-of-pearl. This gradually died away, but other portions assumed the same tints. At 7.30 the tints vanished. Wind, south-west.

Glencar, Kerry, April 26 J. G. [redacted]ENFELL

MADRAS MAGNETICAL OBSERVATIONS[1]

WE are indebted for the present volume to Mr. Pogson, the Government Astronomer at Madras, from whose introductory remarks we learn that he is not yet at the end of his editorial labours.

[1] "Magnetical Observations made at Madras in the Years 1851-1855, under the Superintendence of Mr. W. S. Jacob." Edited by Mr. N. R. Pogson, Government Astronomer. (Madras: Lawrence Asylum Press, 1884.)

Mr. Pogson intends as soon as possible to continue his work, and the greatest praise must be given to this distinguished astronomer for his persistent efforts to complete the records of his Observatory. But what can be thought of a system of administration under which observations are reduced about half a century after they are made? If this were the only instance of such a monstrous delay it would be bad enough, but we seem destined to have another instance, no less flagrant. The late Mr. John Allan Broun finished his work at the Trevandrum Observatory in 1864, and as yet only the first volume of his reductions has seen the light. Here the Observatory has been discontinued, and we do not know that any one has come forward to complete the labours of Mr. Broun, so that the publication of the remaining volumes seems to be adjourned indefinitely. Surely there is something in this system which requires putting right.

Mr. Pogson tells us in his introduction that the vertical force results were never entitled to any confidence, especially before March 1853, when, for the first time, the needle was placed nearly perpendicular to the magnetic meridian, agreeably to the directions given in the report of the Royal Society. Our readers are probably aware that at the present moment a Committee of the British Association is engaged in discussing magnetic observations, and they are anxious to bring together all reasonably good determinations of the solar-diurnal variations of the three magnetic elements for as many places as possible.

It may therefore be of interest, especially after the above remark by Mr. Pogson, to apply some sort of preliminary test to the Madras observations. I shall therefore compare them with the similar results obtained at Bombay, and discussed by Mr. C. Chambers in his recent elaborate and excellent volume.

In the following table we have in the first place a comparison of the solar-diurnal variations of declination at the Colaba Observatory, near Bombay, and at Madras. For the purpose of this comparison it is unnecessary to give the scale values or to exhibit all the months. We have therefore limited our comparisons to a mean of the three months, November, December, and January, and also of the three months, May, June, and July.

TABLE I.—*Comparison of the Solar-Diurnal Variations of Declination at Bombay and at Madras*

Bombay civil time (noon = 12)	Mean of Nov., Dec., Jan.	Mean of May, June, July	Madras civil time (noon = 12)	Mean of Nov., Dec., Jan.	Mean of May, June, July
h. m.			h. m.		
0 12	+23	+ 23	0 41	+ 8	+ 16
1 ,,	+17	+ 37	1 ,,	+ 2	+ 25
2 ,,	+ 4	+ 44	2 ,,	− 3	+ 31
3 ,,	− 12	+ 46	3 ,,	− 12	+ 30
4 ,,	−33	+ 51	4 ,,	− 23	+ 34
5 ,,	− 54	+ 85	5 ,,	− 36	+ 60
6 ,,	− 67	− 206	6 ,,	− 48	+120
7 ,,	− 74	+272	7 ,,	− 40	+129
8 ,,	− 11	+249	8 ,,	− 4	+ 91
9 ,,	+48	+128	9 ,,	+10	+ 21
10 ,,	+33	− 30	10 ,,	− 4	− 47
11 ,,	− 26	− 165	11 ,,	− 10	− 101
12 ,,	− 34	− 245	12 ,,	0	− 121
13 ,,	− 8	− 236	13 ,,	+12	− 105
14 ,,	+28	− 184	14 ,,	+14	− 76
15 ,,	+31	− 105	15 ,,	+22	− 40
16 ,,	+26	− 34	16 ,,	+23	− 12
17 ,,	0	0	17 ,,	+12	0
18 ,,	+ 1	− 6	18 ,,	+16	− 13
19 ,,	+19	− 45	19 ,,	+19	− 22
20 ,,	+17	− 48	20 ,,	+13	− 19
21 ,,	+14	− 33	21 ,,	+ 9	− 9
22 ,,	+18	− 15	22 ,,	+10	0
23 ,,	+24	+ 5	23 ,,	+10	+ 8

Now it will, we think, be seen from Table I. that at both stations the type as well as the range of the solar-diurnal variation is very different for the two groups of months. It will likewise be seen that the peculiarities of the summer variation are very much alike at both stations, and that the peculiarities of the winter variation are also very much alike. Thus the comparison is favourable to the accuracy of the observations at both stations.

Let us now turn to the force components. In Table II. we have a comparison of the horizontal and vertical force variations at the two stations for the two months, June and December.

TABLE II.—*Comparison of the Solar-Diurnal Variations of the Horizontal and Vertical Force at Bombay and at Madras*

Bombay civil time (noon = 12)	Horizontal force June	Horizontal force Dec.	Vertical force June	Vertical force Dec.
h. m.				
0 18	− 105	− 98	+ 36	+ 11
1 ,,	− 96	− 88	+ 37	+ 9
2 ,,	− 97	− 84	+ 36	+ 9
3 ,,	− 94	− 77	+ 30	+ 5
4 ,,	− 92	− 64	+ 36	+ 7
5 ,,	− 90	− 50	+ 59	+ 5
6 ,,	− 47	− 25	+ 95	+ 3
7 ,,	+ 21	+ 28	+ 74	+ 8
8 ,,	+101	+ 93	+ 10	+28
9 ,,	+189	+161	− 80	− 1
10 ,,	+287	+232	−153	−57
11 ,,	+302	+242	−162	−61
12 ,,	+278	+204	−116	−19
13 ,,	+214	+134	65	+ 6
14 ,,	+120	+ 66	− 17	+ 9
15 ,,	+ 21	+ 17	+ 19	+ 8
16 ,,	− 56	− 27	+ 31	+ 7
17 ,,	− 105	− 65	+ 22	− 8
18 ,,	− 132	− 7[illegible]	+ 4	+ 6
19 ,,	− 124	− 86	+ 3	+ 8
20 ,,	− 124	− 105	+ 18	+ 6
21 ,,	− 121	− 114	+ 21	+ 4
22 ,,	− 119	− 111	+ 31	+ 9
23 ,,	− 111	− 109	+ 34	+10

Madras civil time (noon = 12)	Horizontal force June	Horizontal force Dec.	Vertical force June	Vertical force Dec.
h. m.				
0 41	− 309	− 284	+ 923	+ 666
1 ,,	− 299	− 245	+ 543	+ 697
2 ,,	− 268	− 226	+ 757	+ 650
3 ,,	− 258	− 218	+ 515	+ 529
4 ,,	− 243	− 197	+ 558	+ 711
5 ,,	− 236	− 159	+ 617	+ 976
6 ,,	− 128	− 80	+ 300	+ 879
7 ,,	+ 58	+ 88	+ 259	+ 593
8 ,,	+365	+317	− 533	− 217
9 ,,	+658	+573	−1329	− 938
10 ,,	+873	+740	−1688	−1247
11 ,,	+876	+730	−1926	−1043
12 ,,	+716	+580	−1631	−1246
13 ,,	+483	+354	−1096	−1304
14 ,,	+194	+160	− 389	− 872
15 ,,	− 66	+ 15	+ 60	337
16 ,,	−211	− 91	+ 241	− 289
17 ,,	− 281	− 185	+ 30	+ 23
18 ,,	− 319	− 256	+ 426	+ 75
19 ,,	− 338	− 326	+ 555	+ 152
20 ,,	− 323	− 369	+ 596	+ 280
21 ,,	− 336	− 374	+ 640	+ 376
22 ,,	− 319	− 341	+ 779	+ 585
23 ,,	− 311	− 314	+ 991	+ 747

It will be seen from this table that at both stations and for both components the type for June is nearly the same as that for December, the chief difference being in range. Also that the type at the one station is very similar to that at the other. The most marked difference between the two stations is for the vertical force, the range of this element in December bearing a smaller proportion to its

range in June at Bombay than at Madras. To investigate this point it will be desirable to give the comparative ranges for the various elements for the various months at the two stations. This is done in the following table.

TABLE III.—*Ranges for the Various Months of the Diurnal Variations of the Three Elements at the Two Stations*

Month	Bombay			Madras		
	Declination	Hor. force	Vert. force	Declination	Hor. force	Vert. force
January ...	162	389	167	91	1318	3414
February ...	117	507	120	64	1585	3778
March ...	263	571	175	104	1785	4847
April	392	576	216	218	1851	6273
May	486	473	265	243	1522	4198
June	480	434	257	260	1214	2917
July	468	439	263	249	1218	2445
August ...	545	423	301	273	1101	3203
September...	550	407	365	282	1331	6401
October ...	258	437	213	110	1595	5163
November...	103	414	91	73	1362	3633
December...	136	356	89	86	1114	2280

From this table it will be seen that for both stations there is a smaller maximum of declination range about May or June, and a larger maximum in September, while the most decided minima are in November and February for both stations. Again, there is a maximum of horizontal force range for both stations in April, and also in October, while the minima are at Bombay in September and December, and at Madras in August and December.

Finally, at Bombay there is a smaller maximum of vertical force range in May and a larger in September, while at Madras these occur in April and September. The most pronounced minimum of vertical force is in December for both stations.

It would thus appear that there is a very striking likeness between the variations of the three elements at the two stations, and that, notwithstanding Mr. Pogson's remark about the vertical force instrument, its results do not appear to be without value in a comparison of the above nature.

BALFOUR STEWART

PLANTS AND THEIR DEFENCES

A CONSTANT struggle for existence, the consequence of the enormous increase in the numbers of the individuals of almost every species, is the fate of nearly every organism, both animal and vegetable. Some have to sustain the attacks of others which are directly antagonistic to them, and which regard them as prey; in the case of others the struggle is rather one to live in the face of adverse conditions or peculiarities of environment, so that the different organisms are not directly hostile, but each affects its neighbour injuriously by adapting itself more readily to the changing surroundings, and so diminishing the other's power of obtaining nutriment, sunlight, or whatever other condition may be the object of their competition. Thus have been developed in the different competitors different features of their constitution—many perfecting powers of active assault, others facilities for active or passive defence. The last-named is particularly the feature found in the vegetable kingdom. The want of locomotion prevents any aggressive movement of the individual, and hence success in the struggle can only be secured by more complete adaptation to environment than its competitors can show, or by protective mechanisms guarding the individual from the assaults of organisms inclined to prey upon it. These mechanisms exhibit very great variety, and their object often seems obscure till they are looked at in the light of the environment of the plant, the conditions of its life, and the enemies against which it has to contend. The specially-exposed points of attack are three: the succulent leaves and shoots or the attractive fruits are assailed by animals in search of food; the honey secreted by the flower to allure to it the particular insect adapted to bring about properly the process of fertilisation attracts also other insects whose presence is useless for such purpose, and which therefore are only robbers; while the fertilising pollen is itself the object of desire on the part of others which are equally unable to apply it to its legitimate purpose.

The protective mechanisms of plants, therefore, so far as they are directed against aggressive animals, are to be looked for mainly in the neighbourhood of the young growing parts or the reproductive organs. Not exclusively, however, but generally the older vegetative parts are defended by their own inherent qualities, such as their hardness or wiriness, which keep them from being suitable for the food of their assailants. Such young growing parts in many plants, particularly those growing in exposed regions, are plentifully supplied with thorns, spines, or prickles, rendering them in many cases extremely formidable. The thorns or prickles may be produced on almost all the vegetative organs, and may be merely epidermal structures, or much stronger in composition, containing considerable developments of woody tissue. These thorny plants are most noteworthy in desert countries, some that are met with there, notably the so-called "wait-a-bit" thorn of Africa, having spines of immense length, and being quite impenetrable by man or beast. Cases are not of infrequent occurrence where even the lion himself is a considerable sufferer by coming into collision with this plant. So great is the development of the thorny character in this region that Grisebach connects it particularly with desert exposure and scarcity of vegetation. Nor are thorny plants by any means confined to such regions—on our own heaths the gorse is a familiar plant, and one sufficiently formidable to passers-by; while other spiny Leguminosæ, as the wrest-harrow (*Ononis spinosa*), are not infrequent by the wayside. A further peculiarity may be noted in connection with these plants: often the thorns do not occur above the point which is assailable by the animal in its search for food; while, when the shoot has outlived its period of succulent condition, and its tissues have become hard and dry, the thorns do not persist, being much more numerous when the part is young.

Nor is this spiny habit confined to shrubs or trees. The cactuses, which are so remarkable a feature of the vegetation of America, are equally well protected. Their surfaces show great variety of development in this particular: some have small groups of thick rigid spines, others long flexible needles of intense sharpness, penetrating easily the skin of the assailant, and almost impossible to extract.

More formidable defences even than thorns or prickles are found in the varieties of stinging hairs borne so plentifully on the leaves of many plants. These are represented in England by the two species of stinging nettle, which are, as every one knows, capable of producing considerable discomfort to the unwary person who handles them. These are, however, not worth mentioning by the side of many of their tropical relations. The structure of the hair in all these is similar: a mass of cells forms a kind of swollen cushion below; on this is seated the long tapering hair, which ends in a somewhat recurved point or hook. The walls of the upper part of the hair are very strongly silicified, and are, consequently, easily ruptured. Lower down there is but little silica. When touched or rubbed by the hand, the pressure drives the hair downward; at the same time the brittle hook penetrates the skin and breaks off. The downward pressure forces out from the broken hair a fluid of intensely acrid nature, which, on entering the wound made by the point, sets up more or less severe inflammation. This fluid is generally conjectured to be formic acid—a

view based on the fact that this acid can be obtained from the nettle plant by suitable means.

While the English representatives of this group of plants are sufficiently formidable to careless intruders, some of their connections in other parts of the globe are distinctly dangerous. A traveller in Australia describes a specimen of *Urtica gigas* in the following terms :—"A specimen seen by Sir W. McArthur, still in full vigour, rises from its base by a series of buttresses of singularly regular outline, gradually tapering, without a branch, to a height of 120 to 140 feet. The trunk then divides into a regularly-formed, wide-spreading head, which excites admiration from its extraordinary size. But the ordinary elevation of this tree is 25 to 50 feet, with a circumference of 12 to 20 feet. The leaves, when young and in vigorous growth, attain a breadth of 12 to 15 inches, and are of a beautiful dark-green colour. As may be expected, the poisonous fluid secreted from the foliage is very powerful, particularly in the younger leaves, and their sting is exceedingly virulent, producing great suffering, not unattended with danger. It is found in the northern part of New South Wales, and is a great impediment to the traveller." An Indian species (*Urtica* or *Laportea crenulata*) is equally obnoxious. It has rather large leaves, round which numerous small stinging hairs are placed. At certain seasons it emits when bruised so irritating an aroma as to cause a copious flow of saliva and mucus from the nose and eyes for many hours, while violent fevers have been caused by the fluid poured out from its ruptured hairs. *Urtica urentissima*, a Timor species, which is known to the natives by the significant appellation of "devil's leaf," has been known to produce effects so violent as to last twelve months, and has in some cases even caused death. *Malpighia urens* bears on its leaves hairs 1½ inch long, which are pressed flat along the surface. These act very similarly to those of Urtica.

The Loaseæ, or Chili nettles, exhibit similar defences, their power of stinging being very severe.

Other plants are protected also by hairs, which play rather a mechanical than a chemical part. Such are various species of Deutzia, particularly *D. scabra*, which bears on its leaves numerous star-shaped hairs whose walls are permeated with silica.

Besides these defences, which are chiefly mechanical, though in the case of the nettle a secretion acting chemically plays an important part in their behaviour, many plants are protected by chemical means alone. This is seen chiefly, though by no means exclusively, in the case of flowers and fruit. The plant secretes in different parts, or it may be throughout its system, a juice which may be poisonous, or acrid, or harmless in effect, but very unpleasant to its assailant. Thus very many of the Solanaceous plants have poisonous fruit, as *Atropa Belladonna*, and some species of Solanum. The whole plant is charged with juice of great pungency in many of the Ranunculaceæ, *R. sceleratus* causing sores if allowed to come into contact with a delicate mucous membrane such as that of the mouth. Parts of the Aconite (*A. Napellus*) are intensely poisonous, while the seeds of *Strychnos Nux-vomica* yield the well-known drug strychnine. Others have a latex or juice which is intensely bitter and unpleasant to the taste, as the different species of spurge (Euphorbia), the dandelion, the wild lettuce, different species of poppy, and many others. An acrid juice is to be met with in many Cruciferæ, as the mustard and the radish. The aromatic Umbelliferæ, also, are protected in this way from many of their enemies, the peculiar flavour which they possess being very unpalatable to many birds which are attracted by their fruits. Other plants pour out resinous and other sticky secretions which serve the same purpose. Some others are protected by the possession of a very fœtid odour, much resembling putrefying animal matter, though this has probably been developed to attract the carrion-loving flies which secure cross-fertilisation of the plants. Such are *Arum Dracunculus* and Stapelia, a genus of Asclepiadaceæ.

A very different kind of defence against intruders is found in a Sumatran parasite, *Hydriophytum formicarum*. This plant, instead of developing special weapons of its own, attracts to itself a colony of ants whose sting is very severe. These resent very effectually the attacks of animals inimical to the plant. It is described as parasitic on trees in the form of a large irregular tuber, fastening itself to them by fibrous roots, and throwing out several branches above. The tuber is generally inhabited by ants, and is hollowed out by them into numerous winding passages, which frequently extend a good way along the branches also, giving them the appearance of being fistular. A similar arrangement is found in *Acacia sphærocephala*, but a more elaborate one, as the plant not only serves as a habitation for the ants, but develops certain organs to attract them to it. The stem and branches are furnished with very large thorns, which are set along them in pairs. The thorns are enormously swollen at their bases, which are hollow, and in these swellings the nests of the ants are found, the magnitude of the enlargement being no doubt caused by the irritation of the insects. At the base of each pair of thorns, about midway between the two, is found a large nectar-secreting gland, which is very active. The leaves of the plant are pinnate, and on the leaflets are numerous small pear-shaped glands, consisting of delicate masses of cells containing an oily secretion. *Cecropia* is also protected in the same way; its stem is hollow, and contains the nests of the ants. As in the case of the Acacia, glandular structures are present, which attract the ants and afford them food. Schomburgk describes a plant belonging to the order Polygonaceæ (*Triplaris Schomburgkiana*), a native of Guiana, as having its trunk and branches hollow between the nodes, and serving as the habitation of venomous ants. He also mentions an orchis (*Schomburgkia tibicinis*), which, he says, has pseudo-bulbs arising from creeping root-stocks. These have a small hole at their base, and ants and other insects construct their nests therein.

Turning more especially to the reproductive organs of plants, we find them attractive to intruders, not only on account of their own palatability or succulence, but as providing two especial delicacies much sought after by the insect world—honey or nectar, and pollen. The object of the secretion of the former is to secure the due transference of the latter from the stamen of one flower to the pistil of another, and this is effected in most cases by some particular insect. The invasion of others would hence lead to loss of honey or pollen, or both, without securing the end aimed at. It is natural, therefore, to expect to find many contrivances to secure the secretion to the appropriate insect, and an almost infinite variety is found, some mechanical, others chemical, others partaking of the nature of both. The enemies most guarded against are those insects which we have seen in some other plants especially courted—ants. In assailing the plant they must usually ascend the stem from the ground, and many and various are the pitfalls placed in their way. In the teasle, the leaves, arranged in pairs along the stem, have their bases attached to it and to one another, forming deep cups, which are filled with water, thus presenting an obstacle to their ascent. The leaves of the pine-apple are arranged to bring about the same result. Some plants are surrounded in their growth by water, as many of the Polygonaceæ. In *P. amphibium*, which grows sometimes in water, and sometimes on land, and has two characteristic forms accordingly, the land form has developed round the flower-stalks a number of sticky glands, while the water form has nothing of the sort. The two forms are protected from the ants, but by different means. *Silene*, the catchfly, and *Circea*, the enchanter's nightshade, also are examples of plants furnished with sticky glands. *Lactuca*, the wild lettuce, emits

a milky juice on being assailed by them. Other plants, as some varieties of the willow, have very slippery flower-stalks, which the ants cannot pass along. The forms of the flower, too, lend themselves to protective purposes: thus *Antirrhinum* and *Linaria* have a close-shutting corolla, which they cannot enter; *Cobæa* is furnished with free hairs growing on the corolla, which block the way to the nectar, and which are insurmountable by the insects. Where such means are not found, in some cases a counter-attraction is provided to draw the unwelcome visitors to parts where their attentions will be harmless: thus *Impatiens* has honey-glands on the leaves which are said to stop the ants on their way to the flower.

Other insects than ants are also to be guarded against. Many flowers are capable of fertilisation by more than one species of insect, but others are especially adapted only to one kind. In these the form of the flower, while affording facilities for the proper insect to receive its pollen upon the proper region of its body, also presents obstacles to others which would be useless. The peculiar construction of the corolla in such cases serves as a protection to both nectar and pollen. This may be carried still further, access to the honey by other than the appropriate channel being hindered by chemical means. An instance of this is seen in the Alpine varieties of the Aconite, which are adapted for fertilisation by bees. Instead of the insect inserting its proboscis into the flower from the front, so as to make it pass the stamens and pistil, one bée (*Bombus mastrucatus*) bites a hole in the back of the hood formed by the sepals, and abstracts the honey. The white variety of the flower is unprotected against the theft, but the other, blue in colour, has a nauseous, bitter taste, and so is let alone.

Besides meeting the attacks of animals in these different ways, plants have to cope with other dangers, and require for these another system of defences, which are more associated with peculiarities of environment. They are assailed continually by varying conditions of climate and temperature, and have in many cases very curious modifications of structure and habit to correspond with these. A danger that threatens most plants, except in a few regions of the world, is that of having their pollen injured by rain. To meet this many varieties of form of corolla have been developed. Many have a long narrow tubular shape, the claws of the petals cohering together, while the free limbs can curve outwards in fine weather, but arch over the tube when wet. Others have a campanulate form, with the base of the bell upwards, so that rain falling on the flower cannot get near the stamens, but is shot off as by a roof. In others the stamens are covered over by development of another part of the flower, as in the Iris; the filament of the stamen, too, may be broad, and bear the anther on its under surface, as in the Naiadaceæ. It is rather curious that flowers that produce large quantities of pollen have not such defences against this danger as those which form but little, while the most complete adaptations are found in the cases of plants that inhabit damp climates.

Many flowers are defended by habit rather than structure. In wet weather they do not open their corollas at all, and not a few, even in fine weather, keep open for a very little while, only a few hours in many cases.

Besides rain, other meteorological conditions are fraught with danger. One of the most commonly occurring is frost; and allied to this is the loss of heat by radiation during the night. The power of resistance to these conditions varies very much, but in many whose constitution makes them peculiarly susceptible to damage thereby there has been developed the so-called power of sleep. The term is no doubt a misnomer, but it has been adopted and associated with certain well-defined movements which the leaves of the plants perform at the close and at the beginning of day. The movements differ very greatly with different plants, but they bring about such a position of the leaves as will protect the upper surface from radiation. Some of them are of a very complex nature, particularly those shown by certain of the Leguminosæ, which have pinnate leaves. It is in this natural order that the property of sleep is most prevalent, certain of the Oxalidaceæ and their allies coming next to them.

A similar mechanism protects very many plants from excess of sunlight, which is injurious to the chlorophyll. In bright sunshine the leaves assume a position which has been called "diurnal sleep." In it they present their edges and not their faces to the light. In other leaves the chlorophyll corpuscles themselves move, taking up a position on the lateral walls of the cells rather than on the front ones, or so placing themselves that their profile and not their surface is exposed to the sun. In some of the Algæ, as *Mesocarpus* and *Vaucheria*, this sensitiveness is seen.

Other protective devices may be seen by studying the adaptations of plants to their conditions of life. Thus the leaves of submerged plants are preserved from being broken by the currents of water by being minutely subdivided, so that they adapt themselves easily to the motion, and do not oppose a resistance. Desert plants are protected from drought by the development of a succulent habit. Aërial parts of plants, again, are protected in many cases from becoming moistened by water by a deposition in the cuticular layers of the epidermis of varying amounts of wax or resin.

THE ORIGIN OF OUR POTATO

THE year 1886, by its tercentenary associations, brings once before us the subject of the introduction of the potato into our islands, but brings it still with most of the connected questions unsolved.

How, and when, and whence it was brought was considered by Banks in 1808, and it was by him attention was drawn to a manuscript statement in 1693 by Dr. Southwold Smith, F.R.S., that his grandfather received it from Sir Walter Ralegh, and sent it to Ireland.

It was considered by Sabine in 1822, when he concluded a paper before the Royal Horticultural Society with the remark, "The introduction of the potato *into* Virginia is still involved in obscurity."

It has been considered by De Candolle in his "Géogr. Bot. Raisonée" in 1855, and more recently in his "Origin of Cultivated Plants" in 1882. It has also been considered by others. While of the old unanswered questions some are now regarded as of mere antiquarian interest, there are others to which greater importance is attached than there ever has been before.

Among the latter a fresh interest has been given by Mr. Baker's paper before the Linnean Society in January, 1884, to the old question, was it *S. tuberosum* that was introduced from Virginia? The suggestion he, in conjunction with Earl Cathcart, has thrown out, that to strengthen our cultivated potato against disease we should cross with some other species of tuber-bearing Solanum, makes it important we should clearly know what is the species we have been for 300 years cultivating. There are many other questions surrounding the consideration, some of which border on that fundamental question, What constitutes a species?

That simple but highly practical method of approaching the question, "What is our species?" the method of introducing supposed distinct wild species, and watching their changes from year to year in cultivation, has not yet been followed sufficiently long, nor with a sufficient number of such species to effect much more than establish well-founded hopes that by it there is much we may learn. At present the twenty (?) years' cultivation of *S. maglia* is the only experiment on which we can rely. What conclusions such experiments may eventually lead us to it is impossible to predict, but this is certain, that

proceeding by such a method on fact, and untrammelled by tradition, the results will be sure. Hitherto we have relied over much upon traditions and mis-called history. It has been assumed that our species is a Virginian species, and beyond that the question, till recently, has not been pushed.

It would be a fitting observance of the third centenary of the date that may be most reasonably fixed for the introduction from Virginia, if we could celebrate it, not by speeches and after-dinner toasts to the memory of Drake or of Ralegh, but by clearly laying down our lines of inquiry, for they have been very ill-defined.

It may be one useful part of the work to reconsider the traditions and inferred history of our potato—for there is no doubt that botanists, if not perhaps actually led astray, have at least been hampered and puzzled by them.

One of the commonest traditions repeated over and over again in histories, dictionaries, works of gardening and agriculture, is that Sir Walter Ralegh brought the potato from Virginia. The great error in this is that Ralegh never was in or near Virginia.

His patent for founding an English colony in the New World was granted March 25, 1585, and he parted with it on March 7, 1589. We have records of the various expeditions sent out at his cost to endeavour to establish and maintain a colony, with the dates of sailing and returning, the names of the captains, and other details. Ralegh's life all through the period is known, and his time is so fully accounted for that he could not have gone out even *incognito*. The traditions, therefore, that he brought both the potato and tobacco from Virginia, may be for ever laid at rest. Whether some of his returning colonists, or one of the returning ships that had been sent out with supplies, brought it, is another question. There is not even tradition to that effect, far less any statement in the contemporary history of any of the expeditions.

Gerard, however, in his "Herbal," 1597, at p. 781, describing the "Potatoes of Virginia," says:—"I have received rootes hereof from Virginia, otherwise called Novembeya, which grow and prosper in my garden, as in their owne native countrie." The value of Gerard's picture and letterpress will be presently discussed, but the point here to notice is that he makes the statement that he did receive "rootes" (by which, of course, he means tubers) from Virginia. One of the names he mentions for the potato is "papus." The name "papus" also occurs in the first catalogue of plants growing in his garden in 1596, so that the "rootes" he had he received not later than early in that year. The exact date is perhaps unimportant, as there is no record of any expedition to Virginia after 1590 till 1606. The land named Virginia was first visited in 1584. The introduction is therefore limited to some time between 1584 and 1590. At a period when the study of plants was confined almost wholly to apothecaries, and when sea-captains thought more of fighting a Spanish or Portuguese ship than of observing the natural products of a newly-discovered land, it was not expected that the account of a voyage should refer to roots brought home. The sea-lion that roared its presage of Sir Humphry Gilbert's death is of course carefully described as a marvel, but a root is too ordinary a thing for notice. Can we by any consistent inferences account for the introduction between 1584 and 1590?

That learned mathematician, Thomas Heriot, who went out in the expedition of 1585 and returned in 1586, wrote a report on the "commodities" of the then known area of Virginia. The Island of Roanoak contained the head-quarters, and we know from Lane's report that exploring expeditions had been sent to the south for 80 miles, to the north for 130 miles, and also to the north-west for 130 miles. But that was all that was known of Virginia till the time of James I. The second part of Heriot's report is "of such commodities as Virginia is knowen to yeeld for victuall and sustenance of man's life usually fed upon by the naturall inhabitants as well also as by us during the time of our abode; and first such as are sowed and husbanded." Under the sub-heading "of roots" he says:—"Openauk are a kinde of root of round forme, some of the bignesse of walnuts, some farre bigger, which are found in *moist* and *marshy* grounds growing many together one by another in ropes as though fastened with a string. Being boiled or sodden, they are very good meat." In the third edition is added, "Monardes calleth these roots beads or paternostri of St. Helena" ("Monardes," parte 2, lib. 1, cap. 4). This report is dated February, 1587, seven months after his return to England. How far it was written from memory we have no means of knowing. But this should be noticed—that Lane says that when, after much discussion, the colonists decided on returning to England, their departure was so hurried that there were "left or thrown over, cards, books, and writings." Heriot nowhere speaks of writing or making notes on the spot.

It has been generally supposed that the root here described under the name "openauk" is the potato. It should not escape notice, however, that Gerard does not in any way allude to the name "openauk," and it is nowhere said that openauk was brought to England. The only mentioned habitat, "moist and marshy grounds," seems strange, but the usual answer (in conversation at least) to the objection is, if the openauk is not the potato, what is it? and Gerard's statement that he received potatoes from Virginia is taken to strengthen the supposition. The suggestion, however, has been made that it was the Jerusalem artichoke.[1] All that can be said is, there stands Heriot's description, and there stands Gerard's statement. To link the two together may be a fair assumption, but it remains a mere assumption. The omission by Gerard of any reference to the name "openauk" is against the supposition he received roots from Heriot personally. Gerard's use of the word "papus" calls for notice, but there is one point that should be referred to before quitting the openauk.

Heriot, who is said to have been Ralegh's mathematical tutor, describes himself in his report as "servant to Sir Walter Ralegh, a member of the colony, and then employed in discovery a full twelvemonths." If he brought potatoes with him, it would be by courtesy said Sir W. Ralegh introduced them. All the expeditions were his. But there is another tradition that Sir Francis Drake brought them. Different writers give different dates for this, which are evidently wrong. He could not have brought them in 1580 from the west coast of South America, because he arrived in November, after coming round by India and the Cape, and they would have sprouted on the voyage. That was the return from his famous circumnavigation. It could not have been 1585, because he left England, after four years ashore, in that year, and did not return till July 1586. If Heriot had anything to do with the introduction of the openauk, it is almost certain Drake brought it in 1586, for the circumstances of his return then were these. His knighthood, conferred upon him after months of deliberation for his great voyage round the world, firmly established his position, and he was intrusted with the command of a fleet to the Gulf of Mexico to harass the Spaniards. His instructions were to visit Ralegh's colony at Virginia on his way home. He called there on June 8, 1586, and found the colonists much distressed that the ship from England that it had been promised should be sent with supplies in the spring had not arrived. He stayed there many days, granted their request for a ship to be left with them, but, as many unexpected troubles arose, which are described by Lane,

[1] Asa Gray and Trumbull, *Amer. Journ. Sci. and Art*, xiii., May, 1877, p. 351.

they asked to be taken home, and this was done. Although at the last their departure was so hurried that writings, &c., were not embarked, it does not follow that there had not been opportunity during previous days to embark roots among other provisions. As openauk was among the products "husbanded," Heriot may have had a supply of unplanted roots ready to send home. If this were so, then two traditions would be reconciled. It would be Drake's ships, but Ralegh's colonists, that brought the potato, assuming the openauk to be the potato. This, however, is mere assumption. For the fact that Drake brought home the people there is abundant evidence, but respecting the roots there is not a word. If we wish, however, to account at all for Gerard's receiving potatoes from Virginia, this seems the only likely way in which he could have received them. The overdue relief ship that arrived a few days subsequent to the departure of the colony, and returned after a brief search, may possibly have brought them. All the other expeditions were later in the season than even Drake's return, while of the 349 colonists who went out in 1587 nothing was ever known after they were landed, though a relief expedition made search for them. Gerard distinctly says it was the "rootes" he received, and these could not, like seeds, be available at any time of the year.

It is commonly supposed that the introduction of the potato from Virginia is a duly authenticated historic fact. What forgotten manuscript records or letters there may be it is impossible to say, but at present our sole authority that it was brought thence is Gerard, while the linking of two traditions as here suggested is only assumption.

It has been already mentioned that while Gerard does not use the word openauk, he does give the name papus. Papus is not mentioned by Heriot as a word in use in Virginia; *how then did Gerard come to use it?*

From the travels of Pedro Cieza de Leon [1532-1550] we know that papas was the general name in Peru for an edible root in his time. The root was cultivated, and it was eaten boiled, or else dried in the sun and preserved, when it was called chuña. Acosta, whose travels in the same regions were later [1570-1587], gives almost identically the same information, as also does the native-born Garcilasso. They none of them, however, give any description of papas by which it is possible to identify the plant known by that name.

The two oldest known Continental botanists that give the name papas *in conjunction with a description* of the plant, are Clusius and Bauhin. In addition to descriptions, both give figures.

In his Φυτοπίναξ (1596) Bauhin describes a plant to which he gives the name *Solanum tuberosum*, but without any figure [Lib. v. Sec. 1, No. xix.]. In his "Matthiolus" (1598) he refers to it with a figure. Here he adds, "Vulgo Pappar Hispanorum vel Indorum dicitur." Clusius, in his "Rariorum Plant. Hist." (1601), describes a plant clearly the same, with a figure, under the name *Papas Peruvianorum*. He says there is no doubt this was the plant Cieza de Leon refers to. The expression, "there is no doubt," is, however, somewhat removed from certainty. In 1620, Bauhin again, in his Πρόδρομος, in describing *Solanum tuberosum*, to which he here adds "esculentum," refers to Cieza; and again, in 1623, in his Πίναξ, mentions that this is the plant from which Acosta says chuña is made. Both Bauhin and Clusius give their descriptions as from growing plants.

It might be readily surmised that with such continuous traffic as there was between Spain and the domains she had conquered in South America, the roots so highly prized by the Indians should be carried home. To strengthen this surmise there is the tradition that gives the name of the first to introduce them, a "doctor" named Hieronymus Cardan. What is the history of the introduction into Spain is beside the present question. It is not improbable that with the sustained and frequent intercommunication between Spain and America it was repeatedly introduced. The case is by no means parallel to the question of the introduction into England from Virginia, in Gerard's time, when out of the six expeditions sent out only one made any explorations inland. The opportunities of introduction from Virginia were few. From South America to Spain they were numerous. It seems sufficiently established, both by Bauhin and Clusius, that a plant called papas was introduced and grown in botanical gardens, if not as a food; and that it came to be known as the papas of the Peruvians, of the Indians, and of the Spaniards, for Peruvanorum, Indorum, and Hispanorum seem indiscriminately used. That Clusius suggested its identity with the Arachnida of Theophrastus and other Greek writers is now of little interest. Bauhin was the first to recognise the plant as a Solanum, and his *tuberosum* occurs as No. XIX. in his list of Solanums, in his Φυτοπίναξ.

Though Cieza, Acosta, and Garcilasso drew what appears to have been a consistent distinction between papas (potato) and battatas (sweet potato), that distinction was not always maintained by later European writers. In a way it seems hopeless to endeavour to trace, the Portuguese and Spaniards now use different words for the potato: the former call it batata, and the latter papa. The confusion is more bewildering when the two names were used as synonyms. In botanical nomenclature we have lost papas, but retained battatas. The identity or not of *Battatas edulis* with the battata of the three Spanish travellers is wide of the present consideration. So also would be the question why the Quichan word *ascu* was not used by them. This, however, appears a safe rule—that when papas is mentioned by sixteenth-century writers it may be read as = Solanum (but not necessarily *tuberosum*); when battatas is mentioned it is requisite to see whether it is wrongly used as a synonym or intentionally used for a distinct plant. To the present day chuña is made in Peru from "papas," but apparently not from "battata."

Assuming the rule is a safe one that papas cannot be taken to mean battatas, but battatas may and often does mean papas, then such chronological data as the following are of interest as some indication of the spread of the plant among botanists in Europe. There may be others, but these are all the writer has been able to collect.

Dr. Scholtz had papas growing in his garden at Breslau (Vratislavia), 1587; Clusius received two tubers at Vienna from Hannonia, 1588; Bauhin, in his Πρόδρομος, mentions "iconem suis coloribus delineatam," 1590; Dr. Scholtz's "*Papas hispanorum*" is mentioned in a "Carmen" (pub. at Vratislavia), 1592; Bauhin refers to a "*Pappar hispanorum*" growing in his garden, of which he gives a description, 1596.

It was in this year (1596) that Gerard published the catalogue of plants growing in his garden in Holborn. There occur in it the two names *Papus orbiculatus* and *Papus hispanorum*. In this 1596 catalogue these names, as all the rest, occur without any English equivalent or any description or note. The catalogue is simply a list of names. The word batata does not occur, but Sisarum does. Another catalogue, commonly called a second edition, was published in 1599. The "Herbal" had been published in the meantime (1597). In this 1599 catalogue English names are added to the Latin. These occur: *Papus orbiculatus*, bastard potatoes; *Papus hispanorum*, Spanish potatoes. Batata does not occur. Sisarum does, but without any adjective (we cannot call these second names "specific," while the first were in no sense of the word "generic"), and the English name with this is skyrrits.

Although it would be a natural supposition that with the aid of the figures and descriptions in the "Herbal" it would be easy to identify the plants named in the cata-

logues, it is, on the contrary, a most perplexing puzzle. There are names introduced into the "Herbal" which do not occur in the catalogues, and names in the catalogues which do not occur in the "Herbal." That the "Herbal" of 1597 should not exactly agree with the catalogue of 1596, hardly excites surprise, but that the catalogue of 1599 should so differ from the "Herbal" is more than surprising, it is perplexing. If the explanation given by Mr. Daydon Jackson in his annotations to the catalogues is correct, then the *Papus hispanorum* of Gerard's garden was not the *Papus hispanorum* of Clusius and Bauhin; but this requires very close attention. It involves not only the question whether the *Papus hispanorum* of Dr. Scholtz was Solanum or Batatas, but also whether Bauhin is to be trusted as a cautious incorporator of statements. However highly Bauhin is to be esteemed as a botanist, he may have had a Pliny-like weakness for accepting anything he was told.

Mr. Daydon Jackson's explanation is this:—

"Herbal" of 1597		Catalogue of 1599
Batata virginiana and *Pappus*—Potatoes of Virginia (p. 781) ...	=	*Papus orbiculatus*—Bastard potatoes.
Sisarum peruvianorum, sive *Batata hispanorum*—Potatus or Potatoes (p. 780)	=	*Papus hispanorum*—Spanish potatoes.
Sisarum (p. 871)	=	*Sisarum*—Skyrrits.

Supposing this to be the correct explanation, what are we to think of Gerard allowing his second catalogue to appear so like his first and so unlike his "Herbal"? One point is clear—he uses Papus, Batata, and Sisarum with such want of discrimination that no importance can be attached to his names. But it is strange he should, in both his catalogues, use Papus twice and Batata not at all, while in his "Herbal" he has both *Batata virginiana* and *Batata hispanorum*. According to accounts that have been handed down to us, the "Herbal" was based on Dr. Priest's translation of the Pemptades of Dodonæus, and the plates, with the exception of sixteen, were those that had been used to illustrate works by Jacobus Theodorus ("Tabernæmontanus") and L'Obel. It is said that Gerard so little understood his work that he put cuts in the wrong places, and made so many mistakes that Norton, the publisher and proprietor of the work, engaged L'Obel, who was then living in England, to correct the errors. Gerard resented this, and a quarrel with L'Obel followed. To what extent L'Obel's corrections went we have no record. He would at any rate, we may assume, prevent wrong names and cuts being printed with the letterpress. In the particular case of the three names under consideration, he was already well acquainted with the Sisarum or Batata (p. 780), as he had described it in his "Stirpium adversaria nova," written in conjunction with Pena, and published in London in 1570. He there gives the name Battades, Ignames—Anglicé, Potades. The cut in illustration used in the "Herbal" is that on p. 482 of Tabernæmontanus, where the name used is Sisarum. So that we can account for the names used in the "Herbal" thus:—Sisarum because it occurs in Tabernæmontanus; Peruvanorum is perhaps not to be accounted for. Batata because L'Obel had used it, and Hispanorum because it was first made known to Europe by the Spaniards, who brought it (most probably) originally from the West Indian Islands. Potatus, or potatoes, because that was the Anglicised form of Batata. It is possible that Gerard may have wished to introduce the word Papus, and that L'Obel cut it out.

With regard to the "potatoes of Virginia," Gerard would perhaps have his own way. He thought so much of his having grown some received from Virginia, that in his portrait he has a branch of them in his hand. With regard to the cut used in illustration, we know at present nothing. It is not taken from any other source, and it does not occur anywhere but in this 1597 edition. In the 1633 edition by Johnson the cut from Clusius is used, while Parkinson, in 1640, uses the cut copied from Bauhin. It is one of the sixteen new cuts, but where it was made we do not know, still less do we know whether it was made from a plant growing in his garden.

This last consideration, where the plant grew which is here figured, is closely connected with the question, How did he come by the name papus? In the text Gerard says, under "The Place":—"It groweth naturally in America, where it was first discovered, as reporteth C. Clusius, since which time I have received rootes hereof from Virginia." And then, under "The Names," he says:—"The Indians do call this root papus (meaning the rootes), by which name also the common potatoes are called in those Indian countries."

Although there is no known publication of Clusius so early as this from which Gerard could be quoting, yet, as he had been thrice in England, there is the probability that Gerard and he were acquainted. It is easy to see then that he might easily have had, indeed most likely would have, the South American name papus direct from Clusius.

But did he have anything else from him—a figure, a full description, a dried specimen, or even a tuber? Clusius had two as early as 1588, eight years before Gerard's first catalogue.

We have seen—

(α) That Cieza, Acosta, and Garcilasso speak of papas as a common name in the north-west portions of South America.

(β) That Clusius and Bauhin speak of the "papas of the Spaniards" growing in Europe (which Bauhin recognised to be a Solanum) as the same plant the three mention.

(γ) That it was known in several botanic gardens in Europe before the time of Gerard's first catalogue.

(δ) That Gerard in some way received information from or through Clusius that the plant was first discovered in America. America here evidently means South America.

With Clusius's information we can hardly doubt Gerard would also get the name papus. There is no trace of papus being a name used in North America. Fernandez de Soto, who travelled in Florida [Evora, 1557], mentions Batata, but not papas Benzoni, 1572.

It has been a puzzle to some botanists that papas should have such a wide geographical distribution as from Virginia to South America. The puzzle has partly arisen on the assumption that papus was a Virginian name. As there is not a fragment of evidence it ever was, and as we have seen a way in which Gerard might have had it, that part of the puzzle may perhaps be regarded as entirely withdrawn. There are a sufficient number left in connection with the potato to tax ingenuity.

Can we as easily dispose of the cut in the "Herbal"? Are we on the strength of that cut to continue to believe that *S. tuberosum* was wild within the area known as Virginia? For, though we get rid of the name papas we do not get rid of the wide distribution of *tuberosum* if the plant itself grew wild in Peru and in Virginia? Possibly experts in wood-cutting or collectors of old cuts may be able to say whether the cut is English or Dutch. Sequier says the cuts are brass ["Bibl. Bot.," 1740, pp. 72, 73]. Haller says: "In 'Bib. Bodl.' icones dicuntur æneæ esse: sed ligneæ sunt undique" [1771, tome i. p. 389]. Such a point as this could probably be cleared up definitely.

It seems anomalous that we should base our belief that *S. tuberosum* is a native of Virginia, on a single cut about which we know nothing more than this: that it appears in conjunction with the name potatoes of Virginia; that it was placed there by the direction of a man against whom the charge of deliberate misstatement in his so-called scientific work has never been cleared up; that for some reason it does not appear in the second edition

of the work. If it is charitably supposed that in this case Gerard did not intentionally mislead, still, if his reputation for being a muddler of other people's work is as well founded as it appears to be, he may have made some blunder. It is by no means a far-fetched assumption that his figure was from a Continental source, but that he thought it near enough to represent his Virginian "rootes." Apart from all other considerations it is difficult in at least one particular to reconcile the figure and the text. He speaks of "the temperature and vertues" of the potatoes, and says they are the same as of the common potatoes (*i.e.* his Sisarum). Unless this is a pure invention, many must have been eaten for this conclusion to have been arrived at. The size of the tubers is not greater than of fair-sized peas, and it would take the produce of half a hundred plants to furnish a single dish.

It is perhaps worth consideration whether an explanation of the catalogues different from that given by Mr. Daydon Jackson is possible. Is there any insuperable objection to their being read thus?—*Papus hispanorum* (the *P. h.* of Clusius, &c.), received from the Continent. *Papus orbiculatus* (for orbiculatus is a name of his own) received from Virginia. Sisarum—the "Skyrrits of Peru" (p. 780 "Herbal"), and that the common skyrrits were not mentioned in the catalogue. When he mentions papus in his "Herbal" he does not add either hispanorum or orbiculatus, and it might be he included both under papus there.

The important point however is whether that cut truly represents what he received from Virginia.

In close connection with this it cannot be overlooked that Bauhin gives openauk as a synonym. He also says, "Ex insula Verginea primum allata in Angliam, inde in Galliam aliasque regiones.' He had probably seen De Bry's edition of Heriot, and so obtained the name openauk. But his authority for the remainder of the sentence is not clear. Moreover it does not harmonise with his reference to Peru.

The question of the introduction of the potato is a very complex one, involving many other considerations besides those here referred to. The foregoing notes may, however, clear up the traditions about Ralegh and Drake, remove the difficulty about Gerard's use of the word papus, and perhaps lead to something more certain being known about that cut of Gerard's on which so much hangs.

The origin and change in the use of the *word* potato are subjects which, for their satisfactory elucidation, involve considerations that fall within the provinces of the philologist, the traveller, the bibliographer, the historian, the botanist, and, using the word in its wide sense, the geographer.

Potato is but the English way of pronouncing Batata.

But what is the word Batata? To what language does it belong? The first European knowledge of it appears to be traceable to Cuba, San Domingo, or some of the neighbouring isles at the time they were discovered by Columbus, 1492, &c. But then the sixteenth century writers on Peru also use it as if it were a common word there, and, if it were, it is at least interesting, if not strange, to find a word thus widely spread over and across districts where, it has been said, languages so vary with tribes that one cannot even understand another, though neighbouring, tribe. But first we have to consider is there any *contemporary* evidence that the West Indian natives did make use of a word which, when written by the Spaniards, appeared as *batata*? It would involve a special search among such materials as Navarette had at his disposal to decide that. Compilations are not to be trusted, and English versions are of no avail. What the actual word was, written by Columbus or his companions, is what is wanted. Then, if it were a true West Indian word, and introduced and known with some plant in Spain and Portugal in the early part of the sixteenth century, what is the probability that, at the middle of it, writers on Peru used it as a name that would be understood at home, even though not used by the South American natives. With regard to papas, it is distinctly stated by Acosta it was a native name in South America, but the writer does not know of any passage in which batata is said to be. It has been pointed out above how the mistake arose that papas has been considered a Virginian name, and it is possible batata may prove to be not a South American name at all. There is a Quichau word, Ascu, equivalent, apparently, to Papas, to which only Mr. Clements Markham among English writers seems to have drawn attention. At present, in English translations of travels in Peru, papas and batata appear often confounded.

Then in regard to our own use of the word batata, did we have it with roots through the Spaniards, or direct from the West Indies? The earliest use of the word does not yet seem to have been fully searched for. It may, however, be found earlier than in the list of literary quotations usually given. For example, it occurs in the account of Sir J. Hawkins's voyage, 1565: "Hennes, potatoes, and pines." The earliest description the writer has been able to trace of what the potato was is in the botanical work of 1570, published in London, Lobel's "Stirpium adversaria nova." A figure is given of the root of the Batata, and at the heading is "Anglice Potades."

But we might have had the word half a century before that through Spain, and the fact that Lobel introduces such a curiously-spelled form as the usual English one would imply it had been for some time in use among the common people. The mention of potatoes in the Hawkins voyage without any reference to what they were like would also imply that they were then as familiarly known as pines or hens.

The change of sounds from Batatas to Potades is curious. Why should the flat labial be changed to the sharp, and the sharp linguo dental be changed to the flat, in the same word? Again—the question is not so undignified as may at first appear—when was the form "taters" introduced? It has no doubt been a gradual change, but as a fact country people of the Victorian era no more think of using the form potatoes than those of the Elizabethan era did of using batata. In 1596 the form potaton is met with. In 1627 and 1676 potadoes, and in 1655 pottato. Batata itself, by the Spaniards, seems to have been spelled indifferently batata or battata.

Then there is another curious point. How has it come to pass that for the same plant the Spaniards of to-day retain papas, while the Portuguese use batata, for the plant we *now* call the potato.

In speaking of questions in connection with our having changed the use of the word potato from one plant to another it is an advantage for preventing confusion to refer to the two plants by their present botanical names, the *Batatas edulis*, which belongs to the convolvulus "order," and the *Solanum tuberosum* (perhaps including the supposed different species, *Maglia*), our common potato, which belongs to the nightshade "order." Of the two it was *Batatas edulis*, called then, long before Linnæus's binomial system, simply Battata, that seems to have been first known in Europe.

The first European knowledge of the plant *Solanum tuberosum* (or *Maglia*) was under the name papas, by which it was known till Caspar Bauhin recognised that it was a Solanum in 1596. The date 1596, if not exactly that of his knowledge, is the date of his first publishing it in his "Φυτοπινοξ."

Then as to dates of introduction.

As already said, the first European knowledge of Battata was in 1494 or 1495, that is, assuming that it was among the valuable products of the West Indies Columbus sent home to his patron sovereigns to demonstrate the value of his discoveries. It is mentioned he sent home vegetable products as well as gold. He sent spices,

dye-woods, fruits, and herbs, or intended to. In the history "Primer viage de Colon" (Navarette, cap. 1) is the passage,[1] "And besides there are trees of a thousand species, each having its particular fruit and all of marvellous flavour, so that I am in the greatest trouble in the world not to know them, for I am very certain they are each of great value. I shall bring some home *as specimens*, and also *some of the herbs*." Taking Washington Irving's inspection of Navarette's materials as reliable, Columbus knew the potato—the battata.

Then it is also probable, for here we have to deal with probability only, that the Solanum [under the name papas] was known in Spain soon after the conquest by Pizzaro [1527], when Cieza de Leon wrote [1532-50].

Both of these are at present but assumptions in respect to dates. The exact dates may perhaps be known in Spain. Possibly some people in England may know what is known, but the writer has been unable to trace anything more through the published second-hand statements.

We in England somehow knew the battata, pronounced and spelled potade or potate or potato, before the time of Hawkins's voyage, and before Shakespeare wrote his "Merry Wives of Windsor," where he uses the word. That Shakespeare's potato was the batata is clear from Gerard's reference to the confectioners using the battata as a basis for their sugar work (p. 781 of his "Herbal").

It was Gerard who called the papus (papus, as he chose to spell it, instead of papas) the Virginian potato, or bastard potato.

There in his work we have the word "batata," or patata, or potato, transferred to the papas, to Bauhin's *Solanum tuberosum esculentum*. Though Gerard does not use the word Solanum, his figure and description are sufficient identification. Somehow, though it does not seem possible to trace how, the word "potato" or "taters" has, as an English word, stuck to the *Solanum*. The "battata" has now dropped out of cultivation as an English root, and this no doubt has been the main cause of the transference of the word "battata" from the original battata to the "bastard" potato of Gerard—the Solanum.

The establishment of batata as a botanical name, its recognised description, and its admission into generic nomenclature have a curious history, but that is somewhat wide of the points more immediately under consideration.

The whole question is by no means yet worked out, but the above suggestions may draw attention to the subject.

W. S. M.

THE COLONIAL AND INDIAN EXHIBITION

THIS Exhibition was opened on Tuesday by Her Majesty in state. Science in one form or another will be prominent in nearly all of the sections. The Exhibition as a whole will be a geographical education in its widest sense. Not many can follow the example of Mr. Froude and Baron Hübner, and spend the best part of a year in visiting our scattered Empire. At South Kensington, in the course of a few days, however, we may learn even more of the products and people and geographical aspects of our colonies than we might do by an expensive voyage. Of course the main purpose of the Exhibition is to draw attention to the economical and commercial aspects of the colonies and India; but in doing so, necessarily the introduction of a considerable amount of science is involved. In nearly all the sections, for example, we find excellent large maps of the various colonies on the walls, besides the gigantic map of the world in hemispheres beside the gateway of Old London. Again, several of the colonies have sent specimens of their natives, and from India especially there is a considerable number of individuals of all ages representing the various races which form the heterogeneous population of that vast territory. So, from South Africa, we find Kaffirs, Hottentots, Zulus, and Bechuanas; Singhalese from Ceylon, and Malays from the Straits Settlements. In several of the sections, also, notably in India, do we find life-size models of natives; some of the finest of them are in the British Guiana Court, prepared by Mr. Im Thurn. Several of the colonies, again, have had large reliefs either of the whole or part of their territory prepared. Among the exhibits of the Indian Survey is a relief-map of the Peninsula from the Tibetan table-land to Cape Comorin, on the scale of thirty-four miles to an inch. One of the finest of these models is that of New Zealand by Dr. Julius von Haast, under whose care this Court is markedly scientific. He has brought over with him the skeletons of three large moas; mumerous specimens of flora, fauna, and geology, and the exquisitely beautiful skeleton of a ribbon-fish prepared after the method of Prof. Parker of Dunedin. Maori ethnology is also amply illustrated, though we believe no actual live specimen has been imported. One of the finest conservatories of native plants in the Exhibition will be that attached to the New Zealand Court. But such conservatories will be a marked characteristic of this Exhibition, and will be found attached to the Courts of the Cape of Good Hope, Queensland, Natal, and other colonies. India, of course, has much to show of interest to science, besides its numerous groups of life-size models of natives taken from actual casts. Under the care of Dr. Watt the botany is very fully illustrated. The Geological Survey has sent a fine exhibit; while the Topographical Survey will have a Court to itself. In all the Australian colonies geology is a prominent feature, at least in its economic aspects, and so we may say of botany, at least so far as timber-trees are concerned. In the Australian and several other colonies, moreover, large collections of natural history have been arranged in cases, while of course the numerous game-trophies will interest the naturalist. The trophy of trophies, however, will be the great jungle scene prepared by Mr. Rowland Ward, into which it has been attempted to compress the whole of the fauna of India. It is a triumph of arrangement; and we may refer to it in detail in a future article. An almost equally striking scene is the landscape in the South Australian Court, representing an actual piece of country near Lake Alexandrina. Of course, as in the jungle scene, we have *multum-in-parvo*,—features which in reality are spread over a wide area compressed into a few square yards. But everything is on the scale of nature, and nothing introduced that is not actually met with. We have natives at various occupations, including a woman and child under a rude shelter of branches; kangaroos, wallabies, eagles, and other animals deftly posed; characteristic vegetation and rocks, with mountains away in the background. The model of Hong Kong and the neighbouring coast may also be mentioned. The West Indian Court contains much of interest. The woods of Honduras are conspicuous; many curious land and water products from Trinidad; and a fine collection of Columbian pictures and relics, and several fine paintings and photographs of West Indian scenery. Indeed, in all the sections, pictures, and especially photographs, are among the most conspicuous exhibits, and have much geographical value.

Of course this Exhibition is one of many-sided interest, and we have mentioned here only a few of the points that will attract those interested in science. Its educational value is evident, and we hope that teachers will take advantage of so exceptional an opportunity of giving their pupils a practical lesson in physical geography and its economical and "political" developments. Most of the colonies will publish special hand-books, and in several of them we are glad to know that science will hold a prominent place.

[1] Quoted second-hand through W. Irving's "Life of Columbus."

NOTES

We refer elsewhere to the opening of the Colonial and Indian Exhibition on Tuesday. It argues ill for the spirit in which this Show is to be conducted that the representatives of British science, on which the progress of England beyond the seas has so largely depended in the past and must depend in the future, were so conspicuous by their absence at the opening ceremony. Not even the President of the Royal Society was invited to be present, though tickets were liberally distributed to a large number whose prior claims we do not care to discuss.

Science was well represented by the President of the Royal Society at the Royal Academy dinner on Saturday. Prof. Stokes showed how in several ways science is capable of rendering service to art. The rules of perspective, he pointed out, involved clear geometrical conceptions; while a knowledge of chemistry and physics would keep the artist often from violating nature. Prof. Stokes illustrated the point by referring to the inverted rainbow picture, adduced as an example for a similar purpose in these pages some years ago. At the same time he admitted with justice that art was not without its uses to science. Especially useful was it, he pointed out, as a refreshing and invigorating change for the mind of the scientific student, apt to get clogged and dulled by too eager direction to one particular subject.

The Fifty-sixth Annual Meeting of the British Association will commence at Birmingham on Wednesday, September 1, 1886. The President-elect is Sir William Dawson, C.M.G., F.R.S., Principal of McGill College, Montreal, Canada. Vice-Presidents: The Right Hon. the Earl of Bradford, Lord-Lieutenant of Shropshire, the Right Hon. Lord Leigh, Lord-Lieutenant of Warwickshire, the Right Hon. Lord Norton, K.C.M.G., the Right Hon. Lord Wrottesley, Lord-Lieutenant of Staffordshire, the Right Rev. the Lord Bishop of Worcester, Thomas Martineau, Mayor of Birmingham, Prof. G. G. Stokes, Pres.R.S. (nominated by the Council), Prof. W. A. Tilden, F.R.S., Rev. A. R. Vardy, Rev. H. W. Watson, F.R.S. General Treasurer: Prof. A. W. Williamson, F.R.S., V.P.C.S., University College, London, W.C. General Secretaries: Capt. Douglas Galton, C.B., F.R.S., A. G. Vernon Harcourt, F.R.S. Secretary: Arthur T. Atchison. Local Secretaries for the Meeting at Birmingham: J. Barham Karslake, Rev. H. W. Crosskey, Charles J. Hart, Council House, Birmingham. Local Treasurer for the Meeting at Birmingham: J. D. Goodman. The Sections are the following:—A. Mathematical and Physical Science—President: Prof. G. H. Darwin, F.R.S.; Vice-Presidents: Donald MacAlister, M.D.; Rev. H. W. Watson, F.R.S.; Secretaries: R. E. Baynes (Recorder), R. T. Glazebrook, F.R.S., Prof. J. H. Poynting, W. N. Shaw. B. Chemical Science—President: William Crookes, F.R.S.; Vice-Presidents: Prof. Carnelly, W. H. Perkin, F.R.S.; Secretaries: Prof. P. Phillips Bedson (Recorder), H. B. Dixon, F.C.S., H. Forster Morley, D.Sc., F.C.S., W. W. J. Nicol, Ph.D., C. J. Woodward, B.Sc. C. Geology—President: Prof. T. G. Bonney, F.R.S.; Vice-Presidents: Prof. C. Lapworth, F.G.S., H. Woodward, LL.D., F.R.S., F.G.S.; Secretaries: W. Jerome Harrison, F.G.S., J. J. H. Teall, F.G.S., W. Topley, F.G.S. (Recorder), W. W. Watts, F.G.S. D. Biology—President: William Carruthers, F.R.S., F.L.S.; Vice-Presidents: Prof. E. A. Schäfer, F.R.S., M.R.C.S., P. L. Sclater, F.R.S., F.L.S., Sec.Z.S.; Secretaries: Prof. T. W. Bridge, Walter Heape (Recorder), Prof. W. Hillhouse, W. L. Sclater, F.Z.S., H. Marshall Ward. E. Geography—President: Major-General Sir F. J. Goldsmid, K.C.S.I., C.B., F.R.G.S.; Vice-Presidents: Major-General Sir Lewis Pelly, K.C.B., K.C.S.I., M.P., F.R.G.S., Capt. W. J. L. Wharton, R.N., F.R.G.S.; Secretaries: F. T. S. Houghton, J. S. Keltie, F.R.G.S., J. S. O'Halloran, F.R.G.S., E. G. Ravenstein, F.R.G.S. (Recorder). F. Economic Science and Statistics—President: John Biddulph Martin, F.S.S.; Vice-Presidents: G. W. Hastings, M.P., F.S.S., Sir R. Temple, Bart., G.C.S.I., M.P., F.R.G.S., F.S.S.; Secretaries: E. F. Barham, Rev. W. Cunningham (Recorder), Prof. Foxwell, F.S.S., J. F. Moss, F.R.G.S. G. Mechanical Science—President: Sir James N. Douglass, M.Inst.C.E.; Vice-Presidents: W. Anderson, M.Inst.C.E.; W. P. Marshall, M.Inst.C.E.; Secretaries: Conrad W. Cooke, J. Kenward, Assoc.Inst.C.E., E. Rigg (Recorder). H. Anthropology—President: Sir George Campbell, K.C.S.I., M.P.; Vice-Presidents: Prof. W. Boyd Dawkins, F.R.S., Lieut.-Col. H. H. Godwin-Austen, F.R.S.; Secretaries: G. W. Bloxam, F.L.S. (Recorder); J. G. Garson, M.D., M.A.I., Walter Hurst, B.Sc., R. Saundby, M.D. The first General Meeting will be held on Wednesday, September 1, at 8 p.m. precisely, when the Right Hon. Sir Lyon Playfair, K.C.B., M.P., F.R.SS.L. and E., will resign the chair, and Principal Sir William Dawson, C.M.G., F.R.S., President-elect, will assume the Presidency, and deliver an address. On Thursday evening, September 2, at 8 p.m., a *soirée*; on Friday evening, September 3, at 8.30 p.m., a discourse on "The Sense of Hearing," by Prof. William Rutherford, F.R.S.; on Monday evening, September 6, at 8.30 p.m., a discourse on "Soap Bubbles," by A. W. Rücker, F.R.S.; on Tuesday evening, September 7, at 8 p.m., a *soirée*; on Wednesday, September 8, the concluding General Meeting will be held at 2.30 p.m.

The first general meeting of the Congress of French scientific societies took place in the large hall of the Sorbonne on April 27 at noon. M. Bertrand, Director of the Archæological Museum of St. Germain was in the chair. For the first time a special section has been created for geography, of which M. Bouquet de la Grye is chairman. The section of sciences was presided over by M. Faye, and divided into several sub-sections. M. Lhoste presented a pointed cask, with the assistance of which he hopes to keep a balloon floating in the air for several days over the sea. M. Certes, President of the Zoological Society of France, explained the use of colouring matters for the histological and physiological exhibition of living animalcules. The meetings were concluded on Saturday, May 1, by an address by M. Goblet, the Minister of Public Instruction, in which he advocated the establishment of a secondary education from which Greek and Latin should be excluded, their place being filled by modern languages. A number of decorations were awarded to members of learned societies and academies. M. Berthelot was created "Grand Officier" of the Légion d'Honneur.

The Department of Modern Ethnography in the British Museum being now arranged, the work of arranging the prehistoric section is being taken in hand by Mr. Franks. The three rooms immediately at the head of the western staircase, near the entrance, are devoted to this purpose. The collection will contain the Christy and Museum collections, which will be incorporated with each other, and also the Greenwell collection from British Barrows. The central room of the three will contain palæolithic objects from England and the rest of the world. The finds in the caves of the Dordogne will form an important and interesting part of these. These caves were excavated by the late Mr. Christy at his own expense, and the results added to his collection. The pictures were, at his wish, sent to France. The room on the left of the entrance contains Neolithic objects, arranged under the Stone and Bronze Ages, the objects from the various countries being arranged within the periods. Here Canon Greenwell's remarkable collection from the British Barrows (which will be maintained intact) will find a place. The special value of this collection is that the place and manner of finding of each individual object is known and recorded, and every cir-

cumstance connected with the discovery of each is known. The Barrows, from which the collection was made, are found mostly in Yorkshire, although other places are also represented. In the same room will also be placed the implements used in working flint quarries in prehistoric times, and other objects found there; there will also be some curious implements from countries where the Stone Age still exists, as it does, in a certain measure, in Madeira, Syria, and Iceland. The room on the right will be given up to iron objects, and those of an age which may be called semi-prehistoric, such as the Roman times in Britain.

A SUPERFICIAL examination of the ethnographical galleries in the British Museum shows that the American section is overcrowded. On the left are the American antiquities, which are of the greatest interest, but which do not seem to belong properly to ethnography at all, while the objects on the left, belonging to modern America, and which are certainly ethnographical, are crowded into a space which is quite insufficient. As much has been done as possible to arrange the objects, and there is no confusion, but it is quite impossible to examine the cases properly when they contain so much. Ancient Mexico, Peru, and New Granada crowd modern South, North-West, and Arctic America into a very small space. It is obvious that an attempt should be made to remove the American antiquities to some more suitable place, and to give up the whole of the gallery to American ethnography proper.

AFRICA does not seem so well represented in the Collection as it might be for a country which has sent its missionaries and travellers into every corner of the land. Two or three small South Sea Islands occupy about as much space as the continent of Africa. The only district well represented is that of the Upper Nile, the collection of Lupton Bey being specially noteworthy, as giving one a fair idea of the manufacturing industries of the people of these parts. South Africa is moderately well represented, and in a less degree northern West Africa. East Africa, Central Africa, and southern West Africa are all relegated to a small case and very poorly represented. A spear from one tribe lies beside a pipe or a dagger from another tribe a thousand miles distant. And yet in this enormous region there are tribes singularly expert as blacksmiths, potters, &c. No African tribe produces more beautiful spears than the Wa-Vira, more horridly barbed than those of Nyassa, or more remarkable than those of Maryema or of Masai-land; and yet good collections of all these are undoubtedly in the country. Owing to this meagre display the collection is not of much value for purposes of comparison or to illustrate the relative advancement of the various tribes in arts and manufactures, and yet in this respect there is as much difference between the most degraded of the tribes and the most civilised as there is between the latter and ourselves. The arrangement also leaves much to be desired. Articles manufactured by tribes totally distinct in race, degree of civilisation, and religion are thrown indiscriminately together. Take, for instance, northern West Africa. There one finds the fetishes, idols, and rudely-worked articles of the degraded and barbarous tribes of the Lower Niger figuring amongst the artistic and advanced productions of the Mohammedan and polished tribes of the Central Sudan, and nothing to indicate that they are not the work of one people. In the East African section, again, you find Somali weapons beside those of the Bantu tribes further south, such as the Wa-gogo. Some objects do not appear to be correctly named. Thus the backbone of a shield divested of the hide which it was intended to support now figures as a bow, a string having been stretched from point to point. The map to illustrate Africa is scarcely worthy of the British Museum. The Congo Basin is strikingly shown by an utter blank.

FROM the Royal Gardens, Kew, we have received a cheap, carefully arranged, and highly useful guide to Museum No. III. at that establishment, which is devoted chiefly to specimens of timber and other large articles unsuited for exhibition in the glazed cases of the other museum. Another extremely useful publication is a Route Map of the Royal Botanic Garden and Arboretum on a scale quite large enough to enable any visitor to find his way. The various sections of the gardens are clearly laid down, and on the back is an index to the various entrances, museums, houses, the arboretum, &c., corresponding to the sections in the map indicated by figures and letters.

A MICROSCOPICAL SOCIETY has been started in Glasgow with Dr. Dallinger as first President; over fifty members have been enrolled.

THE volcano of Smeru in Java is stated to be in eruption.

WE have received the first number of *The Indian Engineer*, published by Messrs. Newman and Co., Limited, Calcutta. This is a new publication, the object being to provide a representative organ for all branches of the Indian engineering profession, and to make it a creditable representative of the great engineering and scientific services of the country. The leading article appropriately gives a history of Indian engineering journalism. We are told that the first publication of the kind was made by the Corps of the Madras Engineers in the form of a series of papers, to provide a record of the experience of their members for future reference. Messrs. Newman and Co., twenty-eight years ago, followed this first attempt by publishing a paper called *The Engineers' Journal and Railway and Public Works Chronicle*. Since then several different papers have been issued with varying success. *The Indian Engineer* is nicely got up and well printed, and, to judge by the first number, will prove to be an interesting journal, containing as it does many very good articles on general Indian engineering, civil and mechanical. We trust it will receive general support, and in time become an acknowledged organ of the profession in India.

WE are pleased to see from the current number of the *Agricultural Students' Gazette* that the authorities of the Royal Agricultural College, Cirencester, have provided greater facilities for teaching the increasingly important branch of agriculture, dairy farming. A new working dairy has been erected and fitted with appliances of the most improved kinds. We notice also that further substantial accommodation has been made for out-students. The *Gazette* contains a description of the new buildings and an account of the College live stock; the dairy herd contains specimens of nine breeds, and the specimen flock of fifteen different breeds. An article by Mr. J. M. Muir-McKenzie, on cultivation in the Western Ghâts, gives a description of the prevalent method of cultivation in this part of the Bombay Presidency, by means of wood ash and *rab*; this style of native agriculture entails the destruction of much jungle and denudation of the hills to the detriment of the low lands; it raises various difficulties between the natives and the forest and other officials, and any attempt to grasp its scientific and economic bearings is worth careful attention.

UNDER the title of "Malvern Field Hand-book and Naturalist's Calendar," Mr. G. E. Mackie, Assistant Master in Malvern College, has published a little volume that will be useful both to residents and visitors. The Hand-book was originally begun for the use of the boys of the Malvern College Field Club, but has been much enlarged.

MR. THOMAS WARDLE, of Leek, has been to India to examine the cultivation of the silkworm (*Bombyx mori*) there, and the methods still in use of reeling the silk. Although the reputation of Bengal silk has gone down greatly during the last twenty-five years, yet microscopical examination satisfied him that the fibre of the Indian silk was quite equal to that of Italian, and that improvement in the machinery and method of

reeling was all that was required. The length of thread, however, in each cocoon was very different, the Indian worm only spinning 150 metres, while the more highly-tended and selected Italian worm produced 650 metres. It is suggested that the Government should rear a limited quantity of cocoons, from which a careful selection of "seed" only shall be made, since much of the present inferior quality is traceable to want of discretion in the choice of breeding stock. A loss to the growers of 60 per cent. of their grubs through hot winds can be prevented by the use of mud huts instead of matted walls only. The profitableness of the business is shown by the fact that the zemindars have been able to exact the highest of all agricultural rents for land where the mulberry is grown for this purpose: more than twelve times the amount paid for land adjoining planted with rice. But they do not realise that such high rents are not practicable now silk is at only half its ordinary price.

MR. FORTESCUE, the Superintendent of the Reading Room in the British Museum, has just produced a catalogue which is new, as far as the Museum is concerned, in plan, and which will prove of the utmost benefit to all students, men of science included. It is a catalogue of all the works acquired during the years 1880–85 in all modern languages except Oriental, Hungarian, and Sclavonic, arranged according to subjects. At present the alphabetical system is that employed in the Museum Catalogue, and therefore, unless the student knows, or can [illegible], the name of his author, the Library and its Catalogue are of no use to him. With Mr. Fortescue's Catalogue one can tell at a glance what books have been published during the past five years in any given subject, or branch of a subject, in Europe, America, or the British Colonies. The work contains about 1000 pages, with from 50,000 to 60,000 entries. An analysis of one or two headings will best show the value of the Catalogue. To take "Chemistry," under the sub-head "General" we find, first, all important text-books, then elementary works, both grouped under the different languages; then follow Agricultural, Analytical, Arithmetical, Bibliography, Examination Papers, Inorganic, Medical (with cross-references to Materia Medica and Pharmacy), and, finally, Organic, with about 400 entries in all. This, of course, does not exhaust the subject, for under such heads as Acids, Alkalies, Alkaloids, and so on, throughout the book, we have also the titles of chemical publications. The subject Electricity is a remarkable one for the number of entries under it. They fill ten pages in double columns, and about half refer to the electric light. It is curious to notice, too, that fifty telegraph codes were published in the five years included in the Catalogue; these do not, of course, include the innumerable private and cypher codes.

A UNITED STATES digest of the Report of the British Commissioners on Technical Education by an eminent pioneer in the work has been issued as a Circular of Information by the Bureau of Education. In the writer's earlier days "apprenticeship was rapidly disappearing and home manufactures were giving place to large mills and factories, and yet the schools in which the young were to be specially fitted for their career in the new order of industries were in a large measure limited to the old in methods and principles"—and far too little has there been any alteration since! The British Commissioners' Report is reprinted and added on to the text of this Circular, but the latter is chiefly an account of the French, German, and Russian technical schools, to the latter of which the writer gives the palm of excellence. In these schools, however, a great deal more than teaching is done. In St. Petersburg material is handled in the most wholesale style, and in Moscow orders for specially difficult work are taken and executed. Valuable, however, as such trained ability may be where trained ability is scarce, it is not a solution of the problem before England and America, where the object is to teach every youth the principles which underlie his work. The average age of youths who enter such institutions is over seventeen, and the course extends over five or six years. The result of much of such training in the advanced manufacturing countries must naturally be, as in Germany already, an overflow of highly-trained polytechnic students seeking something above an intelligent mechanic's work. A specially complete set of schools for teaching the various trades at Chemnitz is described. In France the work of such schools in providing a substitute for the extinct apprenticeship system is so efficient that, it is said, "the effort to avoid teaching trades will not be very successful," and they are found already to revive drooping industries and to make new ones. A most important observation, if generally borne out, is that much of this technical work can be added to, not substituted for, ordinary school work.

WE learn from *Naturen* that a committee has been formed at Christiania to promote the long-projected establishment of a zoological garden in the Norwegian capital. The plan suggested by the promoters of the scheme is wisely adapted to the special collection of North European and Arctic animals, such as the Polar bear, reindeer, elk, and the numerous other members of the Cervus family to be found in high latitudes, while no attempt will be made to introduce animal forms belonging to tropical faunas, whose susceptibility to cold makes it difficult to maintain them in health even in zoological stations lying far south of Norway.

WE are sorry to learn that bad weather greatly interfered with the success of Herr Stejneger's explorations of the Behring Straits fauna and flora during his last summer's boating voyage. At the extremity of Komandor Bay he believes that he has identified the exact spot at which Behring and his unfortunate comrades were shipwrecked, and where he perished from the effects of exposure in the winter of 1741. Here Herr Stejneger found buried beneath the soil various relics of this memorable expedition, including a thin brass plate stamped with the Russian double eagle. The search for plants and insects was specially unsatisfactory, for the damp mildewed the few specimens collected, and ruined all the cases and herbaria, while it so thoroughly rusted every fragment of steel and iron that all the instruments intended for meteorological and other observations were made useless.

THE additions to the Zoological Society's Gardens during the past week include two Military Macaws (*Ara militaris*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, presented by Mr. C. Clifton, F.Z.S.; two Ring Doves (*Columba palumbus*), British, presented by Lord Arthur Russell, M.P., F.Z.S.; a Jay (*Garrulus glandarius*), British, presented by Mr. R. Humphries; two Spanish Terrapins (*Clemmys leprosa*) from Spain, a Spotted Salamander (*Salamandra maculosa*), a Fire-bellied Toad (*Bombinator igneus*), six Axolotls (*Siredon mexicanus*) from Mexico, a Green Lizard (*Lacerta viridis*), European, presented by Mr. Alban Doran, F.R.C.S.; twenty Palmated Newts (*Molge palmata*) from Epping Forest, presented by Mr. G. A. Boulenger, F.Z.S.; a Collection of Sea Anemones, from British Seas, presented by Mr. W. L. Sclater, F.Z.S.; two Ring-tailed Lemurs (*Lemur catta*) from Madagascar, an Asiatic Wild Ass (*Equus onager* ♂) from India, deposited; a Ludio Monkey (*Cercopithecus ludio*) from West Africa, three Red-crested Finches (*Coryphospingus cristatus*) from South America, two Rosy-faced Love-Birds (*Agapornis roseicollis*) from South Africa, a Shining Parrakeet (*Pyrrhulopsis splendens*) from Fiji Islands, a Vinaceous Amazon (*Chrysotis vinacea*), a —— Conure (*Conurus* ——) from Brazil, two Short-eared Owls (*Asio brachyotus*), a Magellanic Eagle Owl (*Bubo magellanica*), a Pudu Deer (*Pudu humilis* ♀) from Chili, purchased; a Hairy-eared

Rhinoceros (*Rhinoceros lasiotus* ♂) from India, two Punjaub Wild Sheep (*Ovis cycloceros*) from North-West India, received in exchange.

OUR ASTRONOMICAL COLUMN

THE INFLUENCE OF PHASE ON THE BRIGHTNESS OF THE MINOR PLANETS.—Dr. G. Müller gives an interesting discussion in the *Astronomische Nachrichten*, Nos. 2724-2725, of the variations in brightness of seven of the minor planets. The determinations of the magnitudes of these objects were made by means of a photometer, on Zollner's principle, attached either to the Steinheil telescope of the Potsdam Observatory, of aperture 135 mm. aperture, or to the Grubb equatorial of 207 mm. aperture. The result of these observations seems to show that there is a real connection between the phase of these planets and their apparent brightness, and that Lambert's law of phase brightness does not apply to them. Dr. Müller further divides the planets he has observed into two classes. In the first class, which embraces Vesta, Iris, Massilia, and Amphitrite, the changes in brightness are only perceptible as the planet approaches opposition; in the second, which contains Ceres, Pallas, and Irene, the changes in brightness seem to be co-extensive with the changes of phase. The planets of the first group thus correspond in their behaviour to the planet Mars, and Dr. Müller thinks we may fairly infer therefrom a similarity in their physical condition to that of the ruddy planet. The planets of the second class would appear, on the other hand, to give a light curve similar to that given by our moon, or rather perhaps by Mercury; it is therefore not improbable that they bear more resemblance in their physical constitution to that body.

COMET FABRY.—The following ephemeris by Dr. S. Oppenheim is taken from the *Astronomische Nachrichten*, No. 2722:—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log *r*	Log Δ	Brightness
May 3	5 1 16	7 33·1 S.	9·9351	9·2358	381·4
5	6 16 8	22 59·4	9·9617	9·4446	195·2
11	7 3 53	30 30·4	9·9877	9·5698	97·3
15	7 34 43	34 18·8	0·0130	9·6758	53·2
19	7 55 56	36 29 6	0·0373	9·7632	31·8
23	8 11 35	37 53·6	0·0606	9·8364	20·4
27	8 23 52	38 53·2	0·0828	9·8992	13·8
31	8 34 0	39 39·2 S.	0·1041	9·9528	9·8

The brightness on 1885 December 1 is taken as unity.

BARNARD'S COMET.—The following ephemeris by Dr. H. Oppenheim (*Astr. Nachr.*, No. 2714) is in continuation of that given in NATURE for April 1, p. 518:—

Ephemeris for Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log *r*	Log Δ	Brightness
May 6	1 41 34	39 23·5 N.	9·6858	9·8894	155
10	1 50 59	36 42·5	9·7087	9·8125	199
14	2 8 29	31 42·6	9·7429	9·7266	253
18	2 35 41	23 16·9	9·7828	9·6374	318
22	3 13 3	10 16·3 N.	9·8242	9·5619	371
26	3 58 59	6 32·5 S.	9·8648	9·5291	359

The brightness on 1885 December 5 is taken as unity.

THE APPLICATION OF PHOTOGRAPHY TO ASTRONOMY.—In Appendix III. to the "Washington Observations for 1882," Prof. Harkness, U.S.N., commenting on the difficulty of preventing the solar rays from disturbing the adjustments of a meridian instrument employed in observing the sun, points out that photography seems to afford an escape from the difficulty. He suggests that a transit-circle might be so constructed that its eye-piece could be readily removed, and a sensitive photographic plate inserted just behind its wire system. Then with the eye-piece in position stars can be observed, and the instrumental constants determined in the usual way; while at noon a photographic plate can be inserted, and an instantaneous exposure will suffice to give an image of the sun with the transit and declination wires of the instrument imprinted upon it. The position of the sun's centre relatively to these wires having been measured, this, together with the instrumental constants, the circle-reading and the sidereal time of exposure will give an exact determination of the sun's right ascension and declination. As the instruments will be exposed to the sun's rays only for a few thousandths of a second, no disturbance of its constants can, Prof. Harkness thinks, arise from that cause; and the results, in his opinion, would probably be superior in accuracy to any hitherto obtained by the usual methods.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 MAY 9-15

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 9

Sun rises, 4h. 20m.; souths, 11h. 56m. 16·3s.; sets, 19h. 33m.; decl. on meridian, 17° 25′ N.: Sidereal Time at Sunset, 10h. 43m.

Moon (at First Quarter on May 11) rises, 9h. 12m.; souths, 16h. 58m.; sets, 0h. 36m.*; decl. on meridian, 16° 37′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	3 46	10 19	16 52	5 51 N.
Venus ...	3 0	9 4	15 8	0 0
Mars ...	12 40	19 34	2 28*	9 52 N.
Jupiter ...	14 21	20 39	2 57*	2 50 N.
Saturn ...	7 1	15 13	23 25	22 50 N.

* Indicates that the setting is that of the following morning.

Occultation of Star by the Moon (visible at Greenwich)

May	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image °
15 ...	θ Virginis	... 4½ ...	2 42 ...	3 36 ...	93

May h.
13 ... 16 ... Jupiter in conjunction with and 0° 25′ north of the Moon.

Variable Stars

Star	R.A. h. m.	Decl ° ′			h. m.	
ζ Geminorum ...	6 57·4	20 44 N.	... May	9, 21 30	*m*
			,,	14, 21 40	*M*
S Cancri	8 37·4	19 27 N.	... ,,	12, 22 56	*m*
R Ursæ Majoris ...	10 36·6	69 22 N.	... ,,	12,	*M*
δ Libræ	14 54·9	8 4 S.	... ,,	9, 2 30	*m*
U Coronæ	15 13·6	32 4 N.	... ,,	13, 21 17	*m*
R Draconis	16 32·4	67 3 N.	... ,,	10,	*m*
U Ophiuchi	17 10·8	1 20 N.	... ,,	10, 11 58	*m*
		and at intervals of		20 8	
X Sagittarii	17 40·4	27 47 S.	.. May	12, 2 20	*m*
			,,	15, 0 0	*M*
W Sagittarii ...	17 57·8	29 35 S.	... ,,	11, 2 30	*m*
R Lyræ	18 51·9	43 48 N.	... ,,	13,	*M*
T Aquarii	20 43·9	5 34 S.	... ,,	15,	*m*
δ Cephei	22 24·9	57 50 N.	... ,,	10, 21 30	*m*

M signifies maximum; *m* minimum.

Meteor Showers

Amongst the secondary radiants active at this time are the following:—From Lynx, R.A. 123°, Decl. 40° N.; near δ Libræ, R.A. 223°, Decl. 16° S.; from Delphinus, R.A. 304°, Decl. 7° N.; near ζ Cygni, R.A. 320°, Decl. 18° N.; near κ Andromedæ, R.A. 354°, Decl. 41° N.

BIOLOGICAL NOTES

THE HYMENOPTERA OF THE HAWAIIAN ISLANDS.—In the *Proceedings* of the Literary and Scientific Society of Manchester (vol. xxv. pp. 123-183) is a valuable contribution on the Hymenopterous insect-fauna of the Hawaiian Islands, by the Rev. T. Blackburn, B.A., who resided there for many years, with a short introduction and annotations by Mr. P. Cameron. Eighty-four species are catalogued or described, but Mr. Blackburn says he has taken over 100. The greater part of the species appear to be strictly autochthonous. Of the *Anthophila* (or bees) there are 14 species (excluding the introduced honey-bee), and it is curious that 10 of these belong to 1 genus—*Prosopis*. Of the *Fossores* there are 35 species, and here again there is a paucity of genera, for 19 are included in *Odynerus* and 11 in *Crabro*. Of *Heterogyna* (ants) are only 10 species; and about 25 species of the various parasitic and hyper-parasitic groups. No indication of any of the phytophagous forms occurs in the paper. Before Mr. Blackburn went to the Hawaiian Islands the insect-fauna was almost unknown, so far as what may be termed the

more occult (and therefore the chief) portion of it. Most of what had hitherto been discovered resulted from the casual visits of entomologists (not always trained to the subject). In Coleoptera alone he discovered about 430 species, of which nearly four-fifths appear to be strictly endemic, which is certainly noteworthy in considering the fauna of an insular group of volcanic origin. The minority of more recent "introductions" look largely in the direction of Western North America, with a sprinkling of Polynesian or Australian forms. The Rev. Mr. Blackburn's Hawaiian discoveries in entomology have an important bearing on the selection of naturalists to accompany exploring and other expeditions. A trained observer knows where and how to look, even if in doubt as to what he may find, and is always rewarded by new discoveries. An untrained hand scampers over the country, and, with every desire to distinguish himself, comes back and complains of the barrenness of the land.

VEGETABLE PARASITES OF CODFISH.—Some years ago Prof. Farlow called attention to the presence of a red fungus which was destructive to the dried codfish of the American fisheries (NATURE, vol. xxiii. p. 543). Since then Dr. E. Bertherand has given an account of poisoning which had occurred among the French troops at Algiers, caused, it was believed, by eating dried codfish, which had a vermilion hue owing to the presence of a fungus described by M. Mégnin in the *Revue Mycologique* (vol. vi. p. 114) as *Coniothecium bertherandi*. Specimens of fish with the same colour were also met with at Bordeaux and Dieppe, these latter presumably from Newfoundland. It would appear probable that Mégnin's fungus is the same as that originally described by Farlow as *Clathrocystis roseo-persicina*, Cohn.[1] In addition to this species, however, Farlow has described another parasitic form on the cod, *Sarcina morrhuæ*, which name had to yield in priority to *S. litoralis* of Poulsen, found on mud near Copenhagen, and which has lately been recognised by Saccardo and Berlese as occurring on codfish from Algiers. These botanists seem to think the *Coniothecium bertherandi* identical with *Sarcina litoralis*, and this latter to be but a condition of *Beggiatoa roseo-persicina*: but although they are found in company Farlow sees no good reason to think they belong to the same species. It is curious the form should occur in regions so far apart as New England, Algiers, and salt-marsh mud in Denmark, and it suggests the idea that salt may be the means by which the disaster is spread. Still another species, called *Oidium morrhuæ* by Farlow, by forming small brown spots on the surface of the dried codfish injures its sale, and has been found not only in New England, but also at Algiers.—(W. G. Farlow, *Bull.* U.S. Fish Commission, i. p. 1, February 8, 1886.)

SUPERIMPOSED STAMENS.—Mr. Thomas Meehan suggests a new interpretation for the appearance of superimposed stamens. Stamens are by most, if not by all botanists, regarded as exogenous lateral outgrowths from a caulome, in which latter there has normally been an arrest in its axial development. Stamens, however, occasionally will spring from the inner base of petals, and Mr. Meehan would account for this by taking the petal as the analogue of a leaf on an elongated branch, and the stamen as the development of an axial bud to the petal. "Branching and articulated stamens are frequent in those families that have these organs springing as it were from an axial bud at the base of the petal, as in a diminution or suppressed secondary branch we might expect them to do." In illustration of this idea Mr. Meehan refers to the flowers of *Hermannia verticillata*, Cav., a well-known Byttneriaceous plant from the Cape of Good Hope. The genus is separated from Hermannia chiefly by a cup-shaped gland at the middle of the stamen. A comparison with the axial development of the inflorescence shows the stamen to be formed on precisely the same plan, Mr. Meehan thinks, as the biflowered peduncle. This latter is simply a diminutive branchlet; after forming one node the longitudinal development becomes nearly arrested, and there is a short pediceled flower, then the bud in the axil of the bracteolate leaflet pushes up and over this, giving rise to the longer-stalked flower. So in the development of the stamen, a bud arises in the axil of a petal, the common peduncle is represented by the filament, and the cup-like gland at the middle stands for the bracteole of the bipedicels. Here one of the flower-buds wholly disappears, the innermost becomes the upper part of the filament, the real node may be at the connective, and then the theoretical floral leaves proceed to form the anther. The incised bract is reduced to the fringed cup-like gland from which the stamen proper springs, and he concludes from a survey of the whole subject that in many cases superimposed stamens are the development of theoretical axial buds at the base of the petals, and not the result of an interposition of an extra whorl of leaves for which there seems no warrant in phyllotaxy. It will be seen that even on this explanation the true stamen is phyllomic; the fact that foliage leaves often have stipules ought not, in a consideration of this interesting subject, to be overlooked. Mr. Meehan's observations may throw some light on the herotaxy of the floral organs.—(*Proc. Acad. Nat. Sci.*, Philadelphia, 1886, p. 9).

STRUCTURE OF LINGULA PYRAMIDATA.—From a very important memoir on the structure of this species by Dr. H. G. Beyer, we condense the following. In 1870, when Mr. Dall was studying the species of Lingula, he separated those species which he found provided with raised fulcra for the attachment of certain muscles, forming a median septum or one or two divaricating septa on the other valve, and formed for them the genus Glottidia. All of the known species (four to six in number) are exclusively to be found in American waters, while not a single species of Lingula has been found to occur in America. While the true Lingulas are almost always attached to a fixed rock or stone, Glottidia attaches itself, if at all, only when adult, and usually to a very small pebble or bit of shell. As to the structure of the shell, the author confirms in great measure the observations of Gratiolet, but describes the cuticle as a thin homogeneous layer, and immediately beneath it, sometimes aggregated in clusters, sometimes arranged in linear series, and at other times again irregularly scattered, he found a series of little round bodies, staining with hæmatoxylin, homogeneous, and without nuclei; these are regarded as homologous if not analagous to the bodies occurring within the organic septa in the shell of the Testicardine Brachiopods. Immediately adjacent to the cuticle and this layer of bodies comes a broad layer of horny substance and internally a thin calcareous layer, and these horny and calcareous layers alternate with each other in a number varying with the age of the animal. Towards the periphery the cuticle and horny layer alone are found, and these join the supporting layer of the mantle margin. A very intimate structural relationship exists between the body-wall, the mantle, and the peduncle. It seems doubtful whether the structures described by Vogt, Owen, Hancock, and others as muscle are in reality muscular in character. All the true muscles are smooth muscle-fibres, but other so-called muscles seem to be rather mesenchymatous supporting substance, lacking contractility, but perhaps possessing elasticity. The author's observations on the vascular system confirm rather the views of Shipley, Schulgin, and Morse than those of Hancock, and no central propelling organ over the posterior slope of the stomach was on transverse sections found. The number and division of the nervous ganglia indicated by Hancock for Waldheimia seem to be the same in Lingula, though Hancock's views have lately been criticised by Van Bemmelen. Hancock's details as to the reproductive organs are in great measure confirmed. Three excellent plates of anatomical details accompany this memoir.—("Studies from the Biological Laboratory, Johns Hopkins University," vol. iii. No. 5, March 1886.)

THE CUCKOO.—In the note on the cuckoo in the Biological Notes of April 1 (p. 519, line 6 from bottom), *January* was inadvertently printed for *June*.

NOTE ON EARTHQUAKES IN CHINA[1]

I HAD prepared for presentation to the Seismological Society of Japan a tabulated account of earthquakes that have been recorded in Chinese annals for the past thirty-seven centuries, but it was destroyed by fire during a riot last winter, and with the paper were destroyed also the works from which the seismic facts were derived. Perhaps, however, some general remarks which those records suggest may not be devoid of value.

Nothing can be inferred anent the relative frequency and destructiveness of earthquakes in ancient and modern times from Chinese history; from the earliest recorded earthquakes of Mount Tai in Shantung 1831 B.C. to the commencement of the

[1] Communicated to the Seismological Society of Japan by D. J. Macgowan, M.D.

[1] *Bacterium ruberescens*, Lank.

Han dynasty 200 B.C., only twelve are recorded; tradition and written archives noting those only that presented extraordinary features; a bald list merely mentioning a disturbance of the rivers of the I. and Lo Hanan, 1808 B.C.; Wei, Chin, and So in Shensi, 778 B.C.; the formation of long chasms in the loess, 345 and 206 B.C. From the Han period, notices of the phenomena of course increase, accompanied betimes with a few details relating mainly to loss of life, and the succour afforded to survivors. Geographically considered, earthquakes in China may be grouped as insular, littoral, and inland.

On the island of Formosa earthquakes are hardly less frequent than in Japan, while on Hainan they are comparatively of rare occurrence. These islands form a portion of the great volcanic chain that girdles the coast of Eastern Asia; the Chinese portion rises from the submarine plateau that overlooks the profound abyss of the Pacific Ocean.

Insular earthquakes affect the mainland but seldom, and to a slight extent, which is noteworthy from the proximity of Japan, the least stable portion of the earth's surface, which seemed inexplicable until Prof. Milne's statistics showed that a large majority of earthquakes in Japan originated beneath the Pacific.

The absence from Chinese and Korean annals of notices of earthquakes in that peninsula long inclined me to regard Korea as comparatively exempt from seismic action, and recently, I addressed Consul E. H. Parker, of H.B.M.'s service in that country, for information, who obtained from the prefect of Chemulpo a communication on the subject, the purport of which is, that earthquakes are so infrequent and harmless that records are not made of their occurrence. It is more than ten years since an earthquake was experienced in that kingdom, and on that occasion no one was injured, nor were buildings thrown down. No information is obtainable on the subject from Manchuria, where presumably earthquakes are uncommon: there is, however, a record of a volcanic eruption having occurred about a century ago in that portion of the empire.[1]

The only existing volcanic action on islands of this coast is on the north of Formosa, near Keelung, where three solfataras are in ceaseless ebullition, affording large supplies of sulphur, and emitting during earthquakes so much hydro-sulphuric gas as to occasion a degree of *malaise* to the residents, and to discolour the white paint of ships.[2]

Facts respecting Formosan earthquakes are so scanty that the following from a Chinese writer is worth citing. It relates to an earthquake that occurred in Northern Formosa in the fifth month of 1693. "During that month the earth shook without cessation. A tract of country in which three villages were situated caved in; the inhabitants, however, had time to escape." Three years after that submergence, the narrator, a mandarin, who was on his way to procure sulphur from the solfatara "could see in a lakelet, where the water was shallow, tops of bamboos and other trees of those villages. While near the solfatara he heard for a day and night noises that resembled a cataract precipitated from a lofty cliff; the sound seemed to be near and all about, but no evidence of the cause of the noise was discoverable. When, however, he arrived at the solfatara the mystery was explained, he there heard the same sounds like a rushing of subterranean waters."

Another active volcano is named in a Chinese account of Formosa. It is in Tengshan district in the southern portion of the island at Red Hill, near the Tanshin Creek, on a plateau. Probably it has not been in open action since Formosa was opened to trade, as it does not appear to be known to foreigners.

Formosan seismic action occasionally causes tremors to be felt on the mainland, which is due to the ordinary direction of earthquakes on that island, which are generally from south to north or the reverse. The Liuchiuan group is the centre of seismic force that does not appear to extend beyond those islands.

Submarine disturbances not unfrequently attend the insular earthquakes; the sea sometimes rises on the Formosan coast sixteen feet above the usual height. Independently of the terrene commotions of Formosa, its adjacent waters appear to be subject to submarine agitations occasioning what records of the mainland style "third" or supplementary tides; but these are of rare occurrence. The "tide-rips" that have attracted the attention of hydrographers are notable phenomena, but the following, from a local gazetteer, seems to indicate the existence of phenomena that cannot be referred to tidal action:—"Peculiar noises of the sea are sometimes heard which are commonly regarded as indicative of change of weather, sounds from the north foreboding rain, those from the south being followed by wind. Hissing noises are heard, at times they are low, at others loud; when low, they resemble the beating of a drum or the dropping of beans on that instrument; now, the sounds are near; anon, they are distant; stopping suddenly or continuing for hours. When the noise is loud, it is more noisy than the voices of a hundred thousand men, and the sea bubbles up; in very protracted cases the noises continue day and night for half a month; and when of short continuance the sound lasts three or four days. Coast landers err in supposing that these noises have connection with the weather. They are absent during rains and in drought, in winds and in calms. . . During the sounds, the sea is agitated by fearful billows and furious waves." If that extraordinary seething and roaring of the ocean were synchronous with earthquakes, the fact could not have escaped observation: indubitably that graphic description applies to submarine volcanic action; to which the submarine plateau of eastern Asia is subject, and to which also I attribute the supplementary tides of the adjacent coast. Some thirty years ago an island was thrown up by a submarine volcano on the south of Formosa; the pumice which is cast on the northern shores of that island is evidently a submarine production.[1]

As proximity to the belt of volcanic islands seldom disturbs the mainland of the northern littoral, so the adjacent [illegible] Southern China and Annam enjoy like exemption from [illegible] throes: Chehkiang and Fuhkien are sometimes slightly visited by Formosan shocks, and even the Canton coast slightly, but Philippine earthquakes never affect Annam.

Earthquakes on the coast of China are frequent, but slight and harmless. Their harmlessness is evinced by the tall slender pagodas that adorn the hills and valleys, and they are generally very limited in area, with great diversity of direction, but a majority being from south-west to north-east.

The southern provinces of China, and yet more Indo-China, appear to be comparatively exempt from earth throes, which, however, may be due to lack of information from those regions, but there is evidently no seismic zone in tropical or sub-tropical eastern Asia such as exists in our mid-latitudes.

The tremors that are experienced in Chehkiang, Kiangsu, and coterminous regions to the west, are sometimes followed by the appearance on the ground of substances that in Chinese books are styled "white hairs." When I first called attention to records of that kind that are found in local gazetteers, I suggested that they might be crystals precipitated by gaseous emissions, such as were once reported as occurring after an earthquake in the south-west of the United States; from later descriptions of these "horsetail-like" substances I incline to the opinion that they are organic, perhaps mycillium.

In the summer of 1878 the vernacular press gave an account of the occurrence of the phenomena at Wusoh, a city on the grand canal, thirty miles north of Suchau. "At noon, June 12th of that year, shocks of an earthquake were experienced, which lasted several minutes (*Sin.* 'for the space of time taken in swallowing half a bowl of rice'); the motion was so great that sitting or standing was difficult, but no harm was done. Two days later at night there was a severer shock, after which, within and without the walls of the city, white hairs resembling a silvery beard, about three inches in length, were found, which boys pulled out of the ground, gathering handfulls in a short space of time." My list of Chinese earthquakes for the past two thousand years having been destroyed by fire I am unable to indicate the regions in which earthquakes were followed by the emission of "hairs," but my impression is that all, or nearly all, are alluvial valleys.

The chief foci of inland earthquakes are Yunnan, Szechuan, Shensi and Kansuh—and less frequently Shansi, Chihli, Shantung, and the central provinces, where they are more violent than in other portions of the empire, and frequently present continuous or protracted action, for example:—

A series of earthquakes occurred at Taiyuan, the capital of Shansi, in 1882, followed by shocks at brief intervals for a year. An earlier series occurred in the province of Chihli; the district

[1] Perhaps the following may be explained as a result of volcanic action far distant from Peking. In the month of June, 1465, during a gust of wind at the capital a sound was heard as of hail falling on the ground, when pellets the size of cherries were picked up. On breaking them open they emitted a sulphurous odour. The writer says he could not have regarded such a phenomenon as credible had he not himself witnessed it.

[2] "Head-dizziness" is said to be an occasional accompaniment of earthquakes on the mainland. Slight shocks that occurred at Weichang-November 3, 1885, are described in the *Shen-pau* as exhibiting that phenomenon.

[1] For accounts of the volcanic region of Northern Formosa see Taintor's "Imperial Maritime Customs Report, 1865," and Hancock, 1881.

city Chuchow suffered most, not a house remained standing, many lives were destroyed; frequent shocks occurred for a year after. The province of Szechuan is also liable to continuance of seismic throes, one of these commenced in the fourth month, 1462, and continued eleven months—there were in all 375 shocks.

In the loess formation of Northern China (discovered and described by Baron Richthofen) the land is not unfrequently riven by earthquakes forming long narrow chasms of unknown depth that gradually disappear on account of the vertical cleavage and unstratified nature of loess.

In the first decade of the fourth month, 1828, an earthquake caused a fissure over three miles in length, twenty to thirty feet broad, from which a vapour issued that proved fatal to many: people, animals, houses, and tombs were ingulfed. About two months later, during heavy rain, the chasm gradually filled up.

The chief earthquake region of China lies in a great seismic zone, which extends from near the gulf of Chihli to the shores of the Caspian—including Turkestan and the Aralo-Caspian depression. In Eastern Turkestan they present a periodic character (five per annum with remarkable regularity). Yet there are few portions of the world so far removed from active volcanoes. Recent Russian exploration has discovered that the supposed Tienshan volcano is merely a solfatara, or an ignited coal-field.

Observations of officers appointed by the Emperor Chienlung to examine the newly subjugated territory in reference to these "firefields," are several. They say: "Three days travel to the east of Okishu and to the south of the hill at Palikeh there are several firefields. The ground is of a red colour, and a number of [illegible] stones are piled upon each other in the neighbourhood; from the middle of which flames upward of a foot in height are emitted: they are alternately extinguished and lighted up, while the smell is so strong as to render a near approach to the place impossible. For a distance of about 100 *li* not a blade of grass, not an inch of wood, nor a drop of water can be seen. From the peculiar smell of the fire thus raised, it is imagined that the soil must be strongly impregnated with sulphur."

The same work represents earthquakes as so common in Eastern Turkestan and the desert, that to the inhabitants "they are not considered strong; four or five occur every year; even when violent, they merely cause the doors and windows to rattle, but on account of the firm and adherent character of the soil, and thick walls and light roofs in common use, the houses are never thrown down."

A recent English traveller[1] makes a similar statement respecting Mid-Asian earthquakes generally. At Tashkend they generally average five in a year, but so slight, as not to be noticed by anybody. In that part of the world earthquakes appear to be most frequent at the close season. In the western portion of the seismic zone, they are of greatest frequency and violence in mountain regions.

Anent the opinion of M. Perrey, that a maximum of earthquakes is coincident with the moon's perigee, I submit the following statistical fragment that escaped the loss referred to: it is partially confirmatory of Prof. Milne's observations, that cold weather furnishes the maximum of frequency.

Lists of 738 continental shocks:—

1st month	65	5th month	46	9th month	56
2nd ,,	82	6th ,,	63	10th ,,	43
3rd ,,	72	7th ,,	70	11th ,,	65
4th ,,	49	8th ,,	70	12th ,,	88

(The first day of the first month occurs about February 6th, or at the new moon which falls nearest to the point when the sun is in the fifteenth degree of Aquarius.) In their seismic records the Chinese seldom designate the day of the month (moon) when earthquakes occur. Yet a considerable number may be found. Seventy-two cases show twice as many in the first and second as in the third and fourth quarters of the moon's phrases: forty-eight in the former period, and twenty-four in the latter; of that number fifteen occurred at the syzygies. The 6th day shows the largest number, twelve. None took place on the 2nd, 5th, 13th and 14th; one occurred on each of the following, 4th, 7th, 17th, 20th, 22nd, 23rd, 24th, 28th, 29th. Hours are rarely given; so far as they go, they show that a large majority are nocturnal.

[1] Lansdell's "Russian Central Asia," 1885.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The following list of lectures and classes in Natural Science has been arranged for the summer term:—

Physics.—In the Clarendon Laboratory Prof. Clifton lectures on Instruments and Methods employed in the Study of Optics. Practical instruction in Physics is given by the Professor and by Messrs. J. Walker and A. L. Selby. At Christ Church Mr. Baynes lectures on Electro-Kinematics and Dynamics, and has a class for practical instruction in Electric and Magnetic Measurements. At Balliol Mr. Dixon lectures on Elementary Electricity and Magnetism. At Trinity the new Millard Laboratory will be opened for instruction in Mechanical and Electrical Engineering under Mr. Frederick Smith

Chemistry.—In the Chemical Department of the University Museum Dr. Odling lectures on Some Special Points in Organic Chemistry. Mr. Fisher and Dr. Watts continue their courses on Inorganic and Organic Chemistry respectively. Mr. W. R. Dunstan lectures on Organic and Pharmaceutical Chemistry. Practical instruction is given in the laboratories by Messrs. Fisher, Watts, Baker, and Marsh. At Christ Church Mr. Vernon Harcourt has a class for Quantitative Analysis, and Mr. Dixon for Gas Analysis.

Animal Morphology.—In the Morphological Department Prof. Westwood lectures on the Haustellated Orders of Winged Arthropodous Animals. Prof. Moseley lectures on the Mammalia, Mr. Baldwin Spencer on Embryology, and Mr. J. B. Thompson on the Osteology, Distribution, and Odontography of Birds and Mammals. Practical instruction is given by Prof. Moseley and by Messrs. Robertson and Spencer. In Human Anatomy Mr. A. Thomson lectures on the Vascular and Respiratory Systems, and gives demonstrations on Topographical Anatomy. Daily instruction is also given in Practical Anatomy.

Physiology.—In the Physiological Department Prof. Burdon Sanderson lectures on the Chemical Processes of the Animal Body, and on Elementary Physiology. Mr. Dixey lectures on Histological Methods. Practical instruction is given daily.

Botany.—At the Botanic Garden Prof. Balfour lectures and gives practical instruction in Vegetable Morphology and Physiology. Prof. Gilbert gives four lectures on Rural Economy.

Anthropology.—Dr. Tylor lectures on the Origins of Civilisation.

Geology.—Prof. Prestwich lectures on the Secondary and Tertiary Series as illustrated by the geology of the neighbourhood of Oxford. Each lecture is followed by a geological excursion.

CAMBRIDGE.—The Special Board for Biology and Geology have recommended the following grants from the Worts Fund:

(1) 50*l.* to Mr. W. Bateson, of St. John's College, to assist him in investigations into the fauna of lakes in the neighbourhood of the Sea of Aral in 1886, and an additional 50*l.* if he continues his investigations into the summer of 1887. Mr. Bateson's investigations into the development of Balanoglossus in the Southern United States have, it is well known, been of great value.

(2) 60*l.* to Mr. A. C. Seward, of St. John's College, to assist him in studying and collecting fossil plants in Belgium and France.

(3) 35*l.* to Mr. Hans Gadow, of King's College, to assist him in exploring the ossiferous caves of Portugal, which he has already partly explored during two former visits. Prof. Boyd Dawkins strongly recommends the continuance of these explorations.

(4) 25*l.* to Mr. C. Potter, of Peterhouse, to assist him in elucidating the life-history of the alga parasitic on the water-tortoise in Portugal.

In the list of lectures issued by the Board of Physics and Chemistry for the present term we note that Dr. Ruhemann, assistant to the Jacksonian Professor, will lecture on Gas Analysis, and also on the Aromatic Bodies. The other chemical courses repeat the usual advanced and elementary courses.

In Advanced Mathematics Mr. Forsyth lectures on Thermodynamics, Mr. Glaisher on Theory of Errors, Mr. Webb on Dynamics of a System. The latter course will be continued during the Long Vacation, when also Prof. Darwin will lecture on the Theory of Attractions, Potential, and Figure of the Earth.

In Geology Prof. Hughes lectures on Stratigraphy and Cam-

bridge Geology, Mr. Marr on Advanced Palæontology, especially the Graptolites, Mr. Harker on Microscopic Petrology.

In Botany Dr. Vines is lecturing on the Cryptogams; Mr. F. Darwin on Physiology, and Mr. Potter on Advanced Systematic Botany.

In Zoology, Mr. Sedgwick continues the courses of Elementary Biology, and the Anatomy and Embryology of the Vertebrata; Mr. Gadow gives a summary Course on the Palæontology of the Vertebrata.

In Physiology, beside Prof. Foster's Elementary Course, we have advanced lectures by Dr. Gaskell, Dr. Hill, and Mr. Langley.

Prof. Macalister lectures on the Variations in the Skeletal, Muscular, and Nervous Systems of the Races of Mankind.

The Special Board for Physics and Chemistry report to the Vice-Chancellor on the new Mechanical Science Tripos:—

In consequence, the report states, of the Grace passed March 11, 1886, confirming their report, dated December 14, 1885, the Board have drawn up regulations for the New Tripos in Engineering, Physics, and Chemistry, for which they would propose the name "Mechanical Science Tripos." They do not think it desirable that the University should examine in subjects for which the University does not or may not easily provide adequate teaching, and have therefore made the examination in Engineering mainly an Examination in Mechanical Engineering. They have included, however, in it such elementary portions of Civil Engineering as can be taught in Cambridge and such as may often be advantageously studied by those who are intending to become Mechanical Engineers. With respect to the Engineering papers in Part II. of the Examination one paper would test the ability of the candidates to indicate how a given design should be carried into execution; another would include questions on steam and the steam-engine besides other prime movers, and also on boilers and furnaces; a third would include questions on bridges, roofs, arches, abutments, elementary hydraulics, strength of materials, and elementary building construction. In the Examination in Physics in Part II. the papers would contain questions on the application of dynamics to physical phenomena; gravitation; attractions; hydrostatics and hydrodynamics; properties of matter, including elasticity, capillarity, diffusion, and viscosity; heat; kinetic theory of gases; radiation; light, including the application of the undulatory theory to the problems of geometrical optics; mineralogical physics; acoustics; meteorology; cosmical physics; electricity and magnetism; reduction of observations. The Practical Examination would extend over two days, the Examination on the first day being of such a nature as would test the knowledge of the candidates in the general methods of laboratory work; on the second day a list of experiments would be given, one or more of which each candidate would be expected to complete.

SCIENTIFIC SERIALS

Bulletins de la Société d'Anthropologie de Paris, tome 8eme, 4me fascic., 1885.—On the facial and cranial muscles of a young gorilla, by M. Chudzinski. The subject of this post-mortem examination, a young male, was 98 centimetres in height. The muscles of the head and face were the same in number as in the human species, but in form and dimensions they exhibited certain differences, being combined into a single fleshy mass, which covered most of the face.—M. Pozzi laid before the Society various anatomical characteristics with reference to the comparative constitution of the muscles of the Negro and the white races.—M. Folley drew attention to the greater anastomosis of the subcutaneous abdominal veins of the Negro, and the importance of this peculiarity in giving to the organism a greater power of resisting the action of rapid variations of atmospheric or aqueous pressures.—On the common origin of Malays and Vedahs, by M. Beauregard.—On the universal language of F. Sudre, by M. Gajewski. The basis of the system proposed fifty years ago by M. Sudre is the musical nomenclature of the vocal notes *do*, *re*, &c., and from these he elaborated a language which claims to be equally capable of expression by means of musical instruments and the voice. The defects and impracticabilities of Sudre's proposed musical language were considered at length by MM. Kerckhofs, Dally, and Dehoux.—Suggestions for the modification of Broca's method of determining the direct absolute cranial capacity, by M. Topinard. The points chiefly insisted on are the different results yielded by fresh, and often-used, lead, the latter being valueless after 100 cubage determinations.—On the cause and nature of the vitrification observed in tumuli, and other ancient structures, by M. Manouvrier.—Report of the recent Anthropological Exposition at Buda-Pesth, by Dr. R. Blanchard.—On the dimensions and location of the dolmens of St. Nectaire, by Dr. Verrier.—History and anthropology, by Dr. Fauvelle. The writer draws attention to the tissue of errors which works intended for the instruction of the young continue to promulgate, as exemplified in the current historical explanations of the origin and usages of earlier races.—On the Gallic habitation of Mané Gohenne, Carnac, by M. Gaillard. The finds, which consisted principally of flints and pottery, included a string of twenty-three green serpentine beads cut into various forms.—On certain unique objects shaped like fishes, found in the Mammoth Cave in Varsovia, by M. Zawisza, and supposed to have been employed as fetishes by sorcerers.—On the significance of certain strongly marked impressions on the inner surface of a skull, by M. Manouvrier. Such impressions have been regarded as an evidence of imperfection in the cerebral convolutions, and of consequent mental deficiency.—On man of the age of Palæolithic pottery in the Lozère district, by MM. Martel and L. de Launay. The local finds attest the co-existence there of man and the cave-bear, and the fabrication of pottery at the time.—On the flint implements of Croix Fringant, near Cognac, by M. Germain.—On the calcareous islets of Taled Sah, in the inner sea of the Samsans, in the Malayan peninsula, and the natives who dwell in natural caverns and are engaged in collecting edible swallow-nests, by M. Macey.—On the displacement of the brain in accordance with the different attitudes assumed by the body, by M. Bonnard.—On the form of the hand and figure of Asiatics, by Dr. Mugnier.—Anthropometric [illegible] observations of three Australians now being exhibited in [illegible] by M. Topinard.—On the development of the cranium in the gorilla, by M. Deniker. It is found that, while the frontal region is developed, like other parts of the cranium, as rapidly in the gorilla as in man from the middle of fœtal life to the eruption of the milk molars, different relations supervene after the latter period, the cranial development of the gorilla becoming much more strongly marked in the posterior and inferior than in the anterior regions. At the same time the upper maxillary rapidly acquires its characteristic prognathic form. An almost equal degree of prognathism is observable in the adult Negro, or Australian, and in the infant gorilla, but with its growth the latter acquires a facial angle which is smaller than that of any human cranium.—Ethnographic observations on the cerebral function, by M. Fauvelle.—On a case of an hermaphrodite, by M. A. de Mortillet.—Notes on the post-mortem appearances of an imbecile, by MM. Doutrebente and Manouvrier.—Report, by M. Letourneau, on the Godard Prize Essay of M. de la Calle (1885) on the earliest attempt at speech in infants. M. de la Calle attempts to draw a parallel between the first enunciation of the vowel-sounds *a*, *e*, *o* by infants, and the monosyllabic character of certain languages belonging to various peoples of the far east of Asia, which have scarcely yet entered upon the more advanced stage of lingual agglutination.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 15.—"Dynamo-Electric Machines." By John Hopkinson, D.Sc., F.R.S., and Edward Hopkinson, D.Sc.

Omitting the inductive effects of the current in the armature itself, all the properties of a dynamo-machine are most conveniently deduced from a statement of the relation between the magnetic field and the magnetising force required to produce that field. This relation given, it is easy to deduce what the result will be in all employments of the machine, also the result of varying the winding of the machine in armature or magnets. The magnetic field may be expressed algebraically as a function of the magnetising force, or more conveniently by a curve (*Proceedings* of the Institution of Mechanical Engineers, April 1879, p. 246). Amongst the empirical formulæ which have been proposed to express the electromotive force of dynamo-machines in terms of the currents around the magnets, we may mention that known as Fröhlich's, where $E = \frac{ac}{1 + bc}$, E being the electromotive force of the machine at a given speed, c the exciting current, and a and b constants. For some machines this hyperbola is said to express observed results fairly accurately. In our

experience it does not sufficiently approximate to a straight line in the part of the curve near the origin, and gives too high results for large values of ϵ.

One purpose of the present investigation is to give an approximately complete construction of the characteristic curve of a dynamo of given form from the ordinary laws of electromagnetism and the known properties of iron. Let n be the number of convolutions on the magnets, c the current round the magnets, l_1 the mean length of the lines of force in the iron of the armature, A_1 the area of section of iron in the armature, l_2 the distance from iron of armature to iron of pole pieces, A_2 the area of the magnetic field in which the wires move corrected for its extension round the edge of the pole pieces, l_3 the total length of the magnet cores, A_3 the area of the magnet cores, l_4 the mean length of lines of force in the yoke connecting the magnet limbs in machines of the type on which we have principally experimented, A_4 the area of section of the yoke, l_5 the mean length of the lines of force in each pole piece, A_5 the main area of section of pole piece, I the total induction through the armature when no current passes in the armature, and νI the total induction in the magnet cores; and, finally, let the relation between the magnetic force (α) and induction (a) (*vide* Thomson, "Electrostatics and Magnetism," p. 397, and Maxwell, "Treatise on Electricity and Magnetism," vol. ii. p. 24) be represented by the equation $\alpha = f(a)$, then the characteristic curve is—

$$4\pi nc = l_1 f\left(\frac{I}{A_1}\right) + 2l_2 \frac{I}{A_2} + l_3 f\left(\frac{\nu I}{A_3}\right) + l_4 f\left(\frac{\nu I}{A_4}\right) + 2l_5 f\left(\frac{I_5}{A_5}\right).$$

If the relation between α and a be given in the form of a curve, this formula indicates at once a perfectly simple graphical construction for the characteristic. Taking the curve of magnetisation determined by one of us for wrought iron, and constructing a characteristic in this way, we have obtained a theoretical curve which agrees over a long range with the actual results of observation on a dynamo-machine more closely than any empirical formula with which we are acquainted.

To determine ν, a wire was taken once round the middle of one magnet and connected to a ballistic galvanometer, a known current was then either suddenly passed round the magnets or short-circuited, the elongation of the galvanometer being noted. A similar observation was made with the same current, the galvanometer being connected to a single convolution of the armature in the plane of commutation. The ratio of the two elongations is the value of ν.

The distribution of the waste field $(\nu - 1)$I was roughly ascertained in a similar manner.

The currents in the fixed coils round the magnets are not the only magnetising forces applied in a dynamo-machine. The currents in the moving coils of the armature have also their effect upon the resultant field. In well-constructed machines the effect of the latter is reduced to a minimum, but it can be by no means neglected. This introduces a second independent variable, viz. C, the current in the armature. The effect of the current in the armature depends upon the lead given to the brushes. Denote this by λ, which we may also regard as an independent variable, as it is subject to arbitrary adjustment.

If $I = F(4\pi nc)$ be the characteristic curve when no current passes through the armature, then

$$I + \frac{\nu - 1}{\nu} 4\lambda mC \frac{A_2}{l_2} = F\left(4\pi nc - \frac{4\lambda mC}{\nu}\right),$$

where m is the number of convolutions in the armature. Here we omit the comparatively unimportant portion of the magnetic force in the core of the armature and the pole pieces. From this formula it is not difficult to deduce a geometrical construction for the characteristic surface (*vide* "Practical Applications of Electricity," lectures delivered at the Institute of Civil Engineers, 1882–83, p. 98). The equation may be thus expressed in words, if λ be such that the coils at commutation embrace the whole or nearly the whole induction. The effect of the current in the armature upon the difference of potential between the brushes of any machine, is the same as that of an addition to the resistance of the armature proportional to the lead of the brushes, and to the ratio of the waste field to the total field, combined with that of taking the main current $\frac{m\lambda}{\nu\pi}$ times round the magnets in a direction opposite to the current c. Many consequences can be deduced, of which we may notice the following:—In a series-wound dynamo C is equal to c, and if c be increased beyond a certain point, I must attain a maximum and then diminish; this has been frequently observed. We now see that it depends upon the existence of a waste field. Secondly, let the coils of the magnets be entirely disconnected, and let λ be the negative; if the armature be short-circuited through a small resistance and be run at a sufficient speed, a large current may be produced in the armature. This latter deduction we have verified by direct experiment.

The efficiency of the type of dynamo-machine upon which the experiments before indicated have been made, has been accurately determined by the device of coupling two similar machines, both mechanically and electrically, so that one should act as a generator of electricity, driving the other electrically, whilst the latter acted as a motor driving the former mechanically; the loss of power required to keep the whole combination in movement being determined by direct dynamometric measurement, and the power passing electrically from the one machine to the other being measured by ordinary electrical appliances.

The whole of the experiments were carried out at the works of Messrs. Mather and Platt, to whom we are indebted for the exceptional opportunities we have enjoyed of putting theoretical conclusions to the test of experiment on an engineering scale.

Zoological Society, April 20.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. O. Salvin, F.R.S., exhibited a living specimen of a foreign worm (*Bipalium kewense*), found in a garden in Sussex.—The Secretary read an extract from a letter addressed by Mr. R. A. Sterndale, F.Z.S., to Sir Victor Brooke, concerning a case of hybridism between *Ovis hodgsoni* and *O. vignei*.—Mr. J. Bland Sutton, F.Z.S., read a paper in which he gave an account of some of the investigations he had made during the past twelve months into the diseases affecting the mammals living in the Society's Collection.—A communication was read from Dr. O. Finsch, C.M.Z.S., describing a new species of wild pig from New Guinea, which he proposed to call *Sus niger*.—Mr. Smith Woodward read a paper on the relations of the mandibular and hyoid arches in a Cretaceous shark (*Hybodus dubrisiensis*, Mackie).—A communication was read from Prof. R. Collett, of Christiania, C.M.Z.S., containing an account of the hybrid between the willow-grouse (*Lagopus albus*) and the black grouse (*Tetrao tetrix*), which occurs occasionally in Norway, Sweden, and Northern Russia, and of which the author had examined altogether thirteen specimens, most of them of the male sex.—Mr. G. A. Boulenger, F.Z.S., gave the description of a new Iguanoid lizard living in the Society's Gardens, for which he proposed the name of *Ctenosaura erythromelas*. The exact locality was unknown.—A second paper by Mr. Boulenger contained remarks on specimens of a scarce European frog (*Rana arvalis*) exhibited in the Society's Menagerie.

Royal Meteorological Society, April 21.—Mr. W. Ellis, F.R.A.S., President, in the chair.—Mr. L. J. Petre and Mr. G. B. Wetherall were elected Fellows of the Society.—The following papers were read:—The climate of Killarney, by the Ven. Archdeacon Wynne, M.A., F.R.Met.Soc. The climate is determined partly by its geographical position, and it has the benefit of proximity to the south-west coast, with all the modifying influence of the Gulf Stream. The temperature, however, is locally modified, and a decided difference is found to exist between that of Valencia and of Killarney. The author shows that Killarney is colder than many other places in Ireland, and this he attributes to the fact that it is in a great irregular basin surrounded by mountain ranges for about a third, and by hilly ranges elevated some hundreds of feet above the lakes on most of the remaining two-thirds of the circle.—Note on the probability of weather sequence, by Lieut.-Col. C. K. Brooke, F.R.Met.Soc.—Account of the cyclone of June 3, 1885, in the Arabian Sea, by Capt. M. T. Moss. The author, who was in command of the s.s. *Inchulva*, while on a passage to Bombay had, when near Aden, the misfortune to encounter a most furious storm on the above date. This storm, which was apparently not of very large dimensions, was exceedingly severe, and was accompanied by an immense wave which caused several fine steamers to founder.—Results of solar radiation observations in the neighbourhood of Birmingham, 1874-84, by Rupert T. Smith, F.R.Met.Soc.—Results of meteorological observations made in the Malay Native State of Selangor during 1884, by A. W. Sinclair, L.R.C.P. These observations were taken at four stations, viz. Kwala Lumpor, Klang, Kajang, and Kwala Langat. The mean temperature of the district is about 80°, and the rainfall about 90 inches.

Dublin

University Experimental Science Association, March 16.—The following communications were made:—Prof. J. E. Reynolds, on action of silicon tetrabromide on thiocarbamide.—Mr. H. L. Crosthwait, the Forth Bridge.—On the melting-points of minerals, by J. Joly, B.E. An account of experiments with the meldometer, in which the temperature of the platinum strip, acting as the stage of a microscope, was determined in terms of its resistance according to Siemens's formula. It was mentioned that the order of fusibility assumed in Van Kobel's scale is erroneous. The true order seems to be: (1) stibnite; (2) natrolite; (3) adularia; (4) actinolite; (5) bronzite; (6) almandine. The blowpipe being a powerful chemical agent, may evidently mask the phenomena of fusion with secondary effects. Fair comparison is impossible with it, the shape and conductivity of the specimen used affecting the result. Comparison on the meldometer is not open to these objections. It is very advisable that a scientific scale of fusibility should be adopted for the use of mineralogists. If this scale rested on the melting points of easily-prepared salts, it would then always be easy to determine by comparison the melting-point of a mineral. Approximate determinations could thus be readily effected on very minute quantities of matter. In the author's experiments the substances are reduced to a fine powder, the phenomena attending fusion being observed with a 1" object-glass. These phenomena are often very characteristic and beautiful.

Paris

Academy of Sciences, April 27.—M. E. Blanchard in the chair.—On the quantitative analysis of the organic carbon contained in soils which absorb free nitrogen, by M. Berthelot. The author's researches on the direct absorption of free nitrogen by various argillaceous soils through certain minute organisms have led him to seek some other measure capable of indicating the proportion of these organisms in the ground. It being apparently impossible to isolate them, some idea of their abundance may still be formed by a quantitative analysis of the carbon entering into the constitution of their tissues. Hence the present inquiry, which promises to raise some new and extremely delicate problems.—Observations relative to the proportion and quantitative analysis of the ammonia present in the ground, by MM. Berthelot and André. The experiments conducted during the last four years by the authors at Meudon on the general growth of vegetation and on the formation of nitric compounds, both in plants and in the soil, have led to certain observations here communicated on the processes employed in the quantitative analysis of the ammonia and the starchy compounds. It is inferred generally that the analysis of the ammonia present in the soil should be made without any desiccation, and that arable ground, when watered, tends continually to liberate the ammonia of the ammoniacal salts contained in it.—On the nitric substances contained in rain-water, by MM. Berthelot and André. A process is explained for determining by analysis the exact quantity of nitric substances conveyed to the earth by meteoric waters.—On the movements of meteorites in the atmosphere, by M. Faye. These remarks are made in connection with M. Daubrée's essay on "Meteorites and the Constitution of the Terrestrial Globe," recently presented to the Academy by the author.—Discourse pronounced at Montdidier on the occasion of the celebration of the Parmentier centenary, by M. Chatin.—Note on the meteorological observations made at the Montpellier School of Agriculture since last summer with the registering actinometer, by M. A. Crova. The results already obtained for the variations of solar radiation in summer require to be modified for the autumn and winter seasons. In autumn the oscillations diminish in amplitude, the two maxima of heat intensity tending continually to approach each other and gradually merge together about noon in winter.—Note on M. Lœwy's formulas for the reduction of the circumpolar stars, by M. Gruey. A process, at once simple and easily remembered, is given for establishing all M. Lœwy's formulas without any sacrifice of accuracy.—Remarks on the appearance of Fabry's comet in April 1886, by M. G. Rayet. The comet, observed at Bordeaux on April 7, 13, and 21, exhibited a very long continuous spectrum from the extreme red to the violet, corresponding with the light of the nucleus and of the three ordinary bands of cometary spectra.—Note on the equilibrium of a fluid mass in rotation, by M. H. Poincaré. Some explanations are offered in connection with M. Matthiessen's note inserted in the *Comptes rendus* for April 12.—On the magnetic rotatory power of the crystalline bodies, by M. Chauvin. Iceland spar and some other birefractive crystals, supposed by Faraday and others to be inactive, are shown to possess the property of magnetic rotation.—Action of alcoholic potassa on urea, sulpho-urea, and some substituted ureas; inverse reaction of the artificial urea prepared by Wöhler's process, by M. Alb. Haller.—Note on two properties of the urethanes of the fatty series, by M. G. Arth.—On the abnormal secretion of nitric substances in yeast and mould, by MM. U. Gayon and E. Dubourg.—Remarks on *Polystigma fulvum*, Tulasne, a new disease of the almond-tree, by M. Maxime Cornu.—Propagation of the luminous sensation to the non-excited zones of the retina, by M. Aug. Charpentier. From his optical experiments the author concludes that, in the phenomenon of successive luminous induction, the nervous action which gives rise to the sensation is really transmitted to the parts of the percipient medium lying near the excited part.—An attempt at a physiological explanation of the phenomenon of complementary colours, by the late M. Trève.—Heliophotography and the magnetic perturbation of March 30, 1886, by M. Ch. V. Zenger.—Observation of an aurora borealis at Rolleville, Seine Inférieure, coincident with the magnetic perturbation of March 30, by the Abbé Maze.

Berlin

Physical Society, February 19.—Dr. Pernet reported on the part he had taken in the labours of the International Commission which had for their object the comparative determination of the normal metre. After recounting in a brief historical survey the undertakings carried out in Paris at the end of last century by an International Congress, which, after theoretically determining on the kilogramme and the metre as normal units, produced a normal metre and normal kilogramme of platinum, the speaker discussed the events which in 1878 led to a new international agreement, in consequence of which a new normal metre of platinum-iridium of X-form was prepared and compared with the metre of the Archives. A series of national standards was also compared with the normal metre. The speaker described in a searching manner the arrangements of the Bureau in which the comparisons were undertaken, the contrivances for securing the several comparing rooms against outward disturbances, the means adopted for insuring constant temperatures, and the methods employed in the comparisons, as also in the determination of the expansion coefficients of the rods used. Finally he gave a sketch of his own labours, which had for their object the comparison of a series of normal metre rods of different metals with the metre of the Archives, and the determination whether repeated heatings and coolings between 50° and 0° C., whether concussions, and whether time caused any perceptible changes in the lengths of the rods. As the result of these investigations it was found that the compared national standards, together with their divisions, were exact up to one-thousandth of a millimetre; that, with the exception of steel, which, on account of its changes in hardness, readily yielded modifications of volume and length in the rods made of this material, all the metals out of which the standards were made—namely, platinum-iridium, platinum, and brass—furnished material suitable for normal metre rods; and that repeated heatings and concussions induced no changes passing beyond the limits within which observation fails.—Herr C. Baur described experiments he had made with water-jets, which, issuing from a conically-pointed tube in parabolic curves, were acted upon by certain musical tones so that at some distance from the mouth of the tube they showed a rotation, and that the jet, though broken up into drops behind the apex of the parabola, contracted into a continuous jet. The thinner was the jet the higher must be the tone towards which it was sensitive; the thicker the jet the deeper the tone. Herr Baur had instituted further experiments with water-jets, which he caused to fall on plates. Under certain circumstances there thus arose quite pure tones, which continued as long as the jet hit on the plate. The experiments succeeded best with a Weissmann apparatus, when the jet issued under a pressure of 10 cm. water from a lateral opening of 4 mm. in diameter without tube. Thin window-glass plates and metal plates, which, resting on pedestals, had free movement of vibration, were best suited as receiving-plates. The tone was most certain of occurrence when the node lines of the plates were supported. In the jet itself appeared nodes and ventral segments at some distance from the opening; they were most distinct and regular at its middle; away in the direction of the plates they again became indistinct. If the metal plate

and the water acidified beforehand were connected with a galvanic cell and a telephone, then no interruptions of the current could be recognised during the time of the sounding. The contact of the water-jet with the plate must necessarily therefore be continuous. Herr Baur deemed this mode of excitation very well adapted to the purpose of studying the vibrations of plates.—In the discussion following this address it was pointed out from various sides that more than twenty years ago Prof. Tyndall and after him Magnus had instituted experiments respecting the action of tones on water-jets, and that Prof. Tyndall had at the time shown his experiments to the Physical Society in Berlin.

Physiological Society, March 12.—Dr. Gad reported on the experiments he had made on the subject of haemorrhagic dyspnœa which he had referred to in his last address. If by opening a cannula inserted into the aorta a large supply of blood were taken from an animal, dog or rabbit, then dyspnœa at once ensued, and that in the form of increased inspirations, such as showed themselves in all cases of dyspnœa induced by insufficient conduction of oxygen to the respiratory centre. These heightened inspirations proceeded side by side with a conspicuous sinking of the blood-pressure, and were denominated by the speaker "pneumatorectic" respirations. This respiration was distinguished from normal respiration by regular deep inspirations of unchanged frequency, inspirations in which the middle attitude of the thorax removed farther from the expiratory than was the case in normal respiration. The curve of respiration either then passed over into the [illegible] or convulsions set in, in which case the blood-pressure rose [illegible] respiratory curve grew altogether irregular. After [illegible] heavy discharges of blood, the pneumatorectic passed into the "syncoptic" respiration, which was characterised by deep inspirations of very infrequent occurrence, during which the attitude of the thorax after expiration approximated ever nearer to that which it held in a dead body, till the last breath, and so the death of the animal, occurred. These two kinds of respiration, the pneumatorectic and the syncoptic, were perfectly regular and typical; the former showed itself immediately after a heavy discharge of blood, the latter before death. Between these two extreme forms there passed a series of others in an inter-current manner. Of these there was first to be mentioned a very frequent superficial respiration, which was inadequate to the necessities of the organism, and had the name "hypokinetic" applied to it. If the animal recovered out of this stage, the hypokinetic passed into the pneumatorectic and the normal respiration, otherwise it was followed by the syncoptic respiration and death. The transitional process from the hypokinetic into the pneumatorectic respiration might be experimentally brought about in a perfectly regular manner by the injection into the venous system of warm physiological solution of common salts. With the increase of the blood-pressure the alteration in the form of respiration at once asserted itself, the respiration becoming sufficient. Even at the stage of syncoptic respiration a transition into the pneumatorectic respiration might occasionally, though not always, be induced by injection of solution of common salt, and in that way the life of the animal be rescued. Another form of respiration following heavy bleeding was that which showed itself in periodical increasings of the amplitudes in respiratory movements. These and diminishings of amplitudes ran parallel to the Traube-Hering periodical oscillations of the curves of blood-pressure, though with displacement of the phases. The periodical oscillations in the amplitude of respiration referred to formed a transition to the Cheyne-Stokes phenomenon. The speaker recounted the explanations of the Cheyne-Stokes respiration, and took sides with the older theory, according to which it was to be conceived as a rhythmus of activity on the part of the central organs having periods of a higher order than had the simple rhythmus of respiration. In conclusion Dr. Gad drew from his physiological experiences a series of practical consequences having respect especially to the suitability of transfusions of common salt after heavy bleedings, particularly at the stage of hypokinetic respiration.—Prof. Zuntz spoke of the nature of the stimulations regulating the normal respiratory movements. The every-day experience that increased muscular activity produced an increased respiratory activity, dyspnœa, had suggested simultaneously to the speaker and to Dr. Geppert the idea of investigating whether the gases of the blood, which were universally assumed to be the sole stimulations of respiration, were adequate to the explanation of this dyspnœa. The experiments respecting which the speaker delivered a report were instituted in common. From the carotid artery of an animal habituated to regular work—a draught dog—were taken quantities of blood which sufficed for the purpose of analysing the gases of the blood. The quantities of blood referred to were taken on one occasion while the dog was in a state of rest, lying comfortably at his ease in his cage; or on another occasion while the dog was at work pulling a loaded car in his usual manner. By an ingenious contrivance, which the speaker described, the discharge of blood was rendered possible without the dog noticing anything of the matter. In a similar manner, by special apparatus, without molesting the dog in any way, they were enabled to measure the quantity of the air breathed in a given time, and to take away small quantities of the exhaled air to be subjected to analysis. The examination of the blood-gases showed that the arterial blood during work contained less carbonic acid and more oxygen than it did during a state of rest. During work the blood contained about 39 per cent. CO_2, and in a state of rest about 40 per cent.; the amount of oxygen, on the other hand, was about 18 per cent. during work, and about 12 per cent. in time of rest. The respiratory activity was, however, during work considerably increased. The quantity of exhaled air during work increased to threefold that exhaled in time of rest, and, corresponding with the increased respiratory activity, the air exhaled during work showed a less increase of CO_2 and a smaller loss of oxygen than in time of rest. The increased respiration during work could not now be caused by the blood-gases, seeing that the contents of the arterial blood in CO_2 were less, and in oxygen considerably more, than during a state of rest. Another stimulus must accordingly act on the central organs of respiration during work. It was possible to imagine that, along with the voluntary excitation of the muscles of the body during work, the respiratory muscles might likewise be stimulated, or that from the corporeal muscles contracting themselves during work a stimulus proceeded reflexively exciting the respiratory centres. The following experiment, however, was against both of these possible assumptions. The spinal marrow of an animal was intersected at the top of the thoracic vertebra, and the paralysed lower extremities tetanised while the anterior part of the body remained at rest. Notwithstanding, however, that all nervous connection between the working muscles and the respiratory centre was cut off, the dyspnœa of work still ensued, and disappeared when the tetanus ceased. From this fact the speaker drew the inference that in the active muscle some product or other was generated which arrived with the blood at the respiratory centre and excited it. The accuracy of this conclusion was further confirmed by the following experiment. The abdominal aorta of the animal with intersected spinal marrow was, during the tetanus of the posterior extremities, strongly compressed through the abdominal integuments. The respiration now continued unchangedly normal, nor did any dyspnœa ensue so long as the compression lasted. Dyspnœa showed itself, however, the moment the compression was removed. Even when the aorta was left free after the tetanus was ended, increased respiration still occurred. The speaker conceived therefore he had conclusively established that a substance, still unknown, forming itself during the muscular activity, proceeded with the blood to the respiratory centre and excited it. He conjectured that, in other active organs as well, such an efficient substance developed itself as respiratory stimulus, a substance which operated along with the gases of the blood even in the normal respiration. In the discussion following this address, Prof. Zuntz mentioned that Dr. Lehmann had made some experiments respecting the effect of acids on the respiratory centre, and had found that the acids excited this centre. This excitation was of course not powerful enough to justify the conclusion that the acid produced during the muscular contraction was the respiratory stimulus in the dyspnœa of work.

Meteorological Society, April 6.—Prof. von Bezold, the newly appointed Director of the Meteorological Institute in Prussia, which is to be reorganised, explained the principles in accordance with which the reorganisation in question would be undertaken. He first gave a short survey of the history of meteorological observations, setting forth how, first, the disciples of Galileo in the Academia del Cimento made use of the newly invented instruments for the observation of temperatures and atmospheric pressure; how, next, as early as the beginning of the eighteenth century, several investigators of nature had arrived at the knowledge that meteorological observations of any

comprehensiveness could be successfully instituted only through the association of a considerable number of observers; and how, more than a hundred years ago, the Societas Palatina in Mannheim had organised an extended network of stations of observation, at which observations were instituted with instruments of the same construction, according to the same plan, and at the same times, and were collected at the central office, and published in a manner which would be deemed exemplary even if issued at the present time. This work was prosecuted till the French Revolution put a termination to it. In Prussia the suggestion of a meteorological institute was made by Alexander von Humboldt, and was crowned with success only in 1847, when, on Humboldt's proposal, Mahlmann was made the first Director of the Meteorological Institute, which was connected with the Statistical Bureau. In 1849 Dove succeeded Mahlmann as Director of the Institute, and held the post till his death in 1879. Meanwhile, however, the necessity of a complete transformation of the Meteorological Institute came to be recognised. Formerly, simple average values for the different stations were calculated, and for these no special stress was laid on the single observation, in consideration that mistakes balanced one another. Now, however, when it was a question of preparing synoptic maps and of obtaining exact maps of the meteorological conditions prevailing at a determinate time over a large area, the value attached to the single observation was a much higher one, and it was of the greatest importance that all the data should be as free from error as possible. It would accordingly be the first task of the Institute to provide all stations of the second and third order with good instruments, carefully to see they are maintained in good order, and to collect the materials of observation. The network of stations of observation would have to be completed and equally distributed, and there were about 200 stations of the second and third order, besides some thousands of subordinate stations, in contemplation. The subordinate stations should be equipped with rain-gauges, and make observations on precipitation, thunderstorms, and such like. A second problem of the Institute was the exact determination of the course of the meteorological elements for the day, the month, and the year, by uninterruptedly continuous observations not only of the climatic factors—temperature, atmospheric pressure, moisture, &c.—but also of the phenomena of the earth's magnetism and electricity. This work would be done by the Observatory, which was completely separated from the Meteorological Institute. The Observatory, under a special direction, was transferred to Potsdam to the Astro-physical Observatory. Two similar Observatories of the first rank, one in Breslau, perhaps, and one in Bonn—at all events, in University towns wide apart from each other—were in contemplation. While the Observatory prosecuted its observations in the quiet of Potsdam, the Meteorological Institute should have its seat in the midst of Berlin, in the edifice of what was formerly the Building Academy, and continue in connection with the lively intercourse of the capital. Irrespective of the service for weather warnings to be introduced perhaps at a later date, which would require to be in proximity to the head telegraph office, the central position should be readily accessible to the different observers who came from the provinces to the capital. The Institute, moreover, should be easily available for all students of science and experts who were in need of meteorological data: such, for example, as agriculturists, physicians, persons engaged in hydraulic labours, &c. The Meteorological Institute should, finally, have as its main function that of being a teaching institute for the scientific training of meteorologists. Its function in this respect should not be merely confined to lectures at the University, but should especially consist of practical work done, under the guidance of assistants, by students and young observers in the Meteorological Institute, similar to what is carried on in chemical, physical, and other laboratories. With this programme in hand, the new Director hoped very soon to bring the Meteorological Institute to the degree of efficiency attained by similar institutes in neighbouring countries, and particularly by the teaching thus imparted to cultivate a new field fruitful of good results for science.—Dr. Weinstein, with reference to his paper recently read to the Society, made some further communications respecting disturbances of the earth's currents which had occurred on January 9 and March 30. On March 30 the disturbances were so great that in the course of the forenoon telegraphic communication in Germany was stopped. Even with currents of 60 Daniells no signs could be forwarded by the telegraph wires. The magnetic elements in Wilhelmshaven showed great simultaneous disturbances, and from the direction of these magnetic disturbances it was inferred that the disturbances of the earth's electricity were the primary, the oscillations of the earth's magnetism the secondary.—In connection with these observations of Dr. Weinstein, Prof. Spörer stated that from March 26 to April 4 a very remarkable and numerous group of spots had been observed on the sun. On March 30 Dr. Less had observed squalls, accompanied with remarkable oscillations of temperature and of atmospheric pressure, and Dr. Assmann read several reports on North Light phenomena which had been perceived on March 30 in Eldena, Greiffenhagen, Magdeburg, and Nordhausen.—Dr. Weinstein further communicated that Prof. Förster had entered into an arrangement for having reports of disturbances observed in the earth's current at once forwarded to the Astronomical Observatory that the state of the sun might be simultaneously examined.

BOOKS AND PAMPHLETS RECEIVED

"Journal of the Statistical Society," March (Stanford).—"Earthquakes and other Earth Movements," by John Milne (K. Paul).—"Transactions of the Institution of Engineers and Shipbuilders in Scotland," 1885-86 (Glasgow).—"The Forest Flora of South Australia," part 7, by J. E. Brown (Spiller, Adelaide).—"Jahrbuch der k.k. Geologischen Reichsanstalt," Band xxxvi Heft 1 (Hölder, Wien).—"Archives Italiennes de Biologie," tome vii. fasc 11 (Loescher).—"Sea-Weeds, Shells, and Fossils," by Peter Gray and B. B. Woodward (Sonnenschein).—"A Treatise on Nautical Astronomy," by J. Merrifield (S. Low).—"Birds of Cumberland," by H. A. Macpherson and W. Duckworth (Thurnam, Carlisle).—"Handbuch der Palæontologie," Abtheil. 1, Band 11, Leif. 5, "Myriopoda, Arachnoidea Insecta," by S. H. Scudder (Druck, München).—"Handbuch der Palæontologie," Abtheil. 11. "Palæophytologie." Leif. 4. "Coniferæ und Monocotyledonen," by Dr. A. Schenk (Druck, München).—"Letters and Journal of W. Stanley Jevons" (Macmillan).—"Solid Geometry," 3rd edition, by P. Frost (Macmillan).—"Recherches sur l'Instabilité des Continents et du Niveau des Mers," by J. Girard (Leroux, Paris).—"Johann Kepler," by C. Anschutz (Prag).—"The Management of Athletics in Public Schools," by G. Fletcher (Lewis).

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THURSDAY, MAY 13, 1886

THE CHEMISTRY OF THE COAL-TAR COLOURS

The Chemistry of the Coal-Tar Colours. Translated from the German of Dr. R. Benedikt, and Edited, with Additions, by E. Knecht, Ph.D. (London: George Bell and Sons, 1886.)

THIS is an excellent little practical manual dealing with a subject of great scientific and industrial importance—a subject the scientific side of which has been somewhat neglected in this country, to the inevitable detriment of the industrial side. The decline of this industry in England is a tempting subject to expatiate on; but the moral has of late been pointed with such laudable iteration that we refrain from pointing it afresh. The state of affairs which prevails with regard to the literature of the subject is expressed in the opening words of the editor's preface:—

"Although England may be called the birthplace of the coal-tar-colour industry, it is a remarkable fact that the English literature on the subject is very scanty, and that which does exist is now almost obsolete owing to the rapid strides which have been made during the last ten years in the manufacture of the coal-tar colours."

There is no doubt about the want, and we think that this little work supplies it to the extent aimed at. Both author and editor are specially qualified for their task by experience in teaching the technology of the subject.

The work contains excellent introductory chapters on the optical properties of colouring matters, the methods of testing colouring matters—both spectroscopically and with regard to their tinctorial power—on the relation of the various fibres to the colouring matters, and kindred general questions, of importance both to the colour chemist and to the dyer. "Rule-of-thumb" is everywhere excluded; reasons are fully and clearly given.

The greater part of the work is necessarily devoted to the chemistry proper of the coal-tar colours—the chemical processes by which the various colouring matters are obtained and the reactions by means of which a knowledge of their chemical constitution is arrived at. Constitutional formulæ naturally play a very important part.

Our modern dynamical chemists—some of whom, by the way, appear to be censors first and investigators afterwards—are never tired of crying out for the abandonment of these constitutional formulæ on the ground that they afford only statical, not dynamical, representations of chemical phenomena. Happily, those who have built up the German coal-tar-colour industry of the last fifteen years on the basis of the benzene theory have never shared this opinion; nor is it shared by our authors, who in their little treatise faithfully reflect the methods and results of this great scientific and industrial development. Doubtless, colour chemists would prefer a dynamical formula—one which should indicate, for example, the most suitable temperature at which to perform a potash fusion, or a nitration, with a few hints thrown in as to time of heating, concentration, and so forth—and doubtless the dynamical chemists will in time supply this want; but meanwhile the colour chemist feels, taught by experience, that his humble and inexact calculus of chemical operations, the constitutional formula, is vastly better than anything that has been offered in its stead. But as yet the dynamical critic does not appear to have anything to offer in its stead: like certain *dynamitical* critics he is satisfied with destruction, and his attitude towards constitutional formulæ is not unlike that of the dynamitical critic towards Constitutions—British and other.

There is little which calls for criticism in the chemical portion of the work: the classification is good, and the results of the elaborate investigations of which almost every colouring matter of any importance has of late years been made the subject are given briefly but in a way calculated to make clear to the beginner the significance of such work. We could have wished, however, that Dr. Knecht in his editorial capacity had thought good to give some account of the researches of O. Fischer on flavaniline and chrysaniline, and of Bernthsen on methylene-blue. The problem of the constitution of these compounds has been solved in a very instructive and conclusive fashion—much more conclusively than in the case of some of the colouring matters of which the constitution is discussed in the present work.

In the introduction reference is made to the popular prejudice which exists against the so-called "aniline dyes"—the collective name by which coal-tar colours are known among non-chemists. There is an impression that the tints are crude and glaring, and that the colours lack fastness. Certainly there are coal-tar colours which sin in all these respects. But there is a survival of the fittest here as elsewhere: the vulgar shades and fugitive colours are being weeded out and replaced by better. The accusations come most frequently from persons of an æsthetic turn, and it is perhaps too much to expect that the strenuous æsthete, living laborious days in the endeavour to improve his own taste and that of his neighbours, should be aware that the beautiful and permanent Turkey-red, which he so justly admires, is now a coal-tar colour, and that even indigo may be made from coal-tar. As regards "fastness" of colours, the ideas of the general public on the subject may perhaps be gauged by a speech which we remember reading, made some years ago by a Member of Parliament in distributing the prizes at a technical school. Seeking to inculcate the duty of thoroughness in work, and desirous at the same time to employ only such illustrations as would at once come home to every technologist, he said:—"But it would not be thorough work, for example, to daub a wall with untempered mortar, or *to dye with fast colours*." Probably a life divided between politics and sport had not permitted him to realise that the fastness of colours is distinct from that of race-horses—or of youth!

Where there is so much to praise we regret to have to record a defect, but we think that hardly adequate care has been bestowed upon the proof-reading. The misprints are unnecessarily numerous, and must sometimes be very puzzling to a beginner, especially where, as is occasionally the case, they affect complicated formulæ. A list of errata is given, which, however, needs extension. Whether, for example, the chemistry of the average student of technology will be equal to the task of informing him that not sodium bisulphate

but sodium bisulph*ite* is employed in the preparation of soluble alizarin-blue, or that the three formulæ given on p. 70 in a preliminary account of the products from tar, and described as those of "the three isomeric dinitrobenzenes," are in reality those of the three mononitrotoluenes—errata not corrected in the list—is open to doubt.

In conclusion, we cordially recommend the book. We trust that it will not only be made use of by students of technology as a useful introduction to the larger treatises in French and German, but that the ordinary student of organic chemistry will take the opportunity of making a closer acquaintance with a special branch of his subject, as fascinating from a scientific point of view as it is fertile in practical results. F. R. JAPP

JAPANESE HOMES

Japanese Homes and their Surroundings. By Edward S. Morse, Director of the Peabody Academy of Science. (London: Sampson Low, 1886).

ALTHOUGH Prof. Morse's connection with Japan has been comparatively short and interrupted, few men have done so much for scientific progress in that country. About ten years ago he first visited Japan in order to study certain forms of ocean life on its coasts, and, fortunately, was induced to accept the Chair of Zoology in the University of Tokio. While holding this office he did much to arouse an interest in the minds of his students for biological research, and he established a Biological Society, which is, we believe, still at work. By his discovery and thorough investigation of the shell-mounds at Omori, near Tokio, he stimulated prehistoric studies. His monograph on these mounds—although perhaps his theory as to the builders may not, on more extended examination, have proved tenable—was followed by a number of publications on the Japanese Stone Age, cave-dwellers, and the like; and in many less generally known directions his influence on the advance of science in Japan has been a beneficial and stimulating one. His first visit to Japan has been followed by two others, during which he visited all parts of the country, as well as other regions of Eastern Asia, and has collected material on a variety of matters. The present volume is a monograph on the house in Japan;—the different types of houses, their mode of construction, the uses of each part, the varieties in each from the roof to the foundation, the types and uses of household utensils, &c. The illustrations, which are beautiful, are also very numerous, being, on the average, about one to a page. Without them it would, indeed, be difficult for readers who are not well acquainted with Japanese houses to follow the descriptions. Many of these details Prof. Morse thinks it may soon be difficult, if not impossible, to obtain, and therefore like an old Japanese to whom he refers, and who "held it a solemn duty to learn any art or accomplishment that might be going out of the world, and then to describe it so fully that it might be preserved to posterity," he now describes and copies them for the benefit of future generations who may not have the opportunity of seeing these evidences of Japanese skill and sense of beauty. We do not apprehend that the Japanese will ever change so far as to substitute the jerry-builder for their own carpenters, and we do not think that their style of architecture will ever greatly alter, for the simple reason that they have now what, on the whole, is the fittest. Nevertheless we cannot but be grateful to Prof. Morse for making the Japanese house, inside and out, so familiar to English readers. His work is so clear and detailed that we see no reason why any one who feels so disposed should not be able to erect for himself a home in the Japanese style in England.

In the eighth chapter indications from the most ancient works in Japanese literature are collected together in order to catch a glimpse of what the Japanese house of a thousand years ago was like. It would be useless without a plan of the modern house before us, to refer to these beyond quoting Prof. Morse's conclusion that they are significant indications of the marked southern affinities of the Japanese, and he thinks that, from all we can gather relating to the ancient house of the Japanese, it would seem that certain important resemblances must be sought for in Annam, Cochin China, and particularly in the Malay peninsula—but not amongst the Ainos. This is another nail in the coffin of the theory of an ethnic relationship of the latter with the Japanese. On the whole, Prof. Morse's theory of the history of house development in Japan is a slow but steady progress from the rude hut of the past to the curious and artistic house of to-day—a house as thoroughly a product of Japan as is that of the Chinese, Corean, or Malay a product of these peoples, and differing from all quite as much as they differ from one another. It has just those features incorporated into it that might be expected from its physical proximity to, and historical relations with, China and Corea. The last chapter deals with the "neighbouring house"—that is, Corean, Chinese, Aino, and Loochooan houses. In this chapter the writer has fallen into a curious error in describing Hachijô Island as one of the Bonins. There is no more connection between the two than there is between Iceland and the Isle of Wight. Hachijô has from the earliest times been Japanese; it was at one time a place of exile for political offenders. The Bonins never belonged to Japan until within the last few years; as the name (*Bu* or *Mu Nin*, without people) implied, they were uninhabited, except by a few waifs and strays thrown up by the sea—Caroline Islanders, deserters from whalers and ships of war. The account of the visit to Hachijô, from which Prof. Morse quotes, was published some years ago in the *Transactions* of the Asiatic Society of Japan, and is of exceptional interest, for in this island may still be observed ancient Japanese customs which have long fallen into desuetude on the mainland. Thus the peculiar lustration ceremonies, the special parturition houses, &c, now found in Hachijô, are mentioned in ancient Japanese works as common to all Japanese. The difficulty of access to the island from the adjacent mainland on account of dangerous currents would explain the presence of this little oasis of antiquity. There is this excuse, however, for Prof. Morse's confusion of the Bonin Islands with Hachijô, that the expedition set out for the Bonins, but the writers about Hachijô went no farther than that island, and there, while awaiting the return of the steamer, collected the material for the paper in question.

ACOUSTICS, LIGHT, AND HEAT

Acoustics, Light, and Heat. By William Lees, M.A., Lecturer on Natural Philosophy, the Heriot Watt College, and Lecturer on Mathematics and Experimental Physics, Free Church Training College, Edinburgh. New and Enlarged Edition. (London and Glasgow: Wm. Collins, Sons, and Co.)

THIS is one out of many of the text-books which have been called into existence by the "May" Examinations of the Science and Art Department. Being written especially to meet the requirements of the student who wishes to pass these examinations, it is only brought up to the standard given in the directory of the Department, and may therefore for this purpose be useful. The fact that a new and enlarged edition is now appearing is certainly evidence that this is the case. To make it more serviceable, the questions of all the May Examinations in Subject VIII. from 1872 to 1885 are given.

Though the simple and numerous diagrams and the generally clear nature of the text give it a certain value as a text-book, it is by no means so free from faults and ambiguities as might be expected in a new edition.

It may be well to refer especially to a few places where alterations suggest themselves.

Figs. 19 and 20 show the contrast between a musical sound and a noise. Though it is explained that "noises are due to irregular vibration or a confused mixture of musical sounds which produce aërial waves of great complexity and wanting in periodicity," no explanation is offered of a peculiarity in the "curve of a noise" (Fig. 20), which in three places is actually made to slope backwards.

Some of the figures in optics are rather wanting in precision. Thus in Fig. 73, which shows a real image formed by a concave mirror, a pair of slightly diverging rays are made to cross between the mirror and the principal focus. Again, Fig. 77 shows a caustic on the surface of milk in a glass with its cusp reaching close to the centre. Fig. 103 shows the action of a refracting plate on a beam of light by the turning and approximation of successive wave-fronts. Those two wave-fronts which obliquely cut the surface are shown straight and partly swung round, as if they were rigid lines meeting with resistance at one end. It would surely have been better to have bent the line at the point of intersection, leaving all the wave-fronts and parts of a front outside the medium parallel to one another, and also all inside parallel to one another, but it is possible that wave-fronts, strictly speaking, are not intended.

The explanation of so important a thing as the achromatic lens can hardly be considered satisfactory. Owing to its brevity it is possible to give this in full. "This defect in a lens [the defect of chromatic aberration] is obviated by the combination of a double convex lens of *crown* glass, with a convexo-concave of *flint* glass (Fig. 122). The effect of the second lens is to re-blend the coloured rays which the first has produced, and at the same time such an amount of refraction is preserved as to bring the light to a focus." As nowhere is it directly pointed out that for the same degree of refraction flint glass produces more dispersion than crown, it is not difficult to imagine that a student might fail to form any very clear idea of the principle of the achromatic lens, nor is he likely to be materially helped by the figure (122), which certainly does not represent either the section or any other view of any achromatic lens that was ever made. If it were not for the section lines it would be a good perspective drawing of a short cylinder; the ellipse which appears to be the end of such a cylinder is really meant to show the crown lens in section, and the figure of uniform thickness by its side, as thick everywhere as the ellipse is in the middle, which seems to be the side of the cylinder, is meant for the section of the flint lens. Simplicity in a diagram is a thing to be desired, but there is more than simplicity here.

Very little is said about spectrum analysis; and its application to the measurement of the motion of the heavenly bodies in the line of sight is not even mentioned.

The general weakness of the optical part is to a certain extent compensated for by the chapters on polarisation, which have much to recommend them. There is here, however, a paragraph which requires explanation. "Now it is found that whatever quantity of polarised light there is for any incidence *other than the polarising angle* in the reflected beam, there is always the *same* quantity in the refracted beam. At the polarising angle, however, the refracted beam exhibits traces of polarisation." What is meant by this distinction is by no means clear.

Heat is more precisely and clearly treated than light, but here the general excellence is marred by an example to illustrate expansion in which the working out of the result shows that the obvious meaning of the question is not intended. What any one would understand by the words, "Find the length of a rod of brass which would expand equally with a rod of steel 3 feet long under a change of temperature of 10° C.," is evidently —Find what length of brass will increase in length by the same amount that a 3-foot rod of steel does for a change of 10° C. But what is found in the working of the answer is the length of a piece of brass which will expand so as to be *as long as* a piece of steel 3 feet long when each is *raised* 10° C.

Sufficient has been said to show that this book is not as clear and accurate in either the text or the figures as might be expected in a new edition.

OUR BOOK SHELF

Cholera Curable. By John Chapman, M.D. (London: Churchill, 1885)

DR. CHAPMAN has had the opportunity of testing, in the Hôpital de la Charité in Paris, his method of the so-called neuro-dynamic treatment in Asiatic cholera, and his demonstration of the success of this treatment constitutes, we take it, the cardinal motive for the production of this book, although a good many other, mostly theoretical, considerations are brought into the discussion.

The symptoms of Asiatic cholera are explained by a number of assumptions on the action of the spinal cord and the sympathetic nervous system, but as to which we look in vain for experimental proof. The theories concerning the etiology and causation of cholera are fully treated, and then Dr. Chapman promises to furnish us with a complete solution of these problems in a discovery made by him as to the cause of cholera. When, however, we come to analyse what he really has discovered,

it turns out that he himself is moving in a circle of fallacies. While denying the specific nature of the cholera virus, he explains this latter by the symptoms of the disease. Assuming, for the sake of argument, with Dr. Chapman, the particular disturbances of function in the cord and the sympathetic nerves to which the symptoms of cholera are due, how does this bring us nearer to the knowledge of what causes these particular disturbances? By saying, or even by showing, that such and such a disturbance in the function of the cord and sympathetic causes such and such a symptom of disease, we are not one iota nearer the answer to the question, Why did such and such a disturbance take place? what has caused it? The answer to this one wants to know, but this is not supplied by Dr. Chapman. It is quite true that a great many conditions are required to favour the outbreak and spread of cholera, *e.g.* conditions of temperature, water, atmospheric disturbances, soil, &c., &c., but all these conditions may be present without producing cholera, or typhoid fever, or any other similar disease. Why? Because *the actual cause* of the disease is absent. These two things, viz. secondary conditions favouring the outbreak and spread, and *the actual cause*, must be kept separate; but evidently Dr. Chapman has not arrived at this as yet.

The chapters VIII. to XV. describe the various methods of treatment of the disease, and they form the most important part of the book. E. KLEIN

Seaweeds, Shells, and Fossils. By Peter Gray, A.B.S., and B. B. Woodward. (London: Swan Sonnenschein and Co

THE object of this book is to give to the young English collector a general knowledge how to set about collecting the more common seaweeds, shells, or fossils.

In the first case the subject is dealt with generally, classifying the different seaweeds and stating where each is most likely to be found, and, when found, the best way to press them and get them ready for the cabinet, the most economical way of making or obtaining which is given.

Secondly, shells are dealt with, descriptions and diagrams being added where necessary, together with a table of the more important genera, showing the approximate number of species belonging to each genus, and their distribution.

Thirdly, and lastly, different localities are pointed out where fossils are best found, and the best mode of arranging them in the cabinet. A table of the principal fossiliferous strata arranged in chronological order, with notes on the different formations mentioned in the table, and also of the principal divisions of the animal kingdom, are added to show the order in which the fossils should be arranged. S.

The Modernised "Templeton"; or, "The Practical Mechanic's Companion." By William Templeton. Revised and Modernised by Walter S. Hutton, C.E. (London: Crosby Lockwood and Co., 1886.)

TEMPLETON'S "Mechanic's Workshop Companion" is a work familiar to most mechanics and draughtsmen, having been considered for the last quarter of a century a useful book of reference by all connected with the management of engineering workshops and kindred trades. Books of this description require revising very often, and considering the enormous development of the mechanical sciences during the last few years no one will wonder on hearing that even "Templeton" has to be modernised to keep pace with the times.

The reviser tells us that he has endeavoured to follow as far as possible the lines of the original work, at the same time bringing all the information up to date. Much new matter has been added, giving information on air, gas, water, and steam; methods of testing steam-engines and boilers; turbines and other water motors; the strength and weights of material; and miscellaneous information too numerous to give in detail.

The work has for a frontispiece an illustration of the fine compound locomotive "The Marchioness of Stafford," designed by Mr. F. W. Webb, the able locomotive superintendent of the London and North-Western Railway. On seeing this we are at once led to imagine that at last we have found a book giving recent data on locomotive engineering, and likely to fill a want seriously felt by those who study that most interesting branch of mechanical engineering. We are told to "see p. 360," to which we turn hoping to find a section devoted to locomotive work, having Mr. Webb's fine engine as an example of the latest advance. We find a third of a page giving the bare dimensions of the compound. Even the index makes matters no better, for the book contains no locomotive data whatever! Considering the thousands of mechanics engaged in this class of work, this is a great pity, and should be remedied in a future edition.

An excellent abstract is given of the results of experiments on riveted joints, with special reference to practical work, by Prof. Alexander B. W. Kennedy. This is most interesting and useful, and will well repay careful study by those connected with the manufacture of soft steel boilers and bridges.

The book contains all the usual tables, embracing every subject likely to be required by the intelligent mechanic or draughtsman, including extensive practical rules and data Instruction is also given in the rudiments of arithmetic, algebra, and trigonometry. N. J. L.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Foreign Fishery Boards

IN reference to recent statements in NATURE on this subject, it will interest your readers to know that in Italy the Government has constituted a Fishery Board, which, my friend Prof. Giglioli, of Florence, tells me, is actively employed in advising the executive and in inquiring into the grievances and difficulties of fishermen, and the suggestions for improvement of fisheries; it has also recently, at the expense of the Government, taken practical measures in the stocking of lakes with fish, and in the cultivation of sea-fish. This Commission is a branch of the "Ministry of Agriculture, Industry, and Commerce," which corresponds to our Board of Trade. *The members of the Fishery Commission, with the exception of the first three named below, are exclusively scientific men.* They are as follows:—The Permanent Under-Secretary of State for Agriculture; the Permanent Under-Secretary of State for Commerce; a distinguished lawyer; M. Minni, of Venice; Dr. Renier, of Chioggia (representing the fishermen of this island); M. Friedlander, of Comacchio (specially acquainted with the peculiar fish-culture of this district); Prof. Giglioli, Florence; Prof. Targioni-Tozzetti, Florence; Prof. Costa, Naples; Prof. de Vincentis, Taranto; Prof. Canestrini, Padua; Prof. Pavesi, Pavia; Prof. Issel, Genoa.

The Commission meets from time to time in Rome. The questions submitted to it are brought forward and referred separately to one or two members, who are requested to draw up a report on the particular subject thus referred. The report may take several months, and involve experiment or research, or it may be a simple matter. The report when presented is discussed by the whole Commission. The conclusions and recommendations which it embodies are modified by vote of the majority, and it is obvious from the constitution of the Board that the scientific experts have the voting strength.

The members of the Board or Commission are paid travelling

expenses and 25 francs a day each during its sessions in Rome, or other fixed place of meeting.

The constitution of this Board is admirable, since it secures a fair representation of the leading scientific men of Italy. The Italian Government does not, it seems, refer such questions exclusively to one individual, but endeavours to obtain a consensus of the scientific opinion of the country.

Hôtel de la Ville, Florence E. RAY LANKESTER

Fabry's Comet and Barnard's Comet

NOT having seen any mention of the rapid apparent growth of the tail of Fabry's comet, probably some of your readers are not aware to how great a length it extended. On April 26 occurred the first fine night after a very unusual series of overcast ones, and about 14h. G.M.T. I was surprised to see the tail reaching up to, or at least to within 1° of, δ Cassiopeiæ, a distance of 38° from the place given in the ephemeris for the nucleus, which was far below the horizon; and the tail would doubtless have been visible to a greater distance but for the brightness of the Milky Way. The following night, about 10h., it reached at least up to the Cluster in Perseus, a distance also of 38° from the predicted position of the nucleus; it was very narrow both nights. The next night, which was pretty fine, I failed to find any trace of the tail.

The principal tail of Barnard's comet is also very narrow: on May 1 its length was 4½°, as seen with a pair of field-glasses. With the telescope this comet had also a faint tail *nf*, about 16′ long, making an angle of 65° or 70° with the other.

Sunderland, May 7 T. W. BACKHOUSE

"Pumice on the Cornish Coast"

STEAMER-CINDERS, similar to those referred to by Mr. Whitaker in NATURE for April 29 (p. 604), occur frequently on the Falmouth beaches; but as there seemed to me little probability of their being mistaken for pumice, I did not refer to the matter in my communication to your columns (April 15, p. 559).

Mr. Murray tells me that the pumice I found is felspathic, and that from its form and diminished buoyancy it had evidently been a long time in the water. The fragment was sent by him to Mr. Whitaker, who at once recognised its true character and its distinction from the steamer-cinders observed by him on the Suffolk coast, one of which he sent to Mr. Murray to satisfy him as to their very evident source. H. B. GUPPY

95, Albert Street, Regent's Park, N.W., May 8

THE VELOCITY OF LIGHT

I.

[A reinvestigation of this important constant has recently been published by Prof. Newcomb. Before we state his methods and results we think it well to reproduce the following admirable historical notice with which his monograph commences.—ED.]

WHEN it became clearly understood that vision was not an immediate perception of objects by the eye, but was produced by the passage of an entity called light from the object to the eye, the question of the time which might possibly be required for this passage became one of interest to physical investigators. The first proposal for an experimental investigation of this question is due to Galileo.[1] He suggested that two observers, each holding a lantern, should be stationed at a distance apart, in sight of each other. Each should be supplied with a screen, by which he could, in a moment, cover or uncover his lantern. One observer should then uncover his lantern and the other uncover the other the moment he perceived the light from the first lantern. The interval which elapsed after the first uncovered his light, until he perceived the light of the second, would be the interval required for the light to go and come, plus the time required for the second observer to perceive the light and make the required movement. This experiment was tried by the Florentine Academy, and of course resulted in a conclusion that the time required was insensible, since we now know that it was far below any interval that could have been detected by so rude a method.

It is, however, interesting to notice that, rude though this experiment was, the principle on which it was based is the same which underlies one of the most celebrated methods used in recent times for the attainment of the same object. Two very simple improvements which we might have imagined the Academicians to make in their experiments are these:—

Firstly, to dispense with the second observer, and in his place to erect a mirror, in which the first observer could see the image of his own lantern by reflection. The time required for the second observer to perceive the light and uncover his lantern would then have been eliminated from the problem. The interval sought would have been that between the moment at which the observer uncovered his lamp and the moment at which he perceived the reflection.

Secondly, to use the same screen with which he uncovered his own lamp, to cut off the returning ray from the distant mirror, and thus obviate the necessity of an uncertain estimate of the interval between his muscular effort in removing the screen and his perception of the return flash of light. If the image was perceived before he could cover his own eye with the screen removed from the lamp, it would show that the interval of passage was less than the time required to make a motion with the screen. This interval might have been reduced almost indefinitely by having both lines of sight as near together as possible.

Had these improvements been made, the Academicians would have had, in principle, Fizeau's method of measuring the velocity of light by the toothed wheel, a tooth being represented by the screens. To realise the principle more fully, the two lines of sight should have been rendered absolutely coincident by reflection through a telescope. It does not, however, appear that any effort to put the question to a severer test was made until the subject was approached from a different point of view. It was probably considered that the passage was absolutely instantaneous, or, at least, that the velocity was above all powers of measurement.

The subject was next approached from the astronomical side. In 1676 Roemer made his celebrated communication to the French Academy, claiming that observation of the eclipses of the first satellite of Jupiter did really prove that light required time to pass through the celestial spaces.[1] He found 11m. to be the time required for light to pass over a distance equal to the radius of the earth's orbit. Dominique Cassini, while admitting that the hypothesis of Roemer explained the observed inequality, contested its right to reception as an established theory, on the ground that the observed inequality might be a real one in the motion of the satellite itself.[2]

Continued observation showed that the time assigned by Roemer for the passage of light between the earth and sun, or "the light equation" as it is briefly called, was somewhat too great. In 1809 it was fixed by Delambre at 493″2s., from an immense number of observations of eclipses of Jupiter's satellites during the previous 150 years. This number has been received as a definitive result with a degree of confidence not at all warranted. In 1875, Glasenapp, then of Pulkowa, from a discussion of all available eclipses of Jupiter's first satellite between 1848 and 1870, showed that results between 496s. and 501s. could be obtained from different classes of these observations by different hypotheses.[3]

[1] Poggendorff, *Geschichte der Physik*, p. 402, where reference is made to he *Saggi* of the Florentine Academy.

[1] *Paris Memoirs*, tome i. p. 212, and tome x. p. 575.

[2] *Ibid.* tome viii. p. 47. Poggend rff (*Geschichte der Physik*, p. 636) quotes Maraldi as also contesting Roemer's explanation on the ground that a similar inequality should be found depending on the position of Jupiter in his orbit. The ground here taken was quite correct, the only fallacy being the assumption that such an inequality did not exist.

[3] This paper of Glasenapp's was published only in the Russian language as an inaugural dissertation, and in consequence has never become generally known.

As not a trace of Delambre's investigation remains in print, and probably not in manuscript, it is impossible to subject it to any discussion.[1]

The discovery of aberration by Bradley afforded an independent and yet more accurate method of determining the light equation. We call to mind that the latter constant, and that of aberration, are not to be regarded as independent of each other, but only as two entirely distinct expressions of the same result. The constant of aberration gives a relation between the velocity of light and the velocity of the earth in its orbit from which, by a very simple calculation, the time required for light to pass from the sun to the earth may be deduced.

It is remarkable that the early determinations of the constant of aberration agreed with Delambre's determination of the light equation, although we now know they were both in error by an amount far exceeding what was at the time, supposed probable. Struve's value, 20″·445, determined in 1845 from observations with the prime vertical transit of Pulkowa, has been the standard up to the present time. The recent determinations by Nyrén being founded on a much longer series of observations than those made by Struve, and including determinations with several instruments, must be regarded as a standard at present. His result is :—[2]

Definitive value of the constant of aberration = 20″·492 ± 0″·006.

At the time Struve's result was published there was an apparent difference of 1 per cent. between its value and that of the light equation determined by Delambre. The question then naturally arose whether the light equation, deduced on the hypothesis that the tangent of the angle of the constant of aberration was the ratio of the velocity of the earth in its orbit to the velocity of light, might not need correction or modification. This question cannot yet be considered as definitely settled, since the modifications or corrections might arise from a variety of causes. One of these causes is connected with a very delicate question in the theory of the luminiferous medium ; a question which can be most clearly understood when placed in the following form :—It is a result of optical principles that a ray falling perpendicularly upon the bounding surface of a refracting medium retains its direction unaltered. Now, if this surface is carried along by the motion of the earth, and the light comes from a star, and it is desired that this surface shall be so directed that there shall be no refraction, must it be placed perpendicular to the *true* direction of the star as freed from aberration, or to its *apparent* direction as affected by aberration? The difference of the two directions may exceed 20″, and since the index of refraction of glass exceeds 1·5, there will be a difference of more than 10″ in the direction of the refracted ray, according as we adopt one or the other hypothesis. Assuming that the standard direction would be perpendicular to the true or absolute direction of the star, it is easily shown that the constant of aberration determined in the usual way would be too large by a quantity depending on the ratio of the thickness of the objective to the focal length of the telescope. In an ordinary telescope the difference would be nearly one-hundredth of the total value of the aberration, and would, therefore, closely correspond to the discrepancy between Delambre's result from the satellites of Jupiter and the modern determinations of the constant of aberration. The question of this particular cause was set at rest by Airy's experiments with a telescope filled with water, which showed that the result was independent of the thickness of the objective, and, therefore, that the apparent direction of the star was that on which refraction depended.

If, in accordance with the undulatory theory of light, we suppose the hypothetical entity called "the luminiferous medium" to be a substance, each part of which has its own definite and fixed location in space, then we must conceive that another unknown quantity may enter into the problem, namely, the motion of the heavenly bodies through this medium. We have relative motions in the solar system, exceeding 50 kilometres per second, and possibly greater relative motions among the stars. Now it is clear that the heavenly bodies cannot all be at rest relative to the medium, but must move through it with velocities at least of the order of 50 kilometres per second, and possibly greater without limit, since it is conceivable that the whole visible universe might be moving in a common direction relative to the medium.

It is easily seen that if we suppose the velocity of the earth, through the medium, to have a small ratio, a, to the velocity of light, then the observed constant of aberration may be altered by an amount found by multiplying its value by a quantity of the order of magnitude of a. This alteration would be entirely insensible if the earth does not move through the medium with any greater velocity than it does around the sun, since the value would then be only $\frac{1}{10000}$. It is remarkable that so far as yet investigated every optical effect arising from such a motion, which could be measured on the surface of the earth, is of the order of magnitude of the square of a. Thus, no phenomenon has yet been discovered which can be traced to the motion in question.

Assuming that there is no general motion of the solar system through the ether of a higher order of magnitude than that of the relative motions of the fixed stars to each other, and that the ordinary theory of aberration is correct, there will be three constants between which a relation exists, such that when any two are found the third can be determined. These constants are :—

1. The distance of the sun in terrestrial units of measure ;
2. The velocity of light in units of the same measure ; and
3. The constant of aberration, or, which is supposed to be equivalent, the light equation.

Until our own time the first and third constants were used to determine the second. From the fact that light required about 500 seconds to traverse the distance from the sun to the earth, and that the distance of the sun was, as supposed, 95,000,000 of miles, it was concluded that light moved 190,000 miles per second. The hopelessness of measuring such a velocity by any means at the command of physicists was such that we find no serious attempt in this direction between the date of the futile effort of the Florentine Academy, and that of the researches of Wheatstone, Arago, Fizeau, and Foucault nearly two centuries later. One of the most curious features presented by the history of the subject is that two entirely distinct methods, resting on different principles, were investigated and put into operation almost simultaneously. The revolving mirror of Wheatstone, and its application to determine the duration of the electric spark and the velocity of electricity, come first in the order of time. But, before this ingenious instrument had been applied to the actual measurement of the velocity of light, Fizeau had invented his toothed wheel, by which the same object was attained

Fizeau's paper on the subject was presented to the Academy of Sciences on July 23, 1849.[1] We have already shown that his method and that of Galileo rest fundamentally upon the same principle. The arrangement of his apparatus was substantially as follows :—

A telescope was fixed upon a house at Suresne pointing to the hill Montmartre. On this hill was a second fixed telescope looking directly into the first, the distance between them being about 8633 metres. In the focus of this second telescope was fixed a small reflector, so that

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[2] *Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg*, vii. série, tome xxxi. No. 9.

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a beam of light from the first would be reflected directly back to it. By means of a transparent glass, fixed in the eye-piece at an angle of 45°, a beam of light was sent from the first telescope to the second, and, on its return through a total distance of 17 kilometres, could be seen as a star by an eye looking through the first. Alongside the eye-piece of the latter a revolving wheel, with 720 teeth cut upon its circumference, was fixed in such a way that the beam of light both in going and coming had to pass between the teeth. When the wheel was set so that the tooth was in the focus, the beam would be entirely cut off in its passage through the telescope. Changing the position of the wheel through half the space between the middles of two consecutive teeth, the light would go and come freely between the teeth. When the wheel was set in revolution a succession of flashes would be sent out. If, on the return of each flash, a tooth was interposed, it would be invisible to the eye looking through the telescope. Fizeau found that with a velocity of 12·6 turns per second each flash which went out was on its return cut off by the advancing tooth. With a velocity twice as great as this it was seen on its return through the opening next following that through which it went. With three times this velocity it was caught on the second tooth following, and so on.[1]

This experiment of Fizeau was soon followed by the application of the revolving mirror of Sir Charles Wheatstone. Shortly after measuring the duration of the electric spark this investigator called attention to the fact that the same system could be applied to determine the velocity of light, and especially to compare the velocities through air and through water. In 1838 the subject was taken up by Arago, who took pains to demonstrate that it was possible, by the use of the revolving mirror, to decide between the theory of emission and that of undulations by determining the relative velocities in air and in a refracting medium.[2]

The difficulties in the way of securing the necessary velocities of the mirror and of arranging the apparatus were such that Arago never personally succeeded in carrying out his experiments. This seems to have been done almost simultaneously by Foucault and Fizeau about the beginning of 1850. Both experimenters seem to have proceeded substantially on the same principle and to have reached the same result, namely, that the motion of light through water was slower than through air in the inverse proportion of the indices of refraction of the two media.[3]

An important and most necessary modification of Arago's plan was made by these experimenters. As originally proposed, the plan was to send an instantaneous flash of light through water and through the air, and to receive it on the revolving mirror and determine the relative deviations in the positions of the images produced by the two rays. This system would, however, be inapplicable to the measurement of the actual time of transmission, owing to the impossibility of making any comparison between the time at which the flash was transmitted, and that at which it was received on the mirror. This circumstance would, indeed, have rendered the actual realisation of Arago's project nearly impossible for the reason that the flashes of light, seen through the water, would have reached the mirror at every point of its revolution; and only an exceedingly small fraction of them could have been reflected to the eye of the observer.

This difficulty was speedily overcome by Foucault and Fizeau by a most ingenious arrangement, of equal importance with the revolving mirror itself. Instead of sending independent flashes of light to be reflected from the mirror, a continuous beam was first reflected from the revolving mirror itself to a fixed mirror, and returned from the fixed mirror back on its own path to the revolving one. A succession of flashes was thus emitted as it were from the fixed mirror, but their correspondence with a definite position of the revolving mirror was rendered perfect. Moreover, by this means, the image was rendered optically continuous, since a flash was sent through and back with every revolution of the mirror, and after the velocity of the latter exceeded 30 turns per second, the successive flashes presented themselves to the eye as a perfectly continuous image.

It was not until 1862 that this system was put into operation by Foucault for the actual measurement of the velocity of light through the atmosphere. A new interest had in the meantime been added to the problem by the discovery that the long-accepted value of the solar parallax was too small, and that the measurement of the velocity of light afforded a method of fixing the value of that constant. The central idea of the method adopted by Foucault was that already applied in comparing velocities through different media. The element sought is made to depend upon the amount by which the revolving mirror rotates while a flash of light is passing from its surface to the distant reflector, and coming back again. As the details of Foucault's method will be best apprehended by a comparison of them with those adopted in the present investigation, a complete description of his apparatus will here be passed over. It may, however, be remarked, that what he sought to observe was not the simple deviation of a slit, but the deviation of the image of a reticule. The deviation actually measured was 0·7 millimetre, and the system adopted was to determine at what distance, with a definite velocity, this amount of deviation could be obtained. His result for the velocity of light was 298,000 kilometres per second.

The next measures of the element in question were those of Cornu. The method which he adopted was not that of the revolving mirror, but Fizeau's invention of the toothed wheel. His earlier measures, made in 1870, and communicated to the French Academy in 1871, led to a result nearly the same as that of Foucault.[1] This result was, however, not so satisfactory that the author could record it as definitive. He, therefore, in 1874, repeated the determination on a much larger scale and with more perfect apparatus. The distance between the two stations was nearly 23 kilometres, and therefore much greater than any before employed. He was thus enabled to follow the successive appearances and extinctions of the reflected image to the thirtieth order; that is, to make fifteen teeth of his wheel pass before a flash returned from the distant reflector, and to have it stopped by the sixteenth tooth.

This method has a defect, the result of which is evident by an examination of Cornu's numbers. It is that the extinctions and reappearances of the light as the wheel changes its speed are not sudden phenomena, occurring at definite moments, but are so gradual that it is difficult to fix the precise moment at which they occur. Of this defect the able experimenter was fully conscious, and his discussion of the disturbing causes which come into play, and of the amount of error due both to the apparatus, the observer, and to the method of eliminating them, form altogether one of the most exhaustive discussions of a physical problem.[2] But the uncertainties are not of a kind which admit of complete investigation, and it now appears that although his result was far superior in point of accuracy to that of Foucault, it was nevertheless in error by about 0·0015 of its whole amount. It was, in

[1] It is curious that the author's account of this remarkable experiment, which forms an epoch in the history of physical science, is contained within the limits of two pages, and terminates without any definite discussion of the results. It is merely stated that the result is 70,948 leagues of 25 to the degree, but the velocity, in kilometres, which must have been that first obtained, is not given, nor is it stated what length the degree was supposed to have in the computation.

[2] *Comptes rendus*, 1838, vol. vii. p. 354; *Œuvres de François Arago*, vol. vii. p. 560.

[3] *Comptes rendus*, vol. xxx. 1850, pp. 551 and 771.

[1] *Comptes rendus*, vol. lxxii. 1871, p. 857.

[2] Annales de l'Observatoire de Paris, *Mémoires*, tome xiii.

fact, when reduced to a vacuum, 300,400 kilometres per second, while we may now regard it as well established that the true velocity is less than 300,000.

The next determination of the velocity of light was that of Michelson,[1] whose result was 299,910 kilometres per second. His investigation being a part of the first volume of the present series need not be here discussed, but it is worth while to remark that his method seems far superior in reliability to any before applied.

An attempt has been made by Messrs. James Young and George Forbes to improve Fizeau's method, by diminishing the uncertainty arising from the gradual extinction of the visible image.[2] By the method of these experimenters the result depends, not upon the moment when the image disappears, but when two images, side by side, are equal in brightness. This is effected by employing two reflectors, at unequal distances, but nearly in the same line from the telescope, to return the ray. Each reflector then forms its own image in the field of view of the sending telescope. With a regularly increasing velocity of the toothed wheel, each image goes independently through the same periodic series of changes as when only one mirror is used; but owing to the unequal distance the period is not the same. If the speed of the mirror be carried to such a point that the difference of phase in the two images is half a period, then one image will be increasing while the other is diminishing, and the stage at which the two images are equal would appear to admit of fairly accurate determination.

The distant reflectors were separated from the observing telescope by the Firth of Clyde. The distances were respectively 16,835 feet, and 18,212 feet. A study of the printed descriptions of their experiments gives the impression that the performance of the subsidiary parts of the apparatus was not such as to do justice to the method. The resulting velocity of light was 301,382 kilometres per second, and the difference between the extreme results of twelve separate determinations was 4000 kilometres.

The most important result of the work of these gentlemen, could it be accepted, would be the establishment of a difference between the velocities of differently-coloured rays. We may regard it as quite certain, from the absence of any change in the colour of the variable star, β Persei, while it is increasing and diminishing, that the difference between the times required by red and by blue rays to reach us from that star cannot exceed a moderate fraction of one hour. It is quite improbable that its parallax is more than 0″·1, and therefore probable that its distance is 2,000,000 or more astronomical units. The possible difference between the velocities in question can, therefore, only be a small fraction of the hundred-thousandth part of either of them. No apparatus yet devised would suffice for the measurement of a difference so minute, and we are justified in concluding that the phenomena observed by Messrs. Young and Forbes arose from some other cause than a difference between the velocities of red and blue rays.

The present determination had its origin as far back as 1867. In his "Investigation of the Distance of the Sun," published in that year, the author introduced some remarks upon Foucault's method, and pointed out the importance to the determination of the solar parallax of repeating the determination of Foucault on a much larger scale, with a fixed reflector placed at a distance of three or four kilometres.[3]

From that time forward the subject excited the attention of American physicists, several of whom formed plans, more or less definite, for executing the experiments. As, up to the year 1878, no important steps in this direction had been taken, the author, in April of that year, brought the subject before the National Academy of Sciences, with the view of eliciting from that body an expression of opinion upon the propriety of asking the Government to bear the expenses of the work. The subject was referred to a Select Committee who, in January, 1879, made a favourable report on the subject, which was communicated to the Secretary of the Navy. On the recommendation of the Secretary, Hon. R. W. Thompson, Congress, in March following, made an appropriation of $5000 for the purpose, and the author was charged by the Department with the duty of carrying out the experiments.

In the meantime it became known that Mr. Michelson had made preparations for repeating Foucault's determination at his own expense, with the desirable improvement of placing the fixed reflector at a considerable distance. But before the reliability of Mr. Michelson's work had been established, the preparations for the present determination had been so far advanced that it was not deemed advisable to make any change in them on account of what Mr. Michelson had done. The ability shown by the latter was, however, such that, at the request of the writer, he was detailed to assist him in carrying out his own experiments, and acted in this capacity until September 1880, when he accepted the Professorship of Physics in the Case Institute, Cleveland, Ohio. After the departure of Mr. Michelson his place was taken by Ensign J. H. L. Holcombe, U.S.N., who assisted in every part of the work to the entire satisfaction of the projector until its close.

[1] "Astronomical Papers of the American Ephemeris," vol. i. part iii. Owing to an error in applying one of the corrections the result was given as 299,910 kilometres.

[2] *Philosophical Transactions*, 1878, p. 231.

[3] Washington Observations, 1865. Appendix ii.

PANCLASTITE

DR. SPRENGEL has sent us a reprint of a note sent by him to the *Chemical News* on this subject. After showing that these new explosives, so named by Mr. Turpin, are not original, he continues:—

"The 'beau idéal' of a detonating explosive is a mixture of 8 parts (88·9 per cent.) of liquid oxygen and 1 part (11·1 per cent.) of liquid hydrogen.

"In my paper of 1873 I say, p. 799:—'On referring to the foregoing table the reader will be reminded that peroxide of hydrogen is the highest oxygen compound known, while nitric anhydride is the compound which contains the largest amount of oxygen available for combustion (74 per cent.). But as this compound, as well as the next two, nitric peroxide (69·5 per cent. oxygen) and tetranitromethane (65·3 per cent. oxygen) are: at present: on account of their nature and their difficult preparation, mere chemical curiosities, my attention naturally turned to the fourth, to *nitric acid* (63·5 per cent. oxygen), which is a cheap and common article of commerce.'

"Now, when Mr. Turpin's attention turned to the second oxidiser on my list—to nitric peroxide—he found that this substance does *not corrode* metals, such as iron, copper, and tin under 356° F. (180° C.); and further, that combustible liquids, such as petroleum, carbon bisulphide, and nitro-benzene are readily soluble in nitric peroxide *without* rise of temperature. These are valuable properties, *first noticed by Mr. Turpin.*

"What was formerly a chemical curiosity is now an article of commerce. Nitric peroxide may be bought to-day at eighteenpence the pound, and I see ways and means of producing it a great deal more cheaply. Nitric peroxide is a yellowish liquid, heavier than water (sp. gr. = 1·451), and boils at 71° F. (22° C.), but may be kept like ether or similar volatile liquids. In France it is sent about in tinned-iron cans.

"Taking as a typical example a benzene-mixture—

$$C_6H_6 = 18{\cdot}4 = \begin{matrix} 17{\cdot}0\ C \\ 1{\cdot}4\ H \end{matrix} \Big\} = \begin{matrix} 62{\cdot}6\ CO_2 \\ 12{\cdot}6\ H_2O \end{matrix}$$

$$7\tfrac{1}{2}(NO_2) = \frac{81{\cdot}6}{100{\cdot}0} = \begin{matrix} 56{\cdot}8\ O \\ 24{\cdot}8\ N \end{matrix} \Big\}$$

for March 29, 1886, by Von Henri W. de Graaf, "Zur Anatomie und Entwickelung der Epiphyse bie Amphibien und Reptilien," wherein are described briefly (1) the development of the epiphysis, and (2) the structure of this part in the adult animal in certain amphibia and reptiles. An examination by means of sections at once revealed the fact that in Hatteria the epiphysis becomes modified in a manner more interesting than that found by Von Graaf to obtain in *Anguis fragilis*—the most modified form described by him.

The epiphysis apparently arises as a hollow outgrowth from the roof of the third ventricle (region of thalamencephalon), and in both amphibia and reptilia becomes divided into two parts—a proximal one remaining in connection with the brain, and a distal bladder-shaped structure—the two becoming in most cases completely separated from each other. In *Anguis fragilis* Von Graaf finds that the distal part loses all connection with the brain, and develops into a structure resembling a highly organised invertebrate eye with, however, the important and curious exception that no nerve is present.

In Hatteria a still more interesting modification takes place, the distal portion being, as in Anguis, modified to form an eye; but this, unlike that in the latter, is provided with a well-marked nerve.

Fig. 1 shows the structure of the eye. The whole is enclosed in a capsule of connective tissue (C); anteriorly a lens (L) is present, composed of cells whose nuclei are very distinct. The lens forms the anterior boundary of a vesicle, the walls of which are formed

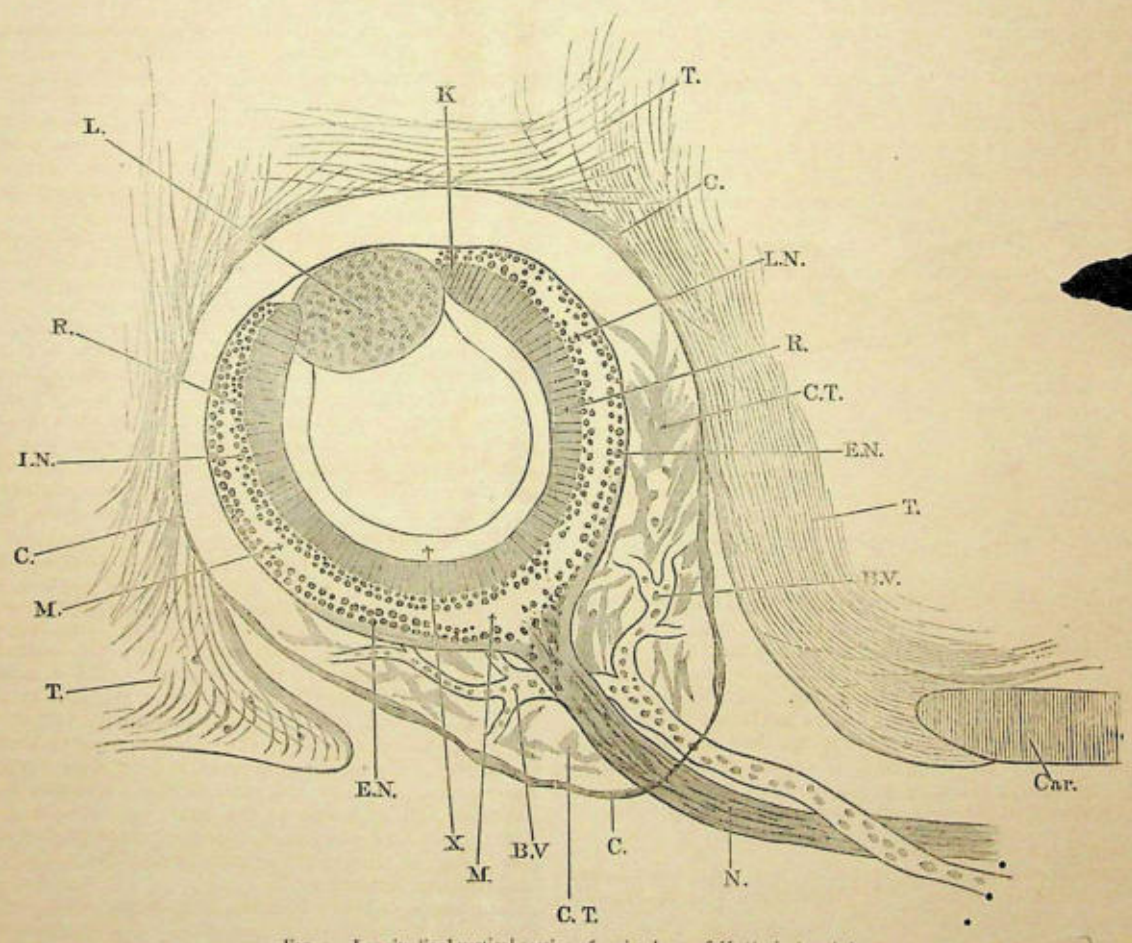


Fig. 1.—Longitudinal vertical section of parietal eye of *Hatteria punctata*.

from within outwards of the following layers:—(1) a layer which is not well marked (X), and which may possibly be due to the shrinkage and clinging to the walls of the contents of the vesicle, fluid in life; (2) a layer of rods (R) embedded in dark brown pigment, the pigment being specially developed anteriorly at the part indicated by the letter K; (3) a double or even triple row (I N) of nuclei; (4) a clear layer (M) which scarcely takes stain, and may be called the molecular; and (5) an outer layer (E N) of nuclei two or three rows deep.

This structure will, so far, be seen to correspond closely with that of Anguis.

Posteriorly a nerve enters the eye, the fibres spreading round behind the vesicle; the rods may be observed giving off processes from their external ends, which in some cases appear to pass right through the layers (3), (4), and (5), and in others to be connected in their passage with the nuclei of these layers.

However, I hope in a very short time to publish a detailed account of the histological structure of the organ.

The capsule containing the eye is filled posteriorly with connective tissue (C T), in which breaks up and ramifies a blood-vessel which enters along with the nerve (B V).

Fig. 2 represents somewhat diagrammatically a section transverse to the parietal foramen, showing that the eye is single and lies exactly in the median line. A depression of the skin of the head occurs immediately over the parietal foramen, but does not lead down into this, which is filled up by a plug of connective tissue (Fig. 1, T, Fig. 2, P T), specially dense (D T) around the eye-capsule. The nerve

is single, and leads downwards and backwards in the median line, being enveloped in the tissue passing from the foramen directly to the roof of the thalamencephalon.

I have not yet actually traced the nerve itself into the brain, but it is difficult to imagine that it can possibly arise as a branch from a cranial nerve, being *single* and *medianly placed*, and, as just said, enveloped in the material running directly to the roof of the brain from the foramen.

There can be little doubt that it represents the stalk connecting the distal with the proximal outgrowth from the roof of the thalamencephalon, this part having apparently disappeared in other reptiles and amphibia (so far as is yet known).

This being the case it is extremely interesting to observe that another instance will be added to that of the optic nerves in which an, at first, hollow outgrowth from the brain becomes solid and transformed into a nerve, and further that the latter, as in the former case, is connected with an organ of vision.

Though it is difficult to imagine what can be the use of the organ in its present state, seeing it is deeply embedded in connective tissue—so deeply as almost to

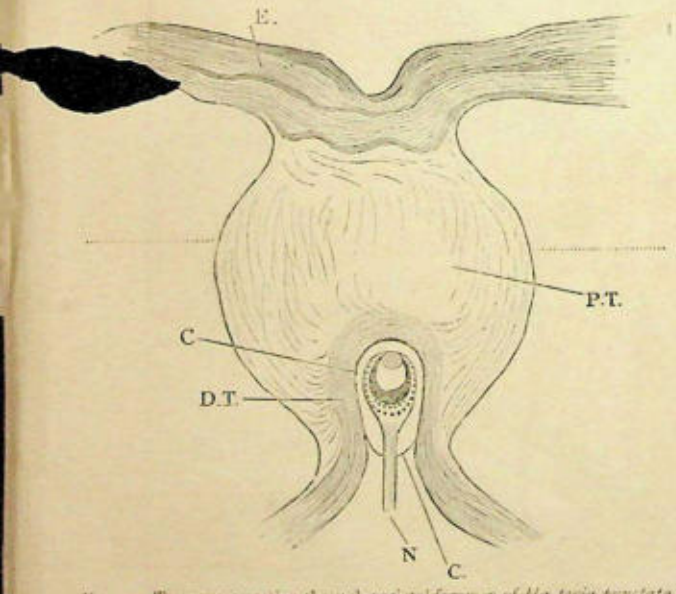


FIG. 2.—Transverse section through parietal foramen of *Hatteria punctata*. The part below the dotted line is situated within the parietal foramen.

preclude the idea of its being affected by light—yet it is important as showing in the same animal eyes developed in both the vertebrate and invertebrate type as regards the arrangement of the layers.

In connection with this subject, it is perhaps of interest to point out that in formation of the paired eyes invagination to form an optic cup takes place, whilst apparently it does not do so in the case of what may be called the *parietal eye*. A little consideration shows that the relative position of the rods depends entirely upon this invagination. In both cases they are formed upon the inner surface of the wall in the position corresponding to the epithelium of the neural canal: but in the one instance they are, by decay of the outer wall of the invaginated cup, placed apparently on the outside of the optic vesicle; whilst in the other instance they are formed in a similar position, but, as no invagination takes place and subsequent decay of one wall, they line the cavity of the vesicle. According to this we must suppose that the part of the wall where the lens is present has either disappeared or become modified into this.

We may further observe that in both types of eye the nerve enters into connection with the elements on the surface opposite to that on which the rods are developed.

In conclusion my thanks are due to Prof. Moseley for his kindness in drawing my attention to the subject, and to Mr. E. B. Poulton, of Keble-College, Oxford, who kindly placed two specimens of Hatteria at my disposal, and to Mr. Beddard, of the Zoological Society, for the use of another specimen.

W. BALDWIN SPENCER
Anatomical Department, University Museum, Oxford

NOTE.—Since writing the above I have found the eye present in several other lizards, notably in Iguana. *Chamæleo vulgaris* and *Lacerta ocellata*, and have traced the nerve into the proximal part of the epiphysis.

ASTRONOMICAL PHOTOGRAPHY[1]

SOME attempts made last year at photographing the heavens by means of an instrument quite rudimentary having yielded good results, the director of the Paris Observatory gave orders for the construction of a special apparatus, the design of which is shown in the accompanying figure (Fig. 1). The mechanical part has been executed in a highly remarkable manner by our accomplished artist, M. Gautier; the objective is our own production.

This new instrument is composed of two telescopes in juxtaposition inclosed in a single metallic tube in the form of a parallelopiped, and separated from each other along their whole length by a narrow partition.

One of the object-glasses, with an aperture of 0·24 m. and a focal length of 3·60 m., is intended for eye observation, and serves as a pointer. The other, with an aperture of 0·34 m. and a focus of 3·43 m., is achromatised for the chemical rays, and serves the purpose of photography. The optical axes of these two objectives being parallel, every star kept in the centre of the field of the eye-piece belonging to the first telescope produces its impression in the centre of the sensitive plate of the photographic apparatus.

The equatorial is mounted in the form called English, that is to say, the centre of the tube rests always in the polar axis of the instrument. This arrangement allows of a star being followed from its rising to its setting without involving the necessity of bringing the instrument back to the vicinity of the meridian. Like a common equatorial it is furnished with hour circle and circle of declination, and with a clock movement keeping the apparatus in operation for three hours without fresh remounting. There are, moreover, independent very slow movements, whereby the axis of the telescope can be kept on a fixed point in the heavens, notwithstanding some slight irregularity in the movement of the clockwork, the orientation of the telescope, or the variations of atmospheric refraction.

The photographic objective—the largest ever yet produced—is formed according to a simple achromatic system, and, though of an extremely short focal length, is able, without the use of any diaphragm, exactly to cover the very considerable field of 3° diameter.

Although but very recently mounted, this apparatus has already availed for the performance of numerous tasks. On star photographs it is possible to distinguish traces of stars of the 15th magnitude, too feebly marked, however, to bear transference on paper. The stars of the 14th magnitude are reproduced with a diameter of 1/40 of a millimetre.

It is obvious that such small points might be liable to be confounded with the impurities of the sensitive coating if the precaution is not taken to multiply the stationary points. Each star is formed by a group of three points constituting an equilateral triangle, each side of which is no more than 1/12 of a millimetre. To the naked eye these three points appear to merge into one, but on examining them with the aid of a somewhat

[1] From an article by the Brothers Henry in *La Nature*.

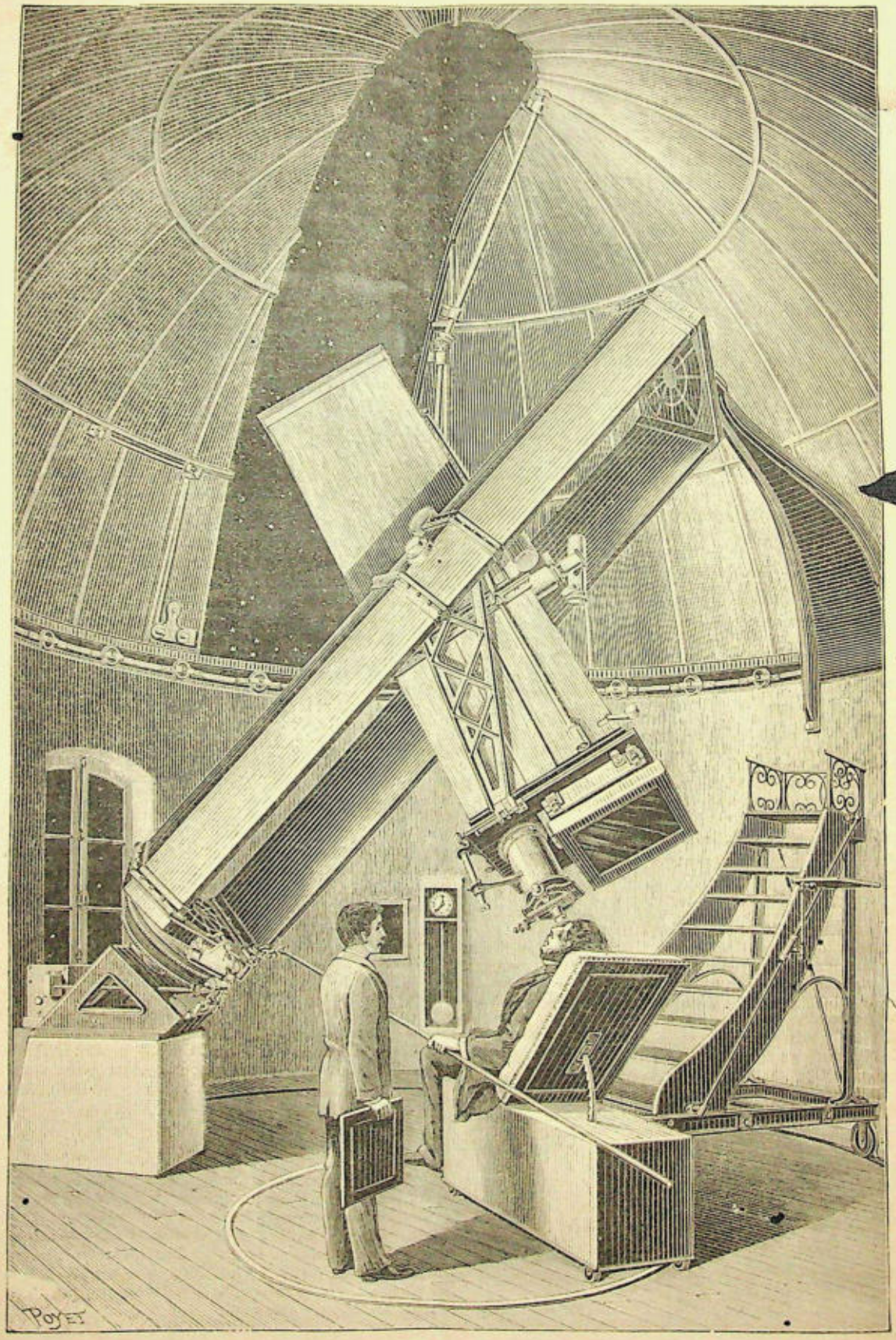


FIG. 1.—Parallactic apparatus newly established at the Paris Observatory for celestial photography.

powerful lens the three points come out distinctly, and it is then an easy task to eliminate all that does not belong to the heavens.

The construction of such a map, obtained by the apparatus as above described in three hours, would assuredly have demanded several months of assiduous labour by the ordinary processes.

The following is the time of exposure requisite to obtain the image of the stars.[1]

Magnitude		h.	m.	s.
1	... ...	0	0	0·005
2	... ...	0	0	0·013
3	... ...	0	0	0·03
4	... ...	0	0	0·08
5	... ...	0	0	0·2
6	The extreme limit of magnitude of stars visible to the naked eye	0	0	0·5
7	... ...	0	0	1·3
8	... ...	0	0	3
9	... ...	0	0	8
10	... ...	0	0	20
11	Mean magnitude of the asteroids	0	0	50
12	... ...	0	2	0
13	... ...	0	5	0
14	... ...	0	13	0
15	The last of the stars visible with the aid of the great instruments	1	23	0
16				

All the above figures represent a minimum. To secure reproductions on paper the time of exposure would have to be increased threefold.

The above table shows that the time of exposure required in taking a star of the first, and that in taking a star of the last magnitude differ from each other as 1 : 1,000,000. (The relation adopted between the brightnesses of two consecutive magnitudes is 2·542.)

Outside the construction of celestial maps, another field of study of great importance now created by photography may be cited, the discovery, namely, of the asteroids. The little stars fixing themselves on the plate as so many mathematical points, so to say, the planets are distinguished therefrom, each by a little line perfectly defined indicating its proper movement in amount and direction during the time of exposure of the apparatus. It is in this way we have already succeeded in obtaining the trace of a small planet of the 11th magnitude which by a small line extremely well defined gave account of its march among the fixed stars.

It will even be possible to study the movement of the satellites round their planet, and perhaps discover new ones.

The study of the double and multiple stars will be greatly facilitated, and photography will be equally available in the investigation of the parallaxes.

Finally, photometry must be adduced as one of the branches of astronomy which will now be able to collect very valuable information through the utilisation of photography.

In conclusion, it is worth while remarking how this fresh step in advance has sensibly enlarged the scope of man's vision. In consequence of it we can now obtain the image of a star, which instruments of the same opening as those employed by photography would never of themselves have elicited out of their invisibility.

PAUL ET PROSPER HENRY

NOTES

THE first *soirée* of the Royal Society this season took place last night. A large number of Fellows and visitors were present, and many objects of interest were exhibited.

THE visitation of the Royal Observatory by the Board of Visitors is fixed this year for June 5.

[1] For these results we have made use of the gelatino-bromide plates of Monckhoven.

THE Royal Irish Academy is celebrating the centenary of its foundation this week.

DR. GILL, Her Majesty's Astronomer at the Cape, has been elected Corresponding Member of the Imperial Academy of Sciences of St. Petersburg.

THE fifty-seventh anniversary meeting of the Zoological Society was held on Thursday week. The chair was taken by Prof. Flower, LL.D., F.R.S., the President. The report of the Council on the proceedings of the Society during the year was read by Mr. P. L. Sclater, F.R.S., Secretary of the Society. It stated that the number of Fellows on December 31, 1885, was 3193, showing a decrease of 62 as compared with the corresponding period in 1884. The total receipts for 1885 had amounted to 25,809*l.* 10*s.* 1*d.*, being a decrease of 3129*l.* as compared with the previous year. This decrease was mainly due to the falling off in the receipts under the head of admissions to Gardens, and in the amounts received for admission and composition fees from newly elected Fellows. The ordinary expenditure for 1885 had been 24,593*l.* 11*s.* 8*d.*, against 26,539*l.* 4*s.* 1*d.* for 1884. Besides that, an extraordinary expenditure of 491*l.* 0*s.* 6*d.* had been incurred, which brought up the total expenditure for the year to 25,084*l.* 12*s.* 2*d.* The visitors to the Society's Gardens during the year 1885 had been 659,896, against 745,460 in 1884. The Davis Lectures on zoological subjects, having been well attended during the past year, would be continued during the present season, beginning with a lecture on "Pigs and their Allies," by Prof. Flower, LL.D., F.R.S., on Thursday, June 3, at 5 p.m. The number of animals in the Society's collection on December 31 last was 2551, of which 756 were mammals, 1366 birds, and 429 reptiles. Among the additions made during the past year 21 were specially commented upon as of remarkable interest, and in most cases new to the Society's collection. About 36 species of mammals, 15 of birds, and 4 of reptiles had bred in the Society's Gardens during the summer of 1885. The report concluded with a long list of the donors and their various donations to the menagerie during the past year.

WITH regard to the recent explosion of the 43-ton gun, it is fortunate that it has happened without loss of life. Competent authorities, as seen from Col. A. Moncrieff's letter (which we reproduce from the *Times*) show that it could. How long are our gun factories to go on making guns condemned by easily-understood scientific principles? "Col. Maitland's interesting paper read at the Royal United Service Institution on June 20, 1884," Col. Moncrieff writes, "published the process adopted at Woolwich in settling the types of the new steel breech-loading ordnance for the British service, as well as the proportions of the new guns on these types then in process of manufacture. Mr. W. Anderson's investigations, published in a lecture read before the Society of Arts on January 29, 1885, and also commented upon in the *Engineer* of February 6, 1885, clearly demonstrated that these guns were deficient in strength in front of the trunnions. It is a remarkable fact that several of the guns have now burst at the point and in the manner which could have been predicted by any one consulting Mr. Anderson's demonstrated results. As the subject is of vital importance to the country, it would seem wise either to refute Mr. Anderson or accept his method and consult him; his valuable service in having discovered the prevailing error and worked out this most difficult problem is too little known; it would thus be utilised and acknowledged to the advantage of the service. By treating a gun as a heat-engine and accounting for every part of the energy generated by the explosion of the powder, he has, in a scientific and complete manner, proved that the metal crusher gauges from which the accepted curve of pressure is obtained are not to be relied on.

The form of the guns is adapted to the curve of pressure; that curve, as shown by Col. Maitland at the Royal United Service Institution, is wrong; the maximum pressure which is near the breech is known, but with the slow-burning powder in a long gun the total pressure, and the maximum pressure at any point of the bore, has never been accurately determined. If Mr. Anderson's conclusions carefully arrived at by calculation are correct, these guns are out of proportion between the trunnions and the muzzle, where the bursts have all taken place. Another branch of the same subject is the measurement of the energy of recoil, of much importance in designing disappearing carriages. In this branch, I can answer for it, that Mr. Anderson's conclusions tally with the practical result—a satisfactory proof of their correctness. His discovery is of great practical value in making gun-carriages of all descriptions, and has changed, once and for all, the previously accepted formulæ for the force of recoil given in the text-books, which often led to costly mistakes in construction. Mr. Anderson has been trying, since the publication of his lecture at the Society of Arts, to induce the Government to test the correctness of his views by means of the Sebert velocimeter, but without success. It must be admitted that in determining so important a matter, one on which the efficiency of our ships and a large national expenditure depends, it should be the first desire of every one to secure without delay the highest scientific and practical experience within reach, and to consult men who have devoted special study and research to the subject."

On April 30 there took place in Paris, at the Ministry of Public Instruction, a meeting of French astronomers. M. Faye was in the chair. It was decided unanimously to build three photographing telescopes. One of these is destined for the Algiers Observatory. The destination of the others will be determined upon when finished. The construction will take eighteen months.

M. Janssen has terminated the installation of the tubes for analysing the influence of the atmosphere on spectroscopic analysis, absorbing power, &c. Their length is 100 metres, and they can be filled with gas under a pressure of 100 atmospheres. The light is supplied by a battery of 60 Bunsen elements. Experiments are conducted on nitrogen, oxygen, common air, &c.

Herr Paul von Ritter, who died at Basle, has left to the University of Jena a sum of 300,000 marks, to be employed for the furtherance of zoological studies.

Canada is nearly the only important British colony without its Government Botanic Garden; the identity of its flora with that of the Northern United States rendering such an establishment of much less value than in most of our colonial possessions. But for some years past leading Canadians interested in horticulture have been exerting themselves for the establishment of a Botanic Garden at Montreal. Through the co-operation of the authorities of McGill College and the Council of the Montreal Horticultural Society, this object is now secured, and the "First Annual Report" of the "Montreal Botanic Garden" is issued. The Garden is not yet in existence; but a very favourable site of seventy-five acres has been secured in Mount Royal Park, a varied piece of ground admirably adapted for the purpose, on the slope of the beautiful mountain overlooking the city, from which it derives its name. An Act of Incorporation for the "Montreal Botanic Garden Association" has been obtained, wherein the objects of the corporation are stated to be "By the medium of a Botanic Garden and other accessories, to promote research in forestry and economic botany, and advance the interests of technical and general botanical knowledge." Among the means contemplated in the future for carrying out these objects we are glad to see the establishment of courses of lectures on special subjects and a laboratory for special research. We wish every success to the new Association, which solicits contributions in trees, shrubs, seeds, and publications.

At the last general meeting of the Folk-Lore Society, Capt. Temple read a paper on the science of folk-lore. At the conclusion he referred to terminology. Folk-lore, he said, is a fine English compound, but there is a sad want of an alternative, if only for the sake of useful and necessary derivatives. Folk-lorist and folk-loric are not pleasant forms, but students have been driven to use both. He suggests some classically-formed synonym, such as *demology*, *demosophy*, or *demonocy*—the last for choice—capable of easy development into passable derivatives, as being of practical use. Dogma has been appropriated already, or *dogmology* might, he thinks, answer, and *demodogmology* is too long. *Dokology* and *doksology*, as the study of fanciful opinions, are also suggested.

In a recent article in *La Nature* M. Martel refers to a discovery which he has made in the prehistoric caves in Lozère. For fifteen years past Dr. Prunières has prosecuted his investigations into the dolmens and neolithic grottos of the gorges of the Tarn, and has obtained some curious results on the fusion of a race of the age of polished stones and of an invading race of the Bronze Age. Last year in the cave of Nabrigas, M. Martel found in immediate contact with the remains of at least two skeletons of the *Ursus spelæus*, or Quaternary bear, nine fragments of human skulls, of which one left superior maxillary had three teeth, and a piece of rough pottery, not turned in a lathe. The question whether, in the Stone Age, man, the contemporary of the reindeer and the great bear, was acquainted with the use of pottery is much debated, eminent names being found supporting the negative as well as the positive. But (continues M. Martel) the curious point about the present find is that fifty years ago, before the birth of "prehistory," when the existence of even Quaternary man was contested, M. Joly found in this very cave of Nabrigas a fragment of a large vessel in contact with the skull of a fossil bear. M. Martel is strongly of opinion that the usual theory of the fortuitous contact of these objects does not apply here; there is no trace of any disturbance, nor are any other neolithic objects found, the skull is in its natural position,—for these and other reasons he is persuaded that fossil man of the palæolithic age was acquainted with the potter's art.

The fish-hatching season at South Kensington, accounts of which we have published from time to time, is now drawing to a close, although there are still half a million fry on view at the Exhibition which have not yet absorbed their *umbilical sac*. The various species of fish bred have been presented by the National Fish Culture Association to public waters in the vicinity of London and in the country, whilst the Fishery of the Association has been well stocked with fry.

The Thames Angling Preservation Society, which is ever ready to secure fresh supplies of fish for the Thames, have lately netted one of the ponds in Kew Gardens for this purpose.

During the present week large consignments of fish have arrived at the aquarium of the Colonial and Indian Exhibition from the south coast and North Sea. The latest arrivals consist of cod, lings, haddocks, crustaceans of various species, grey mullet, bream, and Salmonidæ. A large Ascension turtle has also arrived in the tropical department, measuring 4½ feet by 3 feet. Considering the protracted period it was out of the water during transit, its condition on being placed in the Chelonian tank did not evidence the slightest signs of diminished vitality, which is another proof of the hardihood and tenacity of life possessed by this species. The turtle tank now contains twenty large specimens of the green and hawksbill kind, all of which seem in good health notwithstanding the artificial existence to

which they are subjected. In contiguity to the tank is a miniature beach whereon the turtle rest when out of water. A consignment of turtle eggs is expected this week, which will be laid out in the hatchery on arrival for the purpose of incubation. Some West Indian tortoises have just arrived, together with a selection of snakes and lizards, which form interesting exhibits. In consequence of the inability of the Royal Commissioners to obtain Indian and Colonial fishes, the National Fish Culture Association have taken the matter into their own hands, and have made arrangements with the Zoological Society in Calcutta and other bodies for supplies of tropical and other piscatorial specimens, so that the aquarium will be supplemented with many rare and important specimens.

Mr. Otis T. Mason's account of the valuable Guesne collection of antiquities in Point-à-Pitre, Guadaloupe, which appeared in the Smithsonian Report for 1884, has recently been issued in separate form. The collection originated with M. Mathieu Guesne, whose series of Carib stone implements attracted considerable attention at the Paris Exhibition of 1867. Since then it has been continued, and all but completed, by the son, M. Louis Guesne, who has devoted nearly twenty years of assiduous labour to the task of rescuing from destruction all existing relics of the ancient Carib race in the Island of Guadaloupe. He has also applied his artistic skill to the illustration of these objects, filling two large albums with aquarelles in natural size and colour of all the types in his museum. From these sources Mr. Mason has mainly compiled the present account, which is enriched with no less than 215 carefully prepared woodcuts of the Point-à-Pitre collection, and of a few others introduced for the purpose of comparison, and to supply omissions in West Indian archæology. The collection includes roughly-worked stones, indicating an industry in its infancy; and others so perfectly finished that it would be difficult to improve upon them either in design or workmanship. But all alike belong to what would be called the Neolithic period in Europe; all the stone implements are polished, and there is not a single object of this class formed solely by being chipped. In fact, the volcanic materials of which they are made cannot be worked by chipping, like flint, quartz, or obsidian. Some, especially, of the axes are so small that they seem to belong to a race of pigmies, while others are so large and heavy that they suggest a generation of Titans rather than of human beings. Besides the movable objects, mention is made of enormous stones carved with strange designs resembling those described by Mr. Im Thurn in British Guiana, some so high up as to be almost out of reach, others close to the ground or buried under the surface. Similar inscribed stones occur in the beds of rivers in the Island of St. Vincent, the last refuge of the Caribs in the West Indies.

Herr Schöyen, in a paper recently reprinted from the *Transactions* of the Scientific Society of Christiania, describes a form of disease affecting the roots of growing barley, through which the farmers in Norway have of late years been suffering extensive loss. Contrary to the common opinion that the ravages due to this blight—which is popularly known as "Krog," crook, from the form of the deposits—were produced by an insect, Herr Schöyen maintains that this special barley-pest is a microscopic round worm, of the genus Tylenchus. After describing the appearance and character of the parasitic germs, which are deposited at the extremities of the roots, where their presence speedily manifests itself by the withering and death of the stalk before the grain can be set, he draws attention to the fact that similar deposits have been noticed on the roots of *Elymus arenaria*, the bind-grass so frequent on the Scotch, as well as the Norwegian, coasts. This observation derives special practical importance from the circumstance that at Lom, in Norway, where the barley crops have suffered most severely from the "Krog," the affected fields are in close vicinity to extensive tracts of *Elymus arenaria*. He proposes to continue his observations next summer with special reference to this point, but in the meanwhile he recommends as the only remedy available for the present that barley should not be re-sown on ground where the disease had manifested itself in the preceding season, nor in any locality where Elymus abounds. He finds that the bladder-like egg-cases of *Tylenchus hordei* can be thoroughly desiccated without destroying the inclosed worms.

Some interesting statistics of the Japanese press have lately been published in the *Oesterreichische Monatsschrift für den Orient*, in which the newspapers and periodicals of Japan are arranged according to the subjects with which they deal. It appears that 37 publications are devoted to matters connected with education, and that these have a total circulation of 42,649 per month. There are 7 medical papers, with a monthly circulation of 13,514; 9 relating to sanitary matters, with a circulation of 8195; 2 on forestry; and 2 on pharmacy. There are 7 devoted to various branches of science, with a circulation of 2528; but to these must be added 29 engaged in popularising science, with a total circulation of 70,666.

The additions to the Zoological Society's Gardens during the past week include a Purple-faced Monkey (*Semnopithecus leucoprymnus* ♀) from Ceylon, presented by Mrs. Larkins; a Brazilian Tree Porcupine (*Sphingurus prehensilis*) from Brazil, presented by Mr. J. E. Wolfe; two Sloth Bears (*Melursus ursinus* ♂ ♀) from India, presented by Mr. H. Mainwaring; a Burmese Squirrel (*Sciurus atrodorsalis*) from Burmah, presented by Mr. C. Crofton Black; a West Indian Agouti (*Dasyprocta cristata*) from West Indies, presented by Dr. A. Boon, F.R.C.S.; an Orange-thighed Falcon (*Falco fusco-cærulescens*) from Chili, presented by Capt. W. M. F. Castle, R.N.; five Senegal Parrots (*Pœocephalus senegalus*) from West Africa, presented by Mr. R. B. Sheridan; two Kestrels (*Tinnunculus alaudarius*), British, presented by Mr. J. S. Malcolm; a Wedge-tailed Eagle (*Aquila audax*) from Australia, presented by Mr. R. B. Colvin; a Tuberculated Iguana (*Iguana tuberculata*) from West Indies, presented by Mr. D. Morris; seven European Tree Frogs (*Hyla arborea*), European, presented by Mr. Thompson Hudson; a Californian Quail (*Callipepla californica*) from California, a Herring Gull (*Larus argentatus*), British, presented by Miss Hodge; a Two-banded Monitor (*Varanus salvator*), two Rat Snakes (*Ptyas mucosa*), an Indian Cobra (*Naia tripudians*) from Ceylon, presented by Mr. Carl Hagenbeck; a Moorish Toad (*Bufo mauritanica*) from Italy, a Green Toad (*Bufo viridis*) from Malta, presented by Mr. Alban Doran, F.R.C.S.; two Greek Tortoises (*Testudo græca*), European, presented by Admiral Mellersh; two Common Vipers (*Vipera berus*), British, presented by Mrs. Mowatt; a Small Hill-Mynah (*Gracula religiosa*), from Southern India, deposited; a Hog Deer (*Cervus porcinus*), seven Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

The Flexure of Meridian Instruments.—In a paper which forms Appendix III. to the "Washington Observations" for 1882, Prof. Harkness has made an exhaustive discussion of the subject of flexure, and the means available for eliminating its effects from star-places. He discusses separately the flexure of transit instruments and of vertical circles. The former are divided into two classes, according as their telescopes are straight or bent, but it is in the latter form that the effects of flexure are by far the greatest, the flexure-coefficients being in some instances as much as 0·55s. Prof. Harkness shows that the effect of flexure cannot be satisfactorily eliminated from the concluded right ascension of a star by simply taking the mean of the four results obtained by observing it directly and by reflec-

tion with the clamp of the instrument both west and east. It is better in his opinion to determine for each instrument the necessary corrections to be applied by means of the methods and formulæ explained in this paper.

In discussing the flexure of vertical circles Prof. Harkness compares Repsold's method of eliminating the flexure, by interchanging the object and eye-end of the telescope, with Bessel's method of attaining the same result by observing a star both directly and by reflection with the clamp successively west and east, demonstrating the superiority of the latter method, which appears to be the most satisfactory procedure hitherto devised for freeing an observed declination from the effect of flexure.

Prof. Harkness shows that when there are terms in the flexure depending on multiples of the zenith distance, they cannot in general be completely eliminated, and therefore that star-places derived from observations made with a single instrument are likely to be affected by systematic errors, which will appear when the work of different instruments is compared together. The detection and elimination of such errors can probably, Prof. Harkness thinks, be greatly facilitated by the use of equal altitude instruments of the zenith telescope class, which are so remarkably free from systematic errors.

THE SPECTRUM OF FABRY'S COMET.—M. Trépied having frequently observed the spectrum of this comet since April 7, gives (*Comptes rendus*, vol. cii., No. 18) the following account of it. The three usual cometary bands were seen, and as the brightness of the spectrum allowed a fairly narrow slit, 0·2 mm., to be used, the coincidence of these bands with those of the hydrocarbon spectrum could be very satisfactorily verified. Besides these bands there was also a continuous spectrum, but the remarkable feature of the case was that although the nucleus, which was very distinct and of a truly stellar appearance, appeared very bright as compared with the neighbouring portions of the coma, the band spectrum given by these latter and by the tail was much more brilliant than the continuous spectrum of the nucleus. This circumstance, which was also observed by MM. Thollon and Perrotin at Nice, had been remarked by M. Trépied in Encke's comet last year. He is therefore led to conclude that there is a predominance of gaseous elements in both these comets, and that, further, the relative brilliance of the nucleus of a comet is not necessarily in accord with the degree of condensation of the cometary matter.

On April 14 the bright bands could be easily detected in the spectrum of the tail to a distance of 20′ from the nucleus. The total length of the tail was then more than 3°.

TWO NEW COMETS.—Mr. W. H. Brooks, Red House Observatory, Phelps, New York, discovered two new comets in the last week of April, the first on April 27, the second on April 30. The former is described by M. Bigourdan as being on May 1 a round nebulous object, about 2′ in diameter, brighter towards the centre, but without a nucleus. The existence of a very faint nucleus was, however, suspected on the following night. On May 6 Lieut.-Col. Tupman estimated the comet as being of the 8th magnitude. Dr. H. Kreutz has computed the following elements and ephemeris for it:—

T = 1886 June 6·9585 Berlin M.T.

ω = 202 55′68
Ω = 191 48′58 } Mean Eq. 1886·0
i = 87 33′03
log q = 9·40752

Ephemeris for Berlin Midnight

1886	R.A.	Decl.	Log Δ	Brightness
	h. m. s.	° ′		
May 13	2 9 38	51 43·7 N.	0·1062	2·2
17	2 30 25	47 52·2	0996	2·9
21	2 49 32	43 25·9	0931	4·1
25	3 7 48	38 17·2	0865	6·2
29	3 26 26	32 15·3 N.	0·0794	10·0

The brightness on April 29 is taken as unity.

The second comet is described (*Astr. Nach.* No. 2728) by the Baron von Engelhardt as being very bright on May 3, although the evening was misty. The comet was visible in a bright field, and showed a circular nucleus, from whence proceeded a brighter offshoot, 2′ in length, in the direction of the axis of the tail. The tail was 8′ in length and very bright, narrow at first, but broadening by degrees, and curved with the convex side towards the north. A secondary tail, 6′ in length, faint, and bending towards the south, forked off from the principal tail about 6′ from the nucleus. The following elements and ephemeris are by Dr. E. Lamp:—

T = 1886 May 4·13040 Berlin M.T.

ω = 37 50′15
Ω = 287 22′88 } Mean Eq. 1886·0.
i = 99 47′53
log q = 9·92518

Error of middle place ($O - C$):

$d\lambda = +0'·19$ $d\beta = -0'·02$

Ephemeris for Berlin Midnight

1886	R.A.	Decl.	Log r	Log Δ	Brightness
	h. m. s.	° ′			
May 12	23 52 46	47 23·0 N.	9·9326	9·9924	1·0
14	0 5 38	51 23·8	9·9364	9·9980	0·9
16	0 20 38	55 10·5	9·9410	0·0056	0·9
18	0 38 9	58 39·8	9·9462	0·0149	0·8
20	0 58 38	61 49·5	9·9520	0·0255	0·8
22	1 22 15	64 35·6	9·9583	0·0373	0·7
24	1 49 21	66 55·8	9·9652	0·0501	0·6
26	2 19 47	68 48·4	9·9725	0·0636	0·5
28	2 52 55	70 11·7	9·9802	0·0775	0·5
30	3 27 37	71 5·8 N.	9·9881	0·0918	0·4

The brightness on April 30 is taken as unity.

NEW MINOR PLANET.—A new minor planet, No. 258, was discovered on May 4 by Dr. Luther at Dusseldorf, R.A. 15h. 20m., Decl. 9° 31′ S.; daily motion, R.A. − 48s., D + 7′; mag. 11.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 MAY 16-22

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 16

Sun rises, 4h. 8m.; souths, 11h. 56m. 9·3s.; sets, 19h. 44m.; decl. on meridian, 19° 9′ N.: Sidereal Time at Sunset, 11h. 22m.

Moon (Full on May 18) rises, 17h. 51m.; souths, 23h. 5m.; sets, 4h. 10m.*; decl. on meridian, 11° 22′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	3 34	10 24	17 14	9 7 N.
Venus	2 48	9 4	15 20	2 29 N.
Mars	12 23	19 13	2 3*	8 57 N.
Jupiter... ...	13 52	20 10	2 28*	2 53 N.
Saturn	6 37	14 49	23 1	22 49 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

May	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
17	... η Libræ	6	... 22 16	... 23 32	... 64 240
19	... 24 Scorpii ...	5	... 0 37	near approach	167 —
21	... *d* Sagittarii ...	5	... 22 1	... 22 57	... 19 266
22	... B.A.C. 6658 ...	6	... 5 2	near approach	206 —

Variable Stars

Star	R.A.	Decl.			h. m.	
	h. m.	° ′				
ζ Geminorum ...	6 57·4	... 20 44 N.	...	May	20, 2 20	*m*
V Virginis	13 21·9	... 2 35 S.	...	,,	17,	*M*
δ Libræ	14 54·9	... 8 4 S.	...	,,	16, 2 8	*m*
U Ophiuchi ...	17 10·8	... 1 20 N.	...	,,	16, 0 44	*m*
				,,	21, 1 30	*m*
X Sagittarii... ...	17 40·4	... 27 47 S.	...	,,	19, 2 25	*m*
				,,	22, 0 0	*M*
W Sagittarii ...	17 57·8	... 29 35 S.	...	,,	21, 21 40	*M*
β Lyræ...	18 45·9	... 33 14 N.	...	,,	16, 0 0	*m*
S Vulpeculæ ...	19 43·7	... 27 0 N.	...	,,	17,	*m*
η Aquilæ	19 46·7	... 0 7 N.	...	,,	19, 0 0	*m*
δ Cephei	22 24·9	... 57 50 N.	...	,,	20, 21 35	*m*

M signifies maximum; *m* minimum.

Positions of the Comet Barnard (for Berlin Midnight)

May	R.A. h. m. s.	Decl.	Log. Δ	Brightness
16	2 20 49	28 0 N.	9·682	284
18	2 35 41	23 17	9·637	318
20	2 53 8	17 23	9·596	349

GEOGRAPHICAL NOTES

AMONGST the members of the mission proceeding from India to Tibet, under the charge of Mr. Colman Macaulay, are Col. Tanner, surveyor, Dr. Oldham, geologist, and Dr. Cunningham, naturalist. The expedition will leave Darjeeling about the end of the present month, and, marching through independent Sikkim, will cross the Jalepla Pass into Tibet. Its destination is Lhassa, the capital. Once only has this city been visited by an Englishman, Thomas Manning, and practically the whole route lies through a *terra incognita*. As Mr. Macaulay bears letters from the Chinese authorities, for which he made a special journey to Pekin last year, it is not anticipated that he will meet with any obstacles on his way to, or during his stay on, "the roof of the world." The three scientific members of his mission will find abundance of work to do, and the news of the progress of the expedition may be looked for with interest.

THE new number of the *Journal* of the Royal Asiatic Society (vol. xviii., part 2) contains an interesting article by Mr. Morison, of Tiflis, on the geographical distribution of Turki languages. The following is a summary. Dividing Turki into five sub-branches—Turki proper, Nogai, Uigur, Khirghiz, and Yakut—he states that the various subdivisions of, first, Turki proper, are spoken by the ruling class of the Ottoman Empire and the inhabitants of Asia Minor, in the Governments of Nijni Novgorod, Kasan, Simbirsk, Viatka, and Orenburg, in Trans-Caucasia, and North-Western Persia; the Nogai in Bessarabia, the Crimea, Cis-Caucasia, the Volga Delta, North-Eastern Daghestan, Terek Valley, the north-western shore of the Caspian, the Governments of Kasan and Simbirsk, Astrakan, Orenburg, and Ufa; the Uigur in Yarkhand and Chinese Tartary, the country of the Tekke, Zarafshan Valley, and generally in Central Turkestan, in the Khanate and Desert of Khiva and south of the Aral Sea, and in Kuldja; the Kirghiz from the Volga to the confines of Manchuria, but most compact in South-Western Siberia; and the Yakut in North-Eastern Siberia and on the northern slopes of Mount Sayan. Broadly speaking, says Mr. Morison, the Ugro-Altaic languages, of which Turki is one, are spoken over a region extending through more than 100° of longitude, from the shores of the Adriatic to the Great Wall of China and the plateau of Tibet, and through 35° of latitude, from the frozen steppes of Samoyede and Yakut to the plains of Northern Persia and the head-waters of the Indus. The Turki alone, according to the figures given, is spoken, in one or other of its various forms, by more than 20,000,000 of people.

THE *Proceedings* of the Royal Geographical Society for May contains a paper by Mr. Carles on his recent journeys in Corea, accompanied by a very useful map of the peninsula. Some account of these journeys has already appeared in Parliamentary Blue-Books, but much is added in the present paper. The writer refers to the many different types found amongst the Coreans of the present day; the facial characteristics of the people greatly resemble those of the Manchus, but Jews, Japanese, and Caucasians appear to be universally represented. There is also a curious reference to evidence of some forms of religion other than those imported from China in the *mirok*, or half-length human figures carved in stone. Mr. Needham also contributes an account of an excursion to the Abor Hills from Sadiya in Upper Assam.

BARON MIKLUHO-MACLAY has just returned to Odessa from his journey to New Guinea, which has lasted two years. He has brought a large collection of rare fishes, lizards, snakes, insects, and so on, packed in twenty-two boxes.

ANOTHER Russian traveller, M. Goudatti, the Secretary of the Moscow Society of Friends of Natural Science, who has also just returned from his journey to the north of Siberia, gives a curious account of his failure to accomplish his purpose. The Ostiaks and Samoyedes took him for a Government official on a recruiting mission, especially when he attempted to measure their heads, and took notes in his note-book. Finally the book was stolen, and all the results of his efforts lost.

HERR RADDE, who had started in January last with a scientific expedition from Tiflis to the Transcaspian region, writes from Askabad lately that this spring was very unfavourable for his researches, being three to four months later than usual. Therefore up to the middle of April he had not succeeded in collecting more than 35 species of plants and about 150 birds. Amongst these latter there is an interesting novelty, the *Passer sindiacus*, a pretty bird living in the high shrubs of *Tamarix*. The explorer intends to proceed during the present month to the mountain region between the Murghab and Tejen, and to return to Askabad through Sarakhs.

THE May number of the *Scottish Geographical Magazine* has an interesting article by Mr. Tripp on the physical configuration and rainfall of South Africa, with notes on its geology, diamond and coal-fields, and forests. The paper is accompanied by two maps showing contours and mean annual rainfall. A note by M. Dingelstedt on geographical education in the schools of the Caucasus shows that in Russia primary instruction in geography is as defective as in England. It is not made attractive, the writer complains; it only taxes the memory; the text-books are written to match, and few teachers are equal to the task of interesting their pupils in the subject. There are some interesting notes on the place-names of Kinross-shire by Mr. Liddall, and on the seaboard of Aberdeenshire, by Mr. Ferguson. The geographical notes are particularly copious and comprehensive.

THE current number (Bd. xiii. No. 4) of the *Verhandlungen* of the Berlin Geographical Society contains only one paper—a lecture by Dr. Naumann on the Japanese Islands and their inhabitants. The *Zeitschrift* of the same Society (Bd. xxi Heft 2) is mainly occupied by a paper of Dr. Schweinfurth's on a journey which he made in the "region of depression" around Fayoum at the commencement of the present year. It is accompanied by a map, and fills 53 of the 65 pages forming the number. There is a short paper of great interest on the Maori population of New Zealand, based on the last census of that colony. The writer (who does not give his name) discusses the causes of the dying out of the race, and also the attitude of the Colonial Government towards the Maories. There is a note from Prof. Kunze on the climatology of South America, and, lastly, a long list of barometrical observations by Lieut. François in the Kassai region.

THE SUN AND STARS[1]

VI.

Summary of Results

IN what has gone before we have found that the prominences, and the spots, have special spectra unlike the ordinary spectrum of the sun, and unlike the spectra of the chemical elements.

Further, we know that when we proceed outwards to the spectra of the inner and outer corona we find ourselves very little better off, for, with the exception of hydrogen, there is no substance which is perfectly familiar to us; and finally, when we come to study the association of phenomena on the sun, we find that, exactly while the spots and prominences give us the greatest divergences from terrestrial conditions, solar facts indicate that these phenomena are allied in the most close and obviously important manner. We must henceforth consider that the spots and the metallic prominences and the faculæ represent different indications of the same solar action.

Now, to continue this part of the inquiry is fundamental for us. It is almost impossible to see a large spot at the edge of the sun, which is the place for observing it best, without finding this downrush towards the photosphere answered, so to speak, by an uprush from below the photosphere—without finding this downrush of cool, absorbing, dark-and-widened-line-producing material, re-echoed by an uprush of bright-lined substance.

There is one word which expresses, as well as anything I can think of, the impression which is made on one by the phenomena. There is a *splash*. Imagine an enormous cauldron of liquid iron, as hot as you like. Play some water into it from a hose; there will be a splash. The water, of course,

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from vol. xxxiii. p. 543.

would be very violently heated; we probably might get some explosions, and as the result of these explosions some liquid iron might be carried with the liquid water which has entered into the liquid iron here and there. The metallic prominences always are close to spots. They almost always follow them like the faculæ. I might have told you, in fact, while talking of this, that of 1100 cases in which spots and faculæ have been observed together, in 581 the faculæ were to the left of, or behind, the spots. Only in 45 were they on the right or in front. We shall see the importance of this by and by.

If we can invariably, as we do, associate the descent of material which, though we do not see it falling, we know is there, and that it is relatively cool—*if we can associate these descending absorption-phenomena with a subsequent upward splash*, we must look upon the most intensely active prominences as being return upward currents, though in some cases it may be that what we see as the spectrum of a prominence at the limb is, in part, that of the vapour descending to form a spot.

The Sunspot Period

The next thing we have to do is to discuss the periodicity of the various solar phenomena, to which attention has already been directed. It is worth while again to refer to the two very interesting and important curves in which Prof. Spörer has recorded the results of his own observations.

When the spots are at their fewest the small number we do see begin in a high latitude N. or S., from 30° to 35°; as the spots increase in number and activity we get, at the maximum sunspot period, the chief appearances observed in middle latitudes—about lat. 18°; and then the mean latitude of the spot zone still gets lower and lower, until at the next sunspot minimum we get two systems of spots—one of them, lowest in latitude (about 8° N. and S.), ending the first cycle, and another in latitude 30° beginning the next. These are the salient features of the periodicity to which we have now to confine our attention.

It has been previously pointed out that there are other periodicities with a much shorter period than eleven years; certain changes are seen to occur among the quiet prominences. Still this is the main periodicity with which we are familiar on the sun; and what we have now to do is to endeavour to see whether we can follow all the phenomena in their changes.

The two last maxima occurred in the year 1871 and eleven years afterwards in 1882 and some time after that year. At those times we got the greatest amount of spotted area and the most intense solar action. Similarly the two last periods of minimum activity were in 1867 and eleven years afterwards in 1878.

Now, in order to investigate this question in the most satisfactory manner, I think, and I doubt not you will agree with me, that we should begin with the simplest case.

The Minimum

The simplest case is evidently that in which the sun is quietest. At first sight it may appear a little hazardous to talk about the sun being at its quietest; but we know, as a matter of fact, that there is a tremendous difference at different times in the solar activity along the lines to which reference has been made.

But in the light of what has already been stated let us suppose the sun at its quietest, what phenomena shall we see?

There will be very few of the ordinary tree-like prominences anywhere on the sun, and especially will there be a dearth of them near the poles and near the equator.

There will be faculæ, but the faculæ will be dim; they will not present the bright appearance they generally do, and what there are will be mostly confined to the regions of latitude comprised between 29° N. and 29° S.

If by means of a spectroscope we attempt to determine the chemical materials in the chromosphere, we shall find just those five lines only to which we have referred in the spectrum as ordinarily visible—that is, four lines of hydrogen, and one line named D_3.

Practically speaking, there will be no spots visible upon the disk; the disk will appear to be perfectly pure, almost equally illuminated throughout, barring always the darkening towards the limb.

As there are no spots, or only very small ones in high latitudes, there will be, we can easily understand from what has gone before, no metallic prominences whatever. The spectroscope searching right round the limb of the sun will gather no indications of violent action—no region giving us many lines—nothing but that simple spectrum of hydrogen to which I have already referred.

What, then, is the appearance put on by the corona if we can manage to get an idea of a corona at the minimum sunspot period? We see, the moment that question is suggested, how excessively important it is that all eclipses should be observed, whether they occur at the maximum or the minimum of the solar activity. Fortunately, since the year 1860 these wonderful phenomena have been observed with more or less diligence; and since the year 1871—that is fifteen years ago now—with few exceptions, not only have those eclipses been observed by the eye with great care, but photographs of the extremest value have been obtained.

Unfortunately, that first minimum to which I have referred—the minimum in 1867—took place practically before the general introduction of this perfect photographic record of eclipses; and there is no good photograph extant of that eclipse; but fortunately, good photographs were secured of the eclipse of 1878. You can imagine our American cousins did not let an opportunity like that of advancing knowledge slip; and the result was that the whole land along the line of totality bristled with telescopes and cameras, which did their work in an admirable way. So that in the eclipse of 1878 we did get a photographic record, that is to say, an absolutely trustworthy record, of the appearance presented by the sun's corona at the minimum sunspot period. If it were not so, I should have hesitated to show you the drawing made in 1867; but I think you will say, when I show you these records together, that the drawing in 1867 is so like the photograph taken in 1878 that on that ground alone it is worthy of extreme confidence; and if we can accord such confidence to it, we arrive at the very important conclusion that at two different sunspot minima the appearances presented by the corona were very much alike indeed.

At the minimum period the chief feature is a tremendous extension of the corona in the direction of the solar equator. At both the poles, north and south, there is a wonderful curving

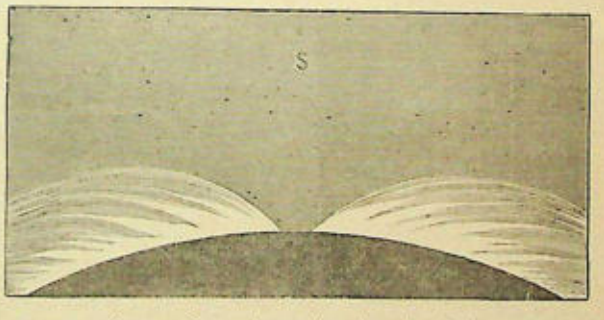


Fig. 19.—Outcurvings at the solar poles (1878).

right and left; this outcurving having been one of the most exquisite things which it is possible to imagine.

There is further evidence indicating that the equatorial extension on the photograph may only after all have been a part of a much more extended phenomenon, one going to almost incredible distances—considering it as a solar atmosphere—from the sun itself.

It has already been stated that at that eclipse one observer took extreme precautions to guard his eyes from being fatigued by the light of the inner corona, which sometimes is so bright that observers have mistaken it for the limb of the sun itself. What this gentleman, Prof. Newcomb did, was to erect a screen which covered the moon and a space 12′ high round it. The result was, that as soon as he took his station at the commencement of totality, he saw a tremendous extension of the sun's equator on both sides the dark moon, the extension being greater than that recorded in the photograph. It does not follow that the photograph gives us the totality of the extension; it may be that the extended portions may have been so delicately illuminated, that they would not impress their image on the photographic plate in the time during which that plate was exposed, or that the light itself is poor in blue rays. So considerable was this extension, amounting to six or seven diameters of the dark moon, which practically may be taken to be the same as that of the sun behind it, that Prof. Newcomb had at once suggested to him the zodiacal light. It happened that while this eclipse was

being observed by Prof. Newcomb and myself—we were practically close together at a height of 7000 feet—other observers were viewing the eclipse from Pike's Peak, some few hundred miles away, at a height of 13,000 feet. You can imagine the purity of the air at that height; there was not too much of it—so little in fact that some observers had to go down. These saw the corona very well indeed; and one or two observers, without taking the precaution of putting up a screen, saw an extension almost comparable with that recorded by Prof. Newcomb.

That, then, we must take to be the undoubted result arrived at during the eclipse of 1878, which happened at the last sunspot minimum. We have a tremendous equatorial extension; that is the great feature, and it is proved by photographs.

The drawing made in 1867 gives us the same result. We again get the equatorial extension east and west, and the wonderful outcurving right and left from the sun's poles.

Hence, then, we must associate a corona of that kind, *i.e.* having a considerable equatorial extension, with that quiet condition of things at the sun, during which metallic prominences, ordinary prominences, faculæ, and spots show a minimum of activity.

You will remember that we saw from the sunspot curve that from minimum to maximum it mounts rapidly, reminding one of a steep cliff. We have in fact only three years from minimum to maximum, while we have eight years from maximum to minimum.

The Approach to Maximum

We have then next to consider the solar condition between minimum and maximum. We must suppose ourselves to be [illegible]way up the steep part of the curve that connects the maximum with the minimum. In this case we find a greater activity in all directions. The hydrogen—or the quiet—prominences are more numerous. The faculæ are brighter. If we now examine the chromosphere we find hydrogen and D^3 are not the only constituents—we get those other short lines added of which Prof. Tacchini has given us such a valuable list, among them chiefly being those three lines of magnesium which are designated b^1, b^2, b^4. That is the chemical difference between the chromosphere of the sun at this time, and the first period at which we considered it. The spots also are more numerous, and what spots there are we have in a lower latitude; instead of making their appearance in latitude 35°, they will be nearer latitude 25°—they will have come down 10° from the solar poles towards the equator. These more numerous spots will also be constantly accompanied by metallic prominences, and the number of lines visible as bright lines in these prominences we shall find increasing as the observations are made month after month.

How about the outer atmosphere of the sun? Well, remarkable changes begin to take place in it too. In considering the minimum corona I said nothing about its spectrum, for the reason that I wished that wonderful bilateral and symmetrical and simple form to rivet the attention. But now it is right that I should say that one of the chief changes between this corona as the maximum is approached and the minimum one is not only the change of form to which I shall have to draw attention, but a change in the spectrum. At the minimum sunspot period the corona gives exactly, or very nearly exactly, the same spectrum as the lime-light or a jet of gas—we get very nearly a continuous spectrum. The chief difference between the spectrum of the corona, then, and the spectrum of the gas jet, is that in this continuous corona spectrum certain dark lines will be seen, but no very obvious bright lines are there. We therefore have to come to the conclusion that at the minimum the corona is not chiefly gaseous in its spectrum, but that it consists of solid particles to a very large extent; and that these solid particles are not only competent to reflect light, but that they actually do reflect light coming from the lower portions of the sun; and in that way we account for the presence of the Fraunhofer lines.

But when we come to the second period we are now discussing, these change to a very large extent; the spectrum is no longer continuous; bright lines begin to make their appearance, and with this coming-in of bright lines comes in a greater brilliancy.

And then as to the sun. The diagram is copied from a drawing taken in the year 1858, at exactly the right period to illustrate any change which may have taken place on the approach to maximum. Unfortunately it is not a photograph. Those who lecture in this theatre twenty or a hundred years after me will be under many better conditions than we are, because they will have a more complete series of photographs to refer to; but in the absence of photographs we must do the best we can. Strange though the drawing is, it brings together so many features seen in other eclipses, that there is very little doubt that it is near the truth. However that may be, it must be acknowledged that between the last drawing you saw and this

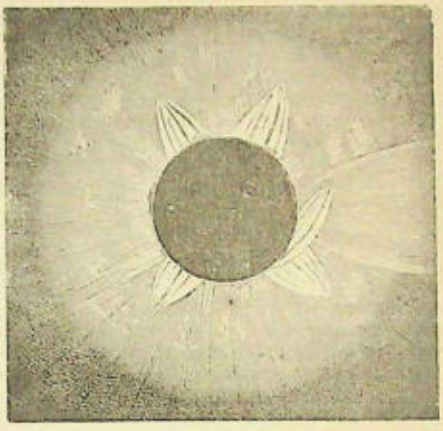


Fig. 20.—Corona of 1878.

there is a most enormous difference. The remarkable point about it is that we have no special feature in the equatorial zone: we get a streamer here with very strange outlines, and we get another there, but the point of this drawing is that we get in middle latitudes, north and south, four wonderful luminous cones, and the amount of light and structure in the corona has increased to such an extent, that that exquisite, that beautiful tracery and double curves—curves east and curves west—we saw at both poles at the minimum, are now hidden in a strong radiance. So much then for the second act, so to speak, in this solar drama.

The Maximum

We next deal with the maximum period when all the solar forces are working full time, and when we get both in prominences and in spots, and indeed in every outcome of action that we can refer to, indications of the most gigantic energies at work, and the most wonderful changes produced; energies and changes displayed from one pole of the sun to the other. When we come to this period of enormous action, we shall find that, although it becomes more general in one sense, it is really more limited in another.

The ordinary prominences, instead of clinging to the equator as they have done previously, are now found to be most frequent at the solar poles; the faculæ are brighter and more spread over the solar surface than they have ever been before. The chromosphere is richer in lines.

The spots occupy broad zones, the mean latitude being in about 18° N. and S. No spots near the poles, no spots near the equator, but spots indicating enormous activity and of enormous area, surrounded by gigantic faculæ, will be seen following each other in these zones. We shall find every one of these indicators of solar activity accompanied by enormous prominences. It is at this time we get the greatest velocities of upthrow in the prominences, and the greatest indications of tremendous downward velocity in the vapours which form the spots. It is at this time we get the spots riddled by bridges of intense brilliancy, full of veiled tints, red, yellow, blue, and violet, and all those other more delicate and beautiful phenomena described by M. Trouvelot and others, to which I have drawn attention.

How about the outer atmosphere of the sun? What has happened to that? Here, fortunately, we have the photographic records of two years—of two maximum years—to study. In these records there is no doubt that we have a thing which is absolutely and truly solar, for the reason that the photograph has undoubtedly, I think, sifted out what may be considered as due to non-solar causes. I say this distinctly, because I was fortunate enough to see both of these eclipses, one in India, and one in Egypt, and certainly there were things which I saw with the

naked eye which one does not see in the photographs. We will consider the eclipse of 1871 first.

We see in a moment that we have something here at the maximum sunspot period different from what we have had before. To compare it with the record of the preceding minima in 1867 and 1878. Instead of having streamers limited to the equator, they exist in high latitudes, and instead of having them limited to four chief maxima, as we had in the year after the minimum in 1868, the energy is now so great that they practically extend to every part of the sun.

The directions of the lines of force, as they may be called, are very various: there are straight rifts; there are curved boundaries; here another streamer is curved bodily, and so we go on. We must always remember that in this photograph what we see is, after all, a projection. We have the spherical moon in front of the spherical sun, from which these streamers project in all longitudes—some straight towards the earth, the tips of which are seen over or under the moon, some more sideways from parts of the sun nearer to or further from the eye than the central section, so that the unravelling of the appearances is very difficult, especially if the eclipse happens when either the sun's north or south pole is tipped towards us or away from us to the greatest extent.

So much for 1871: in another eleven years we have another maximum—that of 1882—an eclipse seen in Egypt. In this case we find the activity more general than in the former one. The top and the bottom of the diagram represent the north and the south poles of the sun as before; but we see now that the streamers are more broken up, and furthermore that the rifts visible round the north and south pole at the previous maximum are entirely covered up—not that the rifts were not there, but that one could not see them in consequence of the extreme brilliancy of the streamers that were thrown towards the eye from the sun between us and the plane passing through the solar poles.

Independently of that, it is easy to recognise that there is a tremendous family likeness between the photographs taken at both maxima, whereas there is the greatest possible difference between either of them and the drawings or photographs taken at the minimum sunspot period. If we accept that, that is a very great step gained.

After Maximum

We need not, after what has gone before, take up any more time, which is short, by discussing the gradual descent to minimum. I say the *gradual* descent because we know there are more years consumed in going from maximum to minimum than from minimum to maximum.

Of course all the various energies slacken down, the mean latitude of the spots and metallic prominences still getting lower till they reach lat. 8° N. and S.; then another series of spots breaks out in lat. 35° N. and S., and the whole story begins anew.

Summary

Now let us deal with the results we have arrived at. At the maximum period the continuous spectrum of the corona gives way almost entirely to a spectrum of bright lines. When I say gives way almost entirely, I mean so far as this: the striking thing when you observe the spectrum of the corona at the maximum period is a series of brilliant lines, or of brilliant circles, according as we use a slit, or simply look through a prism, and the brilliancy of the spectrum seen between these lines or rings is small compared with the brilliancy of the lines or rings. That indicates that the temperature of the gases in the corona is greater than the temperature of the other substances, and of course is very much higher than it is during the time of the minimum, when the gases do not make themselves visible, and, as I said before, the chief spectroscopic effect obtained is the continuous spectrum with dark lines here and there, showing that some part of the light is derived from cooled solid particles which can and do reflect light from the subjacent photosphere.

To deal with results, and to bring them together as sharply as may be, we find, first, that the dimness of the light and absence of bright lines at the minimum shows that the outer atmosphere of the sun is cooler at the minimum sunspot period. When I was in America in 1878, at the period of minimum to which we have referred, I saw at once that the corona was not anything like so brilliant as I had seen it previously in 1871 in India. Eventually, when the observations came to be discussed, the conclusion arrived at was that the brilliancy was not one-seventh of what it was at the previous maximum. There is a very considerable difference which no one can mistake who observes one eclipse after another.

Secondly, when the corona is thus cooler, and therefore dimmer, an extension in the plane of the sun's equator is seen. A question arises here whether this extension is not seen at the maximum because the eye is so much affected by the very brilliant corona? That is a subject which will require to be investigated in subsequent eclipses.

Thirdly, there are plenty of minor prominences at the minimum sunspot period; there are no spots, or very few.

Fourthly, the lower temperature, and therefore relative quiescence, of the solar atmosphere seems to depend on the absence of spots. That is an important matter; and the point I wish to make is this: the quietude cannot depend on the absence of prominences, because they are there—not so many of them, but still some prominences.

Fifthly, when the spots begin in these higher latitudes, 30° or 35°, as we have seen, we get the first brightening of the corona.

Sixthly, the coronal streamers follow the spots—by which I mean that the cones and coronal streamers put on their greatest intensity according as the spots have moved nearer to the equator. When we have the minimum sunspot period, you can hardly call that equatorial extension a streamer at all, because it is so very dim; and further, I take it, it is really of a different nature and origin.

The Circulation in the Sun's Atmosphere

If we make an attempt to discuss the circulation of the atmosphere, a question which we acknowledge to be an extremely difficult one, we must bear in mind the enormous difference between solar and terrestrial conditions. When a portion of the earth's surface is heated in a whole zone—as the equator is in the tropics—by the sun, you see the heat is outside, an ascending current is formed, and winds from north to south set in. For instance, if we consider the equator, and suppose the sun to be over it, we get the earth's atmosphere over that region more highly heated than those parts of the atmosphere near either pole; and the result is, we get an indraught current in that way, both from the northern and southern hemispheres. In consequence of these two currents meeting and beginning their ascent at some distance from the equator, we get a belt of calms, of reduced pressure, and we get almost perpetual rains.

Now, you see, that is all very well as a piece of terrestrial meteorology, but it is of no value to us from the solar point of view, unless it sets us thinking how very different the conditions are.

The sun cannot be heated from the outside. We have seen, in fact, that one chief point about the sun is that it is cooled on the outside; that masses of gas going up to tremendous altitudes eventually arrive where the atmosphere is cold and quiet, and where they again take on the solid or liquid forms, when they begin to go down again. Now the sun, if it is heated at all, must be heated from the inside. What do I mean by the inside? I mean—seeing that the phenomena we have been discussing in these lectures take place outside the photosphere—that the inside must be something below the level of the photosphere. Now what form must that heat take? It will take, as undoubtedly we see in the metallic prominences it does take, the form of the ejection of the tremendously brilliant and incandescent vapours. How are these produced? Something must produce them; they do not ascend of their own sweet will, or they would not come up so locally as we see them.

We get this fact most indisputably, which I hope I have been able to make quite clear, that these ascents of vapours from below the spot region always accompany the spots, and they always follow the spots in time. Then is it not reasonable to suppose they are produced by the spots? You remember I objected to the word "eruption" in connection with these prominences. I do not so much object to the word "explosion," for I cannot understand how if you get twenty million tons of meteorites falling down in a particular latitude of the sun, and plunging into the photosphere—I do not understand how there must not follow after that the most gigantic and terrific explosion, driving heated gases many hundreds and thousands of miles into the upper air along the line of least resistance, and disturbing the photosphere for months afterwards. Now that really does seem to be the plain English of what happens.

I have told you that in the origin of the spots the first disturbance is the formation of a few little openings probably by the advanced guard of the falling solid material. In a few days, by the continuous downpours, these develop into a spot. This spot is followed by a metallic prominence sending up the masses of gas at the rate, may be, of 250 miles a second—a rate Prof. Young has observed; and after that the faculæ appear. I throw that idea out because the greatest prominences are associated with the greatest spots; the spots begin the disturbance, and the energies radiate from the point where we first see the disturbance, which, I repeat, the spot begins.

We see, then, that on the sun the action will be almost just the opposite of what it is on the earth. We get first of all the descent of cooled matter on to the part of the sun where the disturbance begins.

Here we get ascent in consequence of greater heat outside. At the sun the greater heat inside the sun is liberated by the splash and explosion of spot-producing material.

Now, when the material falls in the way we have indicated, we shall get, if the idea is true, a considerable temperature in the region above the fall accompanying the return current in the shape of prominences. We may probably also get a current in the lower atmosphere set up towards the north and towards the south, and another thing we shall certainly get will be a tremendous brightening of this part of the solar atmosphere.

One of the great differences between one part of the solar atmosphere and another depends upon its temperature; so that you must imagine that the moment we get any great change in the temperature of any part of the atmosphere we must get a great change in its brilliancy, even in the higher regions: this may explain the streamers.

If there are these lower currents towards the poles there will probably be upper currents away from them which may in some way locate spot-forming material over the spot zones. On this subject, however, which, though one of the most important in solar physics, is one in which we see our way least clearly, I have not time to enter. J. NORMAN LOCKYER

(*To be continued.*)

THE INSTITUTION OF MECHANICAL ENGINEERS

THE Institution of Mechanical Engineers held their annual meeting, under the presidency of Mr. Jeremiah Head, at the Theatre of the Institution of Civil Engineers, on the 6th and 7th inst.

Mr. T. B. Lightfoot read a paper on refrigerating and ice-making machinery and appliances. He commenced by describing a complete refrigerating machine as an apparatus by which heat is abstracted, in combination either with some system for renewing the heat-absorbing agent, or, as is more usually the case, with a contrivance by which the abstracted heat is rejected and the agent is restored to a condition in which it can again be employed for cooling-purposes.

The first method by which heat is abstracted by the rapid fusion of a solid is probably the oldest. It depends upon the very strong tendency of mixtures of certain salts with water or acids, and of some salts with ice—which form liquids whose freezing-points are below the original temperatures of the mixtures—to pass into the liquid form; heat is absorbed more quickly than it can be supplied from without, and the temperature consequently falls. This method has been mainly employed for domestic and laboratory purposes.

When heat is abstracted by the second method, that is, by the evaporation of a more or less volatile liquid, other things being equal, the liquid with the highest latent heat will be the best refrigerant, because for a given abstraction of heat, the least weight of liquid will be required, and therefore the power expended in working the machine will be the least. There are four different kinds of processes employed.

The first, in which the refrigerating agent is rejected with the heat it has acquired, is generally known as the vacuum process. Water, the only agent cheap enough to be employed, must be reduced to a pressure below 0·089 lb. per square inch, which is the pressure of water-vapour at the temperature of melting ice. A vacuum-pump is employed, combined with a vessel containing strong sulphuric acid, for absorbing the vapour from the air drawn over, and so assisting the pump. Lately an improvement has been effected in this process by the employment of a pump with two cylinders and intermediate condenser, the water being admitted to the ice-forming vessels in fine streams, so as to offer a large surface for evaporation. The second, or compression-process, is used with liquids whose vapours condense under pressure at ordinary temperatures. The first apparatus employed, though in some respects crude, is yet the parent of all compression-machines used at the present time, the improvements being generally in matters of constructive detail. The water to be frozen was placed in a jacketed copper pan, the jacket being partially filled with the volatile liquid, and carefully protected on the outside with a covering of non-conducting material. A pump drew off the vapour from the jacket, and delivered it compressed into a worm, around which cooling water was circulated, the pressure being such as to cause liquefaction. The liquid collected at the bottom of the worm, and returned to the jacket through a pipe, to be again evaporated. Most modern machines comprise a refrigerator, a water-jacketed pump, a condenser, and ice-making tanks containing moulds or cells, around which brine cooled to a low temperature in the refrigerator is circulated by means of a pump. The working pressure in the refrigerator depends upon the reduction in temperature desired, the higher the pressure the greater being the work that can be got out of any given capacity of pump. The liquefying pressure in the condenser depends on the temperature of the cooling water, and on the quantity that is passed through in relation to the quantity of heat carried away; this pressure determines the mechanical work to be expended. To produce transparent ice, the water has to be agitated during freezing, so as to allow the air to escape. Various refrigerating media have been used, such as ether, sulphur dioxide, and anhydrous ammonia. The third is known as the absorption process: the principle employed is chemical or physical rather than mechanical, and depends on the fact that many vapours of low boiling-point are readily absorbed by water, but can be separated again by the application of heat to the mixed liquid. Taking advantage of the fact that two vapours, when mixed, can be separated by means of fractional condensation, an absorption machine has been brought out in which the distillate was very nearly anhydrous. Ordinary liquid ammonia of commerce was heated, and a mixed vapour of ammonia and water was driven off. By means of vessels termed the analyser and the rectifier, the bulk of the water was condensed at a comparatively high temperature and run back to the generator, while the ammonia passed into a condenser, and there assumed a liquid form. The nearly anhydrous liquid was then evaporated in the refrigerator in the ordinary way; but, instead of the vapour being drawn off by a pump, it was absorbed by cold water or weak liquor in a vessel called an absorber, which was in communication with the refrigerator, and the strong liquor thus formed was pumped back to the generator and used over again. In the fourth, which is known as the binary absorption system, liquefaction of the refrigerating agent is brought about partly by mechanical compression and partly by absorption; or else the refrigerating agent itself is a compound of two liquids, one of which liquefies at a comparatively low pressure, and then takes the other into solution by absorption. An interesting application of this system has been recently made by Raoul Pictet, who found that, by combining carbon dioxide and sulphur dioxide, he could obtain a liquid whose vapour-tensions were not only very much less that those of carbon dioxide, but were actually below those of pure sulphur dioxide at temperatures above 78° Fahr. This very remarkable and unlooked-for result may open up the way for greater economy in ice-production.

The third method is that in which machinery is used by which gas is compressed, partially cooled while under compression, and further cooled by subsequent expansion in the performance of work, the cooled gas being afterwards used for abstracting heat. This method has been much employed of late years, under the title of "Cold-air machines" for the preservation of meat and other perishable food. The author has designed machinery of this class, in which a weight of 1000 lbs. of air per hour can be reduced from 60° above to 80° below zero Fahrenheit, with cooling water at 60° F., with the expenditure of about 18 indicated horse-power. The air after being compressed in the compresser passes to the coolers, which consist of a couple of vessels containing tubes, through which water is circulated by a pump. The compressed air passes through one cooler and returns through the second, being cooled to within 5° or 6° of the initial temperature of the cooling water, which circulates in a direction opposite to that of the air. From the coolers the air passes to

the expansion cylinder, and after performing work upon the piston, and returning about 60 per cent. of the power expended in its compression, it is exhausted, having been cooled down from 70° above to 90° below zero Fahr. Besides its application to the importation of dead meat, live cattle, &c., an interesting application was made last year in the construction of a tunnel through a hill in Stockholm, in the excavation of which, some running ground was met with, consisting of gravel mixed with clay and water, which it was determined to freeze. The innermost end of the tunnel next the face was formed into a freezing-chamber by means of partition walls, which were made of a double layer of wood filled in between with charcoal. The temperature of the freezing-chamber was generally from 6° to 15° below zero Fahr. after twelve hours' running, but soon rose to freezing-point when the men began to work. The tunnel was driven through its length of 80 feet with entire success, the daily progress averaging about 1 foot.

A paper on the distribution of the wheel-load in cycles, illustrated by means of fifty-six figures, was read by Mr. J. Alfred Griffiths. The author gives the following five points of efficiency as applying to cycles generally, viz. reduction of dead weight by the avoidance of very large wheels and of heavy or purely ornamental or unnecessary framing; reduction of resistance by avoidance of very small wheels, and by employment of the best designs in bearings and in driving-mechanism for the diminution of internal friction; perfection of load distribution by entire avoidance of wheels that neither transmit motive-power nor assist the steering, and by concentration of the load on the driving-wheels and reduction of that on the steering-wheels; stability when at rest and when in motion on the straight and round curves, when on a smooth surface and also on a rough and lumpy road, and when the brake is applied either suddenly or gradually; arrangement of load and driving-mechanism so that the distribution of the wheel-load shall be as good on rising or falling gradients as on a level. Tables of dimensions and distribution of wheel-load were appended.

A paper on the raising of the wrecked steamship *Pier of the Realm*, which was effected by the platforming method, and without the aid of divers for any part of the operation, was read by Mr. T. W. Wailes, of Cardiff.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The Council of Somerville Hall have decided to build additional rooms for twenty students. Two Entrance Scholarships of 35*l.* and 40*l.* a year are offered for competition on May 25.

SCIENTIFIC SERIALS

American Journal of Science, March.—Examination of Dr. Croll's hypothesis of geological climates, by Dr. A. Woeikof. The author subjects Dr. Croll's theories to a searching criticism, traversing all his fundamental principles. The statement that the ocean must stand at a higher *mean* temperature than the land is shown to be quite erroneous, the oceans which receive cold currents from Polar seas, and even seas like the Mediterranean and Red Sea, which receive no such currents, having a mean temperature considerably lower than the continents. His whole system of estimating temperature breaks down when seriously tested, the errors being enormous, in some cases upwards of 100° F., or greater than the difference of annual temperature between the equator and the North Pole. His hypotheses, although brilliant and fascinating, cannot be accepted, the main points on which they rest being opposed to the most certain teachings of meteorology, and the whole fabric in its explanation of glaciation and geological climates generally being entirely fallacious.—Tendril movements in *Cucurbita maxima* and *C. Pepo* (concluded), by D. P. Penhallow. The author concludes generally that growth is promoted by an increase of temperature and humidity, but may be retarded by an increase of temperature when other conditions are unfavourable. It is also retarded by excessive transpiration, while the conditions favourable to growth, arising from temperature and humidity, may cause greater growth during the day in opposition to the retarding influence of light. Movements of tendrils and terminal buds, being phenomena of growth, are modified by whatever variations of condition affect growth.—Note on a method of measuring the surface-tension of liquids, by W. F. Magie. It is shown that Poisson's formula determining approximately the height of a large liquid drop standing on a level plate holds good, without any change, for a bubble of air formed in a liquid under a level plate.—Remarks on W. B. Rogers's "Geology of the Virginias" (continued), by J. L. and H. D. Campbell. In this concluding paper the authors deal with the most salient points in the higher formations of the geological system of Virginia and West Virginia. Their remarks, based mainly on personal observation, are intended to be supplementary to Mr. Rogers's comprehensive treatise on the geology of this region.—Observations on the Tertiary of Mississippi and Alabama, with descriptions of new species, by D. W. Langdon. An important result of these observations is the establishment of the relation of the Jackson beds to the Orbitoides limestone and marl beds of Byram Station. The new species, which will be figured in the forthcoming Report of the Geological Survey of Alabama are: *Verticordia eocenis*, apparently the first Verticordia described from this epoch; and *Bulla* (*Haminea*) *aldrichi*, an elongate oval shell resembling *Bulla glaphyra*, Desh.—On the area of Upper Silurian rocks near Cornwall Station, Eastern Central Orange County, New York, by Nelson H. Darton. The paper contains a careful study of the Towsend Iron Mine district and vicinity, where a small mass of Lower Helderberg limestone has been protected from the general denudation by a firm backing of coarse strongly cemented sandstones. The whole forms a ridge running just west of Cornwall Station, its more prominent geological features being shown on the accompanying map.

Rivista Scientifico-Industriale, March 15.—On the crepuscular lights that followed the Krakatão eruption, by Prof. Alessandro Sandrucci. The author surveys with Hirn the various theories propounded to explain this phenomenon, and rejects them all as inadequate, or else based on impossible assumptions. He concludes that for the present the after-glows must be classed with the numerous effects the causes of which have not yet been fathomed.—On the origin of atmospheric electricity, by Prof. Luigi Palmieri. A simple experiment is described, by which it is clearly shown that positive electricity is generated by the moisture of the air, when it becomes condensed by a lowering of the temperature. This conclusion is reconciled with the theory recently advanced by Prof. Edlund, of Stockholm, who argues that the electricity of the air is derived from the earth by the unipolar induction of terrestrial magnetism, while its return to the earth is caused by the condensation of the aqueous vapours, and especially by their conversion into the fluid state.

Rendiconti del Reale Istituto Lombardo, April 1.—Reptiles of the Orta-Kenei district, Adrianople, by Prof. F. Sordelli. This is an account of the collection recently made at the southern foot of the Balkan Range by the Cavaliere Luigi de Magistris, and by him presented to the Civic Museum of Milan. Of over twelve species of reptiles three only are found in the Po Valley, all the rest being of an essentially Eastern character, with a range extending from the Balkan Peninsula to the Iranian Plateau.—Note on a fundamental theorem in the theory of the functions of a complex variable quantity, by G. Morera.—Stratigraphic observations in the province of Avellino, by Prof. T. Taramelli. The paper contains a systematic study of the stratified rocks exposed by the cuttings of the Avellino and Santa-Venere line of railway, and ranging through the whole series from the Lower Chalk through the Eocene, Miocene, and Pliocene, to the more recent Quaternary formations.—Account of a rare and interesting ornithological specimen, by Prof. Pietro Pavesi. The author describes a fine specimen of *Bernicla leucopsis*, Bechst., recently shot at Corana in the Po Valley, and now preserved in the Civic Museum of Pavia.—On the rational curves in a linear space to any number of dimensions, by A. Brambilla.—Meteorological observations made at the Brera Observatory, Milan, during the month of March.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, May 4.—Prof. W. H. Flower, LL.D., F.R.S., President, in the chair.—Mr. E. L. Layard, F.Z.S., exhibited a fine example of a rare Beetle of the family Cerambycidæ (*Macrotoma heros*), obtained in the Fiji Islands; and a series of specimens of shells of the genus Bulimus from New Caledonia and the adjacent islands.—A letter was read from Mr. F. W. Styan, F.Z.S., relating to some Chinese ani-

mals of which he had lately obtained specimens.—Mr. W. F. Kirby read some remarks on four rare species of Sphingidæ, of which he had lately examined specimens.—Mr. F. E. Beddard read a paper containing observations on the ovarian ovum of Lepidosiren (Protopterus), and described the entrance of follicular cells into the interior of the ovum. It was believed that these cells played an important part in the formation of the yolk.—Mr. Beddard also communicated a paper by Mr. J. T. Cunningham, on the mode of attachment of the ovum of the smelt (*Osmerus eperlanus*).

PARIS

Academy of Sciences, May 3.—M. Jurien de la Gravière, President, in the chair.—On the magnetic principle, by M. Mascart. The author's theoretical studies lead to the general inference that, in a magnetic and isotropic body of any form there are three rectangular directions for which the magnetic force is parallel to the outer field with different coefficients, f_1, f_2, and f_3. These coefficients possess the same properties as those of a sphere of slightly magnetised anisotropic substance. For steel the mean coefficient of longitudinal magnetic force is much weaker than for soft iron; hence the increased importance of transverse magnetisation.—On the formation of oxalic acid in plants: a study of *Rumex acetosa* (sorrel), by MM. Berthelot and André. The analysis of the dried seeds of this plant yielded 0·05 per cent. of oxalic acid, which is also largely present in the leaves and stalk, but to a less degree in the root.—Remarks on MM. Berthelot and André's communication on the proportion and quantitative analysis of the ammonia present in the ground, [illegible] appeared in the last number of the *Comptes rendus*, by M. [illegible]sing. The author takes exception to MM. Berthelot and André's account of his process for effecting the analysis, and also traverses the statement that arable land, when irrigated, tends constantly to liberate the ammonia of the ammoniacal salts contained in it.—On holmine, or M. Soret's earth X, by M. Lecoq de Boisbaudran. This was a sealed paper recently deposited with the Academy, and now opened at the author's request. It shows that holmine contains at least two metallic radicals.—On dysprosium (symbol Dy), by M. Lecoq de Boisbaudran.—Remarks on a work entitled "Science and Philosophy," presented to the Academy by the author, M. Berthelot.—Observations on the new comet 1886 *a* (Brooks I.), made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—On the spectrum of the Fabry Comet, by M. Ch. Trépied. In this comet, as in that of Encke, there appears to be a predominance of the gaseous elements on the one hand, while on the other its spectrum seems to show that the relative brightness of the nucleus bears no necessary relation to the degree of condensation of the cometary matter.—On the density of liquid atmospheric air and its constituent elements, and on the atomic volume of oxygen and nitrogen, by M. S. Wroblewski.—Practical method for the preparation of the Nicol and Foucault prisms (three illustrations), by M. L. Laurent.—On the penetration of light into deep sea-water, by MM. H. Fol and E. Sarasin. From the author's experiments it appears that layers at a depth of 300 metres are illumined every day for the whole time that the sun remains above the horizon; at 350 metres light penetrates for at least eight hours daily. Even after sunset the actinic rays seem to reach considerable depths.—On the combinations of phosphoric acid with titanic acid, zircon, and stannic acid, by MM. P. Hautefeuille and J. Margottet. The general conclusion of the author's researches is that the phosphates of titanic acid, zircon, and stannic acid possess the atomic composition of the phosphate of silica. By employing phosphoric acid as a dissolvent they can be obtained only under the octahedric form, while the phosphate of silica is obtained not only under this but under three other forms incompatible with the first.—Action of vanadic acid on the ammoniacal salts, by M. A. Ditte.—On the constitution of batter, by M. E. Duclaux.—On xenotime, a rare mineral from Minas Geraes, Brazil, by M. H. Gorceix. This substance, which on analysis yields PhO_2, 35·64, YO + ErO, 63·75, and insoluble residuum 0·4, appears to be a phosphate of yttria and of a second earth, very probably erbine.—On the endothelium of the inner wall of the vessels in invertebrates, by M. W. Vignal.—On the existence in birds of a series of cephalic ganglia of sympathetic character, corresponding to the segmentary cranial nerves, by M. F. Rochas.—Researches on the structure of the stomach in birds, by M. M. Cazin.—On *Entonisus ascendens*, a parasite infesting the *Carcinus mœnas* crab, by M. A. Giard.—On some phenomena connected with the division of the cellular nucleus in plants, by M. L. Guignard.—Remarks on M. Boutroux's recent communication on an acid fermentation of glucose, by M. Maumené. The author shows that this acid differs in no respect from that already determined and described by him in the year 1875, under the name of "hexepic."

BERLIN

Physiological Society, March 26.—Dr. Kossel communicated the results of experiments instituted by Dr. Schotten respecting the cholic acids. As was known, two different nitrogenous acids entered into the composition of the bile, glycocollic acid and taurocholic acid, which broke up respectively into glycocoll and cholalic acid, and into taurin and cholalic acid. The constitution of this azoteless acid, common to both, had not yet been determined. It was, however, known to be different with different animals. In the bile of horned cattle two cholalic acids had been found, distinguished as taurocholic acid and choleic acid. In the bile of swine a third cholalic acid had been found, hypocholalic acid; and in the bile of geese, a fourth, chenocholalic acid. It was probable that still more cholalic acids would be discovered. Dr. Schotten's studies had for their object the elucidation of the constitution of cholalic acid. By heating to 300° C. he was able to split two molecules of water, and to obtain a body of an equal quantity of carbon, a less quantity of hydrogen and of oxygen. By subjection to a still greater degree of heat, from two molecules of the acid a molecule of water was separated, and a substance obtained consisting of two groups of atoms connected by an atom of oxygen. By treatment with anhydrous acetic acid Dr. Schotten established that cholalic acid was both monobasic and monovalent. Finally he investigated the composition of human bile from 350 gall-bladders, with a view to testing the statement that in human bile was contained a peculiar cholalic acid, the anthropocholalic acid of Herr Beyer. Although at first he received the same results, viz. a salt of baryta containing much less carbon than the other cholalic acids, yet subsequently, by continued purification and transcrystallisation of the product, he came to the conviction that in the human bile only the taurocholic acid of horned cattle was present. The results at first obtained of apparently different significance were due to the fact that the soluble barytic cholalate with carbonate of barium very readily formed insoluble double salts which were not easily split.—Dr. Biondi spoke on the intermaxillary bone, and discussed the fact that the doctrine set up by Goethe, that on each side but one intermaxillary bone was developed, namely from the frontal process, while the superior maxilla, on the other hand, was evolved from the maxillary process of the skull, had, in the year 1879, been replaced by a new doctrine advanced by Herr Albrecht. According to this new doctrine two intermaxillary bones were developed on both sides, growing out of the lateral and median frontal process, and then coalescing with the superior maxilla from the maxillary process. According to the older view, at present defended in particular by Dr. Kölliker, the hare-lip originated between superior maxilla and intermaxillary bone. Prof. Albrecht, on the other hand, removed the position of the hare-lip to between median and lateral intermaxillary bone. By way of proof for this latter view, the circumstance was adduced that externally from the fissure an incisor tooth was regularly found. Dr. Biondi had examined a very large number of normal and pathological skulls, and had followed the development in embryos of the facial bones. Like Prof. Albrecht, he regularly found an incisor tooth externally from the hare-lip fissure, and, in the case of embryos, in the intermaxillary bone two points of ossification, whence were developed two separate intermaxillary bones. Between these two were situated the hare-lip fissure and that of the palate. The views of Dr. Biondi and of Prof. Albrecht deviated on the contrary very materially from each other respecting the place where the two intermaxillary bones originated. In accordance with the speaker's views, the superior maxilla and the outer intermaxillary bone developed from the maxillary process, while, on the other hand, the inner intermaxillary bone sprang from the median frontal process. The lateral frontal process did not reach so far down. The hare-lip, in point of fact, therefore, as had been maintained by earlier authorities, was situated between the maxillary and frontal process. The upper lip, in the opinion of the speaker, developed itself, in perfect accordance with the relations obtaining in respect of the superior maxilla and its alveolar margin, out of the maxillary process and the inner frontal process, while the

outer frontal process formed the alæ nasi. In respect of the two intermaxillary bones on each side, the presence of which the speaker assumed along with Prof. Albrecht, Dr Biondi deviated from the latter in so far as that he had found, not an outer and inner intermaxillary bone on each side, but an anterior and posterior. The incisor teeth, as also the supernumerary teeth, developed themselves only in the intermaxillary bone. Dr. Biondi illustrated his address by preparations, drawings, and photographs he produced.—Dr. Pohl-Pincus next gave a supplement to his address on the polarisation colours of the hair of the human head, adducing the reasons which determined him to lay down three types of colouring: the normal, the pathologic, and an intermediate type. It was nevertheless to be understood that a whole series of transitionary hues intervened between the two extremes. He further stated that, in accordance with his experience, hair pathologically changed in its double refraction in consequence of stimulation from inflammation or from psychical excitement was long in returning to its normal condition. The speaker next described two experiments on a frog's heart. When he removed from a frog the anterior part of the cerebrum, under avoidance of heavy bleedings, then set free the heart, and stimulated one or several sensory nerves of the body, he then observed that the systole of the heart was unchanged. During the diastole, however, there appeared on the surface a chess-board-like drawing, and the diastole itself was interrupted in the middle by an intermission. By stimulation of the vagus he was able to overcome this effect of the irritated sensory nerves. The second observation he communicated respected the local diastole which a considerable time previously had been noticed by others as well as by himself. The occurrence of this diastole under local mechanical stimulation of the frog's heart was always a very uncertain one. Dr. Pohl-Pincus had now quite recently found that the local dilatation took place only when the stimulation was given during the second half of the systole. At the beginning of the systole, on the other hand, the stimulation had no effect whatever, and during the diastole it even gave rise to local systole. The effects of the local mechanical stimulation lasted some time, and, besides the local contraction or relaxation, manifested itself in a heightening of the diastolic or systolic state on each occasion at the stimulated spot.

Physical Society, April 2.—Prof. du Bois Reymond spoke on the irreciprocal conduction of electricity found by him in the electrical organ of fishes, and discussed the teleological significance of this property for the capability of fishes to discharge strong electrical currents outwardly (NATURE, vol. xxxiii. p. 407).—Following up the address at the last sitting by Dr. Baur, Dr. Pernet spoke on some other more recent thermo-stats, in particular on those which effected the regulation by means of vapour pressure. In the closed short leg of a manometer was a small quantity of a fluid readily susceptible of evaporation; above it was placed quicksilver, which also filled the long leg of the manometer. The short leg of the manometer with the fluid referred to lay in the bath, the temperature of which should be kept constant. Did the temperature rise above the desired degree, then the quicksilver of the manometer also mounted in consequence of the pressure of the vapour, and the flow of the gas to the flame got thereby in part shut off. The temperature than sank, the vapour condensed, and the quicksilver in the manometer fell. To render the apparatus available at every over-pressure, the manometer was cut through and connected by a movable piece of tube. As the material best adapted for these flexible connections, the speaker recommended thin steel tube, which was coated over with lead, thereby rendering it easily pliable and not liable to any elastic after-effect. The regulation by means of the long manometer tube was accomplished in an electrical way by an electro-magnet. The details of the arrangement of the thermostats in question were illustrated in part by models, in part by drawings. As fluid for very low temperatures, a mixture of two hydrochloric ethers was used; for higher temperatures, a mixture of ether and alcohol; for temperatures above 100° C., water; and for still higher degrees of temperature, other fluids. With respect to the efficacy of these thermostats, the speaker adduced that he was able to keep a water-bath for a considerable length of time constant to within 0°·02 C.—Dr. König laid before the Society a photometer sent to him from Messrs. Yeates and Son, of Dublin, which apparently far surpassed the Bunsen photometer. It consisted of two quadratic prisms of cast paraffin connected with each other on a longitudinal side. Between these two prisms was placed a silver leaf or a tinfoil leaf. When light from one source fell on the one prism, then it appeared clear white on account of the diffused reflexions. The light was able to penetrate to the other only through the metal sheet. The other prism therefore appeared dark. If a second light was placed on the other side, then the other prism appeared likewise bright. By displacement on a scale the photometer could be brought into the position in which both sides appeared equally bright. The distance from each other of the two sources of light gave in that case the relation to each other of the intensities. The speaker proposed some arrangements which would render this photometer available for coloured light as well. Similar proposals for this purpose had already been made by Dr. Jolly.—Dr. König further made some supplementary communications on the case recently discussed by him of anomalous colour-seeing arising from alcoholism. After determining that the occurrence of a neutral point in the spectrum was a perfectly certain proof that the eyes in question perceived only two fundamental colours, he investigated the extension of the colour curves by the employing of mixed colours, and thereby obtained important results, which he promised to communicate to the Society in a complete form in May or June next.

BOOKS AND PAMPHLETS RECEIVED

"Hand-book of Plant Dissection," by Arthur, Barnes and Coulter (Holt, New York).—"Manual of Physical Geography of Australia," by H. B. de la Poer Wall (Robertson, Melbourne).—"Journal of the Chemical Society," May (Van Voorst).—"Papers and Proceedings of the Royal Society of Tasmania for 1885" (Tasmania).—"Journal of the Royal Agricultural Society of England," April (Murray).—"Proceedings of the Bath Natural History and Antiquarian Field Club," No. 1, vol. vi. (Davies, Bath).—"The [illegible] graphic Features of Lake Shores," by G. K. Gilbert (Washing[illegible] and Varnishes," by J. Cameron (Churchill).—"Year-Book of S[illegible] Learned Societies, 1886" (Griffin).—"Notes on Analytical Chemistry," edition (Churchill).—"Mountain Ascents," by J. Barrow (Low).—"Dogs in Disease," 2nd edition, by Ashmont (Low).—"Bulletin de la Société Impériale des Naturalistes de Moscou," Nos. 1 and 2 (Moscow).—"British Petrography," part 4, by J. J. H. Teall (Watson, Birmingham).—"Missionary Work among the Ojibway Indians," by Rev. E. F. Wilson (S.P.C.K.).—"Our Island Continent," by Dr. J. E. Taylor (S.P.C.K.).—"A Manual of the Diseases of the Elephant," by J. H. Steel (Moore Madras).—"A Treatise on Elementary Statics," by J. Greaves (Macmillan).

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THURSDAY, JUNE 3, 1886

BRITISH FUNGI

Hymenomycetes Britannici—British Fungi (*Hymenomycetes*). By Rev. John Stevenson, Author of "Mycologia Scotica." Vol. I. Agaricus—Bolbitius. 8vo, pp. 372, with Cuts. (Edinburgh: William Blackwood and Sons, 1886.)

A QUARTER of a century ago, the number of persons in this country who made any pretence to study the fungi might have been counted on the fingers, and almost on the fingers of one hand. At that time Berkeley's "Outlines of British Fungology" had just appeared, but with it came no visible evidence of an increased number of students. An unfortunate desire to limit the volume to a definite size and price acted injuriously upon its contents. Half the book was a mere list of names without descriptions, and in the other half the descriptions were reduced to short diagnoses, quite insufficient except for those who were somewhat expert in the study. The young student struggling to get some knowledge of these obscure plants had no alternative but to fall back on the supplementary volume of Hooker's "English Flora" for the information he needed, oftentimes with much disappointment. Hence it is not surprising that only a few had the courage to persevere in a study for which there was no adequate text-book. It was not until 1871 that Cooke's "Hand-book of British Fungi" supplied what was required, and imparted a stimulus to the pursuit of that section of British botany, which has gradually increased in force, until at the expiration of another fifteen years, the "Hand-book" is out of print, and out of date, with a greatly augmented body of students looking anxiously for a new edition, or an entirely new work.

At this crisis, and under these circumstances, the work now before us has made its appearance, opportunely, and it is to be hoped satisfactorily, to fill a vacant place. No apology is offered, and none is required, where there is no rivalry, and a manifest necessity has been created by the flux of time. If the new work fulfils all the conditions of such a "Hand-book" of mycology as the student would require, there is a good and valid case in its favour. It must be conceded that although his previous "Mycologia Scotica" was little more than a localised catalogue, there was every reason to believe that the Rev. John Stevenson would bring practical experience and literary ability to his task, and acquit himself well in the production of a more elaborate work. In the result his friends have no reason to be disappointed. He has laboured conscientiously, and although in some things we do not agree with him, has accomplished a useful task.

It is hinted in the preface, although not clearly stated, what is the character of the book, namely, that it is practically a translation of Fries's "Monographia" in so far as the British species are concerned. There is no doubt that this was the best course to adopt, because there can be no two opinions of the value of Fries's observations, and the book in which they are written is very rare, and beyond the reach of the ordinary student. Still it would have been better not to have left this point in suspense, since a long detailed description which can be attributed without reservation to Fries is of infinitely more value than the most careful compilation would be. Unfortunately, any one who opens the book to consult it for the first time will at once conclude that the descriptions are the original production of the author, whose name appears on the title-page. We do not for a moment imagine that there was any desire to appropriate wholesale and take credit for the product of another man's brains, but unfortunately that *is* done sometimes in scientific books, and an honest author should be above suspicion.

Of the type, paper, and general appearance of the work, including the woodcuts by Mr. Worthington Smith, we have nothing to say except in strong commendation. But we cannot help quoting one sentence from the preface, which at least is original—"The tendency in recent years has been to multiply species unnecessarily, and ultimately many so-called species must disappear. The pruning-knife must be unsparingly used; but this must be the work of a Congress of Cryptogamic Botanists, not of individual authors." This quotation is made without intention of dissenting from it, but as a prelude to a statement of the fact that in the present volume two sub-genera and about fifty species (good, bad, or indifferent) which have been recorded as British, some on the authority of the Rev. M. J. Berkeley, and many of them figured, are entirely excluded without comment or apology. Was this "the work of a Congress of Cryptogamic Botanists or of an individual author?"

Some writers, and compilers, of the present day exercise a questionable originality in the correction, or alteration, of the orthography of generic names which have been in use for, perhaps, half a century. No useful purpose is served, except the gratification of personal vanity, and the multiplication of synonymy. We note, on p. 304, an instance of this kind, where *Psalliota* is written *Psaliota*. Without inquiring which is most accurate, or most elegant, surely its uniform use by Fries, in the previous form, since 1821, should have been sufficient to protect it from the "pruning-knife," and given it some title to usage in perpetuity. To such manipulators of names we would commend the following sentence from De Candolle's Commentary on the Laws of Botanical Nomenclature:—"In these kinds of questions, it must be borne in mind that the fixity of names is of superior importance."

We observe also two or three instances in which the orthography of specific names has undergone a change, but as it is just possible that these may be referred to typographical errors, and not to any intentional mutilation, we will accord the author the benefit of the doubt.

Some apology is made in the preface for a departure in the present work from the ordinary method of giving first a short diagnosis of the species, and afterwards a detailed description. "I am aware," it says, "that the departure from this method will touch existing prejudice; but it seems desirable to avoid repetition, to the extent of one-third, or one-half, in the account of each species, and thereby to secure space for fuller description. Moreover the *diagnosis* is not lost. From the arrangement which is adopted in printing, the student, if he is a student at

all, can at a glance pick it out for himself." We confess that we are not conscious ourselves of any prejudice which this arrangement touches inconveniently, since the diagnoses, by themselves, can be obtained in another form.

This first volume extends to the end of the genus *Bolbitius;* a second volume is proposed to complete the work, embracing all the British Hymenomycetes. Thus far we have descriptions of 822 species, corresponding to 485 which were included in the "Hand-book of British Fungi" in 1871, and 383 in Berkeley's "Outlines" in 1860, whilst all the European species included in Fries's "Hymenomycetes" up to the same point was 1271. Hence it would appear that two-thirds of the species enumerated by Fries as European have been found in the British Isles. This may not be absolutely accurate, since there are some included in the present volume which are not to be found in Fries, but the proportion is small and will not much affect the ratio. It is an interesting fact that the number of British species has been nearly doubled in fifteen years, which at least must be taken to indicate a larger number of observers and increased activity, for which there was doubtless some good and sufficient cause. Although coloured figures of upwards of 700 out of the 822 species have been published in this country since 1881, that would scarcely have been an appreciable factor in the result.

Criticisms of particular species would prove of little interest to any but practical mycologists, and therefore we forbear. In these times, when authority is held to have such slender claims, and independence of opinion is esteemed more highly than respect for the convictions of the old masters, it is a great consolation to encounter such an earnest and faithful disciple of the good old mycologist of Upsal as we meet with in the author of the book before us. Yet, notwithstanding this good trait, he has evidently a weak place in his human nature, without the tact to conceal it, and this is to be regretted, since rancour—like young chickens—comes home to roost.

M. C. C.

A MEDICAL INDEX-CATALOGUE

Index Catalogue of the Library of the Surgeon-General's Office, United States Army. Vol. VI. Heastie-Insfeldt. (Washington: Government Printing-Office, 1885.)

AMONGST the vast and rapidly-increasing mass of scientific literature it is a singular satisfaction to meet with a first-rate work such as this "Index Catalogue," which holds out good promise of being a clue to some parts at least of what is far too large for any single grasp. And if in any department of science it is more important than in another to trace generalisations to their foundations upon observations, and to have the facts before one, it is in medicine, which still contains so many dogmas whose foundations are not beyond attack, and so many observations in want of an adequate theory to explain them. In giving a clue to medical knowledge this "Index Catalogue" is in one respect at least, and in one very important respect, unique among its class; for under subject-headings such as, in this volume, hernia, hooping-cough, hydrophobia, hip-joint, hospitals, hygiene, insanity, &c, it gives a list not only of all the books and pamphlets in the library dealing with them, but also a list of the full titles of all the articles on them in all the periodical literature that it possesses, *Journals*, *Transactions*, *Reports*, *Reviews*, *Bulletins*, &c.; and when we reflect that the list of such periodicals taken in by the Surgeon-General's Office amounts now to at least 3095 (of which a very considerable proportion are weekly or monthly publications), such a careful classification of their separate articles would seem to be beyond all hope. However, the unexampled energy of Mr. J. S. Billings and his able assistants, which gives us every month the *Index Medicus*, has proved equal to this gigantic task, which it would have seemed to most men mere foolishness to attempt. The advantage to the student is immense; for in such periodical literature, by modern fashion, a great number of important facts in medicine lie buried, and there would hardly be a chance of finding them without some such help as is given us here. For though the literature of science is far less at present in bulk than the literature of some other subjects, most notably divinity, yet the literature of natural science, even in one of its many subdivisions, such as medicine, is paralysing in its profusion. To take as an instance the literature of a disease which, though just at present it is the fashion to talk much about it, is yet so rare that many doctors with considerable experience have never seen it, viz. hydrophobia, we find catalogued here not only 368 books dealing with it specially, but also the full titles of more than 1900 signed articles, not in the general but the medical press of the European languages, that have to do with it as well; and yet that is not a fifth part of what is catalogued under "Cholera" in Vol. III., and not a tenth of what is catalogued under "Fever" in Vol. V. The subdivision and arrangement of the masses of information so gathered together is admirable, and that, for subjects so difficult to deal with as hospitals and hygiene, which occur in this volume, is not a little to be proud of, and one that any student will appreciate. To the accuracy of every entry it would be absurd to pretend to testify on our own investigation, but frequent use of the five preceding volumes and some testing of this sixth volume leave us in little doubt that a very high standard was previously reached, and will be found to be maintained, and of course that is one of the points of cardinal importance in what is practically a dictionary of reference.

The Washington Library, or, as we should say more accurately, the "Library of the Surgeon-General's Office, United States Army," is one of the two or three largest collections of medical books in the world, and its growth has been astonishingly rapid. It was begun in 1830, and, after the first thirty years, in 1860, it contained only 350 volumes. To what size, at the end of the next thirty years, in 1890, we may see it grow we hardly venture to speculate; but in 1883 it stood at about 60,000 books and 66,000 pamphlets, and took in more than 2600 periodicals; and yet a careful critic last year estimated that for every hundred medical books that were in both the Washington Library and the British Museum there were also another hundred in each that were not in the other. If that be true, it would not astonish us to hear that for every hundred held in common there were fifty or more in the Bibliothèque Nationale at Paris, which were not to be

found in either of them. The largest medical specialist library in England, that of the Medical and Chirurgical Society, cannot claim to be more than half the size of the Washington Library, or to contain many books that are not to be found elsewhere; and it does not grow with all the rapidity of the New World.

For some time probably all seekers after the most difficult and most complete medical knowlege will have to turn to this "Index Catalogue," and will trust that Mr. Billings may be able to go on year after year putting forth his modest quarto of 1000 pages, until six or seven years may see him at the end of his great work.

A. T. MYERS

OUR BOOK SHELF

Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux. 3e série, tome i. (Paris: Gauthier-Villars, 1885.)

WE have frequently had occasion to direct our readers' attention to the high-class memoirs which this energetic Society puts forth. The volume before us is one of a kind that we should like to see brought out by our own scientific Societies. Under the title "Niels-Henrik Abel, sa vie et son action scientifique," it contains a full and most valuable sketch, by Prof. C. A. Bjerknes, of Christiania, of the writings and life of one of the ablest and acutest mathematicians of modern times. That the account is a full one will be evident when we say that the work occupies 365 octavo pages: it is a translation in French from the original memoir, and is further enriched by a considerable appendix. The labour of seeing the present form of the work through the press has principally fallen upon M. Houel, to whom the author warmly expresses his thanks. Abel was born at Findö, Christiansand, on August 5, 1802, and died near Arendal on April 6, 1829, and was interred at Froland.

The main body of the work consists of fifteen chapters, and the appendix occupies thirteen chapters more. His works, originally edited by M. Holmboe, the professor under whom he studied, were published in 1839, and quite recently a new edition was referred to in these columns. We give two or three extracts which show the appreciation of his powers amongst his contemporaries, an appreciation which has rather increased than decreased since his death. Jacobi writes of a *deduction* Abel had drawn as being "elle est au-dessus de mes éloges, comme elle est au-dessus de mes travaux." Legendre says, "il me tarde beaucoup de voir les méthodes qui vous ont conduit à de si beaux résultats; je ne sais si je pourrais les comprendre, mais ce qu'il y a de sûr, c'est que je n'ai aucune idée des moyens que vous avez pu employer pour vaincre de pareilles difficultés. Quelle tête que celle d'un jeune Norvégien!" Gauss expresses similar views, and on hearing of Abel's death, wishes for particulars of the life "de cette tête eminemment distinguée." We could easily add other extracts from Prof. Bjerknes' admirable record of the distinguished Norwegian's life, which is a fitting companion to the before-cited edition of "the works," but forbear. Should any desire, with Gauss, to have his portrait, they will see here in the frontispiece the well-known, to some of us, lineaments.

Solid Geometry. By Percival Frost, D.Sc., F.R.S. Third Edition. (London: Macmillan and Co., 1886.)

IT would have been superfluous to recommend the third edition of Dr. Frost's "Solid Geometry," even if the third edition had been merely a reprint of the second. The book has now taken its position alongside the very best mathematical treatises in use, and requires "no bush." What we have got to do with, however, is no mere reprint; there is once again presented to us a notable increase of matter—much more than a cursory glance is likely to detect—and there has been considerable improvement generally. One change, greatly to the student's advantage, is the careful graduation of the problems at the end of each chapter, and the separation of them into groups. There is still a lack of references to original memoirs, and though, apparently, the author is conscious of it, he needs reminding that it is not sufficient merely to say that this or that is due to Cayley, Chasles, or any one else. Such incomplete statements serve only to give discoverers their dues; they do not assist the advanced and inquiring student.

We have pleasure in learning that an Appendix is about to be issued giving hints for the solution of the problems, but the pleasure is far more than counterbalanced by observing that the title-page bears no longer the words "Vol. I.," the inference being that Dr. Frost has followed the sad example of Thomson and Tait. There is no dearth of men willing and on the whole able enough to write mathematical text-books for beginners: those who could produce a volume to follow Frost's "Solid Geometry" are rare as white crows. When found—by press delegates—they should not only be made a note of, but coerced.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Flora of South Africa

No one, who ever spent much of the impressionable period of his youth at the Cape, that land of lowly plants with exquisite flowers,—but will be vividly interested in the masterly description of those plants' geographical regions of habitat, as given by Mr. Bolus, per your reviewer, "J. D. H.," on pp. 77-79 of your last week's issue.

But what can either one, or other, of those gentlemen mean by saying of "the Natal region" that it is "bounded on the east and south-east by the Atlantic"?

By the Indian Ocean if you like; and then you have a ready means of conveyance for those "Indian types of plants, both in genera and species" which the above-quoted authors say do abound along that eastern coast of South Africa,—but which the Atlantic could never have brought to it.

There is, however, a further local difference in the qualities of the two oceans, of such overwhelming importance to all vegetation, that I wonder no mention appears of it in a Cape botanical essay.

The Natal coast, for instance, on the east, is washed by a warm current from the equator, giving out so much steamy moisture that not only, as your article truly states, are there "the herbage- and bush- and tree-foliage greener, and the leafage larger" than elsewhere; but there, in that region of luxuriously fed, densely growing plants, does game abound; there do Kaffir tribes congregate and establish their kraals; and thereto do Dutch Boers emigrate out of the old, dried-up, southern colony, and found new republics; while therein have we also, every few years, to wage successive wars either with them, or with Zulus or Amakosi tribes of various power, until British lives have been sacrificed by thousands, and British money expended by millions.

But the west coast of South Africa, bless it, being washed by a cold current of the Atlantic coming from Antarctic seas, and giving out little or no vapour, even under a nearly vertical sun,—can hardly but be, even just as it is, an arid desert, where only a few starving Boschjesmen wander miserably up and down, existing perhaps on an occasional antelope, or roasted ants and stray locusts; and no one fights there for permanent possession of the ground.

Now all this egregious contrast between human society, as well as the flora, on the one side, *versus* the other, of Southern Africa (excepting some details dependent on the soil and the prevailing direction of the wind) are due to the Indian Ocean imparting to the air on the east coast an invisible, yet most potent quality which the Atlantic does not confer on the western coast. Could there then be found a more expressive emblazon, suitable to the present day, for a coat of arms for one of the flourishing new Governments on the eastern side of South Africa, than a wet, and dry, bulb hygrometer pictured with both bulbs marking 85° F., and with the surf of the Indian Ocean beating in the distance?

C. PIAZZI SMYTH

May 29

The Composition of the Edible Bird's-Nest

As I have been much interested in the controversy concerning the composition of the edible bird's-nest, and particularly in the bearing of Mr. Green's investigations, which are given at length in your last issue (p. 81), would you permit me to give the result of some observations I made on this subject in the Solomon Islands. It will be remembered that it was the association of these nests with a so-called "fungoid growth" in the caves of North Borneo that led Mr. Pryer to consider that he had found the source of the material of which the nests are made, a supposed discovery which led to the re-opening of the controversy (NATURE, vol. xxx. p. 271). This low plant-substance was determined by Mr. George Murray to be the result of the growth of a microscopic alga, a species, probably new, of *Glaeocapsa* (*Proc. Zool. Soc.*, 1884, p. 532).

In the Solomon Islands I was only able to obtain the edible nest in one locality (Oima Atoll) since the bird usually frequents inaccessible sea-caves and cliffs. The nests were of inferior quality, and were for the most part composed of fibrous materials derived from the vegetable drift (the husks of pandanus seeds especially). The gelatinous substance thickly incrusted the interior of the nests, and attached them to the rock. The surface of a cliff in the vicinity of the cave frequented by the swifts was coated by a reddish gum-like growth, which proved on examination to be an aggregation of the cells of a protophytic alga about 1/2500 of an inch in size. Unfortunately my specimens of this growth have miscarried, but I feel assured that it is very similar to that observed by Mr. Pryer in the Borneo caves, samples of which, through the kindness of Mr. George Murray, I had the opportunity of seeing at the British Museum. A similar growth is commonly to be found coating the coral-limestone cliffs in this group. It may be seen in all stages, the older portions being dark-coloured and rather tough, and the fresher portions being, as Mr. Pryer aptly remarked, like half-melted gum tragacanth. There are but few cells in the fresh alga, the mass being apparently composed of cellular debris, immersed in a rather diffluent material, the whole somewhat resembling the third section given in Mr. Green's paper.

That the salivary glands are especially concerned in the production of the gelatinous nest-substance there can now be but little doubt, and the investigations of Mr. Green have established the nature of its composition; yet it is possible, and I make the suggestion with great diffidence, that a *vegetable mucin*, or a substance closely allied to this animal product, may be found in these low plant-growths.

H. B. GUPPY

95, Albert Street, N.W., May 29

"Arithmetic for Schools"

IN NATURE of May 20 (p. 51) there appears a criticism of my "Arithmetic for Schools," in which your reviewer states:—"In the purely arithmetical part of the book logical accuracy is attempted with considerable success. Want of grasp is much more evident in the part which deals with the applications. Then the division into subjects is strangely illogical, and slight inaccuracies of thought and language occur. Is it really the case, for example, that rate of interest (p. 181) is totally independent of *time*?" These are very serious charges to make against a book of the kind, and ought not to be made without very good reason. As your reviewer suggests the inferences (1) that the book is divided into parts, one of which contains the "pure arithmetic," and the other the "applied," and (2) that it is stated that *rate of interest is totally independent of time*, and as neither of these inferences has any foundation in fact, it seems only fair to myself that your reviewer should be asked to quote *verbatim* the other slight inaccuracies on which he bases his general statement.

Gonville and Caius College, May 24

JOHN B. LOCK

SUNSPOTS AND PRICES OF INDIAN FOOD-GRAINS

IN the volume of the *Bombay Gazetteer* which deals with the province of Kathiawar, there is at page 21 a long list of prices of the principal food-grains at Bhavnagar. The list contains, along with other information, the price of Indian millet for nearly every year from 1783 to 1882. This series of figures is long enough to afford the means of testing whether there is any tendency, in India, for times of scarcity, and consequent dearness of food, to recur after more or less regular intervals of years.

Ever since the discovery by Schwabe of the periodicity of the sunspots, and the further discovery by Sabine of the same periodicity in the variations of the earth's magnetism, there has been a growing belief in the minds of scientific men that the varying condition of the sun exerts a far greater influence on terrestrial affairs than is usually thought at all probable, and various investigators have traced, with more or less definiteness, a periodicity of eleven years—coinciding with that of the sunspots—in the variations of the rainfall, in those of the temperature and pressure of the atmosphere, and in the frequency of storms, &c. The late Prof. Stanley Jevons went so far as to express the opinion that even trade depressions are the remote effects of corresponding variations in the condition of the sun.

I am not aware that any attempt has hitherto been made to trace out any direct connection between the variations of prices in India and solar phenomena. The apparent hopelessness of the task has probably acted as a sufficient deterrent, for although it may be reasonable to suppose that solar variations influence the rainfall and other purely physical phenomena, yet it is well known that there are many causes of variation of price which cannot, with any show of reason, be attributed directly to the sun. Such, for instance, are wars, the gradual increase of the population, variations in the quantity of money in use, changes in the total volume of trade, &c. These circumstances complicate the problem very much, but it does not necessarily follow that it is hopeless to attempt to trace the possible influence of solar periodicity on the prices; for there are statistical methods by which most of the disturbing influences can be approximately, if not entirely, eliminated. Indeed, when these methods of elimination have been applied, it may be found that the solar periodicity is more decidedly traceable in the prices than in the rainfall: for, in the one case, the produce of every field exercises its due share of influence in determining the price; while, in the other case, the quantity of rain actually measured is but an infinitesimal portion of the whole quantity which falls, and may therefore very imperfectly represent the total rainfall over the whole of a district.

In considering a price in relation to the causes of variation to which it is subject, it may be thought of as divided into portions, each portion being assigned to its own particular cause. What is wanted here is to separate as distinctly as possible that portion which may be due to the variation of the influence of the sun from all the rest. But before any satisfactory attempt can be made to distinguish that portion of the price variation which may be due to variation of solar influence from the portion due to the average amount of solar influence and to other causes, it is necessary to adopt some standard of comparison which may reasonably be supposed free from solar effects of a periodically variable nature. Now as the physical state of the sun is known to go through a complete cycle of changes in a period of almost exactly eleven years, the average price for any consecutive eleven years

will be affected by the average amount of solar influence, and the difference between this average price and the actual price for the middle year of the eleven will be affected by the difference between the average condition of the sun and its actual condition in that middle year. This difference of price may also include the effects of other extraneous and non-periodic causes. Eleven years after the middle year just mentioned the sun will again be in its former condition, and a similar price difference for that year may be calculated. The same process may be carried on to the twenty-second, thirty-third, &c., years, and it will then produce a series of price differences equally affected by equal periodical solar influence. Non-periodic causes will, however, sometimes tend to unduly raise these price differences, sometimes to depress them, but on the average such disturbances will, in a long series of years, tend to balance each other, leaving the periodical portion of the solar influence outstanding. If, for instance, the years for which the calculations of the price differences have been made are those in which the sunspots are at a maximum, the average price difference will show how much prices tend to be raised or depressed by that condition of the sun which produces most spots. A similar series of calculations may be made for the years in which the spots are at a minimum, also for the intermediate years when the spots are increasing, and for those years when the spots are decreasing. A set of eleven average price differences, one for each year of the sunspot cycle of eleven years, will thus be obtained, and if, on arranging them in consecutive order, they show that prices are, on the average, decidedly high in those years when there are few sunspots, and decidedly low when the sunspots are numerous, or if they show any other decided and systematic variation in the sunspot period, the conclusion will be that the sunspot cycle does really affect the prices. If, on the other hand, the prices do not change in any systematic manner in the different years of the sunspot cycle, the conclusion will be against the hypothesis of a periodical variation of the prices corresponding to the periodical variation of the sunspots.

There is one point of view from which this method of taking differences is open to some objection. Suppose, merely for the sake of illustration, that the average price of millet throughout some particular sunspot period of eleven years is 50 pounds for a rupee, but that in the year of maximum sunspots the solar influence is such as to double the crop and lower the money price or raise the quantity price proportionately, that is, to 100 pounds for a rupee. The price difference for that year would be 50. If, however, by reason, say, of a more plentiful supply of money, the average price of millet for the whole of another sunspot period of eleven years is only 25 pounds for a rupee, and the crop in the year of maximum sunspots is, through solar influence, similarly doubled, the quantity price would only rise to 50 pounds, and the price difference would be only 25, although the solar influence, which is supposed to have produced the change, is the same as before. The difference between the two results would be due simply to the more plentiful supply of money, not at all to a difference of solar influence. This shows that it is needful to adopt some modification of the method, which will allow for gradual changes in the amount of money in use, and other similar causes of alteration of price. Such a modification will be made if, instead of taking price differences, the actual price of the middle year of the eleven is expressed as a percentage of the average price. Expressed in this way, the percentage for the year of maximum sunspots in each of the above examples would be 200, that is to say, in each case the number of pounds for a rupee would be 100 per cent. greater than the average number.

Table I. contains the Bhavnagar price list expressed in the percentage form in the manner just described. In the original table the prices are expressed in pounds for a rupee. If, therefore, the number for any year in Table I. is 125, it means that the number of pounds of grain for a rupee is 25 per cent. greater than the corresponding eleven-yearly average; and if the number is 75 it means that the number of pounds for a rupee is 25 per cent. less. In other words the excess above or the defect below 100 shows how much per cent. the number of pounds for a rupee is above or below the corresponding eleven-yearly average.

TABLE I.—*Percentages, Bhavnagar.*

Years.	1	2	3	4	5	6	7	8	9	10	11
1783 to 1793 . .	57	66	56	143	157	172	185	104	24	60	61
1794 to 1804 . .	66	69	140	163	145	131	108	82	78	75	63
1805 to 1815 . .	70	117	97	139	124	115	106	78	38	69	85
1816 to 1826 . .	118	159	162	103	68	81	78	111	71	51	74
1827 to 1837 . .	141	98	137	96	121	131	135	71	78	79	81
1838 to 1848 . .	91	58	100	92	81	141	164	93	86	107	66
1849 to 1859 . .	132	96	96	102	104	100	106	112	109	84	122
1860 to 1870 . .	103	100	103	86	52	62	87	105	104	92	84
1871 to 1881 . .	93	93	133	126	126	107	89	75	71	89	118
1882	100										
Means, including 1863 to 1866 .	97	95	114	117	109	116	118	92	73	78	84
Means, excluding 1863 to 1866 .	97	95	114	120	116	122	121	92	73	78	84
Smoothed means.	93	100	111	117	118	120	114	94	79	78	86

The numbers of Table I. are arranged in lines of eleven numbers each, so that the numbers occurring at equal intervals of eleven years, beginning with 1783, all fall in the first column, those occurring at equal intervals beginning with 1784, all fall in the second column, and so on. Now if there is any decided tendency for high or low prices to recur at more or less regular intervals of about eleven years, the great majority of the high prices should be found in a few contiguous columns in one part of the table, and the great majority of the low prices in a few contiguous columns in another part of the table. An examination of the numbers of Table I. shows that this is the case, for in columns 9, 10, and 11, no less than twenty-two out of the twenty-seven numbers are below 100, and only five of them are above 100; while in columns 3 to 7 the great majority of the numbers are above 100.

The average results are given at the foot of the table. They show that there is a decided tendency for years of high and low prices to recur, with some regularity, in a period of eleven years, five consecutive years being good years, when money prices are below the average; and the six following years being bad years, when money prices are above the average. The years which give the highest average money price, or the smallest number of pounds for a rupee, are those in column 9. The average number of pounds for a rupee in those years is 27 per cent. below the eleven-yearly average. The years which give the lowest average money prices are those in columns 4, 6, and 7. The average number of pounds for a rupee in those years is about 17 per cent. greater than the eleven-yearly average. There is thus an average difference of 44 per cent. between the years of low prices and those of high prices. This percentage difference would have been considerably greater if the prices had been reckoned in rupees for a fixed quantity of grain, instead of in pounds of grain for a rupee. To show that this is the case it is only necessary to convert the three prices 117, 100, and 73 regarded as pounds for a rupee, into their corresponding rupee prices, that is to say, into the number of rupees which would in each case be required to purchase 100 pounds. These are 0·85, 1·00, and 1·37 respectively,

giving a difference between the highest and lowest of 0·52, or no less than 52 per cent. of the average price, which is 8 per cent. more than the corresponding difference in the pound prices. Although this illustration by no means exhausts the question of the difference between quantity prices and money prices, it suffices for the purpose of guarding against the erroneous supposition that results worked out in quantity prices are directly applicable to money prices.

Having now found such remarkable evidence of regularly recurring periodical variations of the price of the staple food-grain at Bhavnagar, amounting on the average to more than 50 per cent. of the average money price, it seems desirable to inquire whether similar variations of price have taken place from year to year in other districts. For this purpose I have selected from the various volumes of the *Bombay Gazetteer* all those price lists which extend over periods of fifty years or more. These are for the districts of Ahmedabad, Kaira, Surat, Khandesh, Poona, Bijapur, Dharwar, Belgaum, and Kanara, and to these I have added Madras, for which station a long price list is given in the Report of the Indian Famine Commission.

The best way of testing whether any considerable portion of the variations of price in these districts can be regarded as regularly recurrent in a period of eleven years, corresponding to that of the sunspots, is to calculate the average eleven-yearly variation by the method already applied to the Bhavnagar prices. These calculations have been made. The results are entered in Table II. The corresponding average sunspot variation is also given.

TABLE II.

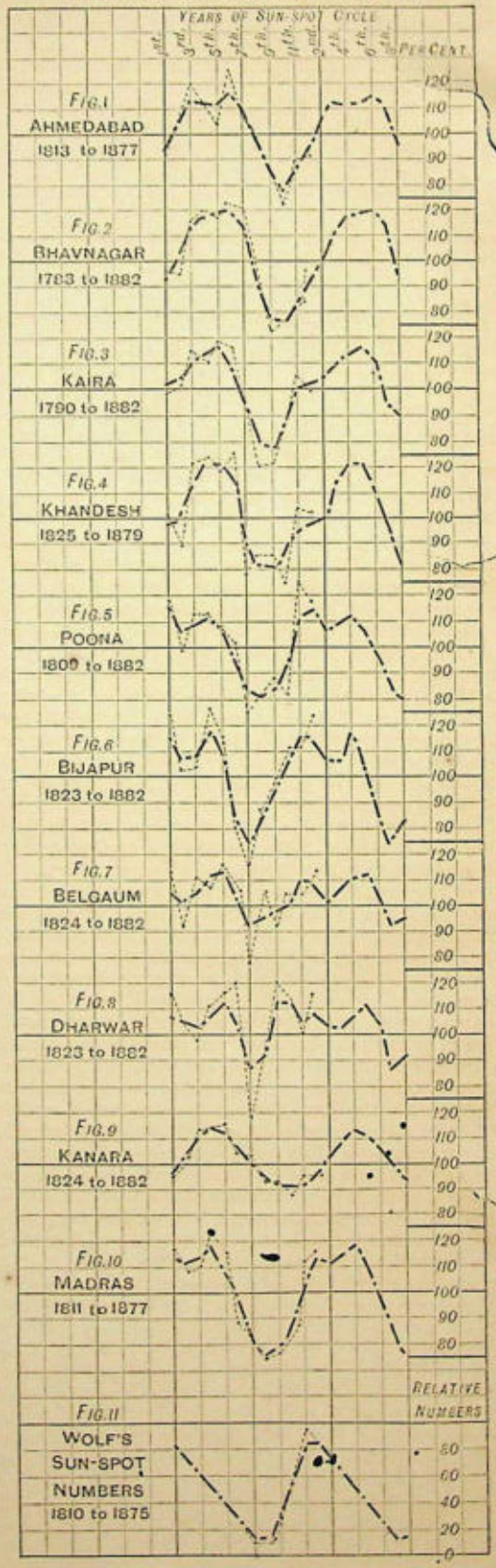
Districts.	Ahmedabad.	Bhavnagar.	Kaira.	Khandesh.	Poona.	Bijapur.	Belgaum.	Dharwar.	Kanara.	Madras.	Sun-spots.
Years.	1813 to 1877	1783 to 1882	1790 to 1882	1825 to 1879	1849 to 1882	1823 to 1882	1824 to 1882	1823 to 1883	1824 to 1882	1811 to 1877	1810 to 1875
[1] 1 .	91	97	99	101	119	124	113	115	95	116	84·4
2 .	101	95	101	89	99	101	91	102	102	109	72·1
3 .	120	114	115	121	113	102	111	98	112	110	58·4
4 .	110	120	110	123	113	127	108	112	114	123	45·0
5 .	104	116	119	118	108	114	117	106	115	115	32·0
6 .	126	122	116	126	102	80	106	120	105	89	19·6
7 .	110	121	95	78	75	67	78	69	103	83	9·4
8 .	98	92	75	83	81	88	106	92	93	75	12·2
9 .	82	73	76	83	89	101	92	120	93	77	33·2
10 .	73	78	87	75	81	111	103	115	88	87	64·0
11 .	89	84	105	104	126	112	103	100	95	113	92·3

In calculating the average sunspot variation the sunspot numbers before 1811 have been excluded, partly because they are very much less reliable than the numbers for the later years, from lack of continuous observations, partly because the mean variation for the later years will be more directly comparable with the price variations, which, except in two cases, are deduced from the data of the years following 1810. In calculating the average eleven-yearly price variations the data for the years 1863 to 1866 have been excluded, because it is known that in those years prices were very much raised by the influence of the American war.

There is some irregularity in the eleven-yearly price variations (especially in those for Dharwar and Belgaum) which can hardly be attributed directly to the solar influence. The best way of removing this irregularity will be to take the means of each consecutive pair of the eleven

[1] The year 1871 is taken as the first year of the sunspot cycle of eleven

PRICES OF FOOD GRAINS IN INDIA
RECKONED IN POUNDS FOR A RUPEE.



average numbers which constitute the eleven-yearly price variation, and to repeat the process on the new means. This has been done, and the results are given in Table III.

TABLE III.

Districts	Ahmedabad.	Bhavnagar.	Kaira.	Khandesh.	Poona.	Bijapur.	Belgaum.	Dharwar.	Kanara.	Madras.	Sunspots.
Years	1813 to 1877	1783 to 1882	1790 to 1882	1825 to 1879	1809 to 1882	1823 to 1882	1824 to 1882	1823 to 1883	1824 to 1882	1811 to 1877	1810 to 1875
1 .	93	93	101	99	116	115	105	108	97	113	83·2
2 .	103	100	104	100	107	107	101	104	103	111	71·7
3 .	113	111	110	113	109	108	105	102	110	113	58·5
4 .	111	117	113	121	112	117	111	107	114	118	45·1
5 .	111	118	116	121	108	109	112	111	112	110	32·1
6 .	116	120	111	112	97	85	102	104	107	94	20·1
7 .	111	114	95	91	83	75	92	87	101	82	12·6
8 .	97	94	86	82	81	86	95	93	95	77	16·7
9 .	84	79	78	81	85	100	98	112	92	79	35·6
10 .	79	78	89	84	94	109	100	112	91	91	63·3
11 .	85	86	99	96	113	115	105	107	93	107	83·2

These smoothed results are graphically represented by the dots connected with black lines in Figs. 1 to 10. To show the effect of the smoothing process the original unsmoothed numbers, viz. those of Table II., are graphically exhibited over the smoothed curves by the dots joined with faint dotted lines. It will be seen from these figures that the application of the smoothing process has got rid of almost all the irregularity. At the same time it has somewhat unduly reduced the range of the eleven-yearly variations. The amount of this reduction may be roughly estimated by applying the same smoothing process to the eleven average sunspot numbers given in the last column of Table II. This has been done in the last column of Table III. The results are curved in Fig. 11. The range of the original unsmoothed numbers is 82·9, that of the resulting smoothed numbers is 70·6; that is to say, the range of the smoothed numbers would have to be increased by 17 per cent. of itself to obtain the full range of the original numbers. From this it may be inferred that the range of each of the smoothed eleven-yearly price variations represented by Figs. 1 to 10 is too small, and should be increased by about 17 per cent. of itself to obtain the full range of the variation. On the other hand, the extreme range of the unsmoothed numbers will probably be somewhat too great in most cases, because the data do not extend over a sufficient number of years to eliminate completely the effects of casual fluctuations. The true mean range of the variation caused by solar influence will therefore probably lie somewhere between the range of the unsmoothed numbers and that of the smoothed numbers. The ranges of both the unsmoothed and the smoothed variations are shown below for each district. The range of each smoothed variation increased by 17 per cent. of itself is also given.

	Ahmedabad.	Bhavnagar.	Kaira.	Khandesh.	Poona.	Bijapur.	Belgaum.	Dharwar.	Kanara.	Madras.
Unsmoothed .	53	49	44	51	51	60	39	51	27	48
Smoothed . .	37	42	38	40	35	42	20	25	23	41
Smoothed, plus 17 per cent.	43	49	44	47	41	49	23	29	27	48

Now these results reveal the remarkable fact that, amid all the apparently irregular fluctuations of the yearly prices, there is in every one of the ten districts a periodical rise and fall of prices once every eleven years, corresponding to the regular variation which takes place in the number of the sunspots during the same period. They also show that in seven out of the ten districts the range of the eleven-yearly variation of prices lies between 40 and 50 per cent. of the average price, and that in the remaining three districts the range lies between 20 and 30 per cent. The ranges are greatest in those districts where scarcity and famine are most frequent, smallest in those which enjoy the greatest immunity in these respects. In Bijapur and the neighbouring districts of Belgaum and Dharwar the highest prices occur in the year of minimum sunspots; in Madras, Poona, and Khandesh a year or two later; in Kanara, Kaira, and Bhavnagar two or three years later; and in Ahmedabad three years later. The lowest prices occur in all the districts from three to five years after the year of maximum sunspots, that is to say, three years after at the southern stations; four or five years after at the northern. Bijapur and Poona are the first to show a very decided rise of prices, and this rise takes place in the year preceding the year of minimum sunspots. At all the other stations a very decided rise takes place a year or two later.

From what has been said it follows that the intervals of time between the year of minimum sunspots and the years of highest prices are less than the intervals between the year of maximum sunspots and the years of lowest prices. This shows that the eleven-yearly price variations do not exactly correspond to the eleven-yearly sunspot variation. The reason may be that on the occurrence of scarcity prices rise very rapidly, while on the return of a season of plenty they fall much more slowly, because the reserve stocks of grain consumed during a period of scarcity cannot be fully replaced until good crops for several successive years have been secured. If it were possible to obtain data showing the actual out-turn of the crops of each year, it would perhaps be found that the eleven-yearly variations calculated therefrom would correspond to the sunspot variation even more closely than the price variations correspond to it.

In estimating the significance of these eleven-yearly variations it must be remembered that quantity prices, not money prices, have been dealt with, and that the corresponding money prices would show a much greater percentage rise in dear times, and a less percentage fall in cheap times than are shown by the quantity prices. Indeed, to a person accustomed to thinking of money prices the quantity prices are apt to be very misleading if the difference is not constantly borne in mind, as may be seen from the consideration that if the quantity price, that is, the number of pounds for a rupee, becomes 50 per cent. less, that is dearer, than usual, the corresponding money price is 100 per cent. higher; while if the quantity price becomes 50 per cent. more, that is cheaper, the corresponding money price is only 33 per cent. lower. From a money point of view, therefore, a fall of 50 per cent. in the number of pounds for a rupee is much more serious than it seems to be, while a rise of 50 per cent. in that number is less advantageous than might at first sight be supposed. For financial purposes it would probably be best to convert the quantity prices at the beginning into their money equivalents, because it is impossible accurately to convert results (such as averages and the like) worked out in quantity prices into corresponding results, expressed in money prices.[1] Such conversions always give a too favourable appearance as regards cheap-

[1] For purely scientific purposes it would perhaps be best to work with the logarithms of the original prices, instead of with the prices themselves, regardless as to whether the prices are expressed in pounds for a rupee, or in rupees for a fixed quantity of grain. It would then be possible to pass directly from the results of one system to those of the other, without having to go through the labour of recalculation.

ness of food in times of plenty; and make the dearness of food in times of scarcity appear far less serious than it really is.

One of the most important practical results of this investigation probably is, that it affords a certain amount of power to predict the variations of prices in the coming sunspot cycle. Of course, until all those fluctuations which appear at present to be subject to no law have been explained and reduced to order, if ever that should be possible, exact prediction in any individual case is altogether out of the question, but as there is a regularly recurring eleven-yearly wave of prices running through the irregular fluctuations and following the sunspot wave in the manner defined by the curves, it is possible to form an estimate of the general level of prices in the different years of the coming sunspot cycle. There is thus some reason for believing that the present period of low prices following the last maximum of sunspots, which appears to have occurred about the end of 1882 or early in 1883, will not last very much longer, a brisk rise of prices being due in the Deccan and in Madras five years after the sunspot maximum, that is, in 1887 or 1888, and in more northern districts a year or two later.

This estimate will, of course, be subject to modification if it should be found that the sunspot curve is declining towards its minimum more or less rapidly than usual. The last period of sunspots appears to have been somewhat longer than the average, that is, about twelve years from the maximum of 1870 to that of 1882, instead of the normal length of almost exactly eleven years; and the coming minimum may possibly follow the last maximum more quickly than usual. Fortunately, the sunspot observations are not the only indicators of this cosmical periodicity, for, as I have shown in a paper communicated to the Royal Society in 1884, the magnetic observations recorded at the Colaba Observatory afford far smoother and more definite indications of this periodicity than the sunspot observations; and, what is even more important, the eleven-yearly magnetic variation precedes the sunspot variation by almost exactly six months, so that the magnetic indications are given half a year earlier than those of the sunspots. FREDERICK CHAMBERS

Bombay, April 1886

THE PHYSICAL APPEARANCE OF MARS IN 1886

A SERIES of observations of Mars were obtained here in March and April last with a 10-inch silver-on-glass reflector by With of Hereford. The powers employed were 252 and 475, but I found no advantage from the latter, which seemed too high for the purpose. As a rule a single lens magnifying 252 was amply sufficient, though there were several occasions when a power of about 350 would have been a decided acquisition.

The planet came to opposition on March 6, but during the first three weeks of March we had intense frosts, and it was not feasible to commence observations until towards the end of that month. The opposition magnitude of Mars was only 16"·6, so that as regards apparent diameter the planet was far from being favourably placed. At the opposition of 1877 the diameter was no less than 29"·5. But at the recent opposition the north hemisphere of the planet (which has not hitherto been so thoroughly examined as the south hemisphere, and does not exhibit so many striking features) was well presented for observation, the latitude of the centre of the disk being about 22° N. in March and April.

The markings seen were both numerous and diversified. There is evidently a mass of detail on the planet, which is, however, most difficult to trace out in reliable characters. Many faint lineaments reach the eye with sufficient distinctness to prove their existence, but they cannot be held steadily enough or with that perspicuity to allow of the delineation of their outlines, or to enable their relative positions to be correctly assigned. Only the more pronounced features can be drawn satisfactorily. The small diameter of Mars during the recent observations has in a great measure induced this uncertainty as to the physical aspect of the disk. Another cause is found in the rarity of really good telescopic images. Not only must the atmosphere be peculiarly favourable to sharp definition, but there must be an absence of wind. A complicated system of markings cannot be made out under the influence of annoying vibrations. Moreover, this planet, considered as a telescopic object, is far less satisfactory than either Jupiter or Saturn, and this circumstance, with the other drawbacks alluded to, have given rise to that uncertainty, and to many of the discordances, in regard to the visible markings observed on his surface.

My intention in the present paper is merely to describe general results, as a particular description would scarcely be intelligible without drawings. Between March 23 and April 30 the planet was examined on twenty-one evenings, and a considerable number of sketches were completed. During the period mentioned the weather afforded an unusual number of clear nights, and whenever the seeing was fairly good the visible features were carefully noted, the results being afterwards compared with each other and with former work in the same direction. My drawings correspond very closely amongst themselves, and there is a fair agreement in the main features with those depicted on the charts of Green, Schiaparelli, Knobel, and others. I have also compared them with the views given in Terby's work on Mars and with Boeddicker's drawings of 1881 and 1884 (with Lord Rosse's 3-foot reflector) published in the scientific *Transactions* of the Royal Dublin Society, and find in many instances a substantial confirmation. Some of the differences are larger than would have been considered probable, but experience has taught us that it is useless to expect uniformity in delineations of planetary details.

During the five weeks over which my observations extended I saw no conclusive evidences of physical changes in any of the markings. But the period was too limited, and the circumstances affecting the review altogether too unfavourable, to enable me to speak definitely on this point. The slight differences apparent amongst my drawings are merely such as were occasioned by changes in local atmospheric conditions. On a bad night faint markings, previously distinguished, would appear obliterated, and on thoroughly good nights I saw delicate appearances which were utterly beyond reach on less auspicious occasions. I am convinced that these changes in the character of the seeing, exercise great influence on the distinguishable features of a planet; more so, in fact, than observers usually concede. Inferences of real change are sometimes hastily adopted in consequence, but they can only be substantiated after the most searching examination and the most convincing proofs.

The exterior edges of many of the well-defined seas on Mars are very brilliant, and their boundaries very definite. These brilliant outlying borders remind one of the light areas often abutting on the dark spots of Jupiter, only in the case of Mars they are more extensive, more permanent, and altogether dissimilar in form. I may instance a particular case of this bright bordering in the immediate region east of the Kaiser Sea on Mars. On several occasions this was so striking as to vie with the bright patch about the north pole. This shimmering extends several degrees east of the dark outline of the sea, but is limited by a faint and irregularly-condensed marking extending northwards, with an inclination east, from the knot in longitude 290° just east of the north extremity of the Kaiser Sea as figured in Mr. Green's chart. This marking runs over a considerable tract, and its east extension underlies Davies' forked bay and Burton Bay, to both of which it is connected by faint ligaments of shade,

reminding one of the "canals" of Schiaparelli. This special marking, which is not included in Mr. Green's map, may be identical with the network of dark narrow streaks figured in this region by Schiaparelli in his chart for January and February, 1882. It is also more or less definitely shown in some other drawings, notably on one by Schmidt, which forms No. 17 in Dr. Terby's Areography.

As to the Kaiser Sea, it appears very faint and narrow, not really broken, in the region some 10° or 15° south of its north extremity. This peculiarity is well drawn in Herr Boeddicker's drawings of December 27, November 19, and December 26, 1881 (Nos. 11, 13, and 14) in the scientific *Transactions* of the Royal Dublin Society for December, 1882. Consulting other drawings I cannot find that this feature is sufficiently indicated. It is obvious, however, that it would only be well detected when placed near the apparent centre of the disk as during the recent opposition.

Mr. Knobel's drawings in 1873 (*Monthly Notices*, vol. xxxiii., facing p. 476) agree generally with mine far closer than those he has published in the *Memoirs*, vol. xlviii. part ii., 1884. I always see Knobel Sea on Green's chart separated on its south side from the fainter curving band running east, as in the sketches Nos. 6, 7, 8, and 9, 1873. This break is not depicted in the subsequent drawings of 1884, so that the appearance has either been subject to actual variation of aspect or the difference of inclination has originated the want of uniformity. Probably the latter is the real cause, for the inclination of Mars in April and May, 1873, was nearly identical with that of March and April, 1886, and it is for these periods the drawings are so nearly alike in their more conspicuous forms. I see the northern boundary of Knobel Sea distinctly separate from the dark longitudinal strip immediately contiguous to the north polar cap. The drawing No. 12, May 19, 1873, by Mr. Knobel, portrays the leading features of this region much as I have more recently observed them. In 1884, Mr. Knobel delineated the whole mass of shading outlying the north pole as blended uninterruptedly, but these differences are unquestionably due to the changes of inclination, which must necessarily introduce such discordances into the apparent forms of the markings as observed at different epochs.

As to the canal-shaped features of Schiaparelli, first seen in 1877 and 1878, and subsequently confirmed, I have distinguished a large number of appearances highly suggestive of such a configuration, but the Italian drawings made during the three months from October, 1881, to February, 1882, give them a definite character, and (apart from their duplication) a straightness of direction and general uniformity of tone which my observations do not confirm. The more delicate and complex markings on the planet appear to my eye, under the best circumstances, as extremely faint, linear shadings with evident gradations in tone and irregularities occasioning breaks and condensations here and there. If they existed under the same aspect and with the same boldness as delineated by Schiaparelli, they would have been readily detected here whenever the seeing was fairly good, for these objects are referred to as readily observed in the 8-inch refractor of the Milan Observatory in February, 1882, when the planet's diameter was only 13". The duplication of these lines was also traceable under the same unfavourable conditions. The wonder is, not that the eminent Italian astronomer has discovered such a marvellous extent of curious detail on this planet, because this detail unquestionably exists, though scarcely in the form and character under which it is represented, but that he should have observed its more complex and difficult configuration at the very period when Mars was so very unfavourably situated for observations of this critical nature.

The surface markings of this planet are so numerous and varied that they are far from being adequately represented on existing charts. In certain regions the disk is so variegated as to give a mottled appearance. Dark lines, and spots, and bright spaces are so thickly interspersed, and so difficult to observe with sufficient steadiness to estimate their positions and forms, that I found it impossible to make thoroughly satisfactory drawings. An observer has to be content with endeavours to depict the more prominent marks only, and even in connection with these there is always some element of uncertainty. The rotation-period of the planet is, however, so slow, the hourly rate being only 14°·6 in comparison with 36°·7 in the case of Jupiter, that plenty of time is afforded for drawing the leading markings before they show a displacement obvious to the eye. In addition to this a drawing of Mars may be made to rest on several successive evenings of observation if the observer comes 37·4 min. later to the telescope on each occasion. In regard to Jupiter the difficulty of suitably drawing the details is far greater, though they admit of more ready observation. The rapid rotation of this planet displaces objects in a few minutes, and makes it imperative that the work both of observing and charting should be very hastily performed; and it is not feasible in this case to base a sketch on observations of following nights, because the markings are influenced by different velocities, and suffer large relative displacements even at short intervals of time.

During the past few months the north polar cap of Mars has been very bright, sometimes offering a startling contrast to those regions of the surface more feebly reflective. Some of the other parts were also notably brilliant. These luminous regions of Mars require at least as much careful investigation as the darker parts, for it is probably in connection with them that physical changes (if at present operating on the planet's surface) may be definitely observed. In many previous drawings and descriptions of Mars sufficient weight has not been accorded to these white spots.

Many of our leading treatises on astronomy attribute a dense atmosphere to Mars, but nothing has been observed during my recent observations to corroborate this theory. It seems to me far more plausible to assume that the atmosphere of this planet is extremely attenuated. The chief spots are invariably visible, and the phenomena occasionally observed are rather to be imputed to the vagaries of our own atmosphere than to that of Mars. Jupiter and Saturn are doubtless enveloped in dense vapours shrouding their real surfaces from terrestrial eyes. Their markings are atmospheric, though in some cases very durable, and constantly undergoing changes of aspect and displacements of position by longitudinal currents. On Mars a totally different nature of things prevails. Here the appearances descried are absolute surface markings displaying none of the variations which are so conspicuously displayed in the markings on Jupiter. It is probable that many, if not all, the changes supposed to have occurred in the features of Mars are simply attributable to the constantly varying conditions under which the planet has necessarily to be observed. Were the circumstances of observation more equable there would be much greater unanimity amongst observers of this interesting object. It seems to me that the very pronounced character of the markings and their great permanency are quite opposed to the idea that the planet is surrounded by a dense cloud-laden atmosphere.

W. F. DENNING

M. CORNU ON THE HYDROGEN FUNCTION OF CERTAIN METALS[1]

WHEN we examine on different photographs those groups of lines which reappear periodically with a particular regularity, we find that these groups belong

[1] Translation from an article in the *Journal de Physique*.

precisely to the category of those which reverse themselves; for some are reversed and the others are on the point of being so. For the same metals, the reversals are more or less complete according to the conditions of the experiment, and for different metals according to their chemical and physical properties.

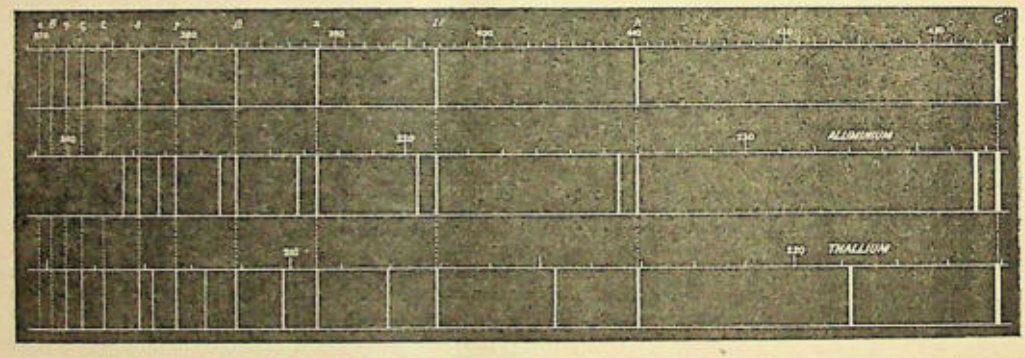
The law of distribution of these groups presents another common character relatively to the succession of distances and intensities: the lines get nearer together towards the more refrangible end and diminish in intensity. This character is much the more striking when the number of reversed lines is considerable, because the field on which they appear is more uniform. It seems that with the elevation of temperature the spectrum tends towards a limit, that of a continuous brilliant background despoiled of all lines except the regular series of the self reversing ones. It is to this constitution that I wish to draw the attention of observers.

The number of metallic spectra capable of giving a regular series of spontaneously reversed lines on a continuous background is considerable; but the most beautiful series that I have observed were supplied by two metals which one could scarcely have anticipated, from a chemical point of view, to find side by side; these are aluminium and thallium, whose equivalents are at the extremity of the list of those of the simple bodies. The diagram gives an idea of the distribution of these reversed lines; one sees that they form in each spectrum a series of doublets fulfilling the conditions of distance and intensity given above.

I shall not stop to indicate the fruitless trials of numerical calculations that I have taken in hand in order to represent each of these series by the substitution of the series of entire numbers in a simple function; I may add that I had given up these researches until the discovery of Dr. Huggins on the spectra of white stars brought back my attention to this subject.

These spectra present, in fact, a common series of dark lines, that is to say, reversed, fulfilling precisely the conditions of distance and intensity which characterise in metallic spectra the spontaneously reversed lines: they prolong the series of well-known lines of the spectrum of hydrogen, C, F, G, *h*. One could then foresee that the whole series belonged to them; that is what has since been confirmed by Vogel, though this result is still not quite certain. The interest of this identification was such that I sought to prove it myself, which I could not realise till lately. The experiment is not without difficulty; but in taking more minute precautions to get rid of all impurity in the hydrogen, I have seen the impurity lines obliterated, and finally I succeeded in obtaining photographs showing the series of star-lines in all their purity.

The spectrum of hydrogen is placed on the first line in the above diagram: the comparison has been rendered



DESCRIPTION OF THE DIAGRAM.—The graduations define the lines according to their wave-lengths. The first line represents the dark lines of the violet and ultra-violet spectra of the white stars. The second represents a double series of inverted lines in the ultra-violet spectrum of aluminium (electric arc). The scale of the drawing has been chosen in a manner to make G and δ coincide with the homologous lines of the first series (first line of each doublet). One could have operated in the same way with the second series (second lines). This mode of representation advantageously replaces the numerical tables, showing the verification of the two empiric formulas—

$$\text{First series} \quad \lambda_1 = 47{\cdot}30 + 0{\cdot}45783\,h$$
$$\text{Second series} \quad \lambda_2 = 47{\cdot}18 + 0{\cdot}43678\,h$$

which give the length of the wave of each line in function of the wave-length *h* of the corresponding line of hydrogen; the difference between the calculation and the observation is of the order of the experimental errors. The third line represents a double series of inverted lines in the ultra-violet spectrum of thallium (electric arc). The scale of the drawing was chosen like the one above; the empiric formulas which represent these two series are:—

$$\lambda_1 = 94{\cdot}61 + 0{\cdot}20776\,h$$
$$\lambda_2 = 111{\cdot}31 + 0{\cdot}75094\,h.$$

easier by the choice of scales showing intuitively the identity of the law of distribution of lines in the three spectra.

We might compare in the same way the more complex groups, like magnesium, zinc, sodium, &c.; the only difficulty is to establish the agreement of the groups; we do this immediately by a quite simple graphic construction. We arrive at the following statement, which resumes the whole of my researches. In the metallic spectra certain series of lines, spontaneously reversed, present sensibly the same law of distribution and intensity as that of the hydrogen lines.

It is not necessary to dwell on the importance of this relation: it makes evident the existence of a law which is general relatively to the emissive powers of incandescent vapours, and, again, it shows that this law of succession of spectral lines, common to so many series, seems to be expressed by the help of the same function, which one might call the hydrogenic function, which should play the principal part in these studies: the result then appears to constitute a first step towards the solution of the great problems which the spectroscope brings on for solution.

R.

VEGETATION OF SOUTH GEORGIA

ON Tuesday, January 17, 1775, Capt. Cook landed on this remote island, which is situated about 1000 miles east of Cape Horn, in about 54° S. lat. and 37° W. long., and took possession of it in the name of King George the Third, after whom he named it. Capt. Cook landed in three different places, and the ceremony of adding the island to the British dominions, he informs us, was performed under a waving of colours and a discharge of small arms. Whether any British subject has ever set foot on it since that day I know not; but the description of the island by its famous discoverer was not likely to tempt any one to go out of his way with that object in view. Although

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Of Nature trusts the mind which builds for aye."—WORDSWORTH

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lying only as far south of the equator as York is north of it, South Georgia is covered, in the higher parts at least, with permanent snows and glaciers, and is altogether of a most wild and desolate aspect. Large masses of ice were continually breaking off from the perpendicular cliffs and falling into the sea with a noise like cannon. "The inner parts of the country," says Cook, "were not less savage and horrible. The wild rocks raised their lofty summits till they were lost in the clouds, and the valleys lay covered with everlasting snow. Not a tree was to be seen, nor a shrub even big enough to make a toothpick. The only vegetation we met with was a coarse strong-bladed grass growing in tufts, wild burnet, and a plant like moss, which sprung from the rocks."

Animal life, however, was more abundant. Seals were plentiful, and the penguins the largest ever seen by Cook; some which were taken on board weighed from twenty-nine to thirty-eight pounds. Eight kinds of "oceanic birds" are enumerated, and one, a yellow bird, was found to be delicious food. All the land birds observed were "a few small larks." From Cook's narrative it appears that Forster, the botanist, was one of the landing party, hence it might have been expected that few flowering plants would have escaped observation, especially as the visit was made in January, the midsummer of the southern hemisphere. Forster himself states ("Observations made during a Voyage round the World," p. 16) that South Georgia is an isle of about eighty leagues in extent, consisting of high hills, none of which were free from snow in the middle of January, except a few rocks near the sea. And he adds that there was no soil except in a few crevices of the rocks.

No further information respecting this island has been published, so far as I am aware, until since the return of a recent German Expedition, which made the island one of its stations for meteorological and other observations. When collecting the materials to illustrate the flora of the very much broken coldest southern zone of vegetation for the "Botany of the *Challenger* Expedition," I had to be content with Cook and Forster's very meagre accounts of South Georgia; but from the published northern limits of drift ice in different longitudes in the southern hemisphere, it was not expected that South Georgia possessed much more than the scanty flora they attributed to it, though Macquarie Island, in the same latitude, and nearly in the longitude of New Zealand, was known to support a comparatively luxuriant vegetation. Dreary and barren as it is, however, South Georgia is not so bad as it has been painted. The officers of the German Expedition spent nearly a year on the island, and appear to have explored it thoroughly, botanically and otherwise. During this period the atmospheric pressure was subject to extraordinary fluctuations, the extremes exhibiting a difference of 64 millimetres, or a fraction over 2½ inches, while the range of temperature during the same period was only 48°6 Fahr., or in round numbers, from 8° to 57° Fahr.; thus showing the freezing-point to be nearly midway in the range. The actual mean temperature of the year was 35°06 Fahr.; of June, the coldest month, 25°6 Fahr.; and of February, the warmest month, 47°6 Fahr.

With regard to the flowering plants collected in the island by Dr. Will, one of the officers of the Expedition, we are indebted to Dr. Engler for an enumeration of them in his *Jahrbücher*, vol. vii. p. 281. They are thirteen in number, and their general distribution is so extremely interesting that I may be pardoned for giving it in detail:—

(1) *Ranunculus biternatus*, Sm. (Ranunculaceæ).—Fuegia, Falklands, Tristan d'Acunha (?) Marion, and Kerguelen Islands.

(2) *Colobanthus subulatus*, d'Urville (Caryophyllaceæ).—Fuegia, Campbell's Island, New Zealand, and Alps of Victoria, Australia.

(3) *Colobanthus crassifolius*, d'Urville (Caryophyllaceæ).—Fuegia and Falklands.

(4) *Montia fontana*, L. (Portulaceæ).—Fuegia, Marion, Kerguelen, Campbell's Island, and widely diffused.

(5) *Acæna adscendens*, Vahl. (Rosaceæ).—Fuegia, Marion, Crozets, Kerguelen, Macquarie Islands, and New Zealand.

(6) *Acæna lævigata*, Ait. (Rosaceæ).—Fuegia.

(7) *Callitriche verna*, L. var. (Haloragæ).—Fuegia, Marion, Kerguelen, Heard Islands, New Zealand, and widely diffused.

(8) *Juncus novæ-zealandiæ*, Hook. f. (Juncaceæ).—New Zealand.

(9) *Rostkovia magellanica*, Hook. f. (Juncaceæ).—Andes, Fuegia, Falklands, and Campbell's Islands.

(10) *Aira antarctica*, Hook. f. (Gramineæ).—Fuegia, Falklands, South Shetlands, and Kerguelen Island.

(11) *Phleum alpinum*, L. (Gramineæ).—Magellan's Straits, and widely dispersed in the cold regions of the northern hemisphere.

(12) *Festuca erecta*, D'Urville (Gramineæ).—Fuegia, Falklands, and Kerguelen

(13) *Poa flabellata*, Hook. f., syn. *Dactylis cæspitosa*, Forst. (Gramineæ).—Fuegia and Falklands.

From the collector's remarks, appended by Engler to each species, it appears that some of the foregoing plants flourish luxuriantly in South Georgia, especially the species of *Acæna* (the burnet of Cook's narrative), and *Aira antarctica* and *Poa flabellata*. The *Ranunculus* was abundant by the side of a stream and elsewhere, and *Colobanthus subulatus* (doubtless the moss-like plant mentioned by Cook) formed large tufts on the south side of the hills. Nine out of the thirteen plants in South Georgia are also found in the eastern part of this southernmost zone of vegetation from Kerguelen to New Zealand, taking these islands together. One, *Juncus novæ-zealandiæ*, had not previously been found in what may be termed the American part of the zone; but, as Prof. Buchanan, to whom Dr. Engler submitted the South Georgian specimens, remarks, this is so nearly allied to the South American *Juncus stipulatus* that it may be cited as another instance of representative and closely-allied species in the American and Australian regions.

Thus are we gradually obtaining a knowledge of the vegetation of the detached fragments of the Antarctic flora; yet several islands are still quite unknown botanically or only very imperfectly. Concerning Diego Alvarez, or Gough Island, situated about 4° south of the Tristan d'Acunha group, we know nothing except that the vegetation is said to be similar to that of Tristan d'Acunha, and to include *Phylica nitida*, the only arborescent member of the latter flora. Then there is a group of islands, including Lindsay, Bouvet, and Thomson, in about the same latitude as South Georgia, but 35° eastward, of which nothing is known botanically.

W. BOTTING HEMSLEY

NOTES

THE Visitation of Greenwich Observatory takes place on Saturday next.

THE Ladies' *Soirée* at the Royal Society takes place on the evening of Wednesday, the 9th inst.

THE honour of C.M.G. has been conferred on Mr. Charles Meldrum, Director of the Royal Alfred Observatory, Mauritius.

THE explosion of the 43-ton gun has led to the appointment of a Committee of Inquiry, in which the name of Mr. Anderson is conspicuous by its absence, although surely no greater authority on the points at issue exists. A year ago, in his important lectures at the Society of Arts, he drew attention to the want of relation between the sections and pressures, and predicted disasters.

Sir Bernhard Samuelson, M.P., and Mr. Philip Magnus, of the City Guilds of London Institute, have been appointed by the Education Department English representatives at the International Congress on Technical Education, to be held at Bordeaux in September next.

Prof. Flower, the Director of the Natural History Department of the British Museum, has allowed the zoological collections made by Brigade-Surgeon J. E. T. Aitchison, C.I.E., the naturalist lately attached to the Afghan Delimitation Commission, to be placed on view temporarily at the South Kensington Department. To those interested in the zoology of those regions and in the geographical range of species, a view of these collections in their entirety will be found most interesting. We believe that at an early date this collection will be broken up to be sent to India, and distributed to various museums and countries, and that it is only localised here until such time as a report on its details is furnished to the Government of India.

Mr. Nicholson has been appointed Curator of Kew Gardens, in the room of Mr. Smith, resigned. Mr. Nicholson has been one of the chief assistants at the Gardens for some years.

A series of Conferences on the "Mineral Resources of the Colonies and India" will be held by the Geologists' Association in the Colonial and Indian Exhibition on Saturday afternoons, commencing at 3 p.m. After the reading of the paper there will be a discussion, terminating at 4.30. The Conference will then adjourn to the Courts, where further explanations of the exhibits will be given. The first meeting will be on Saturday next, when an address will be given on the Mineral Resources of India and Burmah, by Prof. V. Ball, F.R.S.; Sir Richard Temple will preside. The arrangements for succeeding Saturdays are as follow:—June 19, South Africa, by Prof. T. R. Jones, F.R.S.; Sir Ch. Mills in the chair. July 3, Canada, by Dr. A. R. Selwyn; the Marquis of Lorne in the chair. July 17, New Zealand, by Dr. J. Von Haast. July 24, Australia, by Mr. F. W. Rudler. There will probably also be a lecture by the President of the Geologists' Association (Mr. W. Topley), on the Coaling Stations in Relation to the Fuel Deposits of the Empire; but the date of this is not yet fixed. Conferences of the Anthropological Institute on the Races of the British Empire will also be held in the Conference Hall of the Colonial and Indian Exhibition. The first was on Tuesday on the Races of Africa. The others are:—Monday, June 7: Races of America (West Indies). Tuesday, June 22: Races of Australia. Tuesday, June 29: Races of New Zealand, Fiji. Tuesday, July 6: Races (Aboriginal) of India. Tuesday, July 13: Races of Ceylon, Straits Settlements, Borneo. The chair will be taken at 4 p.m. The memoirs read and discussed in the Conference Hall will be illustrated by selections from the exhibits. Afterwards, but not later than 5 o'clock, the Conference will adjourn to the Courts, and there inspect and hear explanations of the remaining exhibits connected with the subject of the day.

The Lick Trustees have decided to purchase from Messrs. Feil and Mantois a 36-inch crown disk, which was made by them at the same time with the crown disk of the objective now in the hands of the Clarks. The Clarks "have received the order to figure this disk as a third (photographic) lens for the large objective."

A curious phenomenon, the *Scotsman* reports, was witnessed at Stonehaven on Sunday afternoon, May 23. At intervals, just before and after high tide, without any apparent cause, the water along the coast rose and fell from 10 to 18 inches at a time, the subsidence leaving as much as 15 to 18 feet of the beach dry. The disturbance continued for three hours, commencing at about half-past 4 o'clock. There was no wind, and the sea was quite smooth, but the water advanced and retired with a speed equal to the run of a large river during a spate, and caused so much commotion in the harbour that the fishermen had to secure their boats with extra moorings to prevent damage being done. Indeed, it is seldom that there is so much commotion in the harbour, even during stormy weather. It is surmised that the phenomenon was due to some eruption or subsidence in the sea bottom.

The Executive Committee of Aberdare Hall, Cardiff, has issued a most satisfactory report of the progress of Aberdare Hall during its first term. Seven students were entered when this Hall for lady students was opened in October 1885. Two of these are studying for the Intermediate Science Examination (London University), one for the Intermediate in Arts, and four for the Matriculation Examination. Two scholarships tenable at Aberdare Hall were awarded. At the beginning of the next session several large scholarships and many exhibitions will be offered for competition at University College, Cardiff, and three exhibitions tenable at Aberdare Hall. The institution deserves every encouragement.

The New York Assembly has passed the Bill providing for the appropriation of 20,000 dollars annually to the Metropolitan Museum of Art and the American Museum of Natural History, in order that they may be kept open to the public, free of charge, on Sundays. It is expected that it will soon be favourably reported by the Senate Committee, and become law.

Up to Saturday morning the accounts from Catania were reassuring; the flow of lava was much slower and was rapidly cooling, and Nicolosi was considered almost safe. But at 4 p.m. a fresh outpour of lava manifested itself, and flowing over the earlier stream which had partially hardened, it again menaces Nicolosi and Belpasso. At 9.15 p.m., the lava stream which threatens Nicolosi showed a front 180 metres wide, from 6 to 10 metres high, and was moving at the rate of 10 metres per hour. According to latest reports the eruption is as active as ever.

On April 28 a lovely mirage was seen at about noon at Östersund, in Northern Sweden. In the south-west, above the Storsjö, a great lake, the lofty Oviks Mountains, covered with snow, were seen reflected on the sunlit clouds. Below them was a dark broad belt of forest sloping down to an ice-covered lake, in which some woody islands could be seen. At the beginning the western sky was clear, but gradually a dark bank of clouds rolled up, at last obscuring the mirage, but it reappeared several times when the sun broke through.

Mr. Penhallow, who has resided for some years in the service of the Japanese Government in Yezo, contributes to the last number of the *Canadian Record of Science* an article on the physical characteristics of the Ainos. Referring to the many contradictory reports as to the great hairiness of the Yezoines, his conclusion is that, although there are many exceptions, they generally possess a more than ordinarily hairy body, enough so at least to make them deserve the epithet of "hairy Kuriles." The bushy appearance of the hair and beard is doubtless due as much to the fact that the men never shave and seem rarely even to clip their beards, as to any natural excess of growth. The Aino of Saghalien offers a striking departure from the rule of hairiness which essentially characterises the Yezoine; and this would appear therefore not to be a race characteristic, but to be due to the peculiar and widely different conditions of life, dress, and exposure to which these people have been subjected. From

number of measurements, Mr. Penhallow sum-
ysical characteristics of the Ainos as follows:—
is usually high, though narrow; eyebrows heavy
ng; nose somewhat inclined to flatness, though
more so than in Europeans; mouth wide, but well
d; chin well formed and medium size; eyes straight,
wn, and dull; cheek-bones inclined to be prominent; facial
gle high, the mean of the measurements giving an angle of
2°; the body is compact, well built, and muscular; much more
han ordinarily hairy, skin of light colour, comparable to that of
Europeans, and the average height is about 5 feet 2 inches.

THAT frogs have a formidable enemy in the common mouse
s evidenced by the following incident. A correspondent, Mr.
W. August Carter, of South Norwood, states that he observed,
short time since, several mice pursuing some frogs in a shed
which was overrun with these reptiles. The alacrity of the
atter, however, rendered the attacks of the mice futile for a
onsiderable period. Again and again the frogs escaped from
he clutches of their foes, but only to be recaptured, severely
haken, and bitten. The energy put forth by these reptiles was
eat that they actually swayed their captors to and fro in
eir efforts to wrest themselves from their grasp. At length
ne wounds inflicted upon them rendered the frogs incapable of
rther resistance, and they were easily overpowered by the
nice, which devoured a certain part of them.

IN a lecture recently delivered before the Scientific Society of Bamberg, Dr. Hartwig, the Director of the new Astronomical Observatory there sketched out the future work of that institution. It was well, he said, that an observatory should devote itself to some specialty, with which its name would be associated, as that of Paris was with the determination and mapping of the fixed stars, Greenwich with the movements of the moon, Vienna with comets, and so on. In a similar way Bamberg would occupy a certain limited field, and labour therein. In the first place it would undertake the systematic investigation of the parallaxes of the fixed stars, a work which had already been partially performed at the Cape Observatory for the southern, and at Newhaven in the United States for the northern hemisphere. Bamberg will be provided with a new 7-inch heliometer, the largest of its kind at present in the world, although the Cape Observatory will shortly be provided with one of the same size. The present Cape heliometer is a 4-inch, and that at Newhaven a 6-inch one. Dr. Hartwig said that this 7-inch heliometer is at present the finest instrument known to astronomy. He pointed out that at present the parallaxes of only eight or ten fixed stars were calculated, while about three thousand remain to be done, and this, he said, would take a single qualified observer more than thirty years to accomplish. He hoped that as Leipzig and Göttingen were about to be provided with heliometers, they would participate in the work, so that in a comparatively short time we may obtain a more accurate notion of the distance of many fixed stars and of their grouping in space. Another work which Bamberg would undertake is the investigation of the physical libration of the moon—a problem that has been studied at Königsberg since 1845, and in Strasburg since 1870. After describing at some length the instruments with which the new Observatory is provided, Dr. Hartwig concluded by assuring his hearers that with these an observatory would be established which would take a high place amongst existing astronomical institutions, and which would be excelled in Germany by the Observatories of Strasburg and Potsdam alone. The Bamberg Observatory, it should be stated, owes its existence to the munificence of a private individual, the late Dr. Remeis, a member of the Scientific Society of Bamberg.

THE *Darling Downs Gazette* of March 20 describes some recently discovered caves fifteen miles from Rockhampton, Queensland. A party, headed by Mr. W. M'Ilwraith, of the Rockhampton Natural History Society, recently visited the caves. From some wells on the route they saw the peaks of an uncommon range of hills. "They stand up in a fine sharp profile like the pinnacles and turrets of a stately Gothic pile. The vestibule of the wonderful structure is formed by an immense chasm in the rocks. Two walls of limestone or marble rock set in an acute angle rise on either side to a height of about 60 feet, and converge in front at a higher elevation. At 9 o'clock at night the party began exploring, and after clambering over a mass of detached, sharp-edged, pock-pitted rocks, got into a rocky chamber. Its walls were beautifully white in parts, and show the rock to be of limestone formation. They visited in succession caves of different dimensions, and named one the 'Chinese Joss-house.' It is a little recess off the passage; the walls are beautifully white, and stalactites and stalagmites unite to form beautiful pillars, the whole being wonderfully beautiful, reminding the visitors of Chinese ivory carved work. In the morning they continued their exploration, wandering through numerous passages, and crawling and slipping till they came to a large cavern. In one of the passages the bats extinguished their candles, and they returned to the upper regions. They then saw daylight streaming from the opposite side of the mountain, and estimated the distance from light to light at five chains or more. They returned to the starting-point, climbed a ladder, and traversed other passages, and crossed a gulf on a bridge formed of saplings. Eventually they reached a wide opening, and the light poured in from an opening in the caves. This latter is a large chamber, and in it are the roots of a tree, which have taken hold in the bottom of the cave, and hang like ropes. The most striking stalagmites in it resemble the head of an elephant and the bust of a man. Various caves were discovered, and also openings leading from one main suite of caves to another one. The cave particularly alluded to is called 'The Cathedral.' It is 50 feet long from the porch to the pulpit stairs, 30 feet across, and the ceiling is so lofty that the gleams of the candle did not reach it. There are stalactitic formations on the ceilings and floor, but the walls are plain, and have niches in some parts. Some of the party descended 60 feet here, and in another failed to reach the opening. The writer says, 'Wherever we went almost underground our footsteps had a hollow sound, and the conclusion we come to at present is that the region has been a hot-spring area, and the caves were formed by the action of hot water.'"

THE various species of Salmonidæ hatched out and reared by the Buckland Museum authorities have been turned into the Thames at Penton Hook, with a view of replenishing the stock of fish in that river. The Thames Angling Preservation Society are making arrangements to receive a consignment of land-locked salmon fry at their nursery again this year, in order to rear them for the Thames. The exertions now being made to re-stock the unpolluted portions of this river are sure to terminate in good results, indeed many of the trout taken lately are said to be the result of previous efforts made by pisciculturists in this direction.

ORNITHOLOGISTS, antiquarians, and librarians will in a few days have the opportunity of possessing a book which is said to be the only work published on the subject of duck decoys. It will be in quarto, with many illustrations, coloured and woodcut. Its author, Sir Ralph Payne-Gallwey, is already known to naturalists by his book on wild-fowl, issued some few years since by the publisher of the present volume, Mr. Van Voorst.

DR. VON HAAST writes that the large geological relief model of New Zealand, referred to in our recent article on the Colonial

and Indian Exhibition, has been prepared by Dr. James Hector, the Director of the Geological Survey of New Zealand, and forms part of the large exhibit of that gentleman. There are several large labels inside the glass case, in which the necessary explanations are given.

THE additions to the Zoological Society's Gardens during the past week include a Ring-tailed Lemur (*Lemur catta*) from Madagascar, presented by Mr. Angus Ogilvy; two Black-tailed Parrakeets (*Polytelis melanura*) from South Australia, presented by Mr. James Thomson; an Indian Cobra (*Naia tripudians*) from India, presented by Messrs. H. Thwaites and V. A. Julius; a Common Viper (*Vipera berus*), British, presented by Mr. W. H. B. Pain; a Loggerhead Turtle (*Thalassochelys caouana*) from the Atlantic Ocean, presented by Mr. R. G. Fraser, R.N.; a Rook (*Corvus frugilegus*), British, presented by Mr. H. J. Peckover; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, a Crab-eating Raccoon (*Procyon cancrivorus*) from West Indies; an Indian Cobra (*Naia tripudians*) from India, deposited; two Spotted Hyænas (*Hyæna crocuta*) from South Africa, two Side-striped Jackals (*Canis lateralis*) from West Africa, a Griffon Vulture (*Gyps fulvus*), a Smooth Snake (*Coronella lævis*), a Viperine Snake (*Tropidonotus viperinus*), European, purchased; two Triangular Spotted Pigeons (*Columba guinea*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

A CATALOGUE OF "COMPARISON" STARS.—Dr. N. M. Kam of Schiedam has published in *Verhandelingen der Koninklijke Akademie van Wetenschappen*, Deel. xxiv. (Amsterdam), a star catalogue compiled from the places of stars determined by meridian observations, which have been extracted from vols. i. to lxvi. of the *Astronomische Nachrichten*, and reduced to the epoch 1855·0. The positions of the stars contained in this catalogue were determined in connection with observations of planets and comets, and it was in compliance with Argelander's express desire that the work of collecting them and reducing the positions to a common epoch was commenced by Hoek, then Director of the Utrecht Observatory. Dr. Kam, who was Hoek's assistant, continued the work after the death of the latter, and has at length been able to publish his results. The principal catalogue contains the completely determined places of 4350 stars, and is followed by two subsidiary catalogues, the first giving the places of 236 stars, and the second those of 335 stars; all of the latter, however, are incomplete, *i.e.* the place is given in one element only. The catalogues are followed by a comparison of the places of the stars contained in them with their places as given in the Bonn *Durchmusterung*, or, for stars south of − 2° Decl., with other authorities. Notes on proper motions, corrigenda, &c., are appended, which are of considerable interest and value. We hope that the work of collecting and cataloguing the class of stars here dealt with will be continued either by Dr. Kam or by some other astronomer as well fitted for the task as he has proved himself to be.

THE PARIS OBSERVATORY.—Admiral Mouchez, Director of the Paris Observatory, has recently published his annual report to the Council of the Observatory. It is a very instructive and interesting document, and affords gratifying evidence of the enterprise and energy with which the work of this great institution is carried on.

The most striking portion of the report is that which deals with the work of the Bros. Henry in astronomical photography, but as this, as well as M. Lœwy's ingenious device for determining the amount of astronomical refraction, have already been noticed in NATURE, it will not be necessary to again refer to them. Leaving these two great undertakings therefore on one side, the rest of the report exhibits a large amount of solid work. The meridian service has comprised 16,173 observations, 795 of the sun and planets. The instruments of the Salle Méridienne have been devoted to the observation of Lalande's stars. As the great Catalogue approaches completion, the stars still to be observed become more widely scattered, and fewer observations are necessarily secured. The division-errors of the Gambey circle are being carefully investigated by M. Périgaud, and the Garden circle has been used for the determination of the absolute positions of a number of circumpolar stars. A apparatus has been constructed by M. Gautier, have been already observed with it. The same in has also devised a new mode of supporting a merc freeing it from the effect of tremors, which has work very satisfactorily. The equatorials have be as usual in observations of comets, minor planets, and the equatorial of the east tower having been employed by Henry in the revision of some of their photographic charts c taining very faint stars, especially the Pleiades and the regio round Vega and ε Lyræ. In the department of the calculations the calculations for the great Catalogue had been completed a far as 8h. of R.A., and were being carried on from 8h. to 12h. The Catalogue itself was printed up to No. 3800, and the manu script prepared up to No. 4700. Of the volume of observations for 1882, seventy-three sheets had been printed, and the res was in the printer's hands. The volume for 1883 had been commenced, and of the *Mémoires*, tome xviii., had been dis tributed, and tome xix. was in course of publication.

Several important investigations have also been carried on by individual members of the staff. M. Lœwy has devised a new method for determining the absolute co-ordinates of circumpolar stars, and M. Renan has published two notes on his experiments in application of these methods. M. Callandreau has published several notes on the theory of the figure of the planet and of the earth, and numerical tables for assisting in the calculation of ephemerides for minor planets; whilst M. Prosper Henr been engaged in devising suitable methods for the measurem and reduction of the photographic star-charts, which differ s widely from ordinary astronomical observations. A new deter mination of the length of the seconds pendulum has also bee made by Capt. Defforges, of the Geographical Service, the length corrected to sea-level being found to be 0·9939.m. Amongst the works to be carried out in the present year is the study of the movements of the soil by the aid of a multiplying seismograph devised by M. Bouquet de la Grye. The report concludes with a reproduction of a photograph of the Pleiades and a comparison of the results thus obtained by photography in a single hour with those obtained by M. Wolf in his study of the same group through the toil of years.

NOTES ON VARIABLE STARS.—Mr. Espin, the special observer to the Liverpool Astronomical Society, has recently commenced the issue of circulars calling attention to various variable stars or stars suspected of variation. Circular No. 1 gives an ephemeris for 10 Sagittæ, the next maximum, mag. 5·6, falling due June 5·4d., and the next minimum, mag. 6·4, June 11·1, period 8·317d. Circular No. 2 calls attention to the star D.M. + 8°, No. 3780, R.A. (1885·0) 18h. 32m. 51s., Decl. 8° 43′·5 N., as a probable variable. Circular No. 3 gives new elements for U Hydræ, R.A. 10h. 31·9m., Decl. 12° 40′·7 S., from whence it would appear that the next maximum is due 1886 June 25·5d. Circular No. 4 gives provisional elements for W. Cygni, R.A. (1886·0) 21h. 31m. 44s., Decl. 44° 51′·0 N., as follows:—P = 120 to 130 days, V = 5·8 ± to 7·5 ±, M = 1886 May 19 ±, *m* = 1886 Feb. 14 ±.

THE "CANALS" OF MARS.—M. Terby, in a note presented some little time ago to the Royal Academy of Belgium, drew attention to the occurrence in the drawings of Mars made by Herschel and Schroeter of several markings resembling the well-known Kaiser Sea in size and distinctness, and pointed out that M. Schiaparelli, in his observations of 1881-82, represented the "canal" Indus as developed to dimensions almost as great as those of the Kaiser Sea, and that this development coincide with the "gemination" or doubling of almost all the othe canals. M. Faye now announces at the last meeting of the Académie des Sciences that M. Perrotin and the other observer at the Nice Observatory have recently been able to re-detect M. Schiaparelli's canals. The reality of the existence of the delicate markings discovered by the keen-sighted astronomer of Brera seems thus fully demonstrated, and it appears highly probable that they vary in shape and distinctness with the changes of the Martial seasons.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JUNE 6–12

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)