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Annual Report of the

Board of Scientific Advice for India

for the year 1910-11

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BOOK NO.
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ANNUAL REPORT FOR 1910-11

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ANNUAL REPORT

OF THE

BOARD OF SCIENTIFIC ADVICE FOR INDIA

1910-11

SUMMARY OF PROCEEDINGS.

Twentieth Meeting held at Simla on the 15th May 1911.

The Board considered the reply by Professor Dunstan, the Director of the Imperial Institute, London, to the request of the Board that in addition to the names of external referees consulted by the Director of the Imperial Institute the names of officers of the Imperial Institute could also, when asked for, be furnished in connection with investigations conducted at the Imperial Institute on behalf of India. The Board accepted Professor Dunstan's decision not to furnish the names of officers of the Imperial Institute staff who had conducted investigations on behalf of India, but understood that it was not in accordance with the usual practice elsewhere to withhold the names of subordinate scientific workers and expressed the opinion that to do so would detract from the value of assistance which the Imperial Institute gives to science in India.

The programmes of the various scientific departments for 1911-12 were then considered. The Board resolved to accept them as they stood except that the Director-General of Observatories was at liberty to withhold from the programme certain items with which his reduced staff could not deal.

Twenty-first Meeting held at Calcutta on the 21st December 1911.

The Board considered the general question of the publication in unofficial journals or memoirs of results of investigations in the Departments of Agriculture, Civil Veterinary, Survey of India, Indian Museum—Zoological, Anthropological and Industrial sections—Forestry, Botanical Survey and Geological Survey. The Board recommended that all papers by the officers of those departments intended for publication should in the first instance be submitted to the head of the department concerned, but the Board were of opinion that the existing rules were adequate in this respect.

The draft Annual Report of the Board for 1910-11 was then considered. The Board resolved that contributors to the Annual Report should not necessarily confine their references to investigations the results of which had been published nor to purely departmental work; that the preparation of the report on Veterinary Science for the coming year should be entrusted to Colonel Pease; that subject to modification in several of the sections the report be adopted.

The revised distribution list of the Annual Report of the Board for 1910-11 was read together with new applications for copies. It was resolved that the list as revised be accepted.

APPLIED CHEMISTRY

BY

J. WALTER LEATHER, PH.D., F.I.C., F.C.S.,
Imperial Agricultural Chemist,

D. HOOPER, F.I.C., F.C.S., F.L.S.,
Curator, Industrial Section, Indian Museum,

AND

PURAN SINGH, F.C.S..
Forest Chemist.

The following is a review of the chemical work done during the year in connection with Indian industries and agriculture, and on Indian material examined in other countries. The matter has been arranged according to the following classification:—

I.—Analytical methods.
II.—Industries based on mineral production.
III.—Chemistry and physics of soils, water and manuring.
IV.—Analyses of organic raw products and manufacturing processes connected with them.

1. Gums, resins and rubber.
2. Fixed and volatile oils.
3. Dyes and dyeing.
4. Tans and tanning.
5. Fibres and paper.
6. Flour, sugars, starch, foods.
7. Accessories to human food.
8. Spirits.
9. Drugs.

I.—Analytical Methods.

Estimation of tannin.—Attempts were made to simplify the process for tannin estimation as adopted by the International Leather Trades Association by finding a suitable substitute of a definite composition for

hide powder. The Forest Chemist is glad to note that he has succeeded in doing so (36). Nickel hydroxide when freshly prepared makes a very good substitute for hide powder. Thirty-seven specimens of different Indian tanning materials such as Mangrove, Acacia, Oaks and Myrobalans were analysed side by side both by the chromed hide powder and freshly prepared nickel hydroxide with results that are in fair agreement with each other. The action of nickel hydroxide was tried on tannin and non-tannin solutions of known strength with the result that the whole of the tannin was precipitated, while such substances as cane sugar and glucose remained in the mother liquor.*

II.—Saltpetre Industry.

Saltpetre.—The refining of saltpetre in India has been the subject of investigation at Pusa. The defects of the present processes as employed in India are as follows:—

(*i*) The time occupied in recovering the refined saltpetre varies from five to ten days before the first product, the "Kalmi shora," and amounts to months before the second or "Kuthia shora" is obtained. Consequently the invested capital is "turned over" only slowly.

(*ii*) The quality of these products, especially the latter, varies, and frequently leaves much to be desired; the "Kalmi shora" varies from about 85 to 95 per cent. of pure potassium nitrate and the "Kuthia shora" from 65 to 75 per cent. It is generally more or less brown coloured.

(*iii*) The amount of water which has to be evaporated and consequently the fuel used is larger than should be necessary.

(*iv*) The processes are interfered with partly or wholly by the monsoon.

(*v*) The loss of nitrate entailed in the processes is not a small amount.

A modified process, which includes the use of special appliances, was devised last year with the object of remedying as far as possible the defects just enumerated. In this the crude saltpetre is heated with a limited amount of mother liquor to a temperature near the boiling point, so as to bring the potassium nitrate into solution. The hot liquid mass is then run into a filter which is maintained at a temperature of near 100°C., and the solution of potassium nitrate separated with the aid of

* A paper on the subject has been sent to the Society of Chemical Industry (36), London, for publication. Further work on the subject is in progress.

pressure from the insoluble matters. The hot clear filtrate is next run into coolers in which the nitrate separates as fine grained white crystals and this product is finally separated from the mother liquor by a centrifuge. Having worked well in the laboratory, a larger sized "plant" suitable for the refinement of one maund of crude saltpetre per day, was made in Mozafferpore and worked at the United Provinces Exhibition throughout the three months. It was found that about nine-tenths of the nitrate in the crude saltpetre could be extracted during the day in the form of a nice white refined saltpetre testing about 94 per cent. purity (that is 6 per cent. refraction) and the process was watched with considerable interest by refiners who visited the Exhibition.

A larger "plant" is now being made, capable of dealing with from 20 to 30 maunds of crude saltpetre daily with which the actual cost of working the process can be ascertained, which was not possible with the small exhibition "plant."

A description of the Indian processes and of the newly devised one has been published as a Bulletin of the Imperial Agricultural Department (18).

III.—Soils.

Drainage.—This subject was briefly referred to in last year's report. The records which have been maintained for some years at Cawnpore and at Pusa, have been compiled and examined and are now being published as a memoir (19). The following are the deductions which have been made:—

(*i*) The amount of drainage and evaporation in India exhibit the same characteristics that have been met with at Rothamsted, namely, the quantity evaporating is nearly independent of the season, whilst the drainage varies with the rainfall. The annual evaporation from fallow land at Pusa is estimated to be about 28″ whilst that at Cawnpore is about 18″ of water.

(*ii*) One effect of a crop is to reduce the amount of water *evaporating from the surface soil*, and the Indian records have provided an estimate of this protective effect. A good crop, whilst itself transpiring large amounts of water, will reduce loss of moisture in this manner to two-thirds or one-half of what it would be from exposed fallow land.

(*iii*) The amount of ammonia present in the drainage water both from bare fallow, as also from cropped land, is as small as

has been found at Rothamsted. The amount of nitrate has been in years of good rainfall much greater than at Rothamsted.

(*iv*) The amount of nitrate in drainage water from cropped land is very much less than from fallow land, which deficiency is in part due to assimilation by the crop, but there is also some evidence that higher plants interfere with nitrification.

(*v*) Nitrification has been found at Pusa to be active only during wet weather and then only for a short time.

(*vi*) The evidence of the Indian records goes to show that the water descending during wet weather passes very uniformly through the soil and not chiefly by means of "large channels" as has been commonly supposed.

Rab.—The *rab* process of heating the earth of paddy seed beds which obtains in most parts of the Bombay Presidency, has been the subject of investigation by Mann, Joshi, and Kanitkar (22). They have shown that heating the surface soil is an advantage to the seedling and this forms another instance of an effect which has been demonstrated by a number of European investigators, but they consider it probable that the effect is not wholly due to biological changes and attribute it in part to a physical change. They also directed attention to the use of oil-cake, more especially safflower cake, as a substitute for the *rab* process, and consider it probable that the field experiments at Lanovli will demonstrate the success of this substitution. One question which is very pertinent to this subject, seems to have been left unconsidered, namely, why it is that this *rab* process is met with only in the Deccan, Gujarat and parts of Sind, whilst it is never employed in other parts of India.

IV.—(1) Gums, Resins and Rubber.

Bombax gum.—The Semul tree (*Bombax malabaricum*) yields in the dry weather a white, opaque, viscous mass which turns red and finally dries into hard, brittle brown tears. This peculiar gum is called "Mocherus." Dr. P. P. Phillips investigated (33) its chemical properties and discovered that it contains a considerable quantity of catechol tannin. On hydrolysis with hydrochloric acid it yields an amorphous, insoluble, crimson substance named "Semul red" and a body reducing Fehling's solution.

Shellac.—Mr. A. C. Langmuir, whose method for the determination of rosin in shellac, based on the iodine absorption under fixed conditions,

has been recommended by the American Chemical Society as a standard, has contributed with Mr. F. S. White (17) a further paper on the analysis of shellac. The authors deal with various methods of iodine absorption when applied to old and fresh samples and they describe shellac-wax and give directions for separating the amount of arsenic added in the form of orpiment or yellow sulphide of arsenic.

IV.—(2) Fixed and Volatile Oils.

Fish oils.—At the instance of the Honorary Director of Fisheries to the Madras Government an enquiry has been made in the Indian Museum as to the nature of the fish oils used in jute batching. It appears that whale or fish oil obtained from Norway, Dundee and Glasgow, mixed with petroleum, is used for this purpose. Samples of the fish oils were found to have a specific gravity ranging from 0·910 to 0·921, acid values from 12·1 to 96·1, and iodine values from 46·1 to 152·1. The acid values are usually high on account of the oxidisable nature of these oils, and the low iodine value points to probable adulteration. The Director of Fisheries, Madras, subsequently sent samples of sardine oil prepared at Cannanore for the purpose of distributing them to the jute mills for an expression of opinion as to their value. The oils possessed a gravity ranging from 0·928 to 0·938, acid values from 4·18 to 37·01, and iodine values from 118·5 to 130·7. The oils proved to be satisfactory when mixed with mineral oil, and provided that they could be supplied at a reasonable rate the local product should meet with a ready demand in the jute mills.

Lemon grass oils.—An interesting account of the distillation of lemon grass oil has been contributed by Mr. W. Reinhart. Lemon grass (*Cymbopogon flexuosus* Stapf) occurs both in the wild state and as a cultivated plant on the western littoral of South India from Cape Comorin northwards to Malabar on the lower spur of the ghâts. The most important districts are the back country of Anjengo, the hilly borders of the Periyar river in Travancore, Peermade in Travancore and Nelliampathies in Cochin. In some few districts as for instance in Wynaad, the low aldehyde content of the oils produced had a discouraging effect upon the production, but the villagers are apparently able to make distilling pay even at as low a price as 2*d*. per oz. Messrs. Schimmel & Co. have recently shown (42) the constants of the readily soluble East Indian (*e.g.*, Malabar, Cochin or Travancore) lemon grass oil derived from *C. flexuosus* Stapf, and the so-called West India oil,

which is distinguished by its slight solubility, from *C. citratus* Stapf. These may be compared with the oil of two varieties of *C. Nardus*, citronella grass, growing in Ceylon.

——	Sp. Gr.	°D.	Citral content.
C. flexuosus	0·916	+ 0°25′	67·5%
C. citratus	0·892	− 0°25′	75%
C. Nardus	0·894 to ·929	+ 12°12′ to 6°32′	Geraniol. 39·1 to 64·7

The lemon grass growing in Jalpaiguri and the Duars, mentioned in last year's report as giving a pleasant smelling oil, has been identified as *C. pendulus* Stapf.

Sandal wood oil.—Mr. W. Reinhart has drawn attention to the preparation of sandal wood oil in Udipi, South Kanara, where it appears to be an ancient industry. Native merchants from Udipi attend the auctions in Mysore and Coorg every year and pay high prices for the wood. The centre of the industry is in the north-east of Karkal up to the foot of the ghâts. The wood is cut into chips and placed in earthenware stills about $2\frac{1}{2}$ feet high and $6\frac{1}{2}$ feet in circumference, water is added and the distillation is continued day and night for a whole month. The oil yield is said to be as follows: Roots about 4·34 per cent., Jugpokalo 3·47 per cent., and Ain Chittas 2·6 per cent. The oil is exported chiefly from Mangalore where it is shipped to Bombay for the Persian Gulf and China. The present value of the oil is about 32 sh. per kilo. Owing to the prolonged duration of the distilling process, decomposition products are formed which must necessarily injuriously affect the quality of the oil. A sample examined by Messrs. Schimmel & Co. (42) had a specific gravity of 0·9898 at 15° and a santalol content of 95·4. The high density, train-like odour and insolubility were unfavourable properties and could not account for the fancy price realised for it.

Oil-yielding qualities of sandal wood.—Fifteen specimens of sandal wood were received from Mr. F. A. Lodge, Conservator of Forests, Madras, for the determination of their oil value, and to find out if the wood of the trees growing in dry rocky mountainous soil is richer in oil than that of the trees found in the more fertile soils of the plains.

Three of the specimens were mostly sap wood showing 0·48 to 0·78 per cent. of essential oil, the others gave from 1·96 to 5 per cent. of oil. It was shown that the wood of the trees growing in rocky soil yielded more oil than that of the trees growing in comparatively fertile soils. The constants of the oil made by mixing the products obtained in the distillations are as follows:—

Specific gravity at 26°C.	·9765
Optical rotation	—15·6° to —16°
Saponification number before acetylation	9·72
Saponification number after acetylation	21·13
Santalol content	99·4

A note on the subject by the Forest Chemist has been prepared in which it is indicated that the industry of the distillation of sandal wood oil in India is full of promise.

Turpentine oil.—The high price of turpentine oil has created a renewed interest in the industrial exploitation of the indigenous *Pinus longifolia*, a tree which is rich in oil. In Kangra several experimental plots have been started in order to learn something of the potentialities of the industry, the best methods and times of tapping, the exact yield of given trees and the effect of repeated tapping on the life of the trees. The oil produced in India is about 50,000 gallons and is consumed locally. There are certain disadvantages in this oil which prevent its successful competition with imported American and European products. The reason for the difficulties in the way of the sale of Himalayan turpentine may perhaps be due to the fact that, as ascertained by Messrs. Schimmel & Co. (42), its composition differs altogether from that of ordinary oil of turpentine, the oil being especially remarkable for its high silvestrene content. For this reason it lacks the valuable oxygen absorbing and drying qualities which are peculiar to pinene. The oil of *Pinus longifolia* in fact possesses some resemblance to pine tar oil.

Cinnamomum glanduliferum.—Mr. R. S. Pearson, of the Forest Research Institute, Dehra Dun, has obtained from the leaves of this laurel tree growing in the lower Himalayas a camphor which must probably be regarded as identical with the Japanese commercial product. A sample sent to Messrs. Schimmel & Co. (42) possessed a melting point of 175°, and a specific rotation in alcohol of +46·32°. When boiled with acetic anhydride no alcoholic constituent, such as borneol, could be detected; the crude product therefore consisted only of d-camphor.

Pinus excelsa *Wall.*—A sample of oil distilled from the cones of the Indian Blue Pine has been examined by Messrs. Schimmel & Co. (42). The oil was of a yellow colour and possessed the following constants: Specific gravity at 15° 0·8757, ^{a}D −32°45′, acid value 0·5, ester value 5·6, corresponding to 2·0 per cent. of bornyl acetate, soluble in 5 volumes and more of 90 per cent. of alcohol. Turpentine is rarely extracted from this pine which grows at higher elevations than *Pinus longifolia*.

Xanthoxylum alatum *Roxb.*—The fruit of this tree belonging to the hills of Northern Bengal as well as China is called "Chinese Wild Pepper." Messrs. Schimmel & Co. (42) obtained by distillation 3·7 per cent. of a lemon-yellow oil with a peculiar odour of water-fennel, and 0·9 per cent. of a crystalline substance. The oil appears to consist chiefly of hydrocarbon, the nature of which remains to be investigated, while the odour suggests the presence of phellandrene. The solid substance was colourless, odourless, optically inactive and melted at 83°. It appeared to be a phenol or lactone-like compound, since it does not react with solutions of alkaline carbonates.

IV.—(3 Dyes.

Tephrosia purpurea.—The glucoside of the annual, *Tephrosia purpurea*, (Leguminosæ), which grows widely in India, has been separated by Clarke and Banerjee at Cawnpore. The dry leaves grown locally yielded about 2·5 per cent., and it was found to yield on hydrolysis quercetin, rhamnose and dextrose. The glucoside is apparently identical with rutin obtained from *Ruta graveolens* and with osyritrin which is the glucoside present in *Osyris compressa*.

IV.—(4) Tans and Tanning.

Manufacture of mangrove extract.—The commercial reports of the samples of Mangrove tannin extracts made last year at the Forest Research Institute point out the following defects on account of which the extracts submitted for valuation could not be used for tanning purposes: (1) excess of moisture, (2) presence of mildew, (3) earthy and dull appearance, and (4) iron contamination. The reports also indicate the commercial possibilities of the extract if it could be freed from the above-mentioned defects. The Forest Chemist, therefore, manufactured about 18 tons of Mangrove tannin extract again this year at the Rangoon Government Tannin Factory, eliminating, as far as was possible, the

defects pointed out above. This year no chemicals were used for decolourisation, because all chemical processes of decolourising tanning extracts can only be carried out at the expense of their tannin strength. According to the last year's reports, the best sample was a mixed extract of Mangrove and Myrobalans decolourised by sodium bi-sulphite in the vacuum pans. The colour measurement for red in this extract was 14. The extract made this year was also a mixed extract of Mangrove bark and Myrobalans in the proportion of 1 : 7. Owing to the bad quality of the bark used this year, the total quantity of the extract obtained was only 30 per cent. instead of an estimated yield of 50 per cent., 18 tons being the yield of 52 tons of the mixed material. Average samples of this lot of 18 tons of Mangrove tannin extract were sent to the Imperial Institute, London, and to Dr. Gordon Parker of the Leather Trades Laboratories, Bermondsey and some English firms, for opinion, who have pronounced this year's extract to be very satisfactory. The colour is said to be still too deep for an ideal tannin extract but the Forest Chemist thinks that this is solely due to the bad quality of the bark used. It is generally recognised that the extract prepared from fresh bark with distilled water gives very good results as regards colour. It may be pointed out here that last year the red colour of the extract was brought down from 33 to 14 by means of chemical treatment, and this year without resorting to any chemical treatment it was brought down to 16. Borneo cutch extract, which is recognised as a market standard, has a red varying from 8 to 10. All the other defects pointed out last year were successfully eliminated.

The extract has been sold this year at the rather low rate of £12 6*s*. per ton c. i. f., Glasgow, it being considered more important to put it on the market at once in order to test its commercial value, than to wait and secure better prices. The Forest Chemist is at present engaged in drawing up a complete report on the prospects of the manufacture of Mangrove and Myrobalans tannin extract in Burma.

Decolourisation of tannin extract.—While experimenting on the manufacture of tannin extracts from red coloured barks of Mangrove and Sal, it was noticed, as is generally admitted, that all chemical decolourisation of the tannin extracts entails a loss in the tannin strength as well as in the tanning properties of the extracts and that the best way to decolourise them would be by a suitable mixture of light coloured tanning materials with the red tanning barks. In continuation of this work, however, as the Forest Chemist was not satisfied with the chemical processes adopted by him for the

decolourisation of the Mangrove and Sal tannin extracts, he tried the action of aluminium and nickel hydroxides. The former proved unsuitable owing to its solubility in water, but the latter added in small quantities effectively decolourises the tannin extracts without showing the defects of the other chemical processes of decolourisation except a small loss in the tannin strength. The colouring matter in such barks as Mangrove and Sal cannot be differentiated from the tannins themselves as contained therein or from certain groups of them and therefore the process of decolourisation consists in fractionally precipitating some of the tannin, which precipitate while settling down takes with it some pectoid and resinous bodies which otherwise keep suspended in the tan liquors. This year only a small amount of preliminary work was done on the decolourisation of tannin extracts by nickel hydroxide and it is hoped that further work on the subject will show whether it would be economical to use nickel hydroxide as such on a commercial basis.

Gambier.—Mr. H. Brumwell in a paper contributed to the Society of Chemical Industry (2) deals with the manufacture, composition and microscopical examination of the extract of leaves and twigs of Gambier (*Uncaria Gambier*).

IV.—(5) Fibres and Papers.

Cellulose investigation.—Mr. William Raitt, Special Paper Expert, attached to the Forest Research Institute, Dehra Dun, gives (38) the following short account of the pulp experiments carried out by him :—

This investigation was begun at the Forest Research Institute Laboratory in March 1911, and is in continuation of that carried on in the laboratory of the Forestry Court of the Allahabad Exhibition during the last cold season. The possibilities of paper pulp production in India now form part of the general work of the Forest Economist, and the results obtained will be incorporated in his report. It has not as yet proceeded far enough to permit of these being recorded, but enough has been done to indicate the vast reserves of raw material suitable for the economical production of cellulose, contained in Indian forests and waste lands, in forms which hitherto have been regarded as waste or unutilisable products. The subject is one that in recent years has received considerable attention in other parts of the world as a result of the rapid growth in the consumption of cellulose for paper making and the many other uses to which this material is now being put, coupled with an equally rapid exhaustion of the chief sources from which supplies have hitherto been drawn, *viz.*, the Spruce and Pine Forests of the Northern Hemisphere. It would seem that the cellulose industry

which is now monopolised by Scandinavia and North America where it is rapidly using up a raw material which takes 40 years to reproduce, and is, therefore, living on and squandering its capital, must eventually migrate to tropical and sub-tropical regions where raw material can be found in species capable of, and growing under conditions which permit of, rapid natural reproduction. In bamboo and in many kinds of fibrous annual grasses, India possesses such species growing under such conditions.

IV.—(6) Flours, Sugars, Starches, Foods.

Phosphorus in Indian food-stuffs.—Referring to the enquiry undertaken last year in connection with rice and beri-beri, Major E. D. W. Greig has published (9) his report on "Epidemic Dropsy in Calcutta" as No. 45 of the Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India. The report gives the results of the analyses of several samples of milled and unmilled rices and other food grains consumed locally. Mr. Hooper has continued the work from a chemical point of view and his results are embodied in a paper on "Phosphorus in Indian food-stuffs" read before the Asiatic Society of Bengal (14). Beyond quoting the analyses of cereal grains before and after milling, an examination has been made of the rice-bran removed in the polishing process and its constituents are discussed. Most of the phosphorus may be removed in the form of phytin, a phospho-organic acid soluble in dilute hydrochloric acid and precipitated by alcohol. Fraser and Stanton have recently shown that the filtrate from phytin is effective in preventing polyneuritis in fowls. The filtrate evaporated to dryness affords 5 to 6 per cent. of phosphoric anhydride and about 1 per cent. of nitrogen and contains the chief basic principles of the rice.

Milk.—The yield of milk and the percentage of butter fat in it has been determined at the Poona dairy farm for Gir and Sind cows by Messrs. Meggitt and Mann over the period 1907-1908, and the following conclusions (24) have been drawn:—

1. In a mixed herd of cows of these two breeds, the composition of the milk may be considered to be fairly constant. The morning milk will contain between four and five per cent. of fat, and the evening milk between five and six per cent. of fat. Under the conditions of the Poona dairy farm, where green fodder is grown and fed throughout the

year, there will not usually be a very marked drop during the rains. The richest milk, taking the whole herd into consideration, is reached in the latter part of the rains.

2. The evening milk is nearly always richer than the morning milk. The difference is, however, less marked in the rainy season than during the remainder of the year.

3. Of the two breeds studied, the 'Gir' gives milk of decidedly poorer fat content than the 'Sind,' the average figures being—

	Morning milk. Per cent.	Evening milk. Per cent.
'Gir' cows	5·2	6·2
'Sind' cows	6·0	6·3

Thus there is a difference of nearly one per cent. in the fat content of the morning milk of these two breeds of cows. There is little difference in the composition of the evening milk.

4. There seems little relationship between the composition of the milk of individual cows and the yield, except that the milk becomes slightly richer at the end of the period of lactation. Apart from this, the milk yielded by a cow is wonderfully constant in composition whatever the amount of milk it is giving.

5. On the other hand, there is a very great variation in the composition of the milk of the animals of one breed. This is what would be expected in breeds of cows which have undergone no selection for many generations.

6. The average lengths of lactation for Gir cows is 40·5 weeks, and for Sind cows 50·8 weeks, but this varies very much, as would again be expected for unselected cows.

7. The yield of milk from a cow rises to its maximum almost at once, and remains almost constant for about the first two-fifths of the lactation period. After this there is a regular and steady decline to the end of the lactation.

8. Among Sind cows there is a tendency for the milk to become richer in fat as the lactation progresses. It seems more obvious in the case of the morning milk than with the evening milk, which usually becomes very marked in the last stage of the lactation. Among Gir cows the rise is not

nearly so constantly found. The figures, in fact, do not seem to indicate any constant relationship between the composition and the period of lactation of the Gir cows.

9. One of the most marked results of the whole investigation is to emphasise the extremely unselected character of herds of even recognised milking breeds like the 'Gir' and 'Sind' in India. The dominance of the individuality of the cows almost renders the environmental influences on the composition of the milk yielded incapable of being detected.

Ghee.—A further communication has been made by Bolton and Revis (3) on the composition of Bombay ghees in which they again emphasise that it is unsafe to depend only on the Reichert-Meissl value, and that the baryta value as obtained by the Avé Lallemant method should always be determined in order to assist in the detection of adulteration. Of seven samples examined five were shown to be adulterated.

Milk products.—In Afghanistan and Baluchistan, Nepal and Tibet a hard form of cheese is manufactured as a portable concentrated food. In the former countries it is a white chalk-like acid substance called 'Karut' or 'Krut,' in Tibet and Mongolia it is called 'Chura' and is sold in thick square pieces held together on a string. According to analyses made by Mr. Hooper the former contains 58 per cent. of casein and the latter 74 per cent. They both disintegrate in hot water forming a milk-like fluid. Analyses were also made in the Indian Museum of the preparations of curds used largely in Bengal called Chhana and Dahi. Chhana has the properties and composition of a rich cream with a pleasant acidulous taste. It contains twice as much casein as average cream and a lower proportion of butter fat. Dahi or Dadhi is a form of butter-milk in which a proportion of lactose or milk sugar is converted into lactic acid by fermentation.

Dahi and lactic acid.—The acidity of a number of samples of Dahi in terms of lactic acid has been determined in the Municipal Laboratory by the Health Officer of Calcutta. In view of the popularity at present enjoyed by curdled milk products several samples of the tablet preparations of lactic acid bacillary cultures were also tested. These cultures are imported for the production of curdled milk and they were examined both for their power of producing lactic acid and for their bacterial contents. While bazar Dahi after 24 hours contained 1·45 per cent. of lactic acid and had an aromatic odour, four imported preparations produced in sterilised milk from 0·34 to 0·53 per cent. of lactic acid and developed a sour

year, there will not usually be a very marked drop during the rains. The richest milk, taking the whole herd into consideration, is reached in the latter part of the rains.

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smell. The great value of lactic acid is its distinct antiseptic property in preventing intestinal decomposition and the multiplication of putrifactive organisms. These experiments show the much greater value of curdled milk as produced in Bengal under the name of Dahi to any artificial preparation produced by a proprietary article to induce fermentation.

Sugar.—Investigations on the sugarcane crop have formed the subject of two communications during the year.

The sugarcanes of Upper India differ in a very marked manner from the canes of other countries and it is well known demand different treatment for their successful culture. It was therefore a necessary preliminary to a survey of the canes of the United Provinces to study the effect of varying some of the cultural conditions on the character of the crop and the yield of sugar. It was thought by Messrs. Clarke, Annett and Zamin Husain (4) as a result of some preliminary experiments in 1908 that some interesting information might be obtained by studying the effect of planting the sets different distances apart.

Starting with a small number of sets per acre planted at wide distances apart, and gradually increasing the number and lessening the distance, it was hoped to ascertain with some degree of certainty the optimum number of sets and the optimum distance apart to plant them.

The experiments were carried out at the Partabgarh experiment station and extended over a period of three years 1908—1911. The results of each year's experiments have been graphically represented and show that where the number of sets per acre is small, *e.g.*, from 3,000 to 9,000, and the distances from centre to centre large, the yield of sugar per acre is liable to considerable variation and the curve for each year's experiments where this number of sets is employed is unsteady, but in some cases each year nearly the maximum yield of sugar is obtained by as few as 6,000 to 8,000 sets per acre where the conditions were ideal. When 12,000 sets per acre are reached the curve representing the yield of sugar becomes stationary and the yield of sugar is not increased by increasing the number of sets per acre beyond this amount. The interpretation of these results appears to be that although a full crop is possible under ideal conditions by the full development of a comparatively small number of sets, under ordinary conditions of cultivation, the risk of obtaining a sufficient number of stools fully developed is considerable if less than 12,000 sets per acre are planted.

The yields of cane per acre are on similar lines to the total yield of sugar, but it is not a general rule that increased yields of cane always mean a correspondingly increased yield of sugar.

In the whole of three years' experiments there is no example of any advantage being derived from using the excessive number of sets per acre that is common in the *desi* method. Indeed there is the disadvantage of rendering the cultural operations exceedingly difficult.

The details are being published as a Bulletin of the Imperial Agricultural Department.

In the "Departmental Records" of the Bengal Agricultural Department (44) Mr. Taylor provides detailed information regarding the composition of twenty-five varieties of Bengal canes. These data are of considerable value and show the composition of the juice, the amount of fibre in the cane and the amount of sugar left unexpressed in the bagass. Like others, he has found that the defect of Indian sugarcane does not lie so much in the quality of the juice, Indian canes being commonly as good in this respect as canes in other countries, but rather in the fact that the amount of fibre in these canes is commonly very high; he found it to vary from 12 to 19 per cent., and in only one cane did the proportion fall below 12 per cent. The effect of a high proportion of fibre is the retention of a high propoftion of juice, and consequently of sugar, in the bagass.

IV.—(7) Water.

Hughly river water.—In the last report of the Health Officer of Calcutta (32) some interesting remarks are made on the composition of the river water as it is supplied to the city after filtration in the sand beds at Pulta. Both the inorganic and organic constituents showed the same variations which have been observed in all previous years and which may appropriately be called "seasonal variations." From the beginning of January to the third week of June, the total solids ranged high, varying from 24·5 to 33·5 parts per 100,000, the maximum being observed in the middle of May. With the advent of the rains in the last week of June, the solids rapidly fell to 11·5 parts on the 28th August, as the minimum, rising to 13·5 parts about the middle of November; after that they gradually rose till by the end of December they reached 21·54 per 100,000. The amount of dissolved chlorides varied *pari passu* with the solids, ranging high during the dry months and diminishing during the rains. It was higher during the middle of May, amounting to 5·4 parts per 100,000, coming down to about 0·3 during the whole of October. It then gradually rose till the end of December when it amounted to 0·6 parts. The amount of "albuminoid ammonia" by Wanklyn's process

varied from 0·0032 to 0·0072 per 100,000. The amount of 'oxygen consumed' varied from 0·007 to 0·015 per 100,000, while nitrogen as nitrates ranged from 0·01 to 0·026. The water was found entirely free from nitrites, and free ammonia was found occasionally in traces only. Thus, chemically considered, the water maintained its character as a good potable water.

Calcutta water supply report.

For a period of one year the water in Calcutta has been subjected to a special bacteriological examination by Major W. W. Clemesha, I.M.S. (6). The river Hughly has also been carefully studied as regards its purity at different times of the year. The two important conclusions which have been arrived at in this report are (1) that the Calcutta filtered water is seriously contaminated by leakage of subsoil water into the masonry underground reservoir. This point is not new as engineers have pointed out this previously, but this is the first time that it has been proved bacteriologically to be the case (2). That the water as it comes into the filters during the wet weather months is not sufficiently purified during this time of the year. The Hughly itself is very highly polluted and the 50 hours' settlement, considering the lack of sunlight, and the amount of silt in the water, is hardly sufficient.

The possible methods of increasing the purity mentioned are (1) more storage capacity, (2) mechanical roughing filters, and (3) chemical sterilization. The Municipality are engaged in considering these suggestions.

Septic tank effluent in Bengal.—The various septic tanks in the neighbourhood of Calcutta have been subjected to a careful scrutiny throughout the year (5). As a rule they are of the "tank latrine" type. The tank is mostly a 5-gallon one as the sewage enters. The following is a rough analysis of what such an effluent should be like when the tank is working satisfactorily.

——	Chlorides.	4 hours oxygen.	Dissolved oxygen remaining.		Nitrates.	Remarks on physical character and sterilisation of effluent.
			24 hours.	48 hours.		
Unfiltered . .	6	3·5	·25	·1	*Nil.*	Slightly hazy but no fœcal odour.
Filtered . .	6	1·5	·45	·25	Present in large quantity.	Clear, slight earthy odour.

Most of the latrines are now giving a result very similar to this. A new chlorinating apparatus has been put into use this year so that the effluent is rendered free from intestinal organisms by the addition of liquor of chloride of lime before it passes into the Hughly. The apparatus is extremely simple and works admirably.

Water supplies in Bengal.—A report will shortly be published for the current year of the analyses of the various municipal supplies throughout the province. Most of these supplies are derived from rivers. In the hot weather and sunny months the purity of many of the large rivers is remarkable. Thus a sample taken in April of the middle of the Ganges at Buxar showed no fœcal organisms in 60 c.c. It is obviously very easy to obtain a good drinking water when the source is of such purity. During the time of rains, however, the rivers are very highly polluted and unfortunately in many cases the purifying arrangements are inadequate. Hence there is a considerable falling off in the quality of the filtered water during this time of year.

IV.—(8) Alcoholic Beverages.

Tari.—The alcoholic strength and acidity of fresh *tari* (the juice of palmyra and date palms) and fermented *tari* has been the subject of investigation by Mr. Jenks, the Officiating Director, Central Excise Laboratory (16). For the end in view instruments were carried on tour which admitted of the following determinations:—

(*a*) The acidity.

(*b*) The temperature and density.

(*c*) The alcoholic strength by means of Long's alcoholometer.

It was thus possible to carry out the tests on the "fresh" and "fermented" juice of the date and palmyra palms in the condition in which they are consumed. The tests were made at various places in Bengal, namely, Calcutta, Faridpur, Arrah, Bankipore, Malda, Hughly; and although required for excise purposes, the investigation is of general interest because of the fact that so little reliable information is available on the subject.

The following are the chief results:—

(*i*) No regular differences were observed between the composition of the *tari* of the palmyra, male or female, and the date palm, except that a lower original gravity was observed in a few fresh date *taris*.

(*ii*) The average alcoholic strength of fresh *tari* is about 3·4, that of fermented *tari* about 3·9 per cent. "Fresh *tari* is therefore an alcoholic beverage comparable with German draught beer or English household beer. There are important reservations as regards fresh *tari* to the above, *viz.*, that in places where there is a low night temperature in winter (*e.g.*, Arrah, Faridpur, where the temperature of the juice in the morning is only 58° to 60° F.) fresh date *tari* is totally unfermented and fresh palmyra *tari* averages only 2 per cent. by volume of alcohol."

The maximum strength found was 6·8 per cent. of alcohol.

(*iii*) The original gravity varied from 1,043 to 1,056.

(*iv*) The acidity of *tari* when the collecting pot was taken from the tree varied from about ·05 to ·5 per cent. calculated as acetic acid. In the *tari* obtained from shops it was somewhat higher, namely, ·2 to ·7 per cent. "*Tari*, however, is essentially a refreshing sweet acid beverage of the character of weak lime juice as drunk by Europeans (with say ½ per cent. free acidity) or even of sherbet rather than of a bitter astringent liquid like beer."

IV.—(9) Drugs.

Cannabis sativa.—Preparations of Indian hemp are at present standardised by a physiological method which consists in the administration to dogs of sufficient doses to produce distinct cerebral depression. This method possesses some disadvantages, and in some cases the percentage of experimental error is remarkable. A greater degree of accuracy can be obtained by experimenting on oneself. In 1908, Mr. Hooper suggested a chemical method of valuing Indian hemp, and proposed that the iodine value of the resinous constituents containing cannabinol should be taken as a gauge of the activity. Fresh samples of charas, bhang and ganja which are physiologically potent were found to have a higher iodine value than old samples which were considered inert. Drs. Marshall and Wigner have examined this method to determine its applicability for purposes of standardisation (23). They came to conclusion that physiologically inert or almost inert substances possessing an iodine number approximating to that of the active principle occur in variable proportions in preparation of Indian hemp and hence a chemical method is of no value. They examined approximately pure principles and found that certain fractions

having almost the same general physical characters and iodine value as the original cannabinol were much less active physiologically.

Mr. H. Deane has investigated samples of the extract of Indian hemp used in medicine and has suggested a process for obtaining a more satisfactory preparation (7).

Podophyllum Emodi.—The relative medicinal values of the resins of the two species of podophyllum, the American, *P. peltatum*, and the Indian, *P. Emodi*, have been the occasion of several chemical and physiological enquiries. The rhizome of the Indian plant yields twice the amount of resin as the American, but there has been a difference of opinion in regard to the activity of the resin. The Indigenous Drugs Committee in a recent report gave medical opinion to the effect that the Indian resin was about equal in value to the pharmacopœial resin made from the American root. It has been recognised in the Indian Addendum and it has been suggested that it should be included in the new British Pharmacopœia. Mr. J. C. Umney (45) on behalf of the Indigenous Drugs Committee has tested a supply of the Indian rhizome collected after fruiting and in a paper read before the British Pharmaceutical Conference showed that it afforded 10·79 per cent. of resin, and 50·3 per cent. of this consisted of picropodophyllin or podophyllin, the recognised active principle. Dr. W. E. Dixon also reported favourably upon its efficiency. In the Indian Museum report for the past year it is recorded that the roots of cultivated plants of *P. Emodi* in Kashmir yield between 13 and 14 per cent. of resin.

Withania somnifera.—The root of this solanaceous plant, well known in India as "Asgandh," has been investigated by Dr. F. B. Power and Mr. A. H. Salway (34). Both the roots and overground portions of the plant responded to tests for an alkaloid. A number of substances were present in the root, leaves and stems; these included essential oil, sugar, hentriacontane, a phytosterol, palmitic, stearic, cerotic, oleic and linolic acids, and ipuranol. From the root were obtained a new monohydric alcohol, withaniol, an amorphous alkaloidal principle, which on treatment with alkali yielded a crystalline base. The leaves and stems yielded the following new compounds: a monohydric alcohol, somnirol; a dihydric alcohol, somnitol; and an acidic hydrolytic product, withanic acid. The authors conclude that *Withania somnifera*, unlike some other solanaceous plants, contains no mydriatic alkaloid, and physiological tests, conducted on a dog, failed to confirm the sedatic or hypnotic properties attributed to it.

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ASTRONOMY.

BY

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Solar physics.—Researches in solar physics are carried on under the direct control of the Government of India at Kodaikánal, the Director being Mr. J. Evershed and the Assistant Director Mr. T. Royds. The chief instruments are:—

(*a*) A spectroheliograph made by the Cambridge Scientific Instrument Company, the object of which is to take photographs of the sun using the light emitted by one chemical element only. In this apparatus a stationary image of the sun is made by a 12-inch triple-achromatic lens of 20-foot focus, fed by an 18-inch Foucault siderostat. Close up to the image and somewhat longer than its diameter is the narrow vertical slit of a spectroscope arranged in such a manner that the light which has passed horizontally through the collimating lens shall be deflected through two right angles by two prisms and a mirror, and so shall emerge from the camera lens parallel to its original direction. This light then falls upon another vertical slit which can be adjusted in such a position as to allow light of any desired wave length to pass through. In the Kodaikánal spectroheliograph the collimating and camera lenses each of 5-inch aperture and 6-foot focal length, together with the prisms and slits, are attached to a rigid framework, while immediately in contact with the slit last described is a stationary photographic plate within a fixed camera. The rigid framework is capable of motion in a horizontal plane in such a manner that the primary slit may pass uniformly across the image of the sun while the secondary slit will move at an equal rate across the sensitised plate; and as in each position an image will be formed at the second slit by light of the desired wave length and no other light can emerge, the result of the movement upon the plate is a complete image of the sun in monochromatic light. At

present the H and K lines of calcium are largely used on account of the convenience afforded by the width of their absorption shading and the fact that the centre of the dark line is frequently 'reversed,' *i.e.*, is bright instead of dark, indicating that the calcium vapour is abnormally hot in the higher levels of the solar envelope. A photograph so obtained shows bright clouds—called 'flocculi'—of calcium vapour scattered about over the sun, and gives a large amount of information that is not otherwise obtainable. Further, by causing the slits to move more slowly the exposure may be lengthened sufficiently to give photographs of the 'prominences' projecting from the sun's margin.

(*b*) Two 6-inch refractors, with one of which an Evershed spectroscope has been used since November 1904. These are used for visual examination of the sun and for spectroscopic study of spots and prominences.

(*c*) A spectrograph consisting of an 11-inch polar siderostat with a 6-inch Grubb lens of 40-foot focus. This is used with a $3\frac{1}{3}$-inch concave grating of 10-foot focus mounted on Rowland's plan. A 2-inch parabolic grating can be substituted for the concave grating and a collimating lens may be employed with either grating to cure astigmatism.

(*d*) A photoheliograph by Dallmeyer. With this a photograph of the sun in ordinary light is made daily when possible. Originals are sent to Greenwich for the use of the Solar Physics Committee for those days for which photographs are not available from Greenwich or Dehra Dun.

(*e*) An 18-inch parabolic mirror (the property of the Director) is mounted in the spectroheliograph room immediately in front of the 12-inch photo-visual lens. It is used to form the solar image on the slit plate of the high dispersion spectrograph. The mounting is on rollers and the mirror can either be moved into position in front of the lens with its centre in the axis of the beam of light coming from the heliostat, or it can be pushed to one side so as not to obstruct the light incident on the lens during the operation of the spectroheliograph and associated instruments.

(*f*) A high dispersion spectrograph mounted on piers in the spectroheliograph room. This is fitted with special arrangements for rotating the sun's image on the slit plate, and

for accurate guiding during long exposures on sunspots. Plane gratings are used in this spectrograph—either a $3\frac{1}{4}$-inch by Rowland or a 6-inch by Michelson. It has been largely used for photographing spot and prominence spectra.

(*g*) An autocollimating spectroheliograph for photographing the sun's disc in the hydrogen radiations. This has been completed and brought into successful operation. Daily photographs are now obtained with the slit set at the centre of the line $H\alpha$, and among many interesting features the plates taken with this instrument show the prominences not only at the sun's limb, but also projected on the disc where they appear as very dark absorption markings.

2. **Routine work.**—In addition to the use of the spectroheliograph and photoheliograph the routine work includes visual examination of sunspots and faculæ, observations of widened and displaced lines in sunspot spectra and spectroscopic observation of prominences. A monthly article describing the solar activity is contributed to the "Monthly Weather Review," while for more technical purposes bulletins and memoirs of the observatory are issued; of the former 23 have appeared while of the latter the first has been published.

3. **The Solar Constant.**—The method of estimating changes in the solar constant by comparing the intensity of moon-light with first type stars has now become part of the routine work, and photographic comparisons are made whenever the atmospheric conditions permit. A good series of photographs was obtained during five of the thirteen lunations; the stars used were Alpherat, Rigel, Sirius, Procyon, and Regulus, all assumed to be invariable in their light.

A suitable photometer for measuring the plates has not yet been obtained.

4. **Spectroscopic investigations.**—A large number of photographs of the spectra of sunspots and of prominences has been obtained with the high dispersion spectrograph. A smaller number of spectra of undisturbed regions on the sun has also been obtained with the same instrument and with the concave grating spectrograph. In studying these plates the main lines of investigation are those connected with the movements of the gases in sunspots, and with the general circulation in the solar atmosphere. The plates of prominence spectra are measured for determining the angular speed of rotation of these objects at considerable heights above the chromosphere.

A few measures have been made of the Zeeman separations of a line in the red region of the spectrum which is doubled in sunspots owing to the magnetic field; and some lines in the ultra violet which are normally single in spots have been recorded as double at a time when a great eruption of gases was in progress. This indicates that a greatly increased magnetic field may accompany such outbursts.

5. **Radial motion in sunspots.**—The photographs of spot spectra obtained during the year have confirmed the previous results as regards the outward accelerating movement of the low level gases over spots. Owing to the comparatively small number of moderate sized or large spots which have appeared during the year not much new evidence has been obtained, and very few of the plates were taken under sufficiently favourable conditions for investigating the small component of motion at right angles to the radial motion which was discovered in the case of six spots previously investigated and mentioned in the last report.

Much of the material recently obtained relates to the behaviour of the high level gases in the chromosphere in and near spots. It had previously been found that the calcium lines H and K, and the hydrogen line C, were systematically displaced over spots, the displacements being in a direction opposite to those of the low level lines of iron and other metals, thus indicating an opposite direction of movement of the high level gases which flow inwards towards the centre of a spot. The more recent results confirm this, and show that the emission as well as the absorption lines of H and K are affected by this inrush. A marked exception was however found in a single instance; a spot group which appeared on the eastern limb on September 29th, 1910, was photographed in the H and K region of its spectrum several times during its passage across to the western limb, and in none of the plates is there any evidence of inward movement either in the emission or absorption lines of H and K. The principal spots of the group were very much encroached upon by bright calcium clouds which may have masked the motion effect. The effect is most strongly shown in those spots which are of a symmetrical outline and not undergoing active change.

6. **Vertical movement of calcium vapour.**—A large number of measures have been made of the wave-lengths of the emission lines H and K in the faculæ in various situations on the sun's disc. The results so far obtained show that in general these lines are displaced towards the red when the faculæ are situated near the centre of the disc. The displacement tends, however, to disappear when the faculæ are observed near the limb. This appears to show conclusively that the displacement is due to motion in the line of sight, and not to pressure

which would displace the lines towards the red in all situations. The movement is one of descent, that is to say, the bright calcium clouds in the disturbed regions near spots are descending relatively to the iron vapour in the reversing layer. This is a somewhat unlooked for result although it has already been announced by Deslandres as a result of some measures made by him. It has been shown by St. John that the emission lines of H and K in undisturbed regions are displaced systematically towards the violet near the centre of the disc, and indicate a rising movement; the few measures which have been made here confirm this point also.

The measures will be continued with a view of obtaining reliable estimates both of the descending and ascending movements.

7. The Observatory is co-operating with the "International Union for Solar Research."

8. There is also at Poona, under the Government of Bombay, the Takhtasingji Observatory, where research in solar physics is carried on by Mr. Naegamvala. The chief portions of the equipment are:—

(*a*) A Foucault siderostat with an 8-inch image lens for use with a spectroscope.

(*b*) An equatorial refractor with a Cooke 6-inch triple photovisual lens. This is provided with two 45° objective prisms, and a prominence spectroscope with a Thorpe transmission grating has been constructed locally for attachment to it.

(*c*) An equatorial reflector with a 20-inch mirror by Common. A focal plane ultraviolet spectrograph is used for stellar spectra.

The twelve 'most widened' lines in sunspot spectra are observed daily and the results forwarded to Sir Norman Lockyer, and a close agreement is maintained with the observations made at South Kensington. The observatory is also co-operating with the International Union for Solar Research, and is observing the region 5300 to 5500 for all lines affected in sunspots.

9. **Solar radiation.**—Two Angstrom pyrheliometers were in use during the year at Simla, and one at Kodaikánal.

METEOROLOGY.

Owing to changes in the gazetted staff of the department and to absences on leave, the progress of current researches was slow and little new work was possible.

Examination of the upper atmosphere.—This work involves the measurement of pressure, temperature, humidity, wind direction and wind velocity at all points from ground level up to heights of fifteen or sixteen miles, and was started primarily with the object of throwing light on the problem of monsoon forecasting. The following considerations show the necessity for this work. It was realised by Blanford, when in 1875 he began the organisation of the system of ground level observatories, that surface observations alone were unlikely to elucidate completely the problem of quantitative or even of qualitive forecasting.* He anticipated that when widely extended ground level data had been collected and analysed, it would probably become necessary to extend the observations to those higher levels in the atmosphere where occur the changes of meteorological conditions which are directly responsible for changes of weather. Blanford's own work, however, was necessarily almost confined to the collection and analysis of ground level conditions over India itself. He examined fairly exhaustively the influence on monsoon rainfall of local surface conditions, and discovered the effects of snowfall in the Himalaya, and of the distribution of pressure, temperature, and winds in India.

His successor, Sir John Eliot, with monsoon forecasts in view, extended the area over which ground level observations were taken, and before his retirement had discussed the greater part of the additional data collected. Taking into account the results of Blanford's work and of his own extensive researches, together with certain definite relations, established by Sir Norman Lockyer, between pressure in India, Australia, South Africa and South America, he finally arrived at the conclusion that little further advance could be made until reliable data for the whole area affected by the monsoon from its source to its sink had been collected and examined.† He advocated this as the next step forwards in the work, but he anticipated that to solve the problem completely an examination of conditions in the upper atmosphere would also be necessary, and he therefore proposed to obtain such observations over India. He hoped that in addition to furnishing important information for seasonal

* See his "Vade Mecum," Vol. II. p. 1.

†; See Indian Meteorolcgical Memoirs, Vol. XVI. 1903-05, p. 307.

p 2

forecasts the observations on the upper atmosphere would assist materially the work of daily forecasting by providing data independent of localised ground level actions. These latter in India are very marked, and are liable to obscure to some extent the operation of general causes of weather change.

Dr. G. T. Walker, who assumed charge of the department in 1904, was able still further to extend the scope of ground level observations. He examined more thoroughly than Blanford or Eliot had done the influence of solar disturbances, and carried out the analysis, in regard to Indian rainfall, of ground level data collected from all parts of the globe. He demonstrated the existence of marked numerical relationships between monsoon rainfall and conditions in Australia, the South Indian Ocean, Africa, and South America, and showed that the effect of observed solar disturbances was comparatively small; but he finally arrived at the conclusions that not more than half of the factors controlling monsoon rainfall had been discovered from the data available; that the factors discovered were inadequate to give reliable forecasts; and that a considerable number of years of geographically extended observations at the ground level would be necessary to give a reasonable probability of further appreciable progress. The anticipations of Blanford and Eliot were thus borne out inasmuch as it became clear that in order to make anything more than extremely slow progress it was essential to undertake active upper air research.

The upper air experiments were begun in 1905 when about three weeks' work from August 26th to September 12th was carried out with kites near Karachi. In the following year the work was carried on in Belgaum for one week at the end of May and three weeks in August and September. In 1907 at the end of July and the beginning of August another series of observations was made during about four weeks at Belgaum and a few days in the Bay of Bengal and the Arabian Sea. The sea observations were taken by an officer proceeding home on leave.

The results obtained from the four brief periods of observation were fairly definite, and were published in the Memoirs of the Meteorological Department, Vol. XX. The Karachi observations indicated that the moist sea winds were replaced at about 1,500 feet by exceedingly dry hot winds which showed evidences of belonging, as was previously suspected, to a large general air movement from the deserts of Baluchistan into India, while the lower moist winds were of comparatively local origin, appearing and disappearing with the diurnal temperature changes of the sea-

board. The upper currents were steady and no change in them occurred, during the period of observation, of a nature to produce changes in the prevailing weather conditions of the surrounding regions. The observations in May 1906 at Belgaum were secured as representing pre-monsoon conditions, and revealed a structure in the atmosphere, somewhat similar to that observed at Karachi in August and September 1905. Comparatively moist low-level westerly winds were replaced at heights of 2,000 to 3,500 feet by very dry winds from a more northerly direction. The thunderstorms which usually characterise the month of May were abnormally few, and no opportunity occurred of examining the state of the upper air associated with them. Later in the same year, in August-September, actual monsoon conditions were sought for, the period of work including the transition from a "break" in the rains to a renewal of monsoon activity. The thickness of the moist monsoon current before its complete re-establishment was found to vary from 4,500 to 7,500 ft., *i.e.*, the current was 3,000 ft. thicker than the corresponding moist parts of the winds in May, preceding the monsoon proper. Time did not allow of the experiments in September being continued until the monsoon was fully re-established so that the question of the total depth of rain-bearing winds during a time of active monsoon still remained unsettled.

In the following year the only time available for the work again happened to occur in the transition period between a "break" and the renewal of the monsoon. On this occasion the upper limit of the moist current exceeded 9,000 feet, the maximum height reached. It was observed that the re-establishment of the monsoon took place in the form of a series of rain squalls, the same type of disturbance as dust-devils and water spouts, in which winds were very localised and extremely violent at some distance above ground. These conditions preceded by over two weeks the full re-establishment of the monsoon, and it was unfortunate that the work could not be continued into the important period then beginning. Observations over the Arabian Sea were practically confined to the sailor's "soft place" in the monsoon area, being taken on three days during the first half of the direct passage from Colombo to Aden. Here, as the kite rose, none of the abrupt changes of humidity and wind which are so characteristic of the land area, were observed. The moist current was about 1,200 ft. in thickness, and above it humidity showed the entirely new feature of a gradual decrease to a low value. It was found that in those latitudes, whatever the direction of the wind at the sea surface might happen to be, the winds above 5,500 ft. were from due west, and carried air along continuously from the Arabian Sea area towards the extreme south of India.

In 1909 no further work of this kind was practicable, and it may be said that during the whole time since the experiments were begun the difficulties in the way of detaching a gazetted officer for considerable periods to carry on the work in the plains have proved very great indeed. In view, however, of the importance of obtaining continuity in the observations and of the impossibility of carrying out the instrumental work in Simla, much time during the year 1909-10 was devoted to the instruction, of an Indian observer from the office staff at Simla who could be spared to go to the plains. The observer chosen had shown some aptitude for the work, and it was hoped that he would be able to calibrate the instruments and liberate the balloons with native help alone, general supervision being exercised by the organising officer by correspondence from Simla. The observer with a few men to help him was established at Jhang in May 1910, and the preliminary work consisting of the liberation of a series of pilot balloons and the plotting of their courses was begun. The system was found to be entirely satisfactory for this section of the work, which involved mere theodolite observations and the calculation from them of heights, wind velocities and wind directions. When, however, the instrumental work was attempted, the many trifling difficulties which must necessarily arise in research operations were found to be insuperable by correspondence, and after long trial it was reluctantly concluded that the work demanded a greater knowledge of the principles of the instruments and of the essential objects of the investigation than could be expected of an observer without a scientific education. The value of the pilot balloon observations alone was considered insufficient to justify the expenditure on the existing establishment, and the work was consequently brought to a close on the 31st March 1911.

Steps are now being taken to secure the necessary personal supervision of an organising officer during a considerable portion of the year, and it is hoped that the experimental investigation may be resumed in 1913 at Allahabad. The work will be directed chiefly towards determining the extent to which enquiry in the upper atmosphere may be expected to throw light on the problem of monsoon and other forecasting.

During the course of the pilot balloon ascents at Jhang, similar balloons were liberated on many days in Simla, and this practice was continued after the closing of the Jhang establishment.

The work of analysing the observations which have already been made is progressing, and it is hoped that it will be possible to publish the results of the analysis in the course of the year 1911-12.

Data from logs of ships in the Indian Ocean.—The collection of these has been continued and they have proved useful in connection with the work of storm-warning, but it has not been possible to put in hand their systematic analysis.

Publications.—The customary Daily Weather Reports of Simla, Calcutta, Bombay and Madras; the monthly and annual supplements to the Simla Daily Weather Report; the Monthly Weather Reviews, the Annual Summary, and various administrative pamphlets were issued during the year: but no departmental memoirs were published.

TERRESTRIAL MAGNETISM.

Magnetic observatories.—*Bombay (Alibag).*—The Bombay Observatory, formerly maintained by the Local Government at Colaba, was moved to Alibag in consequence of the introduction of electric trams into the city: it is now directly under the Government of India, the Director being Mr. N. A. F. Moos. The chief instruments are a set of magnetographs of the Watson pattern and a Schulze earth-inductor, in addition to ordinary magnetometers and dip-circles. All have given satisfactory results through the year. A set of sight-reading instruments of Eschenhagen pattern has been obtained and will be used as a check on the Watson instruments as well as for special observations. The results of the sixty years of observations at Colaba have recently been published.

2. *Dehra Dun, Kodaikánal, Barrackpore and Toungoo.*—These observations were started as base stations in connection with the Magnetic Survey of India, and are all equipped with Watson autographic instruments for declination, horizontal intensity and vertical force. Instead of dip-circles, earth-inductors of the Schulze pattern have been set up at each place. Good results have been obtained through the year, with the exception of the vertical force instrument at Toungoo; this instrument was readjusted in July 1911, but it is feared that the traces for several months previously will have to be rejected. The repairs to Dehra Dun Observatory have been delayed, owing to the special observations asked for by the Royal Society in connection with the Antarctic expedition; they will be carried out at the earliest opportunity.

3. The mean values of the magnetic elements at the Survey observatories for 1910 are as follows:—

Observatories.	Lat.	Long.	Declination.	Dip.	Horizontal force.	Vertical force.
					C. G. S.	C. G. S.
Bombay . .	18° 38′ N.	72° 52′ E.	0° 57′·7 E.	23° 38′·5	·36845	·16143
Dehra Dun .	30° 19′ N.	78° 3′ E.	2° 31′·9 E.	43° 54′·8	·33257	·32019
Barrackpore .	22° 46′ N.	88° 22′ E.	0° 55′·5 E.	30° 42′·2	·37329	·22168
Kodaikánal .	10° 14′ N.	77° 28′ E.	0° 55′·0 W.	3° 45′·2	·37485	·02459
Toungoo . .	18° 56′ N.	96° 27′ E.	0° 24′·9 E.	23° 2′·1	·38801	·16498

4. **Magnetic Survey.**—The general scheme was to execute a preliminary survey of the whole country and a detailed survey of those areas where, owing to local irregularities, further information was required. The preliminary survey was to consist of observations of declination, intensity and dip at about 1,100 stations, and measurements were to be made in successive years at about 22 'repeat' stations in order to effect the elimination of secular variation.

Field work was begun in November 1901, and up to the end of the field season 1909-10 1,324 field stations had been occupied and 23 repeat stations established, in addition to 24 stations on the Seistan trade route where declination had been observed; observations had also been repeated at 142 old field stations, of which 15 have been re-occupied on two occasions. In the detailed survey 193 stations had been occupied.

During the year under report four detachments were employed.

One detachment was engaged in re-observing a number of selected old field stations, the sites of which were permanently marked for future identification.

A second detachment carried out a detailed survey of the Bengal coal-field in response to numerous requests for accurate values of magnetic declination; in addition, at the request of various Companies, six meridian lines were laid down to facilitate the testing of surveying compasses.

The third detachment was intended for the survey of the Andaman and Nicobar Islands, for which the census operations appeared to offer a favourable opportunity. At the last moment, however, the arrangements fell through, and after observing three new stations in the Andamans and the repeat station at Port Blair the detachment returned to

India, and was employed on detail survey in the vicinity of Buxar and Chupra.

The fourth detachment was employed on office duties during the cold season and took the field in April in Kashmir. Twenty new stations were observed, the detachment returning to recess early in July.

5. The officer in charge, Lieutenant H. T. Morshead, R.E., observed at 22 repeat stations, and made comparative observations at the four Survey base stations and at Alibag.

During the season full sets of magnetic observations were taken at 29 new and 80 detail survey stations, while 56 old field stations and 23 repeat stations were re-occupied.

6. During the recess season the computation of the field work carried out during the cold weather of 1910-11 was completed, and the reduction and tabulation of the base station results for 1910 were in hand and nearing completion. In addition to this work the investigation was continued of the instrumental divergences in measurements of H. F., to which reference was made last year.

7. The latter question has proved far more complex than a perusal of last year's report would suggest; it may be considered under the heads of (i) personal error, (ii) changes in the constants of magnetic distribution, (iii) changes in the moment of inertia of the magnet, (iv) thermometric errors, and (v) instrumental changes not otherwise accounted for.

8. *Personal error.*—It becomes increasingly evident that the observed discrepancies are in the main due to "personal error," to which only a passing allusion was made in last year's report, the real significance of this factor having been under-estimated for lack of sufficient data.

By "personal error" in this connection is meant the difference in the mean magnetic moment obtained when the vibration observations are taken—

(*a*) by the eye and ear method,

(*b*) by chronograph.

Experiments have shown that while for the majority of observers results are practically identical when using the chronograph, serious divergencies, as in the case of star transit observers, are found in the former method; further, "personal error" is not necessarily a constant for a

particular observer, but may vary during the limits of a single field season (*cf.* Chauvenet, "Spherical and Practical Astronomy," Vol. II, pp. 189 to 193). The cause of the error lies in the estimation of the time interval elapsing between the beat of the clock and the transit of the centre of the scale by the moving cross wires, the magnitude of the error varying with the amplitude of the arc of vibration, which in India diminishes by one half during the observation. In this respect the observation differs from that of star transits. To show the magnitude of the effect of a timing error we may take a magnet having a magnetic moment of 900 C. G. S. units, and a moment of inertia of 3·4. Then a difference of 0·2 second in the mean value of the several series of 162 vibrations will produce at Dehra Dun an error of 0·4 unit in magnetic movement and an error of 14γ in H. F., *i.e.*, such small errors as 0·1 second in opposite directions in the two series of vibrations would be sufficient to account for the discrepancy.

This source of error does not appear hitherto to have received the attention it deserves in connection with magnetic work. The magnetic moment of a magnet in ordinary field use changes very slowly, and the error introduced by taking as its value that found at any time by the observer in the field, using the eye and ear method, can be avoided by the safer procedure of deducing the magnetic moment for the time in question from the chronographic determinations at the beginning and end of the field season, when those determinations show that the whole change in the interval has been small. For base stations chronographic determinations need be taken only once or twice a month, while for field instruments the determinations must necessarily be confined in India to the bi-yearly comparisons at head-quarters.

9. *Distribution constants.*—As regards the distribution constants P and Q, it has been found in the course of the investigation that real and permanent changes are rare, though apparent and temporary changes (actually due, most probably, to accidental errors of observation) may be comparatively frequent. Real changes need only be looked for when there has been a large dislocation of the value of the magnetic moment, and even in such cases they are infrequent.

10. *Moment of inertia.*—Changes in the moment of inertia do undoubtedly occur in practice, owing to the wear to which the magnets are subject in handling; and the value must therefore be redetermined from time to time. The largest effect of this kind yet noted was in the Survey standard, which showed a progressive change equivalent to a fall of 24γ in H. F. during a period of eight years. In the evaluation

of the constants the observations for determining the moment of inertia give perhaps the least satisfactory results owing to their high probable error.

11. *Thermometric errors.*—These include (1) the gradual zero-creep which is inseparable from all mercury-in-glass instruments, and (2) those due to unexpected changes of correction, such for instance as result from a slight dislocation in the mercury column. Errors of the former class are to be guarded against by periodic redeterminations of the freezing point, but those of the latter are liable to give trouble from their liability to appear suddenly and to change irregularly in amount. Instances of this particular class are not infrequent in India, especially in horizontal thermometers. They are presumably due to imperfect manufacture resulting in a slow emission of gas from the walls of the tube and its eventual collection, in the form of a bubble, as a break in the mercury column. In one case it was found that an apparent change in one of the field instruments in 1904-05 coincided with a change of thermometer used with it.

12. *Instrumental changes not otherwise accounted for.*—Apart from actual damage to a magnetometer resulting in serious alteration to the assumed deflection distances, it is difficult to imagine how an instrumental change can occur, other than one in the constants which are periodically redetermined in the ordinary course. In last year's report, paragraph 6, an example of instrumental change in the standard was given, but it has since been ascertained, from information not available at the time the report was written, that the figures which indicated the effect were based on erroneous data, and that the change had not actually occurred.

13. *Importance of the investigation of the causes of instrumental differences.*—Since the personal error is found to be the main cause of observational discrepancies, it follows that in the use of the Survey standard there is practically as much liability to observational error when using the eye and ear method as with the field instruments: it is consequently to be understood that apparently unimportant but unexplained divergences in comparative results raise a doubt which extends even to the results of the standard magnetometer. The necessity, therefore, arises not merely of correcting the field instruments to the standard, but also of correcting the observations from the standard itself.

It proves then to have been advantageous that the discrepancies in comparative results were given more careful attention than they might

previously have appeared to call for. The elimination of the various errors is to a great extent a question of "trial and error" and the process is necessarily laborious; the final test lies in a comparison of the monthly mean values of H. F. at the various observatories after eliminating secular change. For the purpose of this comparison it is necessary to have the same series of selected days at each observatory, and experience has shown that in order to eliminate as far as possible the effects of accidental disturbance, it is desirable to obtain the mean value by planimeter measurement instead of by the usual process of measuring hourly ordinates.

14. For the next field season three detachments only will be available, the strength of the party having been permanently reduced by one detachment. Of these, two will be employed on detail survey mainly in Central India; while the third will be utilized in office duties in Dehra Dun.

GEOLOGY.

BY

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Mineralogy and Petrology.

Indian arsenates.

1. In his monograph on the manganese-ore deposits of India[1] Dr. Fermor has given a preliminary account of two occurrences of arsenates in Indian manganese mines. The best material available was forwarded to the British Museum (Natural History) for further investigation, which was kindly undertaken by Dr. G. T. Prior and Dr. G. F. H. Smith. From the summary at present available of their papers read before the Mineralogical Society of London[2] it appears that the green mineral found at Kajlidongri in Jhabua State, Central India, is a fluo-arsenate of magnesium and calcium with the chemical formula (MgF) $CaAsO_4$, a specific gravity of 3·768, a hardness of $3\frac{1}{2}$, and monoclinic crystallisation. It is probably identical

Tilasite

[1] *Mem. Geol. Surv. Ind.*, XXXVII, pp. 218, 219 (1909).

[2] *Nature*, Feb. 17, 1910, p. 477, and June 23, 1910, p. 513.

with tilasite, described in 1895 by H. Sjögren from the famous Swedish manganese mine of Langban, and named after a Swedish mining engineer, D. Tilas. The Swedish mineral differs from the Indian in having a grey colour with a violet tinge. From the Indian material, much of which was generously contributed by Mr. H. J. Winch, it has been found possible to work out the crystallographic characters of the mineral, for which purpose the Swedish material was too imperfect.

Fermorite

The other mineral, that found at the Sitapur manganese mine in the Chhindwara district of the Central Provinces, where it is fairly abundant as a white to pale pink mineral associated with hollandite, braunite, sitaparite, and psilomelane, has proved to be an arsenate and phosphate of both calcium and strontium. It is to be regarded as the arsenic analogue of apatite, with which the Sitapur mineral seems to agree in crystallographic characters, as far as can be judged from the material available, for no really well-crystallised specimens have yet been found. The name fermorite has been proposed for this mineral.

The occurrence of these two arsenate minerals in the Indian manganese deposits is of considerable interest, for perhaps one of the most striking facts known with regard to the distribution of minerals is the presence of some 20 species of arsenates and antimonates—most of them not found elsewhere—in the Swedish iron-manganese mines of Langban, Pajsberg (Harstig mine), Nordmark (Moss mine), and Jakobsberg, in Wermland, and of Sjö in the province of Orebro. Nearly all of these minerals contain manganese as an essential constituent, but a few of them, including tilasite, are free from this element. In view of the fact that both the Swedish and the Indian deposits in which the arsenates occur are of Archæan age, it is not unlikely that careful scrutiny of the Indian deposits during their exploitation may lead to the discovery in India of other arsenates, and perhaps also of antimonates.

2. Crystals of braunite, of which an account is embodied in a note in *Records, Geol. Surv. India*, Vol. XLI, p. 43, have recently been obtained from some additional localities in the Central Provinces (Thirori, Kachi Dhana, and Satak), and from Gariajhor in Gangpur State, Bengal, the extension into which of the gondite series of the Central Provinces has already been noticed in the General Report for the year 1908.

Samarskite, cyrtolite, allanite.

3. Mr. Tipper made an examination of the minerals occurring in the Sankara mica mine, Nellore district, Madras Presidency. The occurrence of

samarskite in this mine has already been noted. The other minerals identified from the mica-bearing pegmatite are cyrtolite and allanite. The cyrtolite occurs in sheaf-like aggregates of crystals usually terminated by prism faces but sometimes with strongly curved pyramid faces as in the original cyrtolite. This mineral would seem to be a hydrated variety of zircon containing a small percentage of uranium. A determination of the amount of uranium gave 1·56 per cent. U_3O_8. Further traces of the rare earths are present. Microscopic examination shows that the mineral has undergone very considerable alteration.

The allanite is in long crystals, surrounded by brownish altered epidote, and occurs in a rock composed of garnet, mica and little felspar. Bands of this rock are common in this particular locality and are part of the pegmatite mass.

Wolframite.

4. A large series of specimens of wolfram from Burma, collected by Mr. Page, was examined in order to ascertain if any of them could be classed as hübnerite. All, however, proved to be typical wolframite.

Rocks of Central India and Rajputana.

5. Messrs. Heron and Jones were engaged, during the recess, in working out the microscopic characters of the rocks collected by them in Alwar and Gwalior respectively, and Mr. Heron will shortly publish a memoir embodying the results of his work.

Palæontology.

Indian Ostreidæ.

6. Mr. Vredenburg has been engaged on a study of the Indian fossil *Ostreidæ*, based on the collections preserved in the Geological Museum; these include specimens from India and from Central Asia. The first instalment of the work will shortly be published in the *Palæontologia Indica*, and deals with *Ostrea s.s.* including the species provided with a ribbed lower valve and an opercular valve without radial ribs. The species dealt with have been classified in the following groups:—

Group of *Ostrea flabellula.*

O. multicostata Deshayes.
O. angulata J. de C. Sowerby.
O. latimarginata Vredenburg.
O. cubitus Deshayes.

Group of *Ostrea elegans*.

O. Cossmanni Dolfus.
O. Fraasi Mayer-Eymar.
O. gajensis, nov. sp.
O. gajensis, var. *Feddeni*.
O. orissensis, nov. sp.

Group of *Ostrea digitalina*.

O. digitalina Eichwald, var. *Rohlfsii* Fuchs.

Group of *Ostrea fimbriata*.

O. turkestanensis Romanowski.
O. Esterhazyi von Pavay.

All the species occur in Tertiary strata ranging from Lower Ranikot (landenian) to Upper Hinglaj (middle miocene). *Ostrea Cossmanni* (*O. plicata* Vred.) has been found in the Laki stage; *O. multicostata* characterises both the Laki and Khirthar. *Ostrea cubitus* and *O. Fraasi* occur in the Nari; *O. turkestanensis* has been found in the Upper Nari; *O. angulata* occurs in the Nari and Gaj and is succeeded in the uppermost Gaj by its mutation *O. latimarginata*. *O. gajensis* also characterises the Upper Gaj beds; *O. digitalina* occurs in the Lower Hinglaj of Baluchistan and in beds of corresponding age in Burma; *O. orissensis* is found in Upper Tertiary beds in the coastal district of Orissa.

Ostrea digitalina is identical with the Burmese form described by Noetling as *Ostrea promensis*.

The forms classified by Mr. Vredenburg within the group of *Ostrea elegans* are remarkable on account of their gradual evolution, which can be followed through successive geological periods. The eocene and miocene forms *O. Cossmanni* and *O. gajensis* appear perfectly distinct from one another, but the oligocene form *O. Fraasi* constitutes an intermediate mutation closely connected with both species. The group has survived to the present day in the Indian Ocean where it is represented by *Ostrea nigromarginata* Sow., in which the ribs have become almost obsolete, but which agrees with the fossil forms in all other characters.

7. The discovery of marine Cretaceous beds in a railway cutting was reported to Messrs. King and Foote subsequently to their examination of

the country south of the Cauvery river, but they were unable to confirm the correctness of the report. The rocks have been rediscovered by Mr. Allan Campbell and include friable argillaceous sandstones underlying the Cuddalore series. They include fossil bryozoa, and casts of bivalves some of which are probably referable to *Inoceramus Cripsi*. These rocks probably represent a southern continuation of the Arialur rocks that outcrop to the north of the Cauvery delta.

Marine Cretaceous near Tanjore.

8. A memoir on the fossil *Giraffidæ* of India by Dr. G. E. Pilgrim has been completed. The chief feature of this memoir is the prominence which has been given to the exact horizon at which each species occurs. Two new and primitive genera have been founded, *Progiraffa* and *Girraffokeryx* from the Nari and Lower Siwaliks. The discovery of a skull of the species *Hydaspitherium grande* Lydekker proves its generic identity with that of *Helladotherium* of the Pikermi beds. The new generic name of *Indratherium* has been proposed for the large skull obtained by Falconer from the Markanda valley below Nahan. The Upper Siwalik and Middle Siwalik *Giraffæ* have been specifically separated and two new species of *Hydaspitherium* have been established.

Siwalik vertebrates.

The collection of fossil vertebrates made during the two last years from the Middle and Upper Siwaliks of the Salt Range has been examined and several new genera and species of mammals have been described in a preliminary notice (*Records, Geol. Surv. India*, XL, 63).

A memoir has been written containing full descriptions of the vertebrate fauna of the Gaj stage of the Bugti Hills and the Punjab. This contains several additions and amendments to the preliminary list which was published in 1909 (*Records, Geol. Surv. India*, XXXVII, 139); these occur especially in the *Rhinocerotidæ*.

9. During the year under review, a large amount of palæontological work was done on behalf of the Geological Survey by Mr. F. R. Cowper Reed in England and Dr. C. Diener in Austria. Mr. Cowper Reed has described the collections of Ordovician and Silurian fossils made from time to time by members of the Department in the Central Himalaya and, in a paper published in the *Records* (Vol. XL, p. 1, 'Pre-Carboniferous Life-Provinces'), has discussed their affinities to faunas of other parts of the world. He has also examined and described a suite of Devonian fossils which include a collection sent to the Geological Survey some

Palæozoic fossils of the Himalaya and Afghanistan.

years ago by Lieutenant Grant from the Baroghil Pass in Chitral, a collection from the Hajigak limestone of Afghanistan, a small number of specimens collected by the late Mr. C. L. Griesbach in Khorasan, others obtained by Messrs. Griesbach and Smith in Byans and a small collection from the base of the Lipak series in Kanaur and Upper Spiti. It is an interesting fact that the facies of all these fossils is essentially European. Mr. Reed's paper is published in *Records, Geol. Surv. India*, Vol. XLI, p. 86.

10. One of the many valuable results of Mr. Middlemiss' work during the last three years in Kashmir has been the discovery of Silurian fossils, hitherto unrecorded from any part of that State. The specimens, which were referred to by Mr. Middlemiss in his paper on the Silurian-Trias Sequence in Kashmir (*Records*, XL, p. 213), were sent to Mr. Cowper Reed who has furnished the following results, which are, however, only provisional. The fossils come from four localities:—

(*a*) Gudramer (lat. 33° 48′: long. 75° 27′):—

Calymene Blumenbachii Brong. *var.*
Illænus cf. *Thomsoni* Salt.
Acidaspis aff. *deflexa* Lake.
Phacops sp.?
Primitia sp.
Beyrichia sp.
Turrilepas? sp.
Orthis elegantula Dalm.
" " *var.* (cf. *canalis* McCoy).
" *basalis* Dalm. *var.*
" *sowerbyana* Dav.
" *crispa* McCoy.
Orthis calligramma Dalm. *var.*
Scenidium cf. *Lewisi* Dav.
Leptæna rhomboidalis Wilck.
Triplecia insularis Eichw.
Plectambonites aff. *papillosa* Reed.
Strophonella cf. *euglypha* His.
Strophomena cf. *antiquata* Sow.
" sp.
Trematospira Salteri Dav.?
Rhynchospira Bouchardi Dav.?
Zygospira aff. *pentlandica* Haswell ?

Wilsonia cf. *Wilsoni* Sow.
Rhynchonella (*Camarotœchia*) cf. *nucula* Sow.
,, ,, cf. *borealis* Schl.
Atrypa marginalis Dalm.
Merista or *Meristella* sp.
Nucleospira cf. *pisum* Sow.
Orthoceras cf. *tenuiannulatum* McCoy.
Cyrtoceras sp.
Lindstrœmia cf. *bina* Lonsd.
,, ? sp.

Probable age: Upper Llandovery or Wenlock. *Triplecia insularis* has not hitherto been found above the Upper Llandovery, but there is an absence of many typical Llandovery forms.

(*b*) Gugaldar (33° 51′: 75° 25′), Harpatnar valley:—
Calymene Blumenbachii Brong. *var.*
Encrinurus cf. *punctatus* Brunn.
Acidaspis aff. *coronata* Salt.
Orthis elegantula Dalm.
,, ,, *var.* (cf. *canalis* McCoy).
,, *basalis* Dalm. *var.*
,, cf. *canaliculata* Lindstr.
,, aff. *edgelliana* Salt. ms.
,, cf. *crassa* Lindstr.
Plectambonites transversalis Dalm.
Scenidium cf. *Lewisi* Dav.
Merista or *Meristella* sp.
Nucleospira cf. *pisum* Sow.
Alveolites repens Fougt?
,, ? sp.

Probable age: Wenlock, although the variety of species of Orthis and the absence of a more varied assemblage of fossils are unusual except in the Silurian of Ireland.

(*c*) Below Margan Pass, S. W. side (33° 44′: 75° 32′):—
Conchidium cf. *Knighti* Sow.?
Orthis sp.

Probable age: Aymestry Limestone, on the strength of the doubtful and poorly preserved example of *Conchidium*.

(*d*) Lutherwan (33° 46′: 75° 35′):—

Calymene Blumenbachii Brong. *var.*
Acidaspis aff. *coronata* Salt.
Encrinurus sp.
Illænus ? sp.
Orthis elegantula Dalm.
,, *basalis* Dalm. *var.*
,, *rustica* Sow.
Scenidium aff. *Lewisi* Dav.
Plectambonites transversalis Dalm.
Leptæna rhomboidalis Wilck.?
Alveolites repens Fougt ?
Coenites ? sp.

Probable age: Wenlock. The same remarks apply to this assemblage as to that from locality (*b*).

Anthracolithic fossils of the Shan States.

11. During the course of their surveys of the Northern and Southern Shan States respectively, Messrs. La Touche and Middlemiss obtained a considerable number of fossils of Upper Palæozoic age. These were sent to Dr. Diener for examination; his description of them is now in the press and will shortly be published in the *Palæontologia Indica*.

The fossils, which are derived from Kehsi Mansam and Namun in the Northern Shan States and from between Hopong and Möngpawn in the Southern, are regarded by Dr. Diener as equivalent in age to those of the Upper and Middle Productus Limestone of the Salt Range and the exotic block of Chitichun No. 1 in Tibet. Out of 47 species considered to be specifically determinable, 30 are either identical with or very closely allied to Salt Range forms. In each of the three localities the brachiopods form the most important section of the fauna, but at Namun the prevalence of *Bryozoa* also is very marked. The only trilobite, *Phillipsia sp. ind. aff. Middlemissii* Diener, was collected by Mr. Middlemiss in the Hopong area, whilst *Fusulina elongata* Shumard is abundant at Kehsi Mansam. The latter fossil is of interest since it also occurs in considerable quantity in the Fusulina limestone of Bamian in Afghanistan.

Himalayan Trias.

12. Dr. Diener has also completed a memoir on the distribution and development of the Trias of the Himalaya. This work originated from a paper which was

being prepared at the time of his death by the late Dr. von Krafft, whose wide experience of both Alpine and Himalayan stratigraphical geology rendered him peculiarly fitted for the task. His notes on the subject were eventually forwarded to Dr. Diener, who has incorporated them in his paper, which will shortly be issued as *Memoirs, Geol. Surv. India,* Vol. XXXVI, pt. 3.

Fauna of the Spiti Shales.

13. The work of Professor Uhlig, on the ammonites of the Spiti Shales, which has extended over so many years, has now been finally completed and the last part ("Geological Results") has recently been received from the author. This will be translated by Mr. E. Vredenburg, who has devoted much time and care to the revision and editing of the later fasciculi.

The fauna of the Spiti Shales, so far as it is known at present, includes 218 species of ammonites, 4 of belemnites, 35 of lamellibranchs and two of gastropods. The lamellibranchs and gastropods have been described by Dr. Holdhaus, whose work has been translated by Mr. Vredenburg. From a study of the fauna, Dr. Uhlig has come to the conclusion that the various zones of the Spiti Shales extend from the Oxfordian to the Valanginian, both inclusive. The lower beds contain only a scanty fauna, the commonest fossil being *Belemnites Gerardi*. The bulk of the fauna is contained in the middle and upper subdivisions. The middle Spiti Shales or Chidamu beds appear to contain the equivalents of the Kimmeridge and lower tithonian, while the infra-valanginian (berriasian) and valanginian proper are undoubtedly represented in the Upper Spiti Shales or Lochambel beds which contain also upper tithonian fossil types.

The exact zonal distribution of the Spiti Shales fauna has not been fully worked out in the field; the detail of the subdivisions is difficult to follow owing to the lithological uniformity of the formation. Nevertheless, the abundance of fossils in the upper horizons may ultimately enable this research to be successfully carried out.

From the character of the fauna and of the deposit, Dr. Uhlig concludes that the Spiti Shales were deposited in rather deep water at a distance from the coast. Rocks of similar character and with the same fossils have been described from the Sula Islands in the Dutch Indies. The Himalayan facies of the Upper Jurassic and lowermost Cretaceous shows very little similarity to that of the Russo-boreal region, being much more nearly related to the fauna of same age in the Mediterranean region.

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Fauna of the Giumal Sandstone.

14. The fossils collected at various times from the Giumal Sandstone of the Himalaya have been worked out by Dr. Albrecht Spitz, who regards the Giumal Sandstone as ranging in age from middle neocomian to the base of the Upper Cretaceous.

ECONOMIC ENQUIRIES.

Coal.

Assam.

15. During the field-season of 1909-10, I visited the Saffrai and Taukak valleys with a view to examining the coal outcrops that had not already been reported on by Mr. R. R. Simpson.[1] As the results of my investigations have already been published in the *Records* (Vol. XL, p. 283), they need not be further referred to here.

Bengal.

16. Throughout the greater part of the year, Mr. H. Walker was still engaged in a survey of the Raniganj Coalfield in connection with the large-scale map now under preparation by the Mining and Geological Institute of India, but before completion of the office work in connection with this, he was unfortunately compelled to take sick leave, and the map still remains unfinished. It is hoped that Mr. Walker will be able to complete his share of the work soon after his return from leave.

Burma.

17. Mr. M. Stuart examined certain localities in Henzada district where coal-seams were reported to occur. The chief outcrops are at Posugyi, Kywezin, Hlemauk and Kyibin. Of these Kywezin seems to be the only area worth further attention; the coal there is very friable and greatly crushed, whilst the seam, which is about 10 feet thick, is much contorted. The composition of the coal, however, is good.

Punjab. Dandot boring.

18. The experimental boring at Dandot referred to in the last General Report (p. 53), was completed by Messrs. Kilburn & Co. in October, and coal was found at a depth of 309 feet from the surface. The seam, however, was only 1 foot 10 inches thick. Much difficulty was experienced in sinking the boring, owing chiefly to the cavernous nature of the nummulitic limestone and to the extreme softness of the intervening shales; so great was this difficulty that one hole had to be abandoned at a depth of 256 feet.

[1] *Rec., Geol. Surv. India,* XXXIV, 199.

It is now proposed to put down further borings in the neighbourhood of Tothral and Dalelpur in order to test the coal-measures below the nummulitic limestone towards the centre of the Dilwal plateau.

Engineering Questions.

19. At the request of the respective Local Governments, Mr. H. C. Jones was deputed to examine and report on proposed sites for dams at Ghori Gali, Pind Swika and Rhotas in the Jhelam district, Namal in the Mianwali district, Punjab, and near Nainpur in Mandla district, Central Provinces. His reports were forwarded to the local authorities concerned.

Galena.

Gwalior State: Mr. Jones.

20. In the course of his survey of the Gwalior State, Mr. H. C. Jones examined a deposit of galena occurring at Aindhar (lat. 25° 32′: long. 78° 8′). The galena occurs in small veinlets, patches and streaks, together with quartz and barytes, in a 5 ft. band in the gneiss, which apparently runs parallel to a quartz vein. Four pits had already been sunk somewhat irregularly at the N. E. end of the band and a considerable amount of the ore proved. Mr. Jones suggested fresh localities for further trial pits and for a tunnel in the area S. W. of the pits already opened with the object of proving the band over a longer line of outcrop. He also made some suggestions as to leasing and smelting.

Iron-ore.

Chanda, Central Provinces.

21. Near the small village of Poser (19° 56′: 80° 12′), the Archæan gneisses contain a band of hematite, which has been traced by Mr. P. N. Datta for a distance of 275 yards with an average thickness of about 20 feet and high dip to S. by E. The ore is almost theoretically pure hematite, and contains 69·8 per cent. Fe. Mr. Datta was unfortunately unable to determine the extent of the ore-body.

Iron-ore was also observed in the quartz hills to the south-east of Chamoursi (19° 56′: 99° 57′) and in the range running from near Wingnur (90° 46′: 80° 15′) to Emagarh (19° 42′: 80° 33′), but the amount available is unknown.

Kirana Hills: Mr. Heron.

22. During a visit to the Kirana Hills, Mr. Heron took the opportunity of examining the iron and manganese-ores said to occur there in some quantity. Mr. Heron, however, found only traces of manganese, whilst the iron-

ore proved to be of very poor quantity. Smelting, which was carried on on a small scale in the past, seems now to have been discontinued.

Monazite.

23. In consequence of the discovery of monazite sand in Travancore, Mr. G. H. Tipper was deputed to examine the coastal regions of that State on behalf of the Durbar. He found that certain beaches, chiefly along the west coast, were very rich in monazite, and consisted, in fact, of natural concentrates produced by the mechanical sorting action of the waves. Between Quilon and a point a few miles to the north-east of Cape Comorin, Mr. Tipper examined some seven deposits, in one of which he estimated that there must be at least 18,000 tons of pure monazite.

The mineral has also been found *in situ* in pegmatite near Thadikarenkonam, 14 miles north-west of Nagarcoil, and in the form of felspar-monazite rock, associated with graphite, in the leptynites and charnockites of Travancore.

Petroleum.

24. Mr. E. H. Pascoe paid a flying visit to Digboi early in the year, with a view to drawing up a programme for a subsequent survey of the oil-bearing regions of Assam. For the rest of the year he was engaged on a memoir on the Burma oil-fields; this is now in the press and will shortly be ready for issue.

Assam.

25. During the field-season 1909-10, the following surveys were made by the Burma Oil-fields party:

Burma.

In addition to the examination of Kyundaw Island in Magwe and an area round Nyaungbintha village in Thayetmyo, Mr. Cotter carried out surveys of the areas comprised in the following sheets (1″=1 mile):—

(*a*) sheet 112 complete, with a small portion of the Minbu district in the south-western part of sheet 158 and a part of sheet 113 on the Pegu-eocene boundary;

(*b*) part of sheet 110, to the east of the Irrawadi;

(*c*) sheet 84-K-16 complete, with the exception of the western boundary of the Yenangyat anticline, which was mapped by Sub-Assistant Sethu Rama Rau.

The first of these areas lies in the Minbu district, and its survey has thrown a considerable amount of light on the relations between the Pegu and eocene series of this part of Burma. A section in the Kyetsu chaung shows that the Pegu beds form a sharply folded anticline, the dips on either side of which are approximately the same. The Pegu outcrops widen towards the south. Gas-pools occur to the south of the Kyetsu chaung, and four holes with bubbling mud were noticed in the same locality. There was, however, no sign of oil.

The second area (part of sheet 110 to the east of the Irrawadi) is covered by Plateau Gravel, Red Earth and Irrawadi beds.

Sheet 84-K-16 comprises the Pagan hills, which consist of sandstone and shale bent into a faulted anticline similar to that of Yenangyat. These, together with the Gwegyo hills and the Payagyigon-Ngashandaung anticline may be regarded as different wave-fronts of a single anticlinal fold. Fragments of the crest are seen on the north and on the south of the Naletaw chaung. The crest-line is not continuous, but is broken by dislocation and faulting, and the rocks are often contorted. The curve of the anticline is very similar to that of Yenangyat, except that the beds on the west always dip more steeply than those on the west of the crest in the latter field. To the south the westerly-dipping Pegu beds are faulted against Irrawadi sandstone.

26. Mr. K. A. K. Hallowes was engaged in mapping the country shown on sheets 154 and 201 of the Burma Survey (1″=1 mile). The rocks comprised in this area include Red alluvium, members of the Irrawadi and Pegu series and a volcanic series of late Tertiary and post-Tertiary age. Tuffs, indicating the presence of an older volcanic group, were found interbedded with the Pegu sandstones of the Kyaukaingma anticline. The junction between the Irrawadi and Pegu series is said to be an unconformable one.

No oil-shows were found in this area, which is not regarded as of economic importance.

27. During the course of a survey of the Henzada district, Mr. M. Stuart examined various areas where oil was supposed to occur. He found nothing, however, which offered prospects of the discovery of an oil-field in this district.

28. Sub-Assistant Sethu Rama Rau mapped the area included in sheets (Burma Survey, 1″=1 mile) 155 and $84\frac{K}{12}$ together with parts of 154, 112, $84\frac{K}{15}$, $84\frac{K}{16}$ and $84\frac{L}{9}$. Sheet 155 comprises three distinct anticlines, the Wetmasut, Yedwet-Wetchok and the Gwegon-Pongon.

The first of these, which lies midway between Yenangyaung and Ondwe, appears to be a narrow fold with steep dips; the crest is formed by beds of doubtful age, which are perhaps uppermost Pegu. Although certain considerations tend to discount the value of this anticline as a source of oil, the general conditions point to it as being worth testing.

The Yedwet-Wetchok anticline has already been described by Mr. E. H. Pascoe (*Records*, Vol. XXXVI, p. 286).

29. The Gwegon-Pongon anticline is merely the continuation of the Kabat fold, and its prospects as an oil-field are similar to those of Kabat.

30. After completing sheet 155, Sub-Assistant Sethu Rama Rau undertook the mapping of the boundary between the Irrawadi and Pegu systems along the western edge of the Yenangyat oil-field. In conformity with Grimes' original classification (*Memoirs, Geol. Surv. India*, XXXVIII, 43), the "Red Bed" was adopted as the basal bed of the Irrawadi system and the white sand as the uppermost division of the Pegu. The Red Bed has yielded various fossils, including vertebrate remains, whilst higher up in the series, near Tabingyaung, a calcareous zone, containing numerous Upper Siwalik forms, was traced for a considerable distance.

Opportunity was taken to measure the whole thickness of the Irrawadi system, which was found to be approximately 8,500 feet, as against Dr. Noetling's estimate of 20,000 feet. The fossiliferous calcareous band occurs at 8,000 feet above the Red Bed.

31. During the latter part of the field-season of 1909-10, Sub-Assistant Sethu Rama Rau examined and collected fossils from the neighbourhood of Payaywa and the Man chaung near Ngape in Minbu district. At the village of Pinnebin, there is a coal-seam from 15 to 20 feet thick, overlain by a petroliferous sandstone. The coal is of poor quality, and often passes into carbonaceous shale; it does not appear to be of any economic value.

Salt.

Salt Range and Sambhar: Dr. W. A. K. Christie.

32. A preliminary enquiry was made by Dr. W. A. K. Christie into the occurrence of salts of potassium in the rock-salt beds of the Punjab Salt Range. Two seams struck in the Mayo mine at Khewra and one in the small mine at Nurpur are promising enough to justify more extended prospecting operations, which it is proposed to carry out during the next field-season.

The Sambhar Salt Lake investigation was proceeded with on the system, adopted in the year 1907, by which 30 samples of lake and subterranean brine from different parts of the Lake are collected each year. Analysis of these has so far shown no definite depreciation in the composition of the brine as a result of salt manufacture.

Samarskite.

33. The discovery of samarskite in India has already been recorded (*Records*, XXXVIII, 342), but until recently no opportunity had arisen of making a detailed investigation into its mode of occurrence. Owing to a request from the Madras Government for information on the subject, Mr. G. H. Tipper was deputed to Nellore for this purpose on December 26th; his enquiries should be completed early in 1911.

Nellore: Mr. G. H. Tipper.

Tin.

34. Mr. J. J. A. Page paid a flying visit to Mawchi in Bawlake State, Karenni, in order to examine the tin mines of Kehdaung. The route chosen lay up the Salween from Tavoy, and, owing to lateness of the season and difficulties of transport, the journey was a most arduous one. Mr. Page found the rocks along the route to consist of various sedimentary types, including limestones, sandstones, slates and conglomerates, referable partly to the Mergui and partly to the Maulmain series. Granite and crystalline rocks are also prominent, and are pierced by quartz-veins containing wolfram and cassiterite. The latter mineral also occurs in the granites. At Keh daung (=tin hill) the quartz-veins appear to be the only important mineral occurrence.

Burma: Mr. J. J. A. Page.

Trona.

35. An investigation was made by Messrs. La Touche and Christie into the origin and the resources of the Lonar Lake in the Buldana district of Berar. This curious crateriform hollow measures about a mile and a quarter from crest to crest of its slightly raised rim, and on its muddy bottom, some 250 feet below the level of the surrounding Deccan trap country, is a shallow sheet of brine, from which urao (trona), a hydrated compound of carbonate and bicarbonate of soda, had been profitably recovered for many years. Stress of outside competition has, however, rendered the impure products obtained from the lake by simple

Lonar Lake: Mr. T. D. La Touche and Dr. W. A. K. Christie.

evaporation almost unsaleable, and the enquiry was undertaken with a view to determining what the economic possibilities of the deposit really were.

The resources of the basin, in so far as they could be ascertained without borings, have been determined and in a report now in the press suggestions have been made for their more efficient realisation. The vexed question of the geological structure of the neighbourhood, important on account of this being the only instance of late volcanic activity—if it really were such—in the Peninsula, has been fully discussed by Mr. La Touche, who, rejecting the theory of volcanic explosion suggested by Dr. W. T. Blanford and supported by Mr. R. D. Oldham, considers it to be due to a sudden inrush of vapour or molten rock from below through fissures that did not penetrate to the surface, the central part of the "blister" thereby formed afterwards collapsing into the hollow beneath, when a lateral fissure had allowed of the escape of the imprisoned gas or lava. The origin of the salts in the lake basin has also been discussed, the analytical data affording corroboration of Blanford's theory that the deposit is due simply to evaporation of the stream water in the absence of an exit.

Water.

36. In addition to the usual large number of references, both from officers serving under the various Local Governments as well as from private individuals, on the subject of the prospects of artesian and other borings, special investigations were made into the conditions prevailing in various parts of Gujarat and Broach in the Bombay Presidency, and also at Ongole in Madras.

Gujarat.

In Gujarat, the scarcity of potable water has led to an attempt being made to obtain a sufficient supply either from artesian sources or from deep borings in the alluvium. It was originally suggested by the Geological Survey that trial borings should be put down in the neighbourhood of Wadhwan, but, owing to various considerations, sites were eventually chosen, by the local authorities, at Dholka and Sanand. A Calyx drill belonging to the Geological Survey was lent for the purpose, and borings were sunk into the alluvium; water was found at depths of 304 feet and 200 feet respectively at Sanand and Dholka. The borings were not carried through the alluvium, and the water was consequently not under artesian conditions. Although the water obtained at Sanand was finally found not to be potable, the experiments conducted by the Local Government are

regarded as decidedly promising since they indicate the presence of water in considerable quantities at no great depth below the surface.

Broach: Mr. H. Walker.

37. Mr. H. Walker, who was deputed to examine various sites in Gujarat, came to the conclusion that there is a greater probability of obtaining water from deep borings in the alluvium than from artesian sources in the Tertiary and Mesozoic rocks underlying it. At Broach, on the other hand, he is of opinion that an artesian supply may be obtained from the Tertiary sandstones and grits which crop out to the south-east and, dipping towards the north-west at angles varying from between 30° and 40° to between 5° and 10°, pass under the Nerbudda alluvium on which the town stands. Mr. Walker recommends that, if necessary, a boring should be carried to a depth of 2,000 feet. He does not expect that the artesian conditions will be sufficiently perfect to cause the water to flow at the surface, and a certain amount of pumping would probably be necessary.

Ongole: Mr. G. H. Tipper.

38. With a view to devising a scheme for increasing the water-supply of the town of Ongole, Mr. G. H. Tipper was deputed to make a detailed examination of the neighbourhood. He found that the local conditions were unpromising. The town lies, at a considerable distance from rivers of any size, on the northern slopes of a small range of hills composed of hornblende-schist, the foliation planes of which dip towards the south. The range is surrounded by a narrow strip of lateritic gravel of no great depth or extent, while the adjoining plains are composed of cotton soil. The present water-supply is derived from wells which have been sunk, in some cases through solid rock, in others through gravel and the decomposed gneiss underlying it. The latter wells are naturally the chief sources of supply.

Three schemes were under consideration:—

(*a*) a boring at about 1½ miles to the west of the town with a view to finding water under artesian conditions in the local representatives of the Gondwana system;

(*b*) utilisation of rivers;

(*c*) a filtration gallery on a line of wells near the town.

The first of these was rejected on the ground that any water in the Gondwanas would not be under sufficient pressure to rise to the surface, whilst the cost of the second was considered prohibitive owing to the great distance to the nearest river of any size. The third scheme, which had been

proposed by the Sanitary Engineer, Madras, although not regarded as completely satisfactory, was recommended as the only practicable method of increasing the water-supply.

Wolfram.

39. A report has been submitted by Mr. J. J. A. Page on the wolfram of Mawchi in the Bawlake State, Karenni. This has already been dealt with under *Tin*, *q.v.*

GEOLOGICAL SURVEYS.

Assam.

40. During the field-season of 1909-10, I examined a considerable area of hitherto unsurveyed territory in the Naga Hills between Kohima and the Disang river. The only rocks met with were members of the Disang, Tipam and Dihing series. Fossils, including an ammonite, were found for the first time in the Disang shales, and although they were unfortunately not determinable, they indicate that this series is at least in part pre-Tertiary. The question has been dealt with in a paper published in the *Records*, Vol. XL, p. 283.

Burma.

41. Mr. Stuart was engaged throughout the field-season in mapping the Henzada district. In the General Report for 1909, attention was drawn to the fact that Mr. Stuart had observed an unconformity in Western Prome between the Kama clay and the overlying marine beds which had always been regarded as the upper part of the Pegu system. These marine beds Mr. Stuart included in the Irrawadi system under the name "Marine Irrawadi." In order to avoid confusing established nomenclature by an attempt to change the significance of the term "Irrawadi system," he has now adopted the name "Akauktaung series" for these marine beds, which he has found also in Henzada, where they are said to overlap the whole of the Upper and Lower Prome series and to rest directly on the Sitsayan shales. He regards them as of middle miocene age.

Henzada District: Mr. M. Stuart.

Central India and Rajputana.

42. Mr. Jones continued his revision of the geology, and his investigation of the minerals, of the Gwalior State in those parts which lie to the west and south of the area begun last season (General Report for 1909-10, p. 69).

Gwalior: Mr. H. C. Jones.

The re-examined area lies between latitudes 24° 48′ and 26° 40′ and longitudes 77° 40′ and 78° 30′. The rock groups do not differ from those summarised in last year's General Report and are:—

(1) Bundelkhand gneiss with quartz reefs and dolerite dykes,

(2) Upper Vindhyan sandstones and shales, lying unconformably above the gneisses and also above the Gwalior representatives of the Bijawars,

(3) Laterite, and

(4) Alluvium.

43. In his progress report Mr. Jones remarks on the general geology of the area being very similar to that of the area surveyed the season before. As before, also, he does not find anything to dispute in the original mapping of it as carried out by Messrs. Hacket and Kishen Singh, with the trifling exception of a few laterite hills which he found to be sandstone, in the Vindhyan area. He has, therefore, submitted no new maps, and the bulk of his report is descriptive of local occurrences of the rock systems mentioned above.

44. With the exception of some galena at Aindhar, which has already been referred to, nothing of special economic interest was observed.

Alwar: Mr. A. M. Heron.

45. Except for a few weeks spent in investigating the effects of the Baluchistan earthquake and a passing examination of the Kirana hills, Punjab, Mr. Heron was engaged the whole season in continuing his work in Alwar State, the re-survey of which is now almost finished. As Mr. Heron proposes putting his results in memoir form at an early date, it will be sufficient here to note that his matured conclusions, after a second season, agree with his views briefly outlined in the last General Report (p. 71), as to the true sequence of the formations, which in the main follow Hacket's original scheme as opposed to his (Hacket's) later interpretation of them.

At the same time there are many minor differences between the new and the old survey, and a much greater accuracy of delineation of the geology as displayed in Mr. Heron's new mapping, which, together with his photographs, sections, and detailed petrological studies, should afford material for a full descriptive account of this complicated region, whose geological interpretation has long remained uncertain.

Banswara: Mr. Daru.

46. Mr. Daru continued his survey of Banswara, which he practically completed, by filling in the remaining blanks on sheets 175, 176 and 177 of the Central India

and Rajputana survey left over from last year, and with the addition of about 50 square miles in sheet 178.

Alluvium, Deccan Trap, Aravalli series and crystalline rocks continue as before throughout the region, and Mr. Daru's results may be briefly stated to be an extension into the new area of the mapping of the rock groups already begun by him.

The stratigraphical order of the members of the Aravalli series among themselves, tentatively adopted by Mr. Daru (see General Report for 1909-10, p. 73), has, however, been finally rejected by him. He finds that limestones and even conglomerates have been intercalated at various horizons between the slates, etc., though a conglomerate band has often been found next to the supposed older crystalline rocks.

47. With regard to the problem of the intercalations of those crystalline rocks and the Aravallis referred to in last year's General Report, he now writes:—

> "Although, in this report, following the arrangement of my preceding report, the crystalline intrusives and gneisses are placed as if belonging to an age prior to that of the Aravallis, the validity of such a course is open to dispute, especially with respect to this season's work. Intrusion has undoubtedly taken place into the Aravalli rocks, the intrusives have at times taken on gneissic characteristics, and have yielded boulders for the Aravalli boulder-beds; and these intrusives and gneisses are indistinguishable from those occupying larger but comparatively insignificant areas. Probably, therefore, the Aravallis and the intrusives and gneisses seen this season are coeval; some of the latter are undoubtedly subsequent to the Aravallis as can be seen from the way these have been disturbed. The same might, but with much less certainty, be said of the quartz-veins forming such a conspicuous feature of the Aravallis."

Central Provinces.

Chanda district: Mr. P. N. Datta.

48. The previously unsurveyed portion of Chanda district shown on Atlas sheet No. 73 was mapped geologically. It was found to consist chiefly of crystalline rocks, with a small patch of Vindhyans (conglomerate, sandstone, shale and limestone) in the extreme south-western corner. A red sandstone occurring at Markhunda on the left bank of the

Wainganga is regarded as possibly of Gondwana age. The crystalline rocks comprise three groups:—

(*a*) a series of quartz, mica and hornblende-schists, with gneiss and argillite;

(*b*) gneissose granite; and

(*c*) diabase, granite and quartz.

The schistose gneisses (*a*) are regarded as older than either (*b*) or (*c*). They contain a bed of hematite which may be of economic value.

Punjab.

Kangra district: Dr. G. E. Pilgrim and Sub-Assistant Vinayak Rao.

49. Dr. G. E. Pilgrim has been engaged on a general geological survey of the Sub-Himalayan Tertiary zone between the river Ravi and Subathu, included for the most part in the districts of Kangra and Hoshiarpur, in the State of Chamba, and the Simla Hill States. He was accompanied during part of the time by Sub-Assistant M. Vinayak Rao, to whom was entrusted a portion of the mapping, and on whose work Dr. Pilgrim reports favourably.

Speaking broadly, the general geological and structural features follow those indicated by Medlicott on the map accompanying his memoir on this region (*Mem., Geol. Surv. India*, III, pt. 2). A few modifications, however, have been found advisable. Medlicott omitted to differentiate between the Nahans (Lower Siwaliks) and the Siwaliks (Upper and Middle Siwaliks) to the north-west of the Sutlej, except along the innermost zone. It has now been found possible to separate the Nahans as far as the river Ravi, but, in the middle portion of this area lying between the river Beas and a line joining Una (31° 29′: 76° 20′) to Mandi (31° 43′: 76° 59′), only Upper and Middle Siwaliks are exposed from the Nahan boundary fault mapped by Medlicott right down to the plains. This absence of lower beds is due to the fact that the axes of the various folds dip both from the north-west as well as from the south-east towards this middle portion. As a result the upper beds have been removed by denudation from off the country to the north-west and south-west, thus exposing to view the older beds. The upper boundary of the Nahans (Lower Siwalik) is appropriately fixed by some very constant and very characteristic bands of red calcareous nodular clay, below which the sandstones are harder and, with the exception of a slightly pebbly zone much lower down in the series, contain no pebbles. This zone of red

nodular clays is considered to belong to the uppermost part of the Lower Siwaliks; the fossils found in it—*Dinotherium, Amphicyon palæindicus, Giraffa, Dorcatherium, Hipparion* and *Hemimeryx pusillus* (?)—seem to point to a fauna which is more closely related to the Lower Siwaliks of Sind and Chenji in the Salt Range than to that of the typical Middle Siwaliks of the Salt Range. These nodular clays are very similar in appearance to those which are found in the Lower Siwaliks of the Salt Range. At Nurpur, certain pisolitic, pyritous beds associated with the red nodular clays resemble so closely the Lower Siwalik beds of the Kalawala Rau in the Siwalik Hills to the north of Saharanpur as to lead Dr. Pilgrim to correlate the two. At the same time, there is little doubt that they represent a higher horizon than the Chenji one, and must be put at the very top of the Lower Siwaliks. The fauna, when more fully known, will probably prove to be intermediate between that of the typical Lower Siwaliks of Chenji and that of the typical Middle Siwaliks of Dhok Pathan and Asnot.

50. The lowest member of Medlicott's Sirmur series, the Subathu, *sensu stricto*, is easily separated from the Dagshai-Kasauli group. Its fossils prove it to be of Khirthar age, and Dr. Pilgrim considers that stratigraphically as well as palæontologically, a great unconformity exists above this horizon.

51. There seems to be considerable probability that the Dagshai-Kasauli series passes up conformably into the Nahans. What Medlicott suggests to be an intermediate group (*Mem. Geol. Surv. India*, III, pt. 2, pp. 132, 133), though mapping it for the most part, but not universally, as Nahan, occurs along the base of the Nahan outcrop between Naini Devi (31° 18′ : 76° 36′) and Pinjor (30° 44′ : 76° 58′). Since these beds can be readily separated from the Nahans by their characteristic purple colour and by the greater hardness of the sandstones, while, on the contrary, their separation from the Dagshai-Kasauli group is a matter of extreme difficulty, it will most probably be found convenient to unite them with the latter series.

52. The pebbly sandstones above the Nahan nodular clays contain, north of Babhor (31° 24′ : 76° 26′), *Mastodon sivalensis;* they are harder than the typical Upper Siwaliks of the Pabbi Hills and elsewhere, and it is probable that a portion of the group above the red nodular clays represents the fossiliferous Middle Siwaliks of the Salt Range area. The thickness of this portion probably varies from some 500 feet to 5,000 feet. It is, however, a matter of extreme difficulty to fix the boundary between it and the Upper Siwaliks; the position of such boundary can

only be very approximate, and is based on the harder nature of the sandstones and on the occurrence of somewhat concretionary beds and calcareous bands. The Upper Siwaliks are often fossiliferous down to some 3,000 feet below the top. Near Pinjor (30° 44′ : 76° 58′) and between that place and Rupar (30° 58′ : 76° 36′), remains of the characteristic genera occur, amongst them being *Equus*, *Bos*, *Camelus*, *Elephas*, *Sivatherium* and *Merycopotamus*.

53. The so-called "Belaspur conglomerate," mapped by Medlicott as Nahan, is regarded by Dr. Pilgrim as Upper Siwalik, while the sandstone overlying it he believes to be Middle Siwalik. He also assigns an Upper Siwalik age to the thick beds of conglomerate which are met with at various places along the inner boundary of the Tertiary, faulted against the metamorphic beds. This conglomerate occurs in the hills below Dalhousie and continues almost as far as Dharmsala; it is seen again between Mandi and Beijnath. In all these cases it has been mapped by Medlicott as Nahan.

54. The "Barsar" fault and the Nurpur fault are not on the same line of dislocation. The former fault has not been traced by Dr. Pilgrim appreciably farther to the north-west than the river Beas. The latter, which he regards as a branch of the "Gamber" fault, arises some little way to the north-west of Juwalamukhi (31° 53′ : 76° 23′). It seems to be cut off to the south-west by a cross fault which runs from Deira Gopipur through the Juwalamukhi range and probably extends past the so-called "Puthiar promontory" near the Neogal river. The fault mapped by Medlicott to the south-west of the Naini Devi range appears really to take its rise immediately east of Naini Devi (31° 18′ : 76° 36′) and to continue as a boundary fault between the Upper Siwaliks and the purple intermediate beds mapped by Medlicott as Nahan, but which Dr. Pilgrim prefers to include with the Dagshai-Kasauli series. This fault continues to the hills below Nahan, though often obscured by post-Tertiary deposits. The structure of the Naini Devi and Sola Singhi ridges was regarded by Medlicott as that of a syncline, but is regarded by Dr. Pilgrim rather as that of a much folded anticline.

Kashmir: Mr. C. S. Middlemiss.

55. During the summer, Mr. Middlemiss continued his revision of the survey of Kashmir, and by detailed examination of the Sind valley up to the Zoji La and of parts of the Pir Panjal, added still further to the already large stock of valuable scientific information acquired by him during the last few years. Mr. Middlemiss' work shows that Lydekker's interpretation of the age and structure of the Pir Panjal requires modification in many

important respects, the most striking new fact being the absence of any pre-Carboniferous rocks and the continuation of the Lower Gondwana and Triassic beds along the north-eastern slopes of the range from Gulmarg to the Golabgarh Pass, where they cross the crest. The range is therefore composed of members of the Carbon-Trias squence and constitutes a separate tectonic element, distinct, on the one hand, from the younger Sub-Himalayan and Nummulitic zone to the south-west and, on the other, from the older zone or zones, to the north-east, comprising large areas of rocks of pre-Carboniferous age.

Mr. Middlemiss' results are published in *Records, Geol. Surv. India*, Vol. XLI.

56. During the field-season of 1909-10, Mr. A. M. Heron visited the small groups of hills of the Jech and Rechna Doabs.

Kirana Hills: Mr. A. M. Heron.

There are in all four groups, *viz.*, at Kirana, at Chiniot, at Sangla, and at Shahkot. These hills are of peculiar interest as being at only a comparatively short distance from the fossiliferous belt of the Salt Range, to which, however, they appear to bear no stratigraphical or lithological resemblance. According to Mr. Heron, they consist of highly altered slates and quartzites, which stand almost vertical and strike from N. W. to S. E. On the southern part of the Kirana Hills, there are numerous bands of diabase and dark chert-like rocks. The general facies of the whole series of exposures is said to be somewhat similar to that of the Alwar and Ajabgarh divisions of the Delhi series.

GEODESY.

BY

J. ECCLES, M.A.,
Superintendent, Trigonometrical Surveys.

PRINCIPAL TRIANGULATION.

Operations during the cold weather season of 1910-11 and the hot weather season of 1911 were carried on in the following provinces:—

(1) Burma (Myitkyina district and the Southern Shan States).
(2) Kashmir.
(3) Central India.

(1) Burma.

(a) Myitkyina district. The Upper Irrawaddy Series.

Lieutenant Cardew continued this series from the side Marau H. S.—Matu Bum H. S. on which last year's work closed.

He commenced operations on November 6th, 1910, and completed observations at eight stations, closing work on the 30th March 1911. He extended the series, 100 miles in a westerly direction, by means of three quadrilaterals.

Lieutenant Cardew had hoped to close his work on the Mandalay Meridional Series, but the difficulty of clearing the dense forests on the hills delayed the work to such an extent, that the last figure had to be left unobserved.

The ten completed triangles have an average triangular error of $0''{\cdot}875$ and the triangulation covers an area of 1,760 square miles.

In addition to the triangulation work, Lieutenant Cardew observed an astronomical azimuth at Kumon Bum. The value of this azimuth differs from the geodetic value by $7''{\cdot}02$.

The observations at all stations were taken with a two-microscope $12''$ theodolite.

(b) Southern Shan States. The Great Salween Series.

This series emanates from the side Ubyetaung—Katha of the Mandalay Meridional Series, on meridian 96°. It runs thence due

east, between the parallels 23° and 24°, till it reaches the Salween river which it then follows in a southerly direction to parallel 22°. It then again bends eastward till it meets the eastern frontier of Burma, along which it is proposed to continue the series.

The work had closed in March 1909 at a point midway between the Salween river and the eastern boundary of Burma.

It took six weeks for the detachment to march from Thazi on the railway to Loi Lung, the first station of observation, and observations were therefore not commenced till December 7th.

Lieutenant King, R.E., who was in charge of the detachment, took observations at five stations.

Thick haze set in on the 19th February rendering the continuation of the triangulation impossible. The haze cleared sufficiently towards the end of the month to enable Lieutenant King to observe an azimuth at Hsam-Hsum by means of a referring mark set up a few miles away from the station. On completion of this azimuth the work was closed.

Lieutenant King extended the series about 74 miles in a south-easterly direction by means of one quadrilateral and one tetragon. The nine completed triangles have an average triangular error of 0″·753 and the triangulation covers an area of 2,200 square miles.

The value of the astronomical azimuth observed differs from the geodetic value by 7″·35.

The observations at all stations were taken with a two-microscope 12″ theodolite.

(2) Kashmir.

(a) *The New Kashmir Principal Series.*

Owing to the heavy winter experienced in Kashmir in 1910-11, the commencement of operations on this series was somewhat delayed.

Lieutenant Bell, R.E., who has been the observer this year, continued the series from the side Rutha Pahar H. S.—Chotiwala H. S. on which Mr. Hunter closed his work last year.

Lieutenant Bell began his observing work at Liowi on the 14th June 1911, and by the 25th July had completed observations at four stations. The heights of these average about 16,000 ft., the highest being Liowi 17,480 ft.

The series has been extended some 60 miles in a northerly direction by means of two quadrilaterals to parallel 35° 45′. The eight completed

triangles have an average triangular error of 0″·69 and the triangulation covers an area of 730 square miles.

The observations at all stations were taken with a two-microscope 12″ theodolite during this season. At the end of last season, owing to the difficulties experienced in transporting the 12″ theodolite to the top of Chotiwala H. S. it was considered advisable to use an 8″ theodolite. The forward rays from this station were consequently observed with this instrument. The loss of accuracy is shown by the fact that there are two triangles, which include the angles at this station, in each of which the triangular error exceeds one second.

Lieutenant Bell and Mr. Wainright, the latter of whom had been employed on building forward stations, have now started to reconnoitre the country north of Gilgit, in order to decide whether it will be feasible to carry the triangulation on and finally connect up with the Russian triangulation on the Pamirs. Lieutenant Bell has visited the Darkot Pass and has reported that the peaks of the Sakiz Jarab range are inaccessible.

(*b*) *Teram Kangri.*

Mr. Collins assisted by Mr. Wyatt started from Srinagar in May for the purpose of definitely locating and observing the true height of Teram Kangri, the high Himalaya peak discovered by Dr. Longstaff during his explorations in 1909.

The two officers, making their head-quarters at Leh, visited several of Montgomerie's old trigonometrical stations, but as no glimpse of Teram Kangri could be obtained from any of these, Mr. Collins proceeded with his plane-table to make a rapid reconnaissance to the north, leaving Mr. Wyatt to follow in his footsteps and bring up the triangulation.

Mr. Collins' last report, dated 6th July, states that he proceeded up the Nubra Valley and obtained observations to Teram Kangri from two peaks and hoped to observe it from a third. Mr. Collins places Teram Kangri 6 miles south-east of the position assigned it by Dr. Longstaff and gives its height as 24,272 ft. The data which Mr. Collins has available for basing his computations are derived from his plane-table and his aneroid barometer and his results cannot therefore be regarded as final; so soon as the triangulation is brought up to his stations of observation, it will be possible to give definite information, both as to the position and height of Teram Kangri. As regards the height, the

error is not likely to be considerable and it may be taken as certain that the final corrected height will not approach that of Mount Everest.

(3) Central India.

The work in Central India consisted of the revision of heights on the Great Arc Series. Work commenced at the Sironj base line on January 20th, 1911, and closed on March 20th, 1911.

In all, the heights of ten stations have been revised. There was a difference of about 5 ft. in the new and old value of the second station Bhaunrasa, the old value being in excess of the new value: this difference remained fairly constant in the remaining eight stations.

Base Lines.

A detachment was engaged in the selection of sites for base lines in Burma, with a view to their measurement, in the near future, by means of the new Invar wire apparatus. This apparatus allows of the measurements of base lines of much greater length than those measured in India by means of the Colby compensation bars and it was hoped that a fairly level stretch from 15 to 20 miles long could be selected.

Mr. McInnes, who was in charge of the work, reconnoitred the country round Myitkyina, Bhamo, Toungoo and Prome, but was unable to obtain suitable sites for base lines of the length proposed. He prepared two sites, one at Bhamo 9 miles in length, the other at Prome about 13 miles long; if more favourable sites cannot be found, the measurement of these lines will have to be undertaken.

The Invar wires themselves were received at Dehra nearly two years ago, but the new metre and four metre standards have not yet been received, so that there has been no possibility of carrying out a comparison of the wires. Until this has been done, no actual measurements can be carried out with the wires.

SECONDARY TRIANGULATION.

Three detachments were employed on secondary triangulation, one in the Southern Shan States, the other two in Assam.

ASTRONOMICAL LATITUDES.

During the season of 1910-11, latitude observations were made at ten stations; of these six were in Sind and Baluchistan, and four in the Siwalik Hills to the south and south-east of Dehra Dun.

Special interest attaches to the Sind observations as they are the first astronomical latitudes which have been taken in this region.

The positions of the stations must be described in some detail.

(1) Khojak h.s. Lat. 30° 51′. Long. 66° 37′. Height 7,851 ft.

The station is on one of the peaks of the Khwaja Amran range, which runs from north-north-east to south-south-west in an almost straight line for many miles. The general topography is fairly similar in character on the two sides of this line; on the west lies Afghanistan, and on the east the knotted hills of Baluchistan. The distribution of the mountains within a radius of 50 miles is such as to lead one to expect no marked deflection of the plumb-line.

(2) Quetta. Lat. 30° 12′. Long. 67° 3′. Height 5,500 ft.

The distance from Khojak h.s. is about 50 miles, Quetta lying to the south-east.

In the surroundings of Quetta there is again an apparent balance of masses to the north and south, and there is no cause for deflection of the plumb-line so evident as to be detected by an inspection of the map.

(3) Mach. Lat. 29° 53′. Long. 67° 21′. Height 3,082 ft.

This station is situated in the Bolan Valley about half way between the point where the railway emerges into the Dasht and that at which it leaves the plains. Here there is a notable excess of hills to the north of the station. To the south-east the hills fade away into the plains, the foot being about 20 miles distant. To the south, though there are hills, they are much less lofty than those to the north. From west to south-west, the hills are high, possibly on the whole rather higher than those that lie between west and north-west, but the excess here is much less marked than the deficiency in the remainder of the southern semicircle. A northerly attraction is therefore to be expected at this station.

(4) Dasti. Lat. 29° 0′. Long. 67° 56′. Height 316 ft.

This station is situated in the plains. Its distance from the foot of the hills is about 25 miles, the nearest point being in a north-west direction. In a northerly direction the hills are about 40 miles distant. If we estimate that from west to north-east (clockwise) a belt between circles of 40 and 80 miles radius respectively is occupied by hills, on the average 5,000 ft. higher than the station, the attraction will be (*vide* Professional Paper No. 5, page 50)—

$$0''{\cdot}000742 \times 5000 \times 1{\cdot}766 = 6''{\cdot}6.$$

This may be taken as a rough indication of the attraction which the topography within 80 miles might be expected to produce. If the investigation be extended it will unquestionably indicate that a larger attraction than the above is to be expected, for the country to the north is all elevated while that to the south is low-lying.

(5) Dumb. Lat. 28° 15′. Long. 68° 17′. Height 183 ft.

This station is situated in the plains a few miles west of Jacobabad. The nearest hills lie about 30 miles to the north-east and 50 miles to the west respectively. An analysis of the topography would undoubtedly show that a northerly attraction was to be expected here.

(6) Sultan-ka-Got. Lat. 28° 4′. Long. 68° 39′. Height 213 ft.

This station is situated near the town of Shikarpur. The characteristics of its situation are similar to those of Dumb, but the hills are now more remote.

The results of the observations are as follows:—

Name of station.	Geodetic Lat.	Astrol. Lat.	A—G.
	° ′ ″	° ′ ″	″
Khojak	30 51 24·69	30 51 20·43*	−4·26
Quetta	30 11 57·37	30 11 56·25	−1·12
Mach	29 52 31·51	29 52 20·15	−11·26
Dasti	29 0 29·93	29 0 27·66	−2·27
Dumb	28 15 21·09	29 15 18·76	−2·33
Sultan-ka-Got . . .	28 4 9·41	28 4 7·97	−1·44

* These values are provisional as the computations are not yet complete.

A negative value of A—G denotes a northerly attraction of the plumb-line. At Khojak and Quetta the results are of the nature that an inspection of the neighbouring topography had led one to expect. There is a passage in Professional Paper No. 5, page 52, on the subject of what inferences could be drawn from an observation taken at a point 'beyond Quetta.'

The present observations though not taken in exactly the region contemplated by Colonel Burrard, yet go some way to prove that the

initial latitude of the survey, namely, that at Kalianpur, is not much affected by local attraction.

The fact that the deflections at Dasti, Dumb and Sultan-ka-Got are so much smaller than that at Mach, and the progressive diminution in these deflections, indicate a structure similar to that found at the foot of the Himalayas, namely, a trough of low density at the foot of the hills, succeeded, at a considerable distance, by a belt of abnormally high density.

The present observations point to the conclusion that the place of maximum density is further to the south-east than Sultan-ka-Got. The results of the latitude observations are in good agreement with those of the pendulum observations made in 1906-07. These observations showed a large deficiency in gravity at Sibi and Mach, and an excess at Jacobabad. Further observations both of the intensity and direction of gravity at stations along the Indus and to the south-east of the river are required. The lobe of the mountain region which projects to the south between Sibi and Dera Ghazi Khan is a feature which does not occur elsewhere on the long line of the ranges that shut in the north of India, and it deserves a detailed examination.

Of the four stations in the Siwaliks, Shorpur is on the main ridge, close to the Mohan Pass, where the road from Saharanpur to Dehra crosses it. The other three stations are all on the plains side of the range.

The positions of the stations and the results of the observations are shown in the following table:—

Name of station.	Height.	Long.	Geodetic Lat.	Astrol. Lat.	A—G.
	Ft.	° ′	° ′ ″	° ′ ″	″
Lachkua . .	2,674	78 2	30 4 34·24	30 4 5·20*	−29·04
Hatni . . .	3,096	77 59	30 13 0·44	30 12 31·10	−29·34
Bullawalla . .	2,432	77 59	30 6 51·29	30 6 22·30	−28·99
Shorpur . .	2,916	77 58	30 13 45·59	30 13 14·59	−31·00

* These results are provisional as the computations are not yet complete.

At the east end of the base, which is at the foot of the Siwaliks on the Dun side, nearly due north of Shorpur, the value of A—G is −30″·37, *vide* Professional Paper No. 5, table after page 14.

It is remarkable that the northerly attractions at the east end of the base and at Shorpur are greater than those at the other three stations. It indicates that the approach to the Himalayas is a more important fact than the change from the one side to the other of the Siwaliks. This range is so rugged and precipitous that it is difficult to cross and so appears a formidable barrier, but the amount of matter contained in it is probably not very great and of low density.

Pendulum Observations.

The year's work is interesting as affording the first gravity results yet obtained in Burma. Observations were taken at eleven stations with the results shown in the attached table. The orographical corrections have not been fully computed yet; but in no case can the correction be large, and therefore the results now given may be accepted as representing very closely the actual state of things.

(2) During the recess, computations of the effect of the whole surface of the earth on gravity at stations in India were commenced, using the hypothesis and zones devised by Mr. Hayford of the U. S. Coast and Geodetic Survey in his isostatic enquiries. Commencement was made from the Antipodes, and it has been found possible to use interpolation very freely for the more distant parts of the earth, increasing the number of the computed stations as the zones approach nearer to them.

The stations used for each set of zones are then plotted on a map of India and contours of equal attraction (according to this hypothesis) are thus drawn by interpolation, by means of which the attraction exerted by these particular zones can be read off for any required station in India.

The most laborious part of the work is now done, and by the end of the present recess season it is hoped to bring it to within 300 miles of all stations; after which it will be a very small labour to compute the effect of the complete "Hayford" correction for the whole earth on any desired pendulum station in India or Burma.

The work already done indicates considerable differences of effect, which may somewhat modify the figures used in last year's preliminary discussion, which only included the terrain within 100 miles from the station.

Summary of results, season 1910-11.

No.	Station.	Latitude.	Longitude.	Height above M. S. L.	Observed g.	Correction for height.	Correction for mass.	Correction for terrain.	g_o=G. corrected for height only.	g''=corrected for height and mass.	γ_o.	$g_o-\gamma_o$.	$g''-\gamma_o$.
		° ′ ″	° ′ ″	Ft.									
1	Rangoon . .	16 47 55	96 9 8	164	978·467	+0·015	−0·006		978·482	978·476	978·434	+0·048	+0·042
2	Prome . . .	18 49 40	95 13 40	101	978·543	+0·009	−0·004		978·552	978·548	978·541	+0·011	+0·007
3	Henzada . .	17 39 17	95 27 18	46	978·481	+0·004	−0·002		978·485	978·483	978·478	+0·007	+0·005
4	Bassein . .	16 47 11	94 44 6	23	978·475	+0·002	−0·001		978·477	978·476	978·433	+0·044	+0·043
5	Toungoo . .	18 55 50	96 27 3	159	978·558	+0·015	−0·006		978·573	978·567	978·547	+0·026	+0·020
6	Pyinmana . .	19 44 25	96 11 56	409	978·578	+0·038	−0·014		978·616	978·602	978·593	+0·023	+0·009
7	Meiktila . .	20 51 26	95 51 58	799	978·617	+0·074	−0·028		978·691	978·663	978·658	+0·033	+0·005
8	Mandalay . .	21 59 44	96 6 28	244	978·714	+0·023	−0·009		978·737	978·728	978·728	+0·009	−0·000
9	Maymyo . .	22 1 13	96 28 24	3,495	978·490	+0·326	−0·122		978·816	978·694	978·730	+0·086	−0·036
10	Mogok . . .	22 54 51	96 29 51	3,685	978·539	+0·343	−0·129		978·882	978·753	978·787	+0·095	−0·034
11	Myingyan . .	21 28 56	95 23 50	248	978·690	+0·023	−0·009		978·713	978·704	978·696	+0·017	+0·008

Tidal Operations.

During the past year tidal registrations by automatic tide gauges have been taken at the ports of Aden, Karachi, Apollo Bandar (Bombay), Prince's Dock (Bombay), Madras, Kidderpore, Rangoon, Moulmein and Port Blair. The registrations at these ports have been satisfactory.

Levelling Operations.

During the year 1910-11 the following lines of precise levelling were run :—

(a) In the Punjab.

1. Ambala to Solon.
2. Dera Ismail Khan to Chunda.
3. Darya Khan to Rawalpindi *viâ* Khushab, and Khushab to Shahpur.
4. Rawalpindi to Murree.
5. Nowshera to Risalpur.

(b) In Bombay, Madras and Goa.

1. A number of branch lines to connect bench-marks along the old lines of levels between Bombay and Igatpuri and Bombay and Lonavla with new rock-cut bench-marks in the ghâts.
2. Poona to Ahmadnagar.
3. Morgugao to Bagalkot *viâ* Belgaum.
4. Belgaum to Hubli (revision).

(c) In Eastern Bengal and Assam.

1. Gauhati to Dibrugarh.
2. Gauhati to Dumpep *viâ* Shillong.

These lines comprise three which run from the plains to the hills, *viz.*, Ambala to Solon, Rawalpindi to Murree, and Gauhati to Shillong.

The programme had originally included an extension from Murree, *viâ* Baramula to Srinagar and other points in the valley of Kashmir, but as the Kashmir Durbar took exception to the cost of the connection with the India level net, and as without this the work would have had no geodetic value, the scheme was abandoned.

BOTANICAL SURVEY.

BY

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Eastern India.—Two fasciculi—comprising 6,000 numbers—of the enumeration and identification of the non-herbaceous phanerogams cultivated in the Royal Botanic Garden, Calcutta, have appeared during the year, while the numbers between 6,000 and 10,000 are now in the press. There are still left over 3,400 numbers for identification before the first part of the catalogue can be nominally completed.

An account of the results of Messrs. Smith and Cave's expedition to the extreme north-west of Sikkim that was referred to in last year's report has been issued as a number of the Records of the Botanical Survey, with a map and two photographic plates. The species new to science yielded by the collection include *Clematis zemuensis, Arenaria thangoensis, Astragalus zemuensis, Potentilla perpusilloides; Saxifraga llonakhensis, S. Caveana, S. coarctata, S. inconspicua; Sedum Levii, S. Smithii, S. Fischeri, S. Cavei, S. Oreades, S. Quevai, S. Gagei; Cremanthodium cuculliferum; Primula atrodentata, P. Caveana, P. flagellaris; Parajaeschkea Smithii, Aphyllorchis Pantlingii, Allium Gageanum.* Of these *Parajaeschkea* is a new genus of *Gentianaceæ* described by Mr. I. H. Burkill. In July-August of 1910, Mr. Smith was deputed to explore the south-east corner of Sikkim, more particularly the ridges lying between the Cho-La and Tanka-La. Both those passes had been visited previously by botanists, but not very much was known of the vegetation of the intervening country. During his tour Mr. Smith collected over 6,000 specimens and made careful observation of the vegetation. A detailed account of the tour and its results will appear in the Records of the Botanical Survey so that here only a brief summary need be given. Summer on the Cho-La range would appear to be short and very rainy, the rain coming more as a steady drizzle than in heavy downpours, with rather a limited amount of sunshine in consequence. The flora is less diverse than that of northern Sikkim. The dominant orders are *Ericaceæ, Primulaceæ, Compositæ, Crassulaceæ, Saxifragaceæ* and in a less degree *Ranunculaceæ, Caryophyllaceæ, Juncaceæ, Cyperaceæ, Gramineæ, Scrophulariaceæ, Gentianaceæ, Salicaceæ.* The more important genera are *Rhododendron, Primula, Senecio, Sedum,*

Saxifraga, Potentilla, Gentiana, Pedicularis, Salix, Swertia, Meconopsis, Ranunculus, Anemone, and in a less degree,—*Juncus, Corydalis, Rheum, Codonopsis, Parnassia, Arisæma.*

Prominent species are:—*Abies Webbiana, Clematis montana, Chrysanthemum Atkinsoni, Swertia Hookeri, Gentiana stylophora, Rhododendron campanulatum, Primula sikkimensis, P. reticulata, P. obtusifolia, P. Stuartii, Trollius pumilus, Meconopsis paniculata, Iris Clarkei, Cardamine macrophylla, Lloydia serotina.*

There were lacking or scanty the tufted Arenarias of north-west Sikkim, *Leguminosæ, Tamarix, Saussurea* and *Coniferæ* except *Abies.*

Mr. Smith notes that "*Ranunculaceæ* are represented chiefly by *Anemone, Caltha, Trollius* and small *Ranunculi.* These occur in large numbers wherever there is any approach to meadow conditions. Aconites are apparently much scarcer than in western Sikkim. Of *Berberideæ, Decaisnea* frequents the moist woods just below 9,000 feet, while *Berberis macrosepala* is a trial to travellers on the higher slopes. *Meconopsis* is plentiful and there are several prolific species of *Corydalis. Cruciferæ* are not well represented, *Cardamine* sps., *Cochlearia* sps. and *Draba elata* being the most conspicuous. The almost entire absence of cultivated land precludes many wide-ranging species usually associated with agriculture. Of *Caryophyllaceæ* the region yielded chiefly species of *Stellaria* and *Arenaria,* mostly straggling forms typical of moist alpine conditions and very different from the 'rosette' plants of those genera in northern Sikkim. *Leguminosæ* are almost entirely absent. *Rosaceæ* are represented chiefly by species of *Potentilla* while *Rosa sericea* and *Geum elatum* are common. *Saxifraga* shows many species though not quite so many as northern Sikkim. This is also true for *Crassulaceæ,* prolific in individuals but restricted in species. *Umbelliferæ* show more species than in northern Sikkim but compare unfavourably with the Singalela range in number of species and individuals. Both *Caprifoliaceæ* and *Rubiaceæ* are poorly represented, the dearth of species of *Lonicera* being noteworthy. Of the abundant *Compositæ* the most conspicuous are species of *Senecio* of which three are new species. *Rhododendron* and *Primula* are the most prevalent genera in the area. *Gentiana* and *Swertia* are also well represented. *Borragineæ* are scarce with the exception of *Paracaryum glochidiatum* and *Onosma Emodi.* In *Solanaceæ, Mandragora caulescens* is the only common plant. As elsewhere in Sikkim, *Pedicularis* is well represented while *Veronica* is not uncommon. In the moist forest *Utricularia* is frequent and two species are found above the forest zone. *Labiatæ* are not common, the most conspicuous members being *Dracocephalum speciosum, Phlomis*

sps. and *Calamintha umbrosa*. Of *Polygonum* there are several species. *Euphorbiaceæ* and *Urticaceæ* are scarce. Prostrate *Salices* are abundant and in the valleys are a few trees of fair height. Among monocotyledones, *Orchis* and *Habenaria* are frequent, round clumps of *Iris Clarkei* in the moist valleys and *Lloydia* everywhere. *Arisæma* is prominent. *Juncaceæ* and *Gramineæ* show an average of species equal to other alpine areas of Sikkim."

More than twenty new or noteworthy species were discovered. In addition to working out the results of his own tours Mr. Smith has also worked up the collection made in Bhutan by Mr. J. C. White, C.I.E., late Political Officer in Sikkim, and the Sikkim collections generally in the Calcutta Herbarium. The following species new to science have so far been yielded by these collections and have been described in No. 5 of Volume IV of the Records of the Botanical Survey:—*Garuga Gamblei*, *Enonymus tibeticus*. *Pirus bhutanica*, *Saxifraga Gageana*, *Pimpinella radiata*, *Pentapterygium sikkimense*, *Primula Whitei*, *P. Jonarduni*, *Buddleia tibetica*, *Aerides Greenii*, *Hedychium Greenii*. The following new species also from the Eastern Himalaya have been described by the Curator of the Herbarium elsewhere:—*Senecio biligulatus*, *S. Lagotis*, *S. Chola*, *Saussurea fibrosa*, *S. Pantlingiana*, *S. nimborum*, *S. Laneana*, *Gentiana pluviarum*, *Swertia ramosa*, *S. Burkilliana*. Species not hitherto recorded as occurring in the Eastern Himalaya include *Spenceria ramalana* Trim., *Cydonia cathayensis* Hemsl., *Rodgersia pinnata* Franchet, *Ribes Grossularia* L., *Uncaria macrophylla* Wall., *Senecio arnicoides* Wall., *Calorhabdos Brunoniana* Benth., *Trichodesma calycosum* Coll. & Hemsl.

Mr. J. R. Drummond, I.C.S. (retd.), has described the following new species of *Compositæ* from collections made in the Eastern Himalaya by Calcutta Botanic Garden collectors or with their aid by others:—*Senecio lancifer*, *S. rumicifolius*. M. H. Lèveillé has published a diagnosis of *Hemiboea himalayensis* as a new species of *Gesneraceæ* from the Government Cinchona Plantation, Mungpoo. Mr. W. R. Dykes has described *Iris himalaica* as a new species from near Darjeeling. The moss flora has been studied by Mr. H. N. Dixon who has described as new species from the Eastern Himalaya *Merceyopsis minuta*, *M. sikkimensis*, *M. angulosa* and *Hymenostylium anotinum*.

A notable contribution to our knowledge of the vegetation of Bengal is "A Forest Flora of Chota Nagpur including Gangpur and the Santhal Parganahs" by Mr. H. H. Haines, Deputy Conservator of Forests. Although nominally a Forest Flora the work includes reference also to the

principal economic herbs and the more commonly cultivated trees and shrubs. The area dealt with is over 37,400 square miles in extent and, with the exception of a strip of the Gangetic plain lying along the east and north of the Santhal Parganahs, is composed of plateaux and hills that vary from 400 to 3,000 feet in elevation. A succinct account is given of the topographical and geological features and a comprehensive account of the climate and rainfall of the area. The vegetation is essentially of the monsoon forest type and more or less deciduous during the dry months, although the cool valleys and the tops of some of the highest hills exhibit a vegetation differing somewhat from the general type. The most characteristic tree of the area is *Shorea robusta* Gærtn. (the Sal), which on the driest aspect gives place to such species as *Cleistanthus collinus* Benth., *Anogeissus latifolia* Wall., *Odina Wodier* Roxb., *Nyctanthes Arbor-tristis* Linn. and others of the "mixed forest" type. On the driest rocks purely xerophilous species occur, such as the fleshy *Euphorbias* and *Sarcostemma*. Most of the species avoid the evils of excessive transpiration during the dry season by declining to wear any leaves. Mr. Haines mentions *Sterculia urens* Roxb., *Odina Wodier* Roxb. and *Cochlospermum Gossypium* DC. as typical examples of trees leafless from November to May or June.

The area is characterised by the general association of *Shorea robusta* Gærtn., species of *Anogeissus*, *Bassia latifolia* Roxb., species of *Gardenia*, *Butea* and *Schleichera* and the grasses *Ischæmum angustifolium* Hack. and *Heteropogon contortus* Rœm. The common sub-Himalayan associates of the Sal, such as *Dillenia pentagyna* Roxb., *D. indica* L., *Careya arborea* Roxb., *Stereospermum chelonoides* DC. and *Sterculia villosa* Roxb. are scarce in the area, while Teak, *Dalbergia sissoo* Roxb., *Cupuliferæ* and *Coniferæ* are entirely absent in a wild state. *Rubiaceæ* especially of the genera *Gardenia* and *Wendlandia*, *Acanthaceæ*, species of *Bauhinia*, *Diospyros*, *Terminalia*, *Zizyphus* and such species as *Cleistanthus collinus* Benth., *Nyctanthes Arbor-tristis* L., *Ægle Marmelos* Corr. and *Dendrocalamus strictus* Nees abound.

Dillenia pentagyna Roxb., the common sub-Himalayan associate of the Sal, is replaced in Chota Nagpur by *Dillenia aurea* Sm. The *Anonaceæ* are fairly well represented, as also are the small families *Menispermaceæ*, *Capparidaceæ*, *Polygalaceæ*, *Combretaceæ* and *Lythraceæ*. On the other hand *Urticaceæ*, *Magnoliaceæ*, *Ranunculaceæ*, *Cruciferæ*, *Guttiferæ*, *Ternstræmiaceæ*, *Rosaceæ*, *Umbelliferæ* and *Lauraceæ* are poorly represented. The more important orders according to the number of species represented are *Gramineæ*, *Leguminosæ*, *Cyperaceæ*, *Orchidaceæ*,

Compositæ, *Euphorbiaceæ*, *Acanthaceæ*, *Rubiaceæ*, *Scrophulariaceæ*, *Filicales*, *Labiatæ*, *Urticaceæ*, *Cucurbitaceæ*. Altogether about a thousand species are described or referred to. Keys to the genera and species are furnished and notes added with reference to such practical points as habitat, times of flowering and fruiting, renewal of the leaves and such like. A good map accompanies the volume.

In Assam Mr. I. H. Burkill, while officiating as Director of the Botanical Survey, made along with Mr. S. C. Banerji a tour in the Khasia Hills district. His collections are now being worked up.

The collections previously made in Assam were worked up as far as possible partly by the Herbarium staff at Calcutta and partly by botanists in Europe. From Mr. Meebold's Manipur collections—referred to in the report for 1908-09—the following new species have been described:—*Impatiens spissiflora*, *I. teneriflora*, *I. longirama*, *I. gibbisepala*, *I. odontosepala*, *I. rubrolineata*, and a new variety of *I. tripetala* Roxb. and of *I. lævigata* Wall., by the late Sir Joseph Hooker, and *Epipremnum Meeboldii* by K. Krause. From other collections there have been described as new species—*Justicia Craibii* by the Curator of the Calcutta Herbarium, *Uraria Lacei* by W. G. Craib of the Kew staff, *Prunus* (*Padus*) *bracteopadus* by E. Koehne, *Cirsium Lipskyi* by Fr. Petrak, *Potamogeton orientalis* by O. Hagström, *Tinospora Mastersi* by L. Diels.

Mr. I. H. Burkill has observed the further spread in Assam of the American species *Croton sparsiflorus* Morung that was referred to in last year's report as a recent introduction to India. Mr. Burkill found it at Shamshernagar, at Tilagaon, at "mile 296" a halting place for Haflong, at Lumding and at Gauhati. The species seems to have spread from Chittagong as its point of arrival in India.

In Burma Mr. A. Meebold has partly explored the district of Tavoy, but his collections therefrom still remain to be worked up. In northern Burma Captain S. M. Toppin, R.G.A., collected over the hitherto unexplored country between Mogoung and the Chindwin river, his route being through Kamain, Haungpa and Nainpaw. These collections also still remain to be worked up. Mr. Toppin has in addition contributed to the Survey his collections made in the neighbourhood of Bhamo. Captain R. W. MacGregor, I.M.S., has sent from the Shan States an interesting collection of about 1,600 specimens. Messrs. A. Rodgers, G. E. S. Cubitt, and H. W. A. Watson, Deputy Conservators of Forests, have sent material from respectively the Ruby Mines district, the Bhamo

division and Taunggyi. These and previous collections made by the same officers, by Mr. J. H. Lace, Chief Conservator of Forests, and by Mr. Meebold, have been to a considerable extent worked up by the Calcutta Herbarium staff and by botanists in Europe. So far these collections have yielded the following species new to science:—*Manglietia Hookeri, Melodorum minuticalyx, Paranephelium Hystrix, Craibiodendron shanicum* (a new genus), *Beaumontia brevituba, Didymocarpus bracteatus, D. graciliflorus, Stereospermum grandiflorum, Nyctocalos shanica, Ione salweenensis, Stauropsis shanica* described by the Curator of the Calcutta Herbarium; *Pueraria alopecuroides, Indigofera Lacei, Ophiorrhiza Lacei, Adenosacme chasalioides, Gymnema Lacei, Swertia Lacei* by Mr. W. G. Craib of the Kew Herbarium; *Impatiens Lacei* by the late Sir Joseph Hooker; *Oxytenanthera Lacei* by Mr. J. S. Gamble; *Osbeckia Hildebrandii* by Dr. O. Stapf; *Carex plesiocephala* by Mr. Turrill; *Xylia Kerrii* by Messrs. Craib and Hutchinson; *Amorphophallus kachinensis* by Dr. Engler and Herr Gehrman, *A. Krausei* by Dr. Engler. From the collections made many years ago in the Malayan region by Calcutta Botanic Garden collectors and others Mr. J. S. Gamble has described the following new species of *Lauraceæ:—Cinnamomum graciliflorum, C. Ridleyi, C. Dechampsii, C. Scortechinii, C. aureo-fulvum, C. cinereum; Alseodaphne Wrayi, A. paludosa, A. insignis, A. Ridleyi, A. pendulifolia, A. borneensis; Notaphœbe fruticosa, N. Kingiana, N. reticulata, N. sarawacensis, N. Havilandi; Machilus Scortechinii; Phœbe Kunstleri, P. Forbesii; Stemmatodaphne perakensis; Actinodaphne montana, A. Ridleyi, A. johorensis, A. oleifolia, A. Hullettii, A. cuspidata, A. fragilis; Litsea johorensis, L. trunciflora, L. artocarpifolia, L. gracilis, L. Ridleyi, L. quercina, L. cylindrocarpa, L. Wrayi, L. Teysmanni, L. machilifolia, L. hirsutissima, L. fenestrata, L. Foxiana, L. monticola, L. Scortechinii, L. oblanceolata, L. Kunstleri, L. claviflora, L. Curtisii, L. megacarpa, L. nidularis, L. sarawacensis, L. ujongensis; Neolitsea mollissima, N. kedahensis, Lindera Wrayi.* Sir Joseph Hooker had described two new species of Balsam from the same region—*Impatiens peltata* and *I. Vaughanii*—and Lieutenant-Colonel Prain has figured and re-described a new Labiate genus and species *Acrymia ajugiflora.* Other new species from the same region are *Amorphophallus perakensis* and *A. carnosus* described by Dr. Engler and *Tinospora macrocarpa* and *T. andamanica* by Dr. Diels, and *Selaginella strigosa* by the late Colonel Beddome.

Southern India.—From Madras, Dr. C. A. Barber, Madras Government Botanist, has contributed to the Survey over 800 specimens

Mr. C. E. C. Fischer, Deputy Conservator of Forests, has as usual sent a rich collection of over 1,600 specimens. Mr. Alfred Meebold during the later months of 1910 made an extensive tour through the States of Cochin and Travancore, which yielded a fine collection including rare and new species. Mr. Meebold has presented a set of over 2,000 sheets to the Calcutta Herbarium. The new species published during the year from these and from previous collections from Southern India include *Vernonia Meeboldii*, *V. comorinensis*, *Anaphalis travancorica*, *A. Meeboldii* described by the Curator of the Calcutta Herbarium; *Oldenlandia Prainiana*, *Strobilanthes Meeboldii* by Mr. W. G. Craib; *Impatiens Nataliæ*, *I. bababudenensis*, *I. microtheca*, *I. lenta*, *I. trichocarpa* by Sir Joseph Hooker; *Anaphyllum Beddomei* by Dr. Engler.

Mr. Meebold has published a sketch of the vegetation of Mysore and Mr. R. J. D. Graham, Economic Botanist, Nagpur, has published a useful list of the wild plants—except grasses and sedges—found on the Nagpur and Telinkheri farms. He enumerates 309 species belonging to 205 genera and 56 orders and gives a short description of each species, its frequency of occurrence, time of flowering, vernacular name and use.

Western India.— Mr. G. A. Gammie has continued his studies of the orchids of the Bombay Presidency and has published an account of the species of the genera *Pogonia*, *Spiranthes*, *Zeuxine*, and *Cheirostylis*. Mr. W. Burns, Economic Botanist, has described a *Tamarix* association and the sea-shore vegetation in the neighbourhood of Bassein. He has also presented the Survey with a small but interesting collection of specimens from the Bombay side. During the year he and his assistants collected in various districts of the Presidency. A new species of Balsam—*Impatiens rupicola*—was described by Sir Joseph Hooker.

A second list of mosses from Western India has been published by Mr. L. J. Sedgwick, I.C.S., in which twenty genera are enumerated. Mr. Sedgwick points out that Western India is practically an untouched field as far as the study of mosses is concerned. From amongst the moss collections made by Mr. Sedgwick and others, Mr. H. N. Dixon has described a new genus *Hyophilopsis* and the following new species—*Hyophilopsis entosthodontacea*, *Bryum sahyadrense*, *B. ghatense*, *Merceyopsis pellucida*, *Campylopus Sedgwickii*, *Fissidens Sedgwickii*, *Calymperes tortelloides*. Professor W. West has described a new Alga *Tolypothrix lophodellophila* which was discovered by Dr. N. Annandale in association with freshwater Polyzoa in Igatpuri Lake.

Northern India.—During the year, collections were made in Kumaon by Indian collectors working under the supervision of Mr. N. Gill of the Government Gardens in Kumaon. Captain S. M. Toppin, R.G.A., contributed a small collection of Malakand plants gathered by himself when stationed in that part of India.

The second volume of Mr. J. F. Duthie's "Flora of the Upper Gangetic Plain" has been issued during the year. The scope of this Flora was referred to in the report for 1908-09. The present volume contains descriptions of the species in the orders from *Plumbaginaceæ* to *Plantagineæ*, comprising 26 orders, 185 genera and 331 species. The more important orders as regards specific richness are *Acanthaceæ* with fifty-one species, *Labiatæ* with forty, *Scrophulariaceæ* with thirty-seven, *Convolvulaceæ* with thirty-four, *Asclepiadaceæ* with thirty-three, *Boraginaceæ* with twenty-four. Colonel J. C. Bamber, I.M.S., has continued his descriptive Key to the Flora of the Punjab, North-West Frontier Province and Kashmir. Sir Joseph Hooker published an account of the *Balsaminaceæ* of the State of Chitral, in which he enumerates eight species of *Impatiens*.

Mr. R. N. Parker, Deputy Conservator of Forests, has studied the forest vegetation of Hazara district and has made out a provisional list of species occurring there. His observations have increased the geographical range of not a few species, but details cannot well be given here.

From the previous collections of various botanists the following new species have been described during the year:—*Gerbera Lacei* by Sir George Watt, *Aristolochia punjabensis* by Mr. J. H. Lace, *A. dilatata* by Mr. N. E. Brown; *Impatiens Meeboldii*, *I. pahalgamensis*, *I. Reidii*, *I. Jæschkei*, *I. Aitchisonii*, *I. Stoliczkai*, *I. vexillaria*, *I. polysciadia*, *I. Langeana*, *I. coriosepala* by Sir Joseph Hooker; *Prunus anadenia* and *P. glaucifolia* by Herr E. Koehne.

In the moss flora of the North-West Himalaya Mr. H. N. Dixon has described as new species—*Merceyopsis minuta* (also in the Eastern Himalaya), *M. hymenostylioides*, *Hymenostylium Shepheardæ*, and from Lucknow *Hyophila subflaccida*—also occurring near Bombay.

Additions to the known Flora.—The number of new phanerogamic species added since last year's report to the flora of India within the area covered by Sir Joseph Hooker's "Flora of British India" is not less than one hundred and eighty.

General Systematic.—The Rev. Father Blatter, S.J., has published three more instalments of his account of the palms of British India and

Ceylon. The species described so far belong to the genera *Phœnix*, *Chamærops*, *Trachycarpus*, *Rhapis*, *Coccothrinax*, *Thrinax*, and *Corypha*. Full descriptions are given of the species, and notes on their geographical range, flowering time, uses, English and vernacular names. There are copious references to the literature of the subject and the papers are illustrated with figures of flower analyses and with photographic plates of living specimens, a fair proportion of the photographs having been supplied by the Calcutta Botanic Garden. Signor Beccari's Monograph on "The species of the genus Dæmonorops" appeared during the year as Part I of Vol. XII of the Annals of the Royal Botanic Garden, Calcutta. The genus *Dæmonorops* belongs to the *Lepidocaryeæ* division of palms to which *Calamus*—the subject of a previous monograph by the same author—belongs. The geographical area of the genus is comprised between Lat. 10° S. and 25° N. and between Long. 85° and 132° E., with the greatest frequency of species in the Malayan Archipelago. Signor Beccari in an introductory essay gives a general account of the morphology of the various organs, the uses of the genus, and a more detailed account of the geographical distribution of the species. A key to the species is followed by very full descriptions of the individual species and varieties with critical observations. Altogether 91 species are described of which the following are new to science:—*Dæmonorops acamptostachys*, *D. aruensis*, *D. asteracanthus*, *D. bakauensis*, *D. Binnendykii*, *D. Clemensianus*, *D. floridus*, *D. Hallierianus*, *D. Loherianus*, *D. pachyrostris*, *D. spectabilis*, *D. Treubianus*, *D. turbinatus*. The monograph is illustrated with two plates of analytical figures and 109 magnificent double plates of the species described, and—like its predecessor the monograph on *Calamus*—is one of the finest contributions to botanical science that have appeared in recent years.

Mr. I. H. Burkill has published in the Records of the Botanical Survey an account of the Prickly Pears now wild in India. He gives a general sketch of the distribution throughout the world of the species of the genus *Opuntia* to which the Prickly Pears belong, a detailed account of the occurrence of the five species found in India, a history of their introduction and spread, and their connection with the cochineal insect. A key to the species now wild in India and references to illustrations and descriptions in standard works are furnished as well as critical notes. A map showing the distribution of the genus in India is appended.

Mr. A. W. Lushington, Conservator of Forests, has written a critical paper on the genus *Citrus*, in which after discussing the inconsistencies

in the various accounts of this perplexing genus he gives a synoptical table distinguishing eighteen forms with varieties and sub-varieties. Mr. J. R. Drummond has summarised the more recent information regarding *Agave lurida* and allied species. Mr. S. T. Dunn has rearranged several Indian and Malayan species hitherto included in the genus *Millettia* under the genus *Padbruggea* and a new genus to which Mr. Dunn gives the name *Adinobotrys*. The same botanist has also published a revision of the genus *Actinidia*, giving an account of its history, systematic position—which Mr. Dunn would seem to refer to the *Ternstræmiaceæ*—geographical distribution, and an enumeration of and key to the species. A map showing the sectional distribution of the genus accompanies the paper. M. A. Finet has described as distinct species *Bulbophyllum cylindraceum* Ldl. and *B. khasianum* Griff. that are treated as one species in the Flora of British India. Professor M. Miyoshi has discussed the variability of *Prunus Puddum* Roxb. as exhibited in the Eastern Himalaya and the characters that distinguish the species from *P. campanulata* Maxim. of Japan.

Mr. W. B. Hemsley has cleared up the confusion between *Diospyros Kaki* Linn. f. and *D. Roxburghii* Carrière. Hitherto the latter has been included in the former, but Mr. Hemsley demonstrates that the true *D. Kaki* is confined to Central and Eastern China and Japan, whereas *D. Roxburghii* is a native of Eastern India and Western China.

Iris Clarkei Baker, *Aster Falconeri* Hutchinson and *Meconopsis simplicifolia* Walp. have been figured in the Botanical Magazine.

Several orders and genera represented more or less in India have been studied from the systematic side by various botanists in Europe and America. As such work has a bearing upon the botany of India, brief reference is here called to it. The list of papers at the end of this sketch of the year's work indicates where the reader may look for further information. It is sufficient here to mention the following orders and genera:—*Compositæ, Menispermaceæ, Loganiaceæ, Papaveraceæ, Nyctaginaceæ, Olacineæ, Malvaceæ, Sterculiaceæ, Tiliaceæ, Rutaceæ, Myristicaceæ, Simarubaceæ, Connaraceæ, Barleria, Pedicularis, Juncus, Peperomia, Doronicum, Strychnos, Palaquium, Sideroxylon, Eremurus, Leea, Grewia, Tetrastigma, Cissus, Cayratia, Opuntia, Atalantia, Mastersia, Ougeinia, Cornus, Epilobium, Pogostemon, Aglaia, Amoora, Lansium, Saponaria, Scrophularia, Coffea.*

Anatomical, morphological and physiological.—In India Mr. I. H. Burkill has continued his studies in pollination and has published his observations on the plants of the Central Provinces and Berar.

The plants chiefly observed were Cotton, *Elæodendron glaucum* Pers., *Hardwickia binata* Roxb. and *Dalbergia Sissoo* Roxb. Five species of insects were seen to visit cotton flowers and Mr. Burkill's results support the views of Messrs. Middleton, Leake and Fyson that cross-fertilisation occurs naturally in cotton in opposition to Mr. G. A. Gammie's statement that cotton plants are not naturally cross-fertilised. Mr. C. E. C. Fischer has a paper on the effects of the poisonous juice of *Semecarpus Anacardium* Linn. f. A remarkable example of leaf variation in an individual of *Sterculia alata* Roxb. cultivated in the Calcutta Botanic Garden has formed the subject of independent papers by Mr. W. W. Smith and by Professor M. Miyoshi. Mr. V. N. Hate has published a note on the structure of the giant creeper *Calycopteris floribunda* Lamk. which is remarkable for its capacity for storing water. Professor Miyoshi has written an account of the physiognomy of the vegetation of the outer hills of the Himalayan range.

Outside India a number of orders, genera and species that as occurring in or represented in India are of Indian interest have been investigated by botanists in Europe or America. In a fair proportion of cases the Royal Botanic Garden, Calcutta, aided the investigation by supplying in part or in whole the material. These researches are indicated in the list of papers appended. They include work on *Tamaricaceæ*, *Pandanus*, *Orchidaceæ*, *Lythraceæ*, *Anacardiaceæ*, *Dipterocarpeæ*, *Urticaceæ*, *Musa*, *Piperaceæ*, *Dendrobium*, *Oryza sativa* L., *Eriobotrya japonica* Ldl., *Ardisia crispa* A.DC., *Agave*, *Trapa natans* L., *Ficus*, *Dracæna*, *Cordyline*, *Carica Papaya* L., *Morus*, *Nymphæaceæ*, *Diospyros Kaki* L., *Podocarpineæ*, *Podostemonaceæ*.

A list of papers containing references to the Botany of India published mostly during 1910-11.

BAMBER, C. J. . . Plants of the Punjab. Part VI. (*Journ. Bomb. Nat. Hist. Soc., xx, 1910-11, Nos. 2-4, p. 468-502, 800-836, 1084-1102.*)

BEAUVERD, G. . . Contributions à l'étude des Composées asiatiques. II-IV. (*Bull. Soc. Bot. Genève, 1910, p. 36-51, 99-145, 207-253.*)

BECCARI, O. . . The species of the genus Dæmonorops. (*Ann. Roy. Bot. Gard., Calcutta, xii, Part i, 1911, pp. 239, with 109 plates and 2 plates of analytical figures.*)

BEDDOME, R. H. . . *Selaginella strigosa* in "Decades Kewenses." (*Kew Bull., 1911, No. 4, p. 192.*)

BENOIST, R. . . Espèce et localités nouvelles de *Barleria*. (*Notulæ Systematicæ, i, No. 12, p. 362.*)

BLATTER, E. J. . . The Palms of British India and Ceylon. II-IV. (*Journ. Bomb. Nat. Hist. Soc., xx, 1910-11, Nos. 2-4, p. 347-360, 675-705, 981-995, with 16 plates and 1 map.*)

BONATI, G. . . Contribution à l'étude du genre *Pedicularis*. (*Bull. Soc. Bot. France, lvii, 1910, Mem. 18.*)

BROWN, N. E. . . *Aristolochia dilatata* in "Decades Kewenses." (*Kew Bull., 1911, No. 6, p. 274.*)

BRUNNER, C. . . Beiträge zu vergleichenden Anatomie der Tamaricaceen. (*Dissert. Erlangen, 1909, pp. 94.*)

BURKILL, I. H. . . Notes on the pollination of flowers in India. Note No. 7. A few observations made in the Central Provinces and Berar. (*Journ. Asiat. Soc. Beng., vi, 1910, No. 3, p. 101-107.*)

" . . Notes from a journey to Nepal. (*Rec. Bot. Surv. Ind., iv, No. 4, 1910, p. 59-140, with map.*)

" . . Note on the spreading of *Croton sparsiflorus* Morung along the Assam-Bengal Railway. (*Journ. & Proc. Asiat. Soc. Beng., vi, 1910, No. 3, p. ci-cii.*)

" . . Determinations of the Prickly Pears now wild in India. (*Rec. Bot. Surv. Ind., iv, 1911, No. 6, p. 287-322, with a map.*)

BURNS, W. . . A *Tamarix* association. (*Journ. Bomb. Nat. Hist. Soc., xx, 1910, p. 198-200.*)

" . . A study of sea-shore vegetation. (*Journ. Bomb. Nat. Hist. Soc., xx, 1911, p. 1024-1027.*)

CAMPBELL, D. H. . The Embryo-sac of *Pandanus*. (*Bull. Torr. Bot. Club, xxxvi, 1909, p. 205-220, with 2 plates.*)

CAMUS, A. . . Contribution à l'étude des espèces asiatiques du genre *Juncus*. (*Notulæ Systematicæ, i, 1910, No. 9, p. 274-283.*)

CANDOLLE, C. DE . . Note sur la distribution geographique des espèce du genre *Peperomia*. (*Bull. Geogr. Bot., xx. 1911, p. 3-6.*)

CAVILLIER, F. . Nouvelles études sur le genre *Doronicum*. (*Ann. Conservat. et Jard. Bot. Genève, 1909-10, p. 195-368, with 1 plate.*)

CRAIB, W. G. . [Diagnoses of new species in] "Decades Kewenses." (*Kew Bull., 1910, p. 275-280, 382, and 1911, p. 189-191.*)

CRAIB, W. G., & HUTCHINSON, J. — *Xylia Kerrii* (*Hooker's Ic. Plant., x, 1911, Pt. 2, tab. 2932.*)

CZAPEK, F. — Beitrage zur Morphologie und Physiologie der epiphytischen Orchideen Indiens. (*Sitzungsber. Kais. Akad. Wiss. Wien, 1909, cxviii, p. 1555-1580.*)

" — Ueber die Blattenfaltung der Amherstieen. (*Sitzungsb. Math.-Nat. Kl. Kais. Akad. Wiss. Wien, cxviii, 1, 1909, p. 201-230, with 4 plates.*)

DIELS, L. — *Menispermaceæ.* (*Das Pflanzenreich, 1910, Heft 46, pp. 345.*)

DIXON, H. N. — *Merceyopsis*, a new genus of Mosses, with further contributions to the Bryology of India. (*Journ. Bot., xlviii, 1910, No. 576, p. 297-310, with 2 plates.*)

" — *Hyophilopsis*, a new genus of *Pottiaceæ*, with further contributions to the Bryology of India. (*Journ. Bot., xlix, 1911, No. 581, p. 137-150, with 1 plate.*)

DOP, P. — Sur les *Strychnos* de l'Asie Orientale. (*Compt. Rend. Acad. Sc., 1910, p. 1256-1275.*)

" — Contribution à l'étude des Loganiacées asiatiques de l'herbier du Museum de Paris. (*Bull. Soc. Bot. France, lvii, 1910, Mem. 19, pp. 30.*)

DRUMMOND, J. R. — *Agave lurida.* (*Kew Bull., 1910, p. 344-349.*)

" — Descriptions of several new species of *Compositæ* in "Decades Kewenses." (*Kew Bull., 1911, No. 6, p. 270-272.*)

DUBARD, M. — Recherches sur le genre *Palaquium.* (*Bull. Soc. Bot. France, lvi, 1909, Mem. 16, pp. 24.*)

" — Remarques sur la classification des Sideroxylées. (*Compt. Rend. Acad. Sc. Paris, clii, 1911, 7, p. 390-393.*)

DUNN, S. T. — *Adinobotrys* and *Padbruggea.* (*Kew Bull., 1911, p. 193-198.*)

" — A Revision of the Genus *Actinidia* Lindl. (*Journ. Linn. Soc., xxxix, No. 273, p. 394-410, with a map.*)

DYKES, W. R. — *Iris himalaica.* (*Gard. Chron., xlv, 1909, p. 3.*)

EBERHARDT, PH. — Considerations sur l'origine du Sésame. Son introduction et répartition en Indo-Chine. (*Bull. Mus. Hist. Nat. Paris, 1909, pp. 30.*)

ENGLER, A. . . . *Araceæ-Lasioideæ.* (*Das Pflanzenreich, iv, 23C, pp. 130, with 44 figures.*)

FEDDE, F. . . . *Papaveraceæ-Hypecoideæ* et *Papaveraceæ-Papaveroideæ.* (*Das Pflanzenreich, 1910, Heft 40, pp. 430.*)

FEDTSCHENKO, O. . . *Eremurus.* Kritische Uebersicht der Gattung. (*Mem. Acad. Imp. Sc. St. Petersbourg, xxiii, 1909, pp. 210, with 24 plates.*)

FIEDLER, H. . . . Beiträge zur Kenntnis der Nyctaginiaceen. (*Bot. Jahrbuch., xliv, 1910, No. 5, p. 572-605.*)

FINET, A. . . . *Bulbophyllum cylindraceum* Ldl. et *B. khasyanum* Griff. (*Notulæ Systematicæ, i, 1910, No. 7, p. 193-194.*)

FISCHER, C. E. C. . Poisonous plants. *Semecarpus Anacardium* Linn. f. var. *cuneifolia.* (*Ind. Forest., xxxvi, 1910, p. 361-362.*)

GAGE, A. T. . . . Catalogue of non-herbaceous Phanerogams cultivated in the Royal Botanic Garden, Calcutta. Part I. Numerical list. 1st and 2nd Fasciculi. (*Rec. Bot. Surv. Ind., v, Nos. 1 and 2, p. 1-168, with map.*)

GAGNEPAIN, F. . . Sur la famille des Olacacées. (*Bull. Soc. Bot. France, lvii, 1910, No. 5, p. 373-380.*)

" . . Essai d'une classification des *Leea* asiatiques. (*Bull. Soc. Bot. France, lvii, 1910, No. 5, p. 331-336.*)

" . . Malvacées et Sterculiacées nouvelles de l'Indo-Chine. (*Notulæ Systematicæ, i, 1909, No. 3, p. 77-85.*)

" . . Essai d'une classification du genre *Grewia.* (*Notulæ Systematicæ, i, 1909, Nos. 4-5, p. 119-132.*)

" . . Tiliacées nouvelles d'Asie. (*Notulæ Systematicæ, i, 1910, No. 5, p. 132-137.*)

" . . Essai de classification du genre *Tetrastigma.* (*Notulæ Systematicæ, i, 1910, Nos. 10-11, p. 306-326.*)

" . . Un genre méconnu : classification des *Cissus* et *Cayratia.* (*Notulæ Systematicæ, i, 1910, Nos. 11-12, p. 339-362.*)

GAMBLE, J. S. . . *Oxytenanthera Lacei*, in "Decades Kewenses." (*Kew Bull., 1910, p. 385, and 1911, p. 192.*)

GAMBLE, J. S. . . New *Lauraceæ* from the Malayan region. II-IV. (*Kew Bull., 1910, p. 218-228, 312-321, 357-368.*)

GAMMIE, G. . . . Orchids of the Bombay Presidency. XI. (*Journ. Bomb. Nat. Hist. Soc., xx, 1911, No. 3, p. 597-602.*)

GIN, A. . . . Recherches sur les Lythracées. (*Lons-le-Saunier, 1909, p. 166, with 3 plates.*)

GORIS, M. A. . . Contribution à l'étude des Anacardiacées de la tribu des Mangiférées. (*Ann. Sc. Nat., Bot., xi, 1910, p. 1-29.*)

GRAHAM, R. J. D. . List of Wild Plants found on the Nagpur and Telinkheri Farms. (*Nagpur, 1911, pp. 96.*)

GRIFFITHS, D. . . Illustrated studies in the genus *Opuntia*. (*Rept. Missouri Bot. Gard., xxi, p. 165-174, with 10 plates.*)

GUERIN, P. . . . Recherches sur la structure anatomique de la fleur du fruit, et en particulier de la graine des Diptérocarpées. (*Bull. Soc. Bot. France, lviii, 1911, Nos. 1-3, p. 9-17, 39-48, 82-89.*)

" . . . Cellules à mucilage chez les Urticées. (*Bull. Soc. Bot. France, lviii, 1910, No. 5, p. 399-406.*)

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" . . Espèces ou localités nouvelles pour les Rutacées d'Extreme-Orient. (*Notulæ Systematicæ, i, 1910, No. 7, p. 207-224.*)

HAGSTRÖM, O. . . *Potamogetones* novi. (*Repert. spec. nov., viii, 1910, p. 145-148.*)

HAINES, H. H. . . A Forest Flora of Chota Nagpur including Gangpur and the Santal-Parganahs. (*Calcutta, 1910, pp. VII + 634 + xxxvii.*)

HAMET, R. . . . Note sur deux espèces nouvelles de *Sedum*. (*Repert. spec. nov., viii, 1910, p. 263-266.*)

HARMS, H. . . . Über die Verbreitung der Leguminosen-Gattung *Mastersia*. (*Repert. spec. nov., ix, 1911, p. 367-369.*)

HATE, V. N. . . . Two species of *Chara* from the Bombay Island. (*Journ. Bomb. Nat. Hist. Soc., xix, 1909, No. 3, p. 762-763.*)

HATE, V. N. . . A note on the structure of the giant creeper *Calycopteris floribunda*. (*Journ. Bomb. Nat. Hist. Soc., xx, 1911, No. 3, p. 837-840, with 1 plate.*)

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ECONOMIC BOTANY.

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PART I.—AGRICULTURAL BOTANY.

In accordance with the practice of previous years this report deals only with original contributions to the Agricultural Botany of India which have been published or are in course of publication during the year under review, in this case the year ending June 30th, 1911. The

programmes of work in this subject are given in detail in the last issue of the *Proceedings of the Board of Agriculture in India* and an abstract is to be found at the end of the present volume. Under these circumstances all references to programmes have been omitted and only the results actually obtained are discussed. A list of papers published during the past year is appended.

Cotton.—Several papers on this crop have appeared during the year of which the most important are those of Leake relating to the work on cotton breeding at the Cawnpore Experiment Station. The cotton investigations in progress at this centre are concerned with the production and the subsequent introduction into general cultivation of an improved type suitable for the western cotton growing tracts of the United Provinces. The papers published during the past year give an account of the progress made up to the present time and also outline the scheme of future work. While the direct results likely to be obtained from these investigations chiefly concern the Province concerned, nevertheless both the methods adopted in the investigation and the ideas underlying the work are of much more general application and will be studied by all concerned with the improvement of cotton in India.

A popular account of this work was issued as a pamphlet at the recent Allahabad Exhibition and reprinted in the *Agricultural Journal of India*. The present cotton crop of the Western Districts of the United Provinces consists of a confused mass of types which have been referred by Gammie to a single species *Gossypium neglectum* Tod. All the forms are characterised by short and coarse lint and are entirely unsuitable for use in England or for any commercial purpose beyond the coarser kinds of cotton goods. Other forms of cotton also occur in these Provinces, but no indigenous type is met with with a silky texture suitable for spinning between 30s and 40s which it is the object of these investigations to produce. It is considered that simple selection is not likely to be of much service in finding the type required, but practical results are expected from hybridisation. In the first place the red flowered late *Nurma* cotton with long staple has been crossed with the short stapled silky form of *Bani* found in the United Provinces. In this cross the long staple and red flower of *Nurma* have been combined with the early flowering and silkiness of fibre of the *Bani*. In the second case, the long staple and red flower of *Nurma* have been united to the high lint percentage and earliness of white flowered *Desi* cotton. The reports on the fibre of the new forms are very encouraging, and in one case the sample was valued at Rs. 50

a candy more than fine Cawnpore machine ginned and was considered equal to fine Broach. Other crosses are now being made and it is hoped that these will add still further improvement. The second stage of the work after the production of an improved cotton is to introduce it into general cultivation and to maintain the quality. For this purpose a seed farm is being started near Aligarh from which it is hoped to produce enough seed to sow 1,300 acres in one year producing 500 bales (of 400 lbs.) of cotton. The cultivators growing the 1,300 acres of cotton will each year receive a fresh supply of seed from the central farm while their crop will be separately ginned and the seed distributed to a second series of cultivators controlling 20,000 acres of land under cotton. In this way it is hoped a series of waves of cotton seed emanating from the seed farm will be started which will in a short period establish the crop on a firm basis.

The student of plant breeding will find a detailed account of the Cawnpore cotton experiments in the *Journal of Genetics* (Vol. 1, page 205) while an abstract has appeared in the *Proceedings of the Royal Society*. The inheritance of several of the characters of cotton have been worked out in detail and especially the colour of the corolla, the red colouring matter of the sap, the degree of incision of the leaf, the type of branching, the length of the vegetative period and the leaf glands. Several instances of correlation of character have been observed, two of which are of great interest. The forms with a majority of sympodial secondary branches are early flowering while in those like *Nurma*, characterised by monopodial branching, the vegetative period is prolonged and no fruit is formed until the tertiary branches are developed. It is essential that plants should be of the sympodial type if their cultivation in the United Provinces is to be a commercial success, for the late flowering monopodial forms do not flower in time to give a crop before the winter sets in. At the same time the majority of Indian cottons with a valuable staple belong to the monopodial forms. It has therefore been necessary to resort to hybridisation in order to produce a new set of early flowering forms of sympodial habit, but bearing the long staple of the monopodial type. The second important correlation discussed is that betwen the presence of the red colouring matter of the sap and an increase in the length of the vegetative period. When the red colour is present there is a distinct retardation of the commencement of flowering.

One of the chief difficulties in the production of a new and improved type of cotton and in the maintenance of the seed supply arises from

the fact that cottons readily cross-fertilize in India as in other countries. During the preliminary breeding and selection operations it is necessary to protect the flowers from foreign pollen and to work entirely with self-fertilized seed. This circumstance adds greatly to the labour involved in the work and also entails as a preliminary the isolation of pure lines from the mass of splitting forms (which make up the bulk of the cotton crop of India) before crossing can be begun. Further an improved type will have to grow separately and every care taken to keep the seed supply pure and to prevent any degeneration taking place as a result of vicinism. These aspects of the subject have been dealt with at Cawnpore and the results incorporated in an interesting paper in the *Memoirs of the Agricultural Department of India* (*Botanical Series*). During the progress of this work it was observed both in the pure types and in the crosses that some of the cultures carried on from year to year by means of self-fertilized seed exhibited varying degrees of sterility. These matters however were not for various reasons thoroughly worked out, but it is hoped that opportunity will be found to investigate them more fully in the future. As regards the method by which crossing takes place between different types of cotton, the authors consider that most of the crossing takes place between neighbouring plants and that a distance of 10 feet between the various plots is sufficient to greatly reduce if not to prevent it altogether. If these observations are found to apply to other cotton-growing tracts in India one of the difficulties in maintaining a pure seed supply for distribution to cultivators will have been removed. It is now generally recognised that the degeneration which results when improved cottons are introduced into a new country is largely a result of vicinism. The exotics in the first place are often a mixture of types which cross among each other while further degeneration results from crossing and admixture with local sorts. It is more than probable that the want of success in introducing foreign cottons into India in the past has been mainly due to natural cross-fertilization. It is possible therefore that if the work of introduction is properly carried on in the future considerable success might easily be obtained in this direction.

The shortage of cotton suitable for Lancashire has for some years past led to attempts having been made to find other supplies in the Empire and the efforts of the British Cotton Growing Association in this direction are well known. India has naturally come under notice as a possible source of supply and every effort has been made by the Agricultural Department to investigate this matter and to see how far

it is profitable for this country to supply the new demands. In connection with this a deputation of Lancashire Members of Parliament and of Indian and Lancashire Master Cotton Spinners and Manufacturers was received by the Right Honourable the Secretary of State for India in July 1910 which urged on Lord Morley the necessity of further assistance on the part of Government for the development of cotton cultivation in India. A memorandum was prepared by the Inspector-General of Agriculture in India to show what the Indian Agricultural Departments have done in the matter and to sum up the present cotton position. This paper has been published subsequently as Pusa Bulletin 26 for the information of the public and contains a detailed account of the work being done by the Agricultural Department in the various cotton tracts of India. The concluding paragraph of this bulletin sums up the subject in the following words:—

"It will be seen from what has been said above that the Agricultural Departments have devoted and are still devoting a very large amount of attention to the improvement of the Indian cotton crop. It is not therefore recommended that Government should take up any new line of work for improving its quantity or quality, but it is strongly urged that it be pointed out to the Secretary of State for India for the information of the members of the deputation that no progress in the production of finer cottons can be made until buying agencies are set up in India to buy, gin, bale and export long staple cotton where the cultivator can get a fair price at his door. This could probably be best brought about by the British Cotton Growing Association."

It is hoped therefore that the result of the deputation and of the publication of this paper will lead to the establishment by the trade of suitable buying, ginning and baling agencies in India for long staple cotton in the tracts which are found most suitable for the crop. Such agencies would be a most valuable adjunct to the seed distributing efforts of the Agricultural Department and would do much to firmly establish improved cottons in the various localities in which they can be profitably grown. An avenue is thus opened up for much valuable co-operation between the trade and the Agricultural Department by which alone it appears likely that real progress in the future will be made.

In addition to the papers referred to above the work of the Imperial Cotton Specialist is summed up in the last report of the Agricultural Research Institute, Pusa. In Madras the merits of Cambodia cotton have been referred to by Sampson and Venkayya. In the Central Provinces Clouston has dealt in detail with the development of the cotton

industry in a series of articles in the *Agricultural Gazette* published at Nagpur and has also worked out a classification of the local cottons, an account of which is now being printed.

Wheat.— Progress continues to be made in the wheat investigations in India and during the year several papers have appeared.

Evans in the Central Provinces has sent some of the best local wheats to England for milling and baking tests. Bearing in mind both the yield and the behaviour of the wheats in the mill and bakehouse, it is clear that a type superior to the soft white *Desi Pissi* of the Narbada Valley has not yet been produced at the Hoshangabad Farm. This wheat is now being grown for distribution to cultivators in a pure condition and unmixed with other sorts.

At Pusa an important stage has been reached in the wheat investigations during the year. This relates to the production of new wheats by hybridisation which combine both high yield and high quality. These have been made by crossing high yielding wheats of poor quality such as Muzaffarnagar white and Punjab type 9 with some of the moderate yielding Pusa selections characterised by grain quality equal to that of Manitoba wheat. Adopting modern methods of hybridisation, wheats were obtained in the third and fourth generation which bred absolutely true in all respects and which combined the characters of high yield and high quality. In some cases the straw was exceedingly strong and capable of supporting under Indian condition crops of 2,500 lbs. of grain to the acre. The new hybrids were milled and baked in England by Mr. Humphries, Past President of the Incorporated National Association of British and Irish Millers, who refers to them as follows:—

"The three lots, Nos. 100, 101, and 106, are very beautiful wheats also. On appearance only there is little to choose between them. If anything 106 may be the best looking. These three all behave very well indeed in the milling processes. The flours they all yield are granular, that is to say, they are bread flours rather than biscuit or pudding flours and should be judged by comparison with hard spring wheat flours from Minneapolis or Manitoba rather than by comparison with Muzaffarnagars or similar wheats. They are all flours possessing great potentialities as regards baking value, which can be developed by proper treatment during milling and baking on the special lines mentioned hereinbefore. Without this special treatment they behave very well in the dough and produce loaves of fair but not great volume and of first rate appearance and flavour. They behave like Manitoban good

grade wheats produced in a dry season. That is to say, they, like such Manitobans, respond very markedly to the addition of malt extract and 'yeast foods' and the volume of the loaf can be increased very greatly by the use of the right malt extract. They seem to be possessed of very good qualities capable under favourable conditions of yielding extremely good results."

These matters are referred to in detail in Pusa Bulletin 22 which also contains Mr. Humphries' full report and an illustration showing the actual loaves produced from an ordinary Indian wheat, an improved Pusa wheat and also one obtained from Manitoban flour. In the same paper an account of the method of growing wheat adopted at Pusa has been inserted in response to numerous requests from cultivators, planters and zemindars. The demand for the Pusa wheats has far exceeded the supply. Upwards of 1,000 acres will be sown in Behar alone during the next *rabi* season, while arrangements have been made to test these wheats on a large scale in all the important wheat-growing tracts of India.

In Pusa Bulletin 22 a preliminary account has been given of the work in progress on the production of new rust-resistant wheats by hybridisation. The Indian types differ considerably among themselves in their degree of rust resistance, but none possesses this character to the same extent as some of the rust-resistant forms met with in Europe and North America. When grown side by side in both countries the superiority in this respect of types like American Club is most marked. Attempts to cross American Club with Indian forms at Pusa so as to combine the rust resistance of the exotic parent with the qualities of the best Indian wheats failed on account of the great differences in the time of maturity and the impossibility of getting American Club to form pollen before the hot weather set in. In 1910 this obstacle was got over by growing the Indian parents at Cambridge as spring wheats and carrying out the cross-fertilization in England. This was done last year and the first generation of the hybrids was successfully grown in India during the last *rabi* season. It is now hoped that in a short time real rust-resistant wheats will be available in India.

Fibres.—Several papers on Indian fibre crops have appeared during the year, while others are in the press.

At Pusa the results of a study of patwa (*Hibiscus cannabinus*) and of rozelle (*Hibiscus Sabdariffa*) have been published. Eight types of *Hibiscus cannabinus* belonging to five varieties have been isolated and

their characteristics worked out in detail. As fibre producers they differ considerably while all the types readily cross-fertilize with each other. The effects of vicinism can however be entirely prevented by rogueing the plots during the seedling and early vegetative stages. This enables the method of selection by pure line cultures, ordinarily restricted to self-fertilized plants, to be extended to a crop in which natural crossing is common. Possibly the removal of aberrant plants in this way before flowering takes place can be extended to cotton and other crops in which improved sorts are liable to rapid degeneration as a result of vicinism. In *H. Sabdariffa* four varieties almost identical in all other respects except in the distribution of colour have been isolated. In consequence of a slight difference in the floral arrangements the flowers of this species are self-pollinated and no natural crossing between the varieties when allowed to flower freely has been so far observed at Pusa.

The Fibre Expert to the Government of Eastern Bengal and Assam has summed up his work during the year in the *Agricultural Journal of India*. The classification of the various varieties of jute has been completed and pure types are now available for further study. The flowers of all are said to be normally self-fertilized in which case the selection of single plants will be possible in this crop. Cross-fertilization experiments are also in progress which have been designed to throw light on the origin of the different colour types of plant. The detailed results of the cross-fertilization experiments and on the methods of pollination in this crop are in the press.

The flax experiments at Dooriah in Behar which are concerned with the production of fibre suitable for export to Europe have been summed up by Vanderkerkhove in Pusa Bulletin No. 25 to which an introduction has been contributed by the Inspector-General of Agriculture. During the season of 1909-10 an area of 60 bighas was sown at Dooriah and the crop converted into fibre from which a profit of Rs. 61 per acre is expected. These investigations are being carried out under the supervision of the Behar Planters' Association by means of a joint subsidy from the Imperial and Bengal Departments of Agriculture. The work is being continued and will no doubt be followed closely by all interested in planting enterprise in Behar.

Plant breeding.—An important publication of considerable interest to workers in Agricultural Botany in India has been undertaken during the year and is now in the press. This is Vol. V of *Die Züchtung der landw. Kulturpflanzen* edited by Professor Dr. C. Fruwirth of Vienna

and published by Messrs. Paul Parey of Berlin. The new volume of this important work deals with the breeding of tropical plants and it is expected that its publication will do much to stimulate research work on sound lines on the crops of the torrid zone. The article on cotton has been contributed by the Economic Botanist to the Government of the United Provinces, while papers on the following crops have been prepared at Pusa:—Til (*Sesamum indicum*), jute (*Corchorus capsularis* and *C. olitoris*), patwa (*Hibiscus cannabinus*), rozelle (*Hibiscus Sabdariffa*) and sann (*Crotalaria juncea*).

The results of the earlier work at Pusa on the economic significance of natural cross-fertilization in India, which were referred to in last year's report, were published during the year. During the current year this work has been continued and will be published as opportunity offers. It is now being recognised in India that a detailed study of the methods of pollination in any crop should precede all attempts at improvement and that this knowledge is essential in all schemes of seed distribution.

Miscellaneous.—Gammie has published a paper on the millets of the genus *Setaria* in the Bombay Presidency and Sind in which the various cultivated forms are described and figured. In the *Agricultural Ledger* a bulky compilation arranged alphabetically under the vernacular names dealing with the literature on the races of rice in India has been published as well as a paper on the soy bean in India by Hooper.

PART II.—FOREST BOTANY.

A.—Work done by Forest Botanist.

Research work.

The research work of the Forest Botanist falls under two main heads which may be shortly defined as follows:—

(*i*) The study of the physiology and œcology of our important forest species, with special reference to the factors which determine their natural distribution and which are responsible for their most important diseases.

(*ii*) The detailed systematic study and description of those forms of forest plants of considerable economic importance of which the existing classification is unsatisfactory and for the adequate treatment of which field-study is essential.

As regards sub-head (*i*) it is recognised that, in a large number of cases, such factors as soil-aeration, soil-moisture, temperature, light, and soil-composition are primarily responsible for the diseases and un-

satisfactory growth of our forest plants and that for thoroughly efficient forest-management it is essential to acquire a precise knowledge of the degree of intensity at which such factors first begin to cause disease and at which they must in consequence be considered to be injurious.

Ecology of sal.

Attention is at present being chiefly paid to the factors primarily affecting the healthy development of sal and particularly to those factors which cause the dying-back of seedlings. The preliminary work done up to date shows that, altogether apart from damage by frost, in the local climate of Dehra Dun and in soil similar to that on which most of the local sal forests occur—

(*a*) a large proportion (73 per cent.) of sal seedlings died down from September-June when not watered; of those seedlings growing under similar conditions, with the only exception that they were lightly watered, only 41 per cent. died back, and of those plants which, in addition to being lightly watered, were also shaded only 16 per cent. died back.

(*b*) Sal seedlings developed more successfully [as judged independently by (1) the number of stems which died back and (2) the dry weight of the best stems which survived] when provided with overhead shade and diffuse lateral illumination, than when grown in the open with no shade and watered.

(*c*) Sal is sensitive as regards soil-aeration and water-logging soon proves fatal.

(*d*) The factor of primary importance influencing the establishment and development of sal seedlings appears to be undoubtedly the water-content of the soil. Light is also a factor of great importance, but it has not yet been determined how far the favourable results obtained by shading can be ascribed to the decreased intensity of light, and to what extent they are due to the increased soil-moisture content.

Compared with these two factors the chemical and physical characteristics of the soil appear to be of minor importance.

The preliminary work done up to date is now being prepared for publication and arrangements have been made for the continuation and extension of the experiments with the object of determining instrumentally and accurately the precise intensity of each individual factor

of primary importance which in itself alone suffices to cause the unsatisfactory growth or disease of sal. Once this has been done it will obviously be possible to determine, in the case of any particular forest, whether the absence of sal reproduction there, or the unsatisfactory growth of sal, is, or is not, due to these factors, and this knowledge will indicate the best measures to be adopted for the improvement of the growth.

Œcology of grasses of sal forests.

The memoir on the œcology of forest grasses embodying the results of the work done up to date which was mentioned in last year's report was still in the press at the close of the year, owing to sanction for the publication having been delayed. The œcological study of grasses of sal forests is being continued with the principal object of determining the best treatment to adopt in each case with the object of improving the fodder supply and of facilitating afforestation respectively.

Information is also being collected regarding the grasslands situated in all the Government forests of the United Provinces, the present method of treatment of the same, the species which are dominant in each, the approximate area occupied by each species, its average yield expressed in weight of air-dried grass per acre and its local economic uses. This information will indicate the extent to which the results obtained from detailed work in Dehra Dun, regarding the most suitable method of treatment, are applicable to other forest-grasslands which are approximately of the same type and will also indicate which areas require separate study. Advantage is being taken of the presence of Mr. William Raitt, paper expert, at Dehra Dun to obtain analyses of each species indicating its value for the manufacture of paper-pulp. The results obtained will, it is hoped, be sufficiently complete for publication next year.

Trametes Pini.

Extensive damage by the fungus *Trametes Pini* in the forests of *Pinus excelsa* having been reported in the Simla and Bashahr Forest Divisions, the Forest Botanist visited these forests in May and June of the year under report. It had been ascertained that infection could, in some cases at least, be conveyed through the roots from a diseased to a healthy tree. This mode of infection, if found to be frequent, would obviously greatly increase the difficulties in the way of combating the pest and hence it was desirable to determine how infection was chiefly conveyed from diseased to healthy areas. Study in the

field indicated that the spread of the disease was mainly due to wind-carried spores, the fungus usually gaining access to a healthy tree through the stumps of cut or broken branches. Hence preventive measures in the way of stopping lopping and destroying the sporophores are likely to be effective. The results of the investigation are being prepared for publication and the study will be continued.

Taxonomic work.

As regards work done under sub-head (*ii*) the herbarium material of the genus *Grewia* available at Kew and the British Museum, as well as Jussieu's types at Paris, were examined by the Botanist during the year. Some doubtful points were thus settled and the work is being prepared for publication. Recent work of European botanists has shown that there is more than one species of Indian *Xylia*. It is known that the wood of *pyinkado* varies considerably in quality, but it is not known how far this variation depends on the species or how far the *pyinkado* of commerce is obtained from *Xylia dolabriformis*. Specimens of *Xylia* have therefore been asked for from all forest divisions where the genus is known to occur with a view to determining the distribution and wood characters of the different species. The study of the genus *Saccharum* has shown that the valuable *Saccharum Munja* Roxb. is really a distinct species from the comparatively unimportant *Saccharum arundinaceum* Retz with which it is often confused, that *Saccharum porphyrocomum* Hackel is really identical with *Saccharum Narenga* Wall. and that *Erianthus Griffithii* Hook. f., being founded partly on *Saccharum Griffithii* Munro and partly on *Erianthus Ravennæ* Beauv., cannot be maintained. These results are included in the memoir now in the press.

B.—Work done by others.

Raising of tree stems during natural development.

Some years ago forest officers in Madras reported that permanent marks placed on teak stems in the Nilambur plantation were found in course of time to alter their position and to rise above their original level. An experiment to determine this point is being carried out by the local officers on the lines suggested by the Forest Botanist and a report embodying the first set of observations was received during the year. Thirty-one trees were selected and carefully marked in Nilambur plantation in December 1909, the levels of the marks on the stems with reference to permanent bench marks being carefully taken with a Y level and recorded. The levels of these marks were again taken on April 8th, 1911, and the results compared. Observations must be continued for several years before the results can be regarded as at all final,

but the observations made up to date show that, out of 31 trees, 23 showed an appreciable rise, amounting in some cases to nearly $\frac{3}{4}$ of an inch in a little more than 1 year, 2 trees showed no change and 6 showed a slight sinking. Thus there seems to be some support for the theory that teak trees are actually raised above their original position in the normal process of development.

Taxonomic work.

Mr. H. H. Haines published his *Forest Flora of Chota Nagpur*, Rai Bahadur Upendranath Kanjilal published his *Forest Flora of the Siwalik and Jaunsar Divisions*, and Mr. W. F. Biscoe his *Trees and Shrubs of the Indore State.*

A collection of the plants in the Sind Forest Circle has been commenced with the object of forming a local forest herbarium.

List of papers on Economic Botany published during the year ending June 30th, 1911.

ANSTEAD, R. D. . . Para rubber seed oil and Poonac. [*The Planters' Chronicle* (*Bangalore*), *vi, 122, 1911.*]

AUBERT, L. . . *Andropogon Sorghum:* Millet or pyaung: its cultivation and some of its enemies. (*Agr. Jour. of India, v, 222, 1910.*)

BARBER, C. A. . . The influence of environment on plants. (*Jour. of the South Indian Association, i, 249, 1911.*)

BISCOE, W. F. . . Trees and Shrubs of the Indore State. (*Bombay, 1910.*)

BOOTH-TUCKER, F. . Memorandum regarding leading Eucalypts suitable for India. (*Bull. 21, Agr. Res. Inst., Pusa, 1910.*)

BROWN, W. ROBERTSON. Peach growing around Peshawar. (*Agr. Jour. of India, vi, 14, 1911.*)

BURKILL, I. H. . . Literature on the races of rice in India. (*Agr. Ledger, No. 1, 1910.*)

BURNS, W. . . The Pairi mango. (*Agr. Jour. of India, vi, 27, 1911.*)

BURNS, W. . . Annual reports of the Bassein and Ganeshkhind Botanical Gardens, 1909-10.

CLOUSTON, D. . . Cotton cultivation in the Central Provinces. [*Agr. Gazette* (*Nagpur*), *vi, Nos. 9, 10 and 11, 1910, and vii, No. 2, 1911.*]

COVENTRY, B. . . Report on the progress of Agriculture in India for 1909-10, Calcutta, 1911.

COVENTRY, B. . . Note on the present position of cotton investigation in India. (*Bull. 26, Agr. Res. Inst., Pusa, 1911.*)

EVANS, G. . . . The improvement in the quality of wheat exported from the Central Provinces. (*Bull. No. 4, Cent. Prov. Agr. Dept., 1910.*)

FINLOW, R. S. . . Report on jute and flax experiments during the past year. (*Agr. Jour. of India, vi, 70, 1911.*)

GAMMIE, G. A. . . Caravonica cotton. (*Agr. Jour. of India, v, 249, 1910.*)

GAMMIE, G. A. . . Report of the Imperial Cotton Specialist. (*Report of the Agr. Res. Inst., Pusa, 1909-10.*)

GAMMIE, G. A. . . Millets of the genus *Setaria* in the Bombay Presidency and Sind. [*Mem. Dept. Agr. of India (Botanical Series), iv, No. 1, 1911.*]

GAMMIE, G. A. . . The present position and prospects of cotton cultivation in India. (*Agr. Jour. of India, v, 335, 1910, and vi, 40, 1911.*)

HENDERSON, G. S. . Exotic cottons in Sind. (*Agr. Jour. of India, vi, 131, 1911.*)

HOOPER, D. . . *Glycine hispida* (soy bean). (*Agr. Ledger, No. 3, 1911.*)

HOOPER, D. . . The composition of Indian Yams. [*Jour. and Proc. Asiatic Soc. Bengal (New Series), vii, 57, 1911.*]

HOWARD, A. . . Suggestions for the development of the Hop Industry in Kashmir. Kashmir and Jammu State, 1910.

HOWARD, A., & HOWARD, G. L. C. Studies in Indian Fibre Plants, No. 2. On some new varieties of *Hibiscus cannabinus* and *Hibiscus Sabdariffa*. [*Mem. of the Dept. of Agr. of India (Botanical Series), vi, No. 2, 1911.*]

HOWARD, A., & HOWARD, G. L. C. The milling and baking qualities of Indian wheats, No. 3. Some new Pusa hybrids tested in 1910. (*Bull. 22, Agr. Res. Inst., Pusa, 1911.*)

HOWARD, A., HOWARD, G. L. C., & ABDUR RAHMAN KHAN. The Economic Significance of natural cross-fertilization in India. [*Mem. of the Dept. of Agr. in India (Botanical Series), iii, No. 6, 1910.*]

KANJILAL, U. . . Forest Flora of the Siwalik and Jaunsar Forest Divisions. (*Calcutta, 1911.*)

KULKARNI, L. B. . The cultivation of guavas near Poona, Dharwar and Limboga. (*Bull. 40, Bombay Agr. Dept., 1911.*)

LEAKE, H. M. . . Studies in Indian cotton. (*Jour. of Genetics, i, 1911, 205.*)

LEAKE, H. M. . . Experimental studies in Indian cotton. (*Proc. Roy. Soc., B., vol. 83, 447, 1911.*)

LEAKE, H. M., & PARR, A. E. The problem of improvement of cotton in the United Provinces of Agra and Oudh. (*Agr. Jour. of India, vi, No. 1, 1911.*)

LEAKE, H. M., & RAM PERSHAD. Notes on the incidence and effect of sterility and of cross-fertilization in the Indian cottons [*Mem. Dept. of Agr., India (Botanical Series), iv, No. 2, 1911.*]

MEHTA, G. D. . . An examination of the seed supply of the Broach District. [*Bull. 37 (1910) and 43 (1911), Bombay Agr. Dept.*]

SAWYER, A. M. . The Shank-noo. (*Citrus Hystrix* DC.). (*Agr. Jour. of India, v, 331, 1910.*)

TROUP, R. S., & KANJILAL, U. *Carallia integerrima*. (*Indian Forester, xxxvi, p. 578.*)

VANDEKERKHOVE, E. M. Report on the Flax Experiments conducted at Dooriah during the year 1910-11. (*Bull. 25, Agr. Res. Ins., Pusa, 1911.*)

VENKAYYA, P. . . Cambodia cotton in India. (*Agr. Jour. of India, vi, 160, 1911.*)

WILSON, J. . . Memorandum on Indian wheat for the English market. (*Bull. 20, Agr. Res. Ins., Pusa, 1910.*)

WOODHOUSE, E. J. . Some suggestions as to the organisation of Agricultural Exhibits in Bengal. (*Record No. 1 of 1910, Dept. of Agr., Bengal.*)

WOODHOUSE, E. J. . A note on the value of green-manuring and summer fallows. (*Bengal Quarterly Jour. of Agr., iv, No. 1, 1910.*)

MYCOLOGY.

BY

E. J. BUTLER, M.B., F.L.S.,
Imperial Mycologist.

I.—Plant Pathology.

Palm diseases.—Two papers of considerable length on the diseases of palms appeared during the year. Dr. L. C. Coleman published an account of the Areca palm disease known as *koleroga*, in the Bulletins of the Agricultural Department, Mysore. The fungus which causes this disease was first seen by the writer in 1903, and identified, in a paper published in 1907, as *Phytophthora* (*?*) *omnivora* de Bary. Dr. Coleman, while still including it in the probably composite species, *Phytophthora omnivora*, makes a distinct variety, *Arecæ*, for it. Its hosts are *Areca Catechu*, *Cereus formosus*, *Clarkia elegans*, *Schizanthus wisetonensis*, *Oenothera biennis*, *Salpiglossus variabilis*, *Solanum melongena* and *Lycopersicum esculentum*. A closely allied species occurs on Cacao in Ceylon and other parts of the tropics, and is capable of attacking nearly all the above hosts. As a result of a thorough comparison of the two forms in artificial cultures, Dr. Coleman concluded that they are distinct species and named the Cacao fungus *Phytophthora Theobromæ*. It was, however, named *Phytophthora Faberi* by Maublanc, prior to the publication of Dr. Coleman's paper, and the latter name must stand. A very full account is given by the author of the characters and biology of the Areca parasite and of the remedial measures carried out by him to reduce the losses, estimated at 3 to 4 lakhs of rupees annually, caused by the disease in Mysore. A single spraying with Bordeaux mixture, applied just before the break of the monsoon, was found to be effective in saving a large proportion of the nuts. The cost is well within the means of the arecanut growers. Further experiments are being carried out to test the relative efficiency of various methods of spraying. An abridgment of the bulletin was published in the *Annales Mycologici*.

The bud-rot of palms in Madras Presidency was described by the writer in a memoir published early in the year. The disease has been under observation since 1905, and an extensive campaign to check its spread and stamp it out was started by the writer, with funds and assistance provided by the Madras Government, in 1907. Since 1910

the work has been in the hands of the recently appointed Madras Mycologist, Mr. McRae. The memoir includes a description of the area affected by the disease, an account of its first appearance and spread, the species of palms affected (including palmyra, cocoanut and areca), a full description of the fungus, *Pythium palmivorum*, which is its cause, and a discussion of the operations to check it carried out by Government. The conclusions arrived at are that these operations have been entirely successful in limiting the disease in Godavari district to the area previously infected; it is hoped that they will prove equally effective in Kistna district, where they were started late. This alone should fully justify their cost. At the time the memoir was written it was not easy to determine what effect the previous work had had in reducing the intensity of the disease within the infected area, but further records during the past year tend to show that the steady removal of infected trees is bearing fruit in a diminution of the number of new infections. The operations are being continued and it is anticipated that if the disease can be kept confined within its present limits, it will eventually be possible to stamp it out completely.

Ginger disease.—An account of the soft rot of ginger was written by Mr. McRae for the Agricultural Journal of India. This disease is prevalent in Eastern Bengal, Gujarat and probably elsewhere. In Rangpur the loss in damp soils is 10 to 15 per cent. of the crop; in bad years almost the whole may be lost. The cause appears to be the attack of a fungus (*Pythium gracile*) on the rhizomes and base of the plant. As a result of experiments carried out at Burirhat farm in 1908-09, Mr. McRae was in a position to recommend effective measures for checking the disease.

Turmeric disease.—The writer described a leaf disease of turmeric, found all over Northern India, in the *Annales Mycologici*. It is caused by a previously undescribed species of *Taphrina* which, while not very destructive, is probably responsible for a greater reduction of the yield than the cultivators themselves suspect. No treatment can be recommended as yet.

Tea diseases.— A parasite of the tea bush, *Læstadia Theæ*, found in Java some 12 years ago but not previously recorded in India, was reported from the Dooars in 1910. It causes a leaf disease known as copper-blight, which spreads with great rapidity under suitable weather conditions. A note describing its characters was written by Mr. Shaw for the *Agricultural Journal*. The writer investigated a disease of tea seed, known for many years in Assam to cause considerable loss in

certain tea-seed gardens. Acting on a suggestion made by the officers of the Scientific Department of the Indian Tea Association, a good deal of evidence was obtained indicating that the disease is due to the tea seed bug, *Pœcilocoris latus*. This insect punctures the seed and sucks the juices. Through the opening thus made fungi are able to enter, and the subsequent injury to the seed is due to the growth of one or other of several species of rot-producing fungi at the expense of the seed tissues. It has long been a pathological puzzle how the fungi which are often found within hard-shelled seeds, such as the walnut, have been able to effect an entry; possibly the explanation in these cases will be found to be similar to that of the tea-seed fungus. The Indian Tea Association are issuing a pamphlet on the subject. As a result of the extension of blister-blight in India, mentioned in last year's report, some countries have insisted on the disinfection of all Indian tea seed exported to them. The writer was asked to advise on the subject and recommended steeping in formalin, which has been adopted. It is a matter for congratulation that the Indian Tea Association have decided to strengthen their Scientific Department by the addition of a Mycologist, as the fungus diseases of tea are growing in importance.

Forest tree diseases.—As usual the Forest Department referred a certain number of diseases of trees for investigation in the Mycological Laboratory at Pusa. The chief result was a paper on the root infection of the blue pine by *Trametes Pini*, a fungus which is causing considerable damage in the Simla Hill forests, by A. Hafiz Khan. This fungus was hitherto believed to be able to attack trees through above ground wounds only. A second method of infection was shown to occur below ground, through roots of diseased trees coming into contact with those of healthy ones. Mr. Anstead, Planting Expert to the United Planters' Association of Southern India, has described in the *Planters' Chronicle* the results of experiments conducted in Cochin to prevent the attacks of "pink disease" of rubber trees, caused by the fungus *Corticium javanicum*. Over two hundred thousand Para trees were treated with Bordeaux mixture, with most encouraging results. One estate reported that the disease had been diminished by 75 per cent. and the Manager believes that if every tree were done properly the disease would disappear. The mixture, made up of 6 lbs. copper sulphate, 4 lbs. quicklime and 45 gallons water, with a locally prepared paste or resin or jaggery added to improve its adhesive properties, is brushed on the trees near the forks and over wounds. The cost is very little, only Re. 1 to Rs. 2 per acre. As this is by far the worst disease of rubber trees in South India such results are very gratifying.

Fruit diseases.—The principal work on fruit diseases published during the year was Mr. Burns' bulletin on grape-vine mildew in Bombay Presidency. In this the occurrence of the disease at Nasik and near Poona is described and the results of experiments in its control, carried on under Mr. Burns' direction by his assistants and the owners of the vineyards, are given. Spraying with Bordeaux mixture, to which soft soap was added as an adhesive, was found to reduce the damage considerably. The 6-4-50 formula was used, except when actually spraying the bunches of fruit, when half strength was employed. The results were satisfactory when the work was carefully carried out between Mid-December and Mid-February, the critical period of the year for the disease in this district. Mr. Basu, Assistant Professor of Mycology at the Bengal Agricultural College, investigated a disease of plantains at Chinsurah, and wrote a note describing it in the *Bengal Quarterly Agricultural Journal*. The disease appears to be caused by a species of *Fusarium*, but further work is necessary to establish this.

Miscellaneous.—Experiments carried out at Pusa, and independently by the Mycological Assistant of the Bombay Department of Agriculture at Poona, have demonstrated that the fungus which causes pigeon-pea wilt produces its spores freely on the stems of diseased plants. Hence in addition to soil infection from previously diseased crops, air-borne infection is also possible. Work on sugarcane diseases is in progress at Pusa, Sabour and Poona, but has not yet yielded results to justify publication. Mr. Shaw of Pusa has a large investigation in hand on the root-rot of a number of cultivated plants, caused by a species of *Rhizoctonia*. The results are not yet ripe for publication. Most of the experimental and demonstration work in treating plant diseases, mentioned in last year's report as being in progress at various farms of the Provincial Departments of Agriculture, has been continued.

For some years black spore-like bodies have been observed as impurities in samples of "Indian" rice flour, examined in the Laboratory of Agricultural Chemistry of the Royal Agricultural College, Berlin. Specimens of these sent to the writer enabled him to identify them as the spores of the rice bunt, *Tilletia horrida*. This fungus was hitherto known to occur only in Japan and the United States; it appeared unlikely that its presence in India proper could have escaped detection; the Berlin authorities were therefore asked to ascertain the exact origin of the rice containing the impurity. The results of the investigation were published by Herr P. Filter in the *Centralblatt für Bakteriologie* recently. The rice containing this fungus was found to have been

imported from Siam, Moulmein and Bassein. We may conclude, therefore, that rice bunt occurs in Siam and Burma and is either restricted to these countries by climatic conditions or, more probably, is spreading from a centre in Eastern Asia and will eventually reach India proper.

II.—Systematic Mycology.

A new genus of the *Uredinaceæ* was described by the writer in the *Annales Mycologici*. It was collected on *Olea dioica* in the Deccan and is of considerable taxonomic interest.

A collection of fungi, chiefly *Agaricaceæ*, made by the Rev. Father Blatter in Bombay and Dehra Dun, was described by the Rev. F. Theissen, S.J., in the *Annales Mycologici*. Two new species of the Uredinaceous genus *Phakopsora* were described by Dr. P. Dietel and three new species of smuts by Herren H. and P. Sydow from Indian material supplied by the writer. One of the latter is of economic interest as a parasite of *Panicum frumentaceum*, one of the cultivated millets of India. Notes on the rare genus *Pucciniostele*, based on Himalayan specimens sent by the writer, were included in a paper by Dr. P. Dietel on Japanese *Uredinaceæ*. Mr. Massee has described two new species of fungi which attack wood and also a new species of edible truffle from the United Provinces.

The large collections of Ascomycetous fungi in the Pusa Herbarium were worked through by the writer; annotated lists, prepared in collaboration with Herren H. and P. Sydow of Berlin, are in the press. A description of a remarkable aquatic fungus found at Pusa will also appear shortly.

List of Publications.

Ansteal, R. . . Pink disease of Para Rubber and Bordeaux Mixture. (*Planters' Chronicle, v, No. 18, 1910, and vi, No. 8, 1911.*)

Basu, S. K. . . Report on Banana Disease of Chinsurah. (*Quarterly Journal, Dept. of Agric., Bengal, iv, No. 4, p. 196, 1911.*)

Burns, W. . . First Experiments in treatment of Grape Vine Mildew in Bombay Presidency. (*Dept. of Agric., Bombay, Bull. No. 36, 1910.*)

Butler, E. J. . The Bud-rot of Palms in India. (*Mem. Dept. of Agric. in India, Bot. Ser., iii, No. 5, 1910.*)

BUTLER, E. J. . A new genus of the *Uredinaceæ*. (*Annales Mycologici, viii, p. 444, 1910.*)

BUTLER, E. J. . The leaf spot of Turmeric (*Taphrina maculans* sp. nov). (*Annales Mycologici, ix, p. 36, 1911.*)

COLEMAN, L. C. . Diseases of the Areca palm: I. Koleroga. (*Bull. No. II, Mycol. Ser., Dept. of Agric., Mysore State, 1910, and Annales Mycologici, viii, p. 591, 1910.*)

DIETEL, P. . . Uredineen aus Japan: III. (*Annales Mycologici, viii, p. 304, 1910.*)

DIETEL, P. . . Zwei neue Arten der Gattung Phakopsora. (*Annales Mycologici, viii, p. 469, 1910.*)

FILTER, P. . . Ueber das Vorkommen von Tilletia horrida Takahashi in Reisfuttermehlen. (*Centralbl. für Bakter. Parasitenk. u. Infektionskr., 2nd Ab., xxix, p. 342, 1911.*)

HAFIZ KHAN, A. . Root infection of *Trametes Pini*. (*Ind. For., Oct. 1910.*)

MCRAE, W. . . Soft rot of Ginger in the Rangpur District, Eastern Bengal. (*Agric. Journ. Ind., vi, p. 139, 1911.*)

MASSEE, G. . . Fungi exotici. (*Kew Bull., 1910, No. 7, p. 249.*)

SHAW, F. J. F. . Copper blight of Tea. (*Agric. Journ. Ind., vi, p. 78, 1911.*)

SYDOW, H. & P. . Novæ Fungorum species. (*Annales Mycologici, ix, No. 2, March 1911.*)

THEISSEN, F. . . Fungi aliquot Bombayenses a Rev. Ed. Blatter collecti. (*Annales Mycologici, ix, No. 2, March 1911.*)

SYLVICULTURE.

BY

R. S. TROUP, F.C.H.,

Sylviculturist.

Measurements in sample-plots.

Considerable progress was made during the year in the establishment and measurement of permanent sample-plots for ascertaining the increment of typical woods in girth, height and volume: 29 sample-plots were laid out by the Sylviculturist, these being distributed in the Siwalik, Naini Tal, Haldwani, Pilibhit and Gonda Divisions, and dealing chiefly with *Shorea robusta* (*sál*), *Dalbergia Sissoo*, *Acacia Catechu*, and *Quercus incana*. In addition numerous measurements of typical *sál* coppice areas and *Pinus longifolia* crops were carried out; in such cases permanent demarcation was not necessary, since the ages of the crops were ascertainable. The system employed for estimating the volume of the crops measured is that known as the method of sample-trees by groups. Subsequent re-measurements of the permanent sample-plots will be quinquennial. In several cases adjoining thinned and unthinned plots were laid out in order to ascertain the degree of density required to produce the maximum volume increment per acre under different conditions. It is expected that the establishment of similar sample-plots will be completed in the United Provinces during the year 1911-12, and in subsequent years the work will be continued in other Provinces, those which contain *sál* forests being dealt with first.

The cutting of *sal* coppice.

2. In the Gonda Forest Division of the United Provinces experimental plots were laid out by the Sylviculturist with a view to testing the respective merits of cutting *sál* coppice flush with the ground and at a height of a few inches from ground level. Similar experimental plots laid out by the Divisional Forest Officer in the Gorakhpur Division during the past two years were also visited. It will be some years before conclusive results are arrived at, though the Gorakhpur experiments tend to show that the development of *sál* coppice shoots in early life is somewhat better as a result of cutting some inches from the ground, than where the stumps are trimmed flush with the ground. In the Gorakhpur Division it was proved beyond a doubt some years ago that under certain

conditions the high cutting of *sál* coppice gave better results than cutting at ground level. This was particularly the case in dry hot localities where the stumps, whether cut high or low, died down for a distance of some inches below the cut surface; consequently where the coppice was cut high the base of the stump at ground level remained alive even when the top part dried up, whereas in the case of low cutting the whole stump was liable to dry up for some inches below ground level, being thus rendered incapable of producing coppice shoots. It still remains to be proved whether or not the high cutting of *sál* coppice is advantageous under all conditions.

Causes and effects of drought in *sal* forests in Oudh.

3. The effects of the great drought of 1907 and 1908 on the *sál* forests of Oudh continued to be studied during the year, affected areas in the Gonda, Gorakhpur and Pilibhit Divisions being visited. So far as observations go at present, it appears doubtful if any satisfactory preventive measures for future damage by drought will be practicable, though something might be done in the way of maintaining a liberal proportion of drought-resisting species in areas liable to be affected, as well as adopting a system of management involving the least possible risk of permanent damage. It was noticed in this connection that the standards in coppice-with-standards as a rule suffered more than trees in high forest. As regards the effect of the drought on different species, it is noteworthy that as a general rule the more shallow-rooted species suffered less than the deep-rooted species, the explanation no doubt being that the latter drew their water-supply from moist substrata which became dried up with the lowering of the water-level consequent on the drought, whereas the surface-feeders were habituated to the annual drying up of the upper layers of the soil, and were therefore less liable to suffer from any abnormal drought. The *sál* appeared to suffer more than any other tree, while among the most conspicuous drought-resisting species were *Ficus religiosa*, *F. bengalensis*, *Miliusa velutina*, *Stereospermum suaveolens*, and *Mallotus philippinensis*. The damage done by the drought tended to be greater on sandy subsoils than on subsoils with a fair admixture of clay, owing to the inability of the former to retain sufficient moisture, through lack of retentive power when the water-level sank.

Developments in sylvicultural systems: (I) Haldwani Division *sal* forests.

4. Progress continues to be made in the application of the system of successive regeneration fellings to *sál* forests, the preliminary working-plan report for the forests of the Haldwani Division, United

Provinces, containing some important prescriptions in this respect. The rotation proposed is 150 years, subject to a possible reduction, this being divided into 5 regeneration periods of 30 years each. Some difficulty is anticipated in the allotment of the various crops to the different periods owing to their present irregular state, and some initial sacrifice is inevitable. The compartment being the unit of area for regeneration purposes, and the crops over whole compartments probably in no case being uniform in age, it remains to ascertain approximately the dominant age throughout each compartment, which will then be allotted to its period on this basis within fairly wide limits. Linear valuation surveys will be carried out where necessary to aid in this allotment.

(2) Thano *sal* forest.

5. The working-plan for the Thano *sál* forest, Dehra Dun, alluded to in last year's report, was finally sanctioned during the year. Under this plan the forest will be treated experimentally under the system of successive fellings, the rotation being 144 years, divided into 6 periods of 24 years each. Reproduction being already well established in the first periodic block, preparatory and seeding fellings are not necessary, and there will therefore be only two regeneration fellings, a secondary and a final felling, the one following the other after an interval of 12 years.

Working of bamboos.

6. Two experimental plots, one in the Siwalik Forest Division and the other in the Lansdowne Forest Division of the United Provinces, were laid out during the year, with a view to ascertaining the best methods of cutting and working bamboos (*Dendrocalamus strictus*), a subject on which opinions differ somewhat at present. It may be some years before any conclusive results are arrived at, but it is hoped that something may be learned which will lead to practical results bearing on the systematic working of bamboo forests.

Hardwickia binata.

7. An important contribution to the literature on *Hardwickia binata*, by Mr. D. O. Witt, was published during the year in the *Indian Forest Records*: the development of the tree from the seedling to the mature stage is traced with the aid of a series of good diagrams and photographs, and its various sylvicultural requirements are dealt with in detail.

Santalum album.

8. In the same publication Rao Sahib M. Rama Rao publishes the results of a series of experiments tending to show that the artificial propagation of sandal can be more successfully and economically carried out by *in situ* sowings than by the transplanting of nursery-raised plants, one of the most

important advantages of the former being the freedom from damage to the roots and root attachments of the seedlings and their hosts.

List of Indian Publications, 1910-11.

BEST, J. W. .	. Working-plan for the Government forests of the Bhandara Division, Southern Circle, Central Provinces.
CAVENDISH, F. H.	. Working-plan for the Jokai Reserve of the Lakhimpur Division, Eastern Circle, Eastern Bengal and Assam.
COMBER, E. R. .	. Working-plan for the Reserved forests in the Sambalpur Division, Bengal.
COPELAND, D. P.	. Working-plan for the Kamrup Sál Reserves, Western Circle, Eastern Bengal and Assam.
HOPWOOD, J. C.	. Working-plan for the Nwa Working Circle, Myittha Division, Northern Circle, Burma.
KANJILAL, UPENDRANATH.	Working-plan for the Holongapar Reserve, Sibsagar Division, Eastern Circle, Eastern Bengal and Assam.
LEETE, F. A.	. Memorandum on Teak Plantations in Burma. (*For. Bull. No. 2, 1911.*)
RAMA RAO, M.	. Notes on Sandal. (*Ind. For. Rec., ii, Part III.*)
ROGERS, C. G.	. The Raising of Forests with Field Crops in Berar. (*Ind. For., xxxvii, 8.*)
SMYTHIES, E. A.	. Some Aspects of Fire Protection in Chir Forests. (*Pinus longifolia*). (*Ind. For., xxxvii, 54.*)
TROUP, R. S. .	. Tables for the Volume Measurement of Sample-Plots.
WITT, D. O. .	. The Sylviculture of *Hardwickia binata*. (*Ind. For. Rec., ii, Part III.*)

ECONOMIC FOREST PRODUCTS.

BY

A. RODGER,

Forest Economist.

1. **Economic museum.**—Work in this museum continued during the year, many new specimens of much interest being added. The museum dates from 1881, having been started by Sir Dietrich Brandis.

but it was largely added to and improved by Mr. Gamble when Director of the Forest School. Mr. Gamble was, by the way, never Deputy Director as stated in last year's report. A large collection of economic products of all kinds was received from the United Provinces Exhibition at Allahabad through the kindness of the United Provinces Government and the exhibitors, but these cannot be properly displayed until the new institute buildings are completed.

2. **Testing of *sal* and teak.**—*Sál* logs grown in various localities, hills and plains, high forest and coppice, and teak logs grown in plantations and adjoining natural forest in Burma were received, and beams and blocks prepared for testing and comparison. Splitting tests were carried out with *sál*, and a series of tests with teak grown in plantations and natural forests in Burma were undertaken at Sibpur. As however the trees did not grow under the same conditions of elevation and soil, further tests will be carried out with the new specimens. The results of the first series of tests were published.

3. **Wood and bamboo pulp.**—The Economist visited some of the best bamboo areas of Burma where he made measurements and countings and collected much information regarding the possibility of establishing pulp mills. This has been recorded in a memoir now in the press, which will be completed when the result of certain tests with bamboo now being carried out by a Calcutta firm are made known. Bamboos and woods were supplied to the Chemist working at Dehra Dun.

4. **The match industry.**—The Economist visited several districts in Oudh, and after making countings, reported on the available quantity of *Simal* (*Bombax malabaricum*) and other woods and the facilities for extraction to a central site to be selected for a match factory. The conditions appear most favourable and it is hoped that a large factory will soon be started. Figures have also been obtained for several other localities which look promising. Woods were supplied to firms for testing for match making and it is evident that India is rich in such species.

5. **Antiseptic treatment of woods.**—Numerous experiments with different antiseptics have been continued as detailed in last year's report, but the most important work has been the powellizing by Messrs. Killick, Nixon & Co., at Bombay, of sleepers of the following species, which would not last as sleepers in their natural state:—

650 *Terminalia tomentosa* from Bombay.
431 *Dipterocarpus tuberculatus* from Burma.
127 *Dipterocarpus alatus* from Burma.

Six hundred and thirty-six of these have been treated and delivered to the Oudh and Rohilkhand Railway and the North Western Railway for use in the line, where their behaviour will be carefully noted. The remainder have been powellized, with the exception of a few unserviceable sleepers, and will be despatched during July to the Eastern Bengal State Railway for use in that Railway. About 1,900 pine sleepers from the Chakrata Division are also on their way to Bombay and a further supply of *Terminalia tomentosa* sleepers from Bombay and *Dipterocarpus* sleepers from Burma is also expected, the total number to be treated and issued to Railways being nearly 5,000.

Another experiment has been started with 2,000 sleepers of the same species which are to be treated with an antiseptic called *Avenarius Carbolineum* by the open-tank method. Eight hundred will be treated and laid down in Burma, 400 in Bombay, and 800 in Northern India.

The object of these experiments is to endeavour to prove that native grown woods can be made suitable for sleepers at a cheap rate.

6. **Gums and resins.**—A large number of samples of gums and resins have been sent to various firms in India and Europe and numerous enquiries replied to, but the difficulty of supplying reliable estimates of cost, when small quantities only are handled, and of getting good samples of essences, etc., distilled in the forest and of sending perishable samples, have prevented much progress being made. Analyses of several gums and oils have been received and more are under enquiry. The most promising is Burmese wood-oil from *Melanorrhœa usitata* which has attracted a good deal of attention in Europe, as a result of the Forest Chemist's note on it.

7. **Tea boxes.**—The question of the best method of supplying cheap good tea boxes made of Indian woods to tea gardens, instead of the imported boxes which are at present imported in enormous quantities from Europe and Japan, is under consideration. It appears to be difficult to get any one to move in this matter, as the present arrangements are sanctioned by custom and vested interests, but it is hoped that the antiseptic treatment of certain of the more perishable or unsuitable woods, and increased facility of extraction, as well as possibly the utilization of bamboo-pulp, may help to solve the difficulty in time.

8. **Miscellaneous uses of woods.**—Samples have been supplied to, and experimented with by, makers of matches, pencils, brush-backs, razor handles, cricket bats, tool handles, weaving looms, and other minor goods.

9. **Collection of information on little known valuable woods.**—The information has now been nearly all collected for six timbers and is being written up.

10. **Minor investigations.**—Barks of *Terminalias* and Oaks have been collected green and analysed for tanning value, and myrobalans were collected at different seasons and tested for the same property. The rosin and turpentine industry in the Himalayas has been under enquiry, and help was given to purchasers to encourage the use of walnut burrs and Andamans padauk among other products. Besides the analyses mentioned above, roots of *Podophyllum Emodi* and leaves and bark of *Cinnamomum glanduliferum* were collected and sent to the Forest Chemist for analysis.

List of Publications.

Those marked by an asterisk are still in the press.

GROOM, PERCY . . A Note on Pyinkado Timber. (*Ind. For., March-April 1911, 178.*)

HANKIN, E. H. . Production of Synthetic Rubber. (*Ind. For., August 1910, 489.*)

PEARSON, R. S. . . Note on the Relative Strength of Natural and Plantation Grown Teak in Burma. (*Forest Bulletin No. 3.*)

PEARSON, R. S. . . Catalogue of the Economic Museum of the Forest Research Institute and College, Dehra Dun.

PEARSON, R. S. . . *Commercial Guide to Indian Forest Products.

PEARSON, R. S. . . *Note on Antiseptic Treatment of Timbers.

PEARSON, R. S. . . *Note on the Paper-pulp Industry in India and Burma.

RAITT, W. . . Paper and Paper-pulp Industry in India. (*Ind. For., January-February 1911, 1.*)

RAITT, W. . . Paper-pulp testing at the Forestry Court, Cellulose Laboratory, United Provinces Exhibition, Allahabad. (*Ind. For., January, February, March, April, May 1911.*)

INDIAN ZOOLOGY

with special reference to the work done in the Indian Museum, October 1910 to September 1911, inclusive.

BY

N. ANNANDALE, B.A., D.Sc., C.M.Z.S., F.A.S.B.,

Superintendent of the Indian Museum.

As some misunderstanding has arisen about the scope of the report submitted annually to the Board of Scientific Advice by the Superintendent of the Indian Museum, I may be permitted to commence the present issue with a word of explanation. This report deals in the first instance with the zoological research published or in progress in the Indian Museum; it also deals, but in a less detailed manner, with other zoological research that has a direct bearing on the fauna of the Indian Empire, except that it ignores entomological and parasitological work carried out by Government departments whose representatives themselves submit reports to the Board and by similar departments in Native States. It is for this reason that the entomological investigations undertaken at Pusa, Dehra Dun and Bangalore are apparently neglected, and that no mention is made of the parasitological work of the Civil Veterinary Department.

I.—Work in the Indian Museum.

(*a*) *Laboratory Work.*

Captain F. H. Stewart, I.M.S., Honorary Assistant in the Indian Museum and formerly Surgeon-Naturalist to the Indian Marine Survey, has published a paper in our "Memoirs" on minute structure and post-larval development in certain genera of barnacles. The biological importance of this paper is considerable and the researches it embodies have a peculiar interest as regards zoological reseach in Calcutta, in that they are based on histological work of a delicate nature which was carried out entirely in our laboratories. It has often been denied that such work can be carried out in a tropical climate.

Dr. Annandale has completed a description of the freshwater Sponges, Hydrida and Polyzoa to form a volume in the "Fauna of British India" published under the authority of the Secretary of State in Council. This is the first volume in the series to be written entirely in India, and

it is one of two for the preparation of which in Calcutta sanction has been received, the other being Mr. Brunetti's account of the Nemocera other than Culicidæ, Chironomidæ and Cecidomyidæ. In the volume on the Sponges, etc., special stress has been laid on biological problems.

Mr. S. W. Kemp, besides publishing two short papers on Decapod Crustacea, has been engaged for the greater part of the year on a monograph of the Stomatopoda of the Indo-Pacific seas, and has recently prepared for our "Records" a series of preliminary descriptions of hitherto unrecognized forms. He has been much assisted by the loan of specimens from the British, the Colombo and the Sarawak Museums, and the collections of the Commissioner of Fisheries in New South Wales and of Professor Kishinouye of Tokyo. Mr. Kemp has also spent a considerable amount of time and trouble in improving our collection of the freshwater prawns of the Indian Empire with a view to the preparation next year of an account of the Indian species. Mr. Kemp's work on the higher Crustacea has a special interest for the Indian Museum in that it is in direct continuation of the investigations commenced in 1871 by the late Mr. J. Wood-Mason, then Deputy Superintendent. Mr. Wood-Mason's work on this group was carried on by Colonel Alcock, his successor as Superintendent, with such success that his monographs on the Decapoda have already become classics in taxonomic literature, and it is eminently satisfactory that the tradition thus created should be maintained.

Mr. B. L. Chaudhuri has worked on the large collection of freshwater fishes from Northern India obtained by Mr. M. Mackenzie and from other sources. He has also conducted experiments as regards the destruction of mosquito larvæ by various species of fish.

In the Entomological Sub-Section Mr. F. H. Gravely has commenced and nearly completed an account of the taxonomy, habits and distribution of the Oriental Pedipalpi. He has also done a considerable amount of work on the Scolopendridæ in the collection, and has supervised the preparation of some valuable original drawings of the mouth-parts of various blood-sucking flies. In collaboration with Mr. S. Maulik he has written an account of certain tree-haunting Neuropterous larvæ of the families Myrmeleonidæ and Ascalaphidæ. More recently Mr. Gravely has commenced the study of the beetles of the families Lucanidæ and Passalidæ that occur in India and the neighbouring countries. The former are forest pests of great importance, while the closely allied Passalidæ are of considerable scientific interest and can be studied in Calcutta with peculiar facility owing to our possession of the valuable collection of the late Dr. F. Stoliczka, one of the earliest students of the family. Mr. Gravely's work on the two families has been further

facilitated by the loan of specimens from the Bombay Natural History Society, the Museums of Madras, Trivandrum, Colombo and Sarawak and the Research Institutes at Pusa and Dehra Dun and the Government Entomologist, Ceylon.

In the same sub-section Mr. C. A. Paiva has collected data for a "census" of the mosquitoes of one district of Calcutta, and has devoted special attention to the habits of the predaceous larva of a species of *Toxorhynchites* which feeds on the larvæ of other mosquitoes, notably of the yellow fever mosquito *Stegomyia fasciata*.

A great part of Mr. Brunetti's time has been occupied in work on the Tipulidæ and other Nemocera for his volume in the "Fauna of British India." This work is now approaching completion. Mr. Brunetti has also published a revision of the Oriental blood-sucking Diptera of the family Muscidæ, and preliminary descriptions of about fifty new Indian species of the families Psychodidæ, Bibionidæ, Simuliidæ, Rhyphidæ, Dixidæ and Blepharoceridæ. He has now in the press a preliminary revision of the Oriental Tipulidæ and a revision of his catalogue of the Oriental Culicidæ published some years ago.

The Surgeon-Naturalist of the Indian Marine Survey, Captain R. B. Seymour Sewell, I.M.S., has worked in the Indian Museum during the monsoon. His main study has been that of the surface-living Copepoda of certain parts of the Burmese coast. He has devoted special attention to the biological and hydrographical factors in the distribution of these little Crustacea as well as to their taxonomy. Captain Sewell has also prepared in the Museum a detailed report on the deep-sea fish taken last season by the R. I. M. S. "Investigator" and, in collaboration with Mr. Kemp, has worked out the deep-sea Decapod Crustacea.

(*b*) *Field Work.*

Dr. Annandale spent ten days at Bangalore during the Puja holidays in October 1910, and obtained, with the assistance of Dr. Morris Travers, F.R.S., a representative collection of the Crustacea and Sponges of the district as well as a number of insects. Specimens from the State of Mysore were much needed in the Museum. Accompanied by Mr. Gravely, Dr. Annandale also visited Puri on the Orissa coast in January. The ostensible object of this trip was to collect marine organisms, but unfavourable meteorological conditions rendered this difficult and special attention was paid to the Crustacea and leeches of ponds and streams and of the Sur Lake, which is situated about four miles from Puri. A good series of freshwater prawns (especially of the family Atyidæ) and leeches

of the family Glossosiphonidæ was obtained. A second visit was paid to the Sur Lake by Dr. Annandale and Mr. Gravely in September and an interesting collection of the fauna of the sand-dunes which separate the lake from the sea was obtained.

Mr. S. W. Kemp in May 1911 visited the lakes of Kumaon in the W. Himalayas and obtained a very interesting collection of the invertebrate fauna, especially of the Crustacea, Polyzoa and Sponges. The invertebrates of these lakes were hitherto almost unknown.

The field work undertaken of recent years by the Indian Musuem has been for the most part of a somewhat indiscriminate nature. This was unavoidable so long as only one officer could go on tour, but now that the scientific staff has been increased to four officers, we are in a position to specialize further and our field work is being pressed on mainly in two directions, namely:—

(i) A survey of the freshwater fauna of the Indian Empire.
(ii) The collection and observation of those groups of insects and arachnida which are actually being worked out in the Museum and of those regarding which arrangements for identification have been made with specialists abroad.

The survey of the freshwater fauna of the Indian Empire was really commenced about 40 years ago by the late Mr. J. Wood-Mason, but the importance of the investigations on marine zoology undertaken in succeeding years totally overshadowed it. It is now our endeavour, without neglecting marine zoology, to press on the survey of the rivers and lakes of India and Burma. The first-fruits of this survey are to be found in Colonel Alcock's revision of the freshwater crabs published in the Catalogue of Decapod Crustacea of the Indian Museum last year. Other published results are Dr. Annandale's account of the freshwater Sponges, Hydroids and Polyzoa in the "Fauna of British India" and Mr. Kemp's account of the Crustacea Anostraca in a recent number of the "Records of the Indian Museum," while work in progress in the Museum includes an account of the freshwater fishes of Northern India by Mr. Chaudhuri and of several families of flies which pass their earlier stages in water by Mr. E. Brunetti. The account of the aquatic Rhynchota in vol. v of Mr. W. L. Distant's account of this order of insects in the "Fauna of British India" is largely based on specimens sent from the Indian Museum, and the same will be the case with future volumes in the same series on the leeches by Mr. W. A. Harding and on the molluscs of the family Unionidæ by Mr. H. B. Preston. Collections of freshwater microscopic Crustacea and other

plancton from over two hundred localities have also been sent to be worked out by Professor E. von Daday of Buda-Pesth, while Major J. Stephenson, I.M.S., Professor of Biology in the Government College, Lahore, is publishing a series of papers on the aquatic oligochæte worms collected by us. It may therefore be stated with confidence that our survey of the freshwater fauna has already made and is continuing to make great progress. We have to thank a large number of private persons in different parts of India and Burma for assistance in the survey.

The collection and observation of insects and Arachnida belonging to special groups is at once a more simple and a more difficult matter than the conduct of a survey of the freshwater fauna. Specimens are as a rule more easily obtained, but in most cases it is difficult, if not impossible, to assign them to their proper groups in the field. Our special attention has been directed to the Arachnid group Pedipalpi, on which Mr. Gravely is preparing an elaborate monograph, but efforts have also been made to obtain specimens of the families of Diptera to which Mr. Brunetti has recently devoted his attention, and we have also endeavoured to gather together as many specimens as possible of those groups of insects on which volumes are being written in the "Fauna of British India." As regards insects and Arachnida we have also to thank a large number of private collectors for specimens.

Although the marine field work undertaken by the Surgeon-Naturalist to the Indian Marine Survey is not, strictly speaking, a part of the work of the Museum, it may be discussed here because all the specimens he obtains become the property of the Museum. The biological investigations of the R. I. M. S. "Investigator" have attained a world-wide celebrity, thanks to the energy and scientific knowledge of succeeding Surgeon-Naturalists, and it is therefore unfortunate that the exigencies of survey work have recently somewhat lessened the opportunities given to the Surgeon-Naturalist. The following table showing the number of trawls made in different seasons illustrates this fact with sufficient clearness:—

Survey seasons.	Average number of trawls.
1887-88 to 1891-92	20·8
1892-93 to 1896-97	17·8
1897-98 to 1901-02	15·6
1902-03 to 1906-07	14·6
1907 08 to 1910-11	3·75

Another fact, however, is not always appreciated, *viz.*, that we now know a good deal more of the deep-sea or abyssal fauna of Indian seas than we do of the littoral and sub-littoral fauna, and that the mid-water fauna of these seas has hitherto been totally neglected. If this fact were appreciated it might perhaps be possible for greater facilities to be granted to the Surgeon-Naturalist, even if it is no longer possible to trawl in deep water so frequently as was once the case. Last season Captain Sewell did a good deal of valuable work in shore, collecting on the coast of Tavoy and on the Moscos Islands, as well as in collecting and studying the surface plancton (botanical as well as zoological) off the same coast.

II.—Work done in India outside the Museum.

Great activity has recently been displayed, especially in the Punjab, by officers of the Indian Medical Service as regards the identification and description of mosquitoes, the most important result, so far as publications go, being the issue of a new edition of James and Liston's "Anopheline Mosquitoes of India." This handsome volume is practically a new work, the whole having been completely revised and much new material added. It is unfortunate that the authors have greatly discounted its value from a zoological point of view by totally ignoring the rules of nomenclature accepted by zoologists, and it is to be feared that the great confusion which already exists as regards some of the commonest Indian mosquitoes will be thereby still further increased. This is the more unfortunate as the book contains much information of great value. Major S. R. Christophers and Major S. P. James, of the Indian Medical Service, have also published several papers on mosquitoes in "Paludism," the new journal devoted to the study of malaria and published officially by the sanitary authorities.

One of the most important zoological discoveries recently made in India is that of a freshwater medusa of the genus *Limnocnida* in tributaries of the river Krishna. This discovery is due to Mr. S. P. Agharkar, Lecturer on Biology in the Elphinstone College, Bombay, who, after studying for some time in the laboratories of the Indian Museum in Calcutta, made important collections of the lower aquatic invertebrates in the streams of the Western Ghats and presented them to us. *Limnocnida* was at one time thought to be peculiar to Lake Tanganyika in Central Africa, its existence in which was one of the strongest arguments brought forward in support of the now discredited theory that Lake Tanganyika had recently been connected with the sea. The medusa,

however, has now been found in other African lakes and also in a lagoon at the mouth of the river Niger near the West Coast of Africa. Its existence in India was not hitherto suspected, although Lieutenant-Colonel A. Alcock, F.R.S., obtained a single specimen of a freshwater medusa in Chota Nagpur many years ago.

The Bombay Natural History Society has during the past year inaugurated an important movement by collecting subscriptions for a survey of the mammals of India, the smaller members of this group being still practically unknown. The movement has been successfully inaugurated by the appointment of a trained collector, who is now at work in Western India; and Mr. Oldfield Thomas, F.R.S., of the British Museum has undertaken to arrange for the identification and description of the species. It is to be hoped that the results will finally be dealt with in a connected form and will not consist merely of a series of papers in which new species and sub-species are described.

In the Government College, Lahore, Major J. Stephenson, I.M.S., has continued his studies on aquatic oligochæte worms, the results of which are published from time to time in the "Records of the Indian Museum." In the "Journal of the Bombay Natural History Society" a number of papers, chiefly on birds and other popular groups, have been published; special mention may be made of Major F. Wall's papers on snakes, and regret may be expressed as to the number of "new species" he has found it necessary to describe.

III.—Work done in Europe and America.

In the official "Fauna of British India" a fifth volume on the Rhynchota has been published by Mr. W. L. Distant, containing descriptions of species belonging to eighteen families of Heteroptera and added to the Indian fauna since the publication of the earlier volumes on the order. Letters in an interesting correspondence regarding the "Fauna" are published in an appendix to the report of the officer in charge of the Zoological Section of the Indian Museum for the financial year 1910-11. There is always danger of a "Fauna," written in a country other than that to which the animals belong, developing into a dry museum compilation in which only old and faded specimens are described, of little use except to specialists in the groups discussed; the fact that even dried specimens were once living animals is apt to be forgotten, and geographical facts are ignored or distorted. The "Fauna of British India" has recently been criticized

severely from this point of view by "H. M. L." in Journ. Bombay Nat. Hist. Soc., vol. xx, p. 841; but it cannot be denied that a great improvement has been made in the volumes issued under the present Editor, who has shown himself sympathetic to work done in India, and it is perhaps not too much to hope that as the study of zoology progresses in this country and the number of zoologists increases, more and more of the volumes of the "Fauna" will be written by men with an intimate personal knowledge of the country and qualified by the examination in a living condition and even in their natural surroundings of at least some of the animals which they discuss, as well as of the whole of the collections preserved in India, to speak with some authority on the natural appearance of these animals and to discuss their biology and distribution.

A very important addition to our knowledge of the fauna of Indian seas will be published shortly in Mr. A. H. Clark's (of Washington, U. S. A.) account of the Crinoids in the collection of the Indian Museum. This work will form a part of the "Catalogue of the Echinoderma of the Indian Museum," but will differ from the parts already issued in including a synonymic catalogue of all the species as yet recorded from the Indo-Pacific region as well as much information of theoretical interest and a complete bibliography. In order to complete his catalogue Mr. Clark has examined practically all the material preserved in European and American museums as well as that sent him from Calcutta.

Other work on the Indian fauna recently carried out in Europe and America is noticed in the attached bibliography, which has been compiled by Mr. B. L. Chaudhuri, Assistant Superintendent, Indian Museum. Special attention may be directed to the investigations on the anatomy of Indian snails carried out by the veteran Indian naturalist, Lieutenant-Colonel H. H. Godwin-Austen, F.R.S., and also to Dr. W. Michaelsen's studies of the taxonomy and distribution of Indian earthworms (Abh. Naturwiss. Ver. Hamburg, xix, 1910).

List of papers, memoirs and books having a special reference to Indian Zoology recently published.

Memoirs published in India.

GENERAL.

In the *Records of the Indian Museum.* Report on a collection of aquatic animals made in Tibet by Captain F. H. Stewart, I.M.S.,

during the year 1907. Part III—Turbellaria and Summary. By Dr. A. Meixner, A. Muth and Captain F. H. Stewart, M.A., D.Sc., M.B., I.M.S. Vol. vi, 57.

In the *Journal and Proceedings of the Asiatic Society of Bengal.* Materia Medica Animalium Indica. By David Hooper, F.C.S. Vol. vi, 1910, 507.

In the *Journal of the Bombay Natural History Society.* Notes on Game Animals from near Gyantse and in the Chumbi Valley. By Captain F. H. Bailey. Vol. xx, Part 4, 1028.

In the *Agricultural Ledger.* Bat and Bird Guano in India. By I. H. Burkill, M.A. Nos. 1 and 2 of 1911.

Protozoa.

In the *Spolia Zeylanica.* On some Parasitic Protozoa from Ceylon. By Clifford Dobell, M.A. Vol. vii, 1910, 65.

Porifera (Sponges).

In the *Records of the Indian Museum.* Some Sponges associated with gregarious Molluscs of the family Vermetidæ. By Dr. N. Annandale, D.Sc., F.L.S., C.M.Z.S., Superintendent, Indian Museum. Vol. vi, 1911, 47.

Notes on the Sponges. By the same author. Vol. vi, 1911, 225.

In the *Spolia Zeylanica.* Notes on a freshwater Sponge from Ceylon. By the same author. Vol. vii, 1910, 63.

Vermes.

In the *Records of the Indian Museum.* On some aquatic Oligochæte worms commensal in *Spongilla carteri.* By Major J. Stephenson, M.B., D.Sc. Vol. v, 1910, 233.

On *Bothrioneurum iris,* Beddard. By the same author. Vol. v, 1910, 241.

On some aquatic Oligochæta in the collection of the Indian Museum. By the same author. Vol. vi, 1911, 203.

In the *Spolia Zeylanica.* Notes on new land Planarian from Ceylon. By Dr. Iwaji Ikeda. Vol. vii, 1911, 113.

Some notes on the Ceylon Pearl-inducing worm. By T. Southwell, A.R.C.Sc., F.L.S., F.Z.S. Vol. vii, 1911, 124.

Some remarks on the occurrence of Cestodes in Ceylon. By the same author. Vol. vii, 1911, 194.

In the *Ceylon Marine Biological Reports*. Description of nine new species of Cestode Parasites, including two new genera from Marine Fishes of Ceylon. By the same author. Part v, 1911, 216.

Crustacea.

In the *Memoirs of the Indian Museum*. Studies in post-larval development and minute anatomy in the genera *Scalpellum* and *Ibla*. By Captain F. H. Stewart, M.A., D.Sc., M.B., I.M.S. Vol. iii, No. 2, 1911.

In the *Records of the Indian Museum*. On the classification of the Potamonidæ (Telphusidæ). By Colonel A. Alcock, C.I.E., F.R.S. Vol. v, 1910, 253.

On certain species of *Palæmon* from South India. By J. R. Henderson, M.B., F.L.S., and George Mathai, M.A. *Ibid.*, 277.

Note on a Rhizocephalous crustacean from fresh water and on some specimens of the order from Indian seas. By Dr. N. Annandale, D.Sc., Superintendent, Indian Museum. Vol. vi, 1911, 1.

Notes on Decapoda in the Indian Museum (II). By S. W. Kemp, B.A., Assistant Superintendent, Indian Museum. *Ibid.*, 5.

Preliminary description of new species and varieties of Crustacea Stomatopoda in the Indian Museum. By the same author. Vol. vi, 1911, 93.

Indian Isopods. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S. Vol. vi, 1911, 179.

Notes on Asiatic species of Crustacea Anostraca in the Indian Museum. By S. W. Kemp, B.A. *Ibid.*, 229.

In the *Journal of the Bombay Natural History Society*. Notes on the growth of Barnacles in Indian seas. By N. Annandale, D.Sc. Vol. xx, 1911, 1170.

In the *Spolia Zeylanica*. Association of Barnacles with Snakes and Worms. By Dr. A. Willey, D.Sc., F.R.S. Vol. vi, 1910, 180.

Myriapoda.

In the *Spolia Zeylanica*. Symphyla of Ceylon. By F. H. Gravely, M.Sc., Assistant Superintendent, Indian Museum. Vol. vii, 1910, 110.

INSECTS.

In the *Records of the Indian Museum*. A revision of the species of *Tabanus* from the Oriental region including notes on species from surrounding countries. By Gertrude Ricardo. Vol. iv, No. vi, 1911, 111.

Notes and descriptions of the Indian Microlepidoptera. By E. Meyrick, B.A., F.R.S. Vol. v, 1910, 217.

Alluaudella himalayensis, a new species of degenerate male Cockroach. By F. H. Gravely, M.Sc., Assistant Superintendent, Indian Museum. *Ibid.*, 307.

Rhynchota Malayana. Part III. By W. L. Distant. *Ibid.*, 313.

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Contributions to the Fauna of Yunnan. IV.—Les Chironomides (Tendipodidæ). Par J. J. Kieffer, Doct. Phil. Nat., Professeur à Bitesch. *Ibid.*, 27.

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ECONOMIC ENTOMOLOGY.

BY

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I.—Agricultural Entomology.

(a) Pusa Research Institute.

The study of the life-histories and habits of injurious insects was continued at the Pusa Research Institute and by the Assistants in the Provincial Agricultural Departments. The more important of these insect pests have been the—

Rhinoceros Beetle (*Oryctes rhinoceros*).
Surface Grasshopper (*Chrotogonus trachypterus*).
Painted Grasshopper (*Pœcilocera picta*).
Tingid Potato Bug.
Lucerne Hypera (*Hypera medicaginis*).
Small Cabbage Caterpillar (*Hellula undalis*).
Rice Weevil (*Calandra oryzæ*).
Green Bug (*Nezara viridula*).
Potato Mealy Bug (*Dactylopius nipæ*).
Fish Insect (*Lepisma sp.*).
Red Pumpkin Beetle (*Aulacophora foveicollis*).
Termites (*Termes spp.*).

Work on methods of checking the mound-building White-ant (*Termes sp.*) has been continued in collaboration with the Deputy Director of Agriculture, Northern Circle, Central Provinces, and considerable success has been obtained though the experiments are not yet completed. Numerous insecticides sent in for trial have been tested and reported on. Three students have been given a training in advanced Entomology at Pusa, whilst thirteen and fifteen applicants from all parts of India have been given short courses of practical training in Sericulture and Lac-culture respectively.

Experiments have been made on the crossing of Italian and French univoltine Mulberry Silkworms with all the available indigenous multivoltine races, the object being to secure a robust and vigorous multivoltine race yielding a better quality of silk than is produced by the native

forms at present cultivated; the earlier stages of such a series of experiments are necessarily devoted largely to the elimination of useless forms, but the information obtained appears to justify the continuance of these attempts. Two broods of Mulberry silkworms from imported European seed were successfully reared at Pusa on bush mulberry between November and March and the resulting silk was reported on in extremely favourable terms. The cultivation of the Eri silkworm was continued at Pusa and a great stimulus was given to this industry by the exhibits shown by this section at the Allahabad Exhibition. Ericulture has been taken up by the Provincial Agricultural Departments of the United Provinces (at Shahjahanpur), of Bengal (at Sabour) and of Madras (at Coimbatore), and every effort has been made to bring rearers into touch with one another and with the silk trade for the supply and disposal of eggs, cocoons and thread. Practical demonstrations of methods of silk-culture, spinning, reeling, etc., were given at numerous Agricultural Exhibitions held in Bengal and Eastern Bengal and Assam. A simple machine, for the doubling and twisting of thread in one action was invented at the instance of this Department by Mr. Watson, of Muzaffarpur, and has been made available.

Experimental work in lac-culture was continued at Pusa, and two courses of practical training in this subject were given during the year. In collaboration with the Forest Department a continuation was made of the collection of the races of lac insects from various trees with a view to investigation of their affinities. An investigation into Apiculture has been commenced, two races of specially-selected Italian honeybees having been imported to Pusa in November 1910 with a view to ascertaining their suitability to the conditions prevalent in the plains of India, and the experiment has so far proved a success.

The Allahabad Exhibition (November 1910 to February 1911) offered an opportunity for demonstration that was not neglected. Besides a large working exhibit of silk-culture, cases were exhibited showing common Indian birds and their insect food, insects destructive to crops of the United Provinces, and the connection of insects with disease. Steady progress has been made in the preparation and issue of coloured plates of injurious and beneficial insects and a large series of these is now available for demonstration purposes, besides series on silk and lac. These plates have been very largely circulated and used by Provincial Departments.

A very large and constantly increasing volume of correspondence on insects is received and dealt with as far as possible and it is inevitable

that this branch of the work must expand as the work of the Department becomes better known. The parcels of injurious insects sent in during the year numbered 166, and in the same period 2,384 inquiries came in from official and public sources and were replied to officially. Advice and help to inquirers has formed no small part of the work of the staff during the past year and for this reason and on account of the large amount of other work now on hand no time has been available for original research.

(b) Provincial departments.

The work of the Entomological Assistants in the Provinces has been mainly confined to demonstration of methods of control of crop-pests and teaching of Elementary Entomology to students of General Agriculture at the Colleges. In Madras steady progress has been made in obtaining a knowledge of the life-history, occurrence and means of control of the crop pests of the Province, in the Central Provinces work against Potato Moth has been continued, in the United Provinces methods of control of Cane Grasshopper and Potato Moth have been demonstrated, and in Bengal methods have also been adopted against Potato Moth and good results achieved.

(c) Other works.

In the South of India, Mr. R. D. Anstead, Planting Expert, has continued to stimulate an interest in insect pests amongst the planting community, and in Mysore Dr. L. C. Coleman has published two Entomological bulletins, one on the Rice Grasshopper (*Hieroglyphus banian*), the other on the Deccan Grasshopper (*Colemania sphenarioides*). Mr. C. B. Antram, Entomologist to the Indian Tea Association, has continued his work on insect pests of tea.

II.—Forest Entomology.

The subject of the insects beneficial and injurious to Sal (*Shorea robusta*) received special attention during the year under review. Observations made in the Siwalik Hills on the common wood-borer *Æolethes holosericea* indicate that its life-cycle extends over a period of two years; this borer has also been reported as damaging *Hardwickia binata* and *Chloroxylon Swietenia* in addition to Sal, so that it possesses considerable importance as a pest. Sal fruit attacked by larvæ of the Eucosmid moth, *Pammene theristis*, Meyr MS., was collected locally and the moths bred out in July-August, thus indicating that this pest has two generations in the year, one feeding in the roots of the young

seedling, the other living in the fruit. The above are two of the more important pests of Sal, but in addition many other insects of less importance were dealt with, some 1,500 specimens having been collected and many notes recorded regarding their life-histories and habits.

Great progress has been made with the reference collection of insects during the year, a total number of 1,220 named species having been added; of these 917 were received from the Pusa Research Institute and 143 from the Indian Museum. The species have been properly arranged in systematic order and a card index catalogue has been commenced. Special attention has been paid to the formation of a good reference collection of preserved larvæ and pupæ with a view to ready identification of economically important species. In addition to the named collection, a large number of specimens has been sent to Europe for identification, 51 parcels having been despatched during the year.

Specimens of seed-lac sent by the Imperial Sylviculturist from *Butea frondosa* trees in the Siwalik Division were kept under observation during the year. From this lac the following species were bred out:—

(*a*) *Eublemma amabilis*,
(*b*) *Hypatima pulverea*,
(*c*) *Stagmatophora spodochtha*,
(*d*) *Silvanopsis iyeri*,
(*e*) *Berginus maindroni*,

of which the last two are new to science. Particular attention was paid to the dates of emergence as if parasitic species are found to emerge after the swarming of the brood-lac, the collection of the brood-lac sticks immediately before the swarming affords a means of checking the injurious predaceous and destructive insects.

The following insects sent in by Forest Officers during the year under review appear to be noteworthy:—

(*a*) Aphids (*Pemphigus bursarius*, Kalt.) sent from Naini Tal as forming galls on *Populus ciliata*.
(*b*) *Arhopala atrox*, Hewits., reported as defoliating Sal in the Kheri Division of the United Provinces.
(*c*) *Cyrtotrachelus longimanus*, Fb., reported as damaging shoots of *Dendrocalamus strictus*, and *Caryoborus gonagra*, Fb., reported as damaging seeds of *Hardwickia binata*, both from Saugor, Central Provinces.

(*d*) Two beetles attacking *Ficus elastica* in the Tista Division, Bengal. These proved to be *Mecotagus tigrinus* and *Hectarthrum iyeri*, Grouv. MS., the latter being a hitherto undescribed species and probably parasitic on the former.

(*e*) Beetles and flies damaging Sundri trees in the Sunderbans Division, Bengal.

(*f*) Specimens of *Olenecamptus curvipes* which were reported as having attacked wood of *Anogeissus latifolia* in Madras and Indore, but it is not clear as to whether healthy living trees were attacked or not.

(*g*) Specimens of a scale insect, *Leucaspis salicis*, Green MS., damaging Willow trees in Baluchistan.

(*h*) Various insects bred from seeds of *Albizzia Lebbek*, *Cassia Fistula*, *Bauhinia malabarica*, and *Dalbergia lanceolaria* communicated by the Imperial Sylviculturist.

Specimens sent in by eleven officers of the Department during the year were duly identified.

The Museum collection has been rearranged during the year and several additions have been made, amongst which may be mentioned:—

(*a*) Models of sections of White-ant's nest and of Ant-lion's pit.
(*b*) Model of wasp's nest.
(*c*) Model showing damage done by Cheroot Weevil.
(*d*) Wall-plates illustrating life-cycle of the malarial parasite.
(*e*) Two stuffed pythons obtained locally.

Specimens have been contributed to the collection during the year by the British Museum, the Indian Museum, Mr. E. Ernest Green, Ceylon Government Entomologist, and others.

The work of opening separate Ledger Files for each named species in the collection received careful attention during the year, as the information had hitherto been scattered through a number of routine office files.

List of Publications.

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ANTRAM, C. B. . . Capsid Bugs on Bamboos. (*Indian Tea Association Journal.*)

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BAINBRIGGE - FLETCHER, T. - (Four Reviews in *Agric. Jour. of India* and one in *Jour. of Bombay Nat. Hist. Society.*)

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GHOSH, C. C. . . Palm Beetles. (*Mem. Dept. of Agric. India, Entomological Series, ii, No. 10.*)

GHOSH, C. C. . . Life-history of *Croce filipennis.* (*Jour. of Bombay Nat. Hist. Society.*)

IYER, V. S . . Further note on *Casuarina* Insect Pests of Madras.

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STEBBING, E. P. . Monograph on Lac Insect. (*Forest Mem., i, Pt. 3, 2nd Edition.*)

STEBBING, E. P. . Some Insect Pests of Himalayan Coniferæ. [*Forest Mem., ii, Pt. 1 (Deodar).*]

STEBBING, E. P. . Life-history of *Chermes himalayensis.* (*Trans. Linnean Soc., xi, Pt. 6.*)

STEBBING, E. P. . Some Insect Pests of Himalayan Coniferæ. [*Forest Mem., ii, Pt. 2 (Chir Pine).*]

STEBBING, E. P. , The Blue Pine *Tomicus.*

STEBBING, E. P. . Some Bark-eating and Root-boring beetles of Babul.

Eri Silk as a Cottage Industry. (*Pusa Pamphlet in English, Urdu, and Hindi.*)

Mulberry Silk in the United Provinces. (*Pusa Pamphlet in English, Urdu, and Hindi.*)

List of Injurious Indian Insects. (*Pusa Pamphlet for use of Entomological Assistants.*)

List of Insects in Pusa Collection.

VETERINARY SCIENCE.

BY

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The following table shews the output and issue of the various products at the Imperial Bacteriological Laboratory at Muktesar:—

Name.	Quantity prepared.	Quantity issued.	Increase.
	Doses.	Doses.	Doses.
Anti-Rinderpest Serum	577,969	533,779	168,891
Anti-Anthrax Serum	5,415	9,715	—6,753
Hæmorrhagic Septicæmia Vaccine	50,350	50,350	42,030
Anti-Hæmorrhagic Septicæmia Serum	1,825	1,825	1,825
Charbon Symptomatique Vaccine	33,400	19,900	13,050
Charbon Symptomatique Serum	...	536	...
Mallein	12,941	16,229	3,426
Tuberculin	209	188	—235
Anti-Streptococcus Vaccine	500	500	500
Anti-Streptococcus Serum	1,829	1,117	1,829

Rinderpest.—During the year 1910-11, the output of Rinderpest Serum was 168,891 doses more than the previous year. The demand for this serum increases every year and is far greater than the output. It is interesting to note that its use is being appreciated in the Native States. The preparation of serum by means of Peritoneal Washings gave good results and effected a very considerable saving in the number of animals required.

As the result of a series of experiments carried out at Bareilly, the following important conclusions were arrived at:—

(1) The serum resulting from a single massive injection of virulent blood is superior in potency to that prepared by two successive injections of virulent blood.

(2) The serum resulting from a single massive injection of virulent blood, given at a negative phase, is superior to that prepared by a single massive injection at a positive phase.

(3) The serum from a massive injection of virulent blood diluted in an equal volume of Citrate of Potash Solution is superior to that prepared by a massive injection of defibrinated blood undiluted.

(4) A serum of very high potency can be prepared from Plains Buffaloes by a single massive injection of virulent blood obtained from buffalo controls.

(5) That the period allowed between the injection of virus and the bleeding for serum can, with benefit, be reduced from three to two weeks.

The practical application of these conclusions has so far given good results and it is hoped that the output of this serum can be very largely increased and the expense of preparation and the expenditure of susceptible animals materially decreased.

Anthrax.—A preliminary report on the result of experiments into the methods of Anti-Anthrax Serum and Vaccine preparation and their practical value has been completed.

Hæmorrhagic Septicæmia.—Further tests on the value of the Anti-Hæmorrhagic Septicæmia Serum and Vaccine in the protection of bulls, buffaloes and horses have been carried out, and a report on the subject has been submitted.

Surra.—The successful results of the treatment of this disease in horses have been published during the last year. Further reports on the subject are now ready.

Contagious Lymphangitis of Cattle.—Several specimens from cattle suffering from this disease have been submitted from Quetta. In sections, from the affected glands, club-shaped organisms have been repeatedly observed, similar to those described by me in I. C. V. D. Memoir No. 1.

A List of Papers published during the year 1910-11 bearing on Indian diseases.

BALDREY, F. S. H. . Piroplasmosis in India. (*Journ. Trop. Vet. Science, v, No. 4.*)

" " A comparison of the different methods of preparing Hæmorrhagic Septicæmia Vaccine and the immunizing value of old and new vaccine of Hæmorrhagic Septicæmia. (*Journ. Trop. Vet. Science, v, No. 4.*)

BALDREY, F. S. H.	Transmission of Surra. (*Journ. Trop. Vet. Science, v, No. 4.*)
,, ,,	The preparation of Anti-Rinderpest Serum by other means than the injection of virulent blood. (*Journ. Trop. Vet. Science, vi, No. 1.*)
BALFOUR, A.	Further observations on Fowl Spirochætosis. (*Journ. Trop. Med. & Hyg., xii, No. 19, Oct. 1909.*)
CINCA, AL., & STOICESCU, G.	The Bacteriological Diagnosis of Charbon by cultures of the skin. (*Arhiva Veterinaria, vi.*)
CROSS, H. E.	The preparation of Anti-Rinderpest Serum by the injection of virulent artificial peritoneal fluid. (*I. C. V. D. Memoir No. 3.*)
DARLING, S. T.	Experimental Sarcosporidiosis in the Guinea-pig and its relation to a case of Sarcosporidiosis in Man. (*Journ. Experiment. Med., xii, No. 1, Jan. 1910.*)
EVANS, G. H.	Elephant Surra, Trypanosomiasis in the Elephant. (*Journ. Trop. Vet. Science, v, No. 2.*)
EVANS, G. H., & RENNIE, T.	Notes on some Parasites in Burma—III. (*Journ. Trop. Vet. Science, v, No. 2.*)
,, ,,	Elephant Surra, Trypanosomiasis in the Elephant. (*Journ. Trop. Vet. Science, v, No. 4.*)
GAIGER, S. H.	Rabies. (*Journ. Trop. Vet. Science, v, No. 2.*)
,, ,,	*Filaria medinensis* in the Dog. (*Journ. Trop. Vet. Science, v, No. 3.*)
,, ,,	Further observations on Trypanosomiasis, 1909-10. (*Journ. Trop. Vet. Science, vi, No. 1.*)
,, ,,	Pyelo-Nephritis in a Sheep. (*Journ. Trop. Vet. Science, vi, No. 1.*)
HARTLEY, P.	On the immunity to Hæmorrhagic Septicæmia of Bovines produced by the injection of sensitized vaccines. (*I. C. V. D. Memoir No. 3.*)
,, ,,	On the Immune bodies occurring in Rinderpest Anti-Serum. Part I—The precipitation of the Rinderpest Immune bodies by dialysis of the Immune serum. (*I. C. V. D. Memoir No. 3.*)

HARTLEY, P. . . Report on the preparation of the Rinderpest Anti-Serum by means of diluted virulent fluids. (*I. C. V. D. Memoir No. 3.*)

HOLMES, J. D. E. . The cure of Surra in horses by the administration of Arsenic. (*Parasitology, iii, No. 3, 22nd October 1910.*)

,, ,, . The treatment of Surra in horses by means of Arsenic and its derivatives. (*I. C. V. D. Memoir No. 3.*)

,, ,, . The cure of Surra in horses by the administration of Arsenic. (*I. C. V. D. Memoir No. 3.*)

,, ,, . A further note on the cure of Surra in horses. (*I. C. V. D. Memoir No. 3.*)

,, ,, . Some experiments in the treatment of Surra in camels. (*I. C. V. D. Memoir No. 3.*)

,, ,, . Report to the Government of India on experiments carried out to test susceptibility of cattle for several districts and on improved methods of serum preparation. (*I. C. V. D. Memoir No. 3.*)

,, ,, . The use of Anthrax Anti-Serum and Vaccines, Preliminary Report. (*I. C. V. D. Memoir No. 3.*)

,, ,, . A note on elements resembling Spirochætes in the blood of man and animals. (*I. C. V. D. Memoir No. 3.*)

,, ,, . Further testings of the Hæmorrhagic Septicæmia serum and vaccines on Bovines and Equines. (*I. C. V. D. Memoir No. 3.*)

JOWETT, W. . . Biliary Fever or Malignant Jaundice of the dog (Canine Piroplasmosis). The Drug Treatment. (*Agri. Journ., Cape of Good Hope, xxxv, 1909.*)

LEESE, A. S. . . Second series of experiments on treatment of Surra in Camels. (*Journ. Trop. Vet. Science, v, No. 3.*)

LEIPER, R. T. . Guinea-worm in domesticated animals, with a note of its discovery, by Mr. C. Grey, in a *Leopard*. (*Journ. Trop. Med. & Hyg., xiii, No. 5.*)

MITTER, S. N. .	A case of generalised Tuberculosis in a Macacus. (*Journ. Trop. Vet. Science, v, No. 2.*)
,, ,,	*Gnathostomum spinigerum* in a domestic cat. (*Journ. Trop. Vet. Science, v, No. 2.*)
,, ,,	Cutaneous Filariasis in a Dog. (*Journ. Trop. Vet. Science, v, No. 3.*)
NUTTALL, G. H. F. .	The drug treatment of Canine Piroplasmosis. (*Parasitology, ii, No. 4, 1909.*)
PLACE, F. E. . .	Kumree. (*Journ. Trop. Vet. Science, vi, No. 1.*)
RAYMOND, F. . .	Infectious Lymphangitis in Cattle. (*Journ. Trop. Vet. Science, v, No. 2.*)
,, ,,	Fowl Cholera (Pasteurellosis). (*Journ. Trop. Vet. Science, v, No. 3.*)
RUEDIGER, E. H. .	Observations on Cattle Plague in the Philippine Islands and the methods employed in combating it. (*Philip. Journ. Science, iv, No. 5, 1909.*)
,, ,,	Immunizing cattle against anti-cattle plague serum. (*Philip. Journ. Science, iv, No. 5, 1909.*)
SOWERBY, M. H. .	Some experiments in Trypanosomiasis; an endeavour to discover the reservoir of *Trypanosoma evansi*. (*Journ. Trop. Vet. Science, v, No. 4.*)
TERRY, B. T. . .	An attenuated Surra of Mauritius, with immunity tests after recovery. (*Journ. Exper. Medicine, xii, No. 2.*)

PROGRAMMES OF WORK FOR 1911-12

PROGRAMMES OF WORK OF THE VARIOUS SCIENTIFIC DEPARTMENTS FOR 1911-12.

1.—Combined Programme of the Director of the Imperial Institute, London, and of the Reporter on Economic Products to the Government of India.

1. **Turpentine.**—The determination of the hydrocarbons of Indian turpentine at present in hand at the Imperial Institute will be continued there.

2. **Fragrant gums.**—The examination and identification of the plants yielding the various trade forms of myrrh, frankincense, mastic, byssabol and other like products from the Gulf of Aden, Arabia and the Persian Gulf will be continued.

3. **Dyes.**—The investigation of the flower dyes named in "The Agricultural Ledger," No. 2 of 1908, in the hands of Professor A. G. Perkin, will be prosecuted. Minor investigations on the dyeing properties of *Baccaurea sapida* and *Symplocos spicata* will be carried on.

4. **Oils.**—The survey of Indian fixed oils by Mr. Hooper will be completed. Minor investigations on the oil of *Chrozophora verbascifolia* and *Amoora Rohituka* will be prosecuted.

5. **Oil-cakes.**—The Provincial Agricultural Departments and the Reporter on Economic Products are jointly preparing for a discussion of this subject at the next meeting of the Board of Agriculture.

6. **Citronella oil.**—If satisfactory determinations of the various oil grasses can be obtained the results of this enquiry will be published.

7. **Fibres and papers.**—Work on jute selection will be continued in conjunction with the Fibre Expert to the Government of Eastern Bengal and Assam; and the study of the microscopic structure of Indian paper stuffs will also be continued.

8. **Food grains.**—An attempt will be made to complete during the year the review of Indian races of juar (*Sorghum vulgare*).

9. **Dioscorea.**—The plates for the publication of the Monograph on Asiatic Dioscoreas are being prepared and the manuscript is being prepared for the press.

10. **Pulses.**—The investigations on the botany of Indian pulses will be continued.

11. **Caraway and allied condiments.**—The enquiry on the botany of these plants was transferred to the Royal Botanic Gardens, Kew,

where it is believed that Mr. J. R. Drummond has been entrusted with the work.

12. **Turmerics, Curcumas and other Scitamineæ.**—The enquiry will be continued: it is one which will take several years owing to the difficulty of obtaining good botanic specimens for identification. The object of the enquiry is to determine how far the roots of these plants yield starch and drugs.

13. **Gentians.**—The identification of gentians used as drugs is being prosecuted.

14. **Aconites.**—The investigation is to be continued on the same lines as before at the Imperial Institute.

15. **Hemp drugs.**—The study of the chemistry of Charas by Mr. C. R. Marshall of Dundee is in hand.

16. **Opium.**—Professor Dunstan promises the completion of his investigations on Indian opium.

17. **Solanaceous alkaloids.**—The examination of the alkaloids of *Datura Metel* and *Hyoscyamus niger* is in the hands of Professor Dunstan.

18. **Colchicum luteum.**—A toxicological and chemical examination of this plant is in progress in Cambridge.

19. **Peganum Harmala.**—A chemical study of the seeds is in progress by Professor J. F. Thorpe.

20. **Thalictrum foliolosum.**—Material for the study of this drug has been sent to Professor Dunstan. It is not quite certain if he proposes to continue work on it during the coming year or does not.

21. **Coptis Teeta.**—A chemical comparison will be made of the various forms of the drug.

22. **Saponin.**—Material for an extended study of this in plants continues to be supplied to Professor Schaer.

23. **Indigenous drugs.**—The Indigenous Drugs Committee is experimenting on the following drugs:—

1. *Melia Azadirachta.*
2. *Berberis Lycium.*
3. *Symplocos racemosa.*
4. *Rheum Emodi.*
5. *Ixora coccinea.*
6. *Holarrhena antidysenterica.*

24. **Poisons to stock.**—Attention during 1911-12 will be concentrated on this enquiry.

Enquiries in addition to the last Programme are—Coptis, Oil-cakes, and Opium.

Those in hand at the Imperial Institute are on—Turpentine, Aconites, Opium, Datura and Hyoscyamus, and possibly Thalictrum.

2.—Meteorological Department.

Meteorology.

1. **Daily weather work.**—In connection with the daily forecasting it is proposed to make a systematic study of some of the typical changes of weather of which the indications are at present but little known. Some recent work done upon the cold weather depressions of Northern India has brought to light important facts.

2. **Sounding balloons.**—Attempts have been made to carry on this work systematically by Indian assistants in the plains, the continued presence of an experienced officer being impossible with the present staff. The difficulties which are attendant on its technical and specialised nature indicated in the course of last year that success was very doubtful. The work is so important, however, that it was intended to make continued trials for at least a part of the present year. But it has now been found that successful operation cannot be secured without the personal supervision of an officer on the spot, and as the scientific staff of the department is under its authorised strength it has become necessary to stop the work entirely for the present.

3. **Atmospheric electricity.**—Owing to the absence on leave of Dr. G. C. Simpson, who joined the Antarctic Expedition for scientific purposes, it is not possible to continue, at present, the research work which has in his hands already led to the important results published in the Indian Meteorological Memoirs, Volume XX, Part 8, and the Transactions and Proceedings of the Royal Society.

Astronomy.

1. **Photographing the sun in ordinary light.** This will be continued as in former years.

5. **Photographing the sun in monochromatic light.**—The routine work with the spectroheliograph will be continued and photographs in H a light will be taken with the new autocollimating spectroheliograph.

6. **Record of sunspots and of prominences.**—As before.

7. **Sunspot spectra.**—These will be studied visually with a much more powerful spectroscope than has been used hitherto.

8. **Variations in the solar constant.**—Photographic comparisons between first type stars and moonlight will be continued, and the plates already obtained will be measured and reduced. It is hoped that by this method it will be possible to detect variations from year to year exceeding 2 per cent.

9. **Spectrum photographs.**—High dispersion spectra of sunspots will be obtained whenever possible for studies in radial and other movements in and near spots. In view of the approaching minimum of spot activity it is proposed to give more attention than hitherto to the movements in prominences, and comparison spectra of prominences and the centre of the sun's disc will be made when opportunities occur.

10. **Pyrheliometry.**—Absolute measurements of solar radiation by means of Angstrom's electric pyrheliometers have been made for some years in Simla, and it is intended to continue these. The instruments are liable to show change of constants, and, as there are no absolute means available in India for redetermining the constants, it has been arranged that one of the three instruments in Simla shall in the course of the year be restandardised in Upsala by the successor of the late Professor Angstrom.

Seismography.

11. As hitherto, there will be kept in commission the three Omori seismographs, two in Simla and one in Bombay. The smaller of the two Omori seismographs in Simla is now being replaced by a new machine, a duplicate in essential features of the larger machine in use.

The change will be advantageous in that the east-west and north south traces of the components of an earthquake will become strictly comparable.

The smaller seismograph is to be sent to the Rangoon Engineering College, where arrangements have been made to put it into use for the information of the Public Works Department of Burma on questions of building construction.

A vertical component seismograph of the Wiechert type has been obtained and is being erected in Simla. Its records, combined with those of the two present horizontal component machines, will afford fairly complete information of the ground movement.

Two Wiechert seismographs, of vertical and double horizontal-component types, are at present under test and adjustment in Simla, and are to be installed shortly at the Kolar gold fields by one of the local companies.

3.—Scientific Research Work of the Survey of India.

Gravimetric survey.—Pendulum operations in certain stations in Burma in the areas between Latitudes 12° and 25° and Longitudes 92° and 98° and at Port Blair and also observation of the proposed Moulmein-Bangkok arc of Longitude.

Latitude operations.—Latitudes will be observed in Burma.

Magnetic survey.—Colaba Observatory under the Meteorological Reporter, and the four observatories under the Surveyor-General of India, will continue to work. Observations will be taken at repeat stations and at certain selected old field stations and detailed surveys of disturbed areas will be continued.

Solar photography.—Photographs of the sun will be taken daily at Dehra Dun, as has been done since 1879 in conjunction with Greenwich.

4.—Geological Survey of India.

A.—Continuation of work already in hand.

(1) Revision of the survey of Central India and Rajputana
(2) Survey of the oil-bearing regions of Upper Burma.
(3) Survey of the Southern Shan States (interrupted since 1900).
(4) Survey of oil-bearing regions in Assam and the Punjab.
(5) Chemical investigation of salt and brine from Sambhar Lake.
(6) Examination of the salts of the Lonar Laks;
(7) Palæontological questions: description of—
  (*a*) Liassic fossils of Baluchistan;
  (*b*) Cretaceous and Tertiary fossils of Tibet;
  (*c*) Indian Tertiary mollusca;

(*d*) Jurassic Brachiopoda and Lower Palæozoic fossils from the Shan States;

(*e*) Silurian, Carboniferous and Triassic fossils of the Himalaya and Kashmir;

(*f*) Siwalik vertebrates;

(*g*) Fossil plants from Kashmir and Afghanistan.

B.—New subjects.

(8) Systematic survey of the Central Provinces.

(9) Investigation into the quantity and value of the potash salts in the Khewra mines.

(10) Boring for coal in the Dilwal plateau, Salt Range.

(11) Survey of the auriferous gravels of the chief Burmese rivers.

(12) Collection of Siwalik fossils in Sind and Kathiawar.

5.—Botanical Survey of India.

Work already in progress.—The Superintendent of the Royal Botanic Garden will continue his study of the plants of the Garden and publish a further instalment of the catalogue. The Curator of the Herbarium will elaborate the collections made by himself during 1910 in the south-east corner of Sikkim with a view to publication of the botanical results. He will also work up the collections made in Burma and Southern India during the current year by various officers of other Departments of Government. The Indian assistants for systematic work will aid both in the field and in the Herbarium.

New work.—As far as circumstances will permit the Superintendent will resume work that has been suspended for some time on the Burmese and Malayan species of the Natural Orders *Euphorbiaceæ* and *Urticaceæ*. A short account of the Malayan *Polygonaceæ* will, it is hoped, appear. The preparation for publication of the final instalment of Signor Beccari's great work on the *Lepidocaryeæ* palms will be undertaken; while the materials for the illustration of the Monograph on the genus *Dioscorea* by Colonel Prain and Mr. I. H. Burkill will be worked up.

Field work will, as circumstances dictate, be carried out by either the Director of the Botanical Survey or the Curator of the Calcutta Herbarium or one or other or both of the Indian assistants in a selected district in Eastern Bengal and Assam and in a selected district in the

Madras Presidency. It is not proposed to send any officer of the Survey to Burma as botanical collections in that province will be carried out by quite a number of officers belonging to other Departments of Government.

Work by associated officers.—The Director of the Botanical Survey has received no information as to any systematic work to be undertaken by either the Economic Botanist to the Government of the United Provinces or the Economic Botanist to the Government of Bombay. The Government Botanist, Madras, owing to pressure of work at the Agricultural College, sees no prospect of much touring during the coming year.

6.—Department of Agriculture.

PROGRAMME OF THE AGRICULTURAL RESEARCH INSTITUTE, PUSA.

The scientific work of the Institute for the coming year is indicated under the programmes of the different sections.

Students will be accepted for the post-graduate courses detailed in the prospectus. In addition to these, the short courses in cattle and poultry-breeding and management, fruit-growing, eri and mulberry silk-worm-rearing and silk-spinning, dyeing and weaving and lac cultivation, will be continued.

I.—Agricultural Chemistry.

1. The work on the availability of plant-food in soils will be continued, the immediate aim being the more correct ascertainment of the composition of the aqueous solution in the soil. Included in this section of investigation are naturally the amounts of nitrate in soils and soil-temperatures.

2. The investigation on soil-moisture and water-requirements of plants is being continued on lines which have been sufficiently indicated in the memoirs on the subject.

3. The investigation into the nature of certain *Usar* lands in the United Provinces is being continued.

4. An improved process for refining saltpetre has been devised and is now being tested.

5. The experimental error in sampling sugarcane will be tested.

6. **Education.**—This requires no special comment; it will be conducted according to the lines laid down.

7. The chemistry of the date-sugar industry is being enquired into by the Supernumerary Agricultural Chemist.

II.—Economic Botany.

1. **Training.**—The training of advanced students in this section will be continued.

2. **Plant breeding and plant improvement.**—During 1911, the following crops will be studied:—Wheat, tobacco, oil-seeds and fibre plants.

(*a*) **Wheat.**—The botanical survey of the wheats of Baluchistan and the agricultural survey of the wheats of Bengal will be completed. The production of improved and rust-resistant varieties by selection and hybridisation will be continued. The co-operative experiments on the influence of the environment on the milling and baking qualities of Indian wheats which are being conducted in collaboration with Mr. H. Martin Leake, Economic Botanist to the Government of the United Provinces, will be continued on an extended basis.

(*b*) **Tobacco.**—The production of new varieties by selection and hybridisation will be continued as well as the testing and curing of tht varieties already isolated. The investigations on the influence of the environment on the stability of the type and quality will be continued.

(*c*) **Oil-seeds.**—The study of the oil-seeds of India will be continued on similar lines to those adopted in the investigations on wheat.

(*d*) **Fibres.**—The isolation and testing of pure races of the fibre plants of India will be continued.

(*e*) **Fruit.**—The fruit experiments at Pusa will be continued on the lines laid down in the First Fruit Report. During the months, May to September, the work connected with the development of the fruit industry of Baluchistan will be commenced.

III.—Mycology.

1. **Research and experimental work.**—The work on the wilt diseases of crops will be continued on the lines indicated in the memoir on Pigeon Pea wilt published last year.

The investigation of fungus diseases of sugarcane will be continued. The chief points of the present enquiry are the spread of red-rot through the soil, the relative immunity of thin canes to this disease, and the study of two undescribed cane diseases.

The study of some fruit diseases commenced last year will be continued, particularly with reference to their control by spraying.

The Supernumerary Mycologist is engaged on an investigation of the root rot of a number of crops caused by the fungus *Rhizoctonia Solani*. This will be continued.

2. **Training.**—This will be continued on the lines indicated in the prospectus. Short courses will also be given to students taking the fruit-growing and general courses and to private students, as during the past year.

3. Advice regarding the fungus diseases of plants will continue to be given to other departments, particularly to the Provincial Departments of Agriculture and the Forest Department, and to the general public. The distribution of named specimens and other material to provincial colleges and other institutions will also be continued.

4. The collection and identification of Indian parasitic fungi will be continued. The Ascomycetes already collected having been worked through last year, it is proposed to take up the Deuteromycetes in which India is particularly rich.

IV.—Entomology.

1st Section.

Crop pests.—The study of the insect pests of crops will be continued in the insectary at Pusa and by the Assistants in the Provincial Agricultural Departments. A large amount of information relative to the life histories of many economically important insects has been gathered during the last few years, but for various reasons it has not been possible to publish these hitherto; an attempt will be made to complete these during the year 1911-12 and to publish them in a series of memoirs.

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Termites.—The subject of termites (white ants) is engaging a considerable amount of attention. Methods of destroying them, in the case of those colonies whose nests can be located, are being tested in conjunction with the Deputy Director of Agriculture, Northern Circle, Central Provinces. A large series of experiments is also being conducted at Pusa with a view to the discovery of a really efficient preparation applicable to wood work as a preventive of their attack, and it is proposed to continue these experiments. The whole subject of damage done by Termites is a very important one in India and no opportunity will be lost of acquiring information on the subject.

Other insect pests.—Information will be collected on household pests, and insect pests of grain, fruit and gardens, and it is hoped to publish memoirs on these subjects.

Apiculture.—The subject of Apiculture has been engaging attention. Two strains of specially selected bees have been imported successfully and it is hoped that one or both of these may prove suited to the plains of India, where the ordinary European honey bee will not thrive in the hot weather. The experiments with these bees will be continued.

Lac.—Experiments with babul lac will be continued and seed will be cultivated, but it is not estimated that there will be any surplus seed available for distribution before June 1912.

In conjunction with the Forest Department, the collection of the monthly stages of the various races of the lac insect will be continued. The large amount of material already sent in, together with that to be collected during the current year, should provide ample data for precise discrimination of the distinctness or otherwise of the insects found on different food plants.

Silk.—The experiments with the hybrids already obtained between the Eri silk worm (*Attacus ricini*) and the wild form (*Attacus cynthia*) will be continued, as the hybrid forms promise to give good results from a disease-resisting point of view. Experiments will also be made having for their object the production of a mongrel race, between the European univoltine mulberry silk-worm and the Indian multivoltine form, combining the silk-producing qualities of the former with the many broodedness of the latter. A memoir has been prepared on the results arrived at up to the present in the study of Eri silk and it is proposed to publish this during the current year.

Insecticides.—New insecticides sent in for trial will be tested with a view to their introduction into India if found satisfactory as regards effi-

ciency and price. Particular attention will be paid to the various specifics against termites (white-ants).

Training.—Training of students taking the long course in general Entomology will be continued, besides the short courses in Sericulture. The usual practical training classes in lac culture will also be held in June and October.

Coloured plates, lantern slides, etc.—The preparation of coloured plates and lantern slides of economically important insects will be continued on the lines already laid down and the results rendered available for general use.

General work of the section.—The general work of the section (identification of specimens, preservation of the collections, replies to miscellaneous queries about injurious insects, etc.), will be continued. The amount of correspondence in this section is extremely large, and as the work of this department becomes more widely known, the preparation of replies to questions received takes a constantly increasing proportion of time which could otherwise be devoted to research work.

Every assistance will as hitherto be extended to the Agricultural Departments of the various provinces and of Mysore and Baroda. Due regard will be paid to any special line of investigation called for by the provinces, help will be rendered if required by a serious outbreak of any pests, and the work of the Entomological Assistants will be supervised, at least in the case of those provinces which desire this, in order that the general work on Agricultural Entomology in India may be co-ordinated and rendered as efficient as possible by the various workers being kept in touch with Pusa as a centre and thus with one another.

2nd Section.

Work on blood-sucking insects, ticks and other similar parasites injurious to man either directly or indirectly will be continued, special attention being paid to the insects capable of transmitting *Surra* and to the life histories and occurrence of mosquitoes and sand flies and the means of checking them.

Attention will also be given to the dipterous pests of crops and fruit, and to the application of practical measures to control or minimise their ravages.

During the absence of Mr. Howlett, a large mass of material for the study of biting flies has been received from various officers of the Medical

and Veterinary Departments. A large amount of time will have to be devoted to working through these and to the systematic arrangement of the collection of Diptera.

Instruction of agricultural students in a knowledge of pests of live-stock and poultry will be carried out.

V.—Agricultural Bacteriology.

1. The systematic investigation of the distribution, physiological characters and functions of soil bacteria in India will be continued.

2. A special line of enquiry will be taken up as to the relations existing between the practice of green manuring in India and the activities of soil bacteria.

3. Special problems, such as plant diseases of bacterial origin, will be dealt with as occasion may arise and opportunity permit.

4. The training of the assistants in the section will be continued.

VI.—Agriculture.

(A) Farm.

Permanent experiments.—The permanent manurial and rotation experiments will be continued.

The present scheme of pasture experiments will be abandoned. A modified scheme is under consideration.

(B) Cattle and Poultry-Breeding.

Cattle.—The object of the cattle-breeding operations at Pusa is to produce a superior type of milking cow for India, by selection methods. The type chosen is the Montgomery breed of the Punjab.

Sheep.—It is proposed to continue the crossing of Gorakhpur ewes with the Dumba ram during the coming year.

Poultry.—Work with poultry will mainly consist of—

(1) A continuation of the breeding work with such European breeds as have shown themselves suited to Indian conditions. Such are the various breeds of Wyandottes (except the Silver Laced variety), Orpingtons (except the Jubilee Orpingtons) and Barred Plymouth Rocks. Breeds, which

the experience of the last three years has shown to be absolutely unsuited to Indian conditions, such as Brown Leghorns and Single Combed Black Minorcas, will be eliminated during the year.

(2) It is proposed to introduce breeding pens of some of the best Indian breeds and to improve the type of these by careful selection. A beginning has already been recently made in this respect by the purchase of Bussorahs, Chittagongs and several types of Indian game.

The distribution of fowls and eggs to the Provincial Experimental Farms and to private individuals will be continued and the short course in practical poultry-keeping will be conducted as heretofore.

VII.—Imperial Cotton Specialist.

I.—To visit and advise on points regarding cotton and its cultivation whenever requested to do so by Provincial Departments of Agriculture.

II.—By special invitation of the Department of Agriculture, Punjab, to report on the work done in the way of cotton improvement in that province. The question of the distribution of seeds of improved varieties will be further discussed with the proper authorities in the Central Provinces and Bombay Presidency.

III.—The study of the behaviour of Bourbon, Buri and such other cottons in non-cotton producing tracts as detailed in my last year's programme will be continued.

IV.—The conditions of cotton cultivation in Kathiawar and adjacent parts will be investigated.

V.—An enquiry will be commenced on the manurial requirements of cotton.

VIII.—Provincial Departments of Agriculture.

The programmes for 1911-12 generally follow those approved by the Board of Agriculture held in February 1910. The following are, however, important additions:—

Bengal.—The Agricultural College at Sabour has been opened. Consequently much of the time of the Principal, the Agricultural Chemist and the Economic Botanist will be devoted to teaching work. Special attention will be given by the Professor of Agriculture to the trial of implements designed to save time in preparing the land and sowing

crops so as to enable a larger area of crops to be sown during the short period before and after the monsoon when they can be sown to best advantage. The activity of the Deputy Director of Agriculture will be chiefly directed towards training Superintendents for the management of large areas. He will also undertake the study of manurial residues in collaboration with the Agricultural Chemist. The cultivation of wheat is being undertaken for collaboration with the Imperial Economic Botanist in the survey of the wheats of the province. The use of cotton-cake as a manure and feeding stuff will be tested. At Chaibassa, endeavours will be made to find some convenient device to protect the silk-worms against inclemency of weather. As a result of a preliminary survey of field crops of the province, the Economic Botanist will now be able to undertake a detailed study of *Cucurbitaceæ*, *Leguminosæ*, *Setaria italica* and *Eleusine coracana*. He will also devote some attention to the collection of information regarding the crop pests of the province and to the plant-breeding work. The Agricultural Chemist will make observations in connection with the single plant selected leguminous crops in co-operation with the Economic Botanist, and will also study, if time permits, the effects of the nature of the soil upon an unidentified rice disease which is prevalent in Bengal.

United Provinces.—The Benares experimental farm will be fully equipped though it will not be possible to begin experiments during 1911-12. The Assistant Director of Agriculture will, along with other manurial experiments, take up the trial of cotton-cake manure on sugar-cane at Partabgarh. Groundnut cultivation and hot weather tillage will also be undertaken. The growing of American cotton for seed supply and experiments with different methods of sowing which formed one of the items on the programme of 1909-10 will be abandoned. The Attara Agricultural Station will be equipped and tentative experiments will be started. The following new experiments will be started by the Deputy Director of the Western Circle:—

(1) Tillage experiments with wheat and maize;

(2) Variety tests with groundnut;

(3) Establishment of fuel and fodder reserves; and

(4) Testing of varieties of wheat and jowar.

Punjab.—At the new Agricultural Station of Gurdaspur, sugarcane will be chiefly dealt with. The Agricultural Chemist will undertake a survey of sugarcanes in that district. This work will consist of the analysis of canes at the time of crushing, the direct object being to secure

a record of the sugar-yielding capacity of the district for the purpose of establishing a co-operative sugar refining centre. Some preliminary experiments will also be made at Lyallpur to identify the principal features of the ripening process in cane and the effects of the application of water on this process. The Agricultural Chemist also proposes to investigate the nature of the silt deposited by the rivers Chenab and Jhelum which is reported in some cases to have checked or rendered germination difficult. Trials will be made by the Economic Botanist to determine whether jute can be profitably grown in the submontane or riverain tracts. The classified wheats of the Punjab which have been multiplied to a field scale will be tested in various parts of the province with a view to discover localities for which they are suited. The Assistant Professor of Mycology will undertake the investigation of fungoid diseases reported from districts or discovered during tours.

Bombay.—The Department of Agriculture, Bombay, does not propose to make any change for some years to come in the programme of work already undertaken. It will, however, take up in the near future the following three important lines of work:—

(*a*) To decide which of the exotic and hybridised cottons bred on the various farms offer the greatest profits in different localities and to confine the efforts to putting out the seed of the most promising variety in each case and establishing effective buying agencies for the produce.

(*b*) To study the question of providing the most suitable implements for the efficient cultivation of the various types of the black soil.

(*c*) To make a survey of the fodder supply in various localities and the best means of improving it.

Madras.—The extension of Cambodia cotton and the supply of green manure seeds, with a view to popularise the beneficial practice of green manuring wet lands, will receive increasing attention at the hands of the Department. Varieties of Cholam (*Andropogon Sorghum*), cultivated for grain and fodder in Coimbatore, will be tried direct on the black soil at Koilpatti. Some of the American varieties of Soy beans are being tried on this farm. Encouraged at the success of Cambodia cottons on irrigated lands, the Department has undertaken trials with exotic cottons including Sea Island, Bourbon and American Upland on the Palur farm. It is proposed to open a small factory at the Palur Agricultural Station for the supply of agricultural implements, the demand

for which is constantly increasing. The improvement of the dairy and the working herd, and the management, on commercial lines, of the dairy now under construction will be undertaken at the central farm at Coimbatore. The Agricultural Chemist proposes to give up the work on saline areas in the Periyar tract. The Economic Botanist will devote his attention to the flora of the country around Coimbatore. The Mycologist will investigate smuts of Cumbu (*Pennisetum typhoideum*) and Cholam (*Andropogon Sorghum*) and will continue the work on the Soft Rot of palmyra palms in the Godavari and Kistna Districts. The investigation into the application of the preventives to the Koleroga or Rot-disease of areca palm in South Canara will also be taken in hand.

Central Provinces.—A temporary demonstration experiment station will be started in the area commanded by the Ramtek tank and another on a large and permanent scale in the centre of the irrigable area in Chanda. Steps are being taken to transfer gradually to private enterprise the implement depôts opened at Government experimental farms. The farm at Damoh, which was temporarily started, will be abandoned as it has achieved its object, *viz.*, the demonstration of eradicating *Kans* by deep ploughing and flooding. Experiments will be made at Khandwa with a few varieties of cotton which give special promise. As the relative importance of the sugarcane crop has greatly increased on account of irrigation works, cultural experiments with this crop will be started this year at Raipur. As regards manurial experiments, steps will be taken to popularise the use of bone-meal among rice-growers and to manufacture the bone-meal so that it may be easily available to cultivators. The improvement of agricultural practice in irrigable areas to enable the people to avail themselves fully of the improved water-supply will be the most important feature of departmental work in future. There are at present 21 cotton seed farms and their number will be increased. In the *Kanthar* tract of Jubbulpore district, demonstration plots have been opened at various centres in Narsingpur, Jubbulpore, Seoni and Damoh with promise of success. An improved variety of Maghai *til* which is likely to do well in Narsingpur district is being introduced.

Burma.—No additions are proposed to be made to the programme submitted last year.

Eastern Bengal and Assam.—The principal crops dealt with by the Department are rice, jute, sugarcane, potatoes, tobacco and groundnut. Manurial experiments on rice land have been laid down to contrast the effects of green manure, cowdung, bone-meal and green manure with

lime. The Fibre Expert proposes to bring up to date the publication of the results of the joint investigation with the Reporter on Economic Products to the Government of India into the races of jute in Bengal. If possible, a short account will be published of some preliminary experiments in hybridisation with jute. Mr. Finlow will also publish a Monograph on Jute giving as complete a *resumé* as possible of general information on the subject as well as a summary of the results of experimental work up to date. The manurial requirements of flax are being investigated in collaboration with the Inspector General of Agriculture in India and an enquiry has been undertaken into the possibility of creating, if necessary, a cheaper system for the supply of flax seed from the cooler tracts of India. The various methods of planting sugarcane will be tested this year at Jorhat. As the soil of the Dacca farm has been found suitable for this crop, a larger area is being put down this year. Besides the local variety, several varieties imported from Jorhat will be tested on this farm. It is proposed to test the merits of summer-grown as against winter-grown potato seed on the Shillong farm. The two varieties of potatoes—Magnum bonum and King of Potatoes—which have proved best will be grown on a fairly large scale for distribution of seed. Successful results were obtained at Burirhat with the Sumatra cigar tobacco and the fire-cured cigarette tobacco last year. This line of work will be continued. It is also intended to experiment in producing cigarette tobacco from the local variety by fire-curing. Experiments with groundnuts will be continued at Jorhat as promising results have been obtained. The experimental cultivation of lemon grass will be discontinued as it has been found that the oil extracted does not pay in the province. Proposals are being submitted to the Local Government for the relinquishment of the Wahjain tropical plantation.

Efforts will be made by appointing special officers to bring home to cultivators, by means of demonstrations, such improvements in agricultural methods, as are suited to local conditions. With the object of improving the cattle of the plains districts a survey of the existing types of cattle and buffaloes and of the present sources of supply will be undertaken. In this enquiry, special attention will be paid to plough bullocks. The officer who will be entrusted with this work will be instructed to find out means that can be adopted to ensure a substantial and permanent improvement in the existing types. In the absence of recognised types the enquiring officer will endeavour to fix the ideal type by means of measurements of individual animals which are considered by intelligent raiyats to be the most efficient animals under local conditions.

7.—Forest Department.

Programme of work already carried out by the Sylviculturist during 1910-11.

PART I.

1. **The *sal* tree (Shorea robusta).**—During the year investigations were prosecuted in the Siwalik, Haldwani, Pilibhit, Gonda, and Gorakhpur Divisions of the United Provinces into (1) the effects on *sál* of drought, fire, frost and grazing, (2) the natural reproduction of this tree in forests of different types, and the steps necessary to aid it. Various experimental plots were laid out in connection with these enquiries.

PART II.

1. **The Uniform and Group systems of working forests.**—Investigations were carried out in the Siwalik, Haldwani and Naini Tal Divisions of the United Provinces into the question of the most suitable methods of working forests of *sál* and *Pinus longifolia* under the uniform system, or in certain cases under the group system.

2. **Exploitation of bamboos (Dendrocalamus strictus).**—Experiments in the Siwalik and Lansdowne Divisions of the United Provinces have been commenced in order to ascertain the best method of cutting and working bamboos with a view to obtaining the highest possible yield while maintaining a permanent and undiminished supply in future.

3. **Pollarding of trees for lac cultivation.**—Experiments were in progress in the Siwalik Division, United Provinces, to ascertain the most suitable methods of pollarding and working trees for the cultivation of lac.

4. **Statistical and miscellaneous sylvicultural information.**—The collection of such information has been in progress during the year in the United Provinces, where a number of sample and experimental plots were laid out and measurements taken in the Siwalik, Haldwani, Pilibhit, Gonda, Gorakhpur and Naini Tal Divisions.

Programme of work for the Sylviculturist for 1911-12.

PART I.

1. **The *sal* tree (Shorea robusta).**—Investigations will be continued, chiefly in the United Provinces, into the effects of drought, fire,

frost and grazing on *sál*, and on the conditions most suitable for reproducing this species naturally. Experimental plots will be laid out in various localities in this connection.

PART II.

1. **The Uniform and Group systems of working forests.**—Investigations will be continued, chiefly in the United Provinces, into the question of working forests of different types under the uniform and group systems, the chief species concerned for the present being *sál*, *Pinus longifolia*, deodar, and some other important hill species.

2. **Exploitation of bamboos (Dendrocalamus strictus).**—The experiments started in the Siwalik and Lansdowne Divisions of the United Provinces in 1910-11, to ascertain the best method of cutting and working bamboos, will be continued.

3. **Pollarding of trees for lac cultivation.**—The experiments in the Siwalik Division, United Provinces, to ascertain the most suitable methods of pollarding and working trees for the cultivation of lac, will be continued.

4. **Statistical and miscellaneous sylvicultural information.**—The establishment of sample and experimental plots, for the collection of statistical and sylvicultural information regarding the more important species of trees, will be continued, chiefly in the United Provinces.

Programme of work already carried out by the Forest Botanist during 1910-11.

PART I.

1. **Physiology and œcology of *sal*.**—The experiments carried out during 1909-10 and 1910-11 on the dying back of the seedlings of *sál* and its causes have given interesting results which are now being prepared for publication.

2. **Forest grasses.**—The Botanist was able to study the types of *Saccharum arundinaceum*, *S. Munja*, *S. propinquum* and *Erianthus Griffithii* at the British Museum and Kew during the year with interesting taxonomic results. The results of this work and of the previous field study of these and six other species are now in the press. The detailed study of Bhabar, *Ischæmum angustifolium*, has been commenced.

PART II.

1. **Physiology and œcology of teak.**—The work on teak on the same lines as for *sál* is not yet sufficiently complete for publication.

2. **Fungoid diseases.**—The field study of *Trametes pini* on the Blue Pine has been commenced in the Simla and Bashahr Divisions of the Punjab.

ADDITIONAL OUTSIDE PARTS I AND II.

1. **Systematic Botany.**—The Botanist was able to study the types of *Grewia* sp. at the British Museum, Kew and Paris, during the year and the results are being prepared for publication. The study of *Xylia* and *Anogeissus* has been commenced.

Programme of work for Forest Botanist for 1911-12.

PART I.

1. **Physiology and œcology of *sal*.**—The study of the *sál* will be continued with special reference to the diseases of these trees, the conditions favourable and unfavourable to successful germination and early development, the dying back of seedlings and its causes, the pollination of the flowers and distribution of seeds, the effect of coppicing on the development of the plant.

2. **Forest grasses.**—The study of grasses commonly found over large areas in *sál* forests will be continued chiefly with the object of discovering the best method of treatment for (*a*) increasing the value of these grasslands for fodder or other economic purposes and (*b*) afforesting these grasslands with *sál* (or other valuable tree-species), respectively.

PART II.

1. **Fungoid diseases.**—The study of *Trametes pini* on the Blue Pine will be continued.

2. The study of teak on the same lines as for *sál* will be continued.

ADDITIONAL OUTSIDE PARTS I AND II.

Systematic Botany.—A detailed systematic study and description will be made of forest plants of economic value in cases where the existing classification is unsatisfactory. A study of the following genera is now in hand: *Grewia*, *Xylia* and *Anogeissus*.

Programme of work already carried out by the Forest Economist during 1910-11.

Part I.

Investigation into the economic aspect of the sál *tree* (*Shorea robusta*).

1. **Technical properties.**—A number of tests have been carried out and others are in progress and timber of various kinds is being seasoned for the preparation of scantlings which will be used for shearing, bending and crushing tests.

2. **Antiseptics.**—Numerous experiments are in progress to determine how *sál* wood may best be antiseptically treated.

3. **Supply and markets.**—Much information has been collected and more will be obtained.

Part II.

1. **Paper pulp.**—Many forests were visited and a lengthy note has been written on bamboo, but it cannot be completed until a final report is received from the mill which has undertaken an exhaustive test. In the same report the financial aspect of the work and the question of suitable sites for factories has also been discussed.

2. **Match manufacture in India.**—Several forests in the United Provinces were visited and information collected.

3. **Antiseptic treatment of woods.**—A note on the subject has been sent to press and the experiments are being continued. Arrangements have been made for the powellizing of 5,000 sleepers, of woods that are not durable in their natural state, so that they may be tested by the railway companies. Six hundred and fifty of these sleepers have been treated and sent to the railway companies, the delay in the despatch of the balance is not due to the want of effort on the part of the Research Institute.

4. **Enquiry regarding the possibility of putting certain gums, resins and oleo-resins on the European markets.**—A number of samples have been sent and reports received and enquiries are still being received and information and samples being collected and supplied.

5. **Paving blocks.**—Samples of wood were sent to Japan but no report has yet been received.

6. **Wood for pencils.**—Samples and information have been supplied to firms and a note will be issued shortly.

7. **Wood for other purposes.**—Samples have been supplied, information collected and tests made in some cases with wood for brushes, cricket bats, mathematical instruments, tool handles, weaving looms, umbrella handles and other minor industries.

8. **Description of woods at present little known.**—The information has all been collected for six species and will be published shortly.

9. **Andamans Padauk.**—The question of the disposal of this timber is under investigation.

10. **Miscellaneous.**—Terminalia and oak barks have been tested for tannin, the seeds of *Schleichera trijuga* for oil, the flower of *Strobilanthes* sp. for perfume for soap; information has been supplied to an English firm about Indian walnut burrs, *Cinnamomum glanduliferum* is being tested for Camphor and the roots of *Podophyllum Emodi* are being analysed.

Programme of work for the Forest Economist for 1911-12.

Part I.

Investigation into the economic aspect of the sál *tree* (*Shorea robusta*).

The following investigations, some of which are already in hand, will be undertaken or continued:—

1. Physical properties of *sál* timber: strength under shearing, crushing and bending tests of timber grown in different localities, felled at different seasons and seasoned in different ways: tests of fissibility of the same: best methods of seasoning the same: determination of the specific gravity and of the durability of the same.
2. The effects of different antiseptics on *sál* timber.
3. Uses to which the timber and minor products of *sál* can be put, tanning value of bark, etc.
4. Calorific value of *sál* fuel and charcoal.
5. Collection of information regarding markets for *sál*, past and present prices, available supply, etc.

PART II.

It is proposed—

1. To collect and supply information of all kinds regarding the use of bamboos, wood, and grasses for paper pulp.
2. To collect and supply information of all kinds regarding the development of the match industry in India, which is now assuming a promising aspect.
3. To carry out experiments on woods with various antiseptic preparations, and specially to treat a large number of railway sleepers of inferior woods and have them tested by the railway companies with a view to encouraging their use.
4. To investigate the physical properties and seasoning powers of certain woods.
5. To investigate the properties of certain gums, resins and oil seeds, and tan barks, and to extend their use.
6. To investigate the value of certain Indian woods for packing cases, tea and opium boxes, paving blocks and other minor purposes.
7. To publish full information about certain useful woods at present little known.
8. To investigate the resin tapping of conifers and the possibility of improving the present method of distillation.
9. To investigate the uses of certain fibres.

Programme of work already carried out by the Forest Zoologist during 1910-11.

PART I.

1. ***Sal* insect pests.**—This study was continued during the year but the results are not sufficiently complete for publication.

PART II.

1. **Lac.**—Study was confined during the year chiefly to the insects, parasitic or otherwise, which were bred out of the lac samples collected in different localities. The results are not sufficiently complete for publication.

2. **Reference collection.**—All named specimens were arranged in order under their families and a card index catalogue was commenced.

Specimens which could not be named in India have been sent to European experts for identification.

Programme of work for Forest Zoologist for 1911-12.

Part I.

1. **Sal insect pests.**—The study of insects beneficial or injurious to the *sál* will be continued.

Part II.

1. **Lac.**—The detailed study of the lac insect will be continued in co-operation with the Agricultural Research Institute at Pusa.

2. **Reference collection.**—The work of extending the reference collection of insects which are important from a Forest point of view will be continued.

Programme of work already carried out by the Forest Chemist during 1910-11.

Part I.

1. ***Sal* bark tannin extract.**—The investigation is completed. The report is under preparation.

Part II.

1. **Russa grass oil.**—The investigation is in progress and the oils have been prepared in quantity.

2. **Oil seeds.**—Hydraulic Oil Press has been received. The investigation has been begun.

3. **Oil grasses.**—The distillation of Khas grass is in hand.

4. **Milk of Dichopsis elliptica.**—No progress has yet been made as the milk could not be obtained.

5. **Resin.**—Samples of resin tapped from *Pinus Merkusii* and *Pinus Khasya* are being collected.

6. **Myrobalans.**—The investigation is completed. Final report is under preparation.

7. **Decolourisation of tannin extracts.**—The results of the commercial value of the Mangrove tannin extract, made at Rangoon, are being awaited.

Programme of work for Forest Chemist for 1911-12.

PART II.

1. **Russa grass oil.**—It is desirable to study the causes of differences between the two varieties Moti and Sophia, and the possibility of the conversion of the Sophia into Motia oil. The oils have been prepared in quantity and will be separated into their constituent parts later on.

2. **Oil seeds.**—Oil-yielding forest seeds will be examined as to their oil value and their constituents.

3. **Oil grasses.**—The Khas oil will be studied.

4. **Milk of Dichopsis elliptica.**—The milk of *Dichopsis elliptica* will be studied for its commercial utilisation.

5. **Resin.**—The study of the resins of the principal conifers in connection with the manufacture of turpentine will be continued.

6. **Myrobalans.**—Investigation regarding the best season for the collection of Myrobalans so as to obtain the greatest yield of tannin will be continued.

7. **Decolourisation of tannin extracts.**—The enquiry as to the decolourisation of dark-coloured tannin bark will be continued.

8. Zoological and Anthropological Section, Indian Museum.

The Superintendent will continue his investigations on the fauna of stagnant water.

The Assistant Superintendent in charge of Crustacea and other marine invertebrates will conclude his systematic account of the Indo-Pacific Stomatopods and will begin to investigate the freshwater prawns of India.

The Assistant Superintendent in charge of fishes will continue his work on the freshwater fishes of India and the neighbouring countries, especially those known to be destructive to mosquito larvæ, and will work out the *Carangidæ* taken by the trawler "Golden Crown."

The Assistant Superintendent in charge of Entomology will continue his investigations into the biology and taxonomy of the Oriental Pedipalpi and will, with the assistance of Mr. C. A. Paiva, arrange the data obtained in a year's "census" of the mosquitoes of Calcutta.

The Surgeon-Naturalists of the Indian Marine Survey will probably work in the Museum on the marine Entomostraca of the Burmese coast.

9. Civil Veterinary Department.

By the Imperial Bacteriologist.

1. **Anthrax.**—To continue the investigations laid down in the programme of the previous year.

2. **Surra.**—To continue experiments in methods of treatment and prophylaxis.

3. **Rinderpest.**—Investigations as to possibility of preparing serum for buffaloes; and also the use of other than hill bulls for the preparation of serum for bovines.

4. Furtherr tests of serums and vaccines prepared during the past three years.

By the officer investigating camel diseases.

(1) Investigations into Surra in the field.

(2) The study of Filariasis in the Camel.

(3) Treatment of Surra in the Camel.

By the Provincial Staff—Punjab Veterinary College Laboratory.

(1) Treatment of Surra.

(2) Study of Hæmorrhagic Septicæmia.

By Provincial Superintendents.

Collection of information and the mapping out, as opportunity occurs, of the incidence of Surra, Piroplasmosis, Hæmorrhagic Septicæmia and Anthrax.

APPENDIX.

9. Civil Veterinary Department.

By the Imperial Bacteriologist.

1. **Anthrax.**—To continue the investigations laid down in the programme of the previous year.

2. **Surra.**—To continue experiments in methods of treatment and prophylaxis.

3. **Rinderpest.**—Investigations as to possibility of preparing serum for buffaloes; and also the use of other than hill bulls for the preparation of serum for bovines.

4. Furtherr tests of serums and vaccines prepared during the past three years.

By the officer investigating camel diseases.

(1) Investigations into Surra in the field.

(2) The study of Filariasis in the Camel.

(3) Treatment of Surra in the Camel.

By the Provincial Staff—Punjab Veterinary College Laboratory.

(1) Treatment of Surra.

(2) Study of Hæmorrhagic Septicæmia.

By Provincial Superintendents.

Collection of information and the mapping out, as opportunity occurs, of the incidence of Surra, Piroplasmosis, Hæmorrhagic Septicæmia and Anthrax.

APPENDIX.

APPENDIX.

REPORT ON THE SCIENTIFIC AND TECHNICAL INVESTIGATIONS CONDUCTED FOR INDIA AT THE IMPERIAL INSTITUTE DURING THE YEAR ENDED 30th SEPTEMBER 1911.

BY

W. R. DUNSTAN, M.A., LL.D., F.R.S.

The scientific and technical investigations which have been in progress at the Imperial Institute for India during the year ended the 30th September 1911 are as follows:—

1. **Opium.**—The examination of the constituents of a large number of specimens of opium, collected in various districts of India at the instance of the Government, was completed, and a report is now in preparation. Further recommendations were made during the year for the improvement of the process employed at Ghazipur for the preparation of opium alkaloids.

2. **Solanaceous plants.**—The investigation of Indian Solanaceous plants was continued, and reports were furnished on the alkaloids present in the seeds and capsules of *Datura Metel* and in the leaves and seeds of *Hyoscyamus niger*. These reports concluded the examination of the specimens of Solanaceous plants forwarded to the Imperial Institute from India.

3. **Tobacco.**—Further samples of tobacco grown at the Government Farm, Burirhat (Rangpur district), were received for examination in continuation of the previous investigation. The composition of the tobacco was determined and expert opinions were obtained regarding the quality and commercial value of the specimens. Recommendations were made in the report for the improvement of the tobacco.

4. **Tanning extracts.**—Twelve tanning extracts prepared at the Government Factory, Rangoon, were submitted for examination in continuation of a previous investigation upon which three reports had been furnished. The twelve samples included eight mangrove extracts, certain of which were of promising quality and were richer in tannin than any tanning extracts previously received at the Imperial Institute from India. In order to sell readily in the United Kingdom, however, the extracts should contain less moisture and be of better colour than the samples examined.

At the request of the Imperial Forest Chemist, a sample of mangrove extract, specially prepared at the Government Factory at Rangoon, was examined. It proved to be of superior quality, and a larger sample was asked for in order that practical tanning trials on a commercial scale could be made to determine its market value.

5. **Lemon grass oil.**—A small consignment of oil distilled from four varieties of lemon grass grown at Wahjain in the Khasia Hills was forwarded for examination and sale on the London market. All the oils contained a satisfactory amount of citral and that distilled from "Cochin" grass was particularly rich in this constituent. The latter oil was sold at $3\frac{1}{4}d.$ per oz. and the remainder of the consignment at $2\frac{3}{4}d.$ per oz.

6. **Rubber.**—The rubber of *Cryptostegia grandiflora* from the Punjab was examined, and valued at 2*s.* 9*d.* to 3*s.* per lb. with fine hard Para at 5*s.* $2\frac{1}{2}d.$ per lb. Another sample of this rubber furnished to the Imperial Institute by H. H. the Maharajah Sindhia of Gwalior, was of very fair quality and was valued at 3*s.* 4*d.* to 3*s.* 6*d.* per lb. with fine hard Para at 4*s.* 8*d.* per lb. The rubber of *Cryptostegia grandiflora* would be readily saleable in London, but the small yield obtained on tapping the stems has hitherto prevented its collection on a commercial scale.

7. **Drugs.**—Cultivated rhizomes of *Podophyllum Emodi*, forwarded by the Forest Department of the North-West Frontier Province, were examined. The preliminary results showed that the cultivated rhizomes closely resembled in composition the rhizomes of the wild plant as previously examined at the Imperial Institute, and would probably be as suitable for use in medicine. A further supply was requested in order that therapeutical trials might be made with 'podophyllin' prepared from the cultivated rhizomes.

8. **Turpentine.**—Reports were furnished during the year to the Inspector General of Forests on samples of colophony and turpentine oil prepared at Naini Tal. The colophony was of much better quality than a sample from Naini Tal previously examined at the Imperial Institute, and similar material would sell readily in the United Kingdom at good prices. The turpentine oil would find a market as a substitute for Russian oil.

9. **Black dammar resin.**—In continuation of a previous investigation, samples of black dammar resin prepared by the Imperial Forest Economist were examined in order to determine the suitability of the resin as a substitute for shellac in finishing crape. Technical trials

showed that the resin alone was not very suitable for the purpose, but that when mixed with 8 per cent. of beeswax it might find a restricted application in crape manufacture. The principal incentive to the discovery of a substitute for shellac disappeared however when the price of shellac resumed a normal level in 1910.

10. Investigations were made to determine the suitability for paper-making of jute stems from which the bast fibre had been stripped. It was found that the pulp was composed of very short fibres and consequently would be of little value.

11. **Cotton and silk.**—Samples of cotton from the United Provinces, the Central Provinces, Sind and Burma were examined and reported on during the year. Two samples of mulberry silk from Eastern Bengal and Assam were of promising quality and were valued at 11*s.* and 8*s.* per lb., respectively. A sample of silk from Mysore was of very satisfactory quality and was valued at 13*s.* 6*d.* per lb. in the United Kingdom.

12. Seven samples of asphalt from the island of Bahrein in the Persian Gulf were examined. The best of these contained about 20 per cent. of bitumen in a limestone matrix, and was quite similar to Bahrein asphalt examined at the Imperial Institute in 1903. As a whole the samples represented material which could be used to produce a standard paving asphalt.

The facilities offered by the Imperial Institute for obtaining information respecting the value of Indian products are becoming more widely utilised by the Government officials and merchants in India, as well as by firms in the United Kingdom interested in Indian products, and in addition to the abovementioned investigations, a large number of other products from India were examined and reported on during the period under review. Information has been supplied on such matters as the manufacture of chromates from chrome ore, the manufacture of wood pulp, the manufacture of animal charcoal, the curing and preparation of porpoise hides, the curing of ratskins, the cultivation of vetiver, and the preparation of loofahs; and also regarding the market in Europe for various Indian drugs and for squirrel skins, goat hair, fowls' feathers, etc.

Information was furnished during the year to the Government of Mysore on the subject of the markets for sandalwood in Europe and the United States, and also regarding the exportation of Mysore timbers to Europe.

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Bombay Office.

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Madras Office.

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1. The Surveyor-General of India (Chairman);
2. The Director-General of Observatories;
3. The Director, Geological Survey of India.

Sub-Committee B.—(*Agricultural Products*).

1. The Director, Botanical Survey of India (Chairman);
2. *Vacant.*
3. The Inspector-General of Agriculture.

Sub-Committee C.—(*Soils and Manures*).

1. The Inspector-General of Agriculture (Chairman);
2. The Director, Geological Survey of India;
3. The Inspector-General of Forests.

Sub-Committee D.—(*Forest Products*).

1. The Inspector-General of Forests (Chairman);
2. *Vacant.*
3. The Director, Botanical Survey of India.

Sub-Committee E.—(*Veterinary Subjects*).

1. The Inspector-General, Civil Veterinary Department (Chairman);
2. The Inspector-General of Agriculture;
3. The Superintendent of the Indian Museum.

Sub-Committee F.—(*Libraries*).

1. Morris W. Travers, Esq., D.Sc., F.R.S. (Chairman);
2. The Director-General of Observatories;
3. The Surveyor-General of India;
4. The Director, Geological Survey of India.

ANNUAL REPORT FOR 1912-13

ANNUAL REPORT

OF THE

BOARD OF SCIENTIFIC ADVICE FOR INDIA

1912-13

SUMMARY OF PROCEEDINGS.

Twenty-fourth Meeting held at Simla on the 12th May 1913.

The Board agreed to nominate Mr. C. C. Calder, Officiating Director of the Botanical Survey of India, to officiate as Secretary to the Board during the absence of Major A. T. Gage, I.M.S.

The programmes of the various Scientific Departments for 1913-14 were considered and recommended for acceptance by Government. The Board considered that closer co-operation between the Pathological Entomologist and the Zoological Section of the Indian Museum seemed possible and was advisable in the interests of both Departments.

A letter from the Director of the Imperial Institute, London, on the subject of communicating the names of the investigators conducting scientific work at the Imperial Institute next came up for discussion. The arrangement suggested by Professor Dunstan was not considered altogether satisfactory. It was, however, tentatively accepted and it was suggested that all the Departments represented on the Board, when getting reports from the Imperial Institute, should ask to be supplied

confidentially with the names of persons who conducted the investigations on which the reports were based.

The Board accepted the recommendations of Sub-Committee A, that the Director of the Geological Survey should be regarded as the adviser to Government on seismological questions and that existing seismographs should remain under the control of the several departments that are now maintaining them.

Twenty-fifth Meeting held at Delhi on 12th November 1913.

The Board considered the question of an increased grant towards the upkeep of the Imperial Institute, London. The Board did not consider it desirable to commit themselves at present to a definite statement of further support, but left the matter open until more detailed information was available as to the present condition of the Imperial Institute collections and as to the probable utility of future work and exhibits.

The draft Annual Report of the Board for 1912-13 was considered and after a few minor alterations was approved as was also the revised distribution list of the Annual Report.

On the question of the relation between forests and the retention of atmospheric and soil moisture, a note was put up by the Director-General of Observatories, and on the representations embodied therein, the Board considered that the obstacles in the way of collecting reliable information and the expense involved more than counterbalanced the benefits which might result. They did not therefore recommend undertaking the enquiries at present.

Letters from the Chairman to the Trustees of the Indian Museum and a note by the Superintendent of the Zoological Section of the Museum embodying proposals for the constitution of a Zoological Survey for India were next considered. The Board viewed the constitution of such a survey with sympathy. They agreed in a general way with the proposals submitted, but thought that, in the event of such a scheme maturing, stress should be laid on the relations which were to subsist between the Directorship of the Survey, the Superintendentship of the Museum and the Secretaryship to the Trustees. They did not consider it desirable to lay down as a fixed principle that the Director of the Zoological Survey in particular should continue to be Secretary to the Trustees or Superintendent of the Indian Museum, though he should necessarily in the opinion of the Board be in charge of the zoological collections of the Museum.

APPLIED CHEMISTRY.

PART I.—ECONOMIC AND INDUSTRIAL CHEMISTRY.

BY

D. HOOPER, F.I.C., F.C.S., F.L.S.,
Economic Botanist, Botanical Survey of India.

The following is a review of the chemical work conducted during the year 1912-13 irrespective of that undertaken by the Agricultural and Forest Departments of India. There is very little to record on the subject of inorganic chemistry and the present report deals almost exclusively with substances of vegetable origin examined in India and Europe. As usual a considerable amount of research has been prosecuted by professors and students in the universities, and the titles of the published papers which are not, however, directly concerned with industrial chemistry have been included in the bibliography. Where the author's name is not quoted in the following investigations the work has been carried out in the laboratory of the Industrial Section of the Indian Museum, Calcutta. This laboratory, it may be stated, was closed during the year under review.

The material has been arranged according to the following classification :—

1. Natural exudations : gums and resins.
2. Fixed and volatile oils.
3. Dyes and tans.
4. Fibres and paper.
5. Food substances.
6. Drugs.

I.—Gums and Resins.

Sarcocolla gum.—This is one of the most peculiar natural exudations of plants. Exuding from a shrub identified as *Astragalus fasiculifolius*, Boissier, growing in Persia, it is largely exported to Bombay and is used in medicine and for adulterating opium. It is sweetish to the taste and dissolves for the most part in alcohol and in water. It is not a true gum resin or gutta, but consists principally of a glucoside, sarcocollin which differs in properties from saponin and glycyrrhizin.

Balsamodendron Playfairii.—This shrub growing in the Somali Coast yields a peculiar soapy gum called "Hotai" which is

sent in large quantities to Bombay. It disintegrates in water forming a persistent lather and is used for washing the hair. It contains an acid resin soluble in ether and saponin. The occurrence of saponin in a natural exudation is peculiar. Another substance of a similar nature was collected on tour in Karachi. This is called "Dakh" and is brought from the Mekran Coast, Persian Gulf, and is also used by women for washing the hair. It differs from the first named in appearance and composition, but contains a resin and saponin as its principal constituents.

II.—Fixed and Volatile Oils.

Cotton seed.—Progress is being made in the cotton seed oil industry judging from the number of mills that have been established during the past few years. The Director General of Commercial Intelligence has sent for examination samples of refined oil, decorticated cotton seed cake and hulls. These were found to have a good appearance and quite up to the standard in composition of similar products in the European and American markets.

Soy beans.—Experiments are being continued in the cultivation of soy beans in Northern India. The habits of the plants and the character of the seeds are so various that some care has to be exercised in selecting suitable sites for the different varieties. The Superintendent of the Government Gardens, Kumaon, planted Hollybrook soy beans at Douglas Dale and Ramgarh. Analysis showed that the seeds grown in the first locality gave 18·26 per cent. of oil and those grown at the second locality gave 14·26 per cent. Also samples of gun bean grown at Douglas Dale yielded 18·66 per cent. of oil and when grown at Ramgarh yielded 15·74 per cent. The Director of Land Records and Agriculture, United Provinces, sent samples of the same kind of soy bean grown in four different villages: they afforded 14·3, 12·2, 12·6 and 11·6 per cent. of oil.

Papaw seeds.—The seeds of the ripe fruit of Papaw (*Carica Papaya*) which are usually thrown away as useless were submitted to analysis. The small black seeds have a pungent mustard-like odour and yield an allyl compound when distilled with water. They contain over a quarter of their weight of a yellow fixed oil. The centesimal composition is: water 8·2; oil 26·3; albuminoids 24·3; carbohydrates 15·5; fibre 17·0; ash 8·8.

Litsæa polyantha, Juss.—This is a small evergreen tree met with from the Punjab along the foot of the Himalayas eastwards to Assam. The seeds yield an oil which is used medicinally. A sample of the fruit from Golaghat, Assam, was examined. The cleaned seeds yielded 21·2 and the kernels 33 per cent. of a white crystalline fat,

melting at 38·5°. The constants were: acid value 98·9; saponification value 244·8; iodine value 34·4. The fat is of a useful nature and consists very largely, like that of other Litsæas, of lauric acid.

Nephelium Longana, Camb.—This is the Longan or Ashphal, the fruit of which appears in India in the hot weather. The fresh fruit afforded 13 parts of skin, 60 parts of pulp and 27 parts of seeds in 100. The seeds which are a waste product are sweetish and slightly astringent and contain much starch. Chemical analysis showed them to contain: moisture 10·0; oil 3·86; albuminoids 6·25; carbohydrates 73·76; fibre 3·6; ash 2·5. They are not oil-seeds, but the composition shows them to have a feeding value equal to that of cattle foods.

Tea seed oil.—This oil has once more been examined, this time by Mr. A. K. Menon from kernels obtained from Tinsukia, Assam. Petroleum ether extracted 16·1 per cent. of a clear straw coloured oil which deposited solid fats on standing. The oil had the following characters: specific gravity 0·9028; acid value 3·75; saponification value 189·9; Reichert Meissl value 0·56; iodine value 92·7; unsaponifiable 2·65. The solid fatty acids melted at 57·8° and had the mean molecular weight of 267·3.

Cydnus indicus oil.—This common black stink bug of India has been examined by Mr. E. R. Watson. The strong and unpleasant odour of the insect is due to an oil which it secretes. The oil has been found to contain a large proportion of non-volatile oil of the same character as other animal oils. It also contains about 1·5 per cent. of an oil volatile with steam consisting of an acid $C_8H_{14}O_2$, probably cycloheptanecarboxylic acid and a small quantity of a non-acid substance. The acid has a strong rancid odour and the non-acid volatile substance has a still stronger odour.

Artemisia vulgaris, Linn.—Indian Wormwood oil from Lebong, Darjeeling. The colour is yellowish with a greenish fluorescence and an odour of sage. Examined by Messrs. Schimmel & Co., it was found to be soluble in one vol. of 80 per cent. alcohol. When more than five vols. was added, opalescence ensued and after prolonged standing paraffin crystals separated out of the solution, with semicarbazide-thujone melting at 186° separated from oil. From the odour of the oil it probably contains borneol.

East Indian bees'-wax.—Messrs. Buchner and Fischer have published the results of analyses of a large number of samples of East Indian bees'-wax or "Ghedda" wax. The wax is derived from *Apis indica*, *A. dorsata* and *A. florea*, and differs widely in composition from ordinary bees'-wax, chiefly the product of *A. melifica*. The wax gives abnormal analytical figures in that the ratio between the acid value and the ester value is 12 or higher, and the wax contains glycerides and

neutral substances which might from analytical data be mistaken for ordinary bees'-wax containing adulterations. The results confirm those arrived at by Mr. Hooper who described the sources and composition of Indian bees'-wax in Agricultural Ledger No. 7 of 1904.

III.—Dyes and Tans.

Cotton flowers.—A. G. Perkin has investigated the colouring matter of Indian cotton flowers (*Gossypium herbaceum*) and finds it to be due to gossypetin and quercetin. Gossypetin is also present in the flowers of Egyptian cotton and *Hibiscus Sabdariffa*. The formula is $C_{15}H_{10}O_8$. Fused with alkali it gives pyrocatechuic acid and on oxidation it affords gossipitone in dull red or maroon coloured needles which proved to be a quinone.

Tagetes patula.—Mr. Perkin has also examined the flowers of the African Marigold grown in India. Quercetagin was isolated from the flowers by Latour and Magnier de la Source (*Bull. Soc. Chem.*, 1877, 28, 33) who gave it the formula $C_{27}H_{22}O_{13}$. Perkin finds that the main quantity of the colouring matter is present in the petals as a glucoside, and the colouring matter itself $C_{15}H_{10}O_8$ was isolated from this. It yields protocatechuic acid on fusion with alkali. It is a hexahydroxyflavonol isomeric with myricetin, but differs from this colouring matter and also from the closely allied quercetin in that it possesses a tetrahydroxy-benzene in place of the phloroglucinol nucleus which they contain.

Azo-salicylic acid dyes.—Messrs. A. C. Sircar and E. R. Watson have contributed two papers on Azo dyes to the Society of Chemical Industry. Azo-salicylic acid dyes in chrome mordants have excellent fastness to light. There is a marked difference between the derivatives of a hydroxy-naphthoic and 2·3 hydroxy-naphthoic acids, the derivatives of the former being all fugitive, whilst the majority of the derivatives of the latter have very good fastness. All the dyeings have excellent fastness to acids.

Cæsalpinia digyna.—Mr. T. A. Faust has given the results of experiments with tan pods, from a bush growing wild in Burma and Assam. The pod cases contain as much as 60 per cent. of tannin, and the leather produced by the material is equal in colour to that made from the best sumach. Colour tests in sheep skins were made with solutions of the entire pods and pod cases; the former did not give a uniform colour owing no doubt to the oil in the beans, but the latter gave leather of a light uniform colour. The light colour of the leather tanned with the material was very little darkened by exposure to light for four weeks in which respect the material shows an advantage over allied products of the same class. It would not be profitable for the tanner

to separate the seeds; the pods, however, could be leached whole as the tannin in the cases is extracted very rapidly and the oil in the seeds would not be removed. The material could be obtained at about £9 10*s*. per short ton, which price compares favourably with that of other materials of the same tannin strength.

Cassia auriculata or Turwar bark.—The analysis and uses of this South Indian tanning material has formed the subject of a paper by Mr. P. V. Mehd. The maximum amount of tannin in the bark was 22·1 per cent. and experiments were made with this and myrobalans on English hide. It is concluded that though Cassia bark may not be suitable for fancy leather goods and leather for book-binding, it may be used with advantage for heavy as well as for dressing leathers, giving, when blended with myrobalans, a mellow tannage, a very good, light-coloured leather, which compares favourably with that produced by any of the other blends at present in common use.

Adulterated leather.—In connection with this subject Mr. M. C. Lamb has contributed a paper before the Society of Public Analysts on the analysis of various East Indian tanned hides. The analysis of about sixty samples obtained from reliable sources of various tannages of East Indian hides were made with the object of ascertaining what particular tannages are most liable to adulteration by the addition of mineral matter and oil. The results of the various analyses are given in detail and show that the amount of adulteration suspected in these imported tanned hides is not nearly so prevalent as is generally anticipated and understood by the trade.

IV.—Fibres and Paper.

Hedychium fibre.—Among the sources of supply for the manufacture of paper Messrs. Beadle and Stevens have conducted factory experiments on *Hedychium coronarium*, Koenig., a plant of the ginger tribe. This plant is a native of India and is distributed from the Himalayas to Ceylon and Malacca, ascending to 4,000 feet in the Khasia Hills. It grows abundantly in Brazil where its growth is easily developed. If properly cultivated it yields from 6 to 10 tons of dry material per acre, a quantity much larger than other paper-making materials, including bamboo and wood pulp. The papers prepared from *Hedychium* fibre are among the strongest hitherto recorded, equal or superior to the best manila papers, and are particularly suitable for the manufacture of paper yarns for textile purposes. It is an easy pulp to manipulate and can be worked either bleached or unbleached. The fact that the paper in its natural state, without the addition of any materials whatever, can be made to possess grease-proof and self-sizing qualities is a point of commercial importance. Other plants of the same natural order are *Amomum hemisphericum* and *Alpinia nutans*, and these have been

found to possess the natural advantage of Hedychium and more suitable for the manufacture of white paper made from strong sulphite wood pulp.

In this connection a plant received from Assam as growing in large quantity and known as "Adurantum" has been tested. It was identified as *Plecanthus Wightii* of the nettle tribe, and yielded 33·6 per cent. of strong white fibre.

V.—Food Substances.

Edible roots.—The Director of Agriculture and Industries, Central Provinces, collected and forwarded to the Indian Museum an interesting series of tuberous roots eaten by the inhabitants. Some of these being supported by botanical specimens, were identified and found to be new to economic botany. Chemical analyses were made of the more important.

The list included the following:—*Hibiscus* sp. Ban bhendi or Khapsi kand. *Pynocycla glauca*, Linn. Tejraj. *Peucedanum Dhana*, Ham. Kamraj. *Peucedanum glaucum*, DC. Bhojraj. *Eulophia* sp. Bansinghara. *Habenaria platyphylla*, Spreng. Chilam chatta.

The *Hibiscus* root is very mucilaginous and fairly nitrogenous. *Pynocycla* and *Peucedanum* roots belong to the same order as the carrot and are as palatable. The Eulophia and Habenaria roots of the orchid family afford salep which has long been a favourite dish with certain classes.

VI.—Drugs.

Atropa Belladonna, Linn.—It was shown last year that the roots of belladonna plants grown at the Kumaon Botanical Gardens yielded 0·4 per cent. of alkaloid when one year old and 0·45 when two years old. A sample of roots from three-year-old plants was received this year and was divided into thin and thick roots. The former yielded 0·4 per cent. of alkaloid and the latter 0·44 per cent. showing that the root does not increase in alkaloidal content after the second year.

The leaves of belladonna grown in the same gardens were also examined. Leaves from one, two and three-year-old plants afforded 0·48, 0·49 and 0·49 per cent. of alkaloid respectively. This result indicates that leaves from plants of different ages do not show much variation in composition.

Glycyrrhiza glabra, Linn.—A sample of liquorice root grown in Baluchistan was tested for solid aqueous extract. This amounted to 27·75 per cent. which is well above the pharmacopœia limit of 20 per cent.

Calotropis procera.—Dr. L. Lewin has made a chemical and physiological examination of this common Indian plant. He finds the

active principle, which he designates calotropin, to belong to the class of drugs which act on the heart like *Digitalis*. The substance was not obtained pure for chemical analysis.

Digitalis purpurea.—The Foxglove is cultivated on the Nilgiri Hills and the dried leaves have for some years been supplied to the Medical Stores at Madras for the manufacture of official preparations. Digitalis leaves used in Europe are standardised before being used in medicine. A sample of the Indian grown leaves has during the year been sent to London for this purpose, and it is satisfactory to know, from a report received from Dr. W. Harrison Martindale, that the Indian leaves are equal in medicinal activity to those grown in England.

Euphorbia pilulifera, Linn.—This is one of the indigenous drugs of India and is a popular remedy for a great variety of affections. Dr. Power and Mr. Browning have submitted the plant to a complete chemical examination. The authors separated the following constituents: essential oil, gallic acid, a new phenolic substance, an amorphous glucoside, a lævorotatory sugar, a trace of alkaloid, triacontane, euphosterol, a new monohydric alcohol, a phytosterol, a phytosterolin, jambulol, melissic acid, and a mixture of acids which appeared to consist of palmitic, oleic and linolic acids. Among the various constituents there is none to which any specific physiological action may be ascribed. Such therapeutic virtues as the plant has been presumed to possess would therefore not appear to depend upon any single substance of a definite chemical character.

Gymnosporia manna.—Messrs. J. R. Furlong and L. E Campbell have described a new variety of manna obtained as a white encrustation on *Gymnosporia deflexa*, Sprague. The chief constituent of the manna was dulcitol melting at 188° C. It is interesting to notice that in 1909 Mr. Hooper obtained dulcitol from an encrustation on *Elaeodendron glaucum*. In the latter case the manna was the secretion of an insect *Phromnia marginella*. It is probable that this or some allied insect agency is responsible for the deposit of a saccharine exudation on Gymnosporia as it is on other trees of the natural order Celastrinaceæ which have been found to contain dulcitol. It has been suggested that the Phromnia insect should be encouraged to propagate on plants of this order for the purpose of producing dulcitol on a commercial scale.

Teak wood.—Following up the researches made some years ago by Dr. Romanis of Rangoon, Mr. A. C. Sircar has investigated a possible chemical method of distinguishing between seasoned and unseasoned teak wood. The author finds that teak wood saw-dust yields on steam distillation either a crystalline or oily substance or a mixture of the two, the amount of the former as compared with the amount of the latter being a criterion of the amount of seasoning of the sample of wood

examined. The crystals melted between 156° and 160° without decomposition.

Entada scandens.—Mr. F. T. Eddingfield has investigated the peculiar use in the Philippine Islands of the bark of Gogo (*Entada scandens*) and its effect on gold and gold solutions. It is used by the natives for panning gold-bearing sands, and it is believed that by its use more gold is recovered by causing the fine gold to settle quickly and not float away. The aqueous solution of the bark contains saponin which forms colloidal gold with a purple solution. Apparently its only agency is the effect of the solution falling on the floating particles of gold in the pan and causing them to sink.

Plant ashes.—Several analyses were made during the year of plants ashes having a special reputation for industrial purposes. The ashes of the following plants were tested:—Wormwood (*Artemisia vulgaris*), Bamboo (*Bambusa* sp.), Papaw leave (*Carica Papaya*), Plantain leaves (*Musa sapientum*), Wild Date (*Phœnix paludosa*) and Saltwort (*Suæda maritima*). The ash of the plantain was made a special study, since it has long been used in India as an alkaline mordant, by dhobies in place of soap, by doctors as a medicine, as a crude form of table salt and as a manure. It was therefore considered worthy of enquiry to examine samples of the ash of this plant to discover if they possessed any uniformity of composition and an alkalinity superior to that of other plant ashes. Museum samples were found to have a water soluble extract ranging from 7·94 to 27·51 and insoluble silica from 22·2 to 52·04 per cent. The ash of sample of leaves collected and ignited under supervision were next tested, but these showed striking differences in composition and no single element existed in a constant proportion. The lime, potash and phosphoric acid have a certain value in agriculture and the alkali is useful as a mordant and for detergent purposes, but there is no standard composition peculiar to the plant.

PART II.—AGRICULTURAL CHEMISTRY.

BY

J. WALTER LEATHER, V.D., PH.D., F.I.C.,

Imperial Agricultural Chemist.

SOILS.

The gases of swamp rice soils.(*i*)—An important series of experiments has been in progress during the last four years at the hands of Messrs. Harrison and Subramania Aiyar in Madras on the composition of the

(*i*) Memoir, Department of Agriculture in India, Chemical Series, Vol. III (*in the press*).

gases which are included in the wet paddy lands of certain parts of south India, which together with the biological examination will add very much to our knowledge of the *raison d'être* of the agricultural practice and in places assist in its improvement. The agricultural practice of paddy cultivation varies a good deal in different localities, but frequently it consists in the following sequence of operations; (*i*) admission of water to the land, ploughing, addition of green leaf manure and puddling of the surface layer of soil, (*ii*) removal of the surface water, (*iii*) transplanting the young rice, (*iv*) re-admission of irrigation water after the seedlings have established themselves, and which water is maintained on the land until the crop is nearly mature, (*v*) removal of the water from the land in order to allow the plant to dry up and be harvested.

After the ploughing-in of the green manure, a good deal of gas is formed in the soil and the composition of this gas forms the subject of the first part of the memoir. After the paddy is transplanted and has become established, a film forms on the surface of the muddy soil, which materially affects the composition of the soil gases which reach it. Its character and functions form the subject of Part II.

Restricting the attention to the nature of the gases formed in the soil, these are separated by disturbing the mud. Samples of these gases were obtained by carrying a gas collecting apparatus of suitable design across the field; as the feet disturbed the mud, the released gases passed into the collector. They consist chiefly of nitrogen and methane, and the following examples taken from the numerous ones which the memoir contains will sufficiently illustrate the composition:—

Methane	73·8 %	64·4 %
Nitrogen	10·9	20·1
Carbon dioxide	14·6	3·0
Oxygen	·7	1·0
Hydrogen	*Nil.*	11·5

After the paddy has been transplanted and has become established, the character of the gas mixture changes, the proportion of methane markedly decreases, whilst that of nitrogen increases, and hydrogen production becomes largely inhibited. Thus we find:—

Methane	16·6 %
Nitrogen	78·8
Carbon dioxide	4·4
Oxygen	·2
Hydrogen	*Nil.*

Measurements were made of the relative amounts of gas present in cropped and uncropped land respectively which showed a slightly

greater proportion in the cropped land, though the disparity was not large and the method employed for the purpose was not considered very reliable. The importance of this relationship lies in the fact that (*i*) if less gas is evolved from cropped than from uncropped land, then the production of methane is being interfered with, whilst (*ii*) an increased gas production from cropped land would imply an increased evolution of nitrogen. The question was therefore investigated by means of pot cultures.

It must here be mentioned that when making these cultures it was necessary to stop the formation of the organised surface film, to which more complete reference is subsequently made, because of its complicating influence. Its formation was inhibited by means of a small addition of copper sulphate to the water. Under these restricted conditions, the production of methane progressed until after the paddy seedlings were planted in the jars, when its formation ceased entirely. Concurrently there was a marked decrease in the amount of nitrogen gas evolved. Other measurements showed that manured land produced about three times as much nitrogen as unmanured land. The action of the crop is to restrict the formation of methane and hydrogen either by retarding the rate of fermentation or by a portion of the intermediate products of decomposition being absorbed by the roots. There is also evidence to show that the normal evolution of nitrogen is retarded in a similar manner.

In the ordinary course of events in the field, a film forms on the immediate surface of the mud which varies in different localities, but includes diatoms, usually algæ, and bacteria. It plays the important rôle of an oxygen generator. The quantity of this gas which is formed daily is very considerable, and usually rather greater in the absence of a crop. These processes continue either in the presence or in the absence of manure, but the presence of manure increases the production of oxygen considerably. The roots of the rice plant require oxygen, which is carried from the site of its formation by the surface film in the decending water to the root system, and thus becomes available to the plant.

The authors carried out a series of pot cultures to ascertain the rate at which drainage should pass through paddy land, for it is evident that such descent of the upper water must take place if the above mentioned oxygen is to pass below. These tests showed that the downward movement must be slow. If too rapid, harm resulted. We have thus a fairly good picture of the series of changes which occur:—decomposition of organic matter, utilisation of some of the products of this decomposition by an organised surface film, production of oxygen, transport of this oxygen to the soil by the descending water for the use of the plant roots.

This valuable research appears to have already borne practical fruit, for the Report of the Director of Agriculture,(*ii*) Madras, refers to cases where green manuring has been a failure and which failure is probably explained by an absence of proper drainage, which Messrs. Harrison and Subramania Aiyar have shown to be so desirable.

The investigations are naturally not yet considered by the authors to be complete and are being prosecuted.

WATER.

Evaporation from a plane water surface.—As an accompaniment of the estimations of the water requirements of crops which have been conducted by Dr. J. W. Leather at Pusa for some years, the amount of evaporation from a plane water surface was measured for about three years and the data for 1911 and 1912 have been published.(*iii*) The water surface was provided by a masonry tank 6′ 6″ diam.; the position of the water surface was measured by means of a pointer, which travelled along a groove on a vertical iron pedestal; the distance through which it travels was measured by means of a small wheel travelling along a screw. Differences of ·015 cm. were readily registered. The amount of water percolating through the tank was tested by covering the surface with vegetable oil and was found to be barely measurable in five days and was therefore negligible. The tank was protected from animals by means of wire netting.

The amount of water which evaporated at Pusa was compared with records which have been maintained at Lyallpur by the Irrigation Department and at the Madras Observatory. During the cold weather the daily evaporation at Pusa is very similar to that at Lyallpur, both of which are less than at Madras; during the hot weather it is greatest at Lyallpur and least at Pusa. The total annual evaporation at the three stations was found to be:—

Lyallpur	6·42 ft.
Pusa	4·12 „ (1911).
Do.	4·18 „ (1912).
Madras	6·34 „

An empirical formula was deducted from the Pusa and Lyallpur data.

E = (mm. per 24 hours) $= 2{\cdot}0 (\log t - 1{\cdot}74) + {\cdot}33 (\log D - 1{\cdot}00) + {\cdot}36 (\log W - {\cdot}125)$

in which

t = mean temperature ° F. for day.

D = 100 minus 8 A.M. humidity.

W = mean wind velocity for day.

(*ii*) Report on the operations of the Department of Agriculture, Madras Presidency, for 1912-13, page 5.

(*iii*) Memoir, Department of Agriculture in India. Chemical Series, Vol. III, No. 1.

This formula yields fairly correct results and depends on meteorological data which are published for many places in India.

SUGAR.

The experimental error in sampling sugarcane.(*iv*)—The more systematic sampling of crops has been examined of late years. Until recently the subject had not been examined mathematically, and the taking of a sample to represent a plot or a field was a matter of the fancy of the operator. Some four years ago Dr. J. W. Leather decided to examine the subject in relation to sugarcane at Pusa in order to ascertain what size of sample must be considered necessary, and in what manner it should be taken, in order to reduce the error to certain limits, and to ascertain what those limits may be expected to be.

The first two seasons' work did not yield very satisfactory information, but this year when the tests were conducted on a different system, a much more definite answer to the questions was arrived at.

It was found that the variation among individual canes all growing contiguously was very great indeed, so much so that some 200 had to be tested before the error from the mean value was reduced to small dimensions. It was anticipated in view of the generally accepted ideas in regard to effect of soil, that if a similar number of canes were taken from points distributed all over a plot of say $\frac{1}{10}$ acre, and still more so if they were taken from over a whole acre, this error would be found largely increased. In the event, however, this was not found to be the case; the variation seems to be but little greater on a large than on a small area. The work was conducted not only at Pusa, but also at the Parsa Factory in the north of Champaran district, and the results agreed well at both places.

Duplicate samples of about 200 canes taken in a well distributed manner showed that the probable error from the mean may be depended on to be not more than $\pm$·5 per cent. sucrose in 995 cases in 1,000. If, however, the size of the sample is reduced to about 50 canes, taken in the same manner, the error was found to rise to about $\pm$2·0 in 5 out of 1,000 cases. The canes must of course be taken from all over the area in any case.

Date palm sugar.—A valuable contribution to our knowledge of the date palm sugar industry has been published during the year,(*v*) the author being Mr. H. E. Annett. The survey and experimental work which he carried out relates chiefly to Bengal. The history of the industry shows that it expanded rapidly in the middle of the last century, but since then it has shown signs of declining somewhat.

(*iv*) Memoirs, Department of Agriculture in India, Chemical Series, Vol. III (*in the press*).

(*v*) Memoirs, Department of Agriculture in India, Vol. II, No. 6.

The source of supply in Bengal is almost exclusively *Phœnix sylvestris;* whereas in Madras and Burma *Borassus flabelliformis* chiefly takes its place. Other palms which play a smaller part are *Cocos nucifera* and *Caryota Ureus* in Madras, and *Nipa fruticans* in Eastern Bengal and Burma. Mr. Annett's investigations had to do almost exclusively with the first named, *Phœnix sylvestris.*

The trees are first tapped at an age of 5 or 6 years; the trunk is then about 1½ feet high. Tapping consists in (*a*) the removal of all but the top young leaves from one side of the tree, (*b*) the removal of most of the soft tissue which overlies the sap-supplying inner zone, (*c*) removing, after an interval of some 8 days, a further portion of the outer tissues and (*d*) finally, after a further interval of some 12—14 days, incising into the sap-tissue. The flow of juice is usually taken three nights in succession. It decreases in quantity and frequently in quality on each of these occasions. These succeeding juices are therefore distinguished from one another under the terms "jiran," "dokat," "tekat." After an interval of a further three days, a fresh wound is made and juice again taken for usually three succeeding nights. The tapping season continues from November until sometime in March, the production of juice being greatest during December-January. Mr. Annett estimates the yield of juice per tree per season to be about 170 lbs.

The sugars in the juice were carefully examined and only sucrose and glucose were found. The amounts vary considerably; of sucrose the percentage was found to be as high as 17 per cent. and as low as 7·5 per cent. in the "jiran" juice, whilst it falls as low as 5 per cent. in the "tekat." The proportion also varies in the juice of the same tree a good deal during the night. The proportion of glucose likewise varies within wide limits, being as small as ·3 per cent. and as high as 2 per cent.; great difficulty is, however, experienced in obtaining juice which has not suffered inversion to a certain extent. One of the difficulties of the industry in fact consists in the exposure of the juice to the influence of yeasts and other organisms which commonly cause a serious loss of sucrose. The usual practice is to smoke the pots in which the juice is collected on the tree. This matter formed a subject of special enquiry at Mr. Annett's hands, and will no doubt be taken up by him again, since the protection of the juice in this respect would lead to a considerable improvement in the quantity and quality of the sugar obtained.

Apart from this extraneous influence, both the yield and composition of the juice are affected by other factors. The general atmospheric temperature is one, the greatest yield being obtained during the two coldest months December and January, and any sudden rise of temperature causes a decline; cloudy or rainy weather also causes a decline in the flow. The individuality of the tree, as might be expected, is an important

circumstance and the thickest trees were found to be the best. The effect of soil was not definitely traced, though local opinion favours a clay rather than a sandy soil.

The pots are collected from the trees in the morning and the collected juice boiled down to the consistence of "Rab." Mr. Annett estimates the yield of *gur* per tree per annum at about 21·25 lbs. Calculated to the acre the produce equals some 2·3 tons. During the manufacture of the *gur* there are necessarily some losses of sugar in the same manner as there are in the case of cane juice; these are estimated at about 12·5 per cent.

The refining process is conducted by *Khandsaris* who purchase the *gur* (rab) through middlemen. The earthen pots containing the "rab" are broken and the contents put into large baskets of about $2\frac{1}{4}$ maunds capacity. From these the liquid molasses run off for 3—4 days, after which the sugar is overlaid with wet weed, *Vallisneria spiralis*, which purifies the uppermost layer of sugar in the same way as the weed "sewar," *Hydrilla verticilata*, purifies cane sugar in Rohilkhand. The refined sugar contains from 94—98 per cent. sucrose.

INDIGO.

The newly issued report(*vi*) of the investigations which have been in progress at Sirseah for some years is the last that will appear; it having been decided to conclude that work. Although this course has been decided upon, the report is more than usually interesting. Its subject matter may be conveniently referred to under the following heads:—

Physiology.—Efforts have been made to trace a connection between compounds present in the seed and during germination with the indican of the leaf. These failed. The seeds of *Wrightia tinctoria* and *W. tomentosa* both contain indican; the leaves of the former also contain indican, but those of the latter contain none. No other indigo-yielding plant contains indican in its seed. Moreover, it was not found possible to form indoxyl or any derivative of indoxyl from compounds present in the seed of any of the *indigoferas*.

Experiments were made in the hope that by the aid of stimulants the proportion of indican in the leaf might be increased. Some experiments made in 1908(*vii*) had given rise to a hope that such a result was possible, but no success followed an extension of the experiments.

Other indigo-yielding plants.—A large collection of indigo-yielding plants was made and one of these, *Wrightia tinctoria*, as mentioned

(*vi*) Report of the Indigo Research Station, Sirseah, for 1912-13 by Cyril Bergtheil and F. R. Parnell. Published by Bihar Planters' Association.

(*vii*) Annual Report, Board of Scientific Advice, 1908-09, p. 21.

in last year's report(*viii*) gave some promise of being useful. The leaf yields about ·3 per cent. indigotin. Manufacture of the dye carried out on the laboratory scale (all that the then present supply of plant admitted) indicated that about 9 seers of 60 per cent. indigo might be obtained per acre at one cutting. It is a perennial shrub and several cuttings might be expected per season. A difficulty attending its use is the requirement that a relatively high temperature of the steeping water—104° F.—must be maintained for 12 hours. The explanation of the necessity for this temperature was not ascertained.

Seed supply.—Although this matter has nothing to do directly with the chemical side of the work, it cannot be left altogether unnoticed. It has transpired that a great deal of indigo seed has been coming from Sukkur. The variety of *I. Sumatrana* grown in the neighbourhood of Sukkur is known to yield a very low quality of plant from the manufacturer's point of view, and its disadvantages are obvious.

Indigo paste.—A quantity of indigo was sent to Europe in the form of paste and reported on favourably by dyers. It was also tested at the Cawnpore Woollen Mills and there found to equal the synthetic paste, the two being tested on a basis of equal amounts of indigotin.

Selection and plant breeding.—The second part of the Sirseah Report deals with Mr. Parnell's share of the work of the last four years. His problem was to ascertain whether the plant could be improved in respect of its indigo-yielding power by either selection or hybridisation.

A close study of the morphological characters and the indigo yield showed there was no simple correlation, and it followed that the valuation of every plant must depend on its chemical analysis. It is necessary to realise this and also the circumstance that the chemical test in any one case is a somewhat time-absorbing matter, because it explains that the progress of such work must be a slow one. Another controlling factor is the duration of each generation. The Java plant was worked on chiefly because it seemed to offer a better promise of encouraging results. It is sown in September-October; the plant flowers at the same period of the following year and the seed comes ripe in the succeeding February. Thus two years must elapse before the seed of the second generation is planted.

Commencing in 1910, 235 plants were selected and analysed; the seed of these was expected in the following February. Unfortunately inordinately high floods visited Sirseah and the whole of these plants were destroyed. In 1911, 555 plants were analysed; but misfortune again followed; the disease, which has recently taken such a hold of the

(*viii*) Annual Report, Board of Scientific Advice, 1911-12, p. 30.

indigo plant in Bihar, attacked and killed nearly the whole of these plants.

Whether the proportion of indican in the leaf is chiefly controlled by the inheritance factor is still doubtful, but the curves published in the report show that it is at least possible, and it is much to be regretted that this part of the work should have been brought to a conclusion before it was in the least degree possible to provide an answer to this very important question.

BETEL VINE LEAVES.

A contribution to the knowledge of the chemistry and physiology of the leaves of the betel vine—*Piper betle*—has been made by Messrs. Mann, Sahasrabuddhe and Patwardhan.(*ix*) Although this leaf is consumed so widely in south-east Asia and universally in India this investigation seems to be the first attempt to ascertain its chemical composition and to detect any characteristic compounds. Leaves were examined from different parts of the vine.

Sugars.—Both reducing and non-reducing sugars were found, though not identified; the quantities were 1·5 to 3·0 per cent. of each class; usually there is rather more of the former than of the latter. *Starch* was found in the proportion of approximately 1·0 per cent. *Essential* oils varied only slightly and were present to the extent of about 1·0 to 1·5 per cent. *Tannins* varied from 1·0 to 1·3 per cent. The leaves are slightly acid and contain compounds possessed with diastatic activity, the younger leaves containing the most. *Potassium nitrate* was found in all leaves and also in the stems in comparatively large amount, from 1·0 to 4·0 per cent. of the dry substance, which is a most unusual circumstance in plant life.

Bleached leaves.—An adjunct to the betel leaf industry is the bleaching of the leaves, these bleached leaves commanding a price about three times as great as the ordinary green leaf. Curiously this special industry has never been described in English literature and the authors provide this in the memoir. The process is briefly as follows: The fresh green leaves, in quantity about 50—70 lbs. weight, are packed carefully edge downwards in a circular basket, and at the same time are moistened. Periodically at intervals of every few days the leaves are removed and examined; decayed ones are thrown out, bleached ones removed for sale, and green sound leaves replaced. In experiments conducted by the authors, about 50 per cent. of the leaves bleached, and the greater part of the other half were decayed and useless.

During the bleaching it was found that the amount of essential oil increased from 1·0 to about 4·0 or 5·0 per cent.; the acidity also increased;

(*ix*) Memoirs, Department of Agriculture in India, Chemical Series, Vol. III, No. 2.

the starch and non-reducing sugars decreased; the nitrate remained constant. Experiments were made by exposing small numbers of leaves to the action of various vapours and these indicated that the bleaching process is one of oxidation in acid solution; anything in the nature of an alkali causes rotting of the leaf.

PHYTIN AND PHYTIC ACID.(x)

With a view to a more exact knowledge of the organo-phosphorus compounds in seeds, Mr. G. Clarke has separated phytin and phytic acid from field mustards, and has described them. The ultimate object in view is additional means of bringing the properties of certain seeds into comparison with one another.

PART III.—FOREST CHEMISTRY.

BY

PURAN SINGH, F.C.S.,
Forest Chemist.

The following is a brief account of the more important work carried out by the Chemical Department of the Forest Research Institute during the year under report:—

Burma Myrabolans.—Nineteen samples of Myrabolans collected in different localities in Burma were analysed with the object of comparing their tannin value with that of Myrabolans grown in India. The tannin content of the fruit-pulp was found to vary from 19 to 22 per cent., only two samples showing 34 per cent. Thus the Burmese Myrabolans appear to be 50 per cent. poorer in tannin than those grown in India, the average tannin content of which is about 50 per cent. The Burma Myrabolans also give darker coloured tan liquors which contain four to five times more red and five to six times more yellow than do the liquors prepared from Indian Myrabolans. It is therefore doubtful whether the tree known as *Terminalia Chebula* in Burma is botanically identical with the Indian tree of the same name. The attention of the Forest Botanist has been drawn to this point with the object of deciding the botanical identity of the trees. If they prove to be identical, the factors of the locality, etc., influencing the tannin-content of the fruit will require further investigation.

(x) Proceedings of the Chemical Society, 1913, Vol. 29.

Milk of Palaquium Ellipticum, Benth.—Three samples of the latex were received and the coagulated biscuits of raw gutta prepared therefrom were analysed with the following results:—

—	No. 1.	No. 2.	No. 3.	Calculated on dry material.	
				No. 2.	No. 3.
Moisture	0·37	23·38	19·22	...	...
Proteids	1·90	0·27	0·24	0·35	0·30
Insolubles	4·13	5·27	4·50	6·86	5·57
Pure gutta	31·29	21·78	27·15	28·37	33·61
Resins	62·31	49·30	48·89	64·42	60·52
Ash	0·9	2·21	1·72	2·88	1·51

The first two of these samples were white and brittle and the last one was reddish in colour. From the above table it will be seen that all these samples of gutta are of inferior quality inasmuch as they contain more than 60 per cent. of resin.

Boswellia serrata gum resin.—The enquiry regarding the possible uses of this gum resin is still in progress. Its average composition is:—

	Per cent.
Oil	8
Resin	49·63
Gum	25·99
Moisture	11·91
Impurities	4·47
	100·00

A sample of turpentine oil obtained from the resin yielded the following results on fractional distillation:—

	Per cent.
Portion passing below 160° C.	50
„ „ between 160° C.—167° C.	17·5
„ „ „ 167° C. and 180° C.	11·0
„ „ above 180° C.	21·5
	100·0

These figures indicate a turpentine oil of commercial value. Accordingly a small sample was sent to Messrs. Turner, Morrison & Co., Calcutta, who reported on it favourably as " promising." Preliminary experiments have shown that the distillation of gum resins of this type requires a still of special construction, since in the ordinary stills the gelatinous gum surrounds the particles of resin and thus prevents the full action of the steam. A special still is therefore now being constructed and is expected to be in working order next year.

The resin of this species was chemically examined with the following results :—

Specific gravity	1·8424 at 20° C.
Saponification number	77·33
Acid number	43·72
Ester number	33·61
Iodine	77·49

Tanning materials.—At the request of various Forest Officers several tanning materials were analysed during the year. A sample of *Terminalia paniculata* bark was found to contain 26·07 per cent. of tannin and 9·45 per cent. of non-tannin. It is thus a rich tanning material and might find a place in the tanning industry. A tannin extract is being prepared from it for further study. Twelve different samples of tan barks and fruits were received from Gwalior State for analysis, but most of these were found to be useless as tanning materials, either because they were too poor in tannin content or because the percentage of non-tannin in them was too high. The best of the samples was *Acacia leucophlœa*. It contained 11 per cent. of tannin and 4 per cent. of non-tannin. *Terminalia Arjuna* contained 12 per cent. of tannin and 8 per cent. of non-tannin and *Zizyphus xylopyrus* from Sipri, 14 per cent. of tannin and 9 per cent. of non-tannin. These are, therefore, tanning materials of average quality. An exceedingly rich tanning material, *Din-gun-the* pods, was received from Burma. It greatly resembles Divi-Divi both in appearance and in tannin value and contains 47·74 per cent. of tannin. The botanical name of this species has not yet been definitely settled.

Two short notes, one on oak bark and the other on the bark of *Terminalia tomentosa* as tanning materials for the manufacture of tannin extracts, have been sent to the *Indian Forester* for publication. It has been shown therein that there is little probability of oak bark being used for tannin extracts in the near future, seeing that an abundance of richer and cheaper tanning materials is available in this country. As regards *Terminalia tomentosa* bark, all attempts to utilize it as a source of tan extracts have hitherto failed, but the enquiry is still being kept open at the Research Institute.

Sal soils.—Last year forty different samples of *sál* forest soils were analysed for different Forest Officers. Of these 10 samples were received from the Forest Botanist, 24 from the Divisional Forest Officer, Mandla Division, and 6 from the Divisional Forest Officer, Jalpaiguri Division.

Sundri fruits.—These fruits were analysed with a view to discovering some economic use for its starch, either as a famine food or as a source of soluble starch, spirit, etc. The following is the average composition of the fruit:—

	Per cent.
Moisture	16·85
Tannin	4·44
Fat	4·50
Starch	59·53
Albuminoids	5·60
Woody fibre, etc.	6·38
Ash	2·70
Nitrogen	8·84

Nutrient value:—Albuminoids + starch + starch equivalent of oil (2·3 being the starch equivalent of oil) = 75·48.

Nutrient ratio:—Albuminoids : starch = 1 : 10·63.

It is clear that the fruit may be used as a famine food provided that the tannin is first removed by means of treatment with cold water. The enquiry as to its other possible economic uses is still in progress.

Ceara rubber.—The analysis of a thin sheet of Ceara rubber obtained from Coorg and sent by Mr. W. Raitt gave the following percentages:—

	Per cent.
Moisture	0·85
Proteids	4·10
Resins	11·24
Caoutchouc	82·91
Ash	0·90
Nitrogen	6·56

This sample was a very clean piece of well prepared rubber and it compares favourably with rubbers grown in Ceylon, East Africa and other places. On account of the high percentage of resin, however, its quality is inferior to that of first grade Ceylon rubber. It is hoped that this defect may be removed by more careful treatment.

Neem toddy.—A bottle of the spontaneous exudation of the Neem tree was received from the Conservator of Forests, Gwalior State, and it was analysed by Mr. T. P. Ghose, B.Sc. This toddy is popularly regarded as a remedy for leprosy. The object of the analysis was to

determine its average composition and to locate the active principle. The following is the result of the analysis:—

Specific gravity at 18° C.	1·0589
Angle of rotation at 15° C.	+ 11°
	Per cent.
Moisture	86·56
Proteids	0·36
Gums and colouring matter	6·17
Glucose	2·99
Sucrose	3·51
Ash	0·41

The qualitative analysis of the ash showed the presence of the following substances:—

Potassium, iron, aluminium, calcium, and carbon-dioxide.

Only a trace of resinous and fatty matter was obtained and tests for alkaloids and glucosides gave negative results. No active principle therefore could be located.

Nickel tannates.—These salts were studied to some extent last year. It has already been reported that under different conditions of precipitation tannates of different nickel contents are obtained. These conditions have been further studied this year and it is found that not more than two salts can be obtained by any change in these conditions. One is obtained when nickel hydroxide, dissolved either in ammonium chloride or ammonium acetate, is added to an excess of tannic acid solution, and the other when tannic acid solution is added to an excess of nickel hydroxide solution. These salts gave on incineration the following percentage of NiO:—

(*i*) The salt precipitated from excess of tannic acid 8·74 per cent.

(*ii*) The salt precipitated from excess of nickel hydroxide solution 28·34 per cent.

These salts were the same as reported last year and the question of their constitution has yet to be settled. The work will probably be taken up again next year.

Distillation of Khas Khas oil.—The distillation of Khas Khas grass with a view to determine the variation in oil-content of samples grown in different localities was taken up during the year. Five specimens were examined and in four of these the percentage of oil was found to vary from ·7 to 1; the other specimen was relatively poor and contained only 0·4 per cent. of oil. More specimens are being examined and the enquiry will, it is hoped, be completed next year.

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ASTRONOMY.

BY

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Director-General of Observatories.

Solar physics.—Researches in solar physics are carried on under the direct control of the Government of India at Kodaikánal, the Director being Mr. J. Evershed and the Assistant Director Mr. T. Royds. The chief instruments are:—

(*a*) A spectroheliograph made by the Cambridge Scientific Instrument Company, the object of which is to take photographs of the sun using the light emitted by one chemical element only. In this apparatus a stationary image of the sun is made by a 12-inch triple-achromatic lens of 20-foot focus, fed by an 18-inch Foucault siderostat. Close up to the image and somewhat longer than its diameter is the narrow vertical slit of a spectroscope arranged in such a manner that the light which has passed horizontally through the collimating lens shall be deflected through two right angles by two prisms and a mirror, and so shall emerge from the camera lens parallel to its original direction. This light then falls upon another vertical slit which can be adjusted in such a position as to allow light of any desired wave length to pass through. In the Kodaikánal spectroheliograph the collimating and camera lenses each of 5-inch aperture and 6-foot focal length, together with the prisms and slits, are attached to a rigid framework, while immediately in contact with the slit last described is a stationary photographic plate within a fixed camera. The rigid framework is capable of motion in a horizontal plane in such a manner that the primary slit may pass uniformly across the image of the sun while the secondary slit will move at an equal rate across the sensitised plate; and as in each position an image will be formed at the second slit by light of the desired wave length and no other light can emerge, the result of the movement upon the plate is a complete image of the sun in monochromatic light. At present the H and K lines of calcium are largely used on account of the convenience afforded by the width of their absorption shading and the fact that the

centre of the dark line is frequently 'reversed,' *i.e.*, is bright instead of dark, indicating that the calcium vapour is abnormally hot in the higher levels of the solar envelope A photograph so obtained shows bright clouds—called 'flocculi'—of calcium vapour scattered about over the sun, and gives a large amount of information that is not otherwise obtainable. Further, by causing the slits to move more slowly the exposure may be lengthened sufficiently to give photographs of the 'prominences' projecting from the sun's margin.

(*b*) An autocollimating spectroheliograph built in the observatory workshop. This is attached to the side of the Cambridge instrument and shares in the very perfect transverse movement of the latter. It is designed for photographing the sun's disk in the hydrogen line C. A large grating is used to obtain the highly dispersed spectrum which is necessary in photographing with this line.

(*c*) A high dispersion spectrograph mounted on piers in the spectroheliograph room. This is fitted with special arrangements for rotating the sun's image on the slit plate, and for accurate guiding during long exposures on sunspots or prominences. A special device has also been added for photographing simultaneously the spectrum of an electric arc on either side of a solar spectrum. A grating by Rowland with $3\frac{1}{4}$-inch ruling is usually employed.

(*d*) An 18-inch parabolic mirror (the property of the Director) is mounted in the spectroheliograph room immediately in front of the 12-inch photo-visual lens. It is used to form the solar image on the slit plate of the high dispersion spectrograph. The mounting is on rollers and the mirror can either be moved into position in front of the lens with its centre in the axis of the beam of light coming from the heliostat, or it can be pushed to one side so as not to obstruct the light incident on the lens during employment of the spectroheliograph and associated instruments.

(*e*) An 8-inch visual achromatic lens from the Maharajah Takhtasinji Observatory, Poona, temporarily mounted in the spectroheliograph room on a pier near the Foucault siderostat. It is used for forming a solar image on the spectrograph slit specially for sunspot work.

(*f*) A spectrograph consisting of an 11-inch polar siderostat with a 6-inch Grubb lens of 40-foot focus. This is used with a $3\frac{1}{3}$-inch concave grating of 10-foot focus mounted on

Rowland's plan. A 2-inch parabolic grating can be substituted for the concave grating, and a collimating lens may be employed with either grating to cure astigmatism.

(*g*) A 6-inch equatorial refractor with large grating spectroscope attached is used for the study of sunspot and prominence spectra and for recording the prominences by visual methods. The equatorial mounting and the spectroscope are from the Maharajah Takhtasinji Observatory, Poona.

(*h*) A 6-inch equatorial refractor by Lerebour and Secretan fitted with a photovisual object glass acquired from the Poona Observatory. The instrument is used for obtaining the daily series of large scale photographs of the sun, and for direct observations.

Routine work.—In addition to the daily records obtained by the two spectroheliographs, the routine work includes visual examination of sunspots and faculæ, sunspot spectra, and of bright lines or displaced lines in spots and prominences. The position angles and forms of the prominences are also recorded. A monthly article describing the solar activity is contributed to the "Monthly Weather Review" while for more technical purposes bulletins and memoirs of the Observatory are issued ; of the former 30 have appeared while of the latter the first has been published.

The distribution of prominences.—A remarkable peculiarity in the distribution of the prominences has been brought to light from a study of the Kodaikánal records. If the prominences recorded on the east limb are compared with those of the west a numerical preponderance of east over west is found for each year since these observations were begun in 1904. The averages for the past eight years show that for every 100 prominences observed on the west side of the sun's axis 111 were recorded on the east side and this ratio is nearly constant for each of the eight years. This applies to all classes of prominences, but if the special class which is associated with sunspots is treated separately a considerably greater excess of east over west is found. Prominences showing displacements of the spectrum lines indicating violent movement also show a much greater eastern excess than the average of all prominences.

These results appear to show that both prominences and sunspots are more active when near the east limb than when near the west. The numerical preponderance and the increased activity on the east side is very difficult to explain except on the improbable hypothesis that the earth itself affects the distribution and activity of the prominences, and tends to extinguish the smaller prominences during their transit across the sun's visible hemisphere.

The cause, whatever it may be, is evidently connected with that which produces an excess of spots east of the central meridian of the sun, and the above enquiry was suggested by the very remarkable results obtained by Mrs. Maunder in her exhaustive analysis of the Greenwich sunspot records.

Spectroscopic investigations.—The large grating spectrograph has been employed in obtaining comparison spectra of the sun's opposite limbs, and of the limbs compared with the centre of the disk. A special reflecting device was constructed and used for photographing two or three spectra from different regions on the sun simultaneously and side by side on the plate. A large number of measures of the displacements of the lines at the sun's limb have been made and in addition numerous determinations of the equatorial speed of rotation of the sun.

The rotation results show systematically smaller velocities than the values obtained in 1906 and 1908 at Mount Wilson Observatory, the differences amounting to from 3 to 7 per cent. They agree, however, within 1 or 2 per cent. with the values obtained in 1911 at Cambridge. It seems possible that this indicates a real change of rotation speed in the sun's absorbing atmosphere, which may vary with the sunspot period, but further research is necessary to determine whether systematic errors affect the measures of different observers. A new method of measuring the plates has been devised which it is hoped may help to clear up this uncertainty.

Comparison spectra have also been obtained of the electric arc and the sun for comparing the wave lengths of the iron and nickel lines in the arc and in the sun. In some of the plates the comparison is with the centre of the sun's disk and in others with the east and west limbs. From the latter independent determinations of the equatorial rotation speed have been obtained and these are in agreement with the determinations from spectra in which the east and west limbs are directly confronted.

The displacements observed when the arc is compared with the centre of the disk are found not to agree with the residual displacements observed when the limb is compared with the centre and the rotation displacement is eliminated ; and there seems to be no clear relation between the amount of displacement for the different lines, either limb *minus* centre or centre *minus* arc, and the displacements due to pressure. It is of great importance to determine whether these small displacements in the solar lines are really due to pressure in the reversing layer as has been assumed hitherto. The above results would seem to throw great doubt on the generally accepted theory.

METEOROLOGY.

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,
Director-General of Observatories.

Upper air investigations.—Sanction has been given by Government for a scheme providing three lakhs to be spent in ten years on enquiries into the conditions of the upper air, and Mr. Field has been relieved of his duties at Simla in order to take charge of the work. The head-quarters are to be at Agra, where an observatory is being built and it is proposed to send up instruments twice a week on balloons to as great a height as can be attained. There are to be four or five auxiliary stations where, as also from Agra, instruments will be sent up to lesser heights, say 2 or 3 miles, in order to give information as to the conditions affecting daily weather.

Mr. Field was unfortunately obliged to take leave in August and has not yet returned, so that the initiation of the scheme has been delayed. In the meantime Mr. Harwood, who is to act as his assistant, has been making observations with pilot balloons at Simla and Darjiling, and is working out their results in addition to some previously made.

General meteorology.—Owing to shortness of staff at Simla it has only been possible for a very small amount of research work to be done there. Some progress has, however, been made in the examination of seasonal relationships, and it has been shown that in the great majority of cases the storms that give northern India its precipitation in the cold weather have travelled from Europe, being of the same type as those which give Europe rain through the year.

Publications.—The customary Daily Weather Reports of Simla, Calcutta, Bombay and Madras, the monthly and annual supplements to the Simla Daily Weather Report, the Monthly Weather Reviews, the Annual Summary, and various administrative pamphlets were issued during the year.

TERRESTRIAL MAGNETISM.

BY

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Magnetic observatories.—*Bombay (Alibag).*—The Bombay Observatory, formerly maintained by the Local Government at Colaba, was moved to Alibag in consequence of the introduction of electric trams into the city : it is now directly under the Government of India, the Director being Mr. N. A. F. Moos. The chief instruments are a set of magnetographs of the Watson pattern, a set of sight-reading instruments of Eschenhagen pattern, a Schulze earth-inductor, and ordinary magnetometers and dip-circles. There is also a large declinometer for eye observations, and the old Colaba horizontal force and vertical force magnetographs were in April 1912 transferred to Alibag for use as eye-reading instruments. There is thus a duplicate equipment both for absolute values and for variations.

The instruments have been in good order and under regular observation.

Dehra Dun, Kodaikánal, Barrackpore and Toungoo.—These observatories were started as base stations in connection with the Magnetic Survey of India, and are all equipped with Watson autographic instruments for declination, horizontal intensity and vertical force. Instead of dip-circles, earth-inductors of the Schulze pattern have been set up at each place. Good results have been obtained throughout the year. Observations for personal error (*vide* report for 1910-11) are now made periodically at Kodaikánal where the Director, Solar Physics Observatory, has kindly given permission to use the observatory chronograph.

The mean values of the magnetic elements for 1912 at the observatories are as follows :—

Observatory.	North Lat. and East Long.	Declination.	Horizontal force.	Vertical force.	North dip.
			C. G. S.	C. G. S.	
Alibag	18° 38′ 72° 52′	E. 0° 51′ 11″	·36874	·16367	23° 54′·8
Dehra Dun	30° 10′ 19″ 78° 3′ 19″	E. 2° 25′·9	·33218	·32244	44° 8′·9
Barrackpore	22° 46′ 29″ 88° 21′ 39″	E. 0° 44′·0	·37369	·22316	30° 50′·7
Kodaikánal	10° 13′ 50″ 77° 27′ 46″	W. 1° 5′·8	·37543	·02616	3° 59′·1
Toungoo	16° 55′ 45″ 97° 27′ 3″	E. 0° 13′·4	·38889	·16548	23° 3′·1

Magnetic Survey.—*Field Operations, 1912-13.*—During the field season, three detachments were employed on field work under the Officer in charge (Captain Thomas, R.E.) and two provincial officers.

The Officer in charge inspected Barrackpore and Toungoo base stations, observed at repeat stations and subsequently carried out a preliminary survey of Ceylon.

The provincial officers were partly employed on detail survey and revision of the work of season 1901-02 and partly on revisiting repeat stations.

Comparative observations were made at the four survey base stations and at Alibag to determine the differences from the survey standard.

During the season full sets of magnetic observations were made at the following :—

58 repeat stations.

19 old stations revised.

42 new stations in Ceylon.

3 new stations in India.

20 detail survey stations in the Central Provinces.

Under repeat stations are included observations at the old field stations which were marked by pillars in 1910-11 ; these number in all 50 which, with the original 23 repeat stations, give 73 repeat stations in all or about 1 to 19 stations of the fundamental survey.

One detachment remained at head-quarters and was employed on the reduction of the declination data of the survey which is nearing completion.

The computing section which remains permanently at head-quarters was engaged on its normal work of computation and tabulation of the base station results.

Work during recess 1913.—The reduction and tabulation of the observatory data for 1912 have been completed for five quiet days per month; the results for "all days" will also shortly be available.

The computation of the field work of 1912-13 is in hand and will be completed before the end of the recess.

The investigation of the instrumental differences in H. F. referred to in the two last reports is nearing completion.

List of Publications.

EVERSHED, J. .	. On the presence of radium and the elements of the inactive group in the chromosphere. (*Bulletin No. XXVII.*)
,, ,, .	. On the relative numbers of prominences observed on the eastern and western limbs. (*Bulletin No. XXVIII.*)
,, ,, .	. Summary of prominence observations for the first half of the year 1912. (*Bulletin No. XXIX.*)
,, ,, .	. Summary of prominence observations for the second half of the year 1912. (*Bulletin No. XXX.*)
,, ,, .	. Summary of prominence observations for the first half of the year 1913. (*Bulletin No. XXXI.*)
,, ,, .	. A new method of estimating changes in the general radiation of the Sun. Read at the International Solar Union at Bonn in August 1913.
,, ,, .	. Report on sunspot spectra (a summary of the visual and photographic work done at Kodaikánal during the years 1910, 1911, and 1912). Read at the International Solar Union at Bonn in August 1913.
EVERSHED, J., & ROYDS, T.	Some spectroscopic measures of solar rotation. (*Monthly Notices, Astronomical Society.*)
FIELD, J. H., & JACOB, S. M.	On the rapid calculation of times of moonrise and moonset. (*Memoirs, Vol. XXI, Part IV.*)
ROYDS, T. .	. Prominence periodicities. (*Bulletin No. XXXIII.*)
,, ,, .	. The distribution in latitude of dark H markings. (*Monthly Notices, Astronomical Society.*)
ROYDS, T., & S. SITARAMA AIYAR.	The determination of ancient dates from astronomical data. (*Astronomical Society of India.*)
WALKER, GILBERT T.	Data of heavy rainfall over short periods in India. (*Memoirs, Vol. XXI, Part III.*)
,, ,,	. The liability to drought in India as compared with that in other countries. (*Memoirs, Vol. XXI, Part V.*)
,, ,,	. Monthly and annual rainfall normals. (*Memoïrs, Vol. XXII, Part I.*)
WALKER, GILBERT T., PART I, & HEM RAJ, RAI BAHADUR, PART II.	The cold weather storms of Northern India. (*Memoirs, Vol. XXI, Part VII.*)

GEOLOGY.

BY

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MINERALOGY AND PETROLOGY.

1. **White pyroxene rock: tremolite: bowenite.**—Mr. Middlemiss has described some interesting mineral occurrences from the Aravallis of Idar State. At Bamanvada (lat. 23° 36′; long. 73° 20′) massive, white pyroxene rock is found associated with crystalline limestone and quartz-pyroxene schist, the whole series being intercalated as a band, 50 to 60 feet thick among mica schists. The coarsely crystalline, often pure white, pyroxene is found in beds of from a few feet to as much as 30 feet thick at one place, and may be traced at intervals for many miles. Although pyroxene as a constituent of many igneous rocks is common, this is the first instance recorded of extensive beds of the pure mineral having been found in India. Its optical and chemical characteristics are those of the diopside group of monoclinic pyroxenes, and it suffers local changes into white or pale green tremolite or actinolite in radiating tufts and interlaced fibres. Some of the latter layers are rather compact and semi-translucent, but not sufficiently so to have any value as jade (nephrite) as at present explored, though the occur-

rence is suggestive. The white pyroxene rock mottled here and there by the pale green tremolite makes a tough and handsome ornamental stone when polished.

2. At Bhetali, seven miles along the outcrop from Bamanvada, a grey mottled variety appears with graphite in nests and films round and among the pyroxene crystals. Some of the associated crystalline limestone at Bamanvada shows small patches of hard dark green serpentine (bowenite) resembling in a small way that from the Safed Koh described by McMahon (*Min. Mag.*, Vol. IX, p. 187, 1890). Mr. Middlemiss concludes from the lie and associations of this band of rocks that they are mainly the result of contract-metamorphism induced by dykes of olivine-gabbro and dolerite which penetrate the series.

3. **Idocrase.**—Mr. Middlemiss has further recorded massive idocrase (vesuvianite) from near Nadri (lat. 24° 0′; long. 73° 2′). This mineral does not seem to have been much more than mentioned before in India, with the exception of that from Tonk referred to by Mallet (*Man. Geol. of India*, pt. 4, *Mineralogy*, p. 93). Mr. Vredenburg doubtfully recognised it in some Idar granite collected by Professor Page, a point which so far Mr. Middlemiss has not been able to verify. The present occurrence is in metamorphic Aravalli limestones, which in the neighbourhood are modified by intrusive veins of granite and aplite into a rock composed of calcite, quartz, microcline, diopside, wollastonite, etc., and secondly into the rock now described, by further intrusion into them of the latter bosses of Idar granite. The rock is coarsely crystalline, with large shining cleavage plates of poikilitically developed idocrase among and including the other normal constituents of the calc-gneiss. The bands are several inches across, the proportion of the mineral to the rest of the rock being about 5 to 1. The determination is based on physical and optical tests, no chemical examination having yet been made.

4. **Teng-yueh volcanics.**—Mr. R. C. Burton has examined and described a series of volcanic rocks collected by Mr. Coggin Brown in the neighbourhood of Teng-yueh. These consist of three groups:—

(*a*) pyroxene-andesites;

(*b*) hornblende-andesites, pyroxene-andesites, with augite-olivine andesites and olivine basalt;

(*c*) olivine basalts.

These sub-divisions correspond with the three groups respectively termed by Mr. Brown "bedded andesites," "massive andesites" and "basalt lavas of Tay-in-shan," and are enumerated in order or age, the first being the oldest. The rocks of group (*a*) are very much older than those of group (*b*), which are of pliocene and pleistocene age, some

of the lavas, as for example those of the now extinct She-toe-shan crater, being of recent age.

5. In general characteristics the andesites and basalts described by Mr. Burton are similar to those of the younger Burmese volcanoes, the lava of Ho-shuen-shan being comparable to the late Tertiary basalts of the Northern Shan States. A specimen of augite andesite from Kan-lan-ssu contains a considerable amount of brown glass resembling the palagonite of the Rajmahal trap.

6. **A suggested infra-plutonic zone in the earth.**—An interesting paper read by Dr. Fermor before the Asiatic Society of Bengal (*Journ. A. S. B.*, Vol. VIII, No. 9, p. 315) led him to the consideration of the conditions existing below the surface of the earth, from which he has deduced the presence, below the plutonic zone, of a belt of material under high pressure and containing garnet as a typical constituent; this he terms the infra-plutonic zone (*Rec., Geol. Surv. India*, Vol. XLIII, p. 41). Although admittedly of a somewhat speculative nature, the views put forward by Dr. Fermor are of great interest and highly suggestive; his memoir on the subject when published will undoubtedly form a very important contribution to the study of the chemical and physical constitution of the earth.

PALÆONTOLOGY.

7. **Tertiary mammals in the British Museum.**—During his absence on study leave Dr. Pilgrim examined most of the types of mammalia now in the British Museum from the Upper Siwaliks of the Siwalik Hills, as also from Perim Island and Burma. These have been described partly by Falconer and partly by Lydekker, and there are very few duplicates in the Geological Museum in Calcuttta. Dr. Pilgrim also examined the fine collection of Pikermi species in the British Museum for purposes of comparison with our Middle Siwalik fauna. At the same time he worked out and described a small collection of *Carnivora* from the Lower Siwaliks of Chinji and also from the Middle Siwaliks. This work will, it is hoped, serve as a nucleus for a more extensive revision of the Siwalik *Carnivora* to be undertaken subsequently. Another group examined by Dr. Pilgrim was the *Mastodontidæ*, which he found to be also in need of revision.

8. Mr. Swinhoe's collection of mammals, which is in the British Museum, was also examined. The specimens are from two localities, namely, (1) the right bank of the Irrawadi opposite Mandalay and (2) near Yenangyaung. The collection from the former locality was found to include *Elephas antiquus* (*namadicus*) and is therefore presumably of pleistocene age. Among the specimens from near Yenangyaung Dr. Pilgrim found a new species of *Merycopotamus*, of which, with

Dr. Smith Woodward's consent, he has written a description. Other interesting specimens noticed were a skull from Perim Island attributed by Lydekker to the genus *Strepsicerós*. Dr. Pilgrim on developing this specimen to a considerably greater extent than had formerly been done, found the generic attribution no longer tenable and regards the skull as representing a new genus.

9. Another interesting skull which had apparently been overlooked for some years bears a label containing the word "Ava." If the specimen really came from Ava its age is presumably Middle Siwalik, since numerous Middle Siwalik species have been obtained from that locality. If this is so, its presence is interesting, since Dr. Pilgrim regards it as undoubtedly an ancestral form of the Pliocene *Leptobos*. He also found that it possessed decided antelopine affinities. In view of the interest attaching to it Dr. Pilgrim wrote a description of the specimen with Dr. Smith Woodward's permission.

10. A fine collection of *Hipparion* skulls from Pikermi also proved of considerable interest, being found to comprise two species, namely, the pontian form *H. gracile* and also another which Dr. Pilgrim regards as almost, if not quite, identical with the Indian form *H. punjabiense*, from the Middle Siwaliks of the Salt Range.

11. **Tertiary mammals at Basle.**—Dr. Pilgrim also paid a visit to Basle where Professor Stehlin very kindly allowed him to examine numerous specimens which proved to be interesting and useful for purposes of comparison with Siwalik forms.

12. **Tertiary Mollusca of Sind and Baluchistan.**—Mr. Vredenburg was also absent on study leave during the year and examined collections of Tertiary invertebrate fossils both in England and on the Continent, for purposes of comparison with the Tertiary fossils of Sind and Baluchistan, on a description of which he has been engaged for some years past. His work comprises two main sections, firstly, the revision of the Sind Tertiary types of D'Archiac and Haime, and secondly, a complete description of the post-eocene Tertiary molluscan fauna of North-Western India. D'Archiac and Haime's types have been carefully revised and their geological horizons ascertained. Most of the mollusca proved to be from the Gaj and Lakhi stages, the Gaj being chiefly represented and the fossils from it as a rule well preserved, whereas the specimens from the Lakhi stage were usually casts. There are also a few Ranikot forms, very few from the Nari, none from the Khirthar, and only one from the Cretaceous. The post-eocene mollusca that have been described by Mr. Vredenburg comprise over 350 species of which about 120 are new. Mr. Vredenburg finds that the only forms that show any close relationship to European species are those from the Nari, whereas the percentage becomes very small in the Gaj beds and

still smaller, practically none, in the Hinglaj, the fossils of which latter stage are closely related to those of Java.

13. **Jurassic ammonites.**—Before taking leave Mr. Tipper was engaged on the description of the Jurassic fossils from Baluchistan on which he has been engaged for some years. He has made considerable progress in the work and it is hoped that his results will soon be ready for publication.

14. **Palæontological work being done in Europe.**—The Cretaceous fossils collected by me at Kampa dzong and Tuna in Tibet and the Jurassic brachiopods collected by Messrs. La Touche and Datta in the Shan States are still in the hands of Professor Douvillé and Mr. S. S. Buckman respectively.

15. Collections of Palæozoic fossils made by Mr. Griesbach in N. W. Afghanistan and Khorasan and by me in the Koh-i-Baba have been examined and described by Miss Colley March, B.Sc., of Manchester University. Mr. Griesbach's collections contain well-preserved brachiopods, the best having been obtained from Robat-i-pai near Herat; they include species of *Spirifer* (cf. *bisulcatus* and cf. *clathratus*), *Productus* (*semireticulatus* and *pustulosus*), *Camarophoria* cf. *purdoni* and *Atrypa aspera*. Miss March regards these fossils as essentially Lower Carboniferous, and ascribes the presence of *Atrypa aspera* to a local survival of this species beyond the usual Devonian limit; experience of the difficulties under which specimens are collected during expeditions of the kind on which Mr. Griesbach was engaged at the time, would dispose me rather to infer that he had not had an opportunity of working out horizons in detail and consequently did not suspect the presence of more than one system; it is clear from his lists that fossils collected from beds some little vertical distance apart were not differentiated, and the collection might thus easily contain both Lower Carboniferous and Upper Devonian species. The close association of fossils belonging to these two systems near the Kotal-i-Hajigak in the Koh-i-Baba lends considerable colour to this explanation.

16. Miss March has also described the fossils collected by me from the upper beds of the Hajigak limestone; they are badly preserved, but were found to include *Spirifer wynnei*, *Chonetes* cf. *hardrensis*, (?) *Phillipsia derbiensis*, a new species of *Streblodus* named by Miss March *Str. incurvus*, and several species of *Zaphrentis* and *Syringopora*. The most striking feature of all these fossils is, according to Miss March, their close affinity to European forms. Their age is regarded as Lower Carboniferous.

17. A description of the lamellibranchs of the Ranikot stage by Messrs. Cossmann and Pissarro has been received and will shortly be published.

18. During the year, Professor Seward completed his examination and description of the Gondwana plants collected by Mr. Middlemiss on the Golabgarh pass. These include *Glossopteris indica* Schimp and *Cordaites hislopi* Bunb., both typical species of the Lower Gondwanas of the peninsula; they thus furnish unequivocal evidence of the identity of the Gondwanas of Kashmir with those of the coal-fields of India. Professor Seward's memoir has been published in the *Palæontologia Indica*.

ECONOMIC ENQUIRIES.

Building Stones.

19. The limestone of which the Simla town-hall is built was submitted to the Geological Survey for examination and report. It was said to have been obtained from the quarries on Prospect Hill and was found to be very friable and impure, and not suitable for building purposes. Specimens of the Sanjauli quartzite were also examined and found to be excellent building-stones.

Coal.

20. **Raniganj coal-field.**—The re-survey of the Raniganj coal-field and revision of the map originally prepared by the late Dr. Blandford, on which Mr. Walker was engaged on behalf of the Mining and Geological Institute, in co-operation with a committee of the members of that body, was completed during the year. Mr. Walker's report on the correlation of the seams has also been handed over to the Institute by which it will be published.

21. **Coal in Korea State, Central Provinces.**—Attention having recently been drawn to the possibility of exploiting profitably the coal-fields in the Korea State of the Central Provinces originally examined by Mr. Hughes (*Memoirs, Geol. Surv. India*, XXI, pt. 3), the Chief Commissioner has asked that a member of the Geological Survey should make a more detailed examination of the area. The matter has therefore been taken up by the Central Provinces party and Dr. L. L. Fermor proceeded to Korea at the end of the year. Having only just arrived on the field at the conclusion of the period covered by this report, his results are not yet available. Samples of coal, however, were sent for assay to this Department in September 1912, by the Political Agent, Chhatisgarh Feudatory States; these proved to be of fair quality, the percentage of ash being about 6; the percentage of moisture is undesirably high and varies from 7 to 10 per cent.; the calorific value of the better samples ranged between 6,650 and 6,850. The localities from which the best samples were obtained are Kouraia nala, Kurasia and Kukri nala.

Engineering Questions.

22. **Darjiling landslips.**—In pursuance of the recommendations of the Landslip Committee which met in Darjiling in October 1911, Dr. L. L. Fermor was employed during the summer of 1912 in making a detailed geological survey of the Happy Valley and neighbouring hill-sides. Through the courtesy of Lt.-Colonel R. T. Crichton, C.I.E., Director of Surveys, Bengal, he was provided with large contoured maps. Dr. Fermor's more extensive survey has, while greatly amplifying them, tended to confirm the results arrived at by the committee. His recommendations and conclusions have been forwarded to the Government of Bengal.

23. **Dharmsala hill slopes.**—The conditions of the hill slopes at Dharmsala having given cause for apprehension lest landslips might occur, a committee was appointed to examine the station and report to the Local Government. The services of a member of the Geological Survey having been asked for in this connection, Mr. C. S. Middlemiss joined the committee on his way back from field-work in Kashmir at the end of the monsoon season. Having visited Dharmsala in 1905 in the course of his investigation of the effects of the great earthquake of April 4th, his intimate knowledge of the geological conditions rendered Mr. Middlemiss peculiarly suitable for this further investigation. His conclusions, which were submitted with the report of the committee, tend to show that there is no immediate danger to be apprehended so long as certain necessary precautions be taken without delay. These include the afforestation of bare hill-sides and the closing to grazing and wood-cutting of those already partially deforested; in addition to this certain measures are recommended with regard to rendering the water channels and the drainage system more efficient.

Gold.

24. **Burma.**—Mr. H. S. Bion was deputed at the beginning of the field-season of 1912-13 to take up the examination of the auriferous gravels of the Chindwin river. His work only covers a short period during the year under review, and comprised chiefly an inspection of the gravels at the small gold-washing villages of Manlaikgyi and Manlaikgale, seven miles below Kindat; these were found to be valueless. The gravel island opposite Helaw was also examined and the gold content found to be very irregularly distributed. The surface gravels, which are quite rich in places (carrying from 8 to 15 grains per cubic yard), are barren in others. Only the surface is rich, there being practically no gold at a depth of four feet. Traces of platinum also were met with.

Iron.

25. **Goa and Ratnagiri.**—In March 1912, Dr. Fermor visited the iron-ore deposits of Goa and Ratnagiri, where the Compagnie des Mines de Fer de Goa and Messrs. Jambon & Co. respectively gave him every facility to inspect their properties. In Goa, the iron-ore occurs in beds of the Dharwar system, and the total amount is believed to be very considerable. In the southern parts of Ratnagiri and in the adjoining State of Savantvadi, similar geological conditions prevail, and deposits of iron-ore have been found, at Redi in Ratnagiri and near Banda in Savantvadi. It is considered probable that before long an export trade may be developed from this part of India.

26. **Jaipur State.**—Mr. Heron records the presence of large quantities of hematite in the Raialo marbles near Raialo and Nimla. He attributes these deposits to metasomatic replacement of the calcite by iron-bearing solutions. Whenever a hillock is seen in the Raialo marble, it is found to be due to the superior resistance to denudation of these masses, which stand out as dark-coloured piles of rock from the level stony plain of yellow or pale brown weathered marble. The rock varies, according to the amount of replacement, from marble stained brown by iron, to nearly pure hematite. The deposits are elongated more or less in the direction of the strike, but thicken and thin out in a quite irregular fashion; they are, in fact, lines of irregular lenticular masses rather than bands. It is difficult to estimate their real thickness, as the slopes are covered with boulders which are strewn to a great distance around and quite obscure the rocks beneath, giving an appearance of thickness greater than is really the case. Bands up to seven or eight feet across of pure hematite, were measured, and there are many much wider. If thin calcareous bands, which would be mined along with the ore and eliminated by hand-picking, are included, the width must run to many yards, and the amount of ore is certainly very great. The locality is situated about 15 miles from Dosa railway station, the intervening country presenting no impediment to railway and tramway construction. Extensive old workings are also seen near Nimla and between Raialo and Kalajpuri; these probably supplied part of the raw material for the now extinct iron industry of Bhangarh.

Kaolin.

27. **Jaipur State.**—Mr. Heron records the presence in Jaipur State of deposits of kaolin which may possibly be of value. $1\frac{1}{4}$ mile S. E. of Rasnu (26° 41′; 76° 37′) a long and spacious tunnel has been driven along the strike of a bed of kaolin which runs midway in the ridge of Alwar quartzites and is about 20 yards wide, white but rather impure, banded with quartzite. There is evidently a very large quantity available.

It has been quarried for local uses only, such as white-washing, etc. Kaolin is also dug from the soft argillaceous and talcose zone near the base of the Alwars at the north end of the Lalso hills, chiefly near Daraoli (26° 55′; 76° 58′). There are two beds separated by quartzite; the upper one provides a white and fairly pure clay, slightly mottled with pale purple and pink.

Petroleum.

28. **Assam.**—Mr. Pascoe completed his examination of the petroliferous localities of Assam and prepared a memoir which is now in process of publication.

29. **Burma.**—During the early part of the year, Mr. Cotter was on duty at the Yenangyaung oilfield, where he was succeeded by Mr. Coggin Brown. Owing, however, to his health giving way, the latter officer was relieved in July by Mr. Heron, who remained at Yenangyaung until the beginning of the field-season of 1912-13.

30. Sub-Assistant Sethu Rama Rau describes petroliferous areas at Yeyodaung and 3 miles N. N. W. of Nga-hlain-dwin in Minbu district. At the former locality, where a Burmese well has been dug, the beds at the crest of the anticline dip at low angles of from 10° to 12°. There are also a few Burmese wells at the second locality, and both places are regarded as being probably of economic value. The oil is said to occur in the upper beds of the eocene series.

31. **Punjab and North-West Frontier Province.**—Having completed his work in Assam, Mr. Pascoe proceeded to examine the petroliferous localities of the Punjab and North-West Frontier Province, and was still engaged on this work when an attack of suspected enteric compelled him to return to hospital at Lahore. His results are not therefore available yet.

Potash Salts.

32. **Salt Range.**—Dr. W. A. K. Christie was deputed in January to the Salt Range in the Jhelum District of the Punjab to investigate the potash salts found in his previous prospecting operations in the rock-salt mines at Khewra and Nurpur, worked by the Department of Northern India Salt Revenue. The potash beds found in the Mayo Mine at Khewra are generally overlain by seams of unsaleable marl, and their investigation is rendered difficult because the mining authorities, being mainly concerned with the extraction of marketable salt, which exists in unlimited quantities, naturally change the sphere of their operations as soon as a marl seam is struck and before the deposit underlying it is exposed. The principal potash-bearing bed found in the Pharwala section of the Mayo Mine was traced at various points for some 850 feet

along its strike, and over 250 feet with the dip, which is about N. 30° W., with an inclination of 20 to 50°. Its average thickness is six feet and the potash content varies from 6·8 to 9·6 per cent of K_2O. The distances given are indications of the comparatively extensive nature of the deposit, but they are not intended as a basis for calculation of the material available for extraction, as questions of expediency in pillar preservation completed the issue. Another seam eight feet thick and carrying 7·7 per cent of K_2O was found in a prospecting drift in the Pharwala salt,—what was presumably the same bed being struck in another prospecting drift 700 feet to the E. N. E. In the Buggy section of the Mayo Mine the only seam of any importance that was found was traced for about 150 feet along its strike, which is E. N. E.—W. S. W. The dip of the bed is about 35°, its average thickness two feet nine inches, and it carries 14·4 per cent of K_2O. The seam thins out when followed upwards along the bedding; in another chamber, at a distance of 170 feet south from the nearest exposure, it was found to be only a few inches thick. The seam in the Nurpur mine is exposed only in one place which is difficult of access. It dips S. S. E. at about 75° and at this point is six feet thick. A typical specimen from this deposit carried 14·1 per cent of K_2O.

33. The potassium-bearing minerals of the salt formation are chiefly langbeinite and sylvin, kainite and blödite with a small percentage of potassium being often present in small quantities. The deposits are usually fine-grained mixtures of these minerals with common salt and kieserite. The economic bearing of the occurrences, together with questions of their mineralogy and genesis, will be discussed in a paper now under preparation.

Steatite.

34. **Jaipur State.**—In addition to the locality of Morra long known for its steatite, Mr. Heron describes other and hitherto unrecorded localities where that mineral is extensively developed in thick beds of great purity. The new localities are Dogetha (Dagota), 2¼ miles N. E. of Raialo (lat. 27° 5′; long. 76° 15′), Gisgarh (lat. 26° 53′; long. 76° 40′), and Kawa (lat. 26° 46′; long. 76° 32′). The Dogetha deposit is excavated to a width of about 30 yards, but is probably wider, as the country rock on either side is not laid bare. It runs diagonally, dipping at 80° west by south, across the end of a hill and is only excavated for some 50 or 60 yards along the length of the bed in an open cutting. The steatite is very pure, milk-white or faintly tinged with green, with very thin films of pink ferruginous matter in some of the joints. The joints are irregular and allow of pieces up to one foot or so in length being extracted, but most of the material is in much smaller pieces and

no particular effort is made to get large blocks. The deposit is quite structureless except for the jointing, and no clue could be obtained as to its origin; in no place was a junction with the surrounding rock seen. The cost of excavation is about one rupee for six or seven maunds. It is transported to Dosa station on pack bullocks at two annas per maund. Rs. 3,000 is said to be the annual rent paid for the quarry. From Dosa it is sent mainly to Amritsar and some to Cawnpore.

At Gisgarh the bed is only 2 feet thick and the material inferior to that of Dogetha. At Kawa only traces of steatite were noticed in a well.

With regard to Morra-bhandari, the original locality described by Hacket as the source of the stone used by the Agra stonecarvers, Mr. Heron describes the deposit as extending for 5 miles in the form of richer pockets in a stratum concentrated from talcose schist. One of these is mentioned as being about 25 feet thick. Work is only being done at one place 1 mile west of Morra (lat. 26° 49′; long. 76° 51′).

Water.

35. **Itarsi.**—At the request of the Railway Board, Mr. H. C. Jones visited Itarsi in June, on behalf of the Great Indian Peninsula Railway, in order to report on a proposed scheme for a reservoir. The site chosen for the dam proved unsuitable owing to the porosity of all the rocks in the neighbourhood and no suitable site could be obtained.

36. **Rajdaha, Manbhum district.**—In December I paid a short visit to Rajdaha near Topchanchi in Manbhum district, to examine a site for a dam in connection with an important project for a water-supply for the Jherriah coal-field. It is proposed to build a dam across a small valley immediately below the village of Rajdaha and thus to impound a large body of water. The site for the dam had been chosen where a belt of hornblende-gneiss crosses the valley; this appeared to offer a suitable foundation.

Wolfram.

37. **Tavoy.**—Mr. Page continued his investigations into the condition of the wolfram industry in Mergui and Tavoy. The absence of reliable maps has led to serious difficulties in the matter of granting licenses and leases and Mr. Page's work has been largely of a clerical nature with a view to preventing the confusion that inevitably follows the failure on the part of applicants to define exactly the boundaries of the concessions for which they apply. Mr. Page is preparing an *ad interim* report and it is hoped that by the end of the present field-season he will be in a position to make final recommendations.

GEOLOGICAL SURVEYS.

Bombay, Central India and Rajputana.

38. **Mr. C. S. Middlemiss: Idar State.**—Mr. Middlemiss continued his survey in Idar State, begun the previous season, and completed all the main portion of that State, so far as areas of solid geology are concerned, with the exception of a few strips and corners along the north and east boundaries which will be finished off later in conjunction with other outlying parts of Mahi Kantha Agency. The area is included in the following sheets of the 1″=1 mile Bombay Survey (the numbers in brackets refer to the same sheets numbered according to the Central India and Rajputana Survey):—Nos. 119, 143 (120), 144 (121), 145 (122), 146 (123) and 179 (150).

39. The mapping of the calc-gneisses of the Aravalli system, mentioned in the preceding annual report, was continued north of last year's area into the long strip of Idar territory lying between Udepur on the east and Danta on the west. There, in the neighbourhood of Kherod (lat. 24° 14′; long. 73° 3′) an important modification takes place. Instead of being composed as in the Vadali neighbourhood of calcite, quartz, microcline, diopside, wollastonite, scapolite, etc., profusely penetrated by aplite and pegmatite veins, it takes the form of a dark rock composed mainly of crystalline calcite penetrated on a very minute scale by *lit-par-lit* layers of basic hornblende-felspar material (amphibolite), the resulting complex being a precise reproduction in some of its varieties of the amphibolites described by Adams and Barlow in Canada.* This series, which may be called the Kherod amphibolite series, is folded along with garnetiferous mica-schists and phyllites, and seems to underlie to the west the ordinary calc-gneisses of the Vadali area. The full examination of these rocks is still incomplete in the direction of Posina.

40. Other modifications of the calc-gneiss series, with the production of massive idocrase at one locality, and thick beds of white pyroxene and other rocks at another, are referred to in more detail in a separate part of this report (*supra*, paras. 1—3); whilst the steatite, absestos and associated serpentine, magnesite, etc., of Kundol have already been noticed in the preceding annual report and in a short article by Mr. Middlemiss published in the *Records of the Geological Survey of India*, (Vol. XLII, p. 52).

41. Several instructive examples, demonstrating the later intrusion of the Idar granite masses across the sharply truncated edges of the Aravallis with their included older granite veins, were specially noted this

* Geol. of Haliburton and Bancroft areas, Ontario, Dept. of Mines, Geol. Surv. Branch, Mem. No. 6 (1910), pp. 157—172.

no particular effort is made to get large blocks. The deposit is quite structureless except for the jointing, and no clue could be obtained as to its origin; in no place was a junction with the surrounding rock seen. The cost of excavation is about one rupee for six or seven maunds. It is transported to Dosa station on pack bullocks at two annas per maund. Rs. 3,000 is said to be the annual rent paid for the quarry. From Dosa it is sent mainly to Amritsar and some to Cawnpore.

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GEOLOGICAL SURVEYS.

Bombay, Central India and Rajputana.

38. **Mr. C. S. Middlemiss: Idar State.**—Mr. Middlemiss continued his survey in Idar State, begun the previous season, and completed all the main portion of that State, so far as areas of solid geology are concerned, with the exception of a few strips and corners along the north and east boundaries which will be finished off later in conjunction with other outlying parts of Mahi Kantha Agency. The area is included in the following sheets of the 1″=1 mile Bombay Survey (the numbers in brackets refer to the same sheets numbered according to the Central India and Rajputana Survey):—Nos. 119, 143 (120), 144 (121), 145 (122), 146 (123) and 179 (150).

39. The mapping of the calc-gneisses of the Aravalli system, mentioned in the preceding annual report, was continued north of last year's area into the long strip of Idar territory lying between Udepur on the east and Danta on the west. There, in the neighbourhood of Kherod (lat. 24° 14′; long. 73° 3′) an important modification takes place. Instead of being composed as in the Vadali neighbourhood of calcite, quartz, microcline, diopside, wollastonite, scapolite, etc., profusely penetrated by aplite and pegmatite veins, it takes the form of a dark rock composed mainly of crystalline calcite penetrated on a very minute scale by *lit-par-lit* layers of basic hornblende-felspar material (amphibolite), the resulting complex being a precise reproduction in some of its varieties of the amphibolites described by Adams and Barlow in Canada.* This series, which may be called the Kherod amphibolite series, is folded along with garnetiferous mica-schists and phyllites, and seems to underlie to the west the ordinary calc-gneisses of the Vadali area. The full examination of these rocks is still incomplete in the direction of Posina.

40. Other modifications of the calc-gneiss series, with the production of massive idocrase at one locality, and thick beds of white pyroxene and other rocks at another, are referred to in more detail in a separate part of this report (*supra*, paras. 1—3); whilst the steatite, absestos and associated serpentine, magnesite, etc., of Kundol have already been noticed in the preceding annual report and in a short article by Mr. Middlemiss published in the *Records of the Geological Survey of India*, (Vol. XLII, p. 52).

41. Several instructive examples, demonstrating the later intrusion of the Idar granite masses across the sharply truncated edges of the Aravallis with their included older granite veins, were specially noted this

* Geol. of Haliburton and Bancroft areas, Ontario, Dept. of Mines, Geol. Surv. Branch, Mem. No. 6 (1910), pp. 157—172.

season, one being at the N. W. edge of the Dharol hill (lat. 24° 0′; long. 73° 2′) and another at Asai hill (lat. 23° 55′; long. 73° 3′). A few new types were noted among the older aplites and granite veins, one of which is a medium-grained granite with allanite in crystalline grains completely taking the place of the usual ferromagnesian constituents.

42. The exact lie of the Aravalli complex with reference to the succeeding Delhi quartzite is generally not very clear in Idar State, but at one locality near Khercha (lat. 23° 40′; long. 73° 24′) observed last season, the wandering strike directions of the former show complete discordance against and beneath the presumably younger massive Delhi quartzite. The latter itself, whilst building all the rather lofty and sturdy hill ranges, of this part of the country, is also most intricately involved in foldings, twistings and crushings, whose complexity is such as to render any exact reproduction of them in section very difficult; the outcrop and strike are generally self-evident, but evidence of dip in these rocks is not often reliable.

43. The Delhi quartzite again in turn appears to be succeeded on its eastern border by an extensive younger series of soft, thin-bedded and splintery schists or phyllites, of pale drab, yellowish and greenish colours, quite distinct from the Aravallis, and unlike them pierced by no plutonic intrusives, but only by numerous white quartz veins. These build a third type of country, distinct, on the one hand, from that of the alluvium-covered Aravallis, and on the other, from the massive ridges of Delhi quartzite. It consists of long, low, undulating hills with ribs of vein quartz, the whole making a confused, labyrinthine tract of low knolls and intricate stream-beds, the favourite haunt of the Bhils. In its further extension to the east, this series of phyllites merges into those of Dungarpur State east of Isri and Meghraj, where their survey is still awaiting completion.

44. **Mr. H. C. Jones: Gwalior and Tonk.**—Mr. Jones, continuing his survey of last year in Gwalior, proceeded to the southern part of the main area of that State which lies north-east of Bhilsa town (lat. 23° 31′; long. 77° 52′), and is contained in the 1″=1 mile standard sheets, Nos. 374, 375, 376, 392, 393, and 394 of the Central India and Rajputana Topographical Survey. Only towards the end of the season, in March, was he able to continue his survey still further north into a portion of Tonk State adjoining the Bhilsa district. The area surveyed, on its south-west border, marches with that already mapped in detail, partly by E. Vredenburg (season 1897-98) and partly by C. S. Middlemiss, H. Walker and Sethu Rama Rau (season 1904-05). The great diversity of Upper Vindhyan rock stages, from Lower Kaimur sandstone to Upper Bhander, so well exposed in that completed area, was not found, however, to continue into the ground surveyed by Mr. Jones, and

which is now under review. The latter proved to be mainly Deccan Trap and alluvium, with here and there groups of isolated tabular hills composed solely of one or two members of the Upper Vindhyan sequence, namely, false-bedded, purple and mottled sandstone, judged to be of Lower Bhander horizon, underlain locally, as at Udepur (lat. 23° 54′; long. 78° 5′) by greenish and purple shales presumed to be the Ganurgarh shales, and at one place, namely, three miles south-west of Hydergarh Basoda (lat. 23° 37′; long. 28° 14′), by a limited exposure of siliceous limestones. On account of the entirely detached, inlying character of the exposures, surrounded as they are on all sides by wide expanses of Deccan Trap and alluvial valleys, Mr. Jones cannot be absolutely certain of the exact horizons of these rocks (some of which may possibly belong to the Rewa stage).

45. The country, which is a moderately level plain, lies at a general elevation of about 1,800 feet, diversified by isolated hills and hill ranges rising another 400 feet above that. These latter are mostly the sandstone as described above, generally horizontal, but dipping 2° or 3° north-west in the south-west part of the area, and dipping east near Udepur (23° 54′; 78° 5′). The Deccan Trap presents no new features and consists of superposed sheets of dark, fine-grained basalt without olivine and with amygdaloidal layers and interrupted rarely by a very thin and often disrupted bed of Intertrappean limestone and chart, which sometimes becomes a mere collection of residual blocks. No fossils were yielded by these Intertrappeans.

46. Ferruginous laterite and residual laterite lie in frequent but discontinuous patches, especially in the north-west parts of the area. Some fragments of an aluminous variety were noted near Hura (Saugor district). Good cotton soil covers most of the flatter parts, especially those in the north of Bhilsa district.

47. **Economic.**—Nothing of special economic importance is reported. Excellent building and flag stones are of course obtained from the Vindhyans. Ferruginous laterite, once a source of iron, is now largely used as road metal.

48. **Mr. A. M. Heron: Jaipur State.**—Mr. Heron, having in previous years surveyed in detail Alwar State and the neighbouring geologically connected areas to the east, turned his attention during the last working season to the part of Jaipur State lying to the south and south-west of his original base of operations in Alwar. The area surveyed, besides a large portion of Jaipur, includes also the Tonk Pargana of Tonk State, the Chiefship of Lawa and certain detached villages of Bundi State (the Bundi and Lawa areas being completely enclosed by Jaipur territory). This large area is comprised within eighteen standard (1″ = 1 mile) sheets of the Central India and Rajputana

Survey, namely, Nos. 229 to 232, 260 to 265, 288 to 292 and 316 to 318. Of these sheets Nos. 261 to 263, 289 to 292 and 316 to 317 have been completely surveyed geologically, and 264, 265 and 318 finished so far as Jaipur State is concerned.

49. The area, like that previously revised by Mr. Heron, had already over thirty years ago been surveyed by Hacket, and the geology and economic resources outlined in several publications by that author.* Its re-survey was necessary, in continuation of the regular revision of Hacket's work in this area, for reasons explained in previous General Reports. Excluding sheets 288 and 316, mapped in previous years, the rest of the area stretching to the south and south-west is a vast alluvial and sandy plain with only very occasional, narrow, strike-ridges (*mala*) and stripes and patches of rock with north-east—south-west alignments, rising out of that plain. Of these the Lalsot-Toda Bhim elongated ridge-mass stretches for over 40 miles in length, and has been mapped by Mr. Heron as "Delhi system," but described in his report as the Alwar series. Others again, stretching for even longer distances, and sometimes extremely attenuated, expose only the metamorphic Aravallis, with small areas of intrusive granite, pegmatite and quartz veins. In this newly surveyed region, outside sheet 288, none of the lower members of the Delhi system, namely, the Raialo quartzite and limestone, which come normally below the Alwars, have been recognised. Similarly, none of the series above the Alwar quartzite, namely, the Ajabgarh series and Hornstone Breccia, have been certainly detected. Thus the Delhi system is here restricted so far as outcrops are concerned to its middle member, namely, the Alwar or Delhi quartzite series; but it is possible that the other lower and upper members may lie hidden beneath the alluvium.

50. Having revisited the old area of the Raialos, Mr. Heron finally rejects the tentatively expressed idea that the granite is intrusive into them, and now believes them to lie unconformably upon it. It seems now established, therefore, that the Delhi system lies unconformably above the Aravallis and above their intrusive massive granites, though certain pegmatite veins cut through all the systems including, though rarely, the Ajabgarhs.

51. Mr. Heron's report enters very clearly and fully into the description of the new areas. The metamorphic origin of the Aravallis is amply demonstrated by the varying amounts of alteration of them from hardened, though uncleaved, shales to coarsely crystalline biotite schists with staurolite or garnet in great quantity. The dark, impure, thin-bedded quartzites associated with them are deemed to be quite different from the Alwar quartzites (though sometimes marked as such by Hacket) and never like the latter showing ripple-marks. Strictly subordinate

*Rec. Geol. Surv India, Vol. X, pt. 2 (1887), Vol. XIII, pt. 4 (1880), and Vol. XIV, pt. 4 (1881).

to the above are schistose conglomerates, grits and impure argillaceous limestones and epidiorites, of uncertain origin. The general dip is north-west at high angles of from 30° to vertical. The rocks intrusive in these are quartz veins with a small amount of tourmaline, bosses of granite, slightly pressure-foliated, medium-grained and porphyritic, with a groundmass of microcline and a micrographic intergrowth of quartz and felspar; aplite veins; and pegmatites in masses of all sizes from half an inch to many yards across and of medium to extremely coarse grain, their mineral constitution only differing from that of the granites by the presence of tourmaline. The Alwar quartzite representatives of the Delhi system are caught up among the Aravallis in a double or triple set of synclinal folds combined with anticlines by rapid variation in the pitch of the axes, and some of them resemble more nearly those of the Biana Hills (described last year) than those of Alwar.

52. Only one doubtful occurrence of a black brecciated slate near Podampura (lat. 26° 51′; long. 76° 49′) may represent the Ajabgarh series. The rest of the country is a vast expanse of light loam and sand hills, the latter heaped up by the prevailing winds on the western faces of the rocky ridges, but not much resembling the travelling dunes of more desert-like areas, inasmuch as they all bear a scanty vegetation of tall "munj" grass and various small shrubs.

53. **Economic.**—In addition to iron, kaolin and steatite (see paras. 26, 34), Mr. Heron records some trifling occurrences of mica; quartz is also referred to and the garnet workings long since closed, at Toda Rai Singh and other villages to the south and west of Rajmahal.

54. **Mr. N. D. Daru: Dungarpur.**—The survey of the State of Dungarpur was continued by Mr. Daru, who attributes most of the rocks met with to the Aravalli system, the chief types include ortho-gneisses, schists, phyllites, quartzites, boulder-beds and crystalline limestones; Mr. Daru has not yet been able to subdivide these.

Burma.

55. **Mr. P. N. Datta: Kyaukse and Meiktila.**—Mr. P. N. Datta was engaged in the survey of the eastern parts of the Irrawadi valley lying in the districts of Kyaukse and Meiktila and bounded on the east by the hills of the Shan States. The rocks met with consist of young clastic deposits, referred to the Pegu series on the west, and a group of older sedimentary rocks intimately associated with and altered by intrusive granite on the east. The older rocks consist of shale, sandstone and limestone, all frequently metamorphosed; in the absence of fossils, there is no evidence of their age, but Mr. Datta suggests that it may be Palæozoic. Felsite and andesite are also said to occur in this region, but their relationship to the other rocks is not stated.

56. **Mr. G. de P. Cotter: Yenangyaung and Minbu.**—While acting as "Oilfields Officer" at Yenangyaung during the early part of the year, Mr. Cotter visited the steatite mines in the Arakan Yoma and made some notes on the country traversed; no new facts, however, were brought to light. During the latter part of the year, he took up the systematic geological survey of the western part of the Minbu district including Hpa-aing and the eastern flanks of the Yoma; rocks of eocene and of so-called "lower eocene" age were found, the former yielding the usual "Khirthar" fossils. Serpentine intrusions are numerous. Owing to the unhealthiness of the season, Mr. Cotter was obliged through illness to interrupt his work, temporarily transferring operations to a less malarious area until the season should be more advanced.

57. **Mr. H. S. Bion: Upper Chindwin.**—During the latter part of the year, Mr. Bion took up a survey of the auriferous gravels of the Chindwin. His work has been noticed under *Gold* (para. 24).

58. **Sub-Assistant Sethu Rama Rau: Minbu and Pakokku.**—Sub-Assistant Sethu Rama Rau continued the mapping of the Tertiary beds on the west of the Irrawadi in the districts of Minbu and Pakokku. He completed the survey of the area covered by sheets 84 $\frac{K}{11}$ and 84 $\frac{K}{15}$ with the exception of the part already surveyed by Mr. Cotter. In the Minbu district he added the geology to parts of sheets 84 $\frac{L}{5}$, $\frac{L}{6}$, $\frac{L}{9}$ and sheet 110.

59. **Burmo-China Frontier.**—The results of the geological traverses made by Mr. Coggin Brown a few years ago in the neighbourhood of the Burmo-China frontier about Teng-yueh have now been embodied in a paper which will be published in a subsequent part of these *Records*.

60. The rocks met with are classified by Mr. Brown into six subdivisions, *viz.* (in descending order)—

(6) Recent deposits;
(5) later Tertiary deposits of the Taping, Möng-hsa Möng-wan and Teng-yueh valleys;
(4) eruptive volcanic rocks of the Teng-yueh area;
(3) metamorphic rocks of the Kao-liang series;
(2) intrusive granites of the upper Taping valley;
(1) gneisses, schists and crystalline limestones of the frontier hills.

61. The crystalline series (1) covers the greater part of the country between Bhamo and the Salween; in the neighbourhood of Teng-yueh it is hidden as a rule by younger bedded deposits, but inliers of the old crystalline surface often appear. Granite (2) also occurs in considerable quantity.

62. The metamorphic series (3) consists of quartzites and phyllites, very similar to, and probably of the same age as, the Chaung Magyi series of the Northern Shan States.

63. The eruptive volcanic rocks, of which a separate description has been written by Mr. R. C. Burton (*supra*, para. 4) consist of andesites, basalts and pumice. They fall into an "older" and a "newer" group, the former consisting of grey, close-grained porphyritic andesites, which have a characteristic platy structure and are often folded. They are much older than the members of the "newer" group, although no age is assigned to them, but Mr. Brown seems to contemplate the possibility of their being as old as Palæozoic. The newer group consists of massive andesites, which are of Tertiary age and are again older than the black slaggy lavas of the still existing, though no longer active, vents.

64. The later Tertiary, as well as the Recent, deposits of interest are chiefly of lacustrine origin, the older being similar to those of the Northern Shan States and Tongking and probably of late Tertiary, and perhaps partly pleistocene, age.

65. Hot springs are very numerous in the district of Teng-yueh and are regarded as the last manifestations of the earlier intense volcanic activity.

Central Provinces.

66. **Dr. L. L. Fermor and Mr. C. S. Fox: Chhindwara district.**—During the early part of the year, work was carried out by Messrs. Fermor and Fox in the valley of the Kanhan river and its bordering hills. Owing to the intricacies of the boundaries between the Deccan Trap and the Archæan granites and gneisses and the thickly wooded and sparsely inhabited character of the ground investigated, work was necessarily slow, but a total of some 300 square miles was mapped on the one-inch scale (sheet 53, C. P. Survey).

67. **The Archæan floor below the Deccan Trap.**—There is nothing to add to the account of the Deccan Trap formation given in the previous report, except to refer to the gradually decreasing elevation of the base of this formation as one passes from north to south. Thus, near Pardhan Ghogri the elevation of the base of the trap is 2,075 feet, whilst at Koprawari, only some 13 miles further south, it is about 1,400 feet. At the northern end of the valley the Archæan rocks are found to join the main strip of granites running westward from Chhindwara. It is evident from this and from the fact that granites and gneisses crop out on the Satpuras to the east of Seoni, that the Satpura range, which at first sight appears to owe its elevation to the presence of superposed flows of Deccan Trap lavas, is really a feature of the pre-Trap Archæan surface. Although there is a gradual decrease in the elevation of the

boundary between the Deccan Trap and the Archæan in passing from north to south, yet this change of elevation is locally very irregular and by means of aneroid readings it has been possible to detect many features of the pre-Deccan Trap topography. Thus the basal flow of Deogarh Hill and the underlying Lameta sediments, with those to the south-west of this hill, occupy an old river valley at least 50 feet deep.

68. **Nature of Lameta rocks in Chhindwara.**—Detailed examination of this boundary is necessary owing to the local variations in the thin band of rock usually intervening between the Deccan Trap and the underlying gneisses. This band must be correlated with the Lametas, since it agrees in many respects with occurrences seen in other parts of India; but as the result of detailed work it has been found that by far the larger proportion of this Infratrappean formation is not a sediment, but a rock of chemical origin formed either by the silicification or by the calcification of the underlying gneisses. Every gradation has been found from a fresh porphyritic gneiss, through a similar rock partially veined by chert and calcite, to a more completely replaced stage, in which the gneiss is seen in isolated patches in a network of secondary calcite, finally passing into a capping of typical siliceous limestone, to be distinguished in no way from the Lameta limestone of other parts of India.

69. **At Lameta Ghat.**—In November 1912, Dr. Fermor paid a brief visit to Lameta Ghat in the Jabalpur district, the original locality from which the rock took its name; here he found the limestone to be lithologically indistinguishable from the final products of the calcification of the gneisses in Chhindwara. The limestone of this locality rests, however, upon the sedimentary Jabalpur series of the Gondwana system; it will therefore be necessary to make a very careful study of the Lameta outcrops at Lameta Ghat and near Jabalpur in order to solve this problem satisfactorily. Meanwhile it is interesting to note that in thin sections under the microscope the limestone of Lameta Ghat itself shows evidence of secondary calcification. Provisionally, therefore, it may be regarded as probable that a considerable, if not large, proportion of the rock mapped as Lameta in different parts of India is of chemical origin. This would explain the extraordinary scarcity of fossils in the Lameta formation. A great variety of rocks have been found thus, replaced either by silica or by calcite. Amongst them may be enumerated several varieties of granite and gneiss, also hornblende-schist and crystalline limestone.

70. **Sedimentary Lametas.**—The detailed work along the Infratrappean boundaries has shown, however, that true sediments also occur. These are usually grits of various degrees of coarseness and are probably to be referred to the Lameta formation. At two localities Dr. Fermor succeeded in finding fossils. One of these was a specimen

of *Turritella?* in a piece of silicified rock near the hamlet of Kotmi, but a prolonged search did not lead to the discovery of any further specimens, whilst numerous specimens of *Paludina* were obtained from a siliceous grit at the second locality (about two miles north-west of milestone 23 on the Chhindwara-Nagpur road). The only exposure of the Lameta formation of any considerable size is that occupying the valley to the south of Deogarh Hill: it consists partly of grits and partly of clays.

71. The evidence concerning the date of formation of these calcareous and siliceous rocks is not yet regarded as conclusive by Messrs. Fermor and Fox, but in all probability the silicification was effected by solutions derived from the overlying Deccan Trap formation. It is possible that the Lameta limestones have been formed by the superficial replacement of the gneisses prior to the eruption of the Deccan Trap and the deposition of the sedimentary Lametas. If this deduction be correct the calcification and the silicification of the gneisses must be assigned to different periods, the silicification due to the Deccan Trap having affected both the fresh gneisses, the partially calcified gneisses, the so-called Lameta limestones, and the true Lameta grits, fossiliferous and unfossiliferous. In one place this silicification by the Deccan Trap was found to be accompanied by the introduction of heulandite into both the gneisses and the silicified limestones. But, on the other hand, it is much more probable that the calcification has been effected by solutions derived from the overlying Deccan Trap, in which case the calcification and silicification are to be regarded as two stages of one series of chemical processes.

72. **The Archæan rocks.**—The Archæan rocks in the area mapped are almost entirely granites and ortho-gneisses, metamorphosed sediments being practically absent, until the south-east corner of the sheet is approached, where, in the neighbourhood of Nautal, crystalline limestones are found in great variety. The Archæan gneisses are divided into two sections by a zone of intense crushing marked by rolled out and mylonitized gneisses stretching for 15 miles in a west-south-west direction from a point two miles south of Monkher to a point two miles south-south-west of Dhanora. This zone of crushing is accompanied by a strike fault, and the gneisses have been locally brecciated, and to a large extent replaced by white vein-quartz. In the eastern section this fault-breccia is from 50 to 100 feet wide and gives rise to steep bluffs and well-marked ridges; but in the western section it is either completely absent or only from a few inches up to 5 feet wide. The rock immediately north and south of the quartz-breccia is a hornstone-like rock, which, being really a mylonitized gneiss, has been termed hornstone-gneiss. This belt of crushing extends for about a mile to the north of the quartz reef, the degree of mylonitization of the gneiss decreasing with distance from the quartz-breccia. The mylonitized gneisses are succeeded to the north by intimately

associated porphyritic pink biotite-gneisses and melanocratic biotite-hornblende-gneisses rich in sphene. Still further north the foliation becomes less marked and the rocks may in places be termed porphyritic granites. On the south side of this quartz-breccia reef the rocks are mylonitized for a short distance and then give place to well-foliated schistose biotite-gneisses; and from the field evidence obtained it is deduced that the typical schistose biotite-gneisses of the Sausar Tahsil of this district may be merely foliated forms of the porphyritic granites of Chhindwara. The belt of crushing seems to be a fairly sharp dividing line between the porphyritic granite on the north, with its mylonitized and rolled-out derivatives, and the schistose gneisses on the south. Whereas the terms granite and gneissose granite would frequently be applied to the rocks on the north of the fault, the term gneiss is more generally applicable to those on the south.

73. **Their mutual relationship.**—Amongst the rocks south of the fault there are many varieties extremely rich in hornblende with every gradation between coarse-grained biotitic and coarse-grained hornblendic gneiss, whilst near Nautal a small area of true syenites has been found. Several occurrences have been found, also, of microcline-rocks, which must be regarded as an extreme variety of syenite. In many places throughout the Kanhan valley and that of the Nakta nala there are intrusions of pegmatites and of rather fine-grained granites, and although both these rocks seem to be on the whole distinctly younger than the porphyritic granites and their schistose and gneissose derivatives, yet the evidence obtained indicates a general relationship not only between the fine-grained granites and the pegmatites, but also between each of these rocks and the porphyritic granites and associated gneisses, and points to the probability that all these granites and orthogneisses are magmatic relatives and have been derived from one magma. This idea, however, of a common magmatic origin does not preclude the possibility that some of the gneisses may be of considerably greater age than the porphyritic granites and their derived gneisses.

74. **Pegmatites.**—The pegmatities are of considerable interest. Some of them contain only pink potash-felspar, whilst others contain both potash felspar and a white plagioclase, and still others contain only the plagioclase. Some of the pegmatite dykes are very coarse-grained in parts and have the constitution of fine-grained granites in other parts; one dyke in the Nakta nala consists centrally of a fine-grained granite, whilst both edges are very coarsely crystalline and have in places the constitution of a graphic granite.

75. **Epidiorites and basalt dykes.**—In the neighbourhood of Lawaghogri Mr. Fox found a series of lenticular outcrops of epidiorite intercalated along the foliation planes of the gneisses. They show every

gradation between a slightly altered dolerite and a hornblende-schist. In the same neighbourhood Mr. Fox has also traced several basalt dykes of Deccan Trap age traversing the Archæan rocks. In one case, near Narainghat, one of these dykes is directly connected with the overlying flow of basalt.

76. **Continuity of fault.**—The belt of mylonitization and fault-breccia already referred to is covered over at either end by the Deccan Trap lava flows and it is probable that it continues for some distance beneath the trap. If it continues to the north-east it should, if still existent, reappear somewhere in the neighbourhood of Seoni.

77. **Mr. Walker: Betul district.**—Mr. Walker was engaged in surveying the parts of the Betul district represented by standard sheets (1″=1 mile) 36, 37 and 53. The rocks met with belong to the same general groups as those of Chhindwara and include chiefly gneisses, Dharwar schists and Deccan trap, with Infratrappean and Intertrappean beds in places. To the south of a line drawn from Nilajhar (21° 55′; 78° 32′) to Amla (21° 55′; 78° 10′), the only rock found is Deccan trap, whilst to the north of this line gneisses and schists occur. On the whole, the gneisses play only a subordinate part; they consist of schistose biotite-gneiss with occasional patches and veins of aplite and intrusive masses of epidiorite and hornblende-schist. Dharwar schists are infolded with the gneiss along its margins. The Dharwar rocks comprise three general types, *viz.*, argillaceous sediments, as represented by phyllites, to the north of Kalmeshara (22° 2′; 78° 21′); micaceous quartz-schists and quartzites (metamorphosed arenaceous sediments) to the south of the same place; and old intrusive rocks now represented by epidiorites similar to those of the Kanhan valley, and found at Bordhai (22°; 78° 23′) and Harnia (21° 59′; 78° 22′).

78. Of the Infratrappean beds, Mr. Walker regards five small exposures, consisting of conglomerates, grits and clays, as perhaps of true sedimentary origin; between Nilajhar and Banga (21° 55′; 78° 25′) the trap is usually underlain by limestone and chert, which, as in Chhindwara, are regarded as due to secondary replacement of the underlying crystalline rocks through the contact action of the trap.

79. The Deccan trap is from 400—500 feet thick; the upper and lower flows are vesicular and crowded with geodes of quartz and chalcedony, but zeolites are rare. A slight dip to south-west has been noticed in the basalt flows. Basalt dykes have been found penetrating the crystalline rocks.

80. Intertrappean beds occur at three horizons; they are of the usual type and are often fossiliferous.

81. The schists and gneisses of the Bel valley show signs of considerable disturbance: faults are common, and, in the Dharwar schists, are

accompanied by brecciation; this has given rise to a series of ridges, which form conspicuous features in the local topography.

82. **Sub-Assistant Vinayak Rao: Seoni district.**—After accompanying Dr. Fermor for some six weeks and having become familiar with the sections in the Nakta nala, Sub-Assistant M. Vinayak Rao was sent to commence work on sheet 90 in the Seoni district, with special instructions to search for the continuation of the strike-fault and belt of crushing. He succeeded in finding crushed gneisses and in one place a breccia, approximately where expected. But the dynamic effects seem to be feebler in Seoni than in Chhindwara and split up into more than one belt. In conformity with this the general distinction between more granitic rocks on the northern side of the crush zone and more gneissose rocks on the south is less readily apparent than in the Kanhan area. In the time at his disposal Mr. Vinayak Rao nearly completed a preliminary survey of the whole of this sheet, the boundaries between the Deccan Trap and Archæan rocks being largely obscured by soil. To the south of Seoni a considerable area of laterite was discovered resting on the Deccan Trap, the thickness of the laterite being in one place as much as 140 feet.

83. In his progress report Mr. Vinayak Rao reports the discovery of two dykes near the village of Suktara, two miles north-west of Kanhiwara Railway Station. These have each a very irregular course and vary in width from a few inches to 2½ feet; they are of tachylytic character, with chilled glassy borders.

Kashmir.

84. **Messrs. C. S. Middlemiss and H. S. Bion: Kashmir.**—During the summer months Mr. Middlemiss, with the assistance of Mr. H. S. Bion, continued the revision of the geology of Kashmir. Work was taken up in the neighbourhood of Srinagar and continued round the north end of the valley, including also a portion of the Kishenganga drainage, during the first months of the season, and afterwards in the direction of the Marbal, Hoksar and Changam passes at the south-eastern extremity of the valley. Extensive new collections from the various old and some new horizons of the Silurian-Trias sequence have been made, and the mapping of the area in as much detail as possible carried on to a point where another season, it is hoped, will see the conclusion of the revised survey of the valley of Kashmir proper, that is to say, of all that portion lying within the Jhelum drainage area. It is also hoped that the new 1″=1 mile maps recently made by the Survey of India will be used in this work, which will serve as a valuable basis for the larger and more difficult task of mapping the complicated metamorphic areas to the north, including Baltistan, the Karakoram and the Hindu Kush.

85. Among special results attained, the following may be mentioned: at Tregam (Trigamma) the limestone masses, as also those shown at intervals beyond to the north into the Kishenganga drainage and west again near Zunaresh, were found to be interbedded with the old slate system, and not to belong to the Zanskar system. This was verified by finding at several horizons in the slates interbedded with the limestones a Silurian *Orthis* fauna similar to that of Gugaldar, Gudramer and the Margan pass; the agglomeratic slate series, which comes between the Fenestella series and the Panjal Trap, and which hitherto had yielded no fossils, has now been found to contain at least two life zones, one coming a few feet below the base of the Panjal Trap and the other much lower down. Both are characterised by a rich *Syringothyris* fauna, together with a *Spirifer* allied to *S. Lydekkeri* Dien., *Fenestella*, *Productus* and *Camarophoria*. The lower horizon has so far been found only in the Marbal valley on the way towards the pass; it is very rich in material and of considerable thickness. The upper one is much thinner and is found in the Marbal valley and also at Nagmarg in Lolab.

86. A *Glossopteris* flora, with *Gangamopteris* and *Psygmophyllum*, has also been found just below the Panjal Trap in the Nagmarg sections.

87. In the Manasbal and Bandipur sections, Lydekker's conclusion that no Kuling series is there represented above the Panjal Trap was confirmed, and the most probable inference drawn that the volcanic activity of the Panjal Trap epoch extended up to the base of the Upper Trias in those parts, whilst again in the Imbersilwara hill mass, trap appears to be interbedded with the Upper Trias in a remarkably clear section.

88. A very rich Muschelkalk fauna has been found at many new places in the south-eastern part of the valley. In the Marbal valley the section from Karbodra down to Prumu in the Tansan river shows a wonderfully clear exposure, of about 20,000 feet thickness, through the Silurian-Trias sequence in fine normal folds of 15,000 feet double amplitude.

89. It is difficult to exaggerate the importance to Himalayan stratigraphy of the many discoveries made by Mr. Middlemiss in Kashmir during the last few years, for they have led to the solution of all those vexed questions which have hitherto barred the way to a satisfactory correlation of the various systems in the Jhelum basin with their less complicated representatives in Spiti and Kumaon. Of the work now under review the most striking feature is the complete manner in which Mr. Middlemiss has worked out the age of the Panjal Trap which he has shown to extend from Lower Gondwana to Upper Trias in some places, whilst disappearing in others at the end of the Permian period.

Punjab.

90. **Dr. G. E. Pilgrim: Salt Range.**—From February until May 1912, Dr. G. E. Pilgrim was at work on the northern edge of the Salt Range, where he mapped in detail the ossiferous areas round Chinji and between Hasnot and the river Jhelum, collecting fully from the various stratigraphical zones. The following results of his observations are regarded by Dr. Pilgrim as of chief importance:—

(1) the occurrence at a low horizon in the Middle Siwaliks at Nagri of a fossil fauna believed by Dr. Pilgrim to be intermediate in character between that of Dhok Pathan and that of Chinji;

(2) the apparent absence of *Hipparion* from the lower 1,500 feet of the Chinji beds;

(3) the existence of unfossiliferous strata of Siwalik type, 1,700 feet thick, below the Chinji fossiliferous zone. This had previously been noticed by Mr. Vinayak Rao, who had, however, assigned the beds to the Gaj;

(4) in the Chambal ridge near the Jhelum river, a very distinct unconformity between the Upper and Middle Siwaliks. Many feet of Middle Siwalik strata are entirely missing including the fossiliferous horizon of Hasnot, the equivalent of that of Dhok Pathan. Going towards Hasnot the upper beds gradually come in, and the unconformity diminishes, though it is nowhere, perhaps, entirely absent;

(5) the fossils of the basal beds of the Upper Siwaliks at Tatrot, Kotal Kund, and some other localities have been erroneously united by previous collectors with those of the Middle Siwaliks of Hasnot, and Dr. Pilgrim now considers it necessary to remove from the Middle Siwalik fauna *Hippohyus*, *Sus giganteus*, certain bovines allied to *Bos* and *Anoa* and most of the *Hippopotamus* remains. These occur in the basal beds of the Upper Siwalik associated with *Hipparion*, *Stegodon*, and *Mastodon sivalensis*, it being noteworthy that no trace of either *Equus* or *Elephas* has been found.

91. Dr. Pilgrim considers that these facts, taken in conjunction with the recent discovery by Dr. G. Schlesinger of *Elephas planifrons* in a low zone of the middle pliocene near Vienna, afford additional evidence for the pontian age of the Middle Siwalik fauna of Dhok Pathan and Hasnot. He proposes the following classification for the Siwaliks of the

Salt Range, based partly on his past season's work and partly on the collections made from the Simla hills in 1911 by Mr. Vinayak Rao:—

			Feet above base.
Upper Siwalik	Boulder-bed zone.	With *Camelus Equus, Elephas hysudricus.*	15,000—17,000
	Pinjor zone .	Pebbly sandstones with *Hipparion* and *Elephas planifrons.*	11,500—15,000
	Tatrot zone .	Conglomerates and grits with *Hipparion, Hippopotamus, Hippohyus* and *Mastodon sivalensis.*	10,000—11,000
Middle Siwalik	Bhandar beds .	Unfossiliferous sandstones and clays.	9,500—10,000
	Dhok Pathan zone.	Sandstones and clays with *Mastodon, Stegodon, Tetrabelodon, Hipparion,* large antelopes and giraffoids and *Tragocerus.*	8,500—9,500
	Nagri zone .	Sandstones and clays with *Hipparion,* large antelopes, *Giraffokeryx* and a large giraffoid.	5,500
Lower Siwalik	Upper Chinji zone.	Red nodular clays and sandstones with *Tetrabelodon, Hipparion, Hyæna, Hyotherium, Giraffokeryx, Protragocerus,* and a large antelope.	3,200—4,000
	Lower Chinji zone.	Red nodular clays and sandstones with *Tetrabelodon, Hyotherium, Giraffokeryx, Protragocerus* and small antelopes.	1,700—3,200
	Lower Manchhar zone.	Sandstones and concretionary beds, unfossiliferous in the Salt Range: in Sindw ith *Brachyodus* and *Hyoboops.*	Basal beds.

GEODESY.

BY

LIEUTENANT-COLONEL G. P. LENOX-CONYNGHAM, R.E.,
Superintendent of the Trigonometrical Survey.

PRINCIPAL TRIANGULATION.

Bengal and Madras.

Orissa Division and Ganjam District. The Sambalpur Series.

At the time of submission of last year's report to the Board of Scientific Advice, this series, which emanates from the Calcutta Longitudinal Series in latitude 23° 30′, longitude 85°, had been carried southward along the meridian of 84° as far as latitude 22°, to a point about 30 miles north of Sambalpur. During the season 1912-13, the series has been extended, still following the same meridian, through Sambalpur, the Orissa Feudatory States, the Khondmals and into the Ganjam District of the Madras Presidency, reaching a mean latitude of 19° 30′.

The heavily wooded, inhospitable, tractless country through which the triangulation had to be carried, put many difficulties in the path of the observer and gave promise of but slow progress. Nevertheless, two quadrilaterals, two tetragons and one hexagon were fully completed while a third quadrilateral was partially observed, extending the series by 167 miles. The area covered by these figures is 5,014 square miles.

The observations were made with Messrs. Troughton and Simm's 12 inch micrometer theodolite No. V. The average triangular error exhibited by the 22 triangles is small, 0·185″, the largest triangular error amounting to only 0·564″.

Two astronomical azimuths were observed, one at Sendur in latitude 20° 16′ and the second at Andhari in latitude 21° 58′.

After March 15th, no observing was possible on account of the haze and the smoke of forest fires, and operations had to be suspended.

Of this series, three more figures remain to be completed to effect a junction with the East Coast Series in the neighbourhood of Parlakimedi.

SECONDARY TRIANGULATION.

Central Provinces.

Nimar and Betul Districts and Central India Agency. (Indore State.)

To meet present topographical needs, secondary operations were commenced in the western portion of the Central Provinces and in the Central India Agency.

The Khandwa Series

This series, 141 miles in length, has been carried along the parallel of 22° between the Great Arc Series in longitude 78° and the Khanpisura Series in longitude 75°. It consists of 22 triangles covering an area of 1,820 square miles.

The observations were made with an 8 inch micrometer theodolite. The average triangular error was found to be 1·41″.

The Akola Series.

This is a meridional series emanating from the Khandwa series in longitude 76° 30′. During 1912-13, only the first four stations were selected and built. The series will be carried southwards during 1913-14 to effect a junction with the Bir Series in latitude 19°.

Eastern Bengal and Assam.

The Manipur Series.

A commencement has been made on a secondary series which will connect the Assam Valley triangulation with the Manipur Meridional Series. It will eventually form part of the latter and the observations have, therefore, been carried out with a 12 inch theodolite similar to that used on the Manipur Meridional Series.

In March, low-lying haze covered the country through which the triangulation was being carried and rendered further observations impossible. Had it not been for the unfavourable atmospheric conditions, the series would have been completed. Seven triangles still remain to be observed.

Khasi Hills. The Khasi-Garo Hills Series.

In 1909-10, the Khasi and Jaintia Hills secondary series were run west and east from the Eastern Frontier Series in latitude 25° 30′. As,

however, this latter series was known to have been seriously disturbed by the earthquake of 1897, the positions of stations of the secondary series could be considered as only provisional until a connection could be made with a principal series further to the westward, out of the disturbed area. The opportunity to effect this connection was not forthcoming till this last season, when the Garo Hills secondary series was completed, joining up the Khasi and Jaintia Hills series with the Brahmaputra Meridional Series. The co-ordinates of points of all three secondary series will be recomputed, using the data afforded by the latter principal series.

Bombay.

Bombay City and Island Triangulation.

This triangulation, to serve as a framework for a large scale city survey, was commenced in 1911-12. It has now been completed and supplemented by precise traverse work. The framework comprises 112 permanent points distributed over the city and island. The positions of 65 of these have been determined by triangulation based on a side of the Bombay Longitudinal Series. Of the remaining points, the co-ordinates of 26, situated in the southern and central portions of the island, have been found by running traverses between the triangulated points. The positions of 21 points in the northern part of the island still remain to be determined by traverse.

On account of the difficulty of devising and erecting signals for observation in the densely crowded portions of the island, the determination of co-ordinates by the methods of triangulation could not be effected for all the points it was proposed to introduce into the framework. Recourse had, therefore, to be made to traverse operations. To obtain the requisite degree of precision, the steel 100 ft. tapes which were used (invar tapes not being available at the time) were compared daily with a standard of length laid down between brass plates set in the verandah floor of a suitable building; the temperatures of the tapes were determined from time to time during the day's work; the tapes were strained by the action of weights suspended over pulleys and auxiliary apparatus, reference marks, observation signals, etc., were specially designed.

In the computations, corrections for the temperature of the tape at the time of observation have been applied and all linear measurements have been reduced to terms of the standard length.

Final results are not yet available, but it may be of interest to note that the difference found between two linear measurements of the same traverse line made on different days amounted to 0·06 ft. in 5,131 ft., the ratio of difference to length measured being thus 1/85,500.

Kashmir.

Indo-Russian connection. Hunza Valley.

In 1909, the International Geodetic Conference passed a resolution embodying the desirability of establishing a junction between the Indian and Russian systems of triangulation. Accordingly, during the summer months of 1911, reconnaissances were undertaken of the country intervening between the Kashmir Principal Series and the Pamirs with a view to discovering a practicable route to be followed in making the connection. Three schemes were suggested to the officers entrusted with the reconnaissances. The first was to extend the Kashmir Principal Series as far as the Sakiz Jarab range, on which stations would be established to the east of the Darkot pass. From these points, it was hoped, observations might be made to Concord and Salisbury peaks on the Afghan Russian border, which peaks would be included by the Russian observers in their triangulation on the Pamirs. The investigation of the practicability of this scheme was undertaken by the late Lieutenant Bell, R.E. He reported that the main chain of peaks of the Sakiz Jarab range was inaccessible and that the hills immediately to the south, only a little less difficult to negotiate, though they offered a satisfactory view to the north, were hidden from the south by high inaccessible masses effectually obstructing triangulation carried from the terminal points of the Kashmir series.

A second scheme involved the carrying of secondary triangulation from the principal series up the Yasin and Karamber valleys to the neighbourhood of the Gazan and Bhort passes, from which the Concord and Salisbury peaks might be visible. It was found that such triangulation could be carried as far as Harmot, but that, beyond this place, the valley narrows between precipitous hills to such an extent as to render further progress impossible.

The third alternative scheme was for secondary triangulation to break off from the principal series just south of Gilgit and to follow the Hunza and Kanjut valleys as far as the Kilik and Minktaka passes and from thence to extend over the Taghdumbash Pamir to a junction with the Russian points. This was found to be practicable. The valley as far as Hunza is comparatively open and the hills, though difficult, not inaccessible. Beyond Hunza, though the valley narrows somewhat, fairly well-conditioned figures can still be laid out as far as Misgar. Here in order to obtain triangles of sufficient length of side the series has to turn westward, out of the valley, and, bending again in a northerly direction, approach the Kilik pass from the south-west. From this pass the triangulation can be easily carried across the Taghdumbash Pamir to the Russian points near the Beyik pass.

It proved to be impossible to complete the whole of this connection in the season of 1912. The season was a short one and the detachment was continually hampered by unfavourable weather. Further, the death of Lieutenant Bell, R.E., who was in charge of the operations, caused a short cessation of the work and a dislocation of the arrangements made for its execution. The whole course to be followed by the triangulation was, nevertheless, reconnoitred in detail and, except for a distance of some 30 miles, the stations were selected and built. At a few of the stations at the northern and southern ends of the series observations were completed.

Operations were suspended between the end of October 1912 and May 1913, when the detachment returned to complete, it is hoped, the observations remaining to effect the desired connection.

Note on the Base Line Apparatus of the Survey of India.

As the Survey of India is now, after an interval of 32 years, about to turn its attention once again to base line operations, it may, perhaps, be of interest to review the past connections of the Department with work of this nature, more particularly in regard to the apparatus used, and to consider briefly the methods and equipment that will be employed in the measurements about to be undertaken.

When considering the past base line operations of the Survey of India, we find they fall into two groups, one covering measurements made between 1800 and 1825 and the second those between 1830 and 1870. From the end of the period covered by the second group till the present time, excepting one base measured in 1881, no operations of the kind have been undertaken.

We are now on the eve of a period which will give us a new group.

The triangulation has extended both to the east and to the west considerably beyond the network controlled by the base lines of the second group and additional lines for the verification of the new figures have been among the most prominent of geodetic desiderata during the past decade.

Between 1802 and 1825, during the first phase of development of the Survey of India, eleven base lines, the first operations of the kind carried out in India, were measured by Colonel Lambton. They were used to control the great network of triangulation which was then being extended over the southern portion of the peninsula, from Cape Comorin as far north as the parallel of 19°, for the purposes both of geodetic research and of topographical surveying. Below the latitude of 16°, eight of these base lines were distributed at intervals of from 90 to 250 miles over the whole area of the peninsula. The remaining three lines were

situated close to the meridian of 78°, between latitudes 16° and 24°, and were intended as checks to triangulation carried out mainly for geodetic objects.

The apparatus then available consisted of two 100 ft. steel chains, by Ramsden, and a 3 ft. brass scale made by Cary. One of the chains, received by the Survey in 1802, having been compared with the "standard in London" was never used in the field, but was maintained as a standard of reference with which the older chain was compared from time to time. This latter chain had a curious history, having been originally destined as a present to the Emperor of China and refused by him. It was afterwards taken to Calcutta where it was bought by Lord Clive, then Governor of Madras, and made over to Colonel Lambton.

The manner in which the measurements were performed was not always the same. At some of the base lines the chain was laid in a series of five wooden coffers, supported on posts and adjusted to the horizontal from end to end. The chain was strained by the weight of an $8\frac{1}{2}$ inch shell suspended from the forward end, the rear end being attached to a post by a device which permitted of adjustment of the rear defining mark over a reference mark on the ground. The transference of the defining marks to the ground was effected by means of a plummet. Five thermometers were placed alongside the chain in the coffers and the mean temperature indication was recorded. At other bases, the coffers were dispensed with, and the chain, laid on the ground carefully prepared beforehand, was strained by two small capstans. The tension thus produced could not be estimated nor regulated.

As linear units for geodetic survey, these chains were unsatisfactory. During the latter half of the period of their use, doubt gathered about the assumed invariability of the standard chain. There was no satisfactory means of checking its length and, in addition, there arose uncertainty as to the unit that had been employed in laying off its original length. Efforts were made to determine the amount of variation of the chain by periodical comparisons against a 100 ft. length laid off on a low wall by means of Cary's 3 ft. brass scale and a large beam compass, a procedure not calculated to lead to results of the precision requisite in operations of this nature. The results of these experiments threw suspicion on the accuracy of the comparisons and on the value assumed as the original length of the chain and led to a decision to reject the bases measured with it, as being insufficiently accurate for geodetic purposes and to obtain more efficient apparatus for the measurement of new lines on which to base the geodetic triangulation. This decision put a period to the first group of base line operations.

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For the measurement of the lines which form the second group, the survey acquired, about the year 1830, two standard 10 ft. bars of wrought

iron and the Colby apparatus of compensated bars and microscopes. The bars were designated A and B and were of simple design. The section was a rectangle, 2 inches in depth by rather less than 1 inch in breadth, the ends of the bars being cut away to half their depth to allow of the defining dots, marked on platinum plugs, being placed in the neutral axis. Each bar was supported by rollers at one-quarter and three-quarters of its length.

Bar A became the Indian 10 ft. standard while Bar B appears to have been used as a means of comparing the Indian standard with those of other geodctic surveys. Bar A remained in India till the year 1908 and was used at the eleven base lines measured between 1832 and 1870, and in 1881. In February 1908 it was sent to Sevres to be compared with the international metre and returned to India in November of the same year. Bar B was sent to England in 1843 and was made over to the Ordnance Survey. Between that date and 1865, it was compared with the Ordnance standards and, by Captain A. R. Clarke at Southampton, with the 10 ft. supplementary bars $/_B$ and $/_S$ which were made for the Great Trigonometrical Survey in 1864.

From these comparisons, the relation between Bar A, defining 10 Indian feet, and the English standard yard was found to be—

Bar A = 3·33331886 times the yard at 62° F.

This value was determined by combining Captain Clarke's results with quantities observed by officers of the Great Trigonometrical Survey at Dehra Dun. Into its derivation, comparisons involving the Bars B and / were necessarily introduced.

Viewed in the light of modern comparisons, the precision of this quantity cannot be highly rated. The comparison was not a direct one; it was built up of observations some of which were made in 1865 at Southampton, others between 1867 and 1870 at Dehra Dun. Between the two periods, the bar $/_S$, which formed a link in the chain of comparison, made the voyage from England to India, and whether, during the period between the observations in England and those in India, the bar underwent any change of length there was no means of ascertaining. The bars were of materials possessing large coefficients of expansion and the precise determination of their temperatures during comparison was of the highest importance; the means then available, however, of ensuring steadiness of temperature and of providing that the thermometer reading should truly indicate the temperature of the metal bar must, to-day, be considered imperfect. In addition, judged by modern standards, the defining marks on Bar A cannot be held to admit of precise comparison. These marks are dots graved by a needle in platinum plugs and, when compared with the fine lines cut on a modern standard, they appear of excessive size, imperfect both in quality of outline and in shape.

However, this question of the relation of the Indian to foreign standards was, at the time, mainly academic. The uniformity of unit that now exists among associations and departments occupied in geodetic research had not yet established itself. There was no necessity for the reduction of our measurements to terms of any foreign unit. Bar A was accepted, not as an intermediary, but as the ultimate unit, whatever its length might be, of the Indian Survey. The junction of the Indian Survey with foreign operations was a factor so distant in the future as to be of negligible weight in considering methods and equipment.

The lengths of the base lines were first measured by the Colby apparatus and afterwards reduced to terms of Bar A by means of the relation of the Colby bars to this standard. The Colby apparatus consists of a set of six compensated bars and microscopes, the lengths of each of which was determined by comparison with the standard. A detailed description of the apparatus and the method of its use is given in the departmental records and it will be sufficient to remark here, that the term "compensated" was used in view of the fact that, in the construction of the bars and microscopes, advantage had been taken of the differences of the thermal expansions of brass and iron to devise an apparatus which would, theoretically, indicate a certain invariable length unaffected by changes of temperature.

The comparisons between the Colby bars and the standard A were made by bringing each bar in succession into the line joining the focal points of two microscopes erected, at a distance apart closely approximating to 10 ft. on masonry pillars. Micrometer measurements were then made with each microscope to the defining dots of the bar adjusted below it. A comparison of the measurements thus made gave the linear relation between the bars. The temperatures of the latter were assumed to be those indicated by thermometers, the bulbs of which were placed in small wells cut in the body of the bar and filled with mercury or oil to provide contact between the metal of the bar and the bulb. Some provision was made to procure steadiness of temperature during the comparisons by enclosing the bars in wooden cases, by protecting the comparison room from the sun's rays and by preventing the admission of the outer air.

Between 1832 and 1869, ten bases, all but one of lengths varying from 6·4 to 7·9 miles in length, were measured with this apparatus, one of them being the old chain measured base at Sironj. They served to control the geodetic triangulation which, in 1870, had extended over the whole of India Proper. Since 1870 only one base line has been measured. This was in 1881, at Mergui, to provide a linear datum for the operations about to be carried over Burma.

On these eleven bases, from 275 to 750 miles apart, depends the whole of the triangulation of the Survey of India, as it now stands.

During the last thirty years this triangulation has spread over Burma, on the east, and Baluchistan, on the west. In the north-east of Burma the triangulation has reached a point 700 miles from the nearest base in India and 1,000 miles from its own base in Burma. In the west of Baluchistan, there is triangulation 700 and 800 miles, measured along the chains of triangulation, from the nearest Indian bases. The necessity for providing some check for all this outlying triangulation, in the shape of additional base lines, has given rise to the third period of base line operations upon which we are about to enter.

The measurement of new base lines reopens the question of standards and measuring apparatus, questions, in some respects not so easy of solution to-day as they were eighty years ago. The science of geodesy has developed enormously, even in the last forty years, in matters connected with both methods and instruments. The range of materials and design of apparatus from which selection has to be made is greater now than formerly and, at the same time, greater care has to be exercised in making the selection as the criteria of good work have become more exacting. The creation of an International Geodetic Association has so stimulated interest and endeavour in the various branches of geodesy that, though sympathy and co-operation have been thereby fostered, questions which formerly roused merely local discussion, now attract widespread attention and possibly draw a greater variety of opinions to be weighed and considered. Moreover, in India, we are now effecting our first junction with a foreign system of triangulation and it is probable that in the not distant future we shall form other connections both to east and west, and matters, at one time only affecting ourselves and admitting of a purely local solution, must now be considered with a wider outlook.

When we came to enquire into the standards of accuracy now established abroad, the necessity for the adoption of such standards, and the possibility of attaining the necessary precision with our existing apparatus, it became quite evident that the old base measuring apparatus would have to be discarded. The lowest degree of precision now required in the case of a geodetic base may be represented by $\frac{1}{2,500,000}$ and a failure to attain this standard would almost certainly lead to the subsequent geodetic operations being considered as of almost negligible value. The Colby apparatus is unable to attain this degree of precision. The "compensation" principle involved in its construction, though sound in theory, was impossible of perfect materialisation. Though the thermal expansion of the Colby unit had been reduced to a very small quantity, the effects of changes of temperature had not been eradicated entirely. There was difficulty in ascertaining the temperature of the components of the unit and it had to be assumed that the temperature was the same for each component. The changes of temperature during field opera-

tions were often considerable and the validity of this assumption was very doubtful.

Moreover, by reason of the complexity of the apparatus, the many adjustments that had to be made and the cumbrous nature of the pieces, the field practice was laborious and slow. Though, in its day, it was probable the best base measuring apparatus that had been devised, it must now give way to modern apparatus more portable and simple, yet, at the same time, permitting of the attainment of a higher degree of precision.

The apparatus generally in vogue to-day is designed, in one form or another, to apply Jäderin's system of measurement by wires hung in catenary. This type of apparatus, simple of construction, has been found to combine high accuracy with great portability, rapid progress and simplicity of field procedure. It is an apparatus of this nature that has been chosen to supplant the Colby bars.

But, entangled with the question of measuring apparatus was that of standard and unit. The accuracy of a measurement with any base line apparatus depends ultimately on the precision with which a certain length can be laid off with the basic standard. It had to be considered whether the precision attainable in an operation of this kind made with the present 10 ft. Bar A was of a degree that allowed full advantage to be reaped from the accuracy of measurement attained by the wires themselves; whether the quality of Bar A, as a standard, was sufficiently good to justify its being used in combination with the new apparatus. The enquiry into these matters made it evident that the precision attainable by the intermediary instrument, that is to say, the apparatus with which the actual measurements will be performed, is of a higher order than that inherent in the ultimate unit, the standard, and the retention of the latter could not be justified. It was necessary to declare as obsolete, not only the Colby bars, but also the standard Bar A of 1832. Both measuring apparatus and standard having to be replaced by modern types, the question arose whether this new equipment should be in terms of the foot or the metre. For the sake of simplicity in the operation of comparing base line apparatus with standard, all the equipment should be in terms of one and the same unit. For the purposes of geodesy, it was immaterial which unit was adopted, but, in consideration of the fact that the metre has been adopted now by practically all other geodetic bodies and for the sake of uniformity and the simplification of discussions dealing with work common to our own and to other systems of triangulation, in which the metre would most probably be the unit, it seemed desirable to abandon the foot and to adopt the metre.

The outcome of the decision to use the metre as the unit of future operations will be that the base line measurements of the third group

will be in terms of an abstract unit, whereas those of the second group were in terms of a concrete unit, Bar A.

The change of unit having been decided upon, new metre standards and base line apparatus were designed and constructed for the Survey of India. The equipment of standards consists of two 4-metre bars, one of invar, the other of nickel-steel (42 per cent. nickel) and two one-metre bars, one of invar and the other of pure nickel. They are all of the same type of section, a flanged H with the defining graduations cut on the upper surface of the cross bar. The 4-metre bars are graduated at every metre of their length, permitting of the determination of their linear value in terms of the one-metre bars.

If it be found that the use of a 4-metre bar is necessary in the field, the invar bar will in all probability be employed as the field standard while the Ni-steel will be maintained in Dehra Dun as a reference bar.

The most important desiderata in regard to a standard bar are a small thermal expansion and a great molecular stability. So far no metal or alloy has been found to combine in itself these two characteristics and it is to allow us to profit by the advantages conferred by both that two 1-metre bars have been provided. The invar bar, having a small thermal expansion, is little susceptible to changes due to temperature variations, while the nickel, though having a much larger coefficient of expansion, is more stable than the invar and less subject to molecular changes.

The length of each 1-metre bar has been determined in terms of the international metre.

Modern ideas of accuracy and the high degree of refinement attained in the construction of standards of length and observing instruments demand the taking of extreme precautions in the carrying out of bar comparisons. The chief difficulties to be contended with arise from changes and irregular distribution of temperature and, consequently, we find in modern comparators elaborate devices for ensuring steadiness and controllability in this respect. The old type of comparator existing at Dehra Dun, in which bars under comparison were but indifferently protected from temperature disturbances, will be replaced by apparatus permitting of the control of temperature to $0^{\circ}\cdot01$ C. and by which almost perfect uniformity of temperature distribution is secured.

The description of this new comparator is briefly as follows:—

On two masonry pillars, about 2 ft. high and 15 ft. apart, rests an iron box-girder, suitably protected from the effects of changes of temperature. Held in mountings capable of movement along the face of this girder, are two microscopes fitted with micrometer eye-pieces. The mountings can be clamped at any point on the girder, permitting of

the microscopes being placed at any distance apart from 0·5 metre to 4 metres. Below the girder, on rails laid transversely to its length, travels a platform carrying two tanks, each about 14 ft. long. These tanks are fitted to receive the bars under comparison. One tank will accommodate two bars, side by side, while the second will take only one, the bars being so placed as to be entirely immersed when the tanks are filled with water. In connection with the tanks are motor-driven pumps, capable of circulating the whole of the water in the tanks in 90 secs. In the circuit between the pump and the larger tank are an electric heater and a thermostat. By the operation of the former, the temperature of the water can be raised by rather more than 3° C. per hour. The thermostat is designed to automatically control the action of the heater so that, when the water has been brought to any required temperature, it can be steadily maintained within 0°·01 C. of this point. The temperature is indicated by several thermometers placed alongside the bars.

The small tank, having no heater, is designed to maintain the bar within it at a steady normal temperature. The larger tank provides the means of raising one or two bars to, and keeping them at, any temperature, for the time being abnormal.

By suitably selecting the positions of the microscopes on the girder and traversing the platform along the rails till a bar arrives in the correct position below the microscopes, micrometer observations can be made on the terminal graduations of the bar. If two bars are brought in succession under the microscopes, comparative readings can be made which will allow of the length of the one being deduced in terms of that of the other.

The provision of two tanks, in one of which the temperature may be regulated as desired, makes it possible to carry out a series of comparisons between two bars, one of which is maintained at a constant normal temperature for the whole duration of the observations, while the other is brought to a different temperature for each comparison of the series. Utilising the length of the bar under constant temperature as a datum for the time being, the length of the second bar at varied temperatures can be determined and the characteristics concerning its dilatation investigated.

By placing both bars under comparison in the same tank, determinations can be made of their relative lengths at any and the same temperature.

The comparator thus affords means of investigating the coefficients of expansion of the bars and of determining their lengths in terms of an adopted standard.

The base measuring apparatus consists of a set of 24-metre invar wires designed for use by Jäderin's system.

The determination of the length of a base necessitates the adjusting of the wire in successive positions which, starting from one end of the base, finally close on its further terminal. In each position of the wire the points defined by its limiting graduations are indicated by adjustible reference marks. The mark indicating the forward graduation of the wire in one position becomes the point to which the back graduation must be made to correspond in the next successive position. The determination of the true distances between these reference marks in each position constitutes the fundamental operation in the measurement of a base.

In each position, the wire is hung "in catenary," supported on two pulleys and strained by the action of weights.

The final length of the base is derived by combining the individual measurements given by each of the set of, generally, three wires.

To arrive at the length of the base, it is necessary to know the relation of the distance between the terminal graduations of the wire when hung in catenary, to the ultimate standard. To obtain this relation between our 24-metre wires and the international metre, a 24-metre comparator will be erected in Dehra Dun. The comparator consists of seven microscopes, securely mounted at intervals of 4 metres along a low masonry wall. Below the microscopes are laid rails along which travels a cradle designed to carry one of the 4-metre bars. By moving the cradle along the rails and thus bringing the 4-metre bar opposite each of the 4-metre intervals between microscopes, in succession, and by taking micrometer readings with each microscope of the bar graduation below it in the successive positions of the bar, it is possible to determine the distance separating the extreme microscopes in relation to the length of the 4-metre bar, which, by means of the 4-metre comparator, can be ascertained in terms of the international metre, as represented by the 1-metre standards.

Having determined the length between the extreme microscopes in metres, to get the length of each wire, all that remains to be done is to suspend each wire, in turn, below these microscopes and observe the positions of their defining graduations.

It will not be necessary to move this 24-metre comparator and a 4-metre bar into the field to the site of the base line to be measured. The procedure to be followed will be to standardise six wires at Dehra Dun, before departure for the field; on arrival at the base line, to lay out a 24-metre length between suitable marks on masonry pillars by means of three of the wires, which will, henceforth, not be used in the actual measurement of the base but be maintained as reference wires for the periodical checking of the distance between the marks on the pillars, the field comparator. The remaining three wires will be used to measure the base, their lengths being compared daily with the field comparator. On re-

turn from the field all six wires will again be standardised by means of the 24-metre comparator and thus a check obtained on any variations of length which may have occurred in the field.

PENDULUM OPERATIONS.

During the season 1912-13 measurements of gravity were made at 14 stations along a line extending from Bhopal to Khurja, near Bulandshahr, including Kalianpur, the station of origin of the Indian triangulation. The results are shown in the summary.

The three last columns in the summary need to be explained. The first, headed $(g_o - \gamma_o)$ shows the amounts by which gravity is in excess or defect on the assumption that surface masses have no effect thereon, the height of the station being alone allowed for in deriving g_o, the value of gravity at sea-level, from g the observed value. This method of reduction is sometimes known as the free air method.

The second $(g_o'' - \gamma_o)$ shows the excesses or defects on the assumption that all visible masses are of mean surface density and are entirely uncompensated. g_o'' is derived from g_o by the application of Bouguer's rule. Unless otherwise stated it is these residuals that are referred to in the subsequent discussion of results.

The third column $g - \gamma$ gives the residuals based on Hayford's hypothesis of isostasy or underground compensation of surface masses.

We have now completed a chain of stations along the meridian of 78° from Mussoorie (latitude 30° 28′) to Amraoti (latitude 20° 56′), a distance of about 650 miles, and it may be interesting briefly to review the results.

From Mussoorie to Gesupur (latitude 28° 33′) the defects of gravity decrease rapidly from ·11 to ·02 dynes. Between Gesupur and Khurja we find a rise to ·04 and from thence to Agra the negative residuals again decrease, becoming positive at the latter station. Between Agra and Bina we find 2 belts of deficient gravity or "valleys" separated by a positive area or "ridge." From Bina to Amraoti we have a succession of positive values with only two small negatives at Bhopal (·004) and Shahpur, latitude 22° 12′ (·005).

The existence of this area of excessive gravity, often called the hidden chain, was deduced by Colonel Burrard in 1901 from the evidence of the deflections of the plumb line. The pendulum has verified it, and this year the northern edge has been located between Kalianpur and Goona. This fact lends strong probability to the assumption that the deflection of the plumb line at Kalianpur is southerly.

It is interesting also to note that the positive areas at Sipri and Agra and the sudden change between Khurja and Gesupur are indicated

by the plumb line deflections in these localities. This seems to show that the variations of density which produce these abnormalities are situated near the surface.

Mention was made in last year's report of the investigation of the isostatic correction to gravity results. This has now been extended and about 40 stations have been dealt with. Generally speaking the effect of this new method of allowing for the effects of the topography is to decrease negative residuals and increase positive ones at all stations except those near the sea coast. At coast stations positive residuals are decreased. At stations which are distant both from the sea and from mountains the change amounts to from 0·03 to 0·05, but near the sea and near mountains much greater changes are produced. The following table shows a few of these changes:—

Station.	Locality.	$g_o''-\gamma_o$ Bouguer.	$g-\gamma$ Hayford.	Change.
Mussoorie . . .	On the edge of the Himalaya .	−·110	+·075	+·185
Dehra Dun . .	7 miles from Himalaya . .	−·126	+·029	+·155
Nojli . . .	65 „ „ „ . .	−·095	−·007	+·088
Gesupur . . .	130 „ „ „ . .	−·020	+·029	+·049
Chatra . . .	180 „ „ „ and coast	+·009	+·030	+·021
Madras . . .	On coast	+·014	−·025	−·039

As will be seen from the summary of results and the table above the great majority of the Hayford residuals are positive. This merely means that another formula for computing γ_o, the normal value of gravity at sea-level, will have to be used. The point to be noted is that the Bouguer residuals are as a rule negative near hills and positive near the coast and that the new method will reduce the residuals in each case. Local anomalies, such as have been found during the last season, will, however, not be affected.

Summary of results, 1912-13.

Station.	Latitude.	Longitude.	Height above M. S. L.	Observed value of g.	Correction for			$g_o = g$ corrected for height only.	$g_o'' = g$ corrected for height and mass (Bouguer).	γ_o	$g_o - \gamma_o$ (Free air).	$g_o'' - \gamma_o$ (Bouguer).	$g - \gamma$ (Hayford).
					Height.	Mass (Bouguer).	Mass (Hayford).						
	° ′ ″	° ′ ″	Feet.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.
Bhopal	23 15 58	77 25 00	1,630	978·711	+0·152	−0·057	−·007	978·863	978·806	978·810	+0·053	−0·004	+·046
Ballanpur	24 07 11	77 39 17	1,763	978·717	+0·164	−0·062	−·011	978·941	978·879	978·867	+0·074	+0·012	+·063
Kina	24 10 41	78 11 46	1,355	978·795	+0·126	−0·047	±·000	978·921	978·874	978·871	+0·050	+0·003	+·050
Goona	24 38 48	77 19 13	1,569	978·807	+0·146	−0·055	−·007	978·953	978·898	978·903	+0·050	−0·005	+·043
Lalitpur	24 41 29	78 24 26	1,199	978·814	+0·112	−0·042	+·003	978·926	978·884	978·906	+0·020	−0·022	+·023
Sipri	25 25 52	77 39 25	1,533	978·876	+0·143	−0·054	−·009	979·019	978·965	978·958	+0·061	+0·007	+·052
Jhansi	25 27 02	78 33 43	858	978·910	+0·080	−0·030	+·007	978·990	978·960	978·959	+0·031	+0·001	+·038
Gwalior	26 13 57	78 12 49	658	978·958	+0·031	−0·023	+·012	979·010	978·996	979·015	+0·004	−0·019	+·016
Dholpur	26 42 01	77 54 47	577	978·999	+0·054	−0·020	+·015	979·053	979·033	979·048	+0·005	−0·015	+·020
Agra	27 10 20	78 01 07	535	979·056	+0·050	−0·019	+·018	979·106	979·087	979·083	+0·023	+0·004	+·041
Muttra	27 28 25	77 41 48	562	979·072	+0·052	−0·020	+·019	979·124	979·104	979·105	+0·019	−0·001	+·038
Hathras	27 36 52	78 03 22	587	979·075	+0·055	−0·021	+·020	979·130	979·109	979·116	+0·014	−0·007	+·034
Aligarh	27 53 32	78 00 31	612	979·075	+0·057	−0·021	+·021	979·132	979·111	979·137	−0·005	−0·026	+·016
Khurja	28 14 19	77 51 53	649	979·083	+0·061	−0·023	+·024	979·113	979·120	979·163	−0·020	−0·043	+·004

$\gamma_o = 978{\cdot}00\ (1 + 0{\cdot}00531\ \mathrm{Sin}^2\ \phi)$

LEVELLING OPERATIONS.

During the year 1912-13, the following lines of precise levels were run :—

(*a*) *In Kashmir.*

Kohala to Srinagar.
Srinagar to Islamabad.
Islamabad to Phalgam.
Srinagar up the Sindh Valley.
Srinagar towards Bandipur.
Srinagar towards Shopian.

(*b*) *In the Punjab.*

Multan to Mahiwala.
Ambala to Jagadhri.
Delhi to Hodal.
Murree to Kohala.

(*c*) *In the United Provinces.*

Jagadhri to Meerut.
Meerut to Delhi.
Hodal to Muttra.

(*d*) *In Bengal.*

Comilla to Chittagong.

Brahmanbaria *viâ* Ashuganj, Bhairab, Dacca and Goalundo to Faridpur; crossing the Meghna, Lakhya, Dhaleshri and Padma rivers, distances across being, respectively, 65, 35, 52 and 109 chains of 66 feet.

To cross the first three rivers, the "target" method was adopted, and for the last, vertical angles were observed.

The line Dacca to Mymensingh had been included in the programme, but it was not found possible to complete it. It will be completed in 1913-14.

(*e*) *In Burma.*

Henzada to Bassein along the left bank of the Ngawun river.
Pegu to Mokpalin.

In the programme it had been intended to carry this line on to Magwe which would have completed the first circuit in Burma, but owing to stress of weather, work was stopped at Taungdwingyi, some 60 miles distant from Magwe. It will be finished in 1913-14.

The line Thazi to Taunggyi had also been included in the programme, but it was not found possible to take it up. It is now intended to complete it in 1913-14.

In addition to the above lines of precise levelling, about 41 miles of single levelling were carried out at Darjeeling, in the cantonments of Takdah and Lebong and in the Happy Valley landslip-area, as an aid for the surveying of contours for large scale maps of these places.

TIDAL OPERATIONS.

During the year tidal registrations by automatic tide-gauges have been continued at the following ports, with satisfactory results:—

Aden, Karachi, Apollo Bandar (Bombay), Prince's Dock (Bombay), Madras, Kidderpore, Rangoon, Moulmein, and Port Blair.

BOTANY.

I.—BOTANICAL SURVEY.

BY

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Eastern India.—The work of the Royal Botanic Garden, Sibpur, has become so closely associated with the work of the Botanical Survey that an account of the progress made by officers in their former capacity must find a certain degree of repetition in the Botanical Survey Report. During the year under review, the Director in his capacity as Superintendent of the garden has continued the work of cataloguing initiated by him in 1909 and progress has also been made with the preparation of the systematic list which is intended to be supplementary to the numerical and in which the plants will be arranged according to their Natural system of classification. The numerical list itself is far from complete. In the list as it stands there still remain many blanks to fill up and the addition of new material to the garden will involve additional numbering while the extraction of what dies or has for other reasons to be removed naturally renders such a list useful only within a limited period. The systematic list which it is intended to prepare should serve the useful purpose of letting one know at a glance what the garden actually possesses and the garden numbers which will also be inserted will allow of reference to the plants themselves, without the extra trouble of looking over pages of the numerical list before the particular plant wanted is recognised. The work when completed should form a most useful aid in systematic work, for if doubt is entertained regarding the identity of any species sent in for examination a ready reference will be had to the living plant itself as well as to the dried herbarium material. In July 1912, Volume V, No. 4 of the Records of the Survey appeared and the list as stated in last year's report now totals some 13,400 numbers. As regards the indentification of critical species and the subsequent filling in of blanks a large number of plants of doubtful standing which had accumulated and awaited a favourable opportunity for study was taken by Major Gage to Kew where it is hoped sufficient material will be available to allow of comparison and systematic classification. Signor Beccari continues to investigate the garden palms which are at present most in need of study and several species formerly of

doubtful standing have been identified. Lately a large consignment of these has been forwarded for favour of report, but it is not always possible with palms to send at one time the complete material which a critical study requires as many of the more interesting flower and fruit at irregular intervals. Already a list of useful identifications has been forwarded by Signor Beccari and his requests for complete material are being complied with as the more critical species come to maturity. Outside Eastern and Southern India the limited staff of the Botanical Survey has been able to accomplish no field work, but various collectors who have been engaged in other directions have sent their material for report and record. In January and February of 1913 Major Gage toured in parts of Burma and was thus able personally to supplement the excellent work done by Forest and other Government officers and private individuals on whom the Survey has had to depend so much for material from this province. The collections come mostly from the higher elevations 2,000—4,000 feet. They number some hundreds and were got to the Herbarium in excellent condition. These have been sent to Kew but were first roughly classified before despatch. Time has not yet permitted of their being worked up, but doubtless interesting records will accrue from their examination. The parts explored lie in North Arracan and the Toungoo district of Burma. In North Arracan Major Gage studied the vegetation of the district East of Paletwa which lies between the Kaladan and Mee Rivers and spent a good deal of his time on Kyaukpaudaung Peak. In Lower Burma he botanised in the locality of Thandaung, North-East of Toungoo. In both districts the idea followed was that of intensive collection from a limited area rather than extensive work covering a wider field. During the year Volume IV, No. 7 of the Records of the Botanical Survey has appeared. This number is devoted to a record of the exploration undertaken by Mr. W. W. Smith, late Curator of the Herbarium, in 1910 and treats of the Alpine and Sub-Alpine vegetation of South-East Sikkim. In all some 925 plants are recorded, an interesting general account of the flora is included and the following new species are described in the list:—*Paroxygraphis sikkimensis*, *Draba cholaensis*, *Arenaria Balfouriana*, *Potentilla microphylla* Don., var. *pusilla*, *Saxifraga Gageana*, *Saxifraga pluviarum*, *Trachydium affine*, *Leycesteria Belliana*, *Senecio biligulatus*, *Senecio Kingianus*, *Senecio Lagotis*, *Senecio Chola*, *Saussurea nimborum*, *Saussurea Laneana*, *Gentiana pluviarum*, *Swertia ramosa*, *Swertia Burkilliana*, *Pedicularis siphonantha* Don., var. *prostrata* Bonati, *Pedicularis sikkimensis* Bonati. Two species of *Juncus* may prove to be undescribed species but they require fuller investigation and comparison with ampler material of the genus. In Burma collections were made by Mr. J. H. Lace, late Chief Conservator of Forests, and Captain Abbey and over 200 sheets have been forwarded from this source to the Herbarium for report as well as a small collection from Mr. C. G. Rogers. Among those sent by Mr. Lace, were

several which would have formed useful additions to our Burma material and some of these Mr. Lace has kindly allowed the Herbarium to retain. Mr. Lace has also found it possible during the year to complete his materials for a "List of trees, shrubs and principal climbers recorded from Burma" and the work has now been published. The arrangement follows that of the Flora of British India except that there is an alphabetical arrangement of the species under each genus and Burmese, Kachin, Karen and Shan names are supplied. The work should prove an excellent reference list to students of the flora who can already claim a certain acquaintance with systematic work. The flora of Burma has also received the marked attention of Mr. C. G. Rogers, Conservator of Forests, who continues to submit from time to time small collections for comparison with the Sibpur material. During the year a collection of between forty and fifty sheets has been received from this source and the more useful we have been allowed to retain for the Burma local Herbarium. Botanical exploration in Bhutan has not always been an easy matter in the past, not on account of the area itself offering insuperable difficulties to such work but on account of difficulties in obtaining permission to enter the territories. The acquisition of some 200 specimens collected in this comparatively unworked region by Mr. Jacob, who has been deputed there as Forest officer, is therefore all the more worthy of note. Such a collection even in conjunction with what has already been done on the flora gives but a very superficial knowledge of its wealth, but such forms as *Eleagnus pyriformis* Hook. f. *Argyreia Hookeri* C. B. C., *Schima Wallichii* Choisy, *Anisochilus polystachyus* Bth., *Strobilanthes pentstemonoides*, T. Anders. *Stephania elegans* Hf. & T., *Priotropis cytisoides* W. & A., *Ajuga macrosperma* Thw., *Lysionotus serratus* Don., *Strobilanthes coloratus*, T. And., var. *crinita*, *Daphniphyllum himalayense* Muell. *Photinia integrifolia* Lindl. *Heracleum nubigenum*, C. B. C. *Clematis nepalensis* DC., *Holmskioldia sanguinea* Retz., *Dipsacus inermis* Hf. & T., *Bridelia sikkimensis* Gehrm., *Senecio Bhot* C. B. C., *Natsiatum herpeticum* Ham., and *Wendlandia pendula* DC., at once mark the district as typically East Himalayan in its flora. The last named species is recorded for the first time from Bhutan. Other collections from Northern India include some 500 sheets from Mr. Cave, Curator of the Lloyd Botanic Garden, Darjeeling, and a collection similar in numbers from Mr. B. J. Gould, British Trade Agent in Gyantse. The last named collection though somewhat incomplete as regards the individual specimens nevertheless afforded a number of useful additions. This is only to be expected when one considers the limited amount of biological exploration that has been possible in Tibet. Among those identified there are present *Scutellaria Kingiana* Prain, *Triglochin martimum*, L., *Anemone trullifolia* Hk. f. & T., var. *linearis* P. Bruhl. *Meconopsis paniculata*, Prain., *Braya tibetica* Hk. f. & T., besides many others of interest which have filled

gaps in the general and local Herbaria. A very valuable set of Wight's plants numbering upwards of 7,000 sheets have been presented by the Regius Keeper of the Botanic Gardens, Edinburgh. These have been drawn from all parts of the Peninsula and the co-types which are included add greatly to the value of the set as a whole.

It is not always possible to make analytical work in the Herbarium keep pace with field work but several collections made prior to the year under review have undergone examination. In 1911-12 Mr. Meebold toured in Mergui, Thaton and Salween in Lower Burma and his plants which have now been worked out are useful as showing the occurrence of well marked endemic forms of typical Malayan species and the relative scarcity of Upper Burma species. This is exemplified by the following few species which find a place in the list *Ixora opaca* R. Br., *Glochidion insulare* Hook. f., *Ervatamia cylindrocarpa* King and Gamble, *Embelia nagushia* Don. A new species *Cleistanthus Meeboldii* Jabl. has also been recorded as well as *Cleistanthus myrianthus* and *Cleistanthus Helferi* Hk. f. A small collection of plants made by the same Botanist at Mungpoo in the beginning of 1912 has also been worked up and several gaps in the local Sikkim Herbarium filled though the list shows no new records. During the year Captain Toppin's Kampti Long Mission collections made in 1911-12 have been named with the exception of the genera Quercus and Begonia. A large number of species that were formely supposed to be endemic only in Upper Assam is represented in this collection while a few Chinese plants are also to be found. The families Leguminosæ, Rubiaceæ and Acanthaceæ are well represented. Considering the area dealt with in the collection it would seem that there is quite an appreciable endemic element and a number of new species seems assured. The whole collection has gone to Kew for revision and a report will probably be given on it at a later date. In 1911 Mr. I. H. Burkill and Mr. S. C. Banerji undertook a tour in the Khasia and Jaintia Hills which resulted in the acquisition of nearly 800 sheets. These have now been studied and have resulted in the following new records for the district *Spiræa micrantha* Hk. f., *Rosa Leschenaultiana* W. and A., *Webera corymbosa* Willd. *Leptodermis lanceolata* Wall. *Taxotrophis zeylanica* Thw. Among those examined was also a Sagittaria sagittifolia L. with the leaves elliptic instead of, as is usually the case, hastate, a form which is said to be of rare occurrence.

Mr. Gamble has continued his work on the flora of the Malayan Peninsula and during the year an account of the families *Myristicaceæ*, *Monimiaceæ*, *Thymelaeaceæ*, *Elaeagnanceæ* and *Santalaceæ*, has appeared in the *Journal of the Asiatic Society of Bengal*. Five new species are described of which *Santalaceæ* has four and *Thymelaeaceæ* one.

Mr. W. G. Craib has published his second list of Siamese plants with descriptions of new species. The list comprises the monocotyledons and

the following new species are dealt with. *Globba Kerrii* Craib, *Globba Nisbetiana* Craib, *Globba purpurascens* Craib, *Globba xantholeuca* Craib, *Globba Yeatsiana* Craib, *Curcuma ecomata* Craib, *Amomum siamense* Craib, *Zingiber Bradleyanum* Craib, *Zingiber Kerrii* Craib, *Zingiber Smilesianum* Craib, *Halopegia brachystachys* Craib, *Tacca Garrettii* Craib, *Stemona aphylla* Craib, *Stemona Kerrii* Craib, *Smilax Hemsleyana* Craib, *Disporopsis longifolia* Craib, *Ophoipogon brevipes* Craib, *Ophiopogon gracilipes* Craib, *Chlorophytum intermedium* Craib, *Chlorophytum simplex* Craib, *Aneilema discretum* Craib, *Aneilema siamense* Craib, *Pandanus distans* Craib, *Pandanus similis* Craib, *Arisaema hypoglaucum* Craib, *Arisaema Kerrii* Craib, *Arisaema sootepense Craib*, *Amorphophallus macrorhizus* Craib, *Mariscus Clarkei* Turrill. A new cycad *Cycus immersa* Craib, is also described. The same author has also described *Flemingia Lacei* Craib, *Flemingia augusta* Craib, *Agapetes Lacei* Craib, *Agapetes oblonga* Craib, *Wightia Aplinii* Craib, all new species from Burma. *Primula Wattii* King ex Watt, a species originally met with in Sikkim has also been described by Mr. Craib in the Botanical Magazine No. 1507, where a figure of the plant is also to be found. Mr. Gamble has described the new species *Loranthus Robertsonii* Gamble, *Henslowia Collettii* Gamble, *Henslowia shanensis* Gamble from Burma, *Erytranthe papillosa* Gamble, *Erytranthe Barnesii* Gamble, *Erytranthe Robinsonii* Gamble, *Erytranthe Wrayii* Gamble, *Viscum Wrayii* King ex Gamble, *Viscum flexuosum* King ex Gamble from the Malay Peninsula and *Viscum costatum* Gamble from the Darjeeling district.

Sir David Prain has described three new species of *Helicia* from the Malay Peninsula *Helicia Kingiana*, Prain, *Helicia rufescens* Prain and *Helicia velutina* Prain. Mr. N. E. Brown has contributed a description of *Gentiana minuta* N.E. Brown from the Tunkra Pass in the Himalaya and Mr. S. T. Dunn of *Crotalaria Meeboldii* Dunn and *Polygonum palmatum* Dunn, both from Assam. Other noteworthy species described include a *Cornus* by Dr. Stapf and a new species *Berberis Parkiana* Schneider from the Western Himalaya.

The flora of Indo-China continues to receive the attention of M. Gagnepain and several fasciculi of his Flore Generale de l'Indo-Chine have been published during the year. The treatment of the subject is exhaustive, the last fasciculus to hand comprising 100 pages devoted exclusively to the *Leguminosæ*. Roxburgh's Hortus Bengalensis published nearly a century ago and his catalogue of described plants which had at that time not yet been introduced into the garden have been reviewed by C. B. Robinson, an American botanist, who supplies some interesting observations on the nomenclature used.

Western India.—Mr. D. Hooper has contributed 600 sheets to the Herbarium, some of these having come from the Western side of the

peninsula. Apart from this contribution little has been done by the Botanical Survey staff in the way of field work on the west. A review of the publications of the year, however, will show that botanical work is being well supported there. The Orchids of the Bombay presidency are receiving the attention of Mr. G. A. Gammie who is adding from time to time in the *Journal of the Bombay Natural History Society* to our knowledge of the family while Father Blatter's exhaustive account of the Palms of British India and Ceylon also being continued is a work of which Indian Botanists may well be proud. The same author has now completed his flora of Aden which will appear in parts of the *Records of the Botanical Survey of India* at an early date. The flora gives a history of the Botanical exploration of Aden, a description of the physical aspects, a full general account of the vegetation wild and cultivated, a complete synopsis of the natural orders and descriptions of all the species amounting to 250 nearly thrice as many as described by Anderson 50 years ago. Keys are supplied and also an exhaustive bibliography.

Mr. R. K. Bhide has described two more species of *Gramineæ* from Bombay.

Northern India.—Colonel C. J. Bamber has added in the *Journal of the Bombay Natural History Society* several additions to his plants of the Punjab, North-West Frontier Province and Kashmir, while Herr Schneider has described a new *Berberis* from the Western Himalaya and cites the area as possessing many new and curiously localised species of the genus. Regarding this interesting addition—*Berberis Parkeriana* collected by R. N. Parker in Hazara—he remarks as follows:—

"Ich erhielt diese Art von Herrn R. N. Parker aus Lahore, welcher sie im Hazaradistrikt (westl. Himalaya) sammelte, und zwar die Blutenzweige in Bagnolar, Reserve, 2600 m, April 1910, und die Fruchttriebe in Abbottabad, 1800 m, Juli 1910. Sie gehort in die Sektion Tinctoriæ C. S. (Eutinctoriæ), wo sie aber von allen bisher bekannten Arten durch die lanzettlichen, unterseits nicht papillosen Blatter abweicht. In der Blattform ahnelt sie sehr B. lycium, diese hat aber unterseits weisspapillose Blatter und langere Trauben. Herr Parker bemerkt zu seinen Pflanzen; B. calliobotrys? Die Fruchte erinnern auch an die B. calliobotrys Aitch., allein diese Art hat kleinere Blatter, kahle, braunrote junge Triebe und weicht auch in den kleineren Blutenstanden und sonst ab."

Southern India.—Apart from the publication of botanical work concerned with this part of the peninsula a considerable advance has been made with the collection of materials for the survey. Southern India and Burma will require in the future the increased attention of the Botanical Survey staff for large areas, the knowledge of the flora of which is comparatively scanty, remain for exploration. During the year the Director was able to depute two of the staff Mr. Hooper and Mr. Ramaswami to Tinnevelly and a survey of two taluks Ambasamudram

and Nanguneri in the district was undertaken. Copious notes were made and the expedition resulted in the acquisition of about 700 sheets. Time has not permitted of the whole collection being worked out, but so far as it has been studied it would seem that the family *Leguminoseæ* with fifty-two species is the most widely represented. *Rubiaceæ* comes next with thirty-seven species; *Compositæ* has thirty-two, *Convolvulaceæ*, *Acanthaceæ*, *Labiatæ* and *Filices* twenty-four each, *Verbenaceæ* has eighteen and *Euphorbiaceæ* and *Urticaceæ* thirteen each. The remaining families contain fewer than ten species each. The flora of the plains as might be expected shows a striking similarity to that of the adjacent island of Ceylon, while the hills possess a flora comparable with that found on the slopes of the Nilgiris. Even in the hills, however, there are local variations of the flora due chiefly to local variations in rainfall. As the survey of the district proceeds full reports will appear of its vegetation, but the following few endemic species may now be mentioned as forming part of the collection:—*Leptonychia moacurroides* Bedd., *Homalium travancoricum* Bedd., *Hedyotis purpurascens* Bedd., *Vernonia travancorica* Hook. f., *Blepharispermum petiolare* DC., *Symplocos acuminata* Bedd., *Diotacanthus grandis* Benth., *Mallotus stenanthus* Muell. and *Elettaria cardamomum* Maton. the last named found wild only in this part of India.

Mr. C. E. C. Fischer, Deputy Conservator of Forests, continues to be one of the mainstays of botanical work in this part of the peninsula and has this year contributed over 600 sheets from Coimbatore, Anaimalai and Palni Hills. Numerous interesting records accrue, including some examples of new species recently described by Mr. W. W. Smith from Southern India. During the year the survey has been fortunate in enlisting the services of the Reverend St. Münch, S.J., and the Reverend A. Sauliere, S.J., both of the S. H. College, Shembaganur, and both of whom have ungrudgingly contributed large collections from the Madura district and done much to help on the survey in the Peninsula. Over 700 sheets have been forwarded for identification from this quarter, but the limited staff of the Herbarium has not been able to cope with all demands for floral analyses, and a considerable number of the Madura plants still await examination. From what has been accomplished, however, it becomes evident that the typical Deccan element is well represented in the district explored. A short extract from the report of the Government Botanist, Madras, on Systematic Botany is of interest in connection with South Indian Botany. "All the specimens collected by Dr. Barber, except imperfect and unidentifiable sheets have been identified and incorporated with the main collection. Besides these 887 sheets of specimens of plants collected by Dr. Bourne on the Pulney hills and 691 sheets of Mr. Gamble's collection were also incorporated. The Grewias sent to Kew for identification were returned. In this lot eight

species are new to science; *i.e., Grewia Wightiana, G. Griffithiana, G. Gamblei, G. Lawsoniana, G. Wattiana, G. Barberi, G. Optiva, G. pandaica.* A further lot of Grewias was again sent for identification. About 50 sheets of duplicate specimens of Grewias were sent to Mrs. Bourne. During the year 1,633 sheets were named and names were written on 2,404 sheets. All the original pencil drawings of Wight and Beddome's published works received from Ootacamund have been sorted and mounted in albums. About 150 plants were identified for various correspondents."

General Systematic.—M. G. Dismier has done much to clear up the confusion which existed in regard to Indian and other Asiatic species of *Philonotis* and has set forth his views based on examination of material from the more important European collections, on the characters which separate *Philonotis falcata* (Hook.) Brid. and *Philonotis Turneriana* (Schw.) Mitt. from nearly allied species. He has been able to include in the synonymy list numerous species which rightly have only varietal rank and to furnish critical remarks concerning the species he considers synonymous. A treatment of their geographical distribution adds to the value of the discussion. In *Philonotis falcata* (Hook) Brid. he has been able to include some twelve and in *Philonotis Turneria* (Schw.) Mitt. some four species. As regards his views on the distinguishing characteristics of these the following may be quoted from the Bulletin de la Société Botanique de France. "Toutefois, il me parait nécessaire, au préalable, d'indiquer de quelle manière je comprends les *Philonotis falcata* et *Philonotis Turneriana.* En général, chez ces deux espèces, les feuilles sont ovales-lancéolées, acuminées et disposées en rangées spiralées. Quelques spécimens cependant ne paraissent pas, á première vue, offrir cette disposition caractéristique; mais, en les examinant avec soin, on finit toujours par trouver quelques tiges ou portions de tiges à feuilles sériées. J'insiste sur cette disposition spéciale car elle a pour moi une valeur de premier ordre; elle ne m'a jamais fait défaut dans tous les échantillons—et ils sont nombreux—que j'ai étudiés. J'ajouterai que ces feuilles, chez le *Philonotis falcata* de même que chez le *Philonotis Turneriana,* sont carénées, concaves, â bords plats, et â dents simples sur tout le contour; vues au microscope sous le couvre-objet, elles sont, par suite de leur concavité, les unes condupliquées, les autres fendues sur une assez grande longueur. Quant aux cellules elles sont carrées ou brièvément rectangulaires et papilleuses à leur partie supéricure; de plus, chez le *Philonotis falcata* la nervure est de largeur moyenne, tantôt percurrente, tantôt plus ou moins excurrente, tandis que chez le *Philonotis Turneriana,* qui n'est, à mon avis, qu'une sous-espece, elle est toujours longuement piliforme."

Since last report was written several volumes of Das Pflanzenreich have appeared and the following families are discussed—*Geraniaceæ,*

Goodeniaceæ, Brunoniaceæ, Araceæ, Cannaceæ, Euphorbiaceæ. The value of this work which is the result of years of study by some of the best Botanists in Europe can scarcely be overestimated. It comprises the most noteworthy species known all the world over and reference to the work will show the richness of India in species in comparison with other countries. Several revisions of genera of interest to Indian botanists have appeared during the year. M. R. Benvist has dealt with the structure and classification of the *Acanthaceæ* of the tribe *Barleria*, the genus *Cousinia* has been dealt with by Bornmüller, the *Gentianaceæ* of Indo-China by Dop. A revision of *Saxifraga* section *Hirculus* and new species of other sections has formed the subject of investigation by Engler and Irmscher who have described amongst others the following new Indian species:—*Saxifraga Kinchinjungæ, S. sikkimensis, S. Kingiana* (S. Gageana) *S. eglandulosa, S. chumbiensis, S. subspathulata, S. elliptica* varieties of *S. diversifolia, S. pseudo-hirculus, S. punctulata, S. flagellarioides, S. Andersonii* all from Eastern Himalaya and Calcutta garden collections also *S. Meeboldii* from N. W. Himalaya.

Mr. Gagnepain has published a further fasciculus of his Flora Generale de l'Indo-Chine incorporating his work on the *Leguminosæ* of that region.

Mr. S. T. Dunn who has had much Indian material at his disposal has revised the genus *Millettia* and the following new Indian species and varities are recorded:—*Millettia Griffithii* Dunn, *M. eriocalyx* Dunn, *M. Pulchra* Kurz., var *microphylla, M. trifoliata* Dunn, *M. podocarpa* Dunn, *M. Prainii* Dunn, *M. Cubitti* Dunn. The bibliographical list will show the chief botanical works of a general kind having reference to Indian botany, which have come under notice.

Anatomical and Physiological.—The structure of the female Strobilus of *Gnetum Gnemon* has been dealt with by Mr. E. M. Berridge. The first stages of the development of *Terminalia Catappa L.* has found the subject of a study by M. Colani. Herr Hanausek has studied the pericarp and pericarp secretion in the genus *Carthamus*, Mr. Hector, Economic Botanist to the Government of Bengal, has experimented on the pollination and cross fertilisation of the common rice plant *Oryza sativa* Linn. Mr. E. L. Stephens has been engaged on the anatomy, structure and development of *Striga lutea* Lour. and numerous other Botanists have added materially to our anatomical and physiological knowledge by studies conducted with Indian material or adduced results which can be made applicable to Indian Botany. The Royal Botanic Garden has been instrumental in collecting and forwarding material of *Gnetum* at various stages of development to Professor Pearson who is engaged in a study of the development of the ovule and the results of whose observation are awaited with interest. Further references on anatomical and physiological subjects may be seen in the bibliographical list appended.

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II.—ECONOMIC BOTANY.

Part I.—AGRICULTURAL BOTANY.

BY

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Considering the number of workers in the field, the output of research in Agricultural Botany is, as usual, small. There are, however, very few, especially in the Provinces, who have any time to deal adequately with this important subject. With hardly an exception, the Provincial Agricultural Botanists report that almost the whole of their time is taken up in teaching. Preparing courses of lectures in a country where the very alphabet, in the shape of species, is new, is no light matter, and it must take some time before the new officers have much to say on the applied science, but there are signs that a change is taking place and that more time will be available for research than heretofore. In Madras the much-needed change has taken place during the year and teaching and research have been definitely separated under whole-time officers. In the other Provinces the teaching courses are rapidly becoming stereotyped and more attention is being paid to the collection and study of groups of the cultivated plants. A considerable amount of time is being devoted to the economic survey of the crops grown in India, wheat, sugarcane, cotton, paddy, tobacco, pulses, oil seeds, capsicums, peppers and mangoes having received special attention during the year. Added to this general survey, pure line cultures have been instituted in most of those mentioned.

One of the most striking characters in Indian crops, grown for centuries under the same conditions, is the enormous extent of admixture of varieties in almost every field, and perhaps no part of the world offers a finer field for investigation to the Economic Botanist. In many cases, mere separation of the various types by pure line culture has led to great agricultural progress, while the field opening up for the creation of new varieties along Mendelian lines is a vast one and full of promise, it having been abundantly demonstrated in every crop investigated that there is a large margin within which improvements may be effected. This is perhaps the most promising line of work before the Agricultural Department at the present moment, and it is sincerely to be hoped that

the example of Madras noted above may be followed elsewhere and that the excellent work now being done by the purely agricultural members of the service may be stimulated and encouraged by placing full-time officers in charge of breeding work, the teaching in the Colleges being provided for by the creation of a special teaching staff. Attention is strongly drawn to the fact which has been emphasised by the work of the Howards on wheat, that breeding work is more difficult than was at first anticipated, and that improvement of crops, by the creation of new varieties combining the useful properties of several parents, can no longer be approached lightly. Meanwhile, the mere selection of varieties is leading to important results and it is becoming increasingly certain that, unless full time is available for breeding work and great care exercised in its prosecution, the results are likely to be disappropriating.

An attempt will be made in the present report to deal as widely as possible with the crops being studied and thus to indicate the directions in which future expansion may be looked for. The important work on wheat and cotton, which has filled most of the previous reports, will be more briefly summarised.

Paddy.—There are various indications that this, the most important food crop in the tropics, is at length about to receive the attention it deserves.

Hector has made a survey of the chief Aman transplanted paddies of Lower Bengal. In the 150 varieties which he has isolated and grown in pure lines, he has found that the morphological and cultural characters are transmitted, and no case of crossing has occurred in his pure line plots. The correlation between the varietal and field characters and the composition of the grain is being studied by him in conjunction with the Agricultural Chemist. He has, further, made a study of paddy pollination, and disagrees with Knuth as to the normal dehiscence of the anthers. He finds that paddy in Bengal behaves in the manner described by Akemine in Japan and van der Stok in Java. According to these observers, self-fertilisation is the rule, while crossing occasionally takes place, so that it is necessary to be on the guard against this in breeding work. According to Hector, arrangements are made at the moment of the opening of the flower for immediate anthesis, so that the stigma, still enclosed in the flower, is copiously dusted with pollen from the same flower. In his comparison of the anthesis and flower-opening of the Aman and Aus paddies, he finds differences which he considers to be due to varying degrees of moisture and temperature at these two periods of the year. A little pollen being left in the anthers after the opening of the flower, cross-pollination is possible. Hector has not apparently observed this, but he infers it from the observed characters in the offspring which, when selfed, reproduced the parental peculiarities in Mendelian proportions. He concludes, however, that cross-pollination in

paddy is strictly limited, and only takes place between plants growing in close proximity.

Hilson has made a series of observations on the pollination of paddy in Madras and has commenced a study of the varietal characters which appear to be inherited. Graham in the Central Provinces has completed the survey of the paddies grown, the material accumulated being preserved in 1,345 herbarium sheets. He has isolated 81 varieties and grown them in pure line cultures, and certain of the better kinds have been handed over to the farms for propagation and distribution. Sawyer and Thompstone have done similar work in Burma, pure line cultures having been grown for a couple of years, and a great demand has arisen at the Mandalay farm for certain better kinds.

The purely agricultural work continues. Paddy transplantation in the Central Provinces now extends to 16,000 acres, with an average increase in yield of one-third of the crop, and great hopes are entertained of a further expansion of this work. In the same way the campaign in single-seedling planting has been vigorously continued in Madras and the method is being tested in various other Provinces. It is notable that both in the Central Provinces and in Madras it is claimed that these simple improvements in the method of planting will, in time, amply cover the total cost of their respective Agricultural Departments in increased production. The distribution of improved or pure seed continues to increase, between 30,000 and 40,000 lbs. having been sold during the year in Madras alone.

Wheat.—The excellent work done by the Howards on this important crop continues to yield valuable results, and several papers have been published during the year, while their efforts at improving the Indian wheats have been ably seconded in the various Provinces interested in this crop, especially by Leake in the United Provinces and Clouston in the Central Provinces. It is not proposed to deal with these papers at length in the present report, partly because some attention was drawn to them last year while in the press, but chiefly because of the absence of the authors in England and the extreme importance and intricacy of the subject.

Considerable progress has been made in the study of the inheritance of morphological characters. It has been demonstrated, in confirmation and extension of the work of Nillson-Ehle at Slavöf, that apparently simple characters, such as the red colour of the grain, the hairs in the chaff in felted wheats, bearding, shattering of the ear, and so forth, are really complex and dependent on several factors. It has, further, been demonstrated that the influence of the environment cannot be ignored in these studies, as it is found sometimes to clock inherited characters of minor importance, thus rendering the isolation of new kinds more complicated still. It is not to be supposed that wheat is peculiar in this respect

among Indian crops, and this makes it all the more necessary that workers in this branch of agricultural improvement should be able to devote their undivided attention to it and be freed from all other claims upon their time. As the authors point out "plant breeding has been started at stations as an addition to an already over-loaded programme and the result has been to flood the literature with a mass of superficial results of no permanent value. Whenever plant breeding has been done with thoroughness, and on a sufficiently large scale, it has invariably been found that the inheritance of characters is by no means such a simple matter as at first supposed, and the investigations conducted at such centres as Slavöf explain why it is that the numerous attempts at plant improvement made at Agricultural Experiment Stations have not led to any striking results."

Extended trials have shown that high yield and good quality can be combined in the same plant, while it has been proved that the excellent properties of the Pusa wheats can be preserved under different environmental conditions. This latter thesis is developed in an important paper under the joint authorship of the Howards and Leake of Cawnpore. A series of Pusa wheats were grown under the varying conditions of ten stations in the chief wheat tracts of India, and the results carefully analysed. While it transpired that the conditions of climate and soil exercised a marked influence upon the character of the produce, it was also shown that the good characters of the Pusa wheats were largely maintained, and this in rain-fed land and under irrigation, in the lighter soils of the Gangetic plain as well as in the heavy black cotton soils of the Central Provinces, provided that careful attention was paid to good agricultural practice.

It is an interesting and important fact that the conditions tending to produce good quality in wheat are identical with those producing high yields. Further experiments with hot-weather cultivation tend to show that this treatment is cumulative in its effects, the best results having been obtained in the second and third years. The importance of drainage is emphasised by an ingenious experiment whereby it was demonstrated that the poor yield in badly drained lands is due to nitrogen hunger. Continuous growth of wheat on the same land without manure gave a still higher yield in this, the fifth, year of the experiment and it is considered that the limits of the capacity of the soil have probably been reached.

The principal wheat work in the near future, besides the purely Mendelian study of the inheritance of characters, will presumably be the maintenance in a pure state of the improved types raised. Ample arrangements are meantime being made for the multiplication of the best kinds. There is an increasing demand in Bihar and it is hoped that from 10,000 to 15,000 acres will be under these varieties during the

present year. It is proposed to put down 100 acres on Leake's new farm at Aligarh, while arrangements are being made in different tracts in the Central Provinces for raising a large amount of seed.

Cotton.—There is little work of a purely botanical nature to record regarding this crop. A paper in the press by Leake on the vegetative characters of cotton appears to consist largely of summaries of previous work, amplified by the results of various crossings. It deals with pollination, the colour of the corolla, the red matter in the sap, the leaf factor, the type of branching and the length of the internode. The systems of classification of cottons published by Todaro and Watts are criticised in the light of these new factors and it is specially pointed out that these systems have taken no account of the modes of branching in the various types. Using this character, Leake proposes a tentative classification which may be further considered when the paper is published.

Leake and Parr have contributed an important paper on the problem of improving the existing cottons in the United Provinces, in which they emphasise the importance of dealing only with readily tangible superiority in the introduction of new strains. From various considerations they come to the conclusion that, unless this superiority amounts to at least 25 per cent. of the value of the existing crop, it is idle to attempt to establish a new form. A careful study is made of the whole question in the light of experience gained during the work of recent years, and stress is laid on the improvement of the ginning quality as the most readily appreciable improved character. The authors lay great stress upon the importance, in any improved variety, of having some distinguishing mark by which, it can at once be recognised in the field.

The rest of the cotton work of the year consists of the continued segregation of various pure types from mixed crops and the founding of distributive agencies for such as have been proved to be more profitable than the local growth, whether in better lint, better ginning percentage, greater outturn and greater resistance to disease. It is obviously of little avail, in a crop where crossing in the field is a proved and constant factor, to be satisfied with small, isolated experiments, and every effort is made to deal with as large areas as possible and to ensure that the whole tract dealt with takes up the cotton distributed. From this point of view, the work of the year may be considered to be eminently satisfactory and large distributions have taken place in Tinnevelly, the northern districts of Madras, the Central Provinces, Bombay and the United Provinces, while interesting facts regarding the quality and outturn have been brought to light in the Punjab, the North-West Frontier Province and other parts of India. The most important types at present being dealt with appear to be Karungani in Tinnevelly, Tellapathi in the Northern Circars of Madras, Rosea in the Central Provinces and Bhuri

where wilt exists, Navasari (Broach) in the Deccan, improved Broach in Guzerat, Rosea in Khandesh, and white flowered (Varhadi) in Aligarh. Cambodia is making rapid progress in Madras where there is an increase in the total cotton area (an increase of 600,000 acres this year), undoubtedly largely due to recent introductions of better class cottons. Cambodia has also been proved to be eminently suited to the Dharwar American tract in Bombay and its cultivation there is rapidly extending.

Sugarcane.—In last year's report it was mentioned that the appointment of a full-time sugarcane expert was contemplated, whose main work would be the study of the sugarcanes of India and if possible the production of seedlings of improved quality. This appointment has been made during the year and a cane breeding station has been opened at Coimbatore. The preliminary work carried out by Barber while Government Botanist in Madras was referred to is last year's report and it was stated that the problem of raising canes from seed had been successfully solved. A considerable amount of progress has been made during the year under report.

It has been found that some of the North Indian canes, grown at Coimbatore, flower freely, but that the inflorescences, instead of being perfectly sterile as they appear to be in North India, are provided with large quantities of open anthers with fertile pollen. Provisional experiments have resulted in about 100 seedlings being raised from these canes. A much larger number of seedlings were obtained from the arrows of canes growing round Coimbatore and, although the arrowing season was exceptionally unfavourable because of heavy rains in the middle of November succeeded by a long spell of dry weather, some 12,000 to 15,000 seedlings were obtained in place of the 50 grown in the previous year. Of these, 2,000 have been selected for growing on and examination and most of them are thriving well at the time of writing. About 30 of last year's seedlings were closely studied from every point of view. Their morphological characters received special attention and these were compared with those of their parents with the idea of obtaining some information as to value of the characters from a systematic point of view, nothing being at present known on this subject. They were also very carefully studied in their earlier stages in order, if possible, to obtain criteria for the early rejection of unsuitable forms. The chemical analysis showed that the seedlings of the same parents varied a good deal in sugar content, but that those of different origin approximated somewhat to their parents in this character. A certain relation also appeared to exist between vegetative vigour and sugar content, and it is unfortunate that these seem to vary inversely, the most vigorous seedlings (one of which produced 143 strong canes in twelve months from sowing) having usually very poor juice. On the whole, the results are encouraging and one at least of the first year's seedlings

would appear to be worth trying under North Indian conditions, as it has a very fair proportion of sugar, pure juice and a considerable amount of vigour. It was unfortunately necessary to grow these seedlings on land entirely unsuited for sugarcane cultivation, and, for this reason, it has been thought wise to grow the whole again on the cane farm to check the results and, incidentally, to test the fixity of the characters observed.

The collection of varieties has been largely increased by the addition of canes collected during two long tours in North India and considerable progress has been made in the study of their morphological characters with the prospect of an ultimate classification of the Indian canes. In order to obtain some idea as to the canes most usefully employed as parents, a large number of analyses made in the past have been accumulated, special assistance having been given in this matter by the Imperial Agricultural Chemist and the Agricultural Chemist of Madras. The collection of varieties was greatly helped by the officers in charge of the Sabour, Pertabgarh, Aligarh and Gurdaspur farms.

Some interesting scientific results have accrued from the study of such wild Saccharums as have been obtained. Successful crosses have been made between *Saccharum spontaneum* and two North Indian forms, Chin and Shakarchynia, and this fact, coupled by strong resemblance in the vegetative characters, makes it appear probable that at any rate a number of the North Indian canes have arisen from this wild species, or are very closely allied to it. This conclusion has obtained a certain amount of support from the curious belief expressed by the cultivators round Gurdaspur that their canes, among the most primitive in India, have arisen from a wild grass which appears, from a cursory examination, to be a variety of *Saccharum spontaneum*. But this study of wild species was undertaken with the purpose of learning the systematic value of the vegetative characters, and a good deal of information has been obtained on this point. A number of seedlings were raised from *Saccharum spontaneum* which flowers freely round Coimbatore, and out of these two very different types have been selected for further study. Upon analysing their juice it was found that the more vigorous type contained nearly 3 per cent. of sugar while the stunted slow-growing form had nearly 5 per cent., a curious commentary on the relation between vegetative vigour and sugar content mentioned above in sugarcane seedlings. The other wild Saccharums studied, Narenga, Munja and arundinaceum, appear to differ widely from cultivated sugarcanes.

At Sabour, Woodhouse and Taylor continued their study of the canes of the tract, grown now in pure lines for four years. They have brought together the results of this study and these are awaiting publication.

At Aligarh the distribution of *Saretha Desi* continues to increase, some 200 acres being planted up of this variety in the neighbourhood of

the farm. As a certain amount of prejudice was expressed against this cane because of its habit of free flowering, Parr conducted experiments as to the relative *gur* production and suitability for seed purposes of flowered and unflowered canes. In each case the flowered canes were in no way behind the unflowered. The popularity of the Mauritius canes introduced at this farm continues and it is hoped that there will be a great extension of these kinds as they have proved superior to the local chewing canes.

At Jorhat in Assam, Meggitt has shown that several of the West Indian seedlings are capable of yielding large quantities of sugar per acre of good quality, and are therefore suitable for employment if sugar factories are contemplated.

In Madras the acreage under Red Mauritius continues to increase. A record specimen of Striped Mauritius has been figured, 29 feet long and with 23 feet of cane. On the West Coast B 208 appears to give better results than Red Mauritius and it is gradually supplanting that kind in some places, the sugar industry having received a great impetus from the work on the Taliparamba farm. Over 125,000 sets were distributed during the year.

Several new farms have either been opened during the year or are proposed in the main North Indian sugarcane tracts. One of the objects of these farms will be to test the canes produced at the Coimbatore farm.

Tobacco.—The Howards continue their study of this crop, the inheritance of leaf characters being the work of chief scientific interest during the year. The attempt to produce a good cigarette tobacco has met with considerable success and a consignment of leaf prepared from a selected type, specially cultivated and cured by a modification of the local method in Bihar, was valued at Monghyr at considerably above the normal price.

The Director of Agriculture in Burma considers that the haphazard distribution of Havana and Virginian seed in past years has had an appreciable effect on the quality of the local leaf. He proposes to continue and systematise these importations.

Soy Beans.—Woodhouse and Taylor have published an important Memoir giving the results of their work on Soy Beans for several years. It contains an account of the varieties found in the plains and hill tracts of Bengal and Bihar and Orissa and deals with the unit characters by which they are differentiated. It is interesting to note that many of the varieties from the hill tracts are similar to the Chinese types imported into America, while none of these types are found in the plains, on which the varieties are of long, straggling habit. The most interesting characters dealt with are the percentages of oil and nitrogen in the seeds, which appear to be inherited separately. The differences in the

oil content of pure lines of the different varieties were found to be inherited.

Agriculturally, some of the varieties have given satisfactory yields in the hills and plains, but in the plains the ordinary varieties have the disadvantage of occupying the land for two seasons. A sufficiently high price is not yet offered to encourage its growth for export.

Further work is being done with this crop at Sabour. It has been lately found that the Nepali variety of Soy Bean, which yields well and compares favourably with the best variety on the English market in size and oil content, has the single disadvantage of a brown seed coat.

Other Crops.—A large number of other crops have received attention during the year and some of these are mentioned here to indicate the wide nature of the field awaiting investigation.

Woodhouse has studied the extent of cross-pollination in the genus Phaseolus in Bihar.

Howard has grown certain grams along pure lines and noted considerable variations in their value, both as regards yield and quality. He considers that this crop presents a considerable margin within which improvements may be effected.

Burns has completed his survey of the peas and beans in the Bombay Presidency.

The expansion of the groundnut area continues, some 1,200,000 acres being under the crop. It has been justly pointed out that this extension has been coincident with the growth of the Agricultural Department in India, for every Provincial Department has been active in testing the kinds collected from all quarters of the globe, largely through the agency of the Palur farm in Madras, and distributing such forms as appeared to be suited to its own soil and climate. This distribution still continues on a large scale and several new tracts have been opened during the year.

Oil seeds are receiving a certain amount of attention. At Pusa the study of their pollination is being taken in hand. In Bengal, Hector has established pure lines of the Brassicas of the Province. He has collected and classified the tils and studied the amount of cross-pollination in the fields. Nothing that the oil content of the local kinds was uniformly inferior, he has introduced the best forms from other parts of India with a view to comparative growth and the improvement of the staple. Evans in the Central Provinces has been successful in the selection of better varieties and arrangements have been made for the pure growth of better class tils in 47 villages of Hoshangabad.

Howard has suggested that the present poor growth of indigo in Bihar is largely traceable to inferior cultivation and waterlogging. As

the result of trials at Pusa, he proposes wheat as a cover crop, care being taken to select an early, rapidly maturing variety. The question of seed farms having become urgent because of the increasing difficulty of obtaining good seed, he suggests Cawnpore or South Bihar as suitable places for the establishment of these.

The Howards have continued their study of the botanical characters of fibre plants.

Woodhouse has selected out a number of varieties of *Setaria italica* in Bihar and grown them on in pure lines.

Graham has made a survey of the Cucurbitaceæ of the Central Provinces. He has specially studied certain genera and separated out a number of distinct varieties.

Barber has made a study of the peppers of South India and arranged his collection of 1,143 sheets under a series of types. As remarked by Hooker in the Flora of British India, the genus requires revision by botanists in the field. This has now been largely accomplished and a summary note has been drawn up and placed in the Herbarium at Coimbatore for the guidance of authors of the forthcoming Flora of Madras. Several new species have been accurately studied and described, some of them being considered to be of high commercial value.

The flax experiments at Dhooriah by Vandekerkhove have been successful, showing a large profit, but the cultivation and preparation require a considerable amount of expert knowledge.

Hector has studied the Capsicums in Bengal and has demonstrated cross-pollination in the fields. The classification of those in the Central Provinces has been completed by Graham, specially pungent forms have been selected and largely distributed by seed.

Fruit-culture.—Fruit trees have received some attention. A fruit garden has been established near Quetta but, as the results will take some years to materialise, an older garden has been taken over in Quetta itself. Here various experiments are being conducted. Howard considers that the best form of packing is in chip and board boxes the materials of which are imported from Glasgow. The mango continues to receive a great deal of attention, especially in Bombay, and Hartless of the Saharanpur gardens has furnished a useful scheme for their preliminary classifications.

Work of great promise is being carried on by Robertson Brown in the Tarnab farm near Peshawar in fruit-culture. The introduction of ring-budding has been a great success and the plants so prepared from superior varieties of peaches, with large, well-flavoured fruit, are being readily taken up in large numbers by the local cultivators. The best method of packing these superior peaches has been decided on and it is expected that a large export trade will result.

Root Development.—Closely connected with the working of the soil is the effect of this on root development, but little account seems to be taken of the great diversity in the root systems of different kinds of crops. Parr has shown by experiment that, by deeper planting maize plants at Aligarh and earthing up a distinctly larger yield can be obtained and this method is being taken up by the neighbouring cultivators. Burns has continued his studies of the root systems of fruit-bearing trees in Bombay. Howard has made the interesting observation that, when the roots of banyans are severed, they not infrequently reunite by a process of natural root-grafting.

Barber in Coimbatore has made a survey of the root systems of the crops growing on the farm in mixed black cotton and red soil. Each system has been carefully dissected out, noted and photographed to scale, and interesting facts have been brought to light concerning the duration of crops. A special study was made of the species of cottons growing in the tract and it was recorded that Cambodia was capable of developing a root system suggesting that it might be grown in many parts of the Presidency without irrigation. The root systems of the tamarind, nim, portia (*Thespesia populnea*), babul and agathi (*Sesbania grandiflora*) received special attention with regard to their influence on the crops around them.

Part II.—FOREST BOTANY.

BY

R. N. PARKER, F.C.H.,
Forest Botanist.

Œcology of sal.—Experiments carried out during the year by the Forest Botanist in growing *sál* seedlings (*a*) *in situ* in typical local grasslands and (*b*) at Dehra Dun in large flower-pots in soil collected from the same grasslands have corroborated the fact mentioned in previous reports that the dominant species of grass is an accurate indicator of the local conditions of soil and of the suitability or otherwise of the area occupied by these grasses for the growth of different forest trees. The work done up to date shows that, for the successful growth of *sál* seedlings, the soil must be well aërated and must at the same time be capable of retaining not less than 10 per cent. of moisture throughout the hot season. In a badly aërated soil the percentage of germination of *sál* is lower and the percentage of deaths during the rains is higher than in a well-aërated soil. In addition to this, the average length of root of one-year-old *sál*

seedlings is 12″ and 30″ in badly and well-aërated soils, respectively. Thus the former plants are also more subject to the injurious action of drought, seeing that their roots are situated in the upper layer of soil which dries out rapidly in the hot season. An interesting fact brought out in the experiments is that by simple mechanical pressure (even when the soil is practically dry), such as would be caused by the tread of grazing animals, a soil known to be suitable for the growth of *sál* can be rendered totally unsuitable on account of its bad aëration.

An important point investigated during the year was that of the heavy mortality of *sál* seedlings which usually occurs in the local *sál* forests during the rains, in July-August. The experiments carried out clearly showed that the responsible factor was not shade, *i.e.*, an insufficient intensity of light. The light intensity in the forests when the mortality ranged from 80—90 per cent. of deaths was 0·02 to 0·05. Under artificial shades, on the other hand, *sál* seedlings have been grown successfully with a light intensity as low as 0·007, the mortality during the rains being only 20 per cent. So far as the work has gone at present it indicates that the dominant factor here responsible is bad soil aëration which is brought about chiefly by (*a*) the shade in the forest preventing free air-circulation and thus decreasing the evaporation of water from the soil and (*b*) a high percentage of humus in the surface soil which greatly increases its capacity for holding water. A set of experiments has been designed which should further elucidate this point next year and it has been considered advisable to defer publication until these results are available.

Forest grasses.—The study of the species mentioned in last year's report was continued while the work undertaken in collaboration with Mr. Raitt on those species likely to be valuable for paper-pulp was completed and the results of the latter are now in the press. The following widely distributed and gregarious species have all been found to constitute a first class material for the manufacture of paper-pulp and they can all be treated either separately or in mixture without reducing the value of the product:—

Saccharum spontaneum, Linn.
,, *arundinaceum*, Retz.
,, *Munja*, Roxb.
,, *Narenga*, Wall.
Anthistiria gigantea, Cav.
Arundo Donax, Linn.
Phragmites Karka, Trin.

The following species, although somewhat inferior in quality and strength of fibre to the above, have been found to be admissible

in moderate quantity with them without material prejudice to the yield and quality of the pulp:—

Saccharum fuscum, Roxb.
Andropogon intermedius, Br.
Vetivera zizanioides, Stapf.
Andropogon Nardus, Linn.
Erianthus Ravennæ, Beauv.

A negative result of considerable importance is that the very common *Andropogon contortus*, Linn., the well-known Spear grass of the plains, is of no value and is quite inadmissible in mixture. It has been found that the maximum yield of cellulose is obtained if the grasses are cropped when flowering and as the culms of some of the species require more than one year to attain maturity and flower, this means that they must be worked on a rotation. One species, *viz.*, *Saccharum arundinaceum*, Retz., the culms of which require 3 or 4 years to attain maturity, has been found to give an average annual yield of 14 tons of dry material per acre per annum which is believed to be the highest yield of any pulp-yielding species. (*Hedychium coronarium* has been recently reported to give 10 tons per acre per annum which is apparently the next highest yield.) Another of the species dealt with (*Anthistiria gigantea*) has been found to yield a pulp of quite exceptionally high quality.

Local Forest Floras.—The Forest Botanist prepared a detailed scheme for the preparation of descriptive lists in all provinces for the consideration of the Board of Forestry which met at Dehra Dun during the year. On this note the Board passed the following resolutions:—

(1) That detailed Forest Floras are useful for purposes of reference and that their ultimate publication is an object which should be kept steadily in view.

(2) That the preparation of detailed Floras is not of such urgent importance at the present time as is preparation of descriptive lists.

(3) That the scope and general character of the descriptive lists as detailed in the note are generally suitable.

(4) That the preparation of descriptive lists should be undertaken in the various provinces as soon as circumstances permit.

There is thus good reason to believe that this important work will now be systematically and energetically taken in hand.

A list of trees, shrubs, etc., recorded from Burma with vernacular names was issued by Mr. Lace, Chief Conservator of Forests, during the year.

List of papers on Economic Botany.

ANSTEAD, R. D. . Hevea Rubber in Southern India. (*Agri. Jour. of India, vii, 257, 1912.*)

BARBER, C. A. . . Seedling Canes in India. (*Agri. Jour. of India, vii, 317, 1913.*)

BEALE, R. . . Studies in Vegetable gland tissues. I. (*Poona Agri. Col. Magazine, iv, 267, 1913.*)

BOMBAY DEPARTMENT OF AGRICULTURE. Treatment of a Mango Plantation. (*Agri. and Co-operative Gazette, viii, No. 10, 1912.*)

BROWN, W. ROBERTSON. Annual Report of the Agricultural Stations of the North-West Frontier Province for 1911-12.

BROWN, W. ROBERTSON. Italian Rye Grass in Peshawar. (*Agri. Jour. of India, vii, 391, 1912.*)

BROWN, W. ROBERTSON. English Oats in Peshawar. (*Agri. Jour. of India, vii, 393, 1913.*)

CHIBBER, H. M. . Some Promising Leguminous Crops. (*Poona Agri. Col. Magazine, iv, 252, 1913.*)

" " . Some Economic Water Plants of the Bombay Presidency. (*Poona Agri. Col. Magazine, iv, 49 and 156, 1912.*)

CLOUSTON, D. . . Transplantation of Rice in Chhatisgarh. (*Agri. and Co-operative Gazette, Central Provinces, ix, No. 5, 1913.*)

EVANS, G. . . The Organization of Seed Farms in Central Provinces. (*Capital, June 5th and 12th, 1913.*)

GRAHAM, R. J. D. . Robber Plants. (*Agri. Co-operative Gazette, Central Provinces, ix, 1913.*)

HAINES, H. H. . *Trees, Shrubs and Economic Herbs of the Southern Circle, Central Provinces.* (*Ind. For., October 1912 and February 1913.*)

HARTLESS, A. C. . Report of the Government Botanical Gardens, Saharanpore, for the year ending 31st March 1913. (*Allahabad, 1913.*)

" " . The flowering of the Mango. (*Agri. Jour. of India, viii, 90, 1913.*)

HECTOR, G. P. . . Notes on Pollination and Cross-Fertilization in the Common Rice Plant, *Oryza Sativa*. [*Mem. of the Dept. of Agri. in India (Bot. Series), vi, No. 1.*]

HOLE, R. S. . . *The different forms of Pyinkado.* (*Ind. For., September 1912.*)

" " . . *Burmese Kaing Grass.* (*Ind. For., October 1912.*)

" " . . *Useful Exotics in Indian Forests.* (*Ind. For. Rec., iv, 3, January 1913.*)

" " . . *Albizzia Lathamii*, Hole. (*Ind. For. Rec., iv, 4, January 1913.*)

" " . . *Note on the chief Fodder Grasses of Indian Forests.* (*Ind. For., February 1913.*)

" " . . *A Notorious Indian Fodder Grass.* (*Ind. For., June 1913.*)

HOPE, G. D. . . A Method of renovating tea bushes by pruning. (*Quarterly Journal of the Indian Tea Association, 57, 1912.*)

" " . . The Value of Leguminous trees in tea gardens. (*Quarterly Journal of the Indian Tea Association, 64, 1912.*)

HOPE, G. D., & TUNSTALL, A. C. Green Manuring, Parts I and II. (*Quarterly Journal of the Indian Tea Association, 99, 1912, and 22, 1913.*)

HOWARD, A. . . Natural Root-grafting. (*Agri. Jour. of India, viii, 185, 1913.*)

" " . . Some Aspects of the Agricultural Development of Bihar. (*Bull. No. 33, Agri. Res. Instt., Pusa, 1913.*)

HOWARD, A., & HOWARD, G. L. C. The Improvement of Indian Wheat. (*Agri. Jour. of India, viii, 7, 1913.*)

HOWARD, A., & HOWARD, G. L. C. The Improvement of Crops. (*Agri. Jour. of India, viii, 111, 1913.*)

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INDIAN TEA ASSOCIATION. A tea-garden weed *Eupatorium* sp. (*Quarterly Journal of Indian Tea Association, 109, 1912.*)

INDIAN TEA ASSOCIATION. The Propagation of tea plants by grafting. (*Quarterly Journal of Indian Tea Association, 45, 1912.*)

KOTWAL, T. R. . . Shingada (*Trapa bispinosa*) in the Thana Dist. (*Poona Agri. College Magazine, iv, 19, 1912.*)

KULKARNI, K. D. . Notes on the Cottons of Gujerat. (*Poona Agri. College Magazine, iv, 23 and 111, 1912.*)

" " . Notes on the Cottons of Khandesh. (*Poona Agri. College Magazine, iv, 257, 1913.*)

KULKARNI, L. B. . Experimental Fig-drying at Saswad. (*Agri. Jour. of India, viii, 83, 1913.*)

LACE, J. H. . . *List of Trees, Shrubs and Principal Climbers recorded from Burma.* (*Govt. Press, 1913.*)

LEAKE, H. M., & PARR, A. E. The problem of the improvement of the Indigenous Cottons of United Provinces. (*Agri. Jour. of India, viii, 47, 1913.*)

LEAKE, H. M., & RAM PRASAD. Wheat Experiments on the Botanical Area, Cawnpore, and their bearing on Wheat Cultivation in United Provinces. (*Bull. 31, Agri. Res. Instt. Pusa, 1913.*)

MCGLASHAM, J. . Sugarcane cultivation in India. (*Agri. and Co-operative Gazette, Central Provinces, viii, No. 12, and x, No. 1.*)

MAHOMED AMIN KHAN Ring-budding. (*Agri. Jour. of India, viii, 74, 1913.*)

MAIN, T. F. . . Cambodia Cotton in the Bombay Presidency. (*Agri. Jour. of India, vii, 373, 1912.*)

" " . . Annual Report on the Experimental Work of the Surat Agricultural Station, 1911-12. (*Bombay, 1912.*)

" " . . Annual Report on the Experimental Work of the Dharwar Agricultural Station, 1911-12. (*Bombay, 1913.*)

MEHTA, G. D., & V. G. GOKHLE. A Method of improving the quality of cotton seed. (*Bull. No. 53, Dept. of Agri. Bombay, 1912.*)

PARKER, R. N. . *Eucalyptus in N. W. India.* (*Ind. For., February 1913.*)

PARR, A. E. . . Sugarcane Experiments at the Aligarh Experiment Farm. (*Agri. Jour. of India, vii, 301, 1912.*)

,, ,, . . Root Development of Cereals. (*Agri. Jour. of India, vii, 317, 1912.*)

PATWARDHAN, G. B. . The Experimental Renovation of Orange Plantation. (*Poona Agri. College Magazine, iv, 172, 1913.*)

,, ,, . Further Observations on some Drought-resisting Plants of the Deccan. (*Poona Agri. College Magazine, iv, 108, 1913.*)

PATWARDHAN, V. G. . 'Pan' Cultivation at Ramtek in Nagpur. (*Ibd., iv, 36, 1912.*)

PRAYAG, S. G. . . The Alphonse Mango. (*Agri. Jour. of India, viii, 169, 1913.*)

,, ,, . . Mango Culture in Goa. (*Agri. Jour. of India, viii, 173, 1913.*)

TAMHANEKAR, K. V. . The Flowering of the Mango. (*Agri. Jour of India, vii, 399, 1912.*)

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BOTANY.

III.—MYCOLOGY.

BY

E. J. BUTLER, M.B., F.L.S.,
Imperial Mycologist.

I.—Plant Pathology.

Agricultural Research Institute, Pusa.—The following is an account of the chief diseases of plants investigated at Pusa during the year.

Rice diseases.—A disease of inundated rice, of a very serious nature, has broken out in the deltaic districts of Eastern Bengal, where it is locally known as *ufra*. Much time was given to its investigation. It has been found to be caused by a minute parasitic nematode worm, of the genus *Tylenchus*. Though not mycological, it is referred to here, as, in the absence of any agricultural Helminthologist in India, its further investigation has been taken up by the writer. The parasite, a hitherto undescribed species, attacks especially the deep-water winter rice so extensively grown in the area referred to, and the intensity of the attack is such that affected fields are frequently not considered worth harvesting. In the backward state of agricultural information in Eastern Bengal, it is difficult to arrive at even an approximate estimate of the losses, but they are undoubtedly very heavy and there is evidence that the disease is spreading. The parasite is allied to two of the worst worm parasites of crops known, *Tylenchus tritici* and *T. dipsaci*. It appears to be strictly parasitic on rice, being unable to grow and multiply in the absence of living rice plants. It feeds by piercing the epidermis of those parts of the plant where the outer wall is unthickened and not silicified and, consequently, is restricted to certain definite parts of the plant: the apex of the shoot, the young leaves, above the upper stem nodes, and the young ear being the chief. The result of its attacks is to prevent the ear from maturing properly and there is total or partial loss of the grain. It passes the period between successive crops coiled up, in a resting condition, in the stubble and can stand drying in this condition for over a year. No evidence has, as yet, been obtained that it hibernates in the soil; if subsequent work confirms this, there is a good

prospect of being able to fight it by destroying all stubble left after harvest, and experiments in this direction are being carried out.

The chief fungus diseases of rice studied were bunt, caused by *Tilletia horrida* Tak., false smut caused by *Ustilaginoidea virens* (Cke.) Tak. and a disease caused by *Sclerotium Oryzæ* Catt. Accounts of these diseases have been published since the close of the year under review.

Root rot of various crops.—A description of the morphology and parasitism of two species of the form genus *Rhizoctonia*, soil parasites which attack the underground parts of several crops, was published. Cotton, jute, groundnut, cowpea, potatoes and sesamum are amongst its victims. More recently, it has been found to cause opium blight and to damage lucerne. The published investigations deal with two species, *R. Solani* Kühn on jute, cotton, potato, groundnut and cowpea and *R. violacea* Tul. on groundnut and cowpea. The latter is shown to be an imperfect stage of the basidiomycete *Corticium vagum* B. & C. Details of their morphological characters in culture and their behaviour as parasites, are given.

Phytophthora investigations.—Two species of this most destructive genus of fungus parasites, *Ph. parasitica* Dastur and *Ph. Colocasiæ* Rac., have been under study, and the results were published. *Ph. parasitica* causes a disease of young castor plants, being the most serious disease of the crop known. It was obtained in pure culture and this permitted of a very full study of its characters and parasitism. The chief interest centres in the discovery of a new type of reproduction, a discovery which was anticipated by a British Mycologist, working with an allied species, shortly before the publication of the paper. A very complete series of inoculation experiments was carried out, potato, tomato, brinjal, til and several other plants proving susceptible to attack.

Ph. Colocasiæ attacks the country vegetable, *Colocasia antiquorum*, and, under certain conditions, causes much damage both to the growing crop and, subsequently, to the stored corms. The intensity of the attack is closely dependent on the character of the monsoon, being worst in wet years. The parasite was cultivated artificially and a large series of inoculation experiments carried out, which showed that it has a very restricted range of victims. It possesses the same remarkable type of reproduction as *Ph. parasitica*.

More recently *Ph. infestans*, the cause of the well-known potato blight, has been under study, a serious outbreak having occurred in Bihar and Bengal last year. It has also been obtained in pure culture and it is hoped to get some light on the reason why it is so rarely found in the hotter parts of India.

Sugarcane diseases.—The progress in the investigation of several diseases of this crop is referred to in the Pusa Annual Report for 1911-12.

The work has extended over a number of years, owing to difficulties encountered in carrying on field experiments. It has been so far completed as to allow of the preparation of two Memoirs now in the press, one on red rot (caused by *Colletotrichum falcatum* Went), and a second on some new sugarcane diseases. The chief points elucidated are the channels of natural infection of the crop, in some of the more important stem diseases, and the methods of control to be adopted in practice. These will be referred to more fully in the next report.

Wheat rust.—A severe attack of wheat rust, the first for a number of years, occurred in the Central Provinces in 1912. It was found that orange rust (*Puccinia triticina*) was responsible for much of the damage, though in ordinary years scarce in that part of India. Black rust (*P. graminis*) was also severe. Hence, in breeding rust-resistant wheats, the behaviour to these two rusts must be chiefly considered and, as orange rust may be absent in ordinary years, it may be necessary to carry out some of the work in parts of India where orange rust occurs annually.

Anthracnose of sisal hemp.—This was definitely proved to be due to the fungus *Colletotrichum Agaves* Cav. previously suspected to be its cause. It infects various species of *Agave* readily, and produces a characteristic leaf disease. Collecting and burning diseased leaves, and spraying with Bordeaux mixture, are recommended as measures likely to check the disease.

Damping off.—This seedling disease, caused by *Pythium de Baryanum* Hesse, was not previously reported from Asia, but has been found to occur occasionally at Pusa. It was studied, and some doubtful points in its morphology cleared up. In temperate countries it causes a good deal of loss, but does not appear to be a serious danger in India.

Cereal downy Mildews.—These diseases, caused by members of the genus *Sclerospora*, appear to be of greater importance in India than elsewhere. Maize, several of the more important millets and a fodder grass, are amongst the crops affected. The maize mildew appeared at Pusa for the first time last year, and is probably a recent importation from Java, where it has been known since 1897. It has not yet been found in any other country, but in Java causes much loss. From its investigation at Pusa, it was found to be closely allied to the form on jowar (*Andropogon Sorghum*) and to be a true *Sclerospora*, not a *Peronospora* as stated by investigators in Java. It was also shown that the resting-spore stage described in Java, by which the disease was supposed to be perpetuated, had in reality nothing to do with the fungus, being merely the cystic stage of a Protozoon. Nothing is known of the life-history of the *Sclerosporas*, and observations are being continued in the hope of determining how the parasite persists from one season to the next. Until this is decided, it is not possible to find a rational method of con-

trol, and the only measure that can be recommended is to pull out and destroy all diseased plants, which can only be done in mild attacks.

Mr. Kulkarni, Mycological Assistant, Bombay Department of Agriculture, has given reasons for separating the *Sclerospora* on jowar from that on bajri (*Pennisetum typhoideum*) as a distinct variety, to which he has given the name *Sc. graminicola* var. *Andropogonis Sorghi*. He has also furnished useful notes on the field characters of these mildews.

Indigo blight.—This obscure disease has been under study for some time, but no parasitic organism has been found constantly associated with it and it is considered to be non-fungal in origin. A considerable number of different organisms, mostly of the class known as weak parasites, were isolated from individual plants, in various stages of the disease, but none proved capable of reproducing it. The mycological side of the enquiry has, therefore, been abandoned.

Miscellaneous.—Notes are given in the Annual Report of the Mycological Section, Pusa, for 1911-12, on a number of other diseases of plants studied during that period. The more important were cotton wilt, anthracnose of plantains, foot rot of papaya, lucerne and cauliflower mildews and a number of forest tree diseases. The successful treatment of oat smut by formalin steeping is recorded, and notes are given on the areca palm disease in North-Eastern India, believed to be caused by *Fomes lucidus* (Leys.) Fr.

Provincial Departments of Agriculture.—The following are the chief items of mycological work carried out by Provincial Departments of Agriculture and referred to in the reports published during the year.

Madras.—Mr. McRae continued the campaign against bud-rot of palms (caused by *Pythium palmivorum* Bult.) in the Godavari and Kistna Districts. Some extensions of the disease outside the area covered by the operations were discovered and dealt with. In Kistna there is a distinct decrease in the area affected, as a result of the work, but the checking of extension in the upland forest area is a serious problem. In Godavari the area remains practically the same and there is no decrease in the number of trees cut periodically. In a paper published in the *Agricultural Journal of India*, Mr. McRae calls attention to the danger of allowing palms, which have spots caused by the parasite on the expanded leaves, to remain uncut. The fungus in this position is exposed to wind dissemination and each such tree serves as a centre of spread to surrounding palms. Fortunately the number of cases in which the parasite attacks the leaf blades is small. As there is a difficulty in inducing the ryots to allow these to be cut, a proposal has been made to employ some form of compulsion.

Mr. McRae carried out extensive experiments in spraying areca palms, affected with the *Koleroga* or *Mahali* disease (caused by *Phytophthora omnivora* var. *Arecæ* Coleman), in South Malabar, with such success that the owners have asked that the work should be continued. The increased profit per 100 trees sprayed was over Rs. 20.

A bud-rot of coconuts was reported from Malabar. It was at first believed to be identical with that of Cuba and the West Indies, the cause of which is *Bacillus coli*, but recent reports indicate that it is due to *Pythium palmivorum*. It is, at present, impossible to gauge the importance of this outbreak, but the chief fear which has always been felt by those responsible for the work against this parasite in Madras, has been that it should develop with virulence in the enormously valuable coconut plantations of the West Coast.

Other work in Madras included unsuccessful attempts to secure inoculations with the false smut of paddy [*Ustilaginoidea virens* (Cke.) Tak.], stringent selection of the sugarcane crop at Samalkota with a view to checking red rot, and the study of several diseases of various crops.

Mysore.—Dr. Coleman continued work in connection with the *Koleroga* disease of areca palms, and the parasitism of *Fomes lucidus* on the same tree.

Bombay.—Mr. Ajrekar published a note on the rust of castor (*Melampsorella Ricini* de Toni). Work in connection with the control of *Koleroga* of areca palms and red rot of sugarcane was continued.

Central Provinces.—Work was confined to observations on the behaviour of varieties of wheat to rust, with a view to securing rust-resisting strains, and further tests of the immunity of buri cotton to wilt. The latter were eminently satisfactory, almost complete immunity being shown, even when planted in fields very severely infested with wilt. As the variety yields the cultivator about Rs. 40 less per acre than the cottons ordinarily grown, its use is likely to be restricted to wilt-infested areas.

Bihar.—Mr. Basu studied the outbreak of *Phytophthora infestans* on potato and has published a note on it since the close of the year under review.

Burma.—The anthracnose of cotton (caused by *Colletotrichum Gossypii* Southw.) was found on Pernambuco tree-cotton. A short note giving suggestions for its control was published as a departmental leaflet.

Indian Tea Association.—Mr. Tunstall has contributed a number of notes on tea diseases to the Association's Quarterly Journal. These deal chiefly with root diseases, the commonest being those caused by *Ustulina zonata* Lev., *Hymenochæte noxia* Berk. and *Botryodiplodia*

Theobromæ Pat. Besides the measures previously recommended for the check of these diseases, experiments were carried out with a new treatment, consisting in the application to the soil of ammonium sulphate and lime in equal parts, after removing all dead roots. This results in the liberation of ammonia, which is stated to inhibit the growth of the parasite.

Of leaf diseases the chief referred to are blister blight, caused by *Exobasidium vexans* Mass., and copper blight, caused by *Lœstadia Theæ* Rac. Blister blight was observed in Darjeeling and North-East Assam. It has been found to persist through the cold weather on old nurseries, seed gardens and abandoned tea, and it is recommended that attention should be directed to preventing infection from these sources. None of the plucking area should be left unpruned and no abandoned tea or old nurseries should be kept; all seed gardens should be sprayed with Bordeaux mixture; and planters should unite so as to secure concerted action in stamping out the disease. Copper blight is said to be on the increase, but to cause comparatively little damage at present.

II.—Systematic Mycology.

There is little to record under this head during the year. A few new species have been described from India by Saccardo and Sydow. Dietel points out that the common Himalayan rust of wild vines cannot be identified with *Phakopsora Vitis* Syd., but is a distinct species, which he has named *Phakopsora cronartiiformis* (Barcl.) Diet. Theissen has commenced the publication of a compilation, giving a list of the Fungi of India, in the Journal of the Bombay Natural History Society.

List of Publications.

Ajrekar, S. L. . . The Castor Rust (? *Melampsorella Ricini* de Toni). (*Journ. Bombay Nat. Hist. Soc., xxi, p. 1092, 1912.*)

Annual Reports of the Agricultural Research Institute and College, Pusa, and of the Provincial Departments of Agriculture.

Butler, E. J. . . Ufra disease of Rice. (*Bull. of the Bureau of Agric., Intell. and Plant Diseases, 3rd year, No. 7, p. 1661, 1912.*)

,, ,, . . Pythium de Baryanum Hesse. (*Mem. Dept. of Agri., India, Bot. Ser. V, No. 5, 1913.*)

,, ,, . . The downy mildew of Maize [*Sclerospora Maydis.* (Rac.). Butl.] (*Ibid.*)

Mr. McRae carried out extensive experiments in spraying areca palms, affected with the *Koleroga* or *Mahali* disease (caused by *Phytophthora omnivora* var. *Arecæ* Coleman), in South Malabar, with such success that the owners have asked that the work should be continued. The increased profit per 100 trees sprayed was over Rs. 20.

A bud-rot of coconuts was reported from Malabar. It was at first believed to be identical with that of Cuba and the West Indies, the cause of which is *Bacillus coli*, but recent reports indicate that it is due to *Pythium palmivorum*. It is, at present, impossible to gauge the importance of this outbreak, but the chief fear which has always been felt by those responsible for the work against this parasite in Madras, has been that it should develop with virulence in the enormously valuable coconut plantations of the West Coast.

Other work in Madras included unsuccessful attempts to secure inoculations with the false smut of paddy [*Ustilaginoidea virens* (Cke.) Tak.], stringent selection of the sugarcane crop at Samalkota with a view to checking red rot, and the study of several diseases of various crops.

Mysore.—Dr. Coleman continued work in connection with the *Koleroga* disease of areca palms, and the parasitism of *Fomes lucidus* on the same tree.

Bombay.—Mr. Ajrekar published a note on the rust of castor (*Melampsorella Ricini* de Toni). Work in connection with the control of *Koleroga* of areca palms and red rot of sugarcane was continued.

Central Provinces.—Work was confined to observations on the behaviour of varieties of wheat to rust, with a view to securing rust-resisting strains, and further tests of the immunity of buri cotton to wilt. The latter were eminently satisfactory, almost complete immunity being shown, even when planted in fields very severely infested with wilt. As the variety yields the cultivator about Rs. 40 less per acre than the cottons ordinarily grown, its use is likely to be restricted to wilt-infested areas.

Bihar.—Mr. Basu studied the outbreak of *Phytophthora infestans* on potato and has published a note on it since the close of the year under review.

Burma.—The anthracnose of cotton (caused by *Colletotrichum Gossypii* Southw.) was found on Pernambuco tree-cotton. A short note giving suggestions for its control was published as a departmental leaflet.

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BUTLER, E. J. .	. Note on the investigation of diseased conditions of the Indigo crop in 1911-1912. (*Read at the General Meeting of the Bihar Planters' Association, Jan. 29th, 1913.*)
BUTLER, E. J., & KULKARNI, G. S.	Colocasia Blight, caused by *Phytophthora Colocasiæ* Rac. (*Mem. Dept. of Agric., India, Bot. Ser. V, No. 5, 1913.*)
DASTUR, J. F. .	. On *Phytophora parasitica* nov. spec., a new disease of the Castor oil plant. (*Mem. Dept. of Agric., India, Bot. Ser. V, No. 4, 1913.*)
DEPARTMENT OF AGRICULTURE, BURMA.	Anthracnose (a disease of the Cotton plant). *Cultivators' Leaflet No. 38, 1912.*)
DIETEL, P. .	. Eine Bemerkung über *Uredo cronartiiformis* Barcl. (*Ann. Mycol., x, p. 385, 1912.*)
KULKARNI, G. S.	. Observations on the downy mildew [*Sclerospora graminicola* (Sacc.) Schroet.] of Bajri and Jowar. (*Mem. Dept. of Agric., India, Bot. Ser. V, No. 5, 1913.*)
MCRAE, W. .	. Rows of spots on the leaves of Palmyra palms, caused by the bud rot fungus, *Pythium palmivorum* Butl. (*Agric. Journ., India, vii, p. 272, 1912.*)
SACCARDO, P. A.	. Notæ mycologiæ. (*Ann. Mycol., xi, p. 14, 1913.*)
SHAW, F. J. F. .	. The morphology and parasitism of *Rhizoctonia*. (*Mem. Dept. of Agric., India, Bot. Ser. IV, No. 6, 1912.*)
,, ,, .	. Anthracnose of Sisal hemp. (*Agric. Journ., India, viii, p. 65, 1913.*)
SYDOW, H. & P.	. Novæ fungorum species. (*Ann. Mycol., x, p. 405, 1912.*)
THEISSEN, F. .	. The fungi of India. (*Journ. Bombay Nat. Hist. Soc., xxi, p. 1273, 1912, and xxii, p. 144, 1913.*)
TUNSTALL, A. C.	. Notes (in *Quart. Journ. of the Indian Tea Assoc., 1912 and 1913*).

IV.—AGRICULTURAL BACTERIOLOGY.

BY

C. M. HUTCHINSON, B.A.,
Imperial Agricultural Bacteriologist.

Agricultural Bacteriology.—Nitrogen supply in the soil as affected by intervention of bacteria has been the principal subject of enquiry; in the previous year attention was confined to the conditions under which organic nitrogen of manures and residues was converted into ammonia and nitrates; this line of enquiry affords sufficient work to occupy the whole time of any establishment for many years, but it has been considered advisable to add to it an investigation of the natural conditions under which nitrogen is taken from the air and added to the soil in this country. This if carried out thoroughly would also involve a very large amount of work, but it seems advisable in dealing with such a question as soil bacteriology in this country, where no work on this subject has been carried out before, to make preliminary enquiries, however superficial, on similar important questions, in order to gain some idea of the most useful direction in which to pursue the subject more fully. This is the more necessary on account of the still early stage of development of soil bacteriology as a science, and the fact that many fundamental theories connecting bacterial action with soil fertility have not yet been accepted as axiomatic. It is perhaps unnecessary to emphasize the importance of the question of nitrogen fixation, but it may be pointed out that there is very good reason for supposing that upon this depends the ultimate prosperity of a country, the mineral wealth of which not being commensurate with its agricultural area and population debars it from the purchase of adequate supplies of nitrogen from external sources. At the present time the need of nitrogen in India is becoming increasingly greater owing to the introduction of intensive cultivation, although up till now the soils of this country as a whole have been preserved from undue depletion by the generally superficial and extensive nature of the cultivation employed, which has prevented large crops from being taken off the land, after the reduction of the original virgin soil to the normal level of fertility by the growth of crops. At the same time deportation of nitrogen in the form of produce exported from areas in which it was grown has not been excessive, and in the case of rice much fertilization of the soil takes place by deposition of organic matter carried down from jungle tracts by the irrigation water.

Nowadays, however, this state of affairs is being rapidly altered owing to the expansion of Indian trade, which not only transports food stuffs from agricultural districts to feed the increasingly large populations of cities, but carries enormous quantities of produce out of the country, including not only cereals, oilseeds and fibres, but bones and hides, which represent nitrogen collected from very extensive areas of land. If now, in addition to this constant drain upon the nitrogen resources of the soil, intensive cultivation is introduced, meaning the more rapid conversion of non-available plant food, especially nitrogen, into the available condition, depletion will certainly follow, differing in intensity from such a result in temperate climate as the average soil temperature in India differs from that in Europe, but in an even higher degree. This difference due to temperature has been observed and measured in this laboratory as affecting ammonification, nitrification, and the formation of carbon dioxide by oxidation of the organic matter of the soil, and is not one of a slightly higher degree, but may easily attain to an increase in rate of one hundred per cent. or more; the concurrent loss of nitrogen is not to be measured, therefore, only by the increased crops taken off the land, but by losses in the form of ammonia and of nitrate washed out during the rains from fallows in well drained areas.

A further point must not be overlooked; on the credit side of the nitrogen account must be placed the addition of this element to the soil through the intervention not only of leguminous plants but of nitrogen fixing members of the soil flora such as Azotobacter and Clostridium; the physiological activity of these organisms, however, is strictly limited by soil conditions, and especially in the case of the former by the supply of carbohydrate food, so that should intensive cultivation, carried out without regard to this aspect of the case, lower the supply of organic matter beyond the optimum point for nitrogen fixation by the above-mentioned organisms, this source of nitrogen would be cut off, and the discrepancy already existing between the two sides of the account would be further increased, probably in geometric proportion.

During the past year Azotobacter has been found in all Indian soils examined, including those of such widely differing character as may be found in Sind, Nagpur, and Assam; pure cultures of *A. Chroococcum* from such various sources exhibited nitrogen fixing power very similar to that recorded from European strains, its physiological activity depending upon appropriate supplies of water, air, lime, and especially of carbohydrate food. It is intended to carry out a general survey of Indian soils to get some idea of the distribution of this and similar organisms and the conditions under which they may most readily carry on nitrogen fixation in these soils.

The green manuring experiment begun in collaboration with the Imperial Agriculturist during the previous year was carried on and will continue in 1913-14. The successful use of a green manure crop was found to depend almost entirely upon the incidence of rainfall succeeding the burying of the crop, partly owing to the loss of soil moisture by transpiration during the growth of the green manure, and partly to the necessity for providing a considerable percentage of soil water to ensure the proper decomposition of the buried material. Further experiments during the current season include a special method of dealing with a green manure crop designed to avoid the loss due to want of sufficient soil moisture to ensure complete decomposition after burying; this method consists in hastening the initial stages of decomposition by steeping the cut crop in water and then fermenting it in heaps, under which conditions the less readily decomposed cell walls and lignified tissues are rapidly attacked by bacteria favoured by semi-anærobic conditions; the fermented material is then used in the same way as farmyard manure. The advantages of this method, in addition to the principal one of eliminating the uncertainty of the rainfall as a factor in decomposing the buried green material, include the possibility of applying the fermented manure at the best rate per acre and at the best time for producing its optimum manurial effects; at the same time it is not necessary to grow the green manure crop on the land which is to carry the "rabi" crop intended to benefit by its manurial effect; in some cases this might be of great advantage with regard to the depletion of the soil moisture consequent on transpiration during the period of growth of the green manure crop. This method of dealing with a green manure crop closely resembles the practice in indigo-growing districts of manuring tobacco and other soils with the refuse ("seet") from the indigo factory, which is obtained by steeping the cut indigo plant in water for some 24 hours and subsequently allowing the sodden plants to lie in heaps in which fermentation goes on; the rotted material thus produced is generally applied to tobacco lands, the rented value of which depends almost entirely upon the local availability of the indigo "seet."

The field experiments with green manure in 1912-13 included the growth of a "rabi" crop (wheat) on the experimental area. In no case was there any increase in yield from the green manured plots and in many there was a decided falling off. There can be no doubt that this result was due to the failure of the generally expected rainfall in September and October (locally known as the "Hathia"), as it was found on examination that the buried stems of the green manure had failed to undergo complete decomposition.

Laboratory experiments showed that the nitrate formed from the buried plant tissues increased in amount up to the end of eight weeks from the time of turning into the soil, provided the water supply was

kept up to at least 16 per cent. of the soil weight, but after this period a steady diminution took place, so that after twelve weeks a smaller quantity of nitrate than that present at the end of the eighth week was invariably found. The cause of this loss was not discovered, although it may be conjectured that it was due to the demands of the soil organisms, for nitrogen, but its invariable occurrence is interesting as helping to explain the already well-known fact in field practice that too long an interval between the burial of a green manure and the sowing of the succeeding "rabi" crop is prejudicial to the latter so far as any improvement which may be expected from the use of the former is concerned.

The results of the first year's experiments on green manuring are being published in the form of a bulletin.

Further work on the occurrence of bacterio-toxins in soil, their relation to infertility and the action of tillage, drainage, and manurial application in neutralizing them, was carried out.

Biological analyses of various soils were made and further modifications of the method introduced; this subject is still in a very early stage of development, especially so far as interpretation of results is concerned, but it is hoped that further experience and modification of the method will lead to its successful application to the solution of various soil problems. At present it is possible to determine the optimum moisture content of a soil for certain biological processes necessary for fertility, to ascertain approximately the organic manures most suitable for application, with the important reservation that the sample experimented on may not be truly representative of the area to be treated; this source of error is greatly minimised by the use of large samples and the introduction of the method of using soil media in place of inoculating liquid media with small samples of soil; thus in the old method one gram of soil was generally used as inoculum and the biologic activity of the soil as a whole was judged therefrom. Whereas in the method now used, estimations of nitrifying and ammonifying capacity and efficiency, and general biologic activity, are made with samples varying from 400 grams to 1,200 grams.

Special Enquiries.

Sewage farms.—At the request of the Principal of the Agricultural College, Nagpur, a series of investigations was commenced with a view to determining the effects of the application of the sewage upon the biological condition of the soils of the College farm. The writer visited Nagpur and inspected the farm soils and the sewage installation, and discussed with Mr. Allen and Mr. Plymen the general arrangement of the experimental plots to be put under treatment. An arrange-

ment was made for sending periodic samples to Pusa for examination and at the same time Mr. Plymen agreed to carry out chemical analyses to determine nitrate at Nagpur.

Rice.—An experiment was arranged to determine the effect of soil toxins upon the growth of the rice plant; this was in connection with the work of the Imperial Mycologist upon the "Ufra" disease of this crop, as it was considered possible that the incidence of this disease might depend upon adverse soil conditions. Rice was grown in pots in soil to which large quantities of mustard cake were added, it having been found that the initial stages of decomposition of this manure gives rise to bodies which are toxic to plants. The pots were arranged so that in one set lack of drainage should allow of accumulation of the toxins produced, whilst in the other continuous percolation removed them in solution. The results completely verified expectation, as not only was growth seriously interfered with in the undrained pots, but the root formation in the drained set showed that the toxins carried down by the percolating water had inhibited root growth in the lower soil, whereas in the undrained series more root development took place below than above. No symptoms of "Ufra" appeared, but Dr. Butler has now demonstrated conclusively the connection between this disease and the presence of nematodes in the plants, nor does it appear that soil conditions adverse to healthy growth render the latter more liable to attack. The investigations carried on by Mr. Harrison, Agricultural Chemist to Government of Madras, as to the nature of the changes taking place in soil under rice cultivation are referred to in the section dealing with Agricultural Chemistry.

Indigo disease.—Plants of Java variety were grown and kept under observation for symptoms of wilt in order to determine a possible bacteriological origin of this disease; this work will go on through the current season.

Potato rot.—An extensive series of investigations was carried out, mainly by Mr. N. V. Joshi, First Assistant to the Imperial Agricultural Bacteriologist, as to the cause responsible for the very common rotting of tubers in store. The Economic Botanist to the Government of Bihar and Orissa, at whose instance this work was undertaken, provided samples from various godowns in Bihar, and others were received from Poona. Two rotting bacteria were found to be present invariably and these appear to be normal in Indian soils. It was found that rotting could take place in presence of these bacteria either if the dry tubers suffered mechanical injury or if the uninjured tuber were kept under conditions in which its surface could remain moist for a few hours. Thus tubers stored in sand to keep out potato moth can be attacked, if the rotting organisms are present, either through bruising due to careless handling or by reason of the sand not being perfectly dry, or by contact

between a rotting potato exuding moisture and a sound one; this last possibility necessitates frequent examination of stored tubers and picking out of rotten ones. Various antiseptics were tried on a small scale, of which copper sulphate proved the best: this will be tested along with other preventive measures in the ensuing season.

Publications.

"*Drainage in Rice Soils*" by C. M. Hutchinson, Imperial Agricultural Bacteriologist. (*Agricultural Journal of India, Volume VIII, No. 1, January 1913.*)

FORESTRY.

I.—SYLVICULTURE.

BY

EDWARD MARSDEN,
Sylviculturist.

Statistical work in typical forest crops.—The formation and measurement of sample plots, permanent and temporary, was continued and extended, 31 of the former and 8 of the latter being laid out in the United Provinces, and 31 of the former and 13 of the latter in the Punjab, a total of 62 permanent plots and 21 temporary plots during the year. In addition, 7 experimental plots were laid out in the Punjab with the object of ascertaining the most favourable conditions under which natural regeneration of *Pinus longifolia* could be obtained in practice. The species taken in hand were *Shorea robusta, Dalbergia Sissoo, Cedrus Deodara, Pinus longifolia, Pinus excelsa,* and *Quercus dilatata.*

In the permanent sample plots, the volume of timber standing is measured by means of dividing the total number of trees into inch-classes, and then by felling sample trees representative of three or four groups in which the inch-classes are incorporated. The plots will be remeasured every five years and will thus provide a basis for determining the rate of growth, the degree of density which produces the best results in the quality and quantity of timber formed, as well as forming a nucleus for the ultimate preparation of yield-tables. With the object of effecting a similarity and if possible an uniformity in the system adopted for measuring sample plots and typical trees, a note was published on the method used in the Sylviculture Branch at the Forest Research Institute for the collection and tabulation of statistical data. It is hoped that measurements carried out by Forest Officers working independently may follow the lines indicated, as only by an uniformity in the system of measurement and tabulation will it be possible to co-ordinate and compile all the figures collected.

The Sal tree (Shorea robusta).—A Bulletin was issued by Mr. Troup dealing with the causes and effects of the drought of 1907 and 1908 on the *sál* forests of the United Provinces, and in the course of his investigations it became clear that the subsoil is, in the case of *sál*, a

factor of preponderant importance, whole tracts of forests being destroyed or not according to the hygroscopicity of the subsoil. Experiments are in progress in the sylvicultural gardens to ascertain whether the presence of "nurses" may be of advantage to the young seedlings; the natural reproduction of this species continues to be under special investigation, and experimental plots have been under observation in numerous localities.

Eucalyptus.—The figures collected in the plantations of the Nilgiris show some astonishing results in the rate of growth of *Eucalyptus globulus* (Blue gum).

Mean annual increments of 527 cubic feet per acre per annum in the case of high forest and of 815 cubic feet in the case of 7-year-old coppice show that this species utilizes the productive capacity of the soil to the extent of forming in the case of coppice over 16 tons avoirdupois of wood in one year per acre. In the case of an average plantation, the initial expenditure amounts to Rs. 46 to Rs. 65 per acre (excluding value of land), the annually recurring costs to Re. 1 per acre, and the net receipts after deducting felling and carting charges to Rs. 70 per acre for 5-year-old crops, Rs. 331 for 15 year-old crops, and Rs. 592 for 25-year-old crops. These figures are calculated for coppice wood only, as the data available for high forest are insufficient to yield reliable results.

In the sylvicultural gardens.—Experiments are in progress for testing the regeneration of important species, both natural and artificial, in dense shade and in the open, and in moist patches; sowing combined with the cultivation of field crops is being tried; experiments in the best method and time of collection of seed and continued tests in the fertility of seed from trees of different sizes are in progress, as well as observations on the percentage of germinative capacity. Various methods of nursery treatment, the beds being sometimes weeded and sometimes unweeded, varieties of direct sowing and transplanting, some beds being irrigated and some left dry, are under trial.

Developments in sylvicultural systems.—The publication of "Der Blendersaumschlag Und Sein System" by Wagner marks an advance in the regulation of the method of management by purely sylvicultural considerations, which is the longest step in this direction taken for some time.

Mr. M. R. K. Jerram published a note on the Group System in Germany and its application to Indian forests with special reference to *Pinus longifolia* in the Himalayas; the revision of the Murree-Kahuta Working-Plan in the Rawalpindi Division is now under consideration, and the prescriptions of the new working-plan may be expected to show signs of the influence of this report.

Opinion in the Punjab has for some time been decided in favour of a definite change of sylvicultural treatment for the coniferous forests of the Himalayan hills. The selection system, the first attempt at any regular method of management, has been modified to a removal of the yield by selection in groups, and some Forest Officers now advocate the adoption of the group system in place of the selection system or any modification thereof. The question is a difficult one, and its ventilation by free discussion is to be desired. At the 1913 Punjab Forest Conference, an illuminating paper on the subject was read by Mr. B. O. Coventry, who also pointed out in his paper on the conditions necessary for obtaining natural regeneration in deodar forests:—"For practical purposes it may be assumed that the failure of natural regeneration is due to the accumulation of humus and other organic substances which have interfered with the proper aëration and drainage of the soil." It remains necessary to ascertain by experiment the best means of obtaining the desired conditions. The effect of drought and of the influence a seedling's position upon a steep or a very moderate slope may exercise upon its liability to prolonged cover by fallen snow appear also worth investigation.

The working-plans published during the year present no novel developments in the methods of management adopted.

Xylia dolabriformis.—A remarkable coincidence was the publication in the September 1912 number of the "Indian Forester" by Mr. R. S. Pearson of his observation that in the Western Ghats of Bombay, owing to continued protection from fire, moist deciduous forests were being replaced not at once by the true evergreen type, but by forests of which over 50 per cent. is made up of *Xylia dolabriformis;* while the next article was a statement from Mr. T. W. Forster that, in the Tharrawaddy Division of Lower Burma, fire protection and improvement fellings in combination had resulted in an almost regular forest of *Xylia dolabriformis* being formed from a mixed moist deciduous type.

List of Indian Publications, 1912-13.

AITCHISON, P. E. . Working-plan for the Ankola-Kumta Coast Forests, Bombay Presidency.

,, ,, . Working-plan for the Sopinhosalli High Forests, Bombay Presidency.

BILLSON, H. G. . Working-plan for the Municipal Forests, Mussooree, United Provinces.

FORSTER, T. W. . Natural Regeneration of *Xylia dolabriformis* in Tharrawaddy, Burma. (*Ind. For., xxxviii, 455.*)

GONSALVES, A. F. . Working-plan for the Igatpuri and Sinnar (Part) Range Forests, Bombay Presidency.

GRIEVE, J. W. A. . Working-plan for the Darjeeling Forests, Bengal.

JACOB, W. R. LEG. Report on the Forests of Bhutan bordering on the Boundary of Eastern Bengal and Assam, 1912.

JERRAM, M. R. K. . Report on the Group System of Natural Regeneration in Germany and its application to Indian Forests.

LEETE, F. A. . . Pyinmana Forest Division: Teak and Bamboos in Burma. (*Ind. For., xxxviii, 355.*)

LUSHINGTON, P. M. Note on the Coppicing Powers of Babul. (*Ind. For., xxxviii, 392.*)

MILROY, A. J. W. . Report on the Forest Resources of the Abor Country.

PARKER, R. N. . . Eucalyptus in North-West India. (*Ind. For., xxxix, 81.*)

SCOT, I. S. . . Coppicing of Babul in Guntur District, Madras. (*Ind. For., xxxviii, 396.*)

TROUP, R. S. . A Note on the Blue Gum Plantations of the Nilgiris (*Eucalyptus globulus*). (*Ind. For. Rec., v, Pt. II.*)

" " . . A Note on the Causes and Effects of the Drought of 1907 and 1908 on the *Sál* Forests of the United Provinces. (*For. Bull. No. 22, 1913.*)

" " . . The Collection and Tabulation of Statistical Data in the Sylviculture Branch, Forest Research Institute, Dehra Dun.

WHITEHEAD, J. . Working-plan for the Forests of the Jhansi and Banda Districts, Bundelkhand Division, United Provinces.

II.—ECONOMIC FOREST PRODUCTS.

BY

R. S. PEARSON, F.L.S.,
Forest Economist.

Economic uses of *sal* timber.—The enquiry into the uses, mechanical properties, seasoning qualities, outturn and prices of *sál* timber was completed during the year. It was found that though the durability of hill-grown *sál* is undoubtedly greater than that of the plains-grown varieties, their strength to withstand shearing, compression and transverse strain varies little. As regards the fissibility of the timber, coppice-grown varieties split more easily than those of seedling origin. The total annual outturn of *sál* timber was arrived at after considerable difficulty and was found to amount to 162,411 tons per annum of which 150,336 tons is obtained from Government Forests and the remainder from Native States and private lands. Of this total 38 per cent. is converted into railway sleepers, the remainder being used for construction and other purposes. As regards the price of *sál* timber it is a curious fact that though practically every species of timber has gone up in price during the last 20 years, as for instance that of teak, Deodar, Rosewood, etc., the price of *sál* sleepers has not advanced 10 per cent. during that period.

The results of the above enquiry are now being published, all points having been dealt with except those referring to the relative strength of timber cut at various periods of the year and the seasoning qualities of the same, the experiments in connection with which are not yet complete.

Bamboos for paper pulp.—The enquiry into the uses of bamboos for paper pulp was completed during the year and a report published on the subject. The idea of utilizing bamboos for pulp has of late been seriously considered by interested persons in India, so much so that one firm has been granted a concession to exploit bamboo from a forest in Bengal and another firm has applied for a similar concession in Burma and a third in Arakan. The industry, which is a new one, may in time develop into one of importance.

Antiseptic treatment of timber.—The enquiry as to the value of the antiseptic treatment of Indian timbers, with special reference to railway sleepers, was vigorously prosecuted during the year. The 2,929 Powellized sleepers of five different species of timber which were laid down as an experiment in the Sukkur, Quetta, Lakshar and Lucknow

sections of the line, about two years ago, were inspected and found to be doing well.

The 1,921 sleepers treated with *Avenarius Carbolineum* oil last year have now been laid down, with the exception of a small number still to be dealt with and which are destined to be laid in the line near Agra. The majority of sleepers treated with this oil, having been only recently put in the line, have not as yet been inspected, except those near Pyinmana in Burma.

During the year a third batch of sleepers, numbering 1,375 in all, were treated by a mixed impregnation method. This consisted in first forcing in a large quantity of a 2 per cent. solution of chloride of zinc and after the timber had time to dry, dipping them into a hot bath of green oil, the latter operation being carried out not only to preserve the wood, but also to prevent the salt from leaching out of the timber when exposed to excessive moisture. These sleepers are also being handed over to the Railway Board for laying in the open line.

A fourth batch of sleepers will be treated with Solignum and mineral oil, thus completing this enquiry, the only work remaining to be done being to periodically inspect the sleepers.

Tea-boxes.—A tour was made last year to enquire into the tea-box industry in Assam. One of the chief difficulties under which the tea-box saw-mills managers have to carry on their work is due to the impossibility of storing shooks against demand, owing to the deterioration of the timber and its liability to be attacked by borers. To overcome this difficulty experiments were carried out during the year at the Forest Research Institute, by treating the shooks with chloride of zinc, alum and copper sulphate solutions. It was found that the treated shooks affected the tea-lead with which they came in contact; this was overcome by either applying a coat of varnish to the inside of the shook or by placing brown paper between the lead and the shook or by using silverised paper instead of tea-lead. A further experiment is now being carried out in this connection with the co-operation of Mr. Blair, of the Surma Valley Saw-mills and an Assam tea-planter, by sending tea packed in treated shooks to Europe, with the object of ascertaining whether the tea is affected in any way. The other part of the enquiry consists in placing treated shooks in positions where they are liable to be attacked by insects. They have now been under observation for a year and so far they have not been damaged in any way.

Gums, resins and oleo-resins.—(*i*) A considerable amount of attention has been paid to the possibility of utilizing *Boswellia serrata* gum-resin. Experiments were carried out in order to ascertain the best methods of tapping the tree. These experiments were commenced last year, during the hot weather, very indifferent results being obtained; it was therefore considered necessary to try tapping in the cold weather.

A series of experiments were undertaken by the Divisional Forest Officers of Nimar and Melghat in the Central Provinces, by the Conservators of Forests in Gwalior and Kotah States and by the Forest Economist in the Siwaliks. It was found by all the officers in their various experiments that some trees yielded copious gum-resin while others yielded very little, the size and age of the tree having little to do with the yield obtained. It is proposed to carry out further experiments in this connection during the next cold weather in the Central Provinces in order to ascertain the best rotation for tapping, with special reference to the power of the tree to heal the wound caused by tapping it. The gum-resin of this tree was distilled by the Forest Chemist, turpentine, rosin, gum and an essential oil being prepared. These products were submitted to firms for valuation and the preliminary reports received justify further investigation being made.

(*ii*) A good deal of work was done in connection with the distillation of *Pinus longifolia* resin, resulting in the remodelling of the Government Rosin and Turpentine Factory at Bhowali.

(*iii*) The question of introducing into Europe the natural varnish obtained from *Melanorrhœa usitata* was under investigation, many firms having enquired about this commodity. The subject is still under investigation.

Tan barks.—The enquiry as to the possibility of utilizing certain tan barks for preparing tan extracts was continued and a good deal of information collected as to outturn, the Economist having carried out experiments in the Siwaliks to determine the yield of dry bark from *Terminalia tomentosa* and *Shorea robusta* trees of different girths. In the Central Provinces and in Sind the Conservators carried out extensive experiments to ascertain the yield of bark per acre of *Acacia arabica;* 30 tons of this bark have since been sent to the Ranegunge Tan Extract Factory for testing. The Divisional Forest Officer, Arakan, carried out similar experiments in Mangrove forests and felled a sample plot to ascertain the yield and cost of extraction of the bark, per acre.

Fibres.—Samples of fibre of *Bauhinia Vahlii, Helicteres Isora, Sterculia villosa, Trema orientalis, Urena lobata* and *Calotropis procera* were submitted to a home firm for valuation, some of the reports being encouraging. Enquiry was also made in this connection as to outturn and prices, while two Forest Officers, under the direction of the Conservator of Forests, Sind, carried out extremely interesting experiments with the object of determining the best methods of collecting and separating Calotropis fibre.

Miscellaneous uses of woods.—Samples have been supplied to firms for trial in connection with cement barrels, railway rolling stock, musical instruments, packing cases and for a variety of other purposes, the reports on which are awaited.

Economic and wood museums.—A considerable number of specimens were added to both museums, especially to the latter. A complete collection of specimens of teak from all forests of India and Burma was formed and also one of all timbers used for tea-boxes. A collection of large specimen planks representing the better known timber-species of commercial value is gradually being formed, valuable additions having been recently made to the collection.

Timber and minor product specimens.—A very large number of specimens, chiefly of timbers, were supplied by the Forest Department to various Government Departments, private persons and firms in India, Australia, America and Europe.

List of Publications and Articles on Forest Economic matters published during 1912-13.

Benson, H. K.	. Chemical Treatment of Waste Wood Recovering Values of Low Grade Material. (*Scientific American, June 7th, 1913.*)
Coombs, F. A., & Harrison, R. G.	The Mangrove Bark of North Queensland and the Manufacture of Mangrove Cutch. (*Journ. Soc. Chem. Ind., Vol. XXXI, 212.*)
Donald, J. .	. Notes on a Visit to a Rusha Oil Factory. (*Ind. For.*, Vol. XXXIX, *149.*)
Duchesne, Martin Collier.	English Timber: Its Markets, Value and Production. (*Surveyor's Institution, Transactions, Vol. XLX, Part III.*)
Government of Madras	Report on the Proposed Acetone Factory.
Groom, Percy .	. Resin Ducts of *Pinus Gerardiana* and *Pinus Khasya.*
Hole, R. S. .	. Different forms of Pyinkado. (*Ind. For., Vol. XXXVIII, 461.*)
Kara, S. .	. Banana and its Fibres. (*Cap., Vol. L, No. 1237, p. 78.*)
Macmillan, H. R.	. Pulp-wood. (*Dept. of the Interior Canada, Forestry Branch, Bull. No. 30.*)
Moor, Barrington	. Turpentining in Forests under Management. (*Amer. Forestry, Vol. XIX, 219.*)
Parey, E. J.	. Turpentine Standards. (*Chemist Druggist, Vol. LXXXI, 1,700, 52.*)

PEARSON, R. S. . Note on the Utilization of Bamboos for the Manufacture of Paper-pulp. (*Ind. For. Rec., Vol. IV, Part V.*)

,, ,, . Note on "Ligno Protector" as a possible means of Preventing Timber from Splitting while Seasoning. (*For. Bull. No. 13.*)

,, ,, . Note on the Tea-box Industry in Assam. (*Ind. For. Rec., Vol. V, Part I.*)

,, ,, . Note on Technical Properties of Timber with special reference to the behaviour of *Cedrela Toona* while Seasoning. (*For. Bull. No. 15.*)

,, ,, . A Further Note on the Relative Strength of Natural and Plantation Grown Teak in Burma. (*For. Bull. No. 14.*)

,, ,, . Note on the Economic Value of *Shorea robusta* (Sál). (*In the Press.*)

PERKIN, M. F. . Turpentine and Turpentine Substitutes. (*Oil and Col. Tr. Journ., Vol. XLIII, 708.*)

PETERS, E. W. . The Preservation of Mine Timbers. (*U. S. Dept. of Agr. Bull. No. 107.*)

PURAN SINGH . Note on the Distillation and Composition of Turpentine Oil from the Chir Resin and the Clarification of Indian Rosin. (*Ind. For. Rec., Vol. IV, Part I.*)

,, ,, . Note on the Preparation of Tannin Extracts, with special reference to those prepared from the Bark of Mangrove (*Rhizophora mucronata*). (*Ind. For. Rec., Vol. III, Part IV.*)

,, ,, . Memorandum on the Oil Value of some Forest Seeds. (*Ind. For., Vol. XXXIX, 279.*)

RAITT, W. . Report on Bamboo Pulp as a Material for the Manufacture of Paper. (*Ind. For. Rec., Vol. III, Part III.*)

,, ,, . Report on Savannah Grasses as Material for Production of Paper-pulp. (*In the Press.*)

RAO, M. RAMA . Memorandum on the Tea-chest Industry in Travancore. (*Ind. For., Vol. XXXIX, 5.*)

RODGER, A. . Note on *Gmelina arborea* timber. (*For. Bull. No. 16.*)

,, ,, . Note on *Pterocarpus marsupium* timber. (*For. Bull. No. 17.*)

RODGER, A. . . Note on *Terminalia tomentosa* timber. (*For. Bull. No. 18.*)

,, ,, . . Note on *Lagerstræmia lanceolata* timber. (*For. Bull. No. 19.*)

,, ,, . . Note on *Ougeinia dalbergioides* timber. (*For. Bull. No. 20.*)

,, ,, . . Note on *Anogeissus latifolia* timber. (*For. Bull. No. 21.*)

SURFACE, HENRY E. . Bibliography of the Pulp and Paper Industries. (*U. S. Dept. of Agr., For. Serv., Bull. No. 123.*)

TEESDALE, CLYDE H. . The Absorption of Creosote by the Cell Walls of Wood. (*U. S. Dept. of Agr., For. Serv., Cir. No. 200.*)

WEISS, HOWARD F. . Prolonging the life of Cross-ties. (*U. S. Dept. of Agr., For. Serv., Bull. No. 118.*)

WINSLOW, CHARLIE P. Commercial Creosotes, with special reference to Protection of Wood from Decay. (*U. S. Dept. of Agr., For. Serv., Cir. No. 206.*)

,, ,, Condition of Experimental Chestnut Poles in the Warren-Buffalo and Poughkeepsie-Newton Square Lines after Five and Eight Years' Service. (*U. S. Dept. of Agr., For. Serv., Cir. No. 198.*)

ZOOLOGY.

I.—GENERAL ZOOLOGY.

BY

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Introduction.

In the past years it has been customary to include in the report on zoology a brief statement as to all work with a direct bearing on India carried out outside the Indian Museum. This work has been, for some years past, increasing in bulk, and I have no means of obtaining official information as to its scope and objects until the results are published. It seems better, therefore, to confine any statement regarding it to the bibliography of published works. The present report deals only with zoological work carried out in the Indian Museum during the financial year 1912-13.

I.—General Progress, Zoological Section, Indian Museum.

The most important event of the year has been the occupation of the new laboratories and offices on the top of the main building facing Chowringhee. All the research collections that were in the old building, which has now been transferred entirely to the Geological Survey of India, have been removed and rearranged.

Opportunity was taken to sort out the whole of the unnamed marine material (except the Mollusca) into the proper classes and orders and in some cases families.

II.—Collections.

Mr. Kemp's zoological collections from the Abor country and those of the Surgeon-Naturalist to the Indian Marine Survey have perhaps formed the most important additions of a general nature to the zoological collection. Another important collection, however, is that made by Mr. Gravely with the assistance of Mr. S. P. Agharkar of the Elphinstone College, Bombay, in the Western Ghats. In all these cases many new species have been or are now being described on the basis of the new

material, while important additions have also been made to our knowledge of the distribution of already-known animals.

Since Lord Carmichael came to Bengal he has employed collectors to obtain the insects and other small animals of Sikhim and the Darjiling district. With great generosity His Excellency has arranged to distribute the specimens thus obtained to museums in India, Australia and Great Britain. On the abolition of Mr. Paiva's former post, he appointed him as his private assistant in arranging for the naming and distribution of the specimens. When Mr. Paiva was reappointed on the Museum staff, it was arranged by the Superintendent that he should continue to devote a certain part of his time to His Excellency's collections, which are now attaining great dimensions, in consideration of the fact that the Museum is to be allowed to retain any specimens that are required. Mr. T. Southwell has presented a very large and valuable collection of Entozoa together with some interesting crustacea.

Large additions have also been made by exchange with various Museums abroad and we have to thank our Honorary Correspondents and others for valuable specimens far too numerous to be acknowledged here specifically. Full acknowledgment will be made in various papers on different groups to be published in the "Records of the Indian Museum."

In March 1912, the Government of India made a special grant of £250 for the purchase of Mr. E. Green's collection of moths from Ceylon. This collection will be considered in next year's report.

As has already been pointed out, a large part of our zoological collection has been rearranged during the year. With the exception of the molluscs, on which a great deal of work is being and still remains to be done, all groups may now be said to be accessible to the student.

Mr. F. H. Gravely submits the following report on the entomological collections:—

Arachnida, Myriopoda, and Insecta.

Arachnida.

"**Scorpionidea.**—Dr. Henderson has named the scorpions collected by the Abor Expedition. The scorpions which we sent to Dr. Penther have eventually been forwarded by him to Dr. Kraepelin, who has already named them. Most of these specimens are now on their way back to us, and the rest of our unnamed collection, as well as representatives of the named collection, have been sent direct to Dr. Kraepelin, who hopes to be able to return these specimens also before very long.

Chernetidea.—Mr. Elligsen has identified and returned our whole collection of Pseudoscorpions. Unfortunately his health broke down

shortly afterwards and he has not yet been able to publish his descriptions of the new species.

Araneae.—The spiders of the Abor Expedition have been sent to Dr. Banks for report. The rest of the collection has been arranged by Mr. Gravely in the room adjoining that in which it was previously kept, where it was impossible to give it adequate space. The identifications of all the named Mygalomorphae not seen by Mr. Hirst have been checked, and most of the Argyopidae have been named, as have also a few specimens belonging to other families. But it has not yet been possible to check and synonymise the determinations previously made in other families. A number of specimens have been added to the collection, especially in the family Argyopidae, for the males of the local species of which a special search is being made.

Phalangidea.—Dr. Rohwer continues to determine all Phalangids added to our collection.

Acari.—Professor Nuttall and Mr. Warburton continue to name ticks for us. Dr. N. Banks has the mites of the Abor Expedition.

Myriopoda.

Scolopendridae.—Several new species have been described by Mr. Gravely and added to the named collection.

Symphyla.—All our material has been sent to Mr. Bagnall for examination.

Other forms.—These are still being worked out by Dr. Silvestri.

Insecta.

Thysanura.—Dr. Silvestri is still working at this order for us.

Collembola.—Dr. Carpenter is working out the Collembola of the Abor Expedition.

Darmaptera.—Dr. Burr continues to identify all earwigs we are collecting.

Orthoptera.—Dr. Griffini has undertaken the report on the Abor Gryllacridae and Stenopelmatidae and has asked for the rest of our material in these families as well. This has been sent to him.

The Mantidae and Phasmidae of the Abor Expedition have been sent to Dr. Giglio-Tos and the Tettiginae of the expedition to Dr. Hancock. Mr. Leigh still has material of ours in connection with his work on the life histories of Mantidae and Phasmidae. The deaths of Mr. Kirby and Mr. Shelford have unfortunately brought to an end the work of these investigators on our collections.

Termitidae.—Dr. Silvestri still identifies termites for us.

Mallophaga.—Our material in this group is still in the hands of Professor V. L. Kellogg. We understand that he expects to return it to us very soon now.

Odonata.—Mr. Laidlaw is working out the dragon-flies of the Abor Expedition.

Neuroptera (sensu lato).—Nothing more has been received from Professor Needham as yet. The Neuroptera of the Abor Expedition have gone to Dr. Banks for identification.

Trichoptera.—Dr. Betten still has our unnamed Trichoptera.

Hymenoptera.—Dr. Rohwer has reported on the Hymenoptera Sessiliventres of the Abor Expedition and is now working out the rest of our material in this group; Mr. Claude Morley is still working out Hymenoptera Parasitica for us; Mr. Wheeler is working out our ants and has already sent in his account of the Abor collection.

Coleoptera.—Mr. Gravely has finished rearranging our Passalidae and his catalogue of them is in the press; Mr. Arrow is still working on our Dynastinae, Cetoninae and Rutelinae; and Dr. Gillett has undertaken the identification of our Coprinae. Dr. Horn still names Cicindelidae for us; M. Grouvelle is now dealing with our Paussidae, Rhysodidae, Nitidulidae, Trogositidae, Colydiidae, Cucujidae, Cryptophagidae, Lathridiidae, Mycetophagidae, Parnidae, Heteroceridae; Dr. Bernhauer with our Staphylinidae, Mr. Bickhardt with our Histeridae, M. Lesne with our Bostrichidae, Herr Schenkling with our Cleridae, Mr. Creighton-Wellman with our Meloidae, Herr Borchmann with our Lagridae and Aleculidae, Herr Krekich-Strassoldo with our Anthicidae, Mr. Maulik with our Chrysomelidae Cryptostomes, Mr. Gahan with our Longicorns, and Mr. Marshall with our Curculionids. Dr. Jordan has worked out all our Anthribiidae during the year. In addition to the above specialists who deal with our collections in certain groups as a whole, Dr. Kolbe is working out the Carabidae, Dr. d'Orchymont the Hydrophilidae, Herr Schenkling the Cleridae, Erotylidae and Endomychidae, Herr Wichmann the Scolytidae and Dr. Wagner the Apioninae of the Abor Expedition; while the Lampyridae of the Expedition have been named by M. Olivier and the remaining Malacodermata, together with Ptinidae, Bruchidae and Anthicidae, by M. Pic.

Lepidoptera.—Captain Evans has worked out the butterflies of the Abor Expedition. He has also rearranged our collection of Satyrinae. During his visit to Calcutta further progress was made with the rearrangement and cataloguing of the Hesperidae, all identifications of which he checked last year. Examples of several Bornean species of Lycaenidae have been sent to Mr. Moulton for examination.

Diptera.—The whole of the collection of Diptera has been rearranged and an effort is now being made to catalogue it. Mr. Brunetti

continues his fruitful researches upon it and it is still growing rapidly. Dr. Kieffer is still working on our Chironomidae and Cecidomyidae, Miss Ricardo on our Tabanidae, Dr. Lichwardt on our Dolichopodidae and Nemestrinidae, Professor Bezzi on our Sapromyzidae and Dr. Speiser on our Diptera Pupipara. Mr. Edwards has recently undertaken work on our Culicidae.

Thysanoptera.—Our collection of Thrips is still with Mr. Bagnall.

Rhynchota.—Mr. Distant continues to return specimens to us as he names them. Mr. Rothschild has our Polyctenidae, and Mr. Van de Goot our Aphidae. We are still in communication with Mr. Green about Coccidae and with Mr. Crawford about Psyllidae."

III.—Public Galleries.

There can be no doubt that the public galleries of the Zoological Section should be entirely re-arranged and renovated, if they are to be brought up to the level now demanded of museums in Europe and America. In order to undertake this work, however, it would be first necessary that an entirely new set of exhibition-cases be provided. This would mean the expenditure of many thousands of pounds and if it were to be undertaken in our present financial position would entail the total extinction of our scientific work. By considerable sacrifice of other interests we might possibly afford to buy one or two modern cases: these would make the rest look extremely shabby and the general effect in the galleries would be, for many years to come, incongruous and even less satisfactory than the present condition of affairs. I estimate the cost of placing the zoological galleries in a satisfactory condition on an average a lakh of rupees a gallery, that is to say, about six lakhs altogether.

On my deputation to Monaco last March I took the opportunity to examine with very great care the fittings, etc., of the new Oceanographical Museum there. From the report submitted to the Trustees on my return I may quote the following paragraph:—

> "The actual exhibits of marine animals in the Monaco Museum are much less extensive than those in our own galleries: with few exceptions, they are no better preserved: their scientific interest is no greater and their arrangement in the cases is, from a student's point of view, less satisfactory in that it renders it more difficult to find the specimens of any one group. But the general effect from an artistic point of view is beyond comparison with that of any scientific gallery in the Indian Museum, for the educational appeal of a museum gallery lies almost as much in the environment of the specimens as in the specimens themselves."

IV.—Field Work.

Mr. B. L. Chaudhuri visited Chaibassa in May 1912, in order to make enquiries about the distribution of land tortoises in that district. Although he did not obtain specimens, he was able to arrange with officers stationed at Chaibassa that further enquiries should be made. These resulted in the acquisition of a specimen of an interesting new species of *Geoemyda* (*Rec. Ind. Mus., Vol. IX, Part 2*).

In April 1912, Mr. Gravely made a tour in the Satara and Rathnagiri Districts in the Western Ghats, accompanied by Mr. S. P. Agharkar, Lecturer on Biology, Elphinstone College, Bombay. The object of this tour was to investigate the life history of the freshwater medusa *Limnocnida indica* and also to study the distribution of the freshwater fauna on the two sides of the Ghats. A number of interesting facts were noted and valuable specimens obtained in connection with both enquiries and much material of a miscellaneous nature was acquired. Two papers in the "Records of the Indian Museum," *viz.*, Messrs. Gravely's and Agharkar's "Notes on the habits and distribution of *Limnocnida indica*" and my own account of the freshwater sponges of the Malabar zone, are founded wholly or in part on the results of this tour.

Mr. Gravely also spent a few days in February 1913 in Chaibassa in order to search for *Limnocnida* in the streams of that district, which resemble those of the Western Ghats in many respects. He obtained no satisfactory evidence of the occurrence of the medusa in Chota Nagpur, but collected some interesting sponges and other specimens.

In the same month Mr. Kemp made a tour on the Indian shores of the Gulf of Manaar, for the first part of which he was accompanied by Dr. J. R. Henderson, Superintendent of the Government Museum, Madras, who assisted in a most generous manner with his deep knowledge of the marine fauna of the district. The results are of importance as illustrating the extraordinary richness of the Crustacean fauna of these parts of the coast of India at which suitable conditions prevail. They have not as yet been completely co-ordinated and therefore will be best considered in next year's report.

While on leave I spent six weeks in Palestine and Syria. The object of the visit was, if possible, to trace the genera of sponges, coelenterates and polyzoa characteristic of the fresh waters of India and tropical Africa northwards up the Jordan valley, should they prove to have a distribution in any way similar to that of the Jordan fishes, whose African affinities have long been known. Collections of other invertebrates, more particularly the crustacea, worms and mollusca, were also to be made. The results are now being published in the "Journal of the Asiatic Society of Bengal" and a first set of all the specimens, including a considerable number of types, is being presented to the Museum.

V.—Research.

The removal and re-arrangement of the collections have naturally interfered to some extent with the research work of the section, but a considerable amount has nevertheless been accomplished.

While in Calcutta I have continued my own work on the freshwater sponges of India and have completed an account of those collected in Palestine.

Mr. Kemp has completed and passed for the press his account of the Indo-Pacific Stomatopoda. He has also commenced work on the Onychophora and Crustacea Decapoda of the Abor Expedition.

Mr. Chaudhuri has worked out the fish collected by Mr. Kemp in the Abor country.

Mr. Gravely has continued his work on the Oriental Pedipalpi and Passalid beetles. He has completed a revision of the latter, which will be published shortly in the "Memoirs of the Indian Museum." In addition to entomological work, he has been through the flatworms of the order Temnocephaloidea in the collection and has described certain features of the anatomy of *Temnocephala weberi*, the only Indian representative of its family.

Mr. Ekendranath Ghosh, our new honorary assistant, has carried out, partly in the Museum and partly elsewhere, a detailed study of the anatomy of certain Rathouisiid slugs and also of the blind prawn *Typhlocaris galilea*.

Captain R. B. Seymour Sewell, Officiating Professor of Biology in the Calcutta Medical College, has continued in the Museum his investigations on the marine Copepoda. Apart from their theoretical importance, it is not too much to say that these investigations have added a new group to our collections, as there were no Indian species of the order named in our cases until Captain Sewell began to work out and arrange the Copepods in the townettings obtained by the "Investigator." As Surgeon-Naturalist he has also initiated the use of mid-water nets on board the survey ship. The results are already proving extremely rich in all groups of pelagic Crustacea, etc.

Mr. T. Southwell, Deputy Director of Fisheries, Bengal, has made use of our laboratories in his investigations into the parasitology of Indian fish and other vertebrates. The first paper in what we hope will be a long series on the Entozoa has been published by him in our "Records."

Mr. E. Brunetti has continued his studies on the taxonomy and nomenclature of the Diptera. Amongst other work he has described the collection made by Mr. Kemp on the Abor Expedition.

List of Publications with special reference to Indian Zoology, from September 1912 to July 1913, prepared by B. L. Chaudhuri.

General.

ANNANDALE, N. . The African elements in the Freshwater Fauna of British India. (*Résumés des Communications, IX^e Congrès International de Zoologie, Monaco, Première Série, 29.*)

KEMP, S. W. . . Zoological Results of the Abor Expedition. Introduction. (*Rec. Ind. Mus., viii, 1.*)

" " . . Preliminary Note on the Zoological Results of the Abor Expedition on the North-East Frontier of Assam. (*Résumés des Communications, IX^e Congrès International de Zoologie, Monaco, Troisième Série, 30.*)

LYDEKKER, R. . Biological Work in India. (*Nature, 90, 685.*)

Protozoa.

PATTON, W. S. . Studies on the Flagellates of the genera Herpetomonas, Crithidia and Rhynchoidomonas. (*Sc. Mem. by Officers of the Med. and Sanit. Depts., Govt. of Ind., No. 57.*)

Porifera (Sponges).

ANNANDALE, N. . Freshwater Sponges of the Malabar Zone. (*Rec. Ind. Mus., vii, 386.*)

" " . Porifera of the Abor Expedition. (*Rec. Ind. Mus., viii, 67.*)

Coelenterata.

GRAVELY, F. H., & AGHARKAR, S. P. Notes on the Habits and Distribution of *Limnocnida indica*, Annandale. (*Rec. Ind. Mus., vii, 399.*)

Echinodermata.

CLARK, A. H. . . The Crinoids of the Indian Ocean. (*Echinoderma of the Ind. Mus., Part vii.*)

VERMES.

LANE, C. . . *Trychostrongylus colubriformis* (*Giles*). (*Ind. Med. Gaz., xlviii, 129.*)

" " . . *Agchylostoma ceylanicum*, A new Human Parasite. (*Ibid., xlviii, 217.*)

SOUTHWELL, T. . Some Notes on Cestodes and other Parasites in Indian Fish. (*Deptl. Rec., Dept. of Agri., Bihar and Orissa, No. 1, 1912.*)

" " . On Some Trematode and Cestode Parasites from Fish. (*Rec. Ind. Mus., ix, 79.*)

STEPHENSON, J. . On a collection of Oligochaeta mainly from Ceylon. (*Spolia Zeylanica, viii, 251.*)

CRUSTACEA.

HENDERSON, J. R. . A new variety of freshwater crab from Travancore. (*Rec. Ind. Mus., ix, 47.*)

SEWELL, R. B. S. . Notes on the surface-living Copepoda of the Bay of Bengal. (*Ibid., vii, 313.*)

" " . The post-larval development of the Copepoda. (*Résumés des Communications, IX^e^ Congrès International de Zoologie, Monaco, Troisième Série, 24.*)

MYRIOPODA.

GRAVELY, F. H. . Two New Species of *Scolopendridae*. (*Rec. Ind. Mus., vii, 415.*)

" " . . *Scolopendridae* of the Abor Expedition. (*Rec. Ind. Mus., viii, 69.*)

HIRST, S. . . On a second Indian Species of the genus *Termitodesmus*. (*Ann. Mag. Nat. Hist., xi, 481.*)

INSECTA.

ARROW, G. J. . . Notes on the Lamellicorn genus *Popilha* and descriptions of some new Oriental species in the British Museum. [*Ann. Mag. Nat. Hist., xii (8th Ser.), 38.*]

Bell, T. R. .	. The Common Butterfly of the Plains of India. (*Journ. Bomb. Nat. Hist. Soc., xxii, 92.*)
Bezzi, M. .	. Indian Trypaneids (Fruit-flies) in the collection of the Indian Museum. (*Mem. Ind. Mus., iii, No. 3.*)
Bickhardt, H.	. *Histeridæ* (Coleoptera) of the Abor Expedition. (*Rec. Ind. Mus., viii, 121.*)
Blair, K. G. .	. Some new Species of Indian Tenebrionidae. (*Ann. Mag. Nat. Hist., xii, 50.*)
Brunetti, E. .	. New Oriental Diptera. (*Rec. Ind. Mus., vii, 445.*)
,, ,, .	. Notes on the Life History of *Aphiochæta ferruginea.* (*Ibid., 515.*)
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ZOOLOGY.

II.—ECO OMIC ZOOLOGY.

PART I.—AGRICULTURAL ENTOMOLOGY

BY

A. J. GROVE, M.Sc.,
Officiating Imperial Entomologist.

Pusa Research Institute.—The investigations into the life-history and biology of injurious and useful insects were continued, the following being specially studied:—

1. Indigo Psylla { *Psyllopa punctipennis*, Crawford. (*Psylla isitis*, *Buck.*).
2. Painted Bug, (*Bagrada picta*, Fabr.).
3. Anar Butterfly (*Virachola isocrates*, Fabr.).
4. Termites, (*Termes* spp.).
5. Cotton Bollworms:
   (*a*) *Earias fabia*, Stoll.
   (*b*) *Earias insulana*, Boisd.
   (*c*) *Gelechia gossypiella*, Saund.
6. Parasites of Cotton Bollworms:
   (*a*) *Rhogas lefroyi*, Ashm. Ms.
7. Beetles attacking stored grain:
   (*a*) *Calandra oryzæ*, L.
   (*b*) *Rhizopertha dominica*, F.
   (*c*) *Tribolium ferrugineum*, F. & T.
   (*d*) *Æthriostoma undulata*, Motsch.
   (*e*) *Silvanus surinamensis*, L.
8. Parasites of Castor Semilooper (*Ophiusa melicerte*, Dr.) and Cabbage White Butterfly (*Pieris brassicæ*, Linn.).
9. Sugarcane Fly (*Pyrilla aberrans*, Wlk.).
10. *Aleurodidæ*.

The investigation on Indigo Psylla which was taken up at the request of the Bihar Planters' Association was continued and an article on the results obtained was published in the *Agricultural Journal of India*, Volume VIII, Part I. The investigation into methods for the prevention of damage by insects in stored wheat has been taken up at the request of the Punjab Government and is being continued. The investigation is specially in connection with the Wheat Elevator which is to be erected at Lyallpur. The Cotton Bollworms (*Earias* spp. and *Gelechia* sp.) and their parasite (*Rhogas lefroyi*) have received very close attention this year with the idea of obtaining more accurate information of the relation between the parasite and its host, careful statistical records of the occurrence of the pest and its parasite having been kept.

Trials with European univoltine mulberry races have been continued. It has been found that the eggs are preserved quite satisfactorily if sent to a hill station for storage during the dormant period, this obviating the necessity of cold storage in a refrigerator which is very expensive. The hybridisation work with mulberry worms continues to give satisfactory results. Attempts have been made to make arrangements for the disposal of small quantities of eri cocoons produced by small rearers as the lack of some such arrangement has been a great obstacle in the way of extending the industry. Better organisation for the procuring of fresh disease-free seed is also wanted, and is under consideration.

The lac collections, with the exception of a few ranges, are now complete and the material collected is being arranged for submission to an Expert. The cultivation of lac for experimental and demonstration purposes has been continued.

In Apiculture attention has been mainly directed to obtaining fertilized queens from the European bees and experiments with the common Indian bee (*Apis indica*) in bar frame hives. The difficulties in the way of procuring fertilized queens are very numerous and although twenty-five queens were reared only two were successfully fertilized. However, a better understanding of the problem has now been obtained and further attempts will be made. The work with *Apis indica* was largely hampered by the lack of proper appliances, but these are being obtained, and the experiments will be continued.

Observations on peach flies have been continued by the Imperial Pathological Entomologist.

Provincial Departments.—In Madras the investigations upon the Deccan Grasshopper (*Colemania sphenerioides*) were continued. The observations included the study of parasites and other natural enemies, and the effect of deep ploughing upon the egg masses. A method for preventing damage to stored tobacco by the Cheroot Beetle (*Lasioderma*

serricome) has been devised. Exotic cottons were again considerably damaged by the Cotton Stem Weevil (*Pempheres affinis*) and various experimental methods were tried, but with little success owing to the lack of knowledge of the life-history of the insect. A method was devised for preventing the collecting pots on toddy palms from the depredations of flies. Other pests dealt with included :—

Stenachroia elongella, Hmps.
Spodoptera mauritia, Bdv.
Nymphula depunctalis.
Euxoa segetis.
Azygophleps scalaris.
Antestia cruciata.
Leptocorisa varicornis.
Achæa melicerta.
Euplexia conducta.
Udaspes folus.
Earias insulana, *Earias fabia*, *Gelechia gossypiella*, *Stagmatophora coriacella*, *Dysdercus cingulatus*, *Oxycarænus* sp., *Lecanium nigrum*.
Chilo simplex.
Diatræa sp.
Aleurodes bambusæ.
Epacromia dorsalis.
Kumblihulas.
Pundaluoya simplicia.
Odontotermes sp.
Alcides leopardus.

In the United Provinces methods of preventing damage to potatoes by the potato moth (*Phithorimæa operculella*, Zell.) have been demonstrated. Observations have been carried out on the appearance of the parasite (*Rhogas lefroyi*) of the Cotton Bollworm (*Earias fabia*) in Bhindi and Cotton. Other pests dealt with included the Dusky Cotton Bug (*Oxycarænus lætus*, Kirby), the Cotton Leaf-roller (*Sylepta derogata*, F.) and the Rice Bug (*Leptocorisa varicornis*, F.). Demonstrations of methods of controlling insect pests were given at the Agricultural Shows with the help of show-cases and magic lantern lectures.

In Mysore, Green Bug of Coffee (*Lecanium viride*), insects attacking stored grains, and *Amsacto albistriga* have engaged attention.

In Bengal, the following pests have been investigated :—

Rice Hispa (*Hispa œnescens*).
Rice Swarming Caterpillar (*Spodoptera mauritia*).

Mango Hairy Caterpillar (*Cricula trifenestrata*).
Tobacco Caterpillar (*Prodenia litura*).
Rice Caseworm (*Nymphula depunctalis*).
Rice Bug (*Leptocorisa varicornis*).
Jute Semilooper (*Cosmophila sabulifera*).
Jute mite (*Tetranychus* sp.).
Bihar Hairy Caterpillars (*Diacrisia obliqua*).
Moth Borer (*Chilo simplex*).
White moth borer (*Scirpophaga auriflua*).
Large brown cricket (*Brachytrypes achatinus*).
Mango shoot borer (*Alcides* sp.).
White Weevil (*Myllocerus* sp.).
Litchi mite (*Eriophyes* sp.).

In Burma, experiments with mulberry silkworms were not successful owing to the place in which they were reared being unsuitable. Among the crop-pests studied were the Swarming paddy caterpillar (*Spodoptera mauritia*), the Paddy caseworm (*Nymphula depunctalis*, the Paddy stem borer (*Schœnobius bipunctifer*), Mango weevil (*Cryptorhynchus gravis*, F.) and fruit flies. The effect of spraying with lead Arseniate for Chafer Beetles defoliating Gold Mohar trees was tested and also the use of light traps.

In the Punjab, attention has been specially directed to the Moth borer in Cane (*Chilo simplex*, Butl.), the cotton bollworm (*Earias* spp.) and its parasite (*Rhogas lefroyi*), the introduction of mulberry silkworm rearing among the Zemindars and testing of the effect of SO_2 and CO_2 upon wheat "weevil." With the moth borer (*Chilo simplex*) cutting out of the "dead hearts" has been found very effective in checking the damage done by the borer. The parasite (*Rhogas lefroyi*) of the cotton bollworms (*Earias* spp.) was successfully established in breeding plots at Lyallpur and parasite boxes distributed. The effect of sulphur dioxide is detrimental to the germinating capacity of the wheat and also bleaches it, though effective in killing the "weevil." The effect of CO_2 still requires further investigation as it is not effective in all cases upon the "weevil" and in some cases affects the germinating capacity of the wheat.

In Bombay, the chief pests dealt with were the leaf roller on Til (*Antigastra catalaunalis*), stem borer (*Chilo simplex*) in Jowar, Gram caterpillar on Tur (*Chloridea obsoleta*) and grubs attacking cotton.

In the North-West Frontier Province, attention has been specially directed to determining whether the Peach fruit fly is present there and it has been found that it appears rather late in the peach season, earlier fruits being completely free, but peaches left on the trees after

August 30th were affected by maggots. Peach Aphides have also proved a serious pest. Trap crops of Maize for sugarcane borer (*Chilo simplex*) have been very successful.

In the Central Provinces, experiments were made with the Maize as a trap crop for sugarcane borer.

In Bihar and Orissa the campaign against the Greasy Cut-worm (*Agrotis ypsilon*) was again successfully carried on. Experiments with storing potatoes against damage by Potato moth (*Phthorinia operculella*), demonstration godowns being started at various places.

In Baroda, methods of checking "Katra" (*Amsacta* spp.), Sesamum stem borer (*Oberea* sp.) and Cotton Bollworms (*Earias spp.*). Arrangements were made to commence the cultivation of lac on Babool trees.

The Indian Tea Association.—The Entomologist has been principally engaged in the study of Mosquito Blight on tea. Experiments have been made on the treatment of Mosquito blight, Red spider and various other insect pests of tea and the investigation of their parasites.

Southern Indian Planters' Association.—Experiments have been made in co-operation with the Government Entomologist, Madras, to investigate the rôle played by bees and other insects in the fertilization of coffee. *Heterasia cingalu* was found damaging tea in Nilgiri, Wynaad district. Experiments with Mosquito blight on tea were continued. *Lecanium viride* (Green bug) made its appearance in Coorg and Mysore.

II.—ECONOMIC ZOOLOGY.

PART II.—FOREST ENTOMOLOGY.

BY

C. F. C. BEESON, B.A.,*
Forest Zoologist.

Sal investigation.—The work has been confined to the United Provinces; Dr. A. D. Imms, Forest Zoologist, made a short tour in the *sál* forests of the Siwalik Division. The investigation of the late larva, the pupa and the imago of *Æolesthes holosericea* has now been completed.

* Dr. A. D. Imms held the post of Forest Zoologist up to the 27th February 1913, after which date, until the close of the year, Mr. N. C. Chatterjee remained in charge of the office.

The study of the eggs and early larval stages is being continued. A large number of male and female imagines and pupæ of *Æolesthes holosericea* was found in a felled trunk of *Terminalia tomentosa* in the Hoshangabad Forest Division, Central Provinces.

Three Bombycid moths bred from the larvæ attacking *sál* leaves received from Pilibhit Forest Division mentioned in last year's report were identified by Sir George Hampson as *Euproctis scintillans*, Wlk., or a species close to it.

The Coccinellid larvæ reported last year as predaceous upon Monophlebus scale insects have been identified by Mr. J. Weise as *Macronocius indicus*, sp. nov.

Lac investigation.—The work of studying the parasites of Butea lac has made considerable progress and nearly 2,000 specimens of such parasites have been reared up to date. These are gradually being worked out by various specialists abroad. Touring was undertaken during the year in three Forest Divisions in the Central Provinces and in the Rewah State, for the purpose of obtaining information regarding the local conditions and the frequent causes of failure of the lac crop. A biological study of the lac insect itself is now nearly complete, and it is hoped that this will serve to correct many of the errors prevailing with reference to the insect, and will be useful as a work of reference for all interested in lac cultivation, seeing that a reliable account of it does not at present exist.

Insects of several families were bred out of lac during the year and some of them are still awaiting identification by various specialists. The Coleopterous parasites of lac have been identified by Mons. A. Grouvelle of Paris as follows:—

Cathartus advena, Wlk.
Typhæa hercorea, L.
Cartodera asiatica, Grouv.
Holoparamecus kunzei, Anbi.
Crytophycus ceylonicus, Mos.
Silvanopsis Iyeri, Grouv.
Berginus maindroni, Grouv.
Tribolium ferrugineum, F.

Specimens of Butea stick lac were received from various Divisional Forest Officers of the Central Provinces, United Provinces and of the Khandesh Division, Bombay, and parasites are being bred out of them. The study of these parasites and their bearing on the production and propagation of lac is being continued.

In the winter brood the female lac insect is fertilised by winged and wingless males, but in the summer brood only the wingless form has been observed.

Indian Forest Records, Volume IV, Part II, containing descriptions of the new parasitic Hymenoptera bred from lac, by the late Mr. P. Cameron, was issued from the press during the year.

New species.—Among the specimens identified for us by specialists during the year the following have been described as new species:—

*1. *Ceratopogon lignicola*, sp. nov. (Chironomidæ).

*2. *Plecia impostor*, sp. nov. (Bibionidæ).

*3. *Parapleciomyia carbonaria*, gen. et sp. nov. (Bibionidæ).

*4. *Clitellaria bistriata*, sp. nov. (Stratiomyidæ).

*5. *Systœchus nivalis*, sp. nov. (Bombylidæ).

*6. *Hœmatopota albofasciatipennis*, sp. nov. (Tabanidæ).

†7. *Guadaba maculata*, sp. nov. (Cicadidæ).

A number of new species have been discovered by Dr. Ch. Kerremans (Buprestidæ), H. Gebien (Tenebrionidæ), Mr. Durrant (Tortricidæ), Mr. E. Meyrick (Microlepidoptera), Mr. Julius Weise (Coccinellidæ) and Mons. Grouvelle (Clavicornia), the descriptions of which are not yet published.

A Histerid beetle, *Platylister procerus*, Lew., collected at Dehra Dun, has hitherto been known from China only.

Other investigations.—(*a*) A species of Coccid attacking Chir pine in the Naini Tal Forest Division. The investigation was continued during the year, and a large part of the life-history of this insect has been ascertained. The insect has been sent to Professor R. Newstead for identification. Two species of Coccinellidæ, the larvæ of which are predaceous on these Coccids, have been determined by Mr. J. Weise as follows:—

1. *Exochomus uropygialis*, Muls.
2. *Nephus seocrini*, Ws.

(*b*) A study of the various species of termites found in the Indian forests. The work of collecting specimens of white-ants and notes relating to the damage done by them was continued, and specimens have been received from nearly all parts of India. A large number of specimens was sent to Professor Dr. F. Silvestri of Portici, Italy, for identification, but the work has been delayed by Dr. Silvestri's absence from Italy.

(*c*) Ipidæ attacking Blue pine (*Pinus excelsa*) and Chir pine (*Pinus longifolia*) in the Chakrata Forest Division. Dr. A. D. Imms, Forest

* E. Brunetti—Indian Museum Records, Volume VII, Pt. V.

† W. L. Distant—Ann. Mag. Nat Hist., Volume X.

Zoologist, inspected the affected areas on a short visit in October 1912. The damage done was due to the following species:—

(1) *Tomicus longifolia*, Steb.
(2) *Polygraphus longifolia*, Steb.
(3) *Polygraphus major*, Steb.
(4) *Polygraphus minor*, Steb.
(5) *Scolytus deodara*, Steb.

Remedial measures were carried out in infested areas, but the effect of these is not yet observable.

Damage reported during the year.—(*a*) Caterpillars of Noctuid moth *Ophiusa tirrhaca*, Cram., and of Pyralid moths *Chalcidoptera straminalis*, Guer., and *Macalla moncusalis*, Wlk., attacking *sál* trees in the Morha Range of Kheri Forest Division.

There is no previous record of *Ophiusa tirrhaca, Cram.*, and *Chalcidoptera straminalis*, Guer., attacking *sál*.

(*b*) Ipidæ attacking *sál* trees in the Buxa Forest Division, Bengal.

(*c*) Caterpillars of a Pyralid moth belonging to the genus *Euzophera* or a closely allied one, attacking cones of Chilgoza pine in Zhob, Baluchistan.

(*d*) Coccids attacking Kail (*Pinus excelsa*) in Kamraj Forest Division, Kashmir State. It is believed that further observations will prove this attack to be similar to the one in Naini Tal Forest Division. It has also been noted to occur to some extent in Jaunsar, United Provinces.

(*e*) Bruchid beetles of the genus *Bruchus* attacking stored seeds of *Albizzia Lebbek* sent by the Sylviculturist.

(*f*) Microlepidopterous caterpillars attacking *sál* seeds in the Nowgong Division, Assam.

(*g*) A Lamiid beetle (*Glenea Spilota*, Thoms.) attacking Semal saplings (*Bombax malabaricum*) in the Kheri Forest Division, United Provinces.

(*h*) Caterpillars of a Microlepidopterous moth attacking Bamboo seeds in the North Thana Division, Bombay Presidency.

(*i*) Aphids attacking *Cryptostegia grandiflora* plants in Kangra Forest Division, Punjab.

Two species of Cleridae beetles predaceous on *Sinoxylon anale*, Les., and a variety of *Sinoxylon Crassum*, Les. (which attack Shisham, *Dalbergia Sissoo*, in Dehra Dun), have been identified by Dr. Schenkling to be *Tillus notatus*, Klug; and *Cylidrus cyaneus*, F.

Miscellaneous.—Help in the identification of various insects has been generously given by Sir George Hampson, Mr. G. J. Arrow, Mr.

C. J. Gahan, Mr. C. Morley, Dr. Malcolm Burr, Dr. Max Bernhauer, Dr. F. Silvestri, Mr. W. L. Distant, Mr. S. Hirst, Mr. E. Meyrick, Mr. G. Lewis, Mr. E. Brunetti, Dr. Ch. Kerremans, Mons. A. Grouvelle, Mr. Meade Waldo, Mr. J. Weise, Mr. Gebien, Dr. Schenkling, Dr. K. Jordan and others.

List of Publications on Economic Zoology.

AGRICULTURAL RESEARCH INSTITUTE, PUSA. — Directions for the cultivation of Eri Silk. (*Bull. No. 29.*)

ANDREWS, E. A. — Insects. (*Quarterly Journ., Indian Tea Association, 1912, Part 3.*)

A parasite on the tea mosquito blight (belonging to family Mermithidæ). (*The Quarterly Journ., Indian Tea Association, 1913, Part 1.*)

BAINBRIGGE FLETCHER, T. — Termites. (*Agri. Journ. India, July 1912.*)

Note on a new Ant mimicking Beetle. (*Journ. Bomb. Natl. Hist. Soc.*)

Life-history of Phasmid. (*Journ. Bomb. Natl. Hist. Soc.*)

Life-history of *Coptosoma cribraria*. (*Journ. Bomb. Natl. Hist. Soc.*) Fleas on Horses. (*Agri. Journ. Ind., January, 1913.*)

BAINBRIGGE FLETCHER, T., & WOODHOUSE, E. J. — Caterpillar pest of Mokameh Tal Lands. (*Agri. Journ. Ind., October, 1912.*)

CAMERON, P. — On some new and other species of Hymenoptera in the collections of the Zoological Branch of the Forest Research Institute, Dehra Dun. (*Ind. For. Rec., Vol. IV, Part II.*)

DEPARTMENT OF AGRICULTURE, ASSAM. — Leaflet in English and Khasi on *Paintaphil*, a rice pest.

DEPARTMENT OF AGRICULTURE, BENGAL. — Leaflets on :—

1. Pests of Sann hemp and how to check them.
2. The Jute Semilooper.
3. The Rice Stem-borer.

DEPARTMENT OF AGRICULTURE, BURMA. — Bulletin No. 8 on the Cotton pests of Burma.

Notes in Burmese papers on Rice Hispa, White-ants, Mga Mynaung Daung.

Department of Agriculture, Madras.	Leaflet in English, Telegu and Kanarese on the Deccan Grass-hopper.
	Leaflet in English and Tamil on Insect Pests.
	Notes in Agricultural Calendar on Hairy Caterpillars (Kumblihula), Grasshoppers, Rice Bug and Insect Pests.
	Leaflet in English and Canarese on the Flies spoiling toddy in South Canara.
Dutt, G. R. . .	Life-histories of Indian Insect—Hymenoptera. (*Mem. Department of Agriculture in India, Entomological Series, IV, No. 4.*)
Ghosh, C. C. . .	The Big Brown Cricket (*Brachytrypes achatinus*). (*Mem. Department of Agriculture in India, Entomological Series, IV, No. 3.*)
Hancock, J. L. .	Tetriginæ (Acridinæ) in the Agricultural Research Institute, Pusa. (*Mem. Department of Agriculture in India, Entomological Series, IV, No. 2.*)
Howlett, F. M. .	Yellow Fever and Mosquitos. (*Agri. Journ. of India, October, 1912.*)
Indian Tea Association.	The Sandwich Caterpillar. (*The Quarterly Journ., Indian Tea Association, 1912, Part 1.*)
Kasargode, R. S. .	Two recent Agricultural Pests. (*Poona Agri. College Magazine, iv, No. 3, January, 1913.*)
Lefroy, H. M. . .	The Psylla Disease of Indigo in Bihar. (*Agri. Journ. of India, January, 1913.*)
Lefroy, H. M., & Finlow, R. S.	An Inquiry into the Insecticidal action of some Mineral and other compounds on Caterpillars. (*Mem. Department of Agriculture in India, Entomological Series, iv, No. 5.*)
Main, T. F. . .	A Series of Campaigns against the Rice Grasshopper. (*Agri. Journ. of India, July, 1912.*)
Marshall, G. A. K.	New species of Indian Curculionidæ. (*Ann. Mag. Nat. Hist., Vol. II, No. 62.*)
Misra, C. S. . .	Cultivation of Lac in the Plains of India. (*Bull. No. 28, Agricultural Research Intitute, Pusa.*)
	Litchi Leaf-curl. (*Agri. Journ. of India, July, 1912.*)
Woodhouse, E. J. .	Potato Moth in Bengal. (*Agri. Journ. of India, July, 1912.*)

VETERINARY SCIENCE.

BY

MAJOR J. D. E. HOLMES, M.A., D.Sc., M.R.C.V.S.,

Imperial Bacteriologist, Muktesar.

In compliance with the programme of research work approved for the year 1912-13, the following investigations were carried out:—

Rinderpest.—A series of experiments were made to discover more economical methods of manufacture and improved technique. The details have been submitted for publication in Memoir form.

Many experiments were made on the value of drug treatment in Rinderpest. This investigation is being continued. These experiments, so far, have given negative results. Many drugs and antiseptics were administered to infected cattle, but none had much appreciable influence in the course of the disease.

The Permanganate of Potash treatment, advocated by Major Walker, C.I.E., and under trial in the Punjab, proved to have no beneficial effect when administered to susceptible cattle.

Surra.—Further experiments were conducted on the treatment and transmission of Surra.

An attempt was made during the monsoon to carry out an investigation on certain questions connected with the transmission of Surra, by means of biting flies, on the Kathgodam-Ranikhet Road. The investigation was commenced, but had to be abandoned as there was no one available to continue the work. A further attempt is being made during the present year to continue this research with the aid of the Government Entomologist.

The Annual Report of the Bacteriological Laboratory in the Colony of Mauritius, for 1911, contains a report on the good results obtained in that Colony by the Holmes method of treatment for Surra. The results obtained on Bovidæ proved excellent. Of horses treated, 52·9 per cent. were cured.

The Divisional Veterinary Officer, Burma Division, Maymyo, records successful results with the same treatment among infected mules in Upper Burma.

Anthrax.—An investigation was made on the value of the simultaneous inoculations of an Anthrax vaccine and Anthrax anti-serum as compared with the inoculations of an unmodified virus and anti-serum.

The results show that the method under investigation confers an active immunity, but is open to the same objection as when virus is used, namely, that the results are irregular and in some cases deaths occur after vaccination.

A paper on the subject is being prepared for publication.

Hæmorrhagic Septicæmia.—The investigation regarding the vitality of the organism outside the body was continued and is not yet completed. The results, so far, point to the prolonged vitality of the organism under certain conditions in soil and to the probability of infection being conveyed through fodder and water.

A number of experiments were made on the drug treatment of this disease. The Permanganate of Potash treatment was found of no value. The treated animals died in the same time as the controls. One drug experimented with has given a certain measure of success when administered in the early stages of the disease.

This investigation is being continued.

Foot and Mouth Disease.—From 1st October 1912 to March 30th, 1913, the Imperial Bacteriologist was deputed, in addition to his other duties, to assist the Foot and Mouth Commission sent from England to study certain features of the disease in India. The Commission worked at the Branch Laboratory, Bareilly.

In addition to the sanctioned programme of research, the following subjects received attention.

Bursati.—A study was made of the etiology and histology of this disease. A paper on the conclusions is being prepared for publication.

Kumri.—The investigation of this disease was continued, but as yet no positive results have been arrived at. The disease is one which requires investigation at the seat of outbreaks and this cannot be done with the present staff.

Research from Veterinary Colleges and Provincial Laboratories.

From the Camel Specialist.—Mr. Leese continued his investigations into diseases of the camel and, in particular, the treatment of Surra. The results have been published as a Memoir of the Department of Agriculture, Veterinary Series, Vol. I, No. 3.

Bengal Veterinary College.—Mr. Ganguli, House Surgeon, and Mr. Mitter, Lecturer on Pathology, recorded the presence in Bengal of *Filaria Immitis* in dogs. Mr. Mitter further records the presence of Gastrodisc in an Indian Zebu and describes the occurrence of *Gnathostomum Spinigerum* in India.

A List of Papers published during 1912-13 bearing on Indian diseases.

BRANFORD, R. . . Trypanblau in the Treatment of Canine Piroplasmosis as occurring in India. (*Vet. Journ., Vol. 68, pp. 643—648.*)

CROSS, H. E. . The preparation of Anti-Rinderpest Serum by the injection of virulent Artificial Peritonial Fluid. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. II, pp. 206—215.*)

DUTT, J. F. D. . . Successful treatment of Tetanus with Liquid Ferri Perchloride Fort B. P. (*Vet. Journ., No. 452.*)

GANGULI, H. C. . Filaria Immitis in Calcutta. (*Vet. Rec., No. 1264 of 1912.*)

GILLET, E. S. . . Hæmorrhagic Septicæmia in a horse. (*Journ. of Comp. Patho. & Thera., Vol. XXV, pp. 321.*)

HARTLEY, P. . . On the Immune Bodies occurring in Rinderpest Immune Serum. Part I—The Preparation of the Rinderpest Immune Bodies by Dialysis of the Immune Serum. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. II, pp. 216—230.*)

,, ,, . . Report on the Preparation of Rinderpest antiserum by means of Diluted Virulent Fluids. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. II, pp. 231—241.*)

,, ,, . . On the Immune Bodies occurring in Anti-Rinderpest Serum, and the Variations occurring in the Serum Proteins of Animals during Immunisation and Hyperimmunisation. (*Mem. of the Dept. of Agri., Vety. Ser., Vol. I, No. 4.*)

HOLMES, J. D. E. . The Treatment of Surra in Horses by means of Arsenic and its Derivatives. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. I, pp. 1—48.*)

,, ,, . The Cure of Surra in Horses by the Administration of Arsenic. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. I, pp. 49—72.*)

,, ,, . A further note on the cure of Surra in Horses. (*Mem. Indian Civil Vety. Dept., No. 3 Pt. I, pp. 73—77.*)

,, ,, . Some Experiments in the Treatment of Surra in Camels. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. I, pp. 78-97.*)

HOLMES, J. D. E. . Reports on Experiments carried out to test the susceptibility of Cattle for several districts and on Improved Methods of Rinderpest Serum Preparation. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. II, pp. 98—205.*)

" " . Further Testings of the H. S. anti-Serum and Vaccine on Bovines and Equines. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. III, pp. 242—247.*)

" " . The Practical Value of Authrax anti-Serum and Vaccines. Preliminary Report. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. IV, pp. 248—271.*)

" " . A Note on Elements resembling Spirochætes found in the Blood of Man and Animals. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. IV, pp. 272—276.*)

" " . Anaphylaxis in the larger Animals. (*Mem. of the Dept. of Agr., Vety. Series, Vol. I, No. 1.*)

" " . Salvarsan in the Treatment of Surra in Horses, Dogs and Rabbits. (*Mem. of the Dept. of Agr., Vety. Series, Vol. I, No. 2.*)

" " . A Note on some Interesting Results following the Internal Administration of Arsenic in Canker and other Diseases of the Foot in Horses. (*Agr. Bull. No. 32.*)

" " . A Note on the M'Fadyean Staining Reaction for Anthrax Bacilli. (*Arg. Bull. No. 36.*)

" " . Some cases of Surra treated in the field and in the Laboratory during the Autumn of 1911. (*Mem. of the Dept. of Agr., Vety. Series, Vol. II, No. 1.*)

" " . A Description of the Imperial Bacteriological Laboratory, Muktesar: its Work and Products, English, Urdu and Hindi editions. (*Pamphlet.*)

LEESE, A. S. . . Some more successful Experiments on the treatment of Surra in the Camel with recommendations for Systematic treatment. (*Mem. of the Dept. of Agr., Vol. I, No. 3.*)

MITTER, S. N. . . Some Entozoa of Indian Elephants and a Gastrodisc (?) from an Indian Zebu. (*Journ. of Comp. Path. & Thera., Vol., XXV, Part 2.*)

" " . . A Brief Résumé of our knowledge of Rabies. (*Calcutta Med. Journ., Vol. VII, No. 5.*)

" " . . A Résumé of our knowledge on the occurrence of Gnathostomis Spinigerum in India and its relation to a similar parasite found in man. (*Vet. Journ., December 1912.*)

" " . . Further Note on a Gastrodisc (?) from an Indian Zebu. (*Vet. Journ., March 1913.*)

" " . . Filaria Immitis in Calcutta. (*Bull. de la Soc. de Path. Exot., Tome V, No. 9.*)

" " . . Descriptive Catalogue of Pathological Specimens in the Bengal Veterinary College Museum. (*Bengal Government Publications.*)

OLIVER, E. W. . . Note on Surra. (*Bull. No. 27 of Dept. of L. & A. of Agra & Oudh.*

" " . . Note on the Foot and Mouth disease of cattle in United Provinces. (*Bull. No. 24 of Dept. of L. & A. of Agra & Oudh.*)

WALKER, G. K. . . Rinderpest and Hæmorrhagic Septicæmia with Permanganate of Potash. (*Journ. of Comp. Path. & Thera., Vol. XXV.*)

WHITMORE, A. . . An Account of a Glanders-like disease occurring in Rangoon. (*Parasitology, Vol. XIII, No. 1.*)

MEDICAL RESEARCH WORK.

Work done under the auspices of the Indian Research Fund Association during 1912-13.

The following is a brief review of the work done under the control of the Scientific Advisory Board of the Indian Research Fund Association during the year 1912-13. The more important subjects dealt with were (1) Cholera, (2) Kala Azar, (3) Yellow fever, (4) Malaria.

(1) *Cholera.*—Major E. D. W. Greig, I.M.S., Assistant Director, Central Research Institute, Kasauli, was placed on deputation from the 26th January 1912 to conduct an enquiry into the disease. Calcutta was fixed as the centre of the investigation. His researches at Calcutta and at Puri at the time of the Car festival (which was attended by an outbreak of cholera) have already yielded results of very great interest and practical importance. He has demonstrated the important part played by the human "carrier" in the spread of infection.

(2) *Kala Azar.*—A sub-committee consisting of Surgeon-General Bannerman (President), Lieutenant-Colonel Donovan, Major Christophers and Dr. Bentley was formed to direct the enquiries. Captain F. P. Mackie, I.M.S., Captain Patton, I.M.S., and Dr. V. T. Korke were deputed for the purpose of carrying out the investigations. Captain Mackie has devoted most of his attention to Bengal and Assam and is at present working in the latter province. Captain Patton has been engaged chiefly in laboratory experiments investigating the insect transmission theory of the disease. Dr. Korke has devoted his time to the epidemiology of Kala Azar, studying the distribution and modes of spread of the disease in the endemic areas of Royapuram in Madras City. Their labours have added considerably to our knowledge of the disease, but much yet remains to be done.

(3) *Yellow fever.*—Major S. P. James, I.M.S., was deputed to study yellow fever in its endemic area with the object of drawing up a report as to measures for averting the danger of the introduction of the disease into India, and for stamping out the disease should it appear. Major James has returned and submitted an interesting and valuable report, which contains the opinion that the opening of the Panama Canal will not, immediately at any rate, increase the present danger of India becoming infected with yellow fever. Major James, however, points out that the increase in "local" trade that can be expected to follow the opening of the canal may modify materially the present distribution of the disease and so introduce new dangers which cannot at present be foretold. He advances reasons which lead him to believe that the main

trade routes are unlikely to be materially altered, and as they exist at present the chances of importing infected mosquitos are not considerable.

Meanwhile *stegomyia* surveys have been undertaken in Calcutta, Bombay, Madras, Karachi and Rangoon. The results demonstrate how widely diffused and universally present in the ports of India is *Stegomyia fasciata*, the mosquito responsible for the spread of yellow fever.

(4) *Malaria*.—On the inauguration of the Indian Research Fund, the Malaria Committee, already in existence, was made a sub-committee under the Scientific Advisory Board. Several grants were made to local Governments by the Research Fund during the year to enable them to carry out anti-malarial measures or surveys. Much useful work was done in this connection during the year.

On the recommendation of the Scientific Advisory Board grants were made by the Indian Research Fund during the year in aid of—

(1) Entomological Research in Pusa and at the King Institute of Preventive Medicine, Madras.

(2) Experiments on the subject of plague disinfection of rice in bulk which are being carried out at Parel, Bombay.

(3) Investigations into the chemical composition of milk in the United Provinces.

(4) The supply of scientific literature to brigade laboratories and for the Central Malaria Bureau.

(5) The extension and improvement of the Central Research Institute at Kasauli.

APPENDIX.

REPORT ON THE SCIENTIFIC AND TECHNICAL INVESTIGATIONS CONDUCTED FOR INDIA AT THE IMPERIAL INSTITUTE DURING THE YEAR ENDED 30th JUNE 1913.

BY

W. R. DUNSTAN, M.A., LL.D., F.R.S.,

Director, Imperial Institute.

The scientific and technical investigations which have been in progress at the Imperial Institute for India during the year ended 30th June 1913 are as follows:—

(1) **Opium and other drugs.**—A comprehensive report has been furnished to the India Office on the composition of Indian opium.

A sample of wild *Podophyllum Emodi* rhizomes from the North-West Frontier Province was of very satisfactory quality. These rhizomes would be considerably more valuable commercially than those of *Podophyllum peltatum* if they could be used in European medicine. At present, however, *P. Emodi* is not official in most pharmacopœias and can therefore only be employed for unofficial preparations.

An investigation of the alkaloids of *Peganum Harmala* seed has been carried out by Professor W. H. Perkin, Jr., with material supplied through the Imperial Institute. Copies of three papers on the subject, which he has contributed, in conjunction with Mr. R. Robinson, to the Chemical Society of London, are attached.

(2) **Essential Oils.**—A further report was furnished on the oil of "Nepal sassafras" or "Nepal camphor wood," *Cinnamomum glanduliferum*. The oil contains safrole, and might possibly be used as a substitute for sassafras oil, for which, however, there is only a limited demand, or as a source of safrole, or as a perfume for cheap soaps. For the latter purposes it would have to compete with camphor oil and would only realise about 4*d*. to 6*d*. per lb.

The scientific results of this investigation, conducted at the Imperial Institute, were communicated by Dr. S. S. Pickles to the Chemical Society of London, and a copy of his paper is attached.

A consignment of cuscus roots (*Vetiveria zizanioides*) from Trichinopoly was examined in order to determine the value of the material as a source of vetiver oil. The roots were found to be of inferior quality,

giving a low yield of somewhat abnormal oil, so that it was doubtful whether they would be readily saleable in Europe.

Samples of Kalamet wood (*Mansonia Gagei*) from Tenasserim contained very small amounts of volatile oil which could only be extracted with difficulty. Unless wood containing a higher percentage of oil can be obtained the material would probably not be of value for export.

Five samples of Cochin lemon-grass oil were examined, and suggestions were made as to the reasons for the change which has recently occurred in the character of the lemon-grass oil shipped from Cochin.

(3) **Turpentine Oil.**—Samples of turpentine oil from *Pinus excelsa* and *P. Khasya*, prepared by the Forest Chemist at Dehra Dun, were forwarded for examination. The oil of *Pinus excelsa*, after re-distillation to remove the yellow colour, was found to be equal in quality to the best grades of French and American turpentine oil. The oil of *Pinus Khasya* appears to be a mixture of terpenes, and would probably be classed in the market with low-grade American oil.

(4) **Oils and Oilseeds.**—The investigation of Margosa fat was continued in order to ascertain whether its unpleasant odour could be easily removed. It was found that the odour is due to the presence of a compound of sulphur, which apparently cannot be removed by means of solvents or by any simple or inexpensive process; it disappears when the fat is treated with steam, but subsequently develops again. The commercial utilisation of Margosa seed in Europe therefore seems impracticable at the present time.

A sample of Raina seed (*Amoora Rohituka*) yielded 43·5 per cent. of a viscous yellow-brown oil which would be of fair quality for soap-making, and on this basis the seed was valued at about £9 per ton in the United Kingdom (April 1913). A sample of "Panang" kernels (*Calophyllum Inophyllum*) yielded 71·4 per cent. of oil of good quality for soap-making, and a firm of oilseed crushers stated that kernels containing as much oil as this should be worth £16 per ton in the United Kingdom (April 1913).

Several sardine oils from the Fishery Bureau, Madras, were examined and found to be suitable for the usual purposes to which fish oils are applied, *viz.*, leather-dressing and currying, and to a smaller extent for soft soap manufacture, tempering steel, admixture with paint oils, and jute batching.

(5) **Burmese Lacquer.**—Samples of "Thitsi" or Burmese lacquer, forwarded to the Imperial Institute in order to ascertain the possibility of finding a market for the product in Europe, were submitted to manufacturers, merchants and technical chemists, several of whom expressed considerable interest in the material and undertook to carry

out trials with it. Some of the experiments were still in progress at the end of the year, but the majority of the experts consulted considered that Thitsi could not easily be utilised in the United Kingdom as a varnish, owing to its slowness in drying under ordinary conditions. In order to get the lacquer to dry satisfactorily it is necessary to expose it to a damp atmosphere at 30° to 35° C. for three or four days. A large firm of cabinet-makers, however, reported that they could use Thitsi in place of Chinese lacquer, and they were accordingly furnished by the Imperial Institute with the names of firms prepared to export it from Rangoon.

(6) **Fish Waste.**—Three samples of fish refuse from the Fishery Bureau, Madras, were found to contain average quantities of nitrogen, phosphoric acid and fat, but rather less protein than is usually present in fish meals. The material should be readily saleable as a fertiliser or for the preparation of feeding-stuffs.

(7) **Cotton.**—Fifty-two representative samples of the different types of cotton grown in the Northern Division, Bellary, were very similar in general characters and were, on the whole, of satisfactory quality.

Ten samples grown on the Government Experimental Farm at Akola, Central Provinces, consisted of good clean cotton of very satisfactory growth.

Eight samples grown experimentally at Lyallpur in the Punjab were of satisfactory appearance and strength, and were valued at good prices.

Several samples of cotton from Burma, including native types, Cambodia and "kidney" cottons, were also examined during the year.

(8) **Fibres.**—Three samples of rhea ribbons were forwarded by the Fibre Expert at Dacca for examination. Only one sample was sufficiently prepared to be saleable in Europe, and this was valued at £25 per ton in London by a firm of fibre merchants who expressed a desire to receive consignments.

A fibrous bark, stated to be derived from a species of nettle found in Terai and on the lower slopes of the Himalayas, would be suitable for paper-making, but for this purpose it would probably not be worth more than £4 or £5 per ton in the United Kingdom. It was suggested that possibly a useful fibre could be prepared from the plant by submitting the freshly cut stems to a retting process like that employed in the case of jute.

Four specimens of jute, grown experimentally, were specially examined at the request of the Fibre Expert at Dacca, in order to ascertain the percentage of cellulose present, the tensile strength, and the length of the ultimate fibres.

Samples of *Malachra capitata* and *Urena lobata* fibres grown experimentally were submitted for examination by the Fibre Expert at Dacca. Both fibres were of excellent quality, and were valued in London at prices above those of "first marks" Calcutta jute. The merchants stated that they would be glad to receive consignments of these fibres.

A sample of wild plantain fibre from Burma was of very good quality and was valued at about £20 per ton in London with "fair current" Manila hemp at £22 to £22 10*s*. per ton; a subsequent sample was valued at £35 per ton in London (May 1913) with "fair current" Manila hemp at £33 per ton. Commercial experts were of opinion that the fibre would be suitable for fine spinning, and there is no doubt that it would be readily saleable in the United Kingdom.

A small consignment of Sida fibre forwarded by the Fibre Expert at Dacca was sold in London at £27 per ton. It was however valued at £28 to £30 per ton (July 1912) if shipped in commercial quantities.

(9) **Rubber.**—Six samples of Para rubber from Burma were well prepared and exhibited good physical properties. They varied somewhat in composition, the amount of caoutchouc present ranging from 90·0 to 94·3 per cent. They were valued at about 3*s*. 2*d*. to 3*s*. 4*d*. per lb. in London with fine hard Para at 3*s*. 4*d*. per lb. (April 1913).

(10) **Miscellaneous Official Enquiries.**—In addition to the foregoing reports, information was furnished and assistance rendered during the year to Indian Government officials in connection with various technical and commercial matters, including the following:—

The utilisation of rice.
The analysis of feeding-stuffs.
The use of bamboo pulp as a paper-making material.
The marketing of sandalwood.
The determination of prussic acid yielded by beans.
The cultivation of peas and beans in Burma.
The production of "synthetic" timber.
The preparation of jute fibre.

A number of other miscellaneous enquiries relating to Indian matters received from commercial firms and private individuals in India and in the United Kingdom were also dealt with during the year, information being furnished to the enquirers regarding food grains, oilseeds, turpentine, tanning materials, fibres, minerals and various other subjects.

A number of articles and short notices relating to Indian economic products and their exploitation were published during the year in the

"Bulletin of the Imperial Institute." The principal subjects dealt with were as follows:—

"The Improvement of Cotton in India."

"Lemon Grass Oils from India."

"Turpentine Oils from India."

"Wild Plantain Fibre from India."

"The Occurrence of Samarskite in India."

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Departmental Publications.

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(1) The Indian Daily Weather Report and Chart.
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