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ZOOLOGICAL GARDEN CALCUTTA

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Chapters on the History of Botany in India

IV. THE ROYAL GARDENS AT KEW BEGIN TO GUIDE THE DIRECTION OF BOTANY IN INDIA

BY

I. H. BURKILL

[*Continued from Vol.* **58** (3) : 706]

My first chapter covered the service that **Wallich** gave prior to his long leave (1828-32). His predecessor, **William Roxburgh**, had come near to instituting a 'botanic survey' when he sent his sons, William and John, field-collecting. Wallich moved further in that direction, for he sent out a series of collecting parties whose activities when added to the collecting in the field that he did himself most obviously made up a 'botanic survey' of limited extent. Its limits were towards the north-east of India, towards the north, east, south-east, and south of Bengal, excluding other directions. He himself collected through the tarai of Oudh, into the Himalaya to Kathmandu, through the Ganges plains, the Brahmaputra Valley, Sylhet and the Khasia Hills, and up the Irrawaddy to Ava and the edge of the Maymyo Hills, as well as in the Straits Settlements. His collecting parties worked in Kumaon, Nepal, Chittagong, Sylhet, and Tenasserim (the Moulmein and Tavoy districts). We cannot withhold the term 'survey' from so wide an effort. Wallich distributed the whole of the spoil to date during his leave, and at the same time there was deliberating in Calcutta a Retrenchment Committee, which cut the provision for the Calcutta Botanic Garden so severely as to prevent

any reconstruction of the survey. So it was that Wallich returned in 1832 to a difficult position, and, unfortunate man, in addition to his troubles his health broke down. The delegation to Assam in search of tea which followed was only carried out by a great effort. He had professorial duties at the Medical College and he had his obligation to provide from the Garden whatever growing stock was reasonably demanded; and for more administration than this he seems not to have had the energy.

My reader will recall that **Wight**, immediately on appointment to the post of Madras Government Botanist at Samalcottah (1825), made a long collecting trip—a trip of duration equal to some of Wallich's, and indeed proper for inclusion in the 'survey'. He will recall also that Wight proposed a longer trip in the next year and was promptly called to heel and sent back to military duty. This checking of Wight was part of the retrenchment from which Wallich suffered.

The Retrenchment Committee had been called by Governor-General Lord William Bentinck and rightly, for the finances of the Company had been tremendously disordered by war with Burma and there was not the money to spare for promoting undertakings in which the Company saw little to gain. It is a reasonable comment that immediately Wight and **Griffith** declared their faith, Wight by beginning publication and Griffith by the zeal of his collection and intention to use the same for the preparation of a FLORA. Wight may be said to have been already in the breach. Official planning put the Calcutta Garden out of action in one respect; volunteer surveying took its place.

Of course progress was hindered; but it would be wrong to say seriously. Chapter 3 has given the reader the names of almost a hundred who promoted botany in India during the years of the middle of the 19th century. Picking out from them those whose botany was of a level high enough to reach print, I put the following sequence of arrival before my reader.

Wight, who arrived in Madras in 1819, begins the list. J. S. Law reached Bombay in 1826; John Graham reached Bombay in 1828; General Warren Walker to Ceylon in 1830; John McClelland to Bengal in the same year; David Ritchie to Bombay in 1831; William Griffith to Madras and Hugh Falconer to Upper India in 1832; Joseph Nimmo appeared in Bombay in 1834; Alexander Gibson reached Bombay in 1835; Thomas Thomson to Upper India in 1839; N. A. Dalzell to Bombay in 1841; General William Munro to southern

India in 1843; George Gardner to Ceylon in 1844; Sir Joseph Hooker and John Ellerton Stocks to northern India (Stocks initially to Bombay) in 1847; R. H. Beddome to the central parts of India in 1848.

Sir **Joseph Hooker** was the only one of these who owed his coming to botanical knowledge; and he was not in the service of the East India Company.

It would be easy to gather together a second group of contemporaries whose botany was that of collectors; the group would tell the same story, namely that these came one after another, as the first group did. But what I have given suffices for the recognition of arrival after arrival of men botanically minded. I desire that my reader shall understand that the coming of Botany was a consequence of a knowledge of Botany being spread through Britain so widely as to come as it were by accident. It was not exactly invited; its arrival was somewhat welcomed; its possession sometimes brought rewards. The country was not ready to assimilate it; the results of the studies done in India had to be carried outside in order to be assimilated internationally.

THE GROWTH OF KEW THAT MADE IT THE PLACE FOR THE INTERNATIONAL ASSIMILATION OF INDIAN STUDIES

The little village of Kew had held a royal residence long before the year 1791, when the widowed mother of a king found pleasure in embellishing her garden in various ways and carried the embellishment from design to a great discrimination in the choice of plants grown in it. This discrimination was continued by her son George III after her death and, better to succeed, the advice of Sir **Joseph Banks** was sought and in a measure followed. Banks, who had travelled much, who had visited Newfoundland, Iceland, and Australia, and had sailed with Captain Cook round the world, who had created for himself a considerable herbarium and scientific library, who was so eminent as to be President of the Royal Society, quite naturally saw the means of advancing Botany and used what persuasion he had to that purpose. It is said that he sought sanction for the maintaining of a herbarium by the side of the plants in growth; but this did not come about. At his death in 1820 his own herbarium and scientific books were willed to his librarian Robert Brown, from whom they were to go to the British Museum. That parted the

living and the dead—the exotics in the houses and parterres at Kew, from the references dried and preserved.

In the years of Banks, the flow of interesting plants into cultivation at Kew was maintained by sending collectors abroad who remitted them, and by the services of acclimatization offices in the possessions overseas. We have already seen that William Kerr and Alexander Moon went to Ceylon at the choice of Banks. Of dried plants from India Banks received bundles from Francis Buchanan and Gerhard Koenig, and then by will the whole of the latter's herbarium. Banks used his influence to recommend Roxburgh's work to the East India Company.

Apart from India, in the year of his death he promoted another appointment of great interest, namely the appointment of **William Jackson Hooker**, who was quietly studying plants at Molesworth in Suffolk, to the professorship of Botany in the University of Glasgow. Buchanan, now retired and whose surname had been changed to Hamilton in 1820, wrote expressing expectation that Hooker would be distinguished, and then in 1822 followed this by 'Dr. Hooker at Glasgow I see frequently . . . He is more active than Graham (the professor who preceded Hooker) . . .' Hooker's influence on Wight's publications has already been referred to [see p. 859, *J. Bombay nat. Hist. Soc.* **51** (3) and p. 47, ibid. **54** (1)].

The University of Glasgow was quick to give its new professor a doctorate; and the Crown knighted him in 1838. The two honours equally reached his son **Joseph Dalton Hooker**, who was but four years old when the move to Glasgow came. The son obtained a doctorate in medicine in 1839, and was knighted in 1877. It is convenient, ignoring the dates, here to write of them as Sir William and Sir Joseph.

One of Sir William's activities in Glasgow was the fathering of a new botanic garden, which held about 9000 species in the year after Sir William's arrival, and about 20,000 in the year before he resigned his professorship. By the side of the growing collection went the great growth of his personal herbarium until it was the largest in Britain in private hands. When Sir William removed to Kew, and of course took his private collection with him, the living and dead records, which I remarked were parted by Banks's will, came into juxtaposition and so they were when Sir Joseph returned to his father's Kew house bringing what he had from India with him (1851). Sir William's private collections were purchased from

him in 1861, but through the years to 1861 had been freely open to students.

THE GREAT COLLECTIONS OF SIR JOSEPH HOOKER AND DR. THOMAS THOMSON LINK KEW AND INDIA TOGETHER : THAT WHICH KEW REGARDS AS SPECIFIC LIMITATIONS PASSES TO INDIA, TO INDIA'S GREAT ADVANTAGE

A species is a concept; there is no possible definition, save by consent. The wider the consent the better the international understanding of the concept. Divergent understandings have led to the subdividing with a recognition, say of micro-species or Jordanian species; and other subdivisions will appear. For the advance of knowledge in line, there must be a ruling standard. In brief Kew worked out by consent an idea of permissible variation and on the leadership of Kew the taxonomy of Indian spermatophytes rests.

The following concisely states what happened to the applied work of the two botanists. They had attended the botanical classes given to the medical students by Sir William Hooker, had sat in 1839 for the same examinations and qualified. The one then joined Sir James Ross's ship *Erebus* as Assistant Surgeon and sailed with Ross to the Antarctic to fix the position of the South Magnetic Pole; the second went into the service of the East India Company and was sent to the Upper Gangetic Plain. They were not to meet for ten years. The meeting took place at Christmas 1849, in Darjeeling. Thomson, his delegation to the remoter parts of the north-western Himalayas over, went to the Sikkim Himalaya, where he waited for his old college mate, who meanwhile had the uncomfortable adventure of being held prisoner by an intriguing Sikkim official.

Hooker was bringing back to his base his last specimens. I need to quote what Hooker wrote of the finish of this part of his expedition: 'Thus terminated . . . my last Himalayan exploring journey, which in a botanical and geographical point of view had answered my purposes beyond my most sanguine expectations, though my collections had been in a great measure destroyed by so many untoward events. It had enabled me to survey the whole country and to execute a map of it, and Campbell (Dr. Archibald Campbell, the Superintendent) had further gained knowledge of its resources which the British Government should all along have possessed as the protector of the Rajah and his territories.'

My reader notes the reference to mapping. The Government of India subsidised Sir Joseph's travel to a little under half the cost of

it. Why? Because they needed the geographical information and it was this that they were buying, not the botany. We learn from the same statement that Sir Joseph had lost bundles of his dried plants from time to time; for instance from other sources we know that a large part of what he had collected to illustrate the genus *Impatiens* fell into a river at a certain fording place. The Company had had at other times and from other botanists similar service.

The meeting of the two botanists was followed by discussion of ways of joining work on the collections. It is evident that this was anticipated by both with considerable enthusiasm.

Hooker wished for another year in the Himalaya, and that he could spend it in Nepal. But the Maharajah was unwilling as he was to be away and did not care that strangers should be in the country in his absence. This being so, Hooker and Thomson consented to a season in the Khasia Hills, and after a business visit to Calcutta, where the collections were then lodged, they put in 7½ months of energetic collecting in the hills, seldom having fewer than 16-18 men daily searching the country for plants. Here they collected not only species for drying, but exhibits in the round for an economic museum at Kew, which Sir William had commenced in 1847—timbers, bamboos, dry fruits, gums, resins, etc. This went on until signs of autumn with a cessation of flowers made the flower hunt uncomfortable. Then with about 200 men's loads of spoil they descended to the low country of Sylhet to get water carriage for it to Calcutta. They themselves went southwards to Chittagong, and thence made Calcutta through the Sundarbans.

Does not this collecting again remind us of the thoroughness of Hooker's work? What he lost of his collections, such as most of his specimens of the Sikkim species of *Impatiens* in crossing a swollen river, does not detract from this judgement.

Calcutta was reached on 28 January 1851, and England on 5 March of that year. Naturally Kew and his father's roof was Sir Joseph's destination, and naturally Kew was likewise Thomson's. There they lodged the collections and together began to work on the taxonomy of the higher plants.

HOOKER MAKES THE BEST POSSIBLE USE OF THE HOLD-UP OF HIS *FLORA INDICA*

Thomas Thomson would have buried himself in species-describing, if undisturbed. Sir Joseph Hooker had a mind that took in a much greater breadth of botany. Seemingly both of them had started the

FLORA expecting that the East India Company would promote it just as the Admiralty was promoting the publication of the results of Hooker's work in the Antarctic on Ross's expedition. The Company did not respond. Other possible bodies which might support the publication were tried in vain. The disappointment fell much more heavily on Thomson than on Hooker, for Hooker had a crowd of other interests and the work of Assistant Director to attend to; which was increasing as Sir William Hooker was beginning to lean on his advice. Hooker then did the great service of directing his collections to the advantage of Kew. The distribution of the duplicates as exchanges of material could be done; there were such assistants as Allan Black (1832-1865) to take the burden of such service.

Hooker had described Wallich's distribution of his collections of 1832 as 'the most valuable contribution of its kind to Science'; and Hooker put precept into practice by his own distributing.

Kew, it is recorded, sent out at this time no fewer than 300,000 specimens to institutions and individuals, jointly advancing the internationality of Botany, ticketed with locality of origin and named as far as possible. Moreover by doing this on so large a scale Kew made a great contribution towards fixing on the indefinite unit 'species' an approximate value. This, declared each packet of exchanges, *is the Kew standard*; these specimens are material for critically enquiring if the standard holds.

The Hooker-Thomson sets were being distributed when Wight finally returned to Britain with the balance of his collections for the same treatment. Hooker succeeded in getting India House to release Falconer's 76 cases deposited in 1841 and they also were distributed.

From these distributions the Calcutta Botanic Garden came into possession of so much material which carried the Kew imprint as to get a great lift forward; and by the gifts by wellwishers of Wallichian specimens that were duplicates to them, it had the disadvantage of Wallich having kept nothing for Calcutta in 1832 very largely wiped out.

Justly to be remembered for his services at Kew at this time was **Allan A. Black** (1832-1865). He had had a horticultural training at Kew from which he had been taken into the Herbarium where he proved himself most valuable. In 1863 he was appointed Superintendent of the Bangalore Garden, but died at sea invalided from his post in 1866.

General William Munro (1818-1880)

I introduced General **William Munro** to the reader in Chapter 2 [*J. Bombay nat. Hist. Soc.* **54** (1), p. 54] as a Lieutenant who botanized in the State of Coorg in the year 1834. He was in India until 1848 and collected wherever he went, specializing in grasses until he was the leading authority on them. His last collecting places were in the Himalayas. He had supplied grasses from Agra to Wight; but the two never met. He was resolving the perplexities of the bamboos and was engaged on a monograph on the Gramineae when he died. His collections were bequeathed to Kew. In the year 1837 he prepared a catalogue of the plants in the nursery of the old garden at Bangalore. In 1847 he published a book THE TIMBER TREES OF BENGAL. He was a great advocate of 'soldiers' gardens', and belonging to a British Regiment he was no doubt the originator of an interest in gardening in many of his men when they were in India.

Hugh Falconer, Superintendent of the Saharanpur Garden, 1832 to 1841, and Superintendent of the Calcutta Garden, 1848 to 1855

Hugh Falconer (1808-1865) arrived in India with Griffith; Griffith's voyage ended at Madras; Falconer proceeded to Calcutta, whence he was sent to the Upper Gangetic Plain; and when Royle departed from India in 1832 on long leave, he took Royle's place after so little as two years in India. Though charge of the Saharanpur Garden in general fell to a young man, to be appointed so young as Falconer would seem remarkable. His scientific equipment was more geological than botanical; but then at that time a young scientific man was expected to have wide unspecialized knowledge. No sooner had he landed in Calcutta than we see him seeking geological information which he desired from the museum of the Asiatic Society. Hooker called Falconer 'a mountain of admirable and accurate information' and 'a scientist of inflexible and uncompromising integrity'.

By a coincidence, at the time of Falconer's arrival in the Upper Gangetic Plain fossil bones were discovered to exist in quantity in the Siwalik sandstones by the constructors of the Jumna Canal-head Works at that river's exit from the Himalayas. Govan seems to have known that they existed. Falconer, his geological interests alive, started to collect them, and so did the engineer Sir **Proby Cautley**. To work out what the animals were could not be done in

India; the bones had to be brought to Britain and were brought when that was convenient.

Falconer conducted the affairs of the Saharanpur Garden on the economic lines that Royle had adopted. The reader will recollect that Royle had looked to Kashmir for plants of value to bring into the Garden. Falconer was required in 1836 to join Sir **Alexander Burnes** in an economic mission over the north-western frontier and he left Saharanpur late in that year. Politics called away Burnes, causing him and Falconer to part at the Indus, Falconer seeking a way up the river; but at his third march, when at Darband close to the Black Mountain, his progress was interrupted, force threatened, and he was diverted through Hazara to Kashmir where he wintered. In the next spring he took that route northwards which keeps closest to the Indus though really far from its impassable gorges, until he reached the river again at Sukaram Murbal. Thence he was able, crossing it, to go to Askole, and also up the river through Baltistan and Ladakh. In what way he had contrived to have names for the plants which he collected is not recorded; but he certainly had them, as we know from a letter written to Royle in London and published by Royle. He must have carried books of reference. Falconer's collectors were required to record the localities of the collecting on the coarse packing paper. He was more methodic in this than others of his time. What he published later shows an economic interest. Falconer was back in Saharanpur at the end of the summer of 1838. Then he turned his collectors into the mountains of Kumaon up to the Niti pass; no doubt they also helped him in bringing to him the fossil mammalian bones of the nearer hills.

In 1841 illness drove him to take leave and he took these collections with him, 76 cases of dried plants and 5 tons of the bones. The dried plants were placed in India House and Falconer got to work on his major interest, the bones. So brilliant was his work that his time in Britain was extended that he might get on with it. Furthermore, it led to his election as a Vice-President of the Royal Society.

On his return to India in 1847 he was appointed Superintendent of the Calcutta Garden, from which, as already recorded, he did all that he could to facilitate the work of Hooker and Thomson. From Calcutta he was required to go to Moulmein that he might advise on the teak forests. What he did in Tenasserim is given in the next chapter. The reconstruction of the disordered Calcutta Garden has been referred to in the second chapter.

THOMAS THOMSON (1817-1878)

Thomas Thomson, son of a Glasgow professor and, as already recorded, fellow student of Joseph Hooker, had entered the service of the East India Company in 1839, when he was sent to the Upper Gangetic Plain. In 1841 he was with the troops sent into Afghanistan and lost his all, including whatever collections he had made to date. He was at Ghazni in the next year. Three years later he served through the Sutlej campaign. Between these disturbances he studied the flora of the northern Indian plains and appears to have collected about 1000 species. As a reward for his zeal he was called in 1847 from the medical charge of troops to serve as one of three Commissioners who were to report on the geography and general conditions of the Kashmir-Tibet border. Because Thomson's travels were continuous with Hooker's, whom he joined at Darjeeling in 1850 for a further year of collecting, it has been convenient to me to describe them at pages 339-340 above. Thomson took leave and was in Britain from 1851 to 1854, working at Kew, part of the time on earned leave and part of the time on leave without pay; then he returned to India having been appointed Superintendent of the Calcutta Garden, where the new plantings of Falconer were now 4 to 5 years old. Immediately, Thomson counted his means of organizing a general herbarium in the Garden out of the collection of bundles of dried plants which came into his charge. He had of course brought to Calcutta as much as he could of his own collecting, and through the generosity of friends he had received a very fair representation of the Wallichian dispersal. He reported on the materials that he had, and sent the report to the Asiatic Society of Bengal for publication (*Jour. As. Soc. Beng.* **25** : 405, 1856). Thomson's interest was in the dried plant. With facilities given he might have put in order a very fair working basis for determining Indian plants. Perhaps the living plants in the open garden were too young to interest one whose bias was away from them; and he would not be able to open out under the imposed financial stringency: and again the disaster of the Oudh Mutiny came during his years. Was it by a mis-judgement of his that his horticulturist, Robert Scott, was allowed to slip away to Burma on a collection trip which was prolonged for a whole year, as Thomson's successor says, to the damage of the cultivation which was his proper charge? Finally, Thomson became ill and was invalided out of India in 1861. Mention has been made of the PRAECURSORES AD FLORAM INDICAM, published for Hooker and Thomson after they had been compelled to drop

their FLORA INDICA. The last of the PRAECURSORES appeared in 1861, and with that year Thomson's activity in defining Indian plants ended.

Circumstances had been against him at either end of his service, but with a (to him) golden period of three years of uninterrupted Botany in the middle.

Captain **R. S. Simpson**, who was in Simla when Thomson was starting for the remote parts of the Indus watershed, now reappears as a collector in the Khasia Hills. What he collected reached the Fielding Herbarium and was sent forward to Sir Joseph Hooker at Kew.

THOMAS ANDERSON, THE LAST OF THE SUPERINTENDENTS OF THE SECOND CALCUTTA BOTANIC GARDEN

Thomas Anderson (1832-1870) succeeded Thomas Thomson in 1861. Five years later his brother **John Anderson** (1833-1900) followed him to Calcutta having been selected by the Secretary of State for India in 1865 to be the Curator (shortly afterwards called Superintendent) of the zoological and geological collections which the Asiatic Society were ready to pass over to the new Indian Museum [see pp. 701-2, *J. Bombay nat. Hist. Soc.* **58** (3)]. There are two conditions here for the reader to understand: the one that at the date there were two geological collections in Calcutta, the newer in the possession of the Geological Survey which had been formed in 1851, and the older still in the hands of the Asiatic Society because of agreements not yet completed; and the other condition how it happened that John reached India as much as 10 years after Thomas though only one year younger. This is how it happened. Thomas, having qualified in Edinburgh in Medicine in 1853, went out to India without delay; John went into business, but left it again and qualified in Medicine in 1862, at which time the admission of candidates into the medical service in India had been temporarily suspended. He then taught the Natural Sciences in the Free Church College of Edinburgh until the appointment to the Indian Museum became his. As both brothers collected plants the reader is warned against confusing them. However they were only together in Calcutta from September 1866, when John arrived, until 1868, when Thomas was invalided out of India. During that short time they demonstrably aided each other. John was sent as naturalist on the Yunnan expedition of 1867-1868 and collected between Bhamo in Burma and Momein in Yunnan, i.e. in country never approached by Thomas. The leader of the expedition

was Major **E. B. Sladen** and the plants collected went to the Calcutta Garden where they were in time named by Kurz. Thomas had no connection with them, as illness had overtaken him before they could have reached Calcutta. Thomas's overseas collecting was done in Aden (1860), and Singapore and Java (1861).

When appointing Thomas Anderson to be superintendent the Government had told him that he would be required to introduce Cinchona cultivation into the Sikkim Himalayas. Its experimental cultivation had already showed promise in southern India and Ceylon.

I propose at once to show how the proposals for extension were entangled with Anderson's charge in Calcutta and the reader will find the history of the experiment later.

It was in the nature of governmental policy that such a requirement should be made to the Superintendent of the Garden. My reader recalls that Kyd described the garden which he proposed as one would describe a horticultural nursery. He will recollect that it was laid out on blocks for supplying others. He may be reminded that Wallich met large demands from the Medical Storekeeper for making syrups, lotions, etc., and he may be reminded also that Wallich was in charge of little patches of trees up and down Bengal. There appeared now a demand enormously exceeding anything the Medical Storekeeper might make, a demand in comparison with which Wallich's scattered acres or half acres were insignificant; and moreover to meet which a mountain site was needed. I stress this for it forcefully pulled forward the horticultural nursery and therefore the botanic garden backward.

Anderson took over charge, pulled the Garden's horticultural staff together, making the reluctant Robert Scott to return from his holidaying in Burma—it had lasted a whole year and Anderson said it had been to the damage of the Garden—and then went to Darjeeling to look into his prospects.

The Government's control of the Darjeeling hills had commenced out of the desirability of keeping the Lepchas from subjugation by Nepal. In 1840 a local quarrel caused the Government to send into the hills as arbiter **James William Grant**, then of Malda. He was the Grant to whom Griffith dedicated his genus *Grantia*, and he was once for a short time in charge of the Calcutta Garden. Grant, when he returned from arbitrating, suggested that the establishment of a sanatorium in the hills might repay the cost of establishing it. With this in their mind the Government sent to Darjeeling **Archibald Campbell** who was then their Residency Surgeon at Kathmandu,

choosing him for his two qualifications—a knowledge of what a sanatorium could be and a knowledge of at least some of the hill folk.

Campbell's bridle-paths had by 1861 made the interior accessible enough for tea planters to seek land, and then came Anderson looking for land for Cinchona. He was clearly at a disadvantage; he could not yet know exactly where to find a situation for his purpose where considerable expansion would remain possible if the crop became a success. The tea planters had obtained some of the most accessible positions. Anderson it seems was able to put Cinchona plants out experimentally at various elevations and aspects; then he returned to Calcutta and sailed for Java because an exchange of planting material had been arranged with the Dutch, and he had to give and get what was promised on either side. It was on this trip to Java that he collected in Singapore. He returned via Madras, leaving some of the Cinchona plants that he had got with **McIvor** at Ootacamund and taking thence other plants with which he went back to Darjeeling, the horticulturist **Andrew T. Jaffray** accompanying him. It is not surprising that the difficult first start involved seeking a new place. The use of abandoned army huts at the greatest convenient elevation was a makeshift, and the foggy rim where the clouds bank up an unsuitable position. Anderson would seem to have broken his health in the toil of going down hill by day and up hill in the evening. The Government was sympathetic and recognized that they asked much of him.

As a first contribution towards his success, they engaged in Britain a most excellent horticulturist, **John Scott** (? 1838-1880). He had been trained in Edinburgh and also employed by the Duke of Devonshire in his orchid houses at Chatsworth. John Scott's name is met with in Darwin's account of *Various contrivances by which Orchids are fertilised by insects* (1862) as making observations at Chatsworth.

A second horticulturist followed John Scott; this was **James Alexander Gammie**. The change of position of the plantation came just before the latter's arrival.

Anderson had had the use of abandoned buildings at the forefront of the mountains, constructed as part of the unsuccessful military sanatorium, not accepted by him for his use as suitable, but because they had to be put to use. The position of the new plantation was down hill.

James Alexander Gammie arrived in 1866, at which time Robert

Scott had just resigned his post in Calcutta. Gammie became Manager of the Mungpu plantations and John Scott was given the post of Curator of the Calcutta Garden in the place of Robert Scott.

The reader needs here to be told that the 'Robert Anderson', to whom is credited a CATALOGUE OF CALCUTTA PLANTS, did not exist. While Robert Scott was still in Calcutta, Thomas Anderson had prepared a catalogue of the Garden's plants and it would seem that the name Robert Anderson was due to confusion between Robert Scott and Thomas Anderson. John Scott served in Calcutta until 1880.

Anderson's administrative ability is seen in his seed lists for exchange and his several catalogues. When he returned from Java with the Dutch collections he reported to the Government on that Herbarium, which would have been Thomas Thomson's joy but was Anderson's burden. He explained that he was the only officer at the Garden competent to work it up and that he could not do it for want of time. He went on to tell the Government that he had found two botanists willing to accept the post of Curator of the Herbarium at quite a small salary provided quarters could be given them. One in fact was already working without pay in the Herbarium. This was **Jean-Baptiste Louis Pierre** (1835-1905), of French origin, a native of the island of Réunion and an *émigré* thence because a tornado had destroyed his coffee plantation. The other was **Wilhelm Sulpiz Kurz** (1833-1878), a German, who had been a pupil of the eminent botanist von Martius. He had found it advisable to flee from his native land and enlist under an assumed name in Java. His ability discovered, he was made useful to Teijsmann, who held the post of Hortulanus at the Buitenzorg Garden. Anderson, having gone thither to get his Cinchona plants, heard of Kurz who, like Pierre, was in trouble and that is why they were prepared to take service in India. The Government sanctioned the employment of both; but Pierre almost immediately had an invitation to Pondicherry; and then another to Saigon where he was to build up a Botanic Garden and where he did most excellent work on the forest trees of Indo-China. Kurz became the Curator of the Herbarium in the Calcutta Garden where, be it noted, his appointment created a staff of two botanists, himself and Anderson, which was the first botanical reorganization of the Crown when the Company was displaced.

Kurz had commenced to publish on the Malaysian flora before he left the Dutch service; then after taking service in Calcutta he began to publish through the Asiatic Society on Indian plants, chiefly

on those of Bengal. He wished to publish a Flora of Bengal and some pages were actually in print when his attention was redirected.

The shadow of Sir Dietrich Brandis falls across the page in this. Brandis was in Simla as Inspector-General of Forests; and he influenced the Government of India not unreasonably to send Kurz about Forest business. Kurz received instructions early in 1866 to proceed to the Andaman Islands to study the timber trees, to determine them, to get seedlings and seeds to grow in the Calcutta Garden, and to report. Accordingly he went to Port Blair in April and was away until July. The first part of his stay was disappointing as nothing was in flower, and there was almost a disaster when the Burmese convicts told off to serve him set on him and left him bound in the forest. Kurz returned to Calcutta in the early part of the rains and got together as much information regarding the Andaman flora as the Calcutta Garden had. Various officers had been there, **Kyd** was one; two surgeons, named **Liebig** and **Playfair**, had collected; and there were others. Kurz visited Arakan in the next year. Surely then it was to help the Forest Service for Schlich was there. He was in the Andaman Islands again when he emended his first report, and for the whole of the rest of his service he worked entirely on trees of the Burmese flora, travelling considerably. The culmination was his FOREST FLORA OF BRITISH BURMA, 1877, in two volumes. When, shortly, I come to the work of Sir Dietrich Brandis, the cause of the switch-over from Bengal to Burma will be more evident. Kurz, his BURMA FLORA written, took leave and would have visited his earliest collecting grounds in the Dutch Indies, but he died in Penang (1878) on his way there.

While the stay of Robert Scott in Burma in 1860-1861 was to Brandis's advantage, it is not certain that it was at his suggestion. But a remark made by Thomas Anderson in a letter suggests that the Calcutta Superintendent was not certain that he would be allowed to keep John Scott now on his way to India.

When Anderson had had but three years at the Calcutta Garden, a tremendous disaster fell—waves estimated as 16½ feet above normal for a high spring tide broke into the Garden. It could not have been foreseen. The saline water did great damage. And three years later, after heavy rains had softened the soil, a tornado toppled the trees over like ninepins. This is the record that was made: 'almost the only trees dating from before 1800 that were spared were the Great Banyan tree and a second and smaller tree of the same sort, some Pipals (*Ficus religiosa*), country almonds (*Terminalia catappa*),

about 20 Mahoganies, and some palms'. Someone, seeing that timber specimens would be acceptable in the Bengal Economic Museum, made hand-samples that a little might come from the calamity. Perhaps a few of them still exist in the Industrial Section of the Indian Museum. Anderson's health broke down, and he could not repair the damage and the distress of it must have fallen severely on John Scott. Therein was virtually the end of the second Calcutta Garden.

In some other ways Anderson's years had been years of great achievement, an aftermath of the considerable unification of India.

The head of the Bay of Bengal has a record of destructive but, fortunately, spaced tornados travelling into it: In 1842 the Garden suffered damage by one; in 1897 another hit Chittagong and destroyed 600 acres of planted teak.

The hollow land, that was taken in 1787 for the Botanic Garden, may well have owed freedom from trees to earlier cyclones with flooding from the river.

Reference has been made to the way in which Lord Bentinck's Retrenchment Committee cut Wallich's funds for the Botanic Garden; it was after this that 2½ acres of the Garden were put at the service of Carey's Agri-Horticultural Society. The area was raised later to 25. After the flooding the Society could no longer use it as it was saline.

Chronology of the introduction of Cinchona into India

I propose to give the history of the bringing of Cinchona into India in a series of statements:

(i) The Physicians had decided after an abundance of experience that sulphate of quinine was their sovereign remedy against malaria; but the supply of the bark, whence it was prepared, was subject to manipulation for the sake of financial profit in the Andean states where the wild supplies grew.

(ii) The supplies of bark reaching the ports of shipment showed that the species drawn on were several, and not of equal value. The question of exact specific origin therefore came up.

(iii) The British, chiefly for the benefit of India, and the Dutch, for the benefit of their eastern islands, decided to possess themselves of the desirable species. This required expeditions in search of them; and the probability that the quest would meet with opposition had to be faced.

(iv) Before the agents of either country started, the French explorer, **Hugh Algernon Weddell**, had returned to Europe from the Andes with a little seed from which a small number of seedlings were raised, some in France and some in Edinburgh. The French gave a seedling to the Dutch who sent it out to Java; and one successful cutting was taken from it before it died. It died at Bogor (Buitenzorg); the cutting survived by transfer to the hill garden of Tjibodas. The seedlings raised in Edinburgh were sent to India, conveyed to Sikkim, and there all died. Thus Weddell's exploration left a single plant in Java for a commencement of the work.

(v) The Dutch chose for their mission to the Andes, **Justus Karl Hasskarl**, a former employee in Java whom they recalled from retirement, and sent to Bolivia where, overcoming considerable difficulties, he collected a quantity of seeds and seedlings and they were got down to the coast and conveyed to Java (1854).

(vi) In Britain **Clements Robert Markham** (1830-1916, knighted in 1896), already knowing the parts of the Andes which had to be visited and able to converse in at least two of the languages that were talked, was given authority to organize a more extensive search. He planned a 3-pronged attack, taking for himself the most equatorial latitude for penetration, engaging for penetration a little further north **Q. T. Pritchett** and engaging also the well-known traveller **Richard Spruce** to penetrate further south over the lower slopes of Chimborazo; but Spruce fell ill, whereafter **Robert Mackenzie Cross** took up Spruce's work. Between the three lines of attack very nearly the whole was covered of the latitudes at which the best kinds were expected to occur. A little latitude was added in the north when the German botanist and explorer, **George Hermann Karsten**, fell in with valuable seed a little further north than Pritchett's line. Instructions had been given to Markham that he should send his spoil to Britain; some have said unwisely, as the risks in transport were increased; there was shipment up the South American coast and shipment from the Isthmus of Panama to Britain before the risk of transmitting via Suez to India. The Dutch had avoided such increases in the sea risk. Markham had considerable losses, cancelled out by the largeness of the collecting. Considerable use of Kew was made as a half-way depot.

(vii) An unexpected windfall fell when a merchant, **Charles Ledger**, offered a packet of seed for sale which had reached him as a gift, the excellence of which he did not know.

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(viii) The Government of India had been very well advised,

largely by Markham, on the conditions required for plantations; and preparation had been made both in Ceylon and southern India, chiefly at Ootacamund in the Nilgiri Hills where the horticulturist **W. C. McIvor** was now in charge of an experimental garden. **Cleghorn** had been associated in the choice of land in the Nilgiris. In Ceylon **Thwaites** laid out a high level plantation at Hakgala to receive the plants and raise the seedlings: it was under his horticulturist **William McNicholl**, who however did not remain long; then it passed into the horticultural charge of **William Nock** who added attractive planting.

(ix) The climate of Hakgala proved to suit some of the Cinchonas so perfectly that they grew as weeds; and some showed ready vigour at Ootacamund, so that there was little risk after the journey to India was over. Markham visited the East and approved of what he saw.

(x) The acclimatisation had thoroughly started as the reader sees, in the most equatorial part of Asia where the rainfall is spread fairly well and there is an evenness in the day lengths. Is not this of interest because the genus *Cinchona* is in the Andes at its best equatorially? Furthermore the equatorial preference draws attention to the existence of a latitudinal geography in southern India.

(xi) When an exchange of plants had been arranged between India and Java, as recorded on p. 347, Anderson went to get what the Dutch had to give and took to Darjeeling his material for experiment there, almost assuredly quite ignorant of possible effects of a two-season climate high in rain and day-lengths. The sequel was observation that what suited the south did not do so well in the north. We find Anderson at first with the assistance of the horticulturist **Jaffray**, then with **John Scott**, and then with **James Gammie**.

(xii) Free growth could not be assumed to produce the best bark in the market; chemists were required and the Government engaged **John Broughton** in London to proceed to India. A laboratory was built for him at Ootacamund where he did the essential analyses.

(xiii) At the same time he sought to cheapen the costs of extracting the alkaloid; but he had no success.

(xiv) This did not prevent the planters of Ceylon from adopting Cinchona as a crop selling the bark on the market. The quantity offered depressed market prices and so discouraged them. Most of the tea planters in Darjeeling toyed with little experiments but did not accept Cinchona as a crop. The Ceylon planters who had accepted Cinchona soon abandoned it for Tea. Two Nilgiri Hills

estates were offered for sale, but the Government could not get their price, though these estates were stocked with *Cinchona calisaya* which had been shown in India, as elsewhere, to yield the most sulphate of quinine. The work done had demonstrated an ability to increase the supplies of sulphate of quinine but not an ability to cheapen it. And as there had been a most generous distribution of seeds to many parts of the world, the condition was evidently world-wide.

(xv) The work done in India had now made it obvious that two species, *Cinchona calisaya* and *Cinchona succirubra*, promised better returns than others in this way—the first gave the most sulphate of quinine, the second the more total alkaloids; the first grew more freely in the south, the second in the north.

(xvi) McIvor experimented with increasing the thickness of the bark by injury, but, though he believed in his method, there seems to have been nothing of advantage in it.

(xvii) The Government's promoting of Cinchona was an entirely different adventure from that in Tea. In the case of Tea the Company did the work of proving that the tea plant was present and its cultivation possible. Then the industry took the natural trading profit. But in the case of Cinchona the philanthropic intentions of building a barrier against malaria knocked the natural profit out; for any in sight needed to be sunk in the price.

(xviii) The physicians' opinion that sulphate of quinine was the substance to use kept *Cinchona calisaya* as the more desired therapeutic, and therefore the southern source of supply seemed that to be in particular exploited. After Anderson's departure from India (1868) **C. B. Clarke**, given the acting post, went to the Nilgiri plantation on inspection and Sir **George King**, later in Anderson's post, did the same. *Cinchona calisaya* var. *ledgeriana* had meanwhile won the first place.

(xix) To **C. D. Wood**, a chemist in the service of the Government, employed in Calcutta, was given the work of trying to cheapen the cost of extracting the alkaloids from the bark, but he failed as Broughton had failed. The Government of India then threw the responsibility for this on the Superintendent of the Calcutta Garden, i.e. on King as their Quinologist; and King happened, though not immediately, to learn when visiting the Netherlands a fact which he took to Wood, now retired from India and in business in London. Wood elaborated it of his own free will. King took Wood's process to the Sikkim Plantation where Gammie directed it into commercial lines.

(xx) There was one thing yet for King to do. At the Sikkim Plantations he could have the total alkaloids extracted at an advantageous cost from *Cinchona succirubra*; he had yet to get the surgeons in India to accept it. Several tried it and reported well.

(xxi) The business passed, next, to a group of able administrators who set to work to canalize the course of the febrifuge between factory and the malaria-stricken in the villages in need of it, defeating at the same time speculation by traders who tried to cut in.

The above is the epic of Cinchona establishment. Anderson during its enactment had died from the consequences of malaria, which was almost certainly contracted during his search for land in the Sikkim Himalaya for the raising of the remedy.

The alkaloids, like tannin and some other substances which Man extracts from plants, are seasonally increased. This Broughton learned. No doubt there was little call at 1868 for further enquiry into this physiological matter.

On the Botanical side of Pharmacology

Two appointments were made for the control of the Cinchona work in southern India, respectively in 1882 and 1884. The first was the appointment of **Malmaduke Alexander Lawson** (1840-1896) as Director of a Botanical Department covering the Cinchona undertaking, with headquarters at Ootacamund; the other was the appointment of Dr. **David Hooper** as Chemist under Lawson. Lawson's transfer to India from Oxford, where he was holding the combined Sherardian and Sibthorpian professorships, was not what would have been expected, but I believe it was at his own suggestion. He had been teaching Botany in Oxford for 14 years and had had a part in the great advances in teaching methods instituted by Huxley, but administratively he had not pushed his department forward; nor did he get far in India; he had no personal acquaintance with the flora before he went to India except that he had elaborated three small families for Hooker's FLORA OF BRITISH INDIA. One may say that he was still getting to know the Indian flora when in 1896 he died. Dried plants that he collected in the course of his learning went into the Calcutta Herbarium. Hooper had a long and useful service in India, though more away from Madras than in the Presidency.

David Hooper (1858-1947) studied Pharmacy in the Pharmaceutical Society's London school and then in various manufacturing laboratories in London and in the Netherlands. In 1884 he accepted the

post of Government Chemist, Madras. When the chemical work in the Nilgiri plantations lessened, he was transferred to the Industrial Section of the Indian Museum in Calcutta with the title of Curator. A laboratory was his and a very wide range of material coming in on which he was able to work. The zoologists and the geologists of the Museum had their strong research side; Hooper's laboratory brought the economic annexe into line by providing the research for the annexe. Without it, there had been some want of matching.

Of Hooper at work a biographer has said he was meticulously accurate, careful, industrious in collecting facts, in arranging them, and in publishing them, and in the course of this became an authority on the drugs of Asia.

Much of Hooper's work got its first publicity through Dymock, Warden, & Hooper's PHARMACOGRAPHIA INDICA.

William Dymock (1832-1892) had entered the Indian Medical Service in 1857 and was posted to Bombay. Chance sent him out to sea on a mission westwards and in the ports then visited he seems to have obtained his first interest in the drugs of their markets. Gifted in languages he turned to what he could get out of Flukiger's PHARMACOGRAPHIA and began to make his own study on the material referred to in that book. His first book is based on it. He held the post of Professor of Materia Medica in the Grant Medical College (1874-1881) and was the Government's Medical Storekeeper. He could not have been better placed, for the doors of the trade of the Parsee community had been opened to him. His much larger work, PHARMACOGRAPHIA INDICA, came when he joined with Lieut.-Col. **C. H. J. Warden** and Dr. David Hooper; and the three volumes which make it up appeared in parts. Colonel Warden was Chemical Examiner, Bengal, and Professor of Chemistry in the Calcutta Medical College; and from 1899 to his death in 1900 the official Examiner of Medical Stores. The PHARMACOGRAPHIA deals with Indian drugs in turn, thoroughly and with authority.

The work of the Indigenous Drugs Committee must be passed by as it was without sufficiently deep roots.

John Shortt, who went to Madras in 1846 and was there until 1878, wrote much: some useful. **Edward John Waring's** BAZAAR MEDICINE of 1860 is a book not to overlook. **Henry John Carter**, who was in Bombay from 1842 to 1862, a man of many sides, studied the sources of frankincense. Professor **Kanoba Ranchhodas Kirtikar** (1850-1917) of the Grant Medical College made himself an authority

on poisonous plants and in his subject was followed by **Jean Ferdinand Caius.**

In Calcutta **Udoy Chand Dutt** wrote an informative MATERIA MEDICA OF THE HINDUS (1877) with a glossary by Sir George King.

C. A. BARBER (1861-1933)

When Lawson died, the post of Madras Botanist went to **Charles Alfred Barber**. Barber had been successively a demonstrator in the Botany School at Cambridge; the Superintendent of the Botanical and Agricultural Department, Leeward Islands, where he met with his first sugarcane cultivation; Professor of Botany at Cooper's Hill 1895-1898; then Government Botanist, Madras, and again in contact with sugarcane among a variety of other crops. The importance historically of Barber's transfer to India lies in the circumstance that he may be called a pioneer specialist in agricultural botany of a new school, and the work that he did in the great efforts commenced chiefly in the early years after 1900 to increase the return got from Indian crops. His work with sugarcane was of great excellence.

THE MUNGPU COMMUNITY

It is obvious that the congregation of trained horticulturists growing Cinchona at Mungpu would promote the study of the flora of the Sikkim Himalaya. They were considerably isolated and had to discover uses for their leisure. Exploration of the flora was an obvious outlet.

James Alexander Gammie (1839-1924) reached Mungpu in 1865. Before his arrival the land which Anderson had chosen at first had been abandoned as unsuitable and a new start had been made. He took over charge as 'Manager' with almost entirely new cultivation in hand. He found diversion for his own leisure in the animal life about him, saying that by so doing he sought the means of removing his thoughts as far as possible from the consideration of the problems which Cinchona produced. But King was very soon highly praising his handling of these problems. His interest in the animal kingdom was well spread. He collected information on birds, mammals, and reptiles, and then moved on to insects. But he admitted plants into the attentions of his leisure by making a pleasure garden and bringing into it local plants. The zoologists welcomed his animal records. Some of Gammie's subordinates deserve mention. **A.**

Biermann joined Gammie in 1867 and then was sent from Mungpu to try how the Cinchona would grow in the Khasia Hills whence, after securing information that it would grow, he was recalled to Mungpu, where the growth was such as to suggest that extension in the direction of the Khasia Hills would not be needed. Biermann later became Curator at the Calcutta Garden. A third recruit was **Robert Pantling** (1857-1910). He was not long in Mungpu in the first part of his service for, Biermann dying, he was required to take his place in Calcutta; but he returned to Mungpu in 1879 as Senior Assistant in the place of **J. L. Lister** who, after a short service in Mungpu, had resigned to become a tea planter. Pantling completed his service in Mungpu, succeeding James Gammie on the latter's retirement in 1897. Pantling devoted his leisure and opportunities in a way suggested by Gammie's gardening, and brought from the hill-sides all the orchids that he could get and, being a good draughtsman, he drew and supplied the plates for a volume, conjointly with Sir George King, of the ANNALS OF THE ROYAL BOTANIC GARDEN, CALCUTTA.

Joseph Parkes went to India a year after Pantling, and it fell to him to experiment with Cinchona at Kalimpong. The next assistant due here for naming was **Amos C. Hartless** whose first destination was Calcutta (1889). In 1900 or thereabouts he was transferred from the Calcutta Garden to Mungpu and while at Mungpu he wrote upon the Agriculture of the Darjeeling district. After that he was successively at Bombay, Poona, Mahableshwar, and finally Superintendent of the Saharanpur Garden. He obtained a wide knowledge of Indian horticulture from this extensive experience. He left India in 1923 and died in 1941.

Close on the turn of the century, other assistants arrived whose names a taxonomic student of the Indian flora will find on the labels of herbarium specimens. One who took a considerable part in advancing botanical exploration from Mungpu was **George H. Cave**. He reached India in 1897. **Oliver Teetgen Hemsley** followed in 1898.

Mungpu was naturally a centre which the Calcutta Garden could use as a base for native collectors. Sir George King so used it. Hooker's appreciation of the Lepchas' familiarity with the hill forests was echoed by King, who tried also to use Tibetan familiarity with the way to live in high valleys for getting what he could from the back of the mountains. One of King's men was the Tibetan **Dungboo**. We hear later of the Lepchas Ribu and Kari, making annual trips for seed, which passed into the exchanges with gardens

outside India, and for other material for the Calcutta Garden. Cave at one time directed this collecting of seed. Later, but after the period of this chapter, he made in the company of Sir **William Wright Smith** an arduous collecting trip in north-eastern Sikkim (1909).

O. T. Hemsley, son of W. B. Hemsley, was at Mungpu for 4 years on either side of the turn of the century.

The reader doubtless recognizes that, thanks to the attractiveness of the Sikkim hills, thanks to the succession of botanically-minded forest officers who have served in the Darjeeling District, and thanks also to the steady exploitation directed from Calcutta through Mungpu, our knowledge of the flora has grown a long way towards the possibility of a complete list. It has grown at the same time in a fair measure in regard to local dispersal and altitudinal extension—so much in regard to altitude that there seemed to be profit already in 1925 in putting on record altitudes for comparison with altitudes in the Abor Hills (*Rec. Bot. Survey Ind.* **10**); but there is need for a great deal of further collecting before a complete Flora (Flowering plants and Ferns only) can be produced. No other part of the Eastern Himalayas is known appreciably.

Further collections of the end of the Century

It is time now to mention **George Alexander Gammie** (1864-1935), son of James Gammie. I have separated him from the succession of Mungpu collectors, because most of his collecting was done elsewhere and his training was not that of Kew. But his name was on the service register of Mungpu in 1892 in which year he made a collecting tour in Sikkim. In 1894 he collected up the Brahmaputra Valley; and in Chamba and Kangra. He was in charge of the Saharanpur Garden and the Lloyd Botanic Garden in Darjeeling at different times and had acted as Curator of the Calcutta Garden, when he was transferred to Poona, first in a Botanic Survey, then with the title of Economic Botanist.

It is time also to introduce the names of various collectors of the north-western borderland, some of them collecting just because they desired to help forward the publication of Hooker's FLORA OF BRITISH INDIA. This is evident in the records of plants inwards to the Kew Herbarium. One collector, Colonel **Meade**, was particularly interested in the grasses of the dry north-west, and would seem to have been very thorough in his collecting (1872) for he sent no fewer than

140 in number. In the next year Colonel **Johnstone**, when on duty in Kandahar, made a collection; and these following officers collected during these years near India's frontiers: **J. S. Gibb**, **Sawkins**, **Spratt**, and **G. W. H. Talbert**. The well-known traveller and scientist, **Henry John Elwes**, made the first of his expeditions in Sikkim in 1877 and his collection reached Kew. Another collector of Sikkim was the chaplain **Mountford**. In 1877 Sind collections came from **W. S. C. Pinwill**, who from Sind went to the Malay Peninsula and then returned to create a beautiful garden in Cornwall. The ornithologist **Thomas Caverhill Jerdon** gave plants from peninsular India. A horticulturist trained at Kew who had become a tea planter, **Richard L. Keenan**, sent to Kew an extensive collection from Cachar.

This welcome assistance was to continue through the next decade and beyond. Another student of grasses, **Collins**, a veterinary officer sent grasses of the Punjab (1881).

Intense collecting in the Gilgit Valley, extending into Wakhan and other near parts of the hills, was carried out by Dr. (Surgeon-Major) **G. M. J. Giles** from which Kew greatly benefited.

Surgeon-Captain **Henry Alfred Cummins** collected in Sikkim and on the borders of Bhutan in 1888; Elwes again collected in Sikkim. The District Commissioner **Stephen Lushington Aplin** collected in the Shan Hills. **A. R. Nairne** author at a later date of THE FLOWERING PLANTS OF WESTERN INDIA (1894) was sending plants in 1888 from Bombay.

Sir William Wright Smith wrote in his account of his collecting trip in 1909 after referring to the work done in the Sikkim Himalaya by Sir George King, C. B. Clarke, Sir David Prain, Robert Pantling, George Gammie, and officers of the Forest Service: 'probably no corresponding area in India has been more fully ransacked for its flora and none so well as the Sikkim Himalaya'. His estimate may be approximately right; at any rate it is the opinion of one entitled to express an opinion.

The mountain of Tonglu, which Hooker visited from the eastern side in May 1848 in pouring rain, was made approachable from the south by a new bridle path and C. B. Clarke took an opportunity of visiting it in September 1875. The same rain! Many have used that path since. A number of the flowers along it have the interest of facing downwards so that their pollen is not damaged by the rain.

(To be continued)

Entomological Survey of Himalaya

Part XXVI. A Contribution to our Knowledge of the Geography of the High Altitude Insects of the Nival Zones from the North-West Himalaya

PART 4

BY

M. S. MANI, D.SC., F.L.S., AND SANTOKH SINGH, PH.D., F.R.E.S.

(*With eleven text-figures*)

[*Continued from Vol.* **59** (1): 99]

DIPTERA

In the present state of our knowledge, it is difficult to discuss the distribution of Diptera. As pointed out in an earlier paper (100), the bulk of the Diptera collected by the three Entomological Expeditions is still in the hands of specialists. Though the number of species so far identified amounts to hardly 2.0% of the total nival insect fauna, there is reason to believe that no less than 300 nival species exist at present in the NW. Himalaya. Many of them are found at elevations of almost 6000 m. above m.s.l. above the permanent snow line. Diptera would surpass Coleoptera and would almost represent half the nival insect fauna of the region.

The unidentified Diptera belong to the following families:

NEMATOCERA

1. Tipulidae
2. Mycetophilidae
3. Sciariidae
4. Diadocidiidae
5. Scatopsidae
6. Bibionidae
7. Itonididae
8. Deuterophlebiidae
9. Blepharoceratidae
10. Simuliidae
11. Chironomidae
12. Ceratopogonidae
13. Psychodidae
14. Culicidae

BRACHYCERA

15. Stratiomyiidae
16. Tabanidae
17. Rhagionidae
18. Empididae
19. Asilidae
20. Dolichopodidae

CYCLORRHAPHA—ASCHIZA

21. Phoridae
22. Lonchopteridae
23. Syrphidae

CYCLORRHAPHA—SCHIZOPHORA—CALYPTRATAE

24. Calliphoridae
25. Sarcophagidae
26. Tachinidae
27. Anthomyiidae
28. Muscidae

ZOOLOGICAL GARDEN CALCUTTA

CYCLORRHAPHA—SCHIZOPHORA—ACALYPTRATAE

29. Ochthiphilidae
30. Ulidiidae
31. Piophilidae
32. Helomyzidae
33. Ephydridae

Among the species so far identified, the distribution of Deuterophlebiidae is extremely interesting (Fig. 31). In addition to *Deuterophlebia mirabilis* Edw., we have collected large numbers of the larvae of an unnamed species at an elevation of 3500 m. in the Chenab-Beas drainage area. The family is known from the mountains of central Asia, Korea, Japan (Honshu and Kyushu Islands), Canada, N. Colorado, Wyoming, Oregon, and California in N. America. The distribution of the family is discussed by Pennak (116).

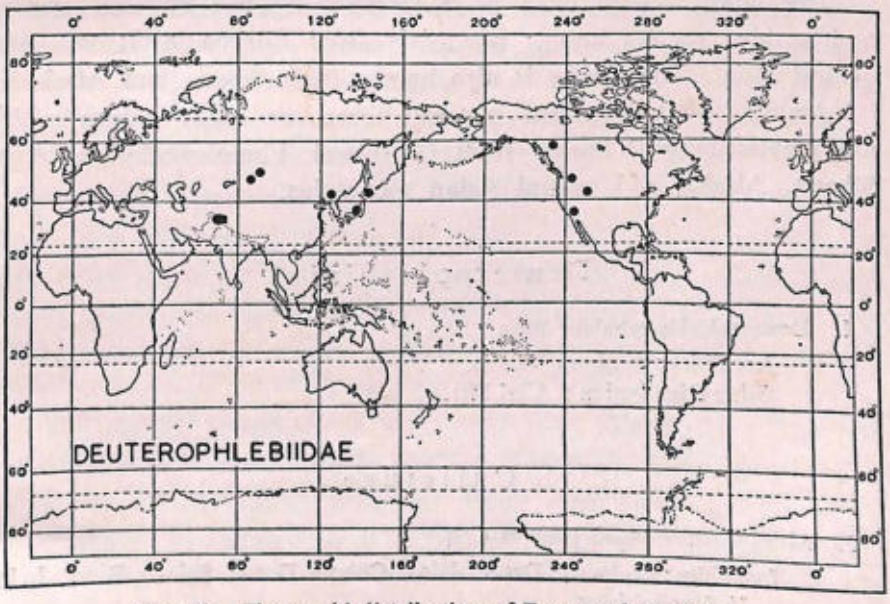


Fig. 31. The world distribution of Deuterophlebiidae

The Culicid *Aëdes* (*Ochlerotatus*) *pullatus* Coq. is also of particular interest. It is widely distributed in the NW. Himalaya

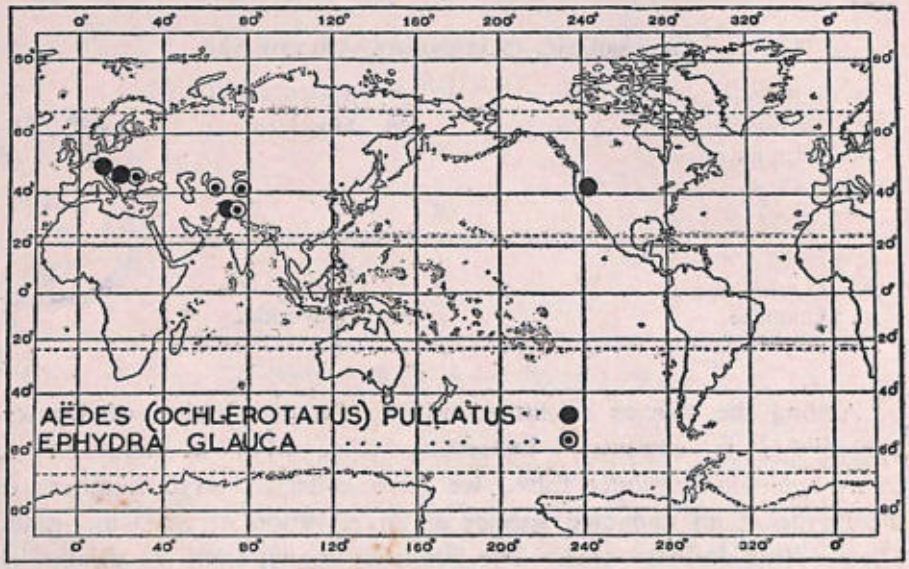


Fig. 32. The world distribution of the two non-endemic nival Diptera from the NW. Himalaya.

and is also known from S. Europe and western North America (Fig. 32).

The family Ephydriidae is represented by two endemic species and a third species known previously from Europe, S. Russia, and central Asia. The family is also known from Siberia and Alaska.

Among the unidentified material there are many genera which are previously well known from Greenland, Finnoscandinavia, Alps, Siberia, Alaska, and central Asian mountains.

Deuterophlebiidae

1. **Deuterophlebia mirabilis** Edw.
   Localities : Kashmir 3050 m.
   Other Distribution : Altai Mts.

Culicidae

2. **Aëdes (Ochlerotatus) pullatus** Coq.
   Localities : Gulmarg, Deosi plains, Chhota Deosi, Shingo River, Indus Valley, Baltistan.
   Other Distribution : Central and south Europe, Western North America.

3. **Theobaldia niveitaeniata** (Theob.)
   Localities : Western Himalaya, about 3000 m., Murree.
   Other Distribution : Kasauli, Theog, Hindustan-Tibet Road, Nainital, Muktesar, Dehra Dun, E. Himalaya north of Yutang, Tibet near Sikkim border 3657 m.

Syrphidae

4. **Criorrhina imitator** Brunetti
   Localities : Kashmir, 3050 m.
   Other Distribution : Onari, Andarban, Garhwal Himalaya 3352 m.

Ephydridae

5. **Ephydra glauca** Meigen.
   Localities : Tso-Kar 4554 m.
   Other Distribution : Europe, Rumania, central Asia, South Russia.

*6. **Ephydra tibetensis** Cresson
   Localities : Kyam hot spring 4750 m., Phuga hot spring 4420 m.

*7. **Halmopota hutchinsoni** Cresson
   Localities : Tso-Kar 4535 m.

THYSANURA

The order is represented only by *Machilanus hutchinsoni* Silv., and two unidentified species of *Ctenolepisma*. The order constitutes roughly 0.76% of the total nival insect fauna of the region (Table I, Fig. 3). All the three species are, as far as is known at present, localized in the Indus drainage area.

COLLEMBOLA

The Collembola constitute the most widely distributed order of insects in the nival fauna from the NW. Himalaya. They surpass all orders in the abundance of their individuals. They have been found inhabiting elevations slightly above 6000 m. above m.s.l. in different parts of the NW. Himalaya.

The species endemism is at present 60% (Table X). The only Indo-Malayan species, which is often found up to an elevation of 4572 m., is *Tomocerus ocreatus* Denis and this species is also localized in the Chenab-Beas drainage area. A widespread species *Sminthurides aquaticus* (Bourlet), known from Europe, Algeria, and Australia, occurs at an elevation of 4763 m. in the Indus drainage

area. Of the endemites known at present, 4 species are localized in the Indus drainage area. Among the non-endemic species, two are known from the mountains of Afghanistan border and one from the other parts of the Himalaya (E. of R. Sutlej) and from the Nilgiri Hills in S. India. Most of the genera found in the nival zones of the NW. Himalaya are also known to inhabit Greenland, Siberia, Alaska, Alps, Caucasus, and central Asian mountains.

In addition to the 15 species listed below, Mr. H. N. Baijal, who was a member of the second and third Entomological Expeditions and who has made a specialized study of the Collembola, has been able to recognize 14 new species in the material collected by the three Entomological Expeditions. Since the descriptions of these new species have not yet been published, we have not included them in our analysis. They belong to the following genera:

Hypogastrura, one species from the Seri Ice Fall, Sonapani Glacier, Great Himalaya (Lahual), 4400 m.

Womersleya, one species from Marhi (Pir Panjal Range), 4000 m.

Bagnallela, one species, slope of Pir Panjal opposite Kulti Nal (Lahaul), 4000 m.

Folsomia, one species from Purana Koksar Nal, Great Himalaya (Lahaul), Seri Ice Fall, Sonapani Glacier area, 3650 m.

Salmonia, one species from Gramphu, N. slope of Pir Panjal (Lahaul), 4000 m.

Proisotoma, one species from Seri Ice Fall, Sonapani Glacier, Purana Koksar Nal, Great Himalaya (Lahaul), 3650 m.

Isotoma, one species from Seri Ice Fall, Sonapani Glacier, Great Himalaya (Lahaul), 4300 m.

Papillomurus, one species from Gramphu on N. slope of Pir Panjal (Lahaul), opposite Kulti Nal, 3500 m.

Entomobrya, 4 species from various localities including Marhi, Gramphu, Kulti Nal, Rohtang Pass, Seri Ice Fall, etc., in the Chenab-Beas drainage area. Altitudes ranging from 3540 to 4500 m.

Sminthurides, one species from Hamta Jot, 5180 m.

Mr. Baijal has also found in the same material the interesting *Isotoma palustris* Müller from various localities like Marhi, Gramphu, Kulti Nal, etc., at elevations of about 3620-4000 m. This species is already known from Siberia, Spitzbergen, Bear Islands, and Canada. The identification reached us too late to be included in our general faunal analysis of the Collembola.

Hypogastruridae

***1. Friesea excelsa Denis**

Localities : Ororotse La 5500 m.

***2. Friesea maxima Baijal**

Localities : Gramphu (Chandar Valley) 3657 m.

*3. **Onychiurus kultia** Baijal

Localities : Gramphu (Chandra Valley) 3657 m.

Isotomidae

*4. **Isotoma spinicauda** Bonet

Localities : Nyangtsu, Ladakh, Ororotse La south side 5300 m.
Other Distribution : Wazirastan near Afghanistan border.

*5. **Proisotoma ladaki** Denis

Localities : Mitpal Tso north edge 5180 m., Togarma Tso.

Mydoniidae

*6. **Drepanosira subornata** (Denis)

Localities : Damb-Guru 4603 m., Takht-i-Sulaiman, Srinagar 1585 m.

*7. **Entomobrya (=Mydonius) himalayensis** (Baijal)

Localities : Glaciers and streams near Thirot 3000-3350 m., Upper Chenab Valley.

*8. **Mydonius hutchinsoni** (Denis)

Localities : Shakya La east side 5440 m.

*9. **Orchesellides boraoi** Bonet

Localities : East of Shakya La 5200 m., Ororotse La south side 5300 m., Marsimik La 5600 m., Ororotse Tso 5513 m.
Other Distribution : Wazirastan.

*10. **Seira brahamides** (Denis)

Localities : Karpet south shore of Pangong Tso 4250 m., Tangyar 4400 m.

11. **Sinella montana** Imms

Localities : Gramphu, Kulti Nal, Chhatru 3657 m., Marhi 3657 m., Hamta Gorge 4267 m., Rahla 2743 m.
Other Distribution : Badrinath, Garhwal, Nilgiris.

*12. **Podura himalayana** Baijal

Localities : From glaciers, Upper Chenab Valley 4267 m.

Sminthuridae

13. **Sminthurides aquaticus** (Bourlet)

Localities : Kyam, spring surface 4763 m.
Other Distribution : Eastern Europe, possibly America, Algeria and Australia.

14. **Sminthurides (Stenacidia) violaceus** (Reuter)

Localities : Bao east of Shakya La, surface of pool 4661 m.
Other Distribution : Tibet, Europe (rare).

Tomoceridae

15. **Tomocerus ocreatus** Denis

Localities : Rahla 3050 m., Marhi 3657 m., Manali-Rahla Road, Rohtang Pass 4110 m., Gramphu 3657 m., Chhatru 3405 m., peak to the west of Rohtang Pass 4572 m., Purana Khoksar Nal 3820 m.
Other Distribution : Indo-China.

III. The Component Elements of the Nival Insect Fauna

The geographic location and the high altitudes of the NW. Himalaya are associated with a number of interesting peculiarities in the composition of the nival insect fauna. Analysis of the material presented in the foregoing section would show that the fauna of the region is heterogenous. There is a complex intermingling of endemites, Tertiary and Pleistocene relicts, Interglacial penetrants, Post-Glacial arrivals, cold-adapted mountain forms, boreal elements, north and central Asiatic Palaearctic elements, Mediterranean forms, Tibetan forms, east Asiatic south Palaearctic (Manchurian) elements, and Indo-Malayan derivatives. The results of the evaluation of some of the major component elements are summarized in Table X and graphically shown in Fig. 33 and 34.

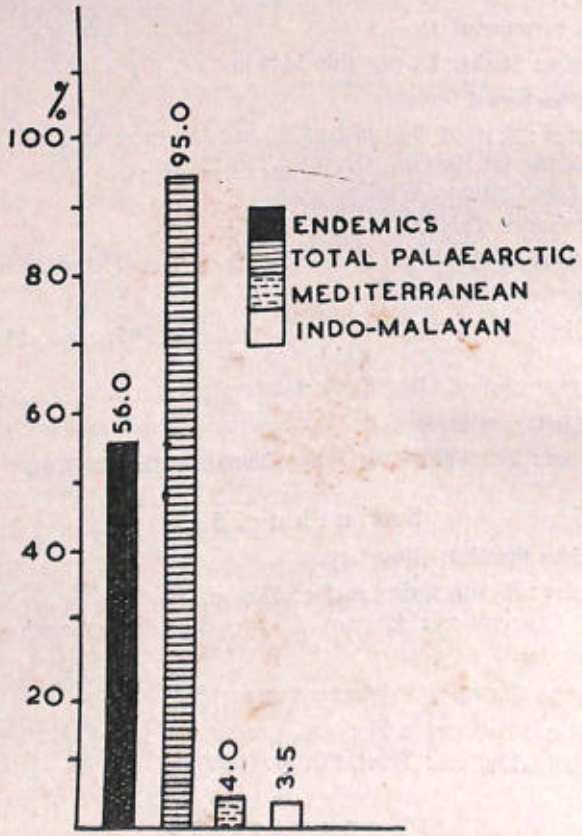


Fig. 33. Faunal elements of total nival insects from NW. Himalaya

Mountain Elements. The greatest bulk of the known species, estimated at about 97.0% of the total nival insects from the region, are typical cold-adapted, mountain-autochthone forms. It is also

extremely interesting to observe that more than two-thirds of mountain-autochthone species are inhabitants of Tertiary mountain systems of comparatively recent uplift. The remaining one-third represents elements derived from the relatively older central Asiatic mountains of the Angaran land mass. As indicated by us in an earlier paper (100), the eurytherm lowland species constitute an extremely

TABLE X

Major Component Elements of the Nival Insect Fauna

No.	Orders	No. of species	Endemism %	Palaearctic %				Indo-Malayan	Remarks
				Total	Central Asian	Tibetan-Himalayan	Mediterranean		
1.	Plecoptera	5	80.0	100.0	—	20.0	—	—	
2.	Odonata	4	25.0	100.0	—	25.0	—	—	2 spp. wide-spread in Holarctic
3.	Orthoptera	14	71.4	85.5	50.0	—	33.3	14.3	
4.	Dermaptera	3	100.0	100.0	—	—	—	—	
5.	Heteroptera	17	64.7	94.0	18.7	—	—	6.2	
6.	Homoptera	1	0.0	—	—	—	—	—	Widespread
7.	Coleoptera	186	59.0	96.0	8.0	14.0	3.0	4.1	1 sp. wide-spread
8.	Hymenoptera	36	47.0	90.0	31.0	10.3	3.0	9.3	
9.	Neuroptera	1	0.0	100.0	—	—	—	—	
10.	Trichoptera	11	100.0	100.0	—	—	—	—	
11.	Lepidoptera	91	44.3	100.0	18.1	8.0	4.5	—	
12.	Diptera	7	—	—	—	—	—	—	
13.	Thysanura	3	100.0	100.0	—	—	—	—	
14.	Collembola	15	60.0	86.6	—	—	—	7.1	1 sp. wide-spread
	Total	394	56.0	95.0	15.0	10.0	4.0	3.5	0.7

Note: Diptera not included

insignificant proportion of the nival insect fauna, confined mostly to the southern slopes of the outer ranges and should in all probability

be considered as comparatively recent arrivals. This pronounced mountainity, evident in nearly every order and family, is associated with a great many of the peculiarities in the ecologic characters of the nival insects and their geographical distribution. There is also a considerable number of mountain autochthone genera, as for example *Gomphomastax*, *Metrioptera*, and *Conophyma*, even in a typically tropical and lowland group of insects like Orthoptera. Anechurinae (Dermaptera) are, as is well known, wholly mountain inhabitants. In Coleoptera, genera like *Amara*, *Bembidion*, *Cymindis*, *Trechus*, and *Atheta* are predominantly mountain forms, or the species occur in the high north and are also circumpolar. The Lepidoptera *Colias*, *Erebia*, and *Parnassius* should also be considered as largely mountain types.

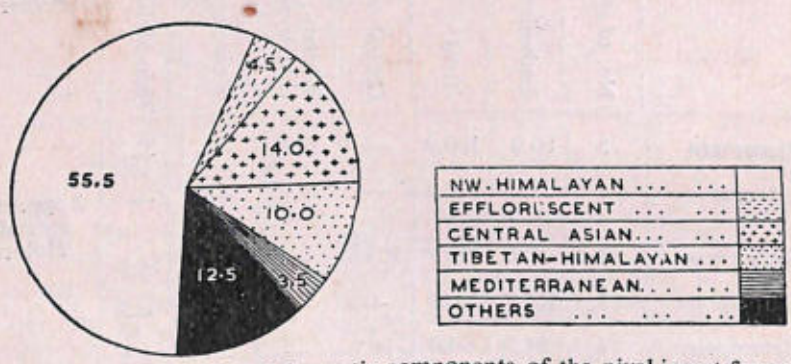


Fig. 34. Analysis of the Palaearctic components of the nival insect fauna from the NW. Himalaya

The older central Asiatic mountain element is typified by the distribution of the interesting mountain midges of the family Deuterophlebiidae (Fig. 31), which has spread NE. to the Nearctic Realm and S. and SE. to the NW. Himalaya, but like nearly every other central Asiatic mountain derivative, has not extended to Europe on the chain of Tertiary mountains, which are not however sufficiently high between Europe and Himalaya.

There are also in addition to the strictly mountain elements, several mountain species of genera which are, properly speaking, not mountain genera. It may also be noted that in the majority of cases the strictly mountain autochthone genera and also genera which have mountain autochthone species belong to Tertiary forms, which had undoubtedly existed before the Pleistocene. The strictly mountain autochthone elements of the fauna of a large mountain range system are often likely to be intermingled with the lowland types from the surrounding area, depending upon the area immediately surrounding

the mountain range, the slope, and numerous other factors. The penetration of the lowland forms is relatively well pronounced on mountain ranges rising gently from the plains around, but in a relatively young, vast, and massive elevated region like the NW. Himalaya the intermingling may be considered as absent for all practical purposes, at least above the timber line.

A considerable proportion of boreal forms is also found. Many of these forms occur not only in Siberia and Finnoscandinavia, but further north in Greenland and arctic Alaska and are truly circumpolar in distribution. This is, for example, the case with *Nysius, Chlamydatus, Bembidion, Colias, Parnassius, Proisotoma,* etc. *Formica (Formica) gagates* Latr., *Formica (Formica) trunicola* Nyl., and *Myrmeca smythiesi* (of which the subspecies *cashmirensis* Forel occurs in the NW. Himalaya) are also typical boreal elements, some of which have spread even S. of the main crest line of the Great Himalaya (34).

ENDEMICS. A fact of considerable zoogeographical and evolutionary significance is the existence of large numbers of endemites, both genera and species, in almost all the orders (Table X, Fig. 33). Endemism of species is total in some groups like Dermaptera, Trichoptera, and Thysanura, and very high in others like Plecoptera, Orthoptera, Heteroptera, Coleoptera, and Collembola. There are several extremely interesting endemic genera like *Dicranophyma, Dolmacoris, Tibetocoris, Chaetobroscus, Ascelosodis, Bioramix, Chianallus,* and *Stenophylina.* The total number of strictly endemic species, which have had their origin and have their range at present restricted within the NW. Himalaya, is 217, representing almost 56% of the total nival insect fauna above the timber line (Table X). There are, in addition, the following 16 efflorescent elements, which also have had their origin within the NW. Himalaya, and have within comparatively recent times extended their range across the R. Sutlej to the rest of Himalaya, in some cases as far as W. Nepal (Fig. 34).

EFFLORESCENT ELEMENTS

Coleoptera

1. *Amara himalaica* Bates
2. *Bembidion gagates* Andrewes
3. *Bembidion hasurda* Andrewes
4. *Bembidion himalayanum* Andrewes
5. *Bembidion pluto* Andrewes
6. *Harpalus melaneus* Bates
7. *Harpalus quadricollis* (Redt.)
8. *Pristonychus kashmirensis* Bates
9. *Tachys octostriatus* Net.
10. *Trechus cameroni* Jeann.
11. *Atheta (Dimetrota) adjacens* Cam.
12. *Oxypoda (Podoxya) nigrita* Cam.
13. *Apatophysa kashmiriana* Cam.
14. *Clytus monticola* Gahan

Hymenoptera

15. *Bombus haemorrhoidalis* Smith

Lepidoptera

16. *Maniola pulchella pulchra* Feld.

The strictly endemite and the efflorescent elements amount to a total of 233 species of true endemites, representing nearly 60.0% of the nival insect fauna.

There are besides, a number of species which have risen unquestionably in the NW. Himalaya and have apparently spread

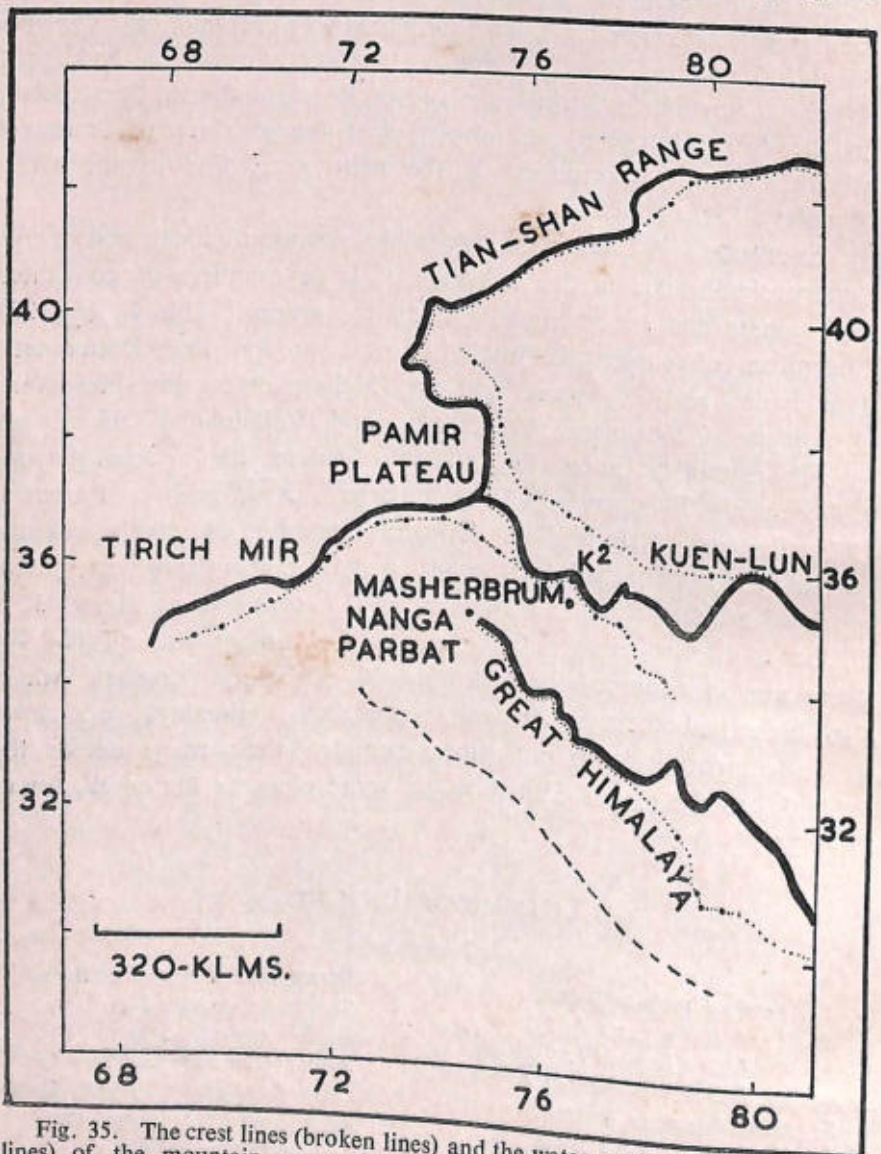


Fig. 35. The crest lines (broken lines) and the water partings (thick continuous lines) of the mountain ranges in the region of the NW. Himalaya together in the so-called Pamir Knot

westward to the high Tertiary mountain ranges of Hindukush, Iran, and Afghanistan. Recent geological evidence (81) seems to show that the Himalayan mountain system does not terminate at Indus, but continues beyond westward. We have some evidence of such faunal continuation also, especially in the case of mountain autochthone insects. We are, however, unable at present to accurately evaluate the extent of this distribution.

The Pamir-NW. Himalaya constitute a continuous geographic system (Fig. 35) and are faunistically closely related. There are about 25 species known in the NW. Himalaya, which are endemic to this system. The total number of species which thus appear to have become differentiated in the region cannot in any case be less than about 260. Almost 70.0% of the species occurring above the timber line would thus appear to have had their origin in the region. The endemites include numerous geographic and local subspecies. We know wellnigh 70 local subspecies in different orders, especially in Lepidoptera. A region like Pamir-NW. Himalaya, which is quite young geologically and has not yet ceased undergoing pronounced physiographical changes, with considerable possibilities for isolation on various high massifs, extremes of ecological conditions, and time for peopling areas, favours the formation of not only numerous local geographical subspecies but also species, subgenera, and genera. Skorikow (142) has recognized these facts in his zoogeographical discussions on *Bombus* from Pamir and found the endemism to be nearly 53.0% in the bumble bees from the NW. Himalaya. Eidmann (34) has also laid special emphasis on the origin of considerable numbers of species and subspecies of ants in the Nanga Parbat area of the NW. Himalaya.

Zoogeographical Elements. The NW. Himalaya lies within the latitudinal boundaries of the Oriental Realm, but its high altitude accounts for the remarkable southward extension (127) of the southern limits of the Palaearctic Realm (Fig. 36). The Mediterranean or the South Palaearctic of Europe attains also its maximum eastward extension in the NW. Himalaya. Here we have thus the meeting point of boreal, Palaearctic, and Indo-Malayan. As we ascend higher and higher on the NW. Himalaya, we may observe a succession of the Indo-Malayan, South Palaearctic, Mediterranean, or rarely also Manchurian, North Palaearctic, and boreal elements at successively higher elevations. This succession is precisely similar to what we see as we proceed N. from S. on lowland and is associated with iso-ecologic conditions at higher

latitudes. Ascent to higher elevations in the NW. Himalaya generally involves also reaching higher latitudes. Eidmann (34) considered an elevation of about 2000 m. above m.s.l. as the boundary altitude between the Indo-Malayan and the Palaearctic on Hsifan Ranges in W. China and somewhat lower in the Nanga Parbat area (situated at somewhat higher latitude) of the NW. Himalaya. The approximate boundary altitudes of the Indo-Malayan, Southern Palaearctic,

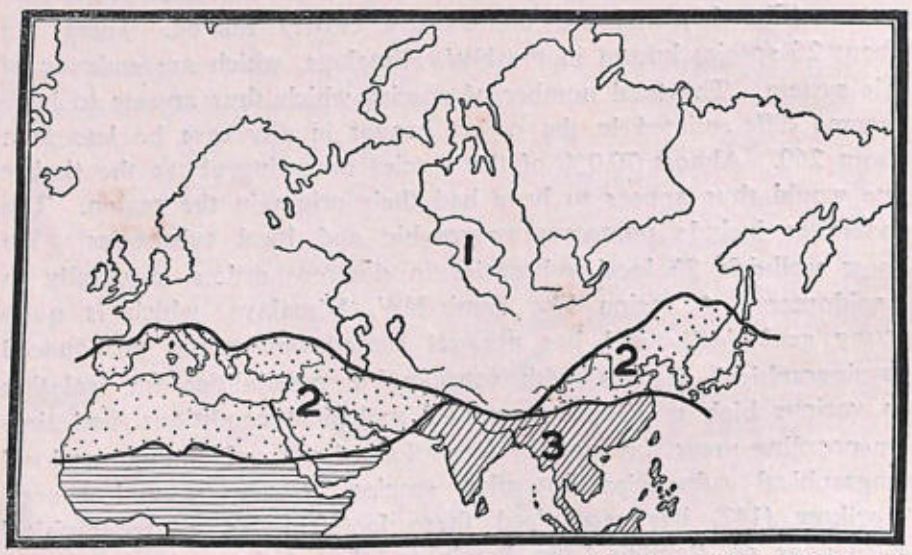


Fig. 36. The areas of the northern Palaearctic (1), the southern Palaearctic (2), and the Oriental Realms (3). Note the southward extension of the northern Palaearctic owing to the influence of the high altitudes in the region of the Himalaya. (*After Eidmann*, 34)

Northern Palaearctic, and the boreal faunal elements on the different ranges of the NW. Himalaya are shown in Fig. 37. It may be observed that, beyond the Pir Panjal Range, the general elevation of the ranges is higher than that of the boundary altitude of the Indo-Malayan, and similarly the boreal altitude boundary is higher than that of the Dhaula Dhar Range, on which the boreal elements are naturally absent. The boundary altitudes thus differ on the different ranges and are by no means rigid even on the same range, and vary within fairly wide limits, depending on the direction of the ranges, the slope, topographical peculiarities, and numerous other local conditions. The longitudinal high valleys of the major rivers like Indus, Chenab, etc. also introduce considerable differences, and frequently narrow inroads and even isolated pockets of one faunal component element occur in the heart of the area of another.

The Indo-Malayan elements, for example, extend on the south slope higher than on the north slope, and deeper north along the river

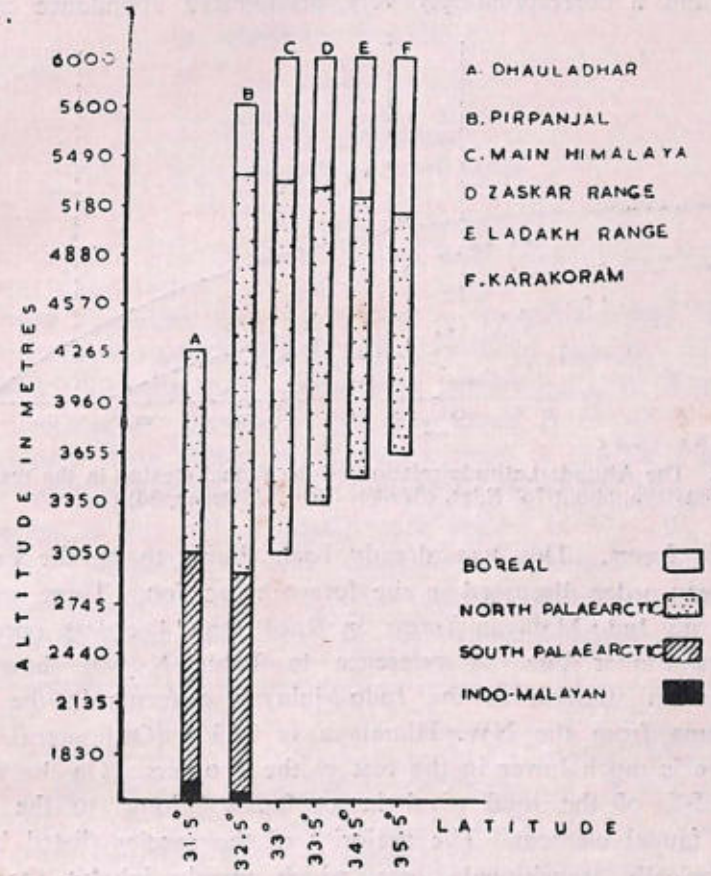


Fig. 37. The boundary altitudes of the faunal Realms on the different ranges of the NW. Himalaya, at a line drawn approximately north through Kangra, somewhat east of 76° E.lat.

valleys often into the heart of the Himalaya. The boundary altitudes should be considered merely as indicators of a more or less irregular, intergrading zone rather than a line. The differences in the boundary are mainly the result of the differences in the increasing latitudes and higher elevations of the ranges successively further north. The relation between latitude, altitude, and the boundaries of the various faunal Realms is shown in Figure 38, with special reference to the NW. Himalaya.

We are now in a position to discuss the relative frequency of the different zoogeographical elements in the nival insect fauna of the NW. Himalaya. In the light of the remarks made above on the

general succession of these elements with the increase in altitude, we should expect an extremely insignificant proportion of the Indo-Malayan and a correspondingly very pronounced abundance of the

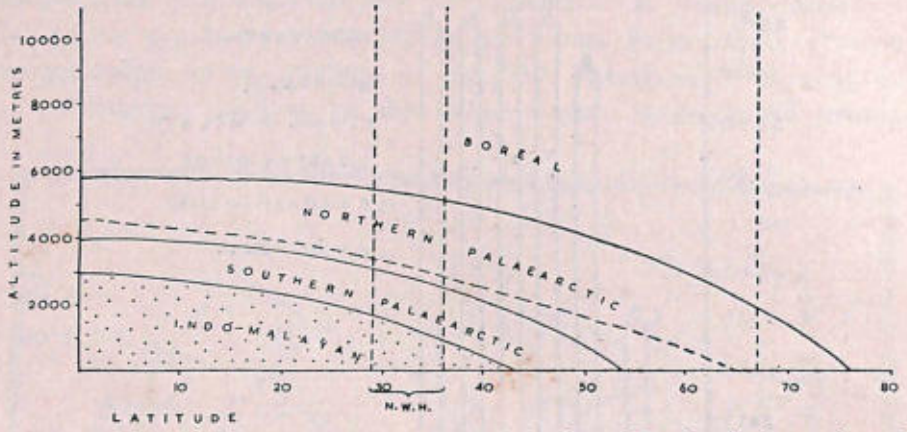


Fig. 38. The Altitude-Latitude relation of the faunal Realms in the region of the NW. Himalaya, about 76° E.lat. (*Modified from Eidmann*, 34)

Palaearctic forms. This has already been shown to be the case in nearly every order discussed in the foregoing section. There are, for example, no Indo-Malayan forms in 9 of the 14 orders occurring above the timber line. A reference to Table X will show that the maximum strength of the Indo-Malayan elements in the nival insect fauna from the NW. Himalaya is 14.3% (Orthoptera). The percentage is much lower in the rest of the 4 orders. On the whole, hardly 3.5% of the total nival insect fauna belongs to the Indo-Malayan faunal element. The majority of the species (listed below) are ecologically transitional types, which mostly inhabit the river valleys at elevations immediately above the timber line and are also localized in the area south of the main crest line of the Great Himalaya.

Indo-Malayan Elements

Orthoptera

1. *Aularches punctatus* (Drury)
2. *Catantops humilis* (Serville)

Heteroptera

3. *Brachyrhynchus tagalicus* (Stål.)

Coleoptera

4. *Phaeropsophus catoiroi* (Dej.)
*5. *Phaeropsophus stenoderus* Chaud.

6. *Phaeropsophus consularis* (Schm.)
7. *Scarites praedator* Chaud.
8. *Blosyrodes pubescens* Marshall
9. *Blosyrodes variegatus* (Redt.)
10. *Mylabris phalerta* (Pall.)

Hymenoptera

11. *Anthophora confusa* Smith
12. *Megachile vigilans* Smith
13. *Ammophila vagabunda* Smith

Collembola

14. *Tomocerus ocreatus* Denis

Most of the species do not occur at elevations above 3500 m., but the maximum altitude up to which isolated members of the Indo-Malayan elements have succeeded in penetrating is 4372 m., at which the collembolan *Tomocerus ocreatus* Denis is found at the end of the Upper Beas Valley on the south slope of the Pir Panjal Range. The localities from which the Indo-Malayan species have so far been collected in the NW. Himalaya are shown in Fig. 39. The Indo-Malayan elements therefore constitute insignificant recent arrivals, practically still restricted to the southern fringe of the otherwise Palaearctic fauna (*vide infra* VII. Concluding Remarks).

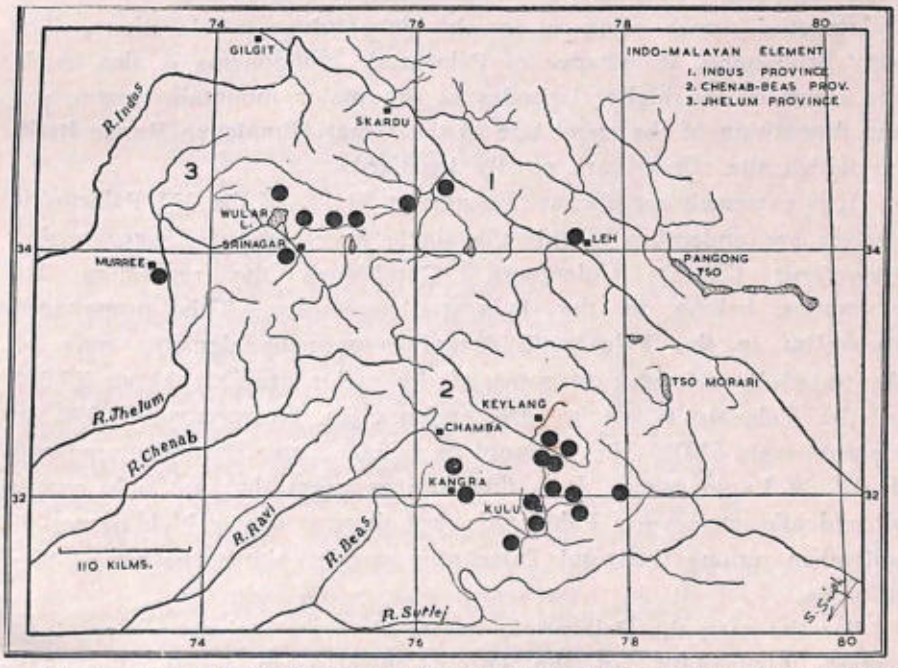


Fig. 39. The distribution of the Indo-Malayan elements in the nival insect fauna from the NW. Himalaya

It is thus evident that the nival insect fauna above the timber line is composed almost exclusively of Palaearctic elements, amounting to over 95.0% of the total nival species known at present. The Palaearctic element is total in 7 of the orders and is never below 85.0% in 5 of the remaining orders. All the 91 species of Lepidoptera so far found inhabiting the nival zones of the NW. Himalaya are, for example, Palaearctic. In Coleoptera, of which 96.0% of the total species belong to the Palaearctic faunal elements, the families Staphylinidae and Tenebrionidae wholly come under the category (Table IV). Carabidae, with 98.0% of the species belonging to the Palaearctic faunal components, stand second. In several of the minor families like Dytiscidae, Hydrophilidae and Histeridae all the known species belong to this faunal component. The same is also the case with Bombidae and Formicidae among Hymenoptera. The high percentage of the Palaearctic forms in many of these groups, which we have cited as examples here, are closely correlated with the general massiveness of the mountain ranges and the average high altitudes which they inhabit in the NW. Himalaya. The greatest majority of species in these groups never descend below an average elevation of 3900 m. Many species of Carabidae, Staphylinidae, Hydrophilidae, Formicidae and Lepidoptera (all of which are Palaearctic forms) occur at much higher average elevations. The very pronounced dominance of Palaearctic components is also partly the result of the higher latitudes of the major mountain ranges and the disposition of the trend line of the Great Himalayan Range itself, on which the species are mostly localized.

It is extremely significant that almost 58.0% of the 371 Palaearctic species are endemites. With the single exception of *Phaeropsophus stenoderus* Chaud. (Coleoptera : Carabidae), the remaining 216 endemites belong to the Palaearctic complex. This pronounced endemism in the Palaearctic faunal component elements may be illustrated by reference to some of the major orders. About 83.0% of the Palaearctic species are endemic in Orthoptera, 69.0% in Heteroptera, 61.0% in Coleoptera, 52.0% in Hymenoptera and 44.0% in Lepidoptera. It is therefore apparent that not only nearly all endemic species are Palaearctic, but there is also a high degree of endemism among the total Palaearctic species above the timber-line altitudes.

For the rest, the Palaearctic faunal elements include a large proportion, viz. 14.0% of the Pamir-Central-Asian forms (Fig. 34). Reference to Table X shows that 50.0% of the Palaearctic species of

Orthoptera are of the Pamir-Central-Asian stock. In Heteroptera the Pamir-Central-Asian element is not so high and it is also extremely weak in Coleoptera, but nearly four times more numerous in Hymenoptera (31.0%). In Lepidoptera this element is about equal to that of Heteroptera. The typical Pamir-Central-Asian forms belong to the interesting genera such as *Conophyma, Metrioptera* and *Gomphomastax* among Orthoptera; *Nysius* in Heteroptera; *Agonum, Bembidion, Bradytus, Nebria* and *Helophorus* among Coleoptera; *Lapidariobombus, Mendacibombus* and *Subterraneobombus* among Hymenoptera; *Parassius, Colias* and *Erebia* among Lepidoptera; and the remarkable Dipterous family Deuterophlebiidae. The species of the Pamir-Central-Asian stock are listed below.

Pamir-Central-Asian Elements

Orthoptera

1. *Conophyma*, 2. *Metrioptera*, and 3. *Gomphomastax*

Dermaptera

4. *Anechura*

Heteroptera

5. *Bianchiella adelungi* Reut.
6. *Microplax hissarensis* Krit.
7. *Nysius ericae* (Schill.)

Coleoptera

8. *Agonum ladakense* Bates
9. *Bembidion bucephalum* Net.
10. *Bembidion dardum* Bates
11. *Bembidion fuscicrus* Motsch.
12. *Bembidion pamiricola* Andrewes
13. *Bembidion petrimagni* Net.
14. *Bradytus apricarius* (Payk.)
15. *Clivinia tenuelimbatus* Ball.
16. *Cymindis mannerhemi* Gebl.
17. *Nebria limbigera* Solsky
18. *Helophorus montanus* d'Orch
19. *Myatis quadriticollis* Bates
20. *Onthophagus gibbosus* (Scriba)
21. *Otiorrhynchus russicus* Stieril

Hymenoptera

22. *Bombus alticus* Eversm.
23. *Lapidariobombus saparandus* (Vogt)
24. *Lapidariobombus alagesianus pamirus* Skor.
25. *Mendacibombus margareiteri* Vogt
26. *Subterraneobombus difficillimus* Skor.
27. *Subterraneobombus melanurus* (Lepel.)

Lepidoptera

28. *Saturnis stoliczana* Feld.
29. *Papilio machaon* Linn.
30. *Papilio machaon ladakensis* (Moore)
31. *Parnassius charltonius* Gray
32. *Parnassius jacquemontii jacquemontii* Boisd.
33. *Parnassius delphius* Eversm.
34. *Colias cocandica* Ersch.
35. *Colias eogene eogene* Feld.
36. *Colias leechi* Gr.-Gr.
37. *Colias stoliczana* Moore
38. *Pieris callidice* (Esper.)
39. *Pieris daplidice* (Linn.)
40. *Pieris deota* (de Nicev.)
41. *Argynnis aglaia vitatha* Moore
42. *Argynnis pales generator* Staud.
43. *Erebia mani* de Nicev.

Diptera

44. *Deuterophlebia mirabilis* Edw.
45. *Ephydra glauca* Meigen

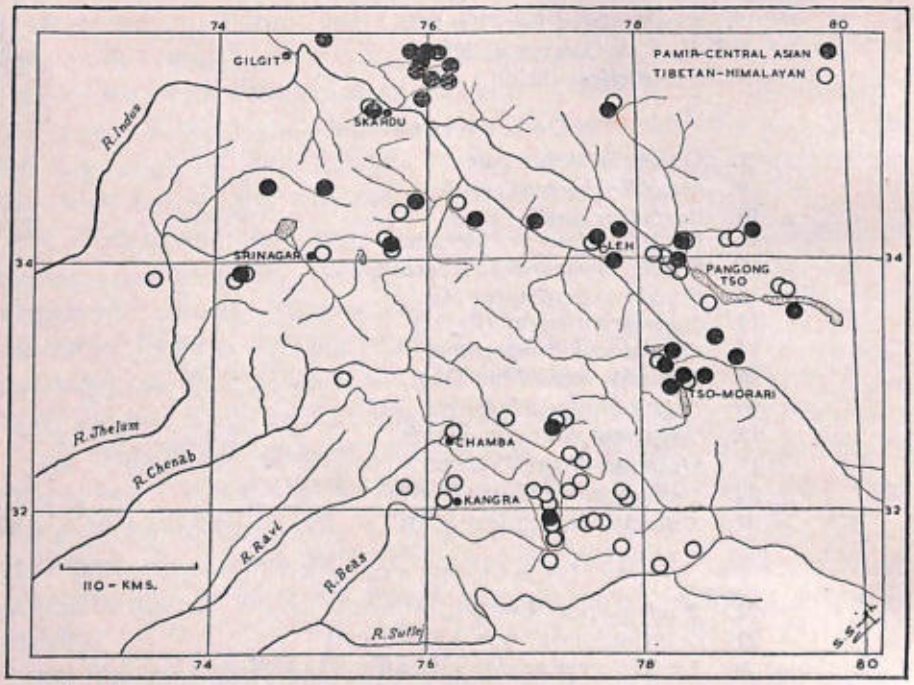


Fig. 40. The distribution of the Pamir-Central-Asian and of the Tibetan-Himalayan (i.e. Himalaya east of the R. Sutlej) in the nival insect fauna in the NW. Himalaya

Next to the Pamir-Central-Asian stock, the Tibetan-Himalayan (i.e. the Himalaya east of R. Sutlej) elements are important (about 10%, *vide* Fig. 34) and attain their maximum strength of 25.0% (Table X) of the total nival Palaearctic species in Odonata from the NW. Himalaya. In Coleoptera the Tibetan-Himalayan element is stronger (14.0%) than the Pamir-Central-Asian (8.0%). On the other hand, the strength of the Tibetan-Himalayan component in Hymenoptera (10.3%) is only one-third that of the Pamir-Central-Asian element. While we observe that the Pamir-Central-Asian element is extremely poor in Coleoptera, the Tibetan-Himalayan element reaches its minimum in Lepidoptera (8.0%). The Tibetan-Himalayan component elements belong to *Amara, Bembidion, Helophorus, Bombus* and other genera. The species are listed below.

Tibetan-Himalayan Elements

Odonata

1. *Orthetrum japonicum internum* Mac Lach.

Coleoptera

2. *Amara brucei* Andrewes
3. *Amara nila* Andrewes
4. *Anchomenus caesitius* Andrewes
5. *Anchomenus ladakensis* Bates
6. *Bembidion braculatum* Bates
7. *Bembidion nivicola* Andrewes
8. *Carabus* (*Imaibius*) *boysi* Tatum.
9. *Cymindis championi* Andrewes
10. *Hypsinephus ellipticus* Bates
11. *Liocnemis himalaica* Bates
12. *Nebria* (*Patronebria*) *himalayica* Bates
13. *Trechus indicus championi* Jeann.
14. *Atracthelophorus frater* d'Orch.
15. *Hydrous pallidipalpus* M'Leay.
16. *Helophorus* (*Helophorus*) *splendidus immaensis* d'Orch.
17. *Helophorus* (*Lihelophorus*) *ser* Zait.
18. *Laccobius* (*Laccobius*) *hingstoni* d'Orch.
19. *Alaeochara* (*Mesochara*) *inornata* Cam.
20. *Atheta* (*Liogluta*) *subumbonata* Cam.
21. *Onthophagus tibetanus* Arrow
22. *Purpuricenus montanus* White
23. *Longitarsus cynipennis* Bryant
24. *Merista quadrifasciata* (Hope)
25. *Callistopopillia iris* (Cand.)

Hymenoptera

26. *Allantus himalayensis* Radzok.
27. *Bombus atrocinctus terminalis* Smith
28. *Bombus rufofasciatus* Smith

Lepidoptera

29. *Campylotes histrionicus* Westwood
30. *Brahmaea wallichii* Gray
31. *Papilio acco acco* Gray
32. *Pontia daplidice moorei* (Röber)
33. *Colias ladakensis* Feld.
34. *Melitaea sindura* Moore
35. *Vanessa ladakensis* Moore

Diptera

36. *Theobaldia niveitaeniata* (Theobald)
37. *Criorrhina imitator* Brunetti

In the distribution of the Pamir-Central-Asian and of the Tibetan-Himalayan faunal elements within the NW. Himalaya (Fig. 40), we have extremely interesting examples of localizations and discontinuity. The existence of these two elements in the nival insect fauna of the NW. Himalaya, suggested by the works of Skorikow (142), Filipjev (38), Kiritschenko (78), Hutchinson (74) and Eidmann (34) may now be considered as satisfactorily established.

The southern Palaearctic, especially the Mediterranean element, which according to Eidmann (34) reaches its maximum boundary altitude at 3000 m. in the Nanga Parbat area, is perhaps the weakest (4.0%) of the total Palaearctic in the NW. Himalaya (Fig. 34). It attains its maximum strength of 33.0% in Orthoptera but never more than 4.0% in Coleoptera, Hymenoptera and Lepidoptera. It includes, in addition to the strictly Mediterranean, a few of the east southern Palaearctic or the Manchurian elements, like *Bryodema* (Orthoptera), with one endemic species in the Indus drainage area. The typical Mediterranean forms fall under genera like *Sphingonotus, Calosoma* and *Pieris*.

SOUTH PALAEARCTIC ELEMENTS

Orthoptera

1. *Bryodema luctuosa* (Stoll.)
2. *Sphingonotus savingnyi* Sauss.
3. *Sphingonotus rubescens* (Walker)
4. *Oedipoda himalayana* Uvarov

Coleoptera

5. *Calosoma maderae auropunctatum* (Herb.)
6. *Calosoma maderae indicum* Hope
7. *Calosoma maderae kashmirense* Breun.
8. *Atheta triangulum* (Kr.)
9. *Cicindela sublacerata balucha* Bates

Hymenoptera

10. *Ammophila laeta* Bingham

Lepidoptera

11. *Colias electo fieldi* Men.
12. *Pieris krueperi devta* (de Nicev.)
13. *Pieris rapae iranica* Le Cerf.
14. *Pontia chloridice alpina* (Verity)

The distribution of the south Palaearctic elements in the NW. Himalaya (Fig. 41) is characterised by marked concentrations in localized patches. Though most of the species occur at elevations of about 3000 m. some, like those of *Calosoma* and *Colias*, reach up to an elevation of 4267 m. Uvarov (155) recognized the penetration of the extreme eastern refuge of the Mediterranean faunal elements, especially the Orthoptera like *Metrioptera* and *Oedipoda*, in the NW. Himalaya to be situated in Kashmir. Eidmann (34) assumed the extreme eastern limits of these elements to be in the Nanga Parbat area. We may now however observe the penetration further east to the drainage areas of Chenab-Beas.

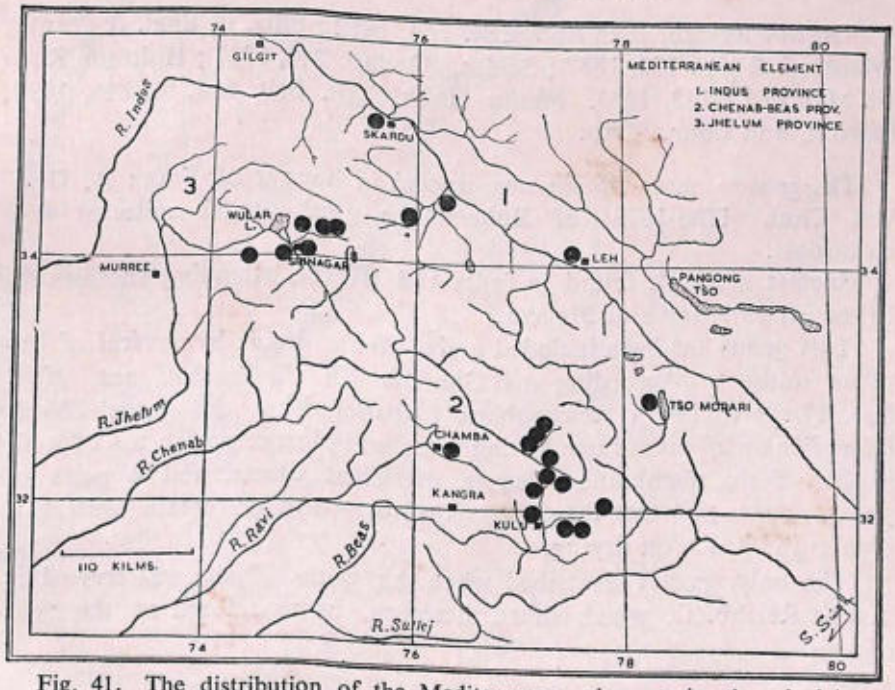


Fig. 41. The distribution of the Mediterranean elements in the nival insect fauna of the NW. Himalaya

In addition to the Palaearctic and the Indo-Malayan faunal elements, the following 5 widespread species are also known to occur in the NW. Himalaya: *Enallagama cyathigerum* Charp, and *Libellula quadrimaculata* Linn. (Odonata); *Poophilus costalis* (Walk.) (Homoptera); *Rahntus pulverosus* Steph. (Coleoptera), and *Sminthurides aquaticus* (Bourlet).

(*To be continued*)

Critical Notes on the Orchidaceae of Bombay State

IX. SOME OF THE SMALLER GENERA (CONTINUED)

BY

H. SANTAPAU, S.J., F.N.I., AND Z. KAPADIA, Ph.D.

(*With eight plates*)

[*Continued from Vol.* **59** (1) : 172]

8. *THUNIA* Reichb. f.

THUNIA Reichb. f. in Bot. Zeit. 764, 1852 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 122, 1887 ; Schltr., Orchid. 244, 1927 ; Holttum, Rev. Fl. Malaya 1 : 183, 1953. *Phaius* Hook. f. Fl. Brit. Ind. 5 : 816, 1890 (partim, non Lour. 1790).

The generic name *Thunia* was erected in honour of Franz A. Graf von Thun (1786-1873) of Bohemia, a great orchid collector and enthusiast.

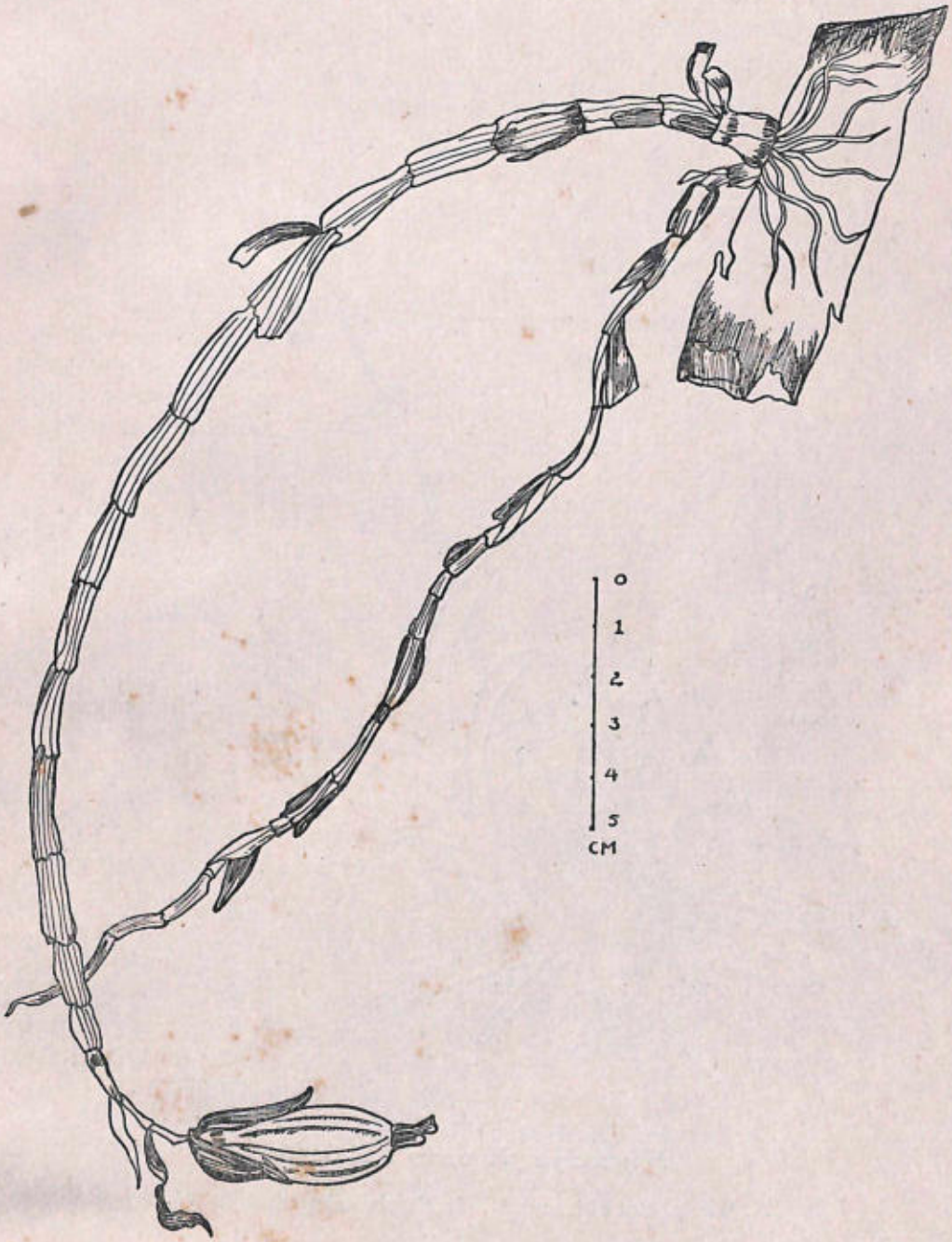
Species about 4, found in India and Burma, extending southwards to the extreme north of Malaya.

This genus has been included under *Phaius* Lour. by several of the older authors. According to Gammie (in *J. Bombay nat. Hist. Soc.* 17 : 941, 1907), Reichenbach f. distinguishes the genus *Thunia* from *Phaius* by the former having terminal inflorescence on top of leafy shoots, fleshy membranous leaves, persistent bracts, and 4 pairs of pollen masses ; further the flowers turn brownish or remain white, not blue as in *Phaius*, on drying.

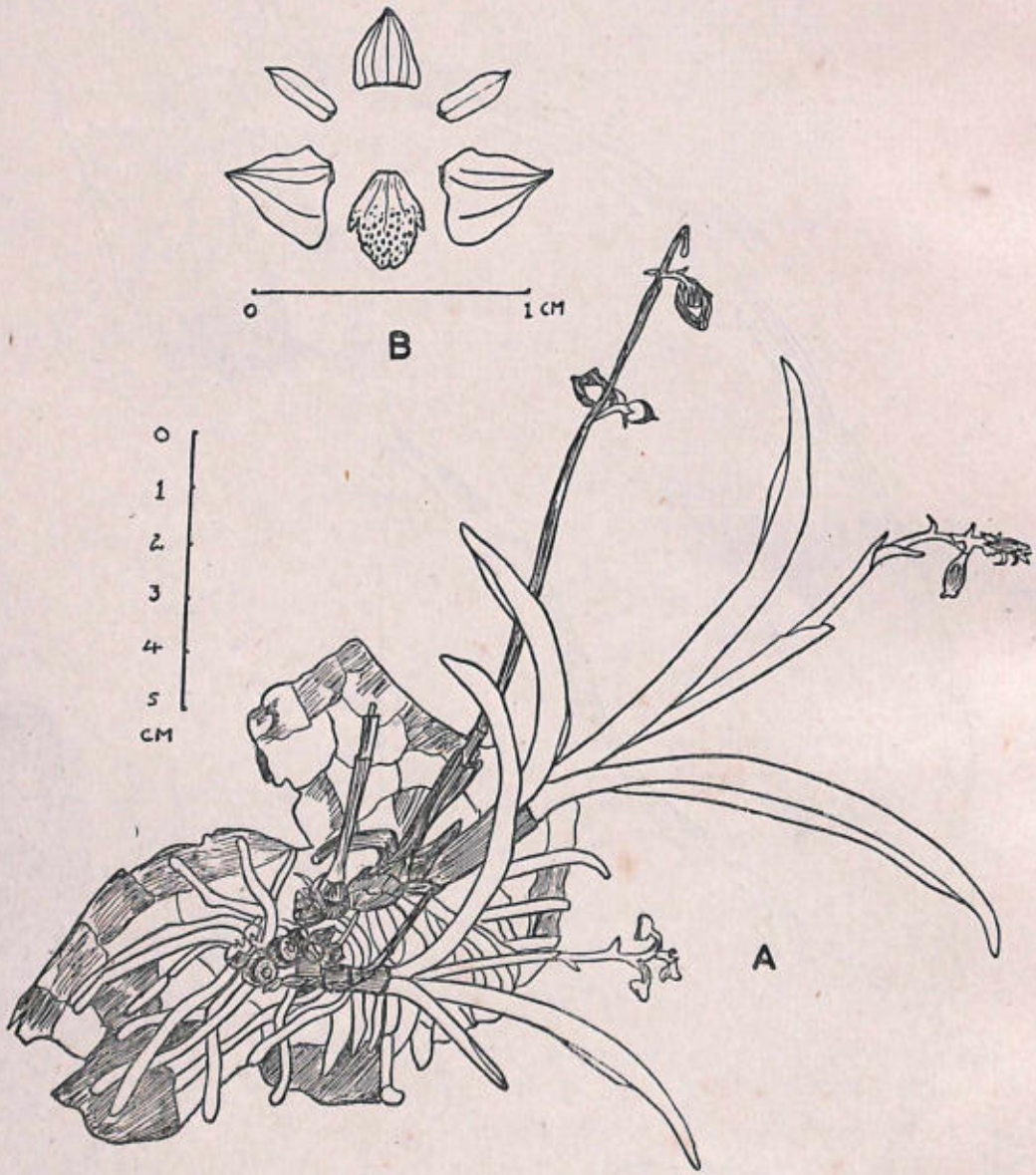
The only species described when the genus *Thunia* was erected is *T. alba* Reichb. f., which must, therefore, be considered as the type species.

Type species : *T. alba* Reichb. f.

Thunia venosa Rolfe in Orchid Rev. 13 : 206, 1905 ; Cooke 2 : 692, 1907 ; Haines, Bot. Bih. Or. 1167, 1924 ; Fischer, Fl. Pres. Madr. 1427, 1928 ; Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 845, 1932. *Phajus albus* Hook. f. 818 (partim) ; Gammie in Journ. Bombay nat. Hist. Soc. 17 : 940, t. 3, 1907. (See Plate XLIII.)



Thunia venosa Rolfe



Polystachya flavescens J. J. Smith

A. Whole plant with support. B. Sepals and petals dissected.

Leaves 10-13 × 1.8 cm., alternate, distichous, sessile, sheathing at the base, elliptic to elliptic-lanceolate, acute, entire, 3-7-nerved. *Inflorescence* in compact, somewhat compressed racemes terminating the leafy stem, from a cluster of apical leaves. *Peduncle* very short, about 0.3-0.5 cm. thick, terete. *Flowers* pedicellate, bracteate. *Bracts* 3.5-5 × 1-1.5 cm., spathaceous, ovate-oblong or ovate-elliptic, acute, entire, several-nerved. *Pedicel* and *ovary* about 3 cm. long. *Sepals* 4 × 1 cm., oblong-elliptic, acute, entire, glabrous, 5-nerved. *Petals* similar, but slightly smaller. *Lip* much shorter than sepals and petals, fimbriate at apex, spurred. *Spur* 5-7 mm. long, linear, obtuse or emarginate.

The description has been drawn from Carstenson's sheet from Mahableshwar (loaned by the National Herbarium, Calcutta). The specimen unfortunately is badly preserved and the structure of the flowers is not very clear. Moreover, the colour of the flowers is not mentioned. We have collected this species only in fruit.

Flowering : July. *Fruiting :* March.

Occurrence in Bombay State : KONKAN : Matheran, eastern side, *Dalzell*. W. GHATS : Khandala, *Graham* ; *Santapau* 4645 ; Mahableshwar, *Carstenson* ; *Fairbanks ex Birdwood*. N. KANARA: Anmod, *Kapadia* 1912.

Distribution : India : Kumaon, Mussoorie, Sikkim, Assam, Khasia, Chota Nagpur, Konkan, W. Ghats, Travancore, Andamans. *World :* India, Burma.

Notes : According to Haines *T. venosa* Rolfe is distinguished from *T. alba* Reichb. f. by the latter species having a more elongate raceme, more numerous and much larger flowers, a yellow disc to the lip and a few lilac radiating veins on the side lobes.

Gammie describes the veins on the lip as purple or red. Dalzell mentions the veins to be carmine.

9. *POLYSTACHYA* Hook.

POLYSTACHYA Hook. Exot. Fl. t. 103, 1825, nom. cons.; Endl. Gen. Pl. 192, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 540, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 133, 1889 ; Hook. f. Fl. Brit. Ind. 6 : 20, 1890 ; J. J. Smith, Fl. Buitenz. 6 : 284, 1905 ; Schltr. Orchid. 292, 1927 ; Correll, Nat. Orch. N. America 309, 1950 ; Holttum, Rev. Fl. Malaya, 1: 542, 1953. *Dendrorkis* Thou. Nouv. Bull. Soc. Philom. Paris 1 : 318, 1809. *Dendrorchis* Thou. Hist. Pl. Orch. 1822 ; O. Kuntze, Rev. Gen. Pl. 2 : 658, 1891.

The generic name is derived from the Greek words *polys* = many, *stachys* = spike, in allusion to the numerous spikes borne upon the scape.

This genus has over 100 species, mostly tropical in distribution. It attains its maximum development in Africa, with a few species (probably only one) in India, Malaya, Java and tropical America.

Type species : *P. luteola* Hook.=*P. minuta* (Aubl.) Britt.

Polystachya flavescens (Bl.) J. J. Smith, Fl. Buitenz. 6 : 284, f. 218, 1905 ; Holttum, 542, f. 161. *Onychium flavescens* Bl. Bidjr. 325, 1825. *Polystachya zeylanica* Lindl. Bot. Reg. misc. 78, 1838 ; Hook. f. 21 ; Alston, Kandy Fl. 75. f. 398, 1938. *Polystachya wightii* Reichb. in Walp. Ann. 6 : 640, 1861 ; Hook. f. 21 ; Gammie in Journ. Bombay nat. Hist. Soc. 18 : 588, 1908 ; Fischer, Fl. Pres. Madr. 1437, 1928. *Polystachya purpurea* Wt. Icon. 5 (1) : 10, t. 1679. 1851 ; Hook. f. 21 (?). *Polystachya luteola* Hook. Exot. Fl. t. 103, 1825 ; Wight, Icon. 5 (1) : 10, t. 1678, 1851. (See Plate XLIV.)

Pseudobulbous *epiphytes*. *Pseudobulbs* 5-10 mm. long, close together, ovate, usually 2-3-noded, pale green with dense clusters of thick fibrous roots. *Leaves* 2-5, each 4-10 × 6-12 cm., narrowly oblong-lanceolate, tapering at the base, glabrous, entire, acute or emarginate, often unequal-sided at apex, midnerve prominent ; lower ones the smallest ; sheaths keeled on back. *Inflorescence* terminal, erect, 4-11 cm. long, simple in all our specimens ; scape with usually 2-3 large sheaths, which are glabrous, oblong, obtuse or sub-acute, flattened, sharply 2-angled, yellowish green. *Flowers* small, ± distichous, somewhat close together towards apex of peduncle, bracteate, shortly pedicellate, greenish-yellow. *Bracts* 3-5 mm. long, persistent, broadly sheathing and concave at base, becoming strongly apiculate and sharp-pointed at apex. *Ovary* with *pedicel* about 3 mm. long, ribbed, pale greenish-yellow. *Sepals* subequal, pale greenish-yellow, subfleshy, entire, glabrous ; dorsal sepal 3 × 2.5 mm., subobtuse, faintly 5-nerved ; lateral ones 4 mm. long, 3.5 mm. broad at base, broadly and obliquely ovate-triangular, apiculate, 3-nerved ; mentum wide, 2.5 mm. long, pale greenish-yellow, obtuse, subtruncate. *Petals* 3 × 1.5 mm., somewhat incurved, narrowly linear-oblong, apiculate, entire, 1-nerved. *Lip* 3.5 mm. long, strongly arcuate, sessile, hinged on the foot of column, 3-lobed, pale yellow ; lateral lobes 1 × 0.75 mm., erect, small, triangular, acute or subobtuse, entire ; midlobe 1.5 × 2 mm., broadly oblong-suborbicular, not constricted at base, crenulate, rounded or sub-retuse, ' with a white mealy covering composed of single loose round cells ' (Holttum), the apical part deflexed. *Column* nearly 2 mm. long, oblong ; foot about 2 mm. long, stout, at right angles to column, both forming a wide obtuse angle with the ovary. *Anther* 1-1.5 mm. long, transversely oblong-orbicular, mucronate on the upper lip. *Capsule* 9 × 3-4 mm., turgid, fusiform ; pedicel 2-3 mm. long.

Flowering : August. *Fruiting :* September onwards.

Occurrence in Bombay State : N. KANARA : *Gammie* ; Belgaum, *Gammie* ; Yellapur, *Bell* ; *Kapadia* 1761, 1962, 2210-2212, 2347 ; Sampkhand, *Hallberg & McCann* 34199 ; Kumbelli Mines, *Kapadia* 2678 ; Anmod, *Kapadia* 1900.

Gammie has recorded this species from Bombay State ; but Blatter & McCann do not include it among their revised list of Bombay orchids.

Distribution : India : N. Kanara, W. Ghats southwards at 600-1200 m. *World :* Ceylon, India, Malaya, Sumatra, Philippines.

10. *CALANTHE* R. Br.

CALANTHE R. Br. in Bot. Reg. t. 573, 1821, nom. cons. ; Endl. Gen. Pl. 207, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 520, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 153, 1889; Hook. f. Fl. Brit. Ind. 5 : 847, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 164, 1898 ; Duthie, ibid. 9 (2) : 118, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 201, 1905 ; Schltr. Orchid. 302, 1927 ; Holttum, Rev. Fl. Malaya 1 : 146, 1953. *Alismorkis* Thou. Nouv. Bull. Soc. Philom. Paris 1 : 318, 1809. *Alismorchis* Thou. Hist. Pl. Orch. 1822 ; O. Kuntze, Rev. Gen. Pl. 2 : 650, 1891.

The generic name *Calanthe* has been derived from the Greek *kalos* = beautiful, and *anthos* = flower, in allusion to the brightly coloured flowers in many of the species.

A fairly large genus with about 40 or more species, widely distributed from South Africa and the islands of the Indian Ocean through India to China and Japan, and southwards and eastwards through Malaysia to Australia and Tahiti.

The characteristic feature of the genus *Calanthe* R. Br. is the union of the column with the base of the lip. It can be readily distinguished from its very near ally, *Phaius* Lour., by the adhesion of the pollen masses to a separable gland ; whereas its other closely allied genus, *Limatodes* Bl., can be separated by its lateral inflorescence and a free cucullate lip.

Type species : *C. veratrifolia* R. Br.

KEY TO THE SPECIES OF *CALANTHE* OF BOMBAY

Leaves sparsely puberulous only in lower surface; floral bracts 20-25 mm. long, sparsely puberulous ; sepals about 3-7 cm. long ; lip 20-25 mm. long, lateral lobes falcate-oblong. . . *masuca*

This genus has over 100 species, mostly tropical in distribution. It attains its maximum development in Africa, with a few species (probably only one) in India, Malaya, Java and tropical America.

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Pseudobulbous *epiphytes*. *Pseudobulbs* 5-10 mm. long, close together, ovate, usually 2-3-noded, pale green with dense clusters of thick fibrous roots. *Leaves* 2-5, each 4-10 × 6-12 cm., narrowly oblong-lanceolate, tapering at the base, glabrous, entire, acute or emarginate, often unequal-sided at apex, midnerve prominent ; lower ones the smallest ; sheaths keeled on back. *Inflorescence* terminal, erect, 4-11 cm. long, simple in all our specimens ; scape with usually 2-3 large sheaths, which are glabrous, oblong, obtuse or sub-acute, flattened, sharply 2-angled, yellowish green. *Flowers* small, ± distichous, somewhat close together towards apex of peduncle, bracteate, shortly pedicellate, greenish-yellow. *Bracts* 3-5 mm. long, persistent, broadly sheathing and concave at base, becoming strongly apiculate and sharp-pointed at apex. *Ovary* with *pedicel* about 3 mm. long, ribbed, pale greenish-yellow. *Sepals* subequal, pale greenish-yellow, subfleshy, entire, glabrous ; dorsal sepal 3 × 2.5 mm., subobtuse, faintly 5-nerved ; lateral ones 4 mm. long, 3.5 mm. broad at base, broadly and obliquely ovate-triangular, apiculate, 3-nerved ; mentum wide, 2.5 mm. long, pale greenish-yellow, obtuse, subtruncate. *Petals* 3 × 1.5 mm., somewhat incurved, narrowly linear-oblong, apiculate, entire, 1-nerved. *Lip* 3.5 mm. long, strongly arcuate, sessile, hinged on the foot of column, 3-lobed, pale yellow ; lateral lobes 1 × 0.75 mm., erect, small, triangular, acute or subobtuse, entire ; midlobe 1.5 × 2 mm., broadly oblong-suborbicular, not constricted at base, crenulate, rounded or sub-retuse, ' with a white mealy covering composed of single loose round cells ' (Holttum), the apical part deflexed. *Column* nearly 2 mm. long, oblong ; foot about 2 mm. long, stout, at right angles to column, both forming a wide obtuse angle with the ovary. *Anther* 1-1.5 mm. long, transversely oblong-orbicular, mucronate on the upper lip. *Capsule* 9 × 3-4 mm., turgid, fusiform ; pedicel 2-3 mm. long.

Flowering : August. *Fruiting :* September onwards.

Occurrence in Bombay State : N. KANARA : *Gammie* ; Belgaum, *Gammie* ; Yellapur, *Bell* ; *Kapadia* 1761, 1962, 2210-2212, 2347 ; Sampkhand, *Hallberg & McCann* 34199 ; Kumbelli Mines, *Kapadia* 2678 ; Anmod, *Kapadia* 1900.

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KEY TO THE SPECIES OF *CALANTHE* OF BOMBAY

Leaves sparsely puberulous only in lower surface; floral bracts 20-25 mm. long, sparsely puberulous ; sepals about 3-7 cm. long ; lip 20-25 mm. long, lateral lobes falcate-oblong. . . *masuca*

Leaves densely puberulous on both surfaces; floral bracts 4-7 mm. long, densely puberulous; sepals about 11 mm. long; lip 6-7 mm. long, lateral lobes oblong-suborbicular, obtuse. .. .. *purpurea*

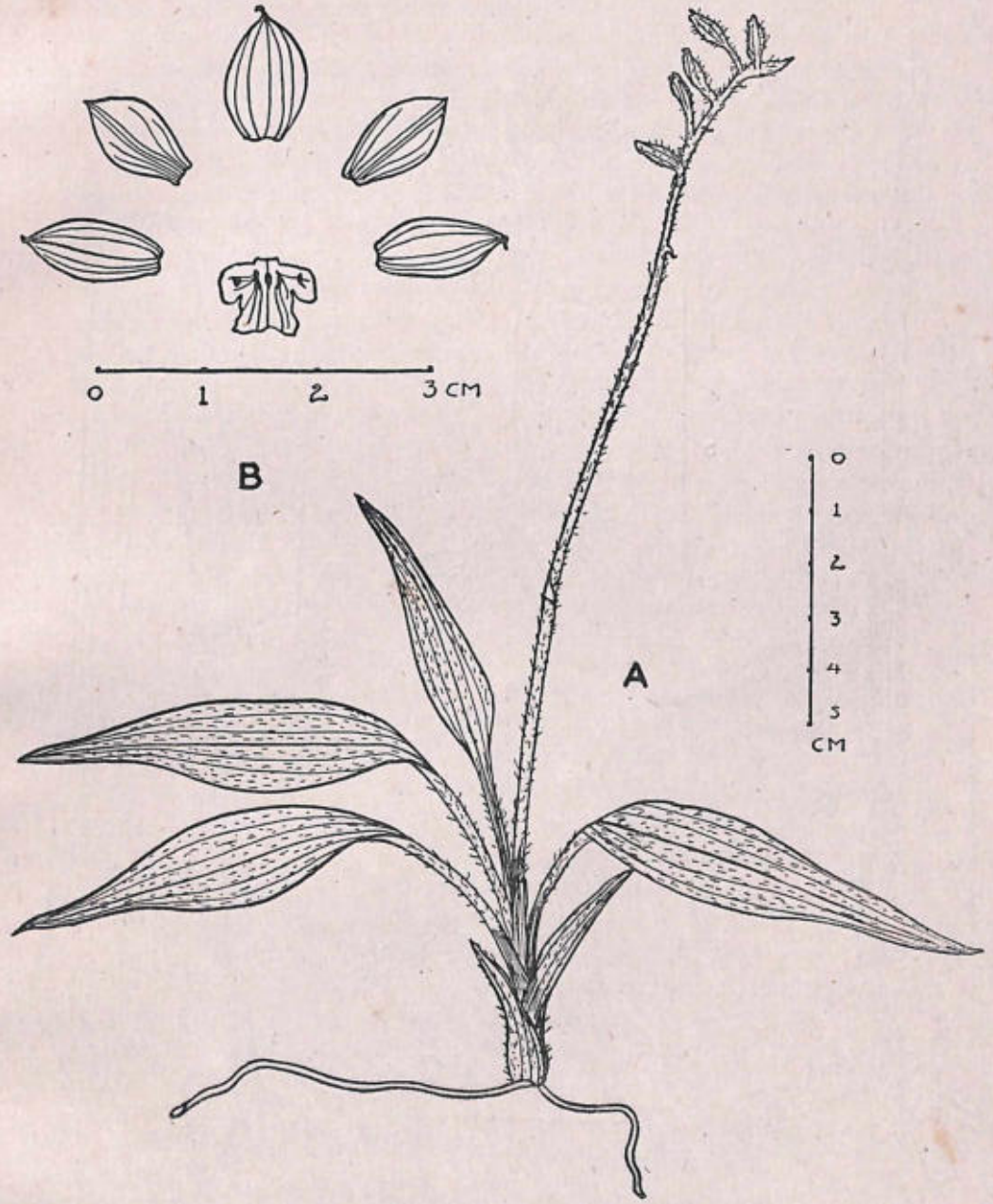
1. **Calanthe masuca** (D. Don) Lindl. [in Wall. Cat. 7337, 1832, nom. nud. et] Gen. Sp. Orch. 249, 1833, et in Bot. Reg. misc. 51, 1842, t. 37, 1844; Reichb. f. in Walp. Ann. 6: 915, 1861; Hook. f. 850; King & Pantl. 173, t. 234; Brühl, Guide Orch. Sikk. 108, 1926; Fischer, Fl. Pres. Madr. 1432, 1928; Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35: 485, 1932. *Bletia masuca* D. Don, Prodr. Fl. Nep. 30, 1825. *Calanthe versicolor* Lindl. Sert. Orch. t. 42, 1826, et Bot. Reg. sub. t. 37, 1844. *C. emarginata* Wight, Icon. 3 (2): 10, t. 918, 1844-1845.

We have not seen any specimens. In the absence of the original description of Lindley, we give the one of King & Pantling: '*Pseudobulbs* narrowly conical, with annular scars, 2 to 3 in. in length. *Leaves* more or less broadly elliptic, acute, narrowed at the base into a petiole, or sessile; length 6 to 15 in., breadth 2.75 to 4.25 in.; petiole 2 to 6 in., or 0. *Peduncle* exceeding the leaves in length, stout, with two or three scattered acute lanceolate *bracts*. *Raceme* about 6 in. long, many-flowered, pubescent. *Flowers* rather crowded, depressed, 2 in. across, with a curved slender cylindric spur longer than the ovary. *Sepals* elliptic or elliptic-lanceolate, acute, spreading, the lateral pair slightly longer than the dorsal. *Petals* smaller than the sepals, sub-acute. *Lip* as long as the sepals, attached to almost the whole length of the column, 3-lobed; the basal lobes oblong, blunt, sub-falcate, directed forwards; apical lobe large, sub-rhomboid, or cuneately reniform, deeply emarginate at the apex; the disc between the side lobes with three unequal elongate tubercular calli. *Column* very short. *Stigmatic surface* in two halves and the rostellum consisting of two projecting plates. *Anther* pointed; pollinia 8, subequal, clavate, sub-sessile on a small oblong gland. *Capsule* elliptic, 1.5 in. long.

'. . . The flowers are of an almost uniform violet tint, becoming of a rusty colour when beginning to wither. The calli of the lip are yellow. The coloration however varies. In the form which was named *C. versicolor* the perianth is white, the lip being purple, changing to yellow. In another form the sepals are crimson and the lip deep purple . . .'

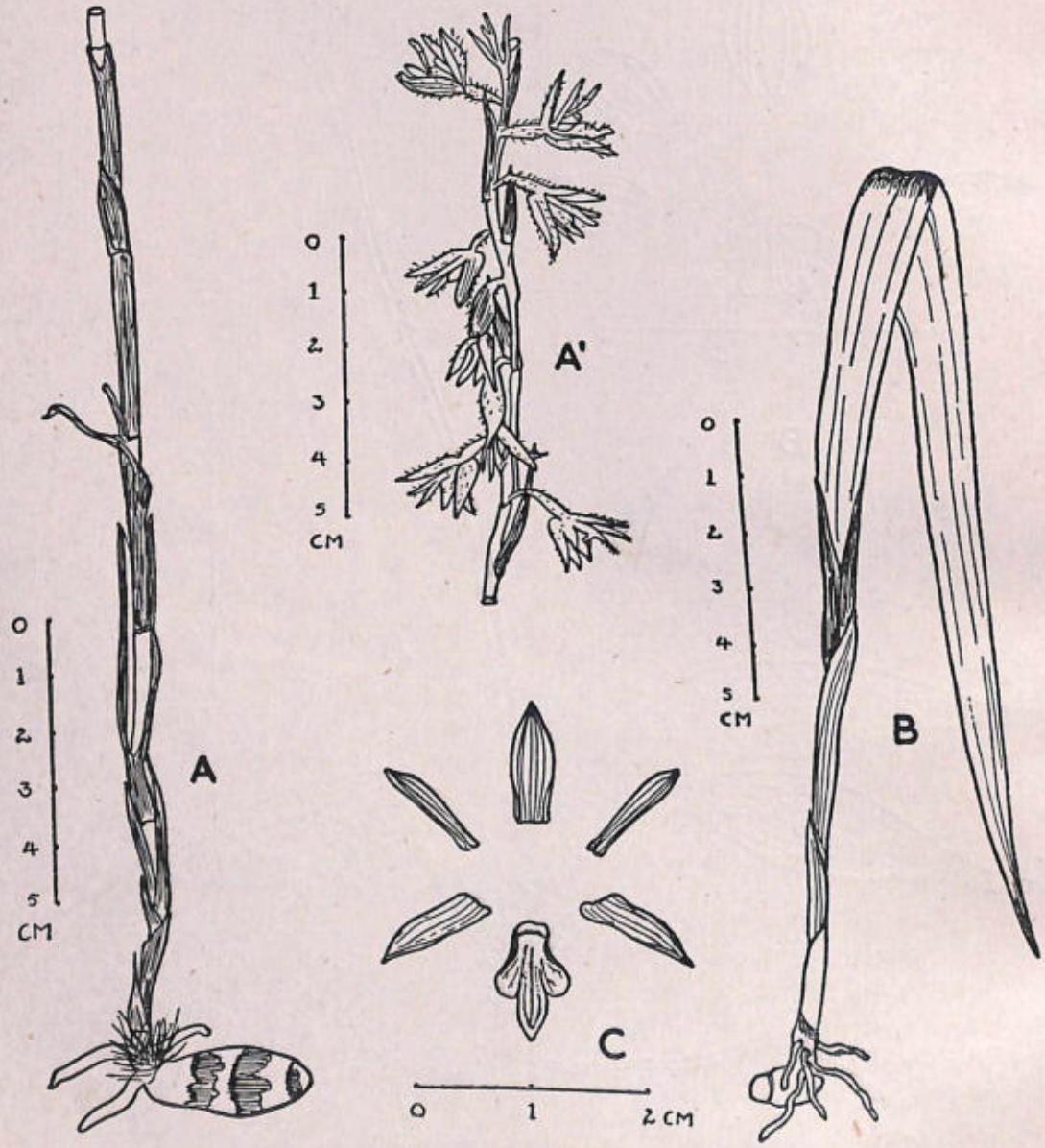
Occurrence in Bombay State: N. KANARA: Malemani Ghat, *Sedgwick*.

Distribution: India: Tropical Himalaya in Sikkim 500-1300 m., Deccan, N. Kanara, southern parts of W. Ghats at 1000-2000 m. *World:* India, Nepal, Malaya, Java.



Calanthe purpurea Lindl.

A. Whole plant. B. Sepals and petals dissected.



Pachystoma senile Reichb. f.

A—A'. Plant in flower. B. Plant in leaf. C. Sepals and petals dissected.

2. **Calanthe purpurea** Lindl. Gen. Sp. Orch. 249, 1833, et Bot. Reg. sub. t. 37, 1844 ; Reichb. f. 915 ; Hook. f. 851. *C. masuca* Thwaites, Enum. Ceyl. Pl. 308, 1884 (?). (See Plate XLV.)

Pseudobulbs not seen. *Stem* sheathed at the base ; foliar sheaths 2 or 3, sessile, plicate, oblong-lanceolate, acute, shortly hirsute, the hairs whitish ; the sheaths forming a pseudostem about 7 cm. long. *Leaves* 4, clustered at the base, somewhat spreading, long-petioled ; petioles 13-15 cm. long, 2-5 mm. thick, sheathing at base, prominently ribbed, sub-hirsute ; lamina 20-28 × 3.5-7 cm., oblong-lanceolate to lanceolate tapering to an acute apex, entire, plicate, many-nerved, dark-green, hirsute with whitish shiny hairs, more so on the upper surface. *Peduncle* 72 cm. long, about 1.5-3 mm. thick, ridged, twisted towards the apex, ± fulvous-hirsute, with bracteate sheaths ; lowermost basal sheath 7 cm. long, the other 3, 1-2 cm. long, lanceolate, hirsute. *Flowers* long-pedicelled, bracteate, in few-flowered lax racemes at apex of peduncle. *Bracts* 4-7 × 1.5-3 mm., persistent, lanceolate, acute, entire, 1-nerved, hirsute. *Pedicels* 8 mm. long, thin, hirsute. *Ovary* 12 × 2 mm., hirsute. *Sepals* 11 × 5-7 mm., entire, 5-nerved, acute with a minute curved apiculum ; dorsal one slightly broader than laterals, broadly ovate ; lateral one oblong, broadest a little beyond the middle. *Petals* 11 × 6 mm., elliptic, ovate acute, without an apiculum, entire, glabrous, 3-nerved. *Lip* 6-7 mm. long, 3-lobed, very shortly clawed ; lateral lobes 4 × 2 mm., erect, oblong, obtuse, the lip across the lateral lobes 8 mm. broad ; midlobe 4 × 5.5 mm., deltoid-oblong, dilated at apex, retuse, subentire; calli 3, small, in between the lateral lobes in the centre of the lip. *Spur* 17 mm. long, linear, straight. *Column* structure not distinct in dried flowers. *Anther* 2 × 3 mm. oblong-ellipsoid, with a somewhat long apiculum; pollinia 8, each 1.2 mm. long, waxy, in pairs, narrowly oblong-linear, clavate, with a small, somewhat orbicular, separable gland. *Capsules* 2.6 × 1-1.2 cm., elliptic, hirsute ; *pedicels* 1.6 cm. long hirsute.

Flowering and *Fruiting :* October.

Occurrence in Bombay State : N. KANARA : Gersoppa Ghat, *Hallberg & McCann* 34754, This species has been mentioned by Hooker f. only for Ceylon. It is not given in any of the regional floras of India ; this, therefore, constitutes a new record for India and Bombay.

Distribution : India : N. Kanara. *World :* India, Ceylon.

Notes : Thwaites has united this species with *C. masuca* Lindl. But as Hooker f. has pointed out, *C. purpurea* Lindl. can be distinguished from *C. masuca* Lindl. by the former having much smaller flowers, leaves hairy on both surfaces, much smaller bracts and slender spur, which more or less equals the pedicel and the ovary.

11. *PACHYSTOMA* Bl.

PACHYSTOMA Bl. Bijdr. 376, 1825 ; Benth. & Hook. f. Gen. Pl. 3 : 511, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 156, 1889 ; Hook. f. Fl. Brit. Ind. 6 : 811, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 101, 1898 ; Duthie, ibid. 9 (2) : 108, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 186, 1905 ; Schltr. Orchid. 312, 1927 ; Holttum, Rev. Fl. Malaya 1 : 145, 1953.

The name *pachystoma* is derived from the Greek words *pachys* = thick, and *stoma* = mouth, in allusion to the thick lip.

A small genus of about 6-8 species, distributed from India, through Malaysia to New Guinea.

The only species described at the time of erection of the genus *Pachystoma* was *P. pubescens* Bl.; this must, therefore, be considered the type species.

Type species : *P. pubescens* Bl.

Pachystoma senile (Lindl.) Reichb. f. in Bonpland. 3 : 250, 1858 ; Hook. f. 812 ; King & Pantl. 101, t. 140 ; Duthie 108, et Fl. Upp. Gang. Pl. 3 : 192, 1930 ; Haines, Bot. Bih. Or. 1169, 1924 ; Brühl, Guide Orch. Sikk. 74, 1926 ; Fischer, Fl. Pres. Madr. 1426, 1928 ; Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 484, 1932. *Apaturia senilis* Lindl. [in Wall. Cat. 3739, 1831, nom. nud. et] Gen. Sp. Orch. 130, 1831. *Apaturia lindleyana* Wight, Icon. 5 (1) : 8, t. 1662. 1851. (See Plate XLVI.)

Leaf one, about 30 × 1.2 cm., narrowly oblong-lanceolate, acute, entire, subplicate, sheathed below. *Inflorescence* 30-40 cm. long, erect, sheathed in the basal region ; sheaths 3-5 cm. long, ± hyaline, lanceolate, acute or acuminate, entire, glabrous. *Flowers* at first erect, drooping after fertilization, bracteate, pedicellate in lax racemes. *Bracts* 1-2.5 × 0.3-0.5 cm., erect, ± hyaline, membranous, narrowly lanceolate, acute or sub-acuminate, entire, many-nerved, glabrous. *Sepals* about 10 × 3.5 mm., entire, 5-nerved, shortly pubescent ; dorsal one oblong, subobtuse ; the laterals oblong-lanceolate, suboblique, slightly saccate at base, ± sharply acute. *Petals* 10 × 1-2 mm., narrowly spathulate, acute, sparsely pubescent, 3-nerved. *Lip* 10 mm. long, subsaccate at base, 3-lobed, sparsely pubescent ; lateral lobes 3-4 × 2.5 mm., erect, ± connivent over the column, oblong, entire, truncate-rounded at apex ; midlobe 5 × 3 mm., obovate-oblong, entire, apex shortly-pointed and slightly deflexed ; disc with 5 longitudinal, parallel ridges. *Column* 6 mm. long, curved, pubescent, apical part much dilated, 3-lobed. *Anther* 1.75 × 1.5 mm. broadly

orbicular, sparsely subrugose, anterior lip truncate-subretuse. *Ovary* 6 × 2.5 mm., pubescent ; *pedicel* 5 mm. long.

Leaves : August. *Flowering :* March.

Occurrence in Bombay State : N. KANARA : Belgaum, *Bell* 942 ; *Chikkannniah*.

Distribution : India : Plains and foothills of N. India from Garhwal to Sikkim, Khasia Hills, Manipur. W. Ghats of Bombay and Madras, N. Kanara. *World :* India, Malaya, (?) Java.

Notes : This species was found by Bell in black soil of grasslands in Belgaum. Specimens of this species were kindly sent to us by Prof. P. G. Chikkanniah, Head of the Botany Department, Lingaraj College, Belgaum.

12. *BULBOPHYLLUM* Thou.

Bulbophyllum Thou. Hist. Pl. Orch. Tabl. esp. 3, 1822, nom. cons.; Endl. Gen. Pl. 191, 1837 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 178, 1889 ; Hook. f. Fl. Brit. Ind. 5 : 752, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 64, 1898 ; Duthie, ibid. 9 (2) : 103, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 414, 1905 (partim) ; Schltr. Orchid. 319, 1927 ; Holttum, Rev. Fl. Malaya 1 : 394, 1953 (partim). *Phyllorkis* Thou. Nouv. Bull. Soc. Philom. Paris 1 : 319, 1809.

The name *Bulbophyllum* is derived from the Greek words *bolbos* = bulb, and *phyllon* = leaf, in allusion to the bulb which bears leaf on top. Certain authors, like Sprengel (*Syst. Veg.* 3 : 732, 1826) and Pfitzer adopt *Bolbophyllum* ; Sprague notes (in Kew Bull. 349, 1928) : ' It is a pity that Thouars did not adopt the form *Bolbophyllum* from Bohhoa and Yuhhov instead of compounding the Latin word *bulbus* with the latter. Nevertheless the generic name must stand as published by Thouars (Art. 50)'. (Art. 73, ed. 1956 of the Code).

One of the largest of all orchid genera. In a wide sense there are probably 1000 species, distributed through tropical Africa and Asia, extending into S. Africa, Australia, New Zealand, Japan, and Korea, and also into Brazil and S. America.

This large genus has been variously divided into sections on the basis of the wide range in vegetative form and floral structure. As pointed out by Holltum, ' A full survey of the genus, and a comparative account of the various sections based on modern knowledge, has still to be written.' Here we have considered the genus *Bulbophyllum* in a restricted sense, excluding *Cirrhopetalum*, which has been included as a section of the former genus by J. J. Smith and Holttum. The former (in *Bull. Jard. Bot. Buitenz.* ser. 2, 8 : 19-29, 1912) has shown that, when all known species of the genus are considered, the distinctive

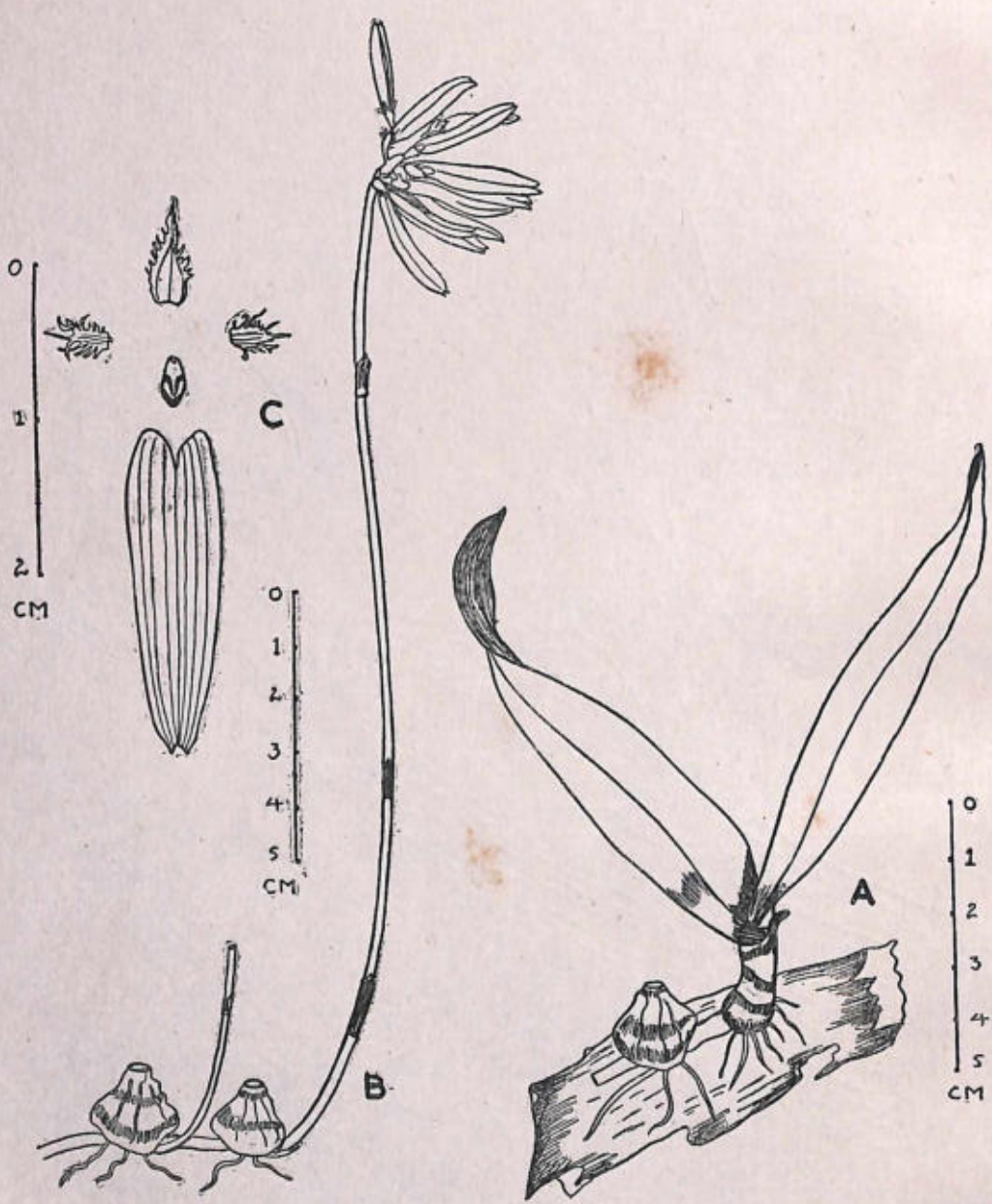
features of the genus *Cirrhopetalum* can be easily accommodated within *Bulbophyllum*. However, orchidologists like Pfitzer, Rolfe, and Fischer are of opinion that *Cirrhopetalum* should be maintained as an independent genus. As far as our Bombay orchids are concerned, the 2 species *Cirrhopetalum fimbriatum* Lindl. and *Bulbophyllum neilgherrense* Wt. are quite distinct in many respects and can be well separated into 2 independent genera. It may be worth noting that both these species are sympodial in structure, as *Dendrobium*, although the rhizome appears to be continuous, and the pseudobulbs to rest upon it. Each new branch of the sympodium begins as a bud at the base of a pseudobulb, grows horizontally as a rhizome for a short distance, and ends in a new pseudobulb with a leaf upon it ; next year's growth continues by a new bud produced from the old pseudobulb.

Type species : *B. nutans* Thou.

Bulbophyllum neilgherrense Wight, Icon. 5 (1) : 6, t. 1650, 1851 ; Bot. Mag. t. 5050, 1858 ; Hook. f. 761 ; Gammie in Journ. Bombay nat. Hist. Soc. 17 : 33, 1906 ; Blatt. & McC. ibid. 35 : 266, t. 1, 1931 ; Cooke, Fl. Pres. Bomb. 2 : 686, 1907 ; Fischer, Fl. Pres. Madr. 1418, 1928. *Phyllorchis neilgherrense* (Wt.) O. Kuntze, Rev. Gen. Pl. 2 : 677, 1891. (See Plate XLVII.)

Epiphytes or *lithophytes*. Rhizome 2-3 mm. thick, creeping, giving out at intervals a pseudobulb and a cluster of roots. *Pseudobulbs* 2-8 × 2-3 cm., ovoid or conical-ovoid, yellowish-green, fleshy, irregularly 3-5-angled. *Leaf* 1, from the top of the pseudobulb, fleshy, coriaceous, tapering into a petiole 1 cm. long; the lamina 4-15 × 1.5-3.5 cm., oblong or elliptic, obtuse, emarginate, entire, glabrous ; midnerve depressed above, prominent below with faint 4-6 lateral nerves ; upper surface deep grass-green, lower much paler. *Inflorescence* up to 12 cm. long, generally shorter than the leaves, arising from the base of a pseudobulb, somewhat drooping, dense ; peduncle 2 mm. thick, mauve-purple, sheathed at the base. *Flowers* 14-15 mm. long, pedicellate, bracteate, chrome-yellow, smelling of highly rotten meat. *Bracts* 7 × 2 mm., about as long as or shorter than the ovary, membranous, pale brown, oblong-lanceolate, acute or subacuminate, entire, 3-nerved. *Pedicel* with *ovary* 5 mm. long, pale green. *Sepals* unequal, yellow very lightly tinged with green, entire, glabrous, faintly 5-nerved; dorsal sepal 6 × 3.5 mm., concave, ovate, the acute apex upturned ; lateral ones 9 × 5 mm., subfalcate, sharply acute, obliquely united by the inner margins to form a hollow concave, cymbiform structure, which is produced below about the middle, into a short subglobular sac. *Petals* 4 × 1.5 mm., pale yellow, gland-dotted, parallel along the column, subobliquely ovate-triangular, entire, 1-nerved, with

Bulbophyllum neilgherrense Wight



Cirrhopetalum fimbriatum Lindl.

A. Leafy plant with support. B. Flowering plant. C. Sepals and petals dissected.

an apiculum 1 mm. long. *Lip* 7 × 4 mm., strongly arcuate, hinged on the column-foot, 3-lobed; lateral lobes 2-3 × 1 mm., purplish-brown with red margins, erect along the foot, linear, acute, entire; midlobe 4-5 × 2-3 mm., ovate-lanceolate, fleshy, subacute, serrate, yellow with 2 brownish ridges in between the lateral lobes. *Column* 5 × 2 mm., flat or subconcave and red on the inner side, rounded and yellow on the dorsal; produced above from the sides into 2 slender acute teeth 1 mm. long; foot 3 mm. long, slightly curved, at about right angles to the column, rounded and orange-yellow on the dorsal surface, broadly red-streaked and subconcave on the ventral, truncate at the apex. *Anther* yellow, subconical, obtuse, with the anterior lip minutely serrulate; pollinia 4, attached in pairs, waxy, brownish-yellow; glandular disc small, somewhat flask-shaped. *Stigmatic surface* yellow with red margins, elliptic

Flowering : December.

Occurrence in Bombay State : N. KANARA : Belgaum Ghats, *Gammie;* Sampkhand, *Woodrow*; *Hallberg* & *McCann* 34842; Yellapur, *Sedgwick*; *Kapadia*; Kumbarwada, *Bell*; Shintheri Rocks between Dandeli and Gundh, *Kapadia* 1740-1746; Londa, *Santapau* 10840-10841; Siddhapur, *Kapadia* 2357; Jog, *Kapadia* 2330-2431.

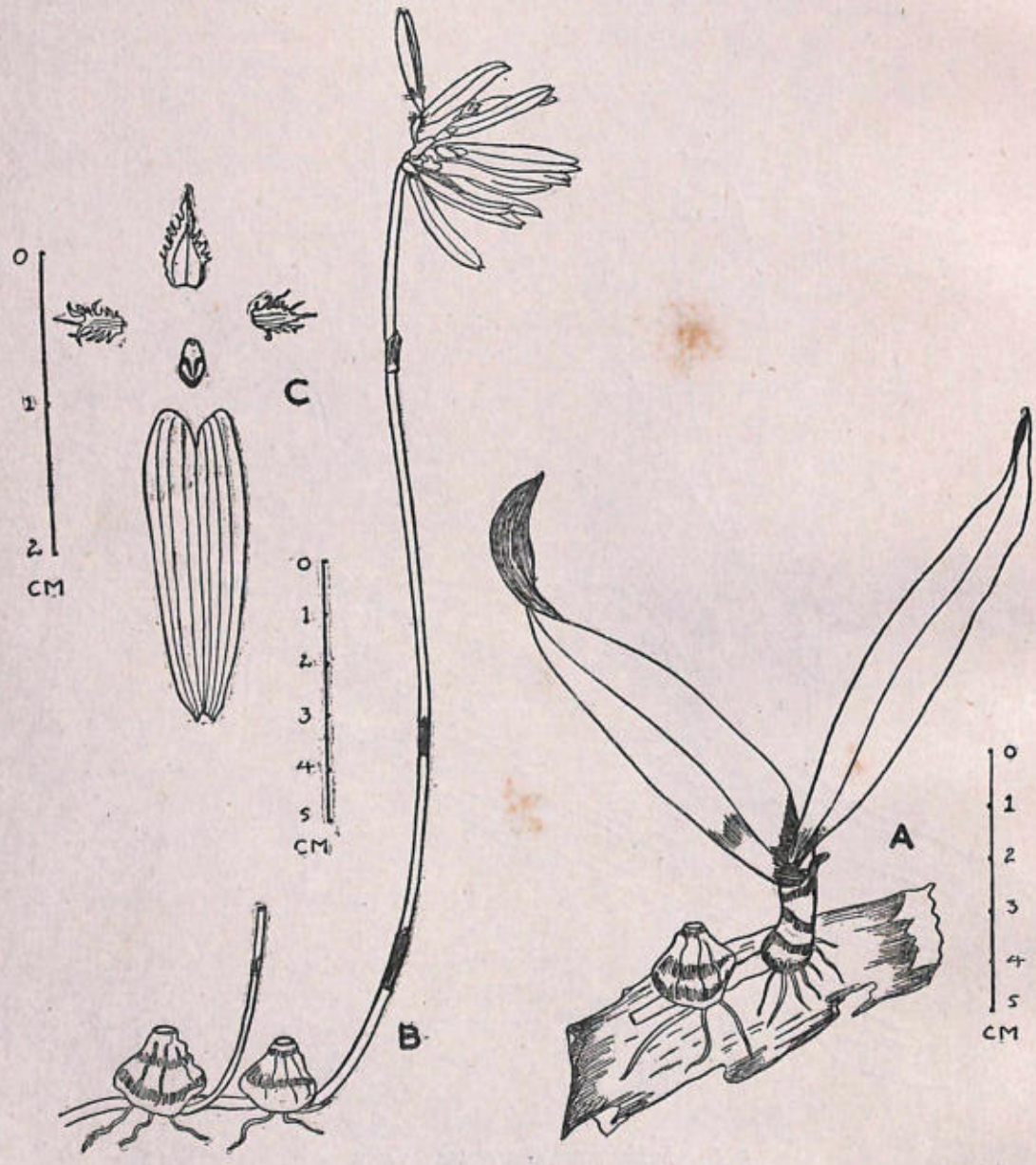
Distribution : N. Kanara, W. Ghats of Bombay State and S. India.

Notes : This species has been observed by us to be both epiphytic and lithophytic, and rarely flowers in cultivation. The flowers have a most disgusting odour of carrion, probably a great attraction for carrion flies, which may be serving as agents for pollination.

13. *CIRRHOPETALUM* Lindl.

CIRRHOPETALUM Lindl. [in Bot. Reg. t. 832, 1824, nom. nud.; et] Gen. Sp. Orch. 58, 1830, cum descr., nom. cons.; Endl. Gen. Pl. 191, 1837; Benth. & Hook. f. Gen. Pl. 3 : 504, 1883; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6): 178, 1889; Hook. f., Fl. Brit. Ind. 5: 772, 1890; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 85, 1898; Duthie, ibid. 9 (2) : 105, 1906; Schltr. Orchid. 328, 1927. *Bulbophyllum* Thou. sect. *Cirrhopetalum* J. J. Smith, Fl. Buitenz. 6 : 467, 1905, et Bull. Jard. Buitenz. ser. 2, 8 : 19, 1912; Holttum, Rev. Fl. Malaya 1 : 400, 1953. *Zygoglossum* Reinw. ex Blume, Cat. Gew. Lands Pl. Buitenz. 100, 1823, nom. nud. et in Hornsch. Syll. Pl. Nouv. Ratisb. 2 : 4, 1828, cum descr. *Ephippium* Blume, Bijdr. 308, 1825. *Hippoglossum* Breda, Gen. Sp. Orch. t. 14, 1827.

The name *Cirrhopetalum* is derived from the Greek *kirrhos* = yellowish, and *petalon* = petal, referring to the prevailing yellow colour



Cirrhopetalum fimbriatum Lindl.

A. Leafy plant with support. B. Flowering plant. C. Sepals and petals dissected.

an apiculum 1 mm. long. *Lip* 7 × 4 mm., strongly arcuate, hinged on the column-foot, 3-lobed; lateral lobes 2-3 × 1 mm., purplish-brown with red margins, erect along the foot, linear, acute, entire; midlobe 4-5 × 2-3 mm., ovate-lanceolate, fleshy, subacute, serrate, yellow with 2 brownish ridges in between the lateral lobes. *Column* 5 × 2 mm., flat or subconcave and red on the inner side, rounded and yellow on the dorsal; produced above from the sides into 2 slender acute teeth 1 mm. long; foot 3 mm. long, slightly curved, at about right angles to the column, rounded and orange-yellow on the dorsal surface, broadly red-streaked and subconcave on the ventral, truncate at the apex. *Anther* yellow, subconical, obtuse, with the anterior lip minutely serrulate; pollinia 4, attached in pairs, waxy, brownish-yellow; glandular disc small, somewhat flask-shaped. *Stigmatic surface* yellow with red margins, elliptic

Flowering : December.

Occurrence in Bombay State : N. KANARA : Belgaum Ghats, *Gammie;* Sampkhand, *Woodrow*; *Hallberg & McCann* 34842; Yellapur, *Sedgwick*; *Kapadia*; Kumbarwada, *Bell*; Shintheri Rocks between Dandeli and Gundh, *Kapadia* 1740-1746; Londa, *Santapau* 10840-10841; Siddhapur, *Kapadia* 2357; Jog, *Kapadia* 2330-2431.

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The name *Cirrhopetalum* is derived from the Greek *kirrhos* = yellowish, and *petalon* = petal, referring to the prevailing yellow colour

in the sepals of the first species ; Graham (*Cat. Bom. Pl.* 205, 1839) and Chibber (in *Journ. Bombay nat. Hist. Soc.* 24 : 280, 1916) incorrectly give the derivation of the generic name from *Cirrhus* = a tendril, and *petalum* = a petal, in allusion to the long filiform tendril-like termination of the lateral sepals.

Species about 50 ; this genus is more or less confined to the Old World from Madagascar through India and Malaysia to the Philippines and New Guinea.

Type species : *C. thouarsii* Lindl. (= *Bulbophyllum longiflorum* Thou.).

Cirrhopetalum fimbriatum Lindl. in Bot. Reg. misc. 72, 1839 ; Wight, Icon. 5 (1) : 6, t. 1655, 1851 ; Bot. Mag. t. 4391, 1848 ; Dalz. & Gibs. Bomb. Fl. 261, 1861 ; Hook. f. 774 ; Gammie in Journ. Bombay nat. Hist. Soc. 17 : 34, 1906 ; Cooke, Fl. Pres. Bomb. 2 : 686, 1907 ; Fischer, Fl. Pres. Madr. 1420, 1928. *Cirrhopetalum wallichii* Graham, Cat. Bomb. Pl. 205, 1839 (non Lindl. 1830). *Bulbophyllum fimbriatum* Reichb. f. in Walp. Ann. 6 : 260, 1861 ; Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 265, 1931. (See Plate XLVIII.)

Epiphytes. Rhizome 2-4 mm. thick, brown, woody, bearing pseudobulbs not more than 2 cm. apart. *Pseudobulbs* 10-25 × 8-20 mm., yellow, leafless at the time of flowering, conical ovoid, irregularly and longitudinally grooved. *Leaves* usually 2 per shoot, spreading from a short pseudostem which is 5-15 × 4-8 mm., sheathed ; leaves 4-12 × 1.1-2 cm., sessile, subcoriaceous, oblong-lanceolate or elliptic, acute, 1-nerved, margins whitish, entire, minutely papillate. *Scape* 8-20 cm. long, 1-2 mm. thick, brown-green, rigid, erect, with a few sheaths, which are 5-10 mm. long, oblong, acute, brown ; the apex with an umbellate raceme is erect in bud, gradually becoming reflexed with the opening of flowers. *Buds* pale green ; with the expansion of the flowers, the lateral sepals turn yellow. *Flowers* about 2 cm. long, bracteate, pedicellate, foul-scented, ± radiating in all directions from the apex of the peduncle. *Bracts* 4 × 1 mm., ovate-oblong, acuminate, entire, pale greenish-brown, 3-nerved. *Pedicel* about 1 mm. long. *Ovary* 2 × 1 mm., subclavate, ribbed, pale green. *Sepals* unequal; dorsal sepal 6 × 2.5 mm., deep pinkish-yellow with purple fimbriae, ovate, acuminate 3-nerved, the lateral nerves faint ; lateral sepals 2 × 0.6 cm. green in bud, changing to yellow with age, oblong, acute, 3-nerved, more or less saccate at base, united by their inner margins into a subcymbiform, structure which is emarginate at the apex. *Petals* 4 × 2.5 mm., similar to dorsal sepal in colour, but with longer fimbriae, oblong to ovate, acuminate, 3-nerved. *Lip* 3 × 1.5 mm., yellow at base and along the centre, the sides crimson, elliptic-oblong, obtuse, thick, fleshy, somewhat

ligulate. *Column* 2 × 1 mm., oblong, white with 2 deep crimson curved horns ; foot 1.5 mm. long, narrow, white with a few, small, reddish spots on the inner face. *Stigmatic surface* yellow. *Anther* minute, reddish-brown, papillate. *Pollinia* 4, waxy, ovoid, with a small glandular viscid mass. *Capsules* 12 × 6 mm., obpyriform, green ; pedicels 5 mm. long.

Leaves : June to November. *Flowers :* March to April.

Occurrence in Bombay State : W. GHATS : Mahableshwar, *James* ; *Hallberg* ; Mahableshwar-Pratapgad, *Kapadia* 1924-1927, 1937, 2096. DECCAN : Purandhar, *Kapadia*. N. KANARA : Tinai Ghat, *Bhide* ; Anmod, *Kapadia* 1869-1870, 1901-1904; Castle Rock, *Kapadia* 2835-2836; Astoli, *Bell* ; Astoli-Chandwadi, *Bell*.

Distribution : Konkan, W. Ghats, N. Kanara, Deccan, Coorg.

Notes : This species is often known as the ' Umbrella Orchid ' on account of its characteristic umbellate racemes, where the flowers more or less radiate from the apex of the peduncle like the ribs of an umbrella. It is usually found in open deciduous forests. The flowers give off a foul scent.

C. wallichii Grah. seems to be this species; Graham gives the locality as Rotunda Ghat ; we have found this species very abundant on Rotunda Ghat along the short cut to Pratapgad from Mahableshwar.

14. *TRIAS* Lindl.

TRIAS Lindl. [in Wall. Cat. 1977, 1829, nom. nud. et] Gen. Sp. Orch. 60, 1830; Endl. Gen. Pl. 191, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 505, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 180, 1889 ; Hook. f. Fl. Brit. Ind. 5 : 780, 1890 ; Schltr. Orchid. 333, 1927.

The generic name *Trias* is derived from the Greek word *treis* = three, alluding to the arrangement of the sepals.

This genus has only 4 to 5 species endemic in India and Burma ; restricted to Tenasserim, but for one, which is found in south India. *T. ovata* Lindl. is a native of SE. Asia.

Trias stocksii Benth. ex Hook. f. Fl. Brit. Ind. 5 : 781, 1890 ; Gammie in Journ. Bombay nat. Hist. Soc. 17 : 34, 1906 ; Blatt. & McC. ibid. 35 : 267, 1931 ; Cooke, Fl. Pres. Bomb. 2 : 687, 1907. (See Plate XLIX.)

Rhizome dirty brown, terete, about 2-3 mm. thick. *Pseudobulbs* 1 × 1.3-1.7 cm., shortly conical-ovoid, dark olive-green or brownish-purple, with a few faint grooves. *Leaf* one, 1.5-4.5 × 0.7-2 cm., coriaceous, erect or deflexed, entire, acute or obtuse, 1-nerved, dark

olive-green above, brown-purple below. *Scape* 0.6-1 cm. long, thin, 1-flowered, with 2 loose, membranous, gland-dotted sheaths. *Flowers* 9-11 mm. across, pedicellate, bracteate, deep chrome-yellow ; all the floral parts thick and coriaceous. *Bracts* tubular, oblong, just above the sheaths of the scape and similar to them. *Pedicel* with *ovary* about 1 cm. long, slightly curved, the ovary clavate, ribbed. *Sepals* subequal 9 × 6 mm., deep chrome-yellow spotted with orange in the basal region, ovate-oblong, obtuse, mucronulate, entire, glabrous, faintly 7-nerved ; dorsal sepal concave ; lateral ones subsaccate and concave at base, and adnate to foot of column to form a broad mentum 3-4 mm. long, emarginate. *Petals* 3-4 × 1-2 mm., narrowly linear-oblong, broad at base, acute, entire, 1-nerved, gland-dotted. *Lip* mobile on the apex of the column-foot, the basal third inflexed and parallel to the foot, glabrous ; the upper two-thirds of lip deflexed at right angles to basal portion, oblong, tuberculate on upper surface, rounded, entire, faintly grooved down the middle, or not ; at the junction of the glabrous and tuberculate portions, there are 2 minute, apiculate, erect auricles on the sides representing the lateral lobes of the lip. *Column* 7-9 × 2-4 mm. broad, oblong, produced in front at the apex into 2 broad, subentire, apiculate wings ; back of the deep clinandrium produced into an apiculum to which the back of the anther is attached ; foot broad, slightly curved, at right angles to the column, about 2-3 mm. long. *Anther* cells about 1 × 1 mm., with a horn 1-2 mm. long, slender ; pollinia 4, waxy, in pairs, oblong. *Stigmatic surface* deep seated. *Capsules* 12-14 × 12 mm., ovoid-orbicular ; *pedicels* about 7 mm. long, curved ; the capsule with 6 strong, 1-2 mm. deep grooves.

Flowering : Feburary to March. *Fruiting :* November.

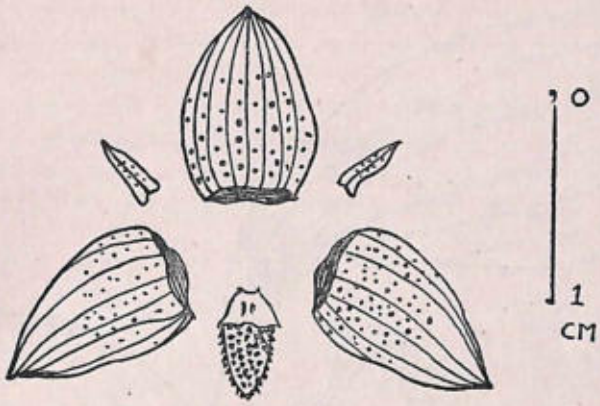
Occurrence in Bombay State : N. KANARA : Castle Rock, *Kapadia* 2819-2820 ; Siddhapur, *Kapadia* 2358-2359 ; Anmod, *Kapadia* 1864 ; Jog, *Kapadia* 1844-1845.

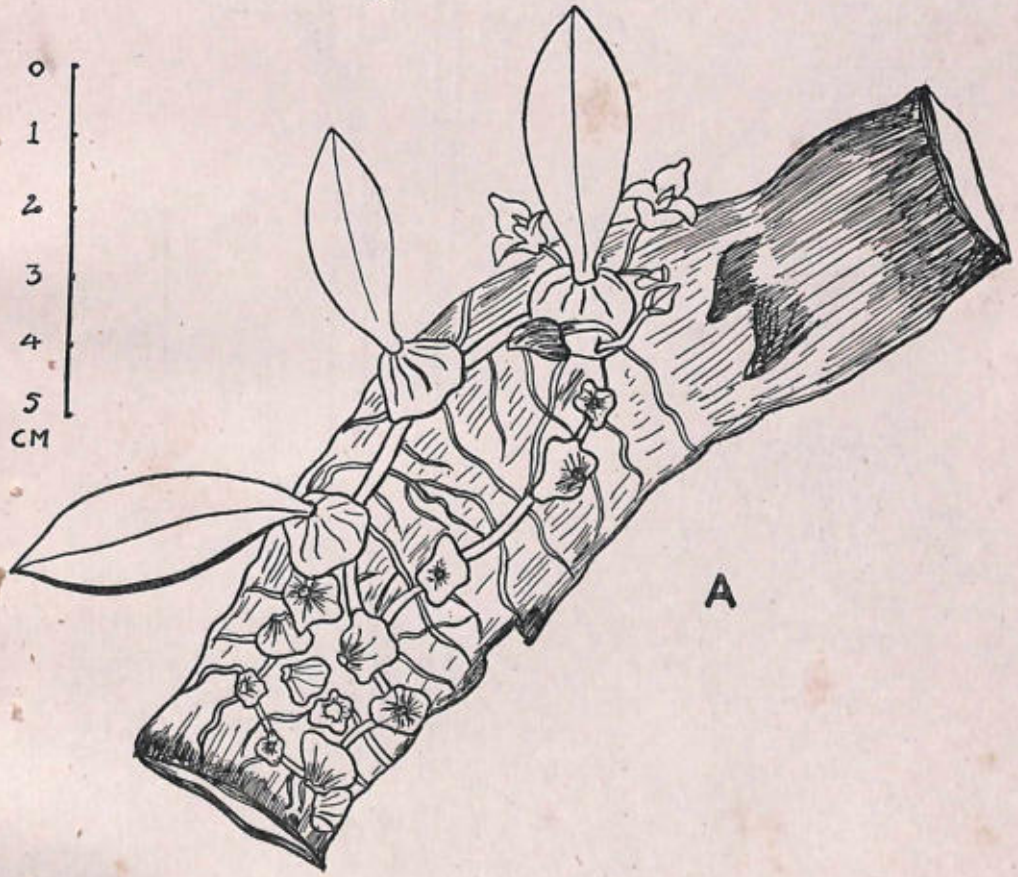
Distribution : Apparently endemic in N. Kanara and the Konkan parts of Bombay State.

Notes : A few flowering specimens of this species were given to us by Prof. Ladhwa of Karnatak College, Dharwar, for which we are very grateful ; they have been of real help in framing our description.

15. *GEODORUM* Jacks.

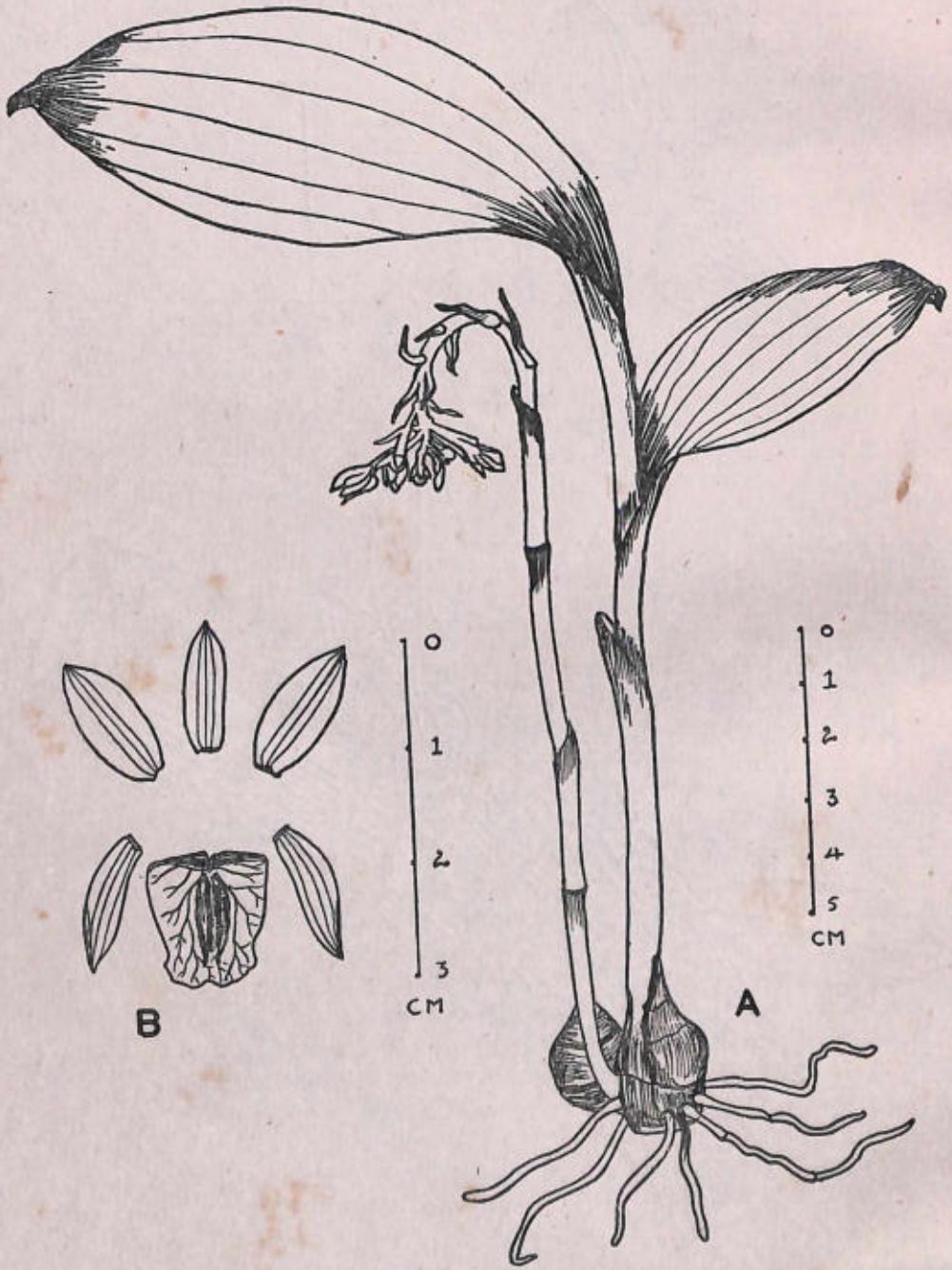
GEODORUM Jacks. in Andr. Bot. Rep. t. 626, 1810; Endl. Gen. Pl. 200, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 538, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 156, 1889 ; Hook. f. Fl. Brit. Ind. 6 : 16, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 181, 1898 ; Duthie, ibid. 9 (2) : 130, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 222, 1905 ; Schltr. Orchid. 340, 1927 ; Holttum, Rev. Fl. Malaya 1 : 534, 1953.





Trias stocksii Benth.

A. Plant with support. B. Sepals and petals disected.



Geodorum densiflorum Schltt.

A. Whole plant. B. Sepals and petals dissected.

The generic name *Geodorum* is derived from the Greek words *ge* = the earth, and *doron* = a gift, meaning a gift of the earth, in allusion to its terrestrial habit.

A small genus of about 10 species distributed from India, Ceylon, Burma, Malaya, and Java to Australia.

The species on which the genus *Geodorum* was erected is *G. citrinum*; this, therefore, must be considered the type species.

Type species : *G. citrinum* Jacks.

Geodorum densiflorum (Lam.) Schltr. in Fedde, Repert. Beih. 4 : 259, 1929 ; Fischer, Fl. Pres. Madr. 1437, 1928 ; Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 487, 1931. *Limodorum densiflorum* Lam. Encycl. 3 : 516, 1791-1792. *L. recurvum* Roxb. Pl. Corom. 1 : 33, t. 39, 1795, et Fl. Ind. 3 : 469, 1832. *L. nutans* Roxb. Pl. Corom. 1 : 34, t. 40, 1795, et Fl. Ind. 3 : 469, 1832 (?). *Malaxis nutans* Willd. Sp. Pl. 4 : 93, 1805 (?). *M. cernua* Willd. Sp. Pl. 4 : 93, 1805 ; Graham Cat. Bom. Pl. 203, 1839. *Geodorum purpureum* R. Br. in Ait. Hort. Kew. ed. 2, 5 : 207, 1813 ; Spreng. Syst. Veg. 3 : 726, 1826 ; Dalz. & Gibs. Bomb. Fl. 266, 1861 ; Hook. f. 16 ; King & Pantl. 181, t. 245 ; Duthie 130 ; J. J. Smith 222, f. 163 ; Holttum 535. *G. dilatatum* R. Br. in Ait. Hort. Kew. ed. 2, 5 : 207, 1813 ; Spreng. 726 ; Wight, Icon. 3 (2): 10, t. 912, 1844-1845; Hook. f. 17; Grant, Orch. Burma 233, 1898; Prain, Beng. Pl. 1017, 1903 ; Cooke, Fl. Pres. Bomb. 2 : 695, 1907 ; Gammie in Journ. Bombay nat. Hist. Soc. 18 : 587, 1908; Haines Bot. Bih. Or. 1170, 1924 ; Duthie, Fl. Upp. Gang. Pl. 3 : 203, 1920. *G. recurvum* (Roxb.) Alston in Trimen, Handb. Fl. Ceyl. 6 : 276, 1931. (See Plate L.)

Terrestrial *herbs*. *Pseudobulbs* tuberous, ovoid-conical, ± regular in shape, greenish-brown with transverse circular bands, about 5 × 3 cm. *Leaves* 1 or 2, forming a pseudostem about 16 mm. tall, and 1-1.4 cm. thick; the leaves 11-40 × 5-10 cm., sheathing at base, subplicate, many-nerved, obovate-oblong, elliptic or elliptic-lanceolate, acute, entire, the upper ones tapering into a long narrow petiole. *Scape* 28-32 cm. tall, arising from the tuber away from the leaves, green, terete, with a few oblong-lanceolate sheaths; the apical part decurved. *Inflorescence* about 4 cm. long, a compact subcorymbose raceme, facing downwards. *Flowers* 1.5 cm. long, pinkish-white or white, opening very little, bracteate, shortly pedicellate. *Bracts* 1.2-1.4 × 0.2-0.3 cm., lanceolate, acute or subacuminate, entire, glabrous, 3-nerved, green. *Sepals* 12 × 4 mm., pure white or white flushed with very pale mauve, more so in the basal regions, acute, entire, 3-nerved ; dorsal sepal obovate-oblong, slightly broader ; lateral ones suboblique, narrowly oblong, somewhat keeled. *Petals* 12 × 6 mm., similar to sepals but slightly broader, elliptic-

oblong, acute, entire, 3-nerved. *Lip* attached all along to the foot, forming a 5 mm. deep, concave, rounded trough, flattening out a little at the apex ; in colour white flushed with pale pink or mauve on the outside as sepals and petals, the inside with deep purple veins on the sides, a central yellow disc bordered with deep mauve and with 2 thin purple veins in the centre of the disc. The lip 12 mm. long, 10 mm. broad on flattening, deltoid-oblong in outline, obscurely 3-lobed ; lateral lobes broad, subentire, middle one crenulate, emarginate. *Column* 5 × 2 mm., white, subclavate, minutely puberulous, produced upwards from behind into an apiculum to which the back of the anther is attached ; clinandrium white with a central faint, transverse, pink line. *Foot* short, broad above, narrowing downwards, margined and tipped with deep mauve. *Anther* 2-2.5 mm. broad, suborbicular, dorsal surface very pale yellow, with the flaps purple-margined. *Stigmatic surface* broad, pure white. *Ovary* with *pedicel* 0.8-1 cm. long, green, clavate, ribbed, not twisted.

Flowering : June.

Occurrence in Bombay State : KONKAN : *Stocks ; Law ; Dalzell* ; S. Konkan, *Graham*; Ghats in S. Konkan, *Stocks*; Wari Country, *Dalzell & Gibson*; Cultivated in St. Xavier's College Garden, *Kapadia* 2921. N. KANARA : Kalanadi, *Ritchie* ; Yellapur-Arbail, *Kapadia* 2044.

Distribution : Considerable confusion has resulted in the synonymy of this species since Roxburgh's publication of 2 species of *Limodorum*, *L. recurvum* and *L. nutans*. In his FLORA INDICA he distinguishes *L. nutans* from *L. recurvum* in the following way : 'Here (*L. nutans*) the bulbs are smooth, there striated. Here the leaves are oval, there lanceolate ; here the scape is longer than the leaves, there not half as long. Here the spike is oblong, and pendulous, there globular retrofracted. Here the flowers stand at some distance from one another, there they are crowded. Here they are of a beautiful rose colour, there white. Here the lip is sharp-pointed, there circular and crenulate.'

R. Brown based his *G. purpureum* and *G. dilatatum* on Roxburgh's plates of *Limodorum nutans* and *L. recurvum*, of which unfortunately no specimens exist.

The inflorescence scape is definitely known to elongate after flowering, as has been pointed out by King & Pantling, and has been observed by us. The flower colour varies from rose-purple to pure white ; our specimens, when first collected, had fairly deep rose-purple flowers ; the next year in cultivation the flowers were white. Therefore, it seems that the only significant characteristic between *L. nutans* and *L. recurvum* which cannot be easily accounted for, is the '. . sharp-pointed tip . .' of the lip. Hooker f. remarks that the characters described for *L. nutans* Roxb. such as scape longer than the leaves, a lax-flowered

raceme, and an acute lip have not hitherto been found in any *Geodorum*. Further : ' . . if it be allowed that the elongate scape and lax-flowered raceme are due to the lengthening of the axis of the scape after flowering, and that the appearance of an acute lip is due to the infolding of its margins towards the apex, then *G. purpureum* is the commonest and widest-distributed Indian species. Dalzell & Gibson alone identify a plant with *G. purpureum* Br., and I have examined authentic specimens of it, which they did not, for they give Brown's characters for this species, whilst those of their specimens are what I have given above.' (i.e. the tip of the lip 2-lobed, not acute). Thus Hooker f. while showing the very close similarity between these two species, keeps them apart and refers the Deccan plants to *G. purpureum*.

Cooke, following Prain, calls our Bombay plants *G. dilatatum* Br., since it is under this name that the lip is referred to as obtuse and 2-fid at the apex and not acute. He further adds : 'In his " Flora Indica ", v. 3 (1832) p. 469, Roxburgh again describes the lip of *Limodorum nutans* as acute and cites Rheede (Hort. Mal. v. 11, t.; 35), who however in his figure of *Bela-Pola* shows the lip as subpandurate, obtuse and 2-fid at the apex. The lip as figured by Rheede corresponds exactly with the lip of *G. dilatatum*.' Therefore it seems that Roxburgh himself was not very sure of the species. Further Cooke adds : 'After spending much time over drawings and descriptions, I have come to the conclusion indicated by Sir J. Hooker (Trimen's Fl. Ceyl. v. 4, p. 179) that *G. dilatatum* and *G. purpureum* are both forms of one species, and as Brown's description of *G. dilatatum* fits the plant better than his description of *G. purpureum*, the former name has been adopted.'

It may be pointed that all the authors describing this species under the name of *G. purpureum* R. Br., including King & Pantling, J. J. Smith, and Holttum, give the lip as obtuse, emarginate or 2-fid at the apex, not sharp-pointed or acute. It does seem probable that the true form described and figured by Roxburgh as *Limodorum nutans* (= *G. purpureum* R. Br.) with a sharp-pointed or acute lip has not been met with after Roxburgh ; its very existence seems to be questionable.

16. *CYMBIDIUM* Sw.

CYMBIDIUM Sw. in Nov. Act. Sc. Upsal. 6 : 70, 1799 ; Endl. Gen. Pl. 199, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 536, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 184, 1889 ; Hook. f. Fl. Brit. Ind. 6 : 8, 1890 ; King & Pantl. in Ann. in R. Bot. Gard. Calcutta 8 : 184, 1898 ; Duthie, ibid. 9 (2) : 133, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 475, 1905 ; Hook. f. Fl. Brit. Ind. 6 : 8, 1890 ; Schltr. Orchid. 354, 1927 ; Holttum, Rev. Fl. Malaya 1 : 513, 1953.

The generic name *Cymbidium* is derived from the Greek *kyme*=boat, in allusion to the hollowed boat-shaped base of the lip in many of the species.

This genus consists of about 50 species, found in Madagascar, in Asia from Ceylon and India to Japan, and through Malaysia to Australia.

Cymbidium aloifolium Sw. in Nov. Act. Upsal. 6 : 73, 1799 ; Roxb. Fl. Ind. 3 : 458, 1832 ; Graham, Cat. Bomb. Pl. 203, 1839 ; Wight, Icon. 5 (1) : 11, tt. 1687-8, 1851 ; Dalz. & Gibs. Bomb. Fl. 266, 1861 ; Hook. f. 10 (partim) ; King & Pantl. 189, t. 252 ; Duthie 136, et Fl. Upp. Gang. Pl. 3 : 206, 1920 ; J. J. Smith 482, f. 367 ; Cooke, Fl. Pres. Bomb. 2 : 696, 1907 ; Gammie in Journ. Bombay nat. Hist. Soc. 18 : 586, t. 5, 1808 ; Blatt. & McC. ibid. 35 : 487, 1931 ; Brühl, Guide Orch. Sikk. 115, 1926 ; Fischer, Fl. Pres. Madr. 1436, 1928. *C. bicolor* Hook. f. Fl. Brit. 6 : 11, 1890 ; Alston, Kandy Fl. 75, f. 400, 1938 (an Lindl. 1833 ?).

Robust *epiphytes*, the roots forming a dense, thick matting over the support. *Pseudobulbs* 4-6 cm. long, ovoid, sheathed by the leaf bases. *Leaves* 20-55 × 1-3 cm., coriaceous, oblong, entire with a prominent midnerve, tapering at the base into a petiole 4-10 cm. long, which is marked by a transverse deep green line ; apex notched, with 2 unequal, rounded, lobes. *Inflorescence* 25-45 cm. long, peduncles erect, racemes pendulous, sheathed at the base. *Flowers* bracteate, pedicellate. *Bracts* minute, persistent, ovate to triangular, acute, 2-5 mm. long. *Pedicel* with *ovary* 20-25 mm. long, greenish below, purplish above. *Sepals* 24-27 × 3-4 mm. spreading, vinaceous purple, lanceolate or oblong-lanceolate, entire, acute, 1-nerved ; the lateral ones somewhat falcate. *Petals* 20-22 × 4-5 mm., yellowish, vinaceous in the centre, oblong, acute, often subfalcate, entire, 1-nerved. *Lip* 16-20 mm. long, somewhat saccate at base, 3-lobed ; lateral lobes 7 × 2-3 mm., oblong-obtuse, entire, mottled with brown-purple ; midlobe 8-10 × 6-8 mm., broadly ovate, acute, sub-entire, much recurved, yellow with broad purple stripes. The throat of the lip with 2 yellow calli. *Column* about 12 mm. long, clavate, vinaceous-brown all along inside, except near top. *Anther* 3 × 2 mm., 2-celled, broadly oblong ; pollinia 2, waxy, yellow, obliquely oblong with a small gland which tapers at the ends. *Capsules* 6.5 × 2.5 cm. ovoid, elliptic, deep green longitudinally and shallowly grooved ; pedicels 10-12 mm. long.

This description is after detailed field observations of H. Santapau.

Flowering : May. *Fruiting :* June onwards.

Occurrence in Bombay State : KONKAN : *Stocks ; Law ;* S. Konkan, *Dalzell* ; Ghats and the hilly parts of the Konkan, *Graham* ; Alibag, *Dalzell & Gibson* ; ? Salsette, *Dalzell & Gibson.*

N. KANARA : Tamboli, near Sawantwadi, *F. X. Miranda* ; Sirsi, *Woodrow* ; *Santapau* 18662-18664 ; *Hallberg & McCann* 35196 ; Chandwar, *Ritchie* ; Kalanadi, *Ritchie* ; Gundh, *J. Fernandez* 1522; *Kapadia* 1722-1724; Siddhapur, *Kapadia* 2372-2374 ; Dandeli, *Kapadia* 1676.

Distribution : India : Sikkim, Bengal, Assam, Andaman Islands, Konkan, N. Kanara, and all the hilly tracts of south peninsular India. *World :* India, Ceylon, Burma, S. China, and southwards to Sumatra and Java.

Notes : Dalzell & Gibson give Salsette as one of the localities for this species. No subsequent worker has been successful in re-locating it in this area ; the species seems to be more or less restricted to the districts of N. Kanara.

C. aloifolium Sw. has often been confused with *C. pendulum* Sw., *C. bicolor* Lindl. and *C. simulans* Rolfe.

King & Pantling have clearly shown the differences between *C. aloifolium* Sw. and *C. pendulum* Sw. ; these two species were founded on figures and not on actual plants ; the first was based on Rheede's plate (*Hort. Mal.* 12 : t. 8), which was named *Epidendrum aloifolium* by Linne (*Sp. Pl.* 953, 1753). *C. pendulum* was based on *Epidendrum pendulum* Roxb. (Pl. Cor. 1 : t. 44).

Hooker f. united the 2 species after a study of the herbarium material, which has little to distinguish them. But King & Pantling having had an opportunity to observe them in nature kept them apart, putting down the differences as follows: 'The plants as they grow, which they do side by side in Sikkim, appear so different that we have kept up both as a species. The sepals and petals of *C. aloifolium*, as we have figured, are yellowish, each having a broad mesial purple strip. Upper surface of the lip is purple, with darker lines of the same colour and a patch of whitish at the base of the apical lobe. The outer surface is yellowish and striped only on the apical lobe. It has broader, blunter, more coriaceous leaves than *C. pendulum* and their apices are notched ; the peduncle of the raceme being erect while the raceme itself is decurved ; whereas in *C. pendulum* the peduncle is decurved from its origin from the stem.'

From a careful study of the literature, *C. bicolor* Lindl. does not seem to be a distinct species. Hooker f., though maintaining the 2 species as different, finds difficulty in keeping them apart and says : 'I am much puzzled with this (*C. aloifolium* Sw.) and the following species, (*C. bicolor* Sw.), which appear to differ in so far as my copious materials show, only in the comparative length of the epichile and hypochil of their lips, and in their geographical ranges, *aloifolium* being strictly northern and eastern, and *bicolor* as strictly western. These characters would be absolute were it not that Rheede's figure of the

Malabar plant has the lip of *aloifolium*.' As noted by Hooker f. himself, *C. aloifolium* Sw. is a very variable species. It should, therefore, include the slight variations in the comparative lengths of the hypochil and epichile.

Lindley under his *C. bicolor* cites the Javanese *C. aloifolium* Bl. (*Bijdr.* t. 19.); the latter has been partly included under *C. pubescens* Lindl. by J. J. Smith.

From these considerations it seems very doubtful if *C. bicolor* Lindl. can be considered an independent species, the Indian and Ceylon plants being probably equal to *C. aloifolium* Sw., and the Javanese ones, to *C. pubescens* Lindl.

Holttum has fused *C. simulans* with *C. aloifolium*. Edward Cooper (in *Dist. Gard.* 2 : 610, 1951) has the following note under *C. aloifolium*: ' Distinct from *C. simulans* by spikes erect, midlobe of lip long, acute . . . Probably not in cultivation. *C. aloifolium* of gardens is a synonym of *C. simulans*.'

H. Santapau has noted this plant as very common and remarkably abundant on roadside trees in the neighbourhood of Haliyal in North Kanara ; most trees at the main fork of their branches held a clump over 1 m. in diameter ; due to their position along the road, most plants were densely covered with dust. Lately the sap of the leaves has been shown to have highly valuable styptic properties ; this seems to have caused the disappearance of the plant from some of its former areas.

17. *CHILOSCHISTA* Lindl.

CHILOSCHISTA Lindl. in Bot. Reg. sub. t. 1522, 1832, nom. nud. et Gen. Sp. Orch. 219, 1833, cum descr. ; Endl. Gen. Pl. 204, 1837 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 216, 1889 ; J. J. Smith, Fl. Buitenz. 6 : 533, 1905. *Sarcochilus* sect. *Chiloschista* Benth. & Hook. f. Gen. Pl. 3 : 575, 1883 ; Hook. f. Fl. Brit. Ind. 6 : 37, 1890.

The generic name *Chiloschista* seems to be derived from the Greek words *cheilos* = lip, and *cheista* shaped like the Greek letter X, in allusion to the shape of the lip.

A very small genus with but a few species (probably 2 or 3) found in India, Nepal, Ceylon and Java.

King & Pantling (in *Ann. R. Bot. Gard. Calcutta* 8 : 206, 1898) have included this genus under *Sarcochilus* R. Br. with the following note : ' . . has the characters of the genus as we believe Robert Brown originally constituted it, and which occur in the only species which he described, viz. *S. falcatus*. These characters are the presence in the lip of two very large side lobes and of a very short anterior lobe, together with the total absence of a spur '. They further add under

Sarcochilus luniferus Benth. ex Hook. f. : 'in the structure of its flowers this exactly agrees with *Sarcochilus falcatus* R. Brown, as figured by Fitzgerald in his Orchids of Australia, part 5. Brown's generic description is a very brief one, and contains nothing that does not fit this plant, which without hesitation we refer to *Sarcochilus*, as Brown defined it'.

Schlecter (in *Die Orchid.* 533, 1927) has also united *Chiloschista* Lindl. with *Sarcochilus* R. Br.

We have followed Pfitzer, J. J. Smith and others in the recognition of *Chiloschista* Lindl. as an independent genus. Pfitzer considers the leafless habit sufficient for keeping the genus distinct. J. J. Smith distinguishes *Chiloschista* Lindl. from *Sarcochilus* R. Br. by the lateral sepals, petals and lip of the former being inserted on the column-foot, whereas in the latter genus only the lip is inserted on the foot of the column.

Type species : *C. usneoides* Lindl.

Chiloschista lunifera J. J. Smith, Fl. Buitenz. 6 : 553, 1905 & f. 169, 1912. *Sarcochilus luniferus* Hook. f. in Bot. Mag. t. 7044, 1889 et Fl. Brit. Ind. 6 : 37, 1890 ; Grant, Orch. Burma 302, 1895 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 207, 1898. *Chiloschista glandulosa* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 488, 1932. (*Chilochista*).

Small, leafless *epiphytes*. *Roots* greyish-green, up to 2 mm. thick, ± radiating in all directions ; in the absence of leaves the roots seem to have taken up the function of photosynthesis. *Stem* 0. *Scape* 2-4 cm. long, from the centre of the root cluster, thin at base, gradually thickening upwards, jointed, bracteate, the lower portion glabrous, the upper glandular-pubescent, hairs white, minute, conical. *Flowers* minute, 2-4, bracteate, almost sessile. *Bracts* 2.5 × 2 mm. ovate in outline, subentire, gland-dotted, strongly 1-nerved, with a small apiculum. *Sepals* unequal, entire, 5-nerved ; dorsal sepal 5 × 2 mm. obovate-oblong, obtuse ; lateral ones 3.5 × 2.5 mm. broadly oblong, subacute. *Petals* slightly longer than the lateral sepals, broadly truncate, rarely with a minute mucro at the apex. *Lip* superior, inflexed on the foot of the column, 3-lobed ; lateral lobes more than twice as long as the midlobe, curving upwards and inwards ; on spreading the lip has a small pouch-like depression just at the base of the midlobe. Midlobe of lip 1.5 × 1.5 mm., broadly obovate, truncate, slightly emarginate ; the 2 lobules woolly-white. *Column* very short, with a foot which is incurved, stout, 2 mm. long. *Anther* broad, obcordate, mucronate, 2-celled; pollinia 2, obovate, slightly compressed, deeply grooved with short extensible caudicles. *Ovary* pale brown,

7 mm. long, glandular-pubescent. *Capsules* 13 × 3 mm. purplish-brown, curved, tapering at base, somewhat 4-angled at apex, with minute, erect, conical, white, hairs.

The colour details of the flowers given by Blatter & McCann are as follows : sepals and petals yellow spotted and blotched irregularly and often densely with brown-red ; column white, with foot purple-blotched ; anther yellowish.

Flowering : January to March. *Fruiting :* March to June.

Occurrence in Bombay State : N. KANARA : Karwar, *Bell* ; Dandeli, *Bell* ; Yellapur, *Bell*; *Kapadia* 2869 ; Joida-Dandeli, *Kapadia* 2767.

Distribution : India : Sikkim, N. Kanara. *World :* India, Burma, and Java.

Notes : Our specimens of *Chiloschista glandulosa* Blatt. & McC. exactly agree with the description and figures of *C. lunifera* J. J. Sm. as given by J. J. Smith and King & Pantling. The only difference seems to lie in the fact that the scape of the N. Kanara plants never reaches the large size of 20 cm. or more as found in Sikkim and Javanese plants.

There seems to be very little difference between this species and *C. usneoides* Lindl., as has been pointed by Hooker f., who however, keeps them apart merely on the basis of colour difference in flowers. J. J. Smith is of opinion that the two species may be identical.

18. *RHYNCHOSTYLIS* Bl.

RHYNCHOSTYLIS Bl. Bijdr. 285, 1825 (*Rhynchostylis*) ; Benth. & Hook. f. Gen. Pl. 3 : 574, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 218, 1889 ; Hook. f. Fl. Brit. Ind. 6 : 32, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 213, 1898 ; Duthie, ibid. 9 (2) : 143, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 628, 1905 ; Schltr. Orchid. 546, 1927 ; Holttum, Rev. Fl. Malaya 1 : 697, 1953.

The generic name *Rhynchostylis* is derived from the Greek *rhynchos* = beak, and *stylos* = column or pillar, in allusion to the column which is beak-like.

This is a small genus of about 4 or 6 species, distributed from India to Malaya, Java and Philippines.

The closer allies of this genus are *Saccolabium* Bl. and *Aërides* Lour. *Rhynchostylis* can be distinguished thus : (1) the lip is scarcely lobed ; (2) the lip is not sharply distinguished from the column-foot ; (3) the spur is backward-pointing and laterally compressed ; and (4) the rostellum is strongly beaked. Holttum has pointed out that when not in flower, the pale lines on the leaves serve to distinguish the plants of this genus. We have, however, observed that dry speci-

mens of *Vanda testacea* Reichb. f. and *V. tessellata* Hook. ex G. Don show pale longitudinal lines on the leaves.

When the genus *Rhynchostylis* was erected by Blume, he included 2 species, *R. retusa* and *R. praemorsa*, under it. The two species are now considered to be synonymous. Consequently *R. retusa* Bl. can be taken as the type species of the genus.

Type species : *R. retusa* Bl.

Rhynchostylis retusa (L.) Bl. Bijdr. 286. t. 49, 1825 ; Hook. f. 32 ; Grant, Orch. Burma 290, 1895 ; King & Pantl. 213, t. 284 ; Duthie 143, et Fl. Upp. Gang. Pl. 3 : 209, 1920 ; Prain, Beng. Pl. 1020, 1903 ; J. J. Smith 629, f. 471 ; Cooke, Fl. Pres. Bomb. 2 : 698, 1907 ; Gammie in Journ. Bombay nat. Hist. Soc. 18 : 833, t. 7, 1908 ; Blatt. & McC. ibid. 35 : 490, 1932 ; Haines, Bot. Bih. Or. 1178, 1924 ; Brühl, Guide Orch. Sikk. 128, 1926 ; Fischer, Fl. Pres. 1440, 1928 ; Santapau in Rec. Bot. Surv. Ind. 16 (1) : 302, 1953 ; Holttum 697. *Epidendrum retusum* L. Sp. Pl. 953, 1753. *Aërides retusum* Sw. in Schrad. Journ. 2: 233, 1799 ; Willd. Sp. Pl. 4 : 130, 1805 ; Graham, Cat. Bom. Pl. 204, 1839. *A. guttatum* Roxb. Fl. Ind. 3 : 471, 1832. *Saccolabium guttatum* Lindl. [in Wall. Cat. 7308, 1832, nom. nud. et] Gen. Sp. Orch. 220, 1833, cum descr., et Journ. Linn. Soc. 3 : 32, 1858 ; Wight, Icon. 5 (1) : 19, tt. 1745-46, 1851 ; Dalz. & Gibs. Bomb. Fl. 263, 1861. *Gastrochilus retusus* (L.) O. Kuntze, Rev. Gen. Pl. 2 : 661, 1891.

Epiphytes. *Stem* sheathed, stout, about 7 mm. thick. *Leaves* coriaceous, channelled, up to 30 × 2 cm., with a sharply-pointed praemorse apex. *Racemes* dense, cylindric, drooping, up to 30 cm. long ; peduncles about 6 cm. long, and 2-3 mm. thick, terete, with a few membranous, brown, sheathing bracts. *Flowers* pale pink with deeper-coloured spots, pedicellate, bracteate. *Bracts* 3-4 × 2 mm. persistent, membranous, oblong-lanceolate, acute, entire, glabrous. *Ovary* whitish or pale pink, spotted with deeper-coloured spots. Dorsal *sepal* 7 × 5 mm. ovate-oblong, obtuse, entire, glabrous, faintly many-nerved; lateral sepals 8 × 7 mm. obliquely and broadly oblong, somewhat decumbent on the column-foot, acute. *Petals* 7 × 3 mm., of same colour as sepals, oblong, tapered at apex and base, entire, glabrous. *Lip* pink-purple, whitish at base, curved upwards and forwards, about 9 mm. long, 2-2.5 mm. broad at the base, the lower half oblong, widening upwards to 7 mm., apex emarginate. *Spur* 6-7 × 2 mm. laterally compressed, pinkish, ± oblong and at right angles to ovary. *Anther* small, pink. *Capsules* 1.5-2 × 0.7-1 cm., obovoid-oblong, winged ; *pedicels* 12-15 mm. long, subclavate; *capsules* usually reflexed.

Flowering : May to June. *Fruiting :* July onwards.

Occurrence in Bombay State : KONKAN: *Stocks*; Salsette, *Dalzell & Gibson*; Thana, *Ryan*; Bhiwandi, *Santapau* 233.2; Chandal-Karjat, *Blatter & Hallberg*; Karjat, *Kapadia* 1953-1955; Malad, *Shah* 4625-4627, 4630; Kasara, *Kapadia* 900. DECCAN: Lanze on Kolhapur-Ratnagiri Road, *Bhide*. N. KANARA: W. of Dharwar, *Mrs. Wilkinson* 4018; Kalanadi, *Ritchie*; Yellapur, *Santapau* 18705.

Distribution : India : Tropical Himalaya from Punjab eastwards to Sikkim up to about 1200 m., Assam, Khasia Hills, Chota Nagpur, Konkan, Kanara, W. Ghats, Deccan, Malabar. *World :* India, Nepal, Bhutan, Ceylon, Burma, Malay Peninsula, Siam, Java, Philippines.

Notes : This species is commonly known as the 'Fox-tail orchid'. Considerable variations in the colour and shape of the floral parts have been recorded ; such variations seem to be more or less local and have often been made the basis of specific or varietal distinctions.

(*To be continued*)

The Birds of Nepal

PART 7

BY

BISWAMOY BISWAS
Zoological Survey of India, Indian Museum, Calcutta

[*Continued from Vol.* **59** (1) : 227]

Subfamily PARADOXORNITHINAE

*548. **Conostoma aemodium** Hodgson. Great Parrotbill.

The Nepali records of this parrotbill consist of collections by Hodgson (Gray & Gray, 1846, p. 102) and Eccles (in Gould coll., see Sharpe, 1883, p. 485), and observation by Smythies (1948, p. 440) in the Gandak-Kosi watershed, central Nepal, at *c.* 3350 m. in autumn.

*549. **Paradoxornis unicolor unicolor** (Hodgson). Brown Suthora or Parrotbill.

The only record of the Brown Parrotbill from Nepal since Hodgson's time is to be credited to Ripley (1950b, p. 393) who obtained a single example out of a small flock in Dhankuta district, eastern Nepal, at *c.* 2865 m. in winter.

*550. **Paradoxornis fulvifrons fulvifrons** (Hodgson). Fulvousfronted Suthora or Parrotbill.

The sole post-Hodgsonian record of the Fulvousfronted Parrotbill from Nepal is due to Stevens (1923b, p. 727) who found it on Singalila Range, eastern Nepal, at *c.* 2745-2895 m. in April-May.

*551. **Paradoxornis nipalensis nipalensis** (Hodgson). Ashy-eared Suthora or Parrotbill.

Since Hodgson's early record, Smythies (1950, p. 513) was the first to report the Ashy-eared Parrotbill from Nepal. He observed

it on Phulchauki Danda, Nepal Valley, at *c.* 2590 m. The first post-Hodgsonian collection of this form from Nepal was, however, made by Fleming (see Rand & Fleming, 1957, p. 126) from Phulchauki Danda, Nepal Valley, at *c.* 2715 m. in April-May.

This parrotbill is said to occur in Nepal only (Baker, 1922d, p. 109), or as restricted by Ripley (1961, p. 370) in 'Central Nepal in the hills adjacent to the Kathmandu Valley'. There is, however, a specimen (♀) in the Koelz collection taken at Girgaon, Kumaon, on June 7, 1948. It is, therefore, quite possible that it occurs from Kumaon all the way east at least to the Nepal Valley, in suitable locations.

*552. **Paradoxornis nipalensis humei** (Sharpe). Blackfronted Suthora or Parrotbill.

The Blackfronted Parrotbill was recorded from Nepal for the first time by Stevens (1923b, p. 726) in the Mai Valley, eastern Nepal, at *c.* 2285 m. in March, and subsequently by Ripley (1950b, p. 393) on Tinjuré Danda, Dhankuta district, eastern Nepal, in winter.

Gray's (1863, p. 37) definite statement (entered under *Suthora poliotis*) that Hodgson's specimens came from Darjeeling was apparently overlooked by Sharpe (1883, p. 487). He did not designate any specific type locality for *humei*, but listed Hodgson's specimens (as coming from Nepal) first, followed by skins from Sikkim and the 'Himalaya'. We may, therefore, accept the locality of Hodgson's specimens, Darjeeling, as the type locality. Any restriction of the type locality within Nepal, such as Ilam district by Ripley (1961, p. 370) is, therefore, untenable. This form was unknown from Nepal until Stevens found it there and it was so reported by him.

*553. **Paradoxornis flavirostris flavirostris** Gould. Gould's Parrotbill.

The only definite record of this parrotbill from Nepal appears to be based on Gould's original specimen which, however, was entered as from 'N.E. India' by Sharpe (1883, p. 496). It was not listed in the catalogue of Hodgson's earlier collection (Gray & Gray, 1846), and in that of the later collection (Gray, 1863, p. 60) it was entered without locality, listing only a drawing. Sharpe (loc. cit.), however, mentioned a specimen from 'Nepal tarai' presented by Hodgson.

Ripley (1961, p. 373) gives the range of this form as from eastern Nepal eastward. There is, however, nothing on record to suggest that Gould's specimen was taken in eastern Nepal.

Subfamily SYLVIINAE

554. **Tesia cyaniventer** Hodgson. Slatybellied Wren-Warbler.

BHABAR : Amlekhganj : 1 (♂), 2 ♀♀ (March 7, 8). MARKHU VALLEY: Deorali : 2 ♂♂ (May 1, 2). CHITLANG VALLEY : Chitlang : 1 (♂), 3 ♀♀, 1 (♀) (April 18-25). NEPAL VALLEY : Thankot : 3 ♂♂ (April 1-10).

The Slatybellied Wren-Warbler is not uncommon in central Nepal in dense bushy undergrowths of forests from the bhabar right up to the Nepal Valley.

Scully (1879) did not find it in Nepal. Ripley (1950b, p. 403) recorded it from *c.* 150 to 1830 m. in western, central, and eastern Nepal. Proud (1955, p. 65) found it very common in the Nepal Valley at *c.* 1525-1830 m. Rand & Fleming (1957, pp. 172-173) reported it only from west-central Nepal at *c.* 915 m. in winter.

Measurements :

	Wing	Tail	Bill
7 ♂♂ :	51 (2), 51.5, 52, 53, 53.5, 54	19 (2), 20 (4), 21.5	15 (5), 15.5, —
6 ♀♀ :	47, 47.5, 48, 49 (3)	16.5, 17, 17.5, 18 (2), —	14.5 (2), 15 (2),— (2)

555. **Oligura castaneocoronata castaneocoronata** (Burton). Chestnut-headed Wren-Warbler.

CHITLANG VALLEY : Chitlang : 3 ♂♂, 3 ♀♀ (April 16-26). NEPAL VALLEY: Thankot : 4 ♂♂, 3 ♀♀, 3 unsexed (March 15-30).

This wren-warbler was occasionally found by us in dense undergrowths on the Chandragiri both on Thankot and Chitlang sides.

Scully (1879) did not report it from Nepal. Stevens (1924a, p. 1013) found it in the Mai Valley, eastern Nepal, at *c.* 2440 m. and upwards in April-May. Smythies (1950, p. 515) noted it as a probable resident bird on Phulchauki Danda, Nepal Valley, above *c.* 2440 m. Rand & Fleming (1957, p. 172) recorded it from west-central and central Nepal at *c.* 915-2895 m.

Measurements :

	7 ♂♂	6 ♀♀	3 unsexed
Wing :	47, 48, 49 (3), 50 (2)	47 (2), 47.5, 48 (2), 49	48, 48.5, 49
Tail :	26 (2), 26.5 (2), 27, 27.5, 28	23, 24 (2), 24.5, 25, 26	24.5, 25, 27
Bill :	12.5 (2), 13 (3), 13.5, 14	12.5 (3), 13, — (2)	13 (2), —

Delacour & Jabouille (1930) separated the Tonkin birds as *abadiei*, Deignan (1951, p. 3) described the birds from Szechwan and north-western Yunnan as *ripleyi*, and Koelz (1954, p. 11) named the population from Mizo district (=Lushai Hills), Assam, as *regia*. While there can be no doubt as to the validity of *abadiei*, I am not sure about *ripleyi* and *regia*. I have examined only four specimens from Yunnan, which measure: W/T1: 49/25, 52/29, 52.5/—, 57/34, the smallest bird (unsexed) coming from Shweli-Salween Divide. The

differences in coloration do not appear to be well marked in my specimens (see also Rand & Fleming, loc. cit.). I have not examined any example from Mizo district, but the description of *regia*, as given by Koelz, is very vague: it does not say how *regia* differs from *ripleyi* and from *abadiei*, nor does it give any measurements of *regia*. Ripley (1961, p. 441) treats *regia* as a synonym of nominate *castaneo-coronata*.

556. **Cettia pallidipes pallidipes** (Blanford). Blanford's Bush Warbler.

TARAI: Simra: 1 ♀ (March 4). BHABAR: Amlekhganj: 1 ♀ (March 7). DUN: Hitaura: 1 ♂, 1 unsexed (May 11, 16).

Blanford's Bush Warbler appeared to us rather scarce in Nepal. It occurred in scrub and grassy patches in the tarai, bhabar and dun of central Nepal.

Neither Scully (1879), nor Rand & Fleming (1957) found it in Nepal, but Ripley (1950b, p. 404) recorded it from western Nepal.

Measurements:

	Wing	Tail	Bill
1 ♂:	51	42	14
2 ♀♀:	52 (2)	41.5, 43	14, 14.5
1 unsexed:	52	42	14

Ripley's example, a female, was quite a large bird, wing 57.5.

*557. **Cettia montana fortipes** (Hodgson). Strongfooted Bush Warbler.

*558. **Cettia major major** (Moore). Large Bush Warbler.

Both these bush warblers do not seem to have been recorded from Nepal since Hodgson's days.

559. **Cettia flavolivaceus flavolivaceus** (Hodgson). Aberrant Bush Warbler.

DUN: Bhimphedi: 1 ♂ (March 11). MARKHU VALLEY: Deorali, Kulikhani: 2 ♀♀ (April 28, 29). CHITLANG VALLEY: Chitlang: 1 ♂, 1 ♀ (April 18, 24). NEPAL VALLEY: Thankot: 1 ♂, 6 ♀♀, 3 unsexed (March 22—April 4, 14).

The Aberrant Bush Warbler is not uncommon in dense bushes and undergrowths of forests in central Nepal from about 1220 to 1830 m.

Scully (1879) and Ripley (1950b) failed to find it in Nepal. Stevens (1924a, p. 1028) recorded it from the Singalila Range, eastern Nepal, at *c.* 3050 m. in May. Proud (1955, p. 65) reported it from Pokhara, west-central Nepal, at *c.* 760-1830 m., and on the new road west of the Nepal Valley at *c.* 915 m. in winter. Rand & Fleming (1957, p. 171) also found it in west-central Nepal and the Nepal Valley.

One of my male specimens, taken on March 11, has the throat in moult, and an unsexed specimen of April 14 has its forehead in moult.

Measurements :

	3 ♂♂	9 ♀♀	3 unsexed
Wing :	53, 56.5, 57	50 +, 50.5, 51 (2), 51.5, 52.5 (2), 53, 54.5	52, 55, 55.5
Tail :	56 (2), 57	50, 50 +, 51, — (2), 53 (2), 53.5, 55.5	53.5 +, 56, 56.5
Bill :	14 (3)	13 (3), 13.5, 14 (2), 14.5, — (2)	13.5, 14 (2)

*560. **Cettia acanthizoides brunnescens** (Hume). Hume's Bush Warbler.

The only definite record of Hume's Bush Warbler from Nepal appears to be Stevens's (1924a, p. 1028), based on a single example from the Singalila Range, eastern Nepal, taken on April 29 at *c.* 3050 m.

The only catalogue that listed Hodgson's material, after the publication of Hume's description of this bird, was that of the British Museum collection, in which Hume's *brunnescens* was given only in the synonymy of *Cettia fortipes* and as many as 15 specimens of Hodgson from Nepal were mentioned there (Seebohm, 1881, p. 137). It is possible that some of those specimens are in fact *C. a. brunnescens*.

561. **Cettia brunnifrons brunnifrons** (Hodgson). Rufouscapped Bush Warbler.

BHABAR : Amlekhganj : 1 ♀ (March 8). MARKHU VALLEY : Deorali : 1 ♂, 3 ♀♀ (April 30-May 1). CHITLANG VALLEY : Chitlang : 1 ♂, 2 ♀♀, 1 unsexed (April 17-26). NEPAL VALLEY : Thankot : 1 ♀ (April 6).

This bush warbler was not uncommonly observed by us in central Nepal in dense bushes, scrub and undergrowths of forests. It was rather difficult to observe owing to its skulking habits.

Scully (1879) did not find it in Nepal. Stevens (1924a, p. 1029) reported it from the Mai Valley, eastern Nepal, at *c.* 2440 m. upwards in March-May.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	45, 47	43.5, 45	11.5, 12
7 ♀♀ :	45 (2), 45.5, 46 (2), 47 (2)	42 +, 44 (3), 45, 46.5, 47	11 (3), 11.5 (4)
1 unsexed :	47	44 +	11.5

I am unable to agree with Vaurie (1954d, pp. 5-6) in treating this species as monotypic. The characters of *whistleri* Ticehurst seem to be well substantiated (see also Ripley, 1961, p. 445).

*562. **Bradypterus thoracicus thoracicus** (Blyth). Spotted Bush Warbler.

The only post-Hodgsonian report of the Spotted Bush Warbler from Nepal has been furnished by Rand & Fleming (1957, p. 171) who obtained a single specimen (a female) from *c.* 455 m. in eastern Nepal in December.

*563. **Bradypterus luteoventris luteoventris** (Hodgson). Brown Bush Warbler.

This bush warbler does not seem to have been recorded from Nepal since Hodgson's days.

*564. **Hippolais caligata caligata** (Lichtenstein). Booted Warbler.

The Booted Warbler has not been reported from Nepal since Hodgson's time.

Seebohm (1881, p. 86) listed two Hodgson skins in the British Museum, one of which was entered as from 'Behar', and the other from Nepal. This latter specimen was also the 'Type of *Hypolais swainsoni* Hodgson' which has been known to be a synonym of *Phylloscopus nitidus* Blyth!

Ripley (1961, p. 468) gives it as a passage migrant through Nepal.

*565. **Graminicola bengalensis bengalensis** Jerdon. Large Grass Warbler.

*566. **Megalurus palustris toklao** (Blyth). Striated Marsh Warbler.

The only records of the occurrence of these warblers from Nepal appear to be those of Rand & Fleming (1957, pp. 171-172) who found them in the western tarai in winter.

*567. **Phragamaticola aëdon aëdon** (Pallas). Thickbilled Warbler.

The only post-Hodgsonian record of the Thickbilled Warbler from Nepal has been provided by Ripley (1950b, p. 404) who took a single example at Chatra, eastern Nepal tarai, in winter.

[**Chaetornis striatus** (Jerdon). Bristled Grass Warbler.

I have not been able to trace any authentic record of the occurrence of this warbler from Nepal, although 'Nepal terai' has been included in its range by Ripley (1961, p. 463).]

568. **Acrocephalus dumetorum** Blyth. Blyth's Reed Warbler.

Acrocephalus dumetorum Blyth, 1849, *J. Asiat. Soc. Beng.* **18**: 815. (No locality; type specimen from the vicinity of Calcutta where the type locality is hereby restricted.)

DUN : Hitaura, Bhimphedi : 2 ♂♂, 6 ♀♀, 1 unsexed (May 3-24). MARKHU VALLEY : Kulikhani : 1 ♂ (April 28). NEPAL VALLEY : Thankot : 1 ♂, 1 ♀ (April 9, 12).

We came across this reed warbler in small numbers in bushes, hedges and scrub from the central dun to the Nepal Valley during spring and summer. In contrast to Rand & Fleming's observation (1957, p. 171), we found it to be commoner in the dun during May than it was in the Valley during spring.

Scully (1879) did not find it in Nepal, and Rand & Fleming (loc. cit.) recorded it also from the eastern tarai in winter.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	60, 61, 62, 65.5	51, 53, 54, 55	17 (2), 17.5 (2)
7 ♀♀ :	60 (2), 61 (2), 61.5, 62, 66	50, 51 +, 52 (3), 54, 54.5	16.5, 17 (2), 17.5, 18 (3)
1 unsexed :	62	53	17

569. **Acrocephalus agricola agricola** (Jerdon). Paddyfield Warbler.

TARAI : Simra : 1 ♂ (March 4).

We encountered the Paddyfield Warbler only once in central Nepal, in reeds near Simra. Proud (1949, p. 708) noted it in the Nepal Valley only on passage in spring. Neither Scully (1879), nor Ripley (1950b) or Rand & Fleming (1957) reported it from Nepal.

Measurements : 1 ♂ : Wing 56 ; tail 56 ; bill 16.

*570. **Acrocephalus stentorius brunnescens** (Jerdon). Indian Great Reed Warbler.

Hodgson's collection of the Indian Great Reed Warbler forms the sole record of its occurrence in Nepal.

*571. **Phylloscopus collybita tristis** Blyth. Siberian Chiffchaff.

The post-Hodgsonian records of the Siberian Chiffchaff from Nepal consist of Proud's (1949, p. 708) observation in the Nepal Valley as a common winter visitor, and Rand & Fleming's (1957, p. 164) report from western, west-central, central and eastern Nepal, in the tarai upwards to *c.* 1370 m. in December, January and April.

*572. **Phylloscopus subaffinis arcanus** Ripley. Western Buffbellied Leaf Warbler.

The Buffbellied Leaf Warbler (*Phylloscopus subaffinis*) had been unknown in Nepal until Ripley (1950a, p. 105; 1950b, p. 400) discovered it from the western and central parts of the country. The only other report of this form is a doubtful sight record from the Nepal Valley by Proud (1955, p. 64).

573. **Phylloscopus affinis** (Tickell). Tickell's Leaf Warbler.

NEPAL VALLEY : Thankot : 2 ♂♂, 1 unsexed (April 10-24).

This leaf warbler was found by us in small numbers in scrub, shrubs on the edges of forests or on wayside bushes of the Nepal Valley in March and April.

It was reported from the Valley on passage in spring and autumn by Scully (1879, p. 307) and Proud (1949, p. 708; 1955, p. 62). It was also recorded from western and eastern Nepal in winter by Ripley (1950b, p. 400); from the Gandak-Kosi watershed, central Nepal, also on passage in late March by Proud (1952a, p. 364); from Manangbhot, northern central Nepal, at *c.* 3655-4265 m. in summer by Lowndes (1955, p. 33); and from Khumbu, eastern Nepal, at *c.* 3655 m. in March, and preparing to breed at *c.* 4265-4570 m. in April by Biswas (1960a).

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	56, 63	46, 51	12.5, —
1 unsexed :	59	48	12.5

*574. **Phylloscopus fuscatus fuligiventer** (Hodgson). Smoky Leaf Warbler.

Rand & Fleming's (1957, p. 165) report of this leaf warbler from the western tarai constitutes its only record for Nepal since Hodgson's days.

I concur with Vaurie (1954c, pp. 9-10) that *P. fuligiventer* (Hodgson), *P. tibetanus* Ticehurst, *P. weigoldi* Stresemann and *P. fuscatus* (Blyth) are best considered conspecific. However, Ripley (1961, pp. 475-476) treats *tibetanus* conspecific with *fuligiventer* and *weigoldi* with *fuscatus*.

575. **Phylloscopus fuscatus fuscatus** (Blyth). Dusky Leaf Warbler.

NEPAL VALLEY : Kathmandu : 1 unsexed (March 23).

The Dusky Leaf Warbler was found by us to be very uncommon in central Nepal. The few that were observed were found in March around Kathmandu on bushes, hedges and on small trees, especially those with small leaves.

Scully (1879) was unable to find it in Nepal; and Ripley (1950b, p. 400) and Rand & Fleming (1957, p. 165) took only single examples in eastern Nepal in winter.

Measurements : 1 unsexed : Wing 57 ; tail 48 : bill 12.5.

*576. **Phylloscopus pulcher kangrae** Ticehurst. Western Orangebarred Leaf Warbler.

This western form of the Orangebarred Leaf Warbler is known from Nepal only through Ripley's (1950b, p. 401) and Rand & Fleming's (1957, pp. 165-166) records from western Nepal in winter. The latter authors also listed an eastern Nepal specimen from Bahaduri, obviously due to oversight, under this form.

577. **Phylloscopus pulcher pulcher** Blyth. Eastern Orangebarred Leaf Warbler.

Ph. [*ylloscopus*] *pulcher* ' Hodgson ' Blyth, 1845, *J. Asiat. Soc. Beng.* **14** : 592. (Nepal, hereby restricted to Nepal Valley ; earlier restriction to eastern Nepal by Ripley, is not admissible. See discussion below.)

Phylloscopus erochroa G. R. Gray in J. E. & G. R. Gray, 1846, Catal. spec. drawings mamms. birds Nepal pres. Hodgson Brit. Mus. 152. (Nepal, restricted to Chandragiri Pass, Nepal Valley, by Ripley, 1950b, p. 401.)

DUN : Bhimphedi : 1 ♀ (March 14). CHITLANG VALLEY : Chitlang : 1 ♂, 6 ♀♀ (March 15, April 16-20). NEPAL VALLEY : Thankot, Chandragiri above Thankot : 7 ♂♂, 7 ♀♀, 2 unsexed (March 21—April 6).

The Orangebarred Leaf Warbler is common in central Nepal from the dun to the Nepal Valley on bushes and trees in forests during March and April.

Stevens (1924a, p. 1020) found it in the Mai Valley, eastern Nepal, at *c.* 2135-3050 m. in March-April. In the northern regions of central Nepal, it was recorded by Proud (1952a, p. 364) in the Gandak-Kosi watershed at *c.* 2440-3505 m. in spring, and Polunin (1955, p. 892) in the Langtang Valley at *c.* 3505 m. in summer. It was reported in eastern Nepal also by Ripley (1950b, p. 401) from Dhankuta district, and by Biswas (1960a) from Khumbu at *c.* 3810-4265 m. in April-May, and at *c.* 1525 m. in the Arun watershed in June.

Some of my March female specimens are moulting. Four of them taken on March 14, 21, 25 and 28 have moulting forecrown, the last mentioned bird having in addition, moulting central tail feathers. Another specimen taken March 22 also has the central tail feathers moulting.

One of my female specimens, taken March 30, showed signs of enlargement of its ovary.

Colours of soft parts : Iris dark brown ; upper mandible black ; lower mandible dark horny with yellowish on base, gape and sides ; legs, feet and claws horny, pads dull chrome yellow.

Measurements :

	8 ♂♂	14 ♀♀	2 unsexed
Wing :	56, 58(3), 60(3), 61	52 (2), 52+, 52.5, 53(2), 54(3), 55(2), 56, 56.5,57	52, 60
Tail :	40, 42, 43.5, 44(3), 44.5, 45	37(2), 38, 39(4), 40, 41, 42,—(4)	37, 44
Bill :	12, 12.5(2), 13(4), 13.5	12(5), 12.5(8), 13	12, 13

I am unable to agree with Ripley (1950b, p. 401) in reviving Gray's name *erochroa* for the birds from the Nepal Valley east to the Arun river. The difference between the specimens of Nepal Valley and of Sikkim-Darjeeling is very slight indeed, and I agree with Rand & Fleming (1957, p. 165) that a name at each end of the cline, namely *kangrae* and *pulcher*, are enough.

Ripley (op. cit., p. 400) restricted the type locality of the nominate *pulcher* to Ilam district, eastern Nepal, because he assumed that 'many of Hodgson's specimens of this period (1845, when Blyth's description of *pulcher* was published) came from east Nepal and Sikkim'. As a matter of fact, however, Blyth's description of *pulcher* was based on Hodgson's specimens registered at the Museum of the Asiatic Society of Bengal in 1844, that is, *before* Hodgson returned from England to live in Darjeeling. Blyth's types undoubtedly formed parts of Hodgson's earlier collection which was divided into several lots and presented to the principal museums of the world from time to time. It would appear that Blyth described *pulcher* from the lot received by the Asiatic Society of Bengal, and Gray provided a description to Hodgson's nomen nudum, *erochroa*, using material from the lot received by the British Museum. There can be no doubt, therefore, that *pulcher* Blyth and *erochroa* Gray represent one and the same subspecies. Furthermore, Hodgson's specimens of this form were most probably obtained in the Nepal Valley where he had been living and where it is very common. Ripley's restriction of the type locality of *pulcher* to Ilam district is, therefore, untenable.

578. **Phylloscopus inornatus humei** (Brooks). Green Leaf Warbler.

MARKHU VALLEY: Deorali: 1 unsexed (May 1). CHITLANG VALLEY Chitlang: 3 ♂♂, 5 ♀♀ (April 17-26). NEPAL VALLEY: Kathmandu, Thankot: 10 ♂♂, 8 ♀♀, 4 unsexed (March 21—April 9).

This leaf warbler is perhaps the commonest of all warblers in central Nepal during March-April at *c.* 1220 m. and above. It occurs on the edges of forests, in villages, as well as in the gardens of Kathmandu town. Although Scully (1879, p. 308) and Proud (1949, p. 708; 1955, p. 63) found it common in the Nepal Valley from October to April, Ripley (1950b, p. 401) noted it 'on passage from the edge of the Terai up to the Valley in central Nepal in late April, and again in mid-November'. Rand & Fleming (1957, p. 166) listed specimens taken in the Nepal Valley in February and April, and in western, west-central and eastern Nepal in December-January.

The coloration of the upper parts, particularly the crown, in my central Nepal specimens (as well as in many specimens from other

areas in India) is somewhat variable. Specimens range from being brownish on forehead to crown, sometimes with olive (see also Scully, op. cit., p. 307), and back and rump green with a brownish wash, to very green coloration as figured by Seebohm (1881, pl. 4, fig. 1). I am unable to correlate this colour variation with age, sex, season or locality of the specimens.

One of my specimens (♂, March 21) has the chin and throat in moult. All the sexed March-April specimens had non-breeding gonads.

Colours of soft parts : Iris dark brown ; upper mandible very dark horny ; lower mandible fleshy or light brown with dark horny tip ; legs horny to dark horny; feet and claws horny to pale horny; pads yellowish white.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	55, 56, 58(2)	41, 42(2),—	11, 11.5, 12(2)
5 unsexed :	52, 53, 55, 56, 60	37, 40(2), 41, 42	10.5(2), 11.5, 12, 12.5

*579. **Phylloscopus inornatus inornatus** (Blyth)[1]. Yellowbrowed Leaf Warbler.

Proud's (1955, p. 63) is the only report of the Yellowbrowed Leaf Warbler from Nepal. She observed it in fair numbers on passage through the Nepal Valley in spring and autumn, when she obtained specimens there.

*580. **Phylloscopus proregulus simlaensis** Ticehurst. Ticehurst's Leaf Warbler.

Ripley (1950b, p. 401) was the first to record Ticehurst's Leaf Warbler for Nepal. He found it at *c.* 275 and 1525 m. in western Nepal in winter. The only other record of this form from Nepal is Rand & Fleming's (1957, p. 166) who took specimens in winter at *c.* 290 m. in western and at *c.* 915 m. in west-central Nepal.

581. **Phylloscopus proregulus chloronotus** (G. R. Gray). Nepal Leaf Warbler.

DUN : Bhimphedi : 1 ♀ (March 11). CHITLANG VALLEY : Chitlang : 1 ♂, 1 ♀, 1 unsexed (March 15, April 21). NEPAL VALLEY : Thankot : 5 ♂♂, 2 ♀♀, 1 unsexed (March 22—April 2).

[1] The type locality of *Regulus inornatus* Blyth [= *Ph. inornatus* (Blyth)] was given by Ticehurst (1938, p. 100) as ' near Calcutta ', presumably based on specimens of this form entered in the Catalogue of the Asiatic Society's collection (Blyth, 1849, p. 184). However, the specimens from the neighbourhood of Calcutta were received by the Society in 1844, that is, two years *after* the description of the species was published. Besides, Blyth (1842, p. 192) stated after the description of *inornatus* : ' Locality of the specimen unknown, but I am told that this inhabits the vicinity of Darjeeling '. Furthe more, in the paper in which the description of *inornatus* was published, Blyth was mainly reporting on a collection of birds made by Dr. Pearson from the vicinity of Darjeeling. The type locality of *Regulus inornatus* Blyth should, therefore, be taken as the vicinity of Darjeeling.

We came across this leaf warbler not uncommonly in small parties in scrub and lighter parts of forests of central Nepal above 1370 m. in March-April.

From the northern regions of central Nepal, it was reported by Lowndes (1955, p. 33) in Manangbhot at *c.* 3655 m. in summer. In eastern Nepal, it was found by Ripley (1950b, p. 401) in Dhankuta district during winter, and by Biswas (1960a) in Khumbu breeding at *c.* 3960-4265 m. in April-May.

The forecrowns in two of my specimens (♀, March 11; ♂, March 26) are in moult.

Colours of soft parts : Iris dark brown ; upper mandible very dark horny ; lower mandible yellowish fleshy with dark horny tip (*cf.* Alexander, 1955, p. 297) ; legs light horny ; feet light horny, sometimes with a yellowish tinge ; claws light horny with darker tips ; pads light yellow.

Measurements :

	Wing	Tail	Bill
6 ♂♂ :	48, 53(3), 55, 58	37.5, 39, 40(3), —	10(2), 10.5(2), 11(2)
4 ♀♀ :	49(3), 50	35(2), 36(2)	9.5, 10, 10.5(2)
2 unsexed :	50, 55	37, 40	9.5, 10

582. **Phylloscopus maculipennis maculipennis** (Blyth). Eastern Greyfaced Leaf Warbler.

MARKHU VALLEY : Deorali : 1 ♂ (May 2). NEPAL VALLEY : Thankot : 1 ♂ (April 1).

The Greyfaced Leaf Warbler is not a common bird of central Nepal during March-May. It occurs on bushes as well as on large trees in forests above *c.* 1525 m.

Scully (1879) did not find it in Nepal. Ripley (1950b, p. 401) collected it in western, central and eastern Nepal. Polunin (1955, p. 892) reported it from the Langtang Valley, central Nepal, at *c.* 2745-3350 m. in summer. Proud (1955, p. 63) observed it on the hills bordering the Nepal Valley. Rand & Fleming (1957, pp. 166-167) found it in western, central and eastern Nepal at *c.* 1675-2895 m. in winter.

Measurements : 2 ♂♂ : Wing 50, 51 ; tail 37, 40 ; bill 10.5, —.

I am unable to recognize Ripley's *centralis* (type locality Rekcha, Dailekh district, western Nepal), for it represents merely the centre of a small but gradual and continuous cline. See also Vaurie (1954c, p. 17; 1959a, p. 287) and Rand & Fleming (1957, p. 167), who also came to the same conclusion regarding *centralis*.

583. **Phylloscopus magnirostris** Blyth. Largebilled Leaf Warbler.

BHABAR : Amlekhganj : 1 ♂, 1 ♀ (March 6, 8). DUN : Hitaura, Bhimphedi : 5 ♂♂ (May 7-20). MARKHU VALLEY : Deorali : 1 ♂, 3 unsexed (April 28-May 1). CHITLANG VALLEY : Chitlang : 1 unsexed (April 27).

We found the Largebilled Leaf Warbler common in central Nepal in May, but only occasionally during March-April, and none in June. It occurs on bushes and on trees in the opener parts of forests.

Scully (1879) and Ripley (1950b) did not include it in their lists. Proud (1949, p. 709) found it occasionally in the Nepal Valley on spring passage, and later (1955, p. 63) noted it also in August-September there. Rand & Fleming (1957, p. 167) obtained a single specimen from the Nepal Valley in April.

A female specimen taken on March 6 is undergoing pre-nuptial moult.

Measurements :

	7 ♂♂	4 unsexed (probably all ♀♀)
Wing :	62.5+, 68, 69, 70, 71, 72.5, 73	63, 63.5, 64, 65
Tail :	52(2), 52.5, 54, 55, 56(2)	52, 52.5, 53, 54
Bill :	13.5, 14.5, 15(2), 15.5, 16(2)	14(2), 14.5, —

Two specimens (1 ♂, Hitaura, Dun, May 17; 1 ♀, Deorali, Markhu Valley, April 30—not listed above) could not be separated from *P. magnirostris* on coloration, but are appreciably smaller (close to *P. t. trochiloides*). They measure:

	Wing	Tail	Bill
1 ♂ :	59	48	15
1 ♀ :	60	50	13

*584. **Phylloscopus trochiloides viridanus** Blyth. Greenish Leaf Warbler.

We had not been able to find the Greenish Leaf Warbler in Nepal. Scully (1879, p. 306) reported it as fairly common in the Nepal Valley in winter till the beginning of May. Ripley (1950b, p. 402) noted it as one of the commonest leaf warblers in central Nepal from the tarai up to *c.* 1830 m., and recorded it also from eastern Nepal in winter. Proud (1955, p. 64) reported it as abundant on passage through the Nepal Valley in March-May and in autumn. Rand & Fleming (1957, pp. 167-168) found it in western and eastern Nepal at *c.* 275-290 m. in winter, and at *c.* 305-2285 m. in central Nepal during April and May.

585. **Phylloscopus trochiloides trochiloides** (Sundevall). Dull Green Leaf Warbler.

DUN : Hitaura, Bhimphedi : 1 ♂, 1 ♀, 3 unsexed (May 5-12). MARKHU VALLEY : Deorali : 3 ♂♂, 1 ♀, 2 unsexed (April 29-May 2).

This leaf warbler was found by us in small numbers in the forests on the Mahabharat Range and the duns of central Nepal during April-May.

It was reported from central Nepal in the Nepal Valley by Scully (1879, p. 307) late in May, Proud (1955, p. 64) on April 30 and in September-October, and Rand & Fleming (1957, p. 167) in April; in the Gandak-Kosi watershed by Proud (loc. cit.) breeding at 2895-3655 m.; in Manangbhot by Lowndes (1955, p. 33) at *c.* 2440-3960 m. in summer; and in the dun by Rand & Fleming (loc. cit.) in April. In eastern Nepal, it was reported by Stevens (1924a, p. 1024) from the Mai Valley at *c.* 2590 m. on April 27; Ripley (1950b, p. 402) from the Kosi Valley at *c.* 150 m. in February; Rand & Fleming (loc. cit.) from the Kamala Valley at *c.* 275 m. in December; and Biswas (1960a) in Khumbu breeding at *c.* 4265 m. in early May.

Measurements :

	Wing	Tail	Bill
4 ♂♂:	62, 63, 64(2)	50, 51(2), —	13(2), 13.5(2)
2 ♀♀:	57, 60	45, 46	13(2)
5 unsexed:	56, 59, 61, 62.5, 65	44, 47, 49(2), 50	13(2), 13.5, 14, 14.5

The Baltistan form of the species, *P. t. ludlowi* Whistler, has been included in her Nepal list by Proud (loc. cit.) on the basis of a single breeding male specimen taken on Sheopuri (Nepal Valley) at *c.* 2440 m. on May 31, in spite of the fact that it was identified by the late Sir Norman Kinnear 'as an intergrade between this race [*ludlowi*] and *P. t. trochiloides*'. Furthermore, Proud's (loc. cit.) thesis that since 'it was in forest and fairly low, it would in any case not overlap with *trochiloides* which is not found in summer below 10,000 ft. and usually in more open country—small bush type of country' is not borne out by Scully's (loc. cit.) observation and ours: specimens of *trochiloides* were taken by us in May at as low as 455 m. (1500 ft.).

Phylloscopus trochiloides ludlowi Whistler should, therefore, be removed from the Nepal list.

586. **Phylloscopus nitidus** Blyth. Bright Green Leaf Warbler.

CHITLANG VALLEY: Chitlang: 1 ♀ (April 21). NEPAL VALLEY: Thankot: 2 ♂♂, 3 ♀♀, 2 unsexed (April 10-14).

We found the Bright Green Leaf Warbler in small numbers in the Chitlang and Nepal valleys during April. It was observed usually singly among foliages of trees on the edges of forests.

It may be noted that all the recorded collections of this species in Nepal (Scully, 1879, p. 306; Ripley, 1950b, p. 402; Rand & Fleming, 1957, p. 168) are dated April, and that all are from central Nepal. Scully (loc. cit.) held that it was found in the Nepal Valley on passage to and from its winter quarters, but Proud (1955, p. 64) noted it on passage only in spring.

Measurements[1] :

	Wing	Tail	Bill
3 ♂♂ :	64(2), 65	48, 49, 51	13.5, 14(2)
4 ♀♀ :	58, 60, 62(2)	43, 46(2), 47	13.5, 14.5(2),—
2 unsexed :	62, 64	46, 49	14, —

587. **Phylloscopus occipitalis occipitalis** (Blyth). Large Crowned Leaf Warbler.

MARKHU VALLEY : Deorali : 1 ♂ (May 1).

The only specimen of the Crowned Leaf Warbler found by us in Nepal was in a mixed feeding party with the Yellowcheeked Tit (*Parus xanthogenys*), Greyheaded Flycatcher (*Culicicapa ceylonensis*), etc., in the canopy of a large oak tree at Deorali.

As far as I can ascertain, this species has not so far been obtained in Nepal[2]. Proud (1949, p. 709), however, observed it in the Nepal Valley as a scarce passage migrant in spring.

Measurements : 1 ♂ : Wing 63 ; tail 51 ; bill 13.5.

588. **Phylloscopus reguloides reguloides** (Blyth)[3]. Blyth's Leaf Warbler.

TARAI : Simra : 1 unsexed (March 6). BHABAR : Amlekhganj : 1 ♀ (March 8). MARKHU VALLEY : Deorali : 2 ♂♂, 1 ♀ (April 29, 30). CHITLANG VALLEY : Chitlang : 1 ♂, 1 ♀ (March 15, April 16). NEPAL VALLEY : Thankot : 7 ♂♂, 1 ♀, 1 unsexed (March 22-April 14).

Blyth's Leaf Warbler was found by us as common in central Nepal during March-April on bushes and trees in dense forests.

Scully (1879) did not include it in his list. Ripley (1950b, p. 402) found it in the western and eastern tarai in winter, and on Chandragiri Pass, central Nepal, in December and April. Polunin (1955, p. 892) reported it from the Langtang Valley, central Nepal, at *c.* 3050 m. in summer. Lowndes (1955, p. 33) recorded it from the Marsiyandi Valley, central Nepal, at *c.* 1980-2440 m. in summer. Proud (1955, p. 64) noted it breeding on the hills round the Valley at *c.* 1220-2440 m. after March. Biswas (1960a) found it breeding in the Dudh Kosi Valley, eastern Nepal, at *c.* 3050 m. in May.

Measurements :

	10 ♂♂	4 ♀♀	2 unsexed
Wing :	56, 57 (2), 58, 58.5 (2), 59, 60 (3)	55, 56, 57, 58	56, 58
Tail :	42, 43 (2), 44 (3), 46, 46.5, 47, 48	40, 42, 43, 45	42, 45
Bill :	12.5 (5), 13 (5)	12.5, 13 (3)	12.5, 13

[1] Including additional Nepalese material present in the Zoological Survey of India.
[2] Under *Ph. occipitalis*, Seebohm (1881, p. 51) listed one Hodgson skin from Nepal in the collection of the British Museum, marked as 'Duplicate type of *Hippolais swainsoni* Hodgs.' which is, however, a synonym of *Ph. nitidus*.
[3] Ripley (1961, p. 484) has shown that the type locality of this species should be taken as Darjeeling and not Calcutta as has been given by Baker (1930, p. 189), Ticehurst (1938, p. 165), Vaurie (1959a, p. 294), among others.

*589. **Regulus regulus himalayensis** Bonaparte ≷ **sikkimensis** R. & A. Meinertzhagen. Nepal Goldcrest.

Very few specimens of the Goldcrest seem to have been taken in Nepal. Those collected in west-central Nepal and in Okhaldhunga district of eastern Nepal by Rand & Fleming (1957, p. 173), as well as the one in the British Museum from northern central Nepal (reported by Vaurie, 1955c, p. 100), are intermediate between the western Himalayan *himalayensis* and the eastern *sikkimensis*. The Nepal Valley birds which Proud (1949, p. 709) saw at *c.* 2440 m. in winter, probably also belong to the intermediate population.

Gadow (1883, p. 82) listed two specimens from Nepal, a female presented by Hodgson, and a male by Gould.

*590. **Regulus regulus sikkimensis** R. & A. Meinertzhagen. Sikkim Goldcrest.

The lone record of the Sikkim Goldcrest from Nepal has been provided by Stevens (1924a, p. 1014), who found it on the Nepal side of the Singalila Range, eastern Nepal, near Tonglu, at *c.* 3050 m. in January.

*591. **Leptopoecile sophiae obscura** Przewalski. Tibetan Tit-Warbler.

The first and the only record of the Tibetan Tit-Warbler from Nepal appears to be Rand & Fleming's (1957, p. 173) who obtained a single specimen, a male, in the Kali Gandak Valley, west-central Nepal, at *c.* 3655 m. in December.

592. **Seicercus burkei burkei** (Burton). Blackcrowned Flycatcher-Warbler.

CHITLANG VALLEY : Chitlang, Chandragiri above Chitlang : 5 ♂♂ (April 17-26). NEPAL VALLEY : Thankot : 10 ♂♂, 2 unsexed (March 21-April 3).

The Blackcrowned Flycatcher-Warbler is common in central Nepal from the Mahabharat Range above Bhimphedi to the Nepal Valley during March-April, in small parties on bushes and trees.

Scully (1879) did not report it from Nepal. Stevens (1924a, p. 1025) found it on the Singalila Range, eastern Nepal, at *c.* 3050 m. in April-May. Proud (1949, p. 709) noted it in the Nepal Valley up to *c.* 2135 m. in winter. Smythies (1950, p. 516) came across it only on Phulchauki Danda, Nepal Valley, above *c.* 2440 m. Ripley (1950b, p. 399) found it in all parts of Nepal from the tarai up to *c.* 1830 m. Polunin (1955, p. 892, reported it from the Langtang Valley, central Nepal, at *c.* 2745 m. in summer. Lowndes (1955, p. 33) recorded it from Manangbhot, central Nepal, at *c.* 2745-3050 m

in summer. Rand & Fleming (1957, pp. 162-163) found it from western to eastern Nepal at *c.* 275-2745 m. in winter and spring.

Most of my specimens taken between March 21 and 29 have the forehead and forecrown in moult.

A male collected on April 17 had non-breeding testes.

Colours of soft parts : Iris very dark brown; upper mandible horny black, paler near the tip and yellowish on the edges and the extreme tip ; lower mandible brownish yellow; legs and feet light horny brown; claws light horny; pads white.

Measurements :

	15 ♂♂	2 unsexed
Wing :	55 (2), 55.5, 56, 57.5 (2), 58 (3), 59 (4), 59.5, 60	57, 58
Tail :	43, 45, 46, 46.5, 47, 49 (2), 50 (3), 51 (2), 52, 53, —	49, —
Bill :	12.5, 13 (11), 13.5 (2), 14	13 (2)

The measurement of the tail, 45 to 46, as given by Baker (1924, p. 487) is obviously very small.

593. **Seicercus castaniceps castaniceps** (Hodgson). Chestnut-headed Flycatcher-Warbler.

MARKHU VALLEY : Deorali : 1 ♀ (April 29). CHITLANG VALLEY : Chitlang : 1 ♂ (March 15). NEPAL VALLEY : Thankot, Chandragiri above Thankot : 4 ♂♂, 2 ♀♀, 1 unsexed (March 23-31, April 14).

This flycatcher-warbler did not appear to us to be particularly common in central Nepal. We found it in small numbers on bushes and trees on the Mahabharat Range and the hills round the Nepal Valley. Smythies (1950, p. 516) also found it scarce, having come across it only once on the Chandragiri in November.

It was also reported from eastern Nepal by Stevens (1924a, p. 1026) in the Mai Valley in April; Ripley (1950b, p. 400) in the tarai, Kosi Valley, in February; and Rand & Fleming (1957, p. 164) at Okhaldhunga, *c.* 2285 m. in December.

One of my female specimens taken on March 15 is marked 'breeding' on its label.

Colours of soft parts : Iris dark brown; upper mandible dark horny, paler on edges and tip ; lower mandible yellowish brown; legs, feet and claws pale greyish horny ; pads white to yellowish white.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	51, 52 (2), 53.5 (2)	40, 41 (2), 42, 43	10,10.5, 11,—(2)
3 ♀♀ :	47,47.5, 50.5	35, 37,38	10.5 (3)
1 unsexed :	50	37	10.5

*594. **Seicercus affinis** Moore. Allied Flycatcher-Warbler.

The record of the Allied Flycatcher-Warbler in Nepal is based on Hodgson's later collection, probably from eastern Nepal (Horsfield & Moore, 1854, p. 341; Gray, 1863, p. 33).

*595. **Seicercus poliogenys** (Blyth). Greycheeked Flycatcher-Warbler.

The sole post-Hodgsonian record of this flycatcher-warbler from Nepal is based on Proud's (1955, p. 65) report. She observed it as very scarce in the Nepal Valley, having come across a few examples only in Kathmandu in November.

*596. **Seicercus xanthoschistos albosuperciliaris** (Jerdon). Western Greyheaded Flycatcher-Warbler.

Rand & Fleming (1957, p. 163) found the western race of the Greyheaded Flycatcher-Warbler in western Nepal at *c.* 275 and 1830 m. in winter, and that forms the only record of this form from Nepal. Ripley's (1950b, p. 399) earlier winter collection from western Nepal was placed by him with the eastern race *xanthoschistos*. I have not myself examined any example from western Nepal, and therefore, am not sure if both the races occur there in winter.

597. **Seicercus xanthoschistos xanthoschistos** (G. R. Gray). Eastern Greyheaded Flycatcher-Warbler.

DUN : Bhimphedi : 3 ♂♂, 1 unsexed (March 11, 12, May 9). MARKHU VALLEY: Deorali : 3 ♂♂ (April 30, May 1). CHITLANG VALLEY: Chitlang, Chandragiri above Chitlang : 7 ♂♂, 2 ♀♀, 1 unsexed (March 31, April 17-26). NEPAL VALLEY : Thankot, Godavari : 5 ♂♂, 7 ♀♀, 2 unsexed (March 23—April 13, May 10).

The Eastern Greyheaded Flycatcher-Warbler is common on hills round the Nepal Valley, and both sides of the Chandragiri and the Mahabharat ranges during March-May. It usually occurs on shrubs or lower branches of trees along mountain trails and on the edges of forests, generally above *c.* 1220 m.

Polunin (1955, p. 893) recorded it from the Langtang Valley, central Nepal, at *c.* 2745 m. in summer. Rand & Fleming (1957, p. 163) reported it from west-central and eastern Nepal at *c.* 1370-1525 m. in December.

Two males taken on March 11 and 12 were marked 'breeding' on the labels, and two other males of April 17 and 21 had fully breeding testes.

Colours of soft parts : Iris brown to dark brown ; upper mandible dark horny to almost black, paler on tip and/or edges ; lower mandible brownish yellow ; legs feet, and claws pale horny to horny brown ; pads white.

Measurements :

	Wing	Tail	Bill
18 ♂♂ :	54 (3), 55 (2), 56 (7), 56.5, 57 (4), 58	42 (4), 43 (3), 43.5, 44 (8), 45 (2)	12 (4), 12.5 (7), 13 (6), —
9 ♀♀ :	49, 52 (2), 52.5, 53 (2), 53.5, 54 (2)	39, 40 (4), 40.5, 41, 42 (2)	11.5, 12 (4), 12.5 (2), 13 (2)
4 unsexed :	52, 54, 56, 57	39, 43 (2), 45	12 (3), 13

As has been said under the preceding form, Ripley (1950b, p. 399) placed his western Nepal birds under the nominate race. However, Rand & Fleming (1957, pp. 163-164) identified their western Nepal material as *albosuperciliaris* Jerdon (type locality Kashmir), and the west-central, central and eastern birds as *xanthoschistos*. I have not examined any western Nepal specimen, but as Rand & Fleming have noted, the Nepal Valley specimens are slightly paler than Sikkim examples, but darker than those from Kashmir. Hodgson's collection on which Gray's description of the species was based, was presented to the British Museum in 1843, and must have been collected while Hodgson was still the Resident at Kathmandu. It is quite likely that he obtained those specimens in the Nepal Valley where the type locality of *xanthoschistos* may be restricted.

598. **Abroscopus superciliaris flaviventris** (Jerdon). Yellowbellied Flycatcher-Warbler.

Abrornis albigularis Blyth, 1861, *Proc. zool. Soc. Lond.* : 200. (Sikkim.) Not *Abrornis albogularis* Moore, 1854.

Abrornis flaviventris Jerdon, 1863, Birds India **2** (1) : 203. (Darjeeling, northern West Bengal.) New name for *Abrornis albigularis* Blyth, 1861, preoccupied.

DUN : Hitaura : 5 ♂♂, 2 juv. ♂♂, 5 ♀♀, 2 unsexed (May 11-29).

The Yellowbellied Flycatcher-Warbler was met with by us only in the central dun along the edges and in the lighter parts of forests. The present report represents the only one from Nepal since Hodgson's days. It may be noted that Nepal has not been included within the range of this form by Ripley (1961, p. 488).

One of the juvenile males (May 13) is similar to adult in coloration, but has the forecrown ashy, green of upper side a little darker, yellow on the underside duller, and it still has some down underneath. The other juvenile male (May 29) is a trifle older. It has an almost adult size, brownish grey on forecrown, rufous edges to rectrices, and a little down on the underside.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	50.5 (2), 51, 52 (2)	42, 43 (3), 44	12 (2), 12.5 (3)
5 ♀♀ :	46, 47, 48 (3)	36, 39, 40 (3)	12, 12.5 (2), 13 (2)
2 unsexed :	47, 48	40, 41	12.5, 13

*599. **Abroscopus albogularis albogularis** Moore. Whitethroated Flycatcher-Warbler.

The only record of the Whitethroated Flycatcher-Warbler from Nepal is based on the type specimens that formed a part of Hodgson's later collection. The examples of the species from the same collec-

tion presented to the British Museum have, however, been listed as coming from Darjeeling (Gray, 1863, p. 32).

600. **Abroscopus schisticeps schisticeps** (G. R. Gray). Blackfaced Flycatcher-Warbler.

MARKHU VALLEY: Deorali: 1 ♂, 1 ♀, 2 unsexed (April 30-May 2). CHITLANG VALLEY: Chitlang: 3 ♂♂ (April 16-21). NEPAL VALLEY: Thankot: 7 ♂♂, 1 ♀, 1 unsexed (March 23-April 14)

We found the Blackfaced Flycatcher-Warbler not uncommonly on hills round the Nepal Valley, above *c.* 1525 m.

Scully (1879) did not report it from Nepal, and curiously, other Nepali records (Ripley, 1950b, p. 400; Proud, 1952b, p. 668, 1955, p. 65; Rand & Fleming, 1957, p. 164) all relate to central Nepal only.

Measurements:

	11 ♂♂	2 ♀♀	3 unsexed
Wing:	45.5, 46, 47, 47.5 (2), 48 (4), 49 (2)	46, 47	47,48.5, 49
Tail:	42 (2), 43 (4), 43.5, 44 (3), —	41, 43	43, 45, —
Bill:	10, 10.5 (2), 11 (7), 11.5	11 (2)	11, 11.5, —

*601. **Abroscopus hodgsoni** (Moore). Broadbilled Flycatcher-Warbler.

The only record of the Broadbilled Flycatcher-Warbler from Nepal is based on Hodgson's later collection.

I agree with Ripley (1961, p. 488) that *Tickellia* Blyth is not generically distinct from *Abroscopus* Baker.

602. **Orthotomus sutorius patia** Hodgson. Nepal Tailor Bird.

TARAI: Simra: 1 ♂, 1 ♀ (March 5, 6). BHABAR: Amlekhganj: 1 ♀ (March 8). DUN: Hitaura, Bhimphedi: 11 ♂♂, 1 (♂), 4 ♀♀ (March 11, 12, May 3-25, June 1). NEPAL VALLEY: Thankot, Kathmandu: 6 ♂♂, 2 (♂♂), 2 ♀♀ (March 22-April 8).

The Tailor Bird is very common in central Nepal from the tarai to the Nepal Valley in gardens, orchards, edges of forests about villages, etc., up to about 1675 m.

Ripley (1950b, p. 402) reported it also from eastern Nepal, and Rand & Fleming (1957, pp. 168-169) from western through eastern.

In March-April many birds were undergoing or had just completed the pre-nuptial moult of the tail. It appears that the central tail feathers moult last (tail moult being sometimes continued up to May), except for two specimens (♂♂, March 11, 31) where they moulted first. It is quite possible, however, that those two specimens underwent post-juvenile moult. Such dissimilarity in the sequence of caudal moult between adult and juvenile has been known in *Cisticola* sp.

Birds were breeding in late March and April

Colours of soft parts : Iris yellowish brown ; upper mandible dark horny (once with fleshy on edges) ; lower mandible fleshy (once with dusky on sides and tip); legs and feet fleshy horny to horny brown ; claws horny to horny brown ; pads fleshy white to yellowish white.

Measurements :

	18 ♂♂	3 (♂♂)	8 ♀♀
Wing :	46 (3), 46.5, 47 (2), 47.5, 48 (2), 48.5, 49 (4), 50 (4)	48 (2), 50	44, 45, 45.5, 46 (5)
Tail :	43, 44, 46 (2), 47, 49, 52, 54 (2), 55, 57 (2), 61 (2), —(4)	45 (2), 57	37, 38, 39 (2), 40 (3), 41
Bill :	15 (2), 15.5 (4), 16 (8), 16.5 (2), — (2)		15.5 (2) ,— 15 (4), 15.5 (3) ,—

603. **Prinia socialis stewarti** Blyth. Stewart's Ashy Wren-Warbler.

DUN : Hitaura : 5 ♂♂, 3 ♀♀ (May 19-30).

The Ashy Wren-Warbler is not an uncommon bird in the central duns, occurring in scrub, bushes and grass near cultivation.

Scully (1879) did not record its occurrence in his area. Ripley (1950b, p. 403) and Rand & Fleming (1957, p. 170) found it only in western Nepal.

One of my male specimens (May 19) has the central tail feathers moulting. A female (May 22) has the tail in moult. Another female (May 25) has the right central rectrix in moult, while yet another female taken May 28 still has the sheaths on the bases of the central rectrices.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	47 (2), 48, 49, 51	50, 52, 53, 54 +, —	14 (3), 14.5, —
3 ♀♀ :	45, 46 (2)	52 +, — (2)	13.5, 14 (2)

Ripley (loc. cit.) identified his single specimen from extreme western Nepal as *inglisi* Whistler & Kinnear, 1933 (type locality Bhutan Duars, Jalpaiguri Dist., northern Bengal). It thus extended 'the range of this race [*inglisi*] five hundred miles to the west, presumably throughout the Nepal lowlands'. This he followed up even in his recent publication (1961, pp. 454-455) where Nepal has been excluded from the range of *stewarti* but included under *inglisi*. However, all my eight specimens from the central dun are no doubt *stewarti*. Rand & Fleming (loc. cit.) also obtained a single example from extreme western Nepal, but they did not identify it subspecifically. Extension of the range of *inglisi* on the basis of a single individual is not justified, especially in the light of our data. Ripley's specimen may represent an individual variation, for all we know.

*604. **Prinia subflava fusca** (Hodgson). Nepal Brown Wren-Warbler.

The first post-Hodgsonian record of the Brown Wren-Warbler from Nepal was made by Ripley (1950b, p. 403) who found it in the

western tarai. Subsequently, it was also reported by Rand & Fleming (1957, p. 170) from eastern and western Nepal at *c.* 275 m.

*605. **Prinia sylvatica gangetica** (Blyth). Northern Jungle Wren-Warbler.

Ripley's (1950b, p. 403) report of the Jungle Wren-Warbler from the western tarai appears to constitute the first record of this species for Nepal. Later, Rand & Fleming (1957, p. 170) also found it in western Nepal at *c.* 275 m.

606. **Prinia hodgsoni rufula** Godwin-Austen. Northern Greybreasted Wren-Warbler.

TARAI : Simra : 3 ♂♂ (March 4, 5). BHABAR : Amlekhganj : 1 ♂, 1 ♀ (March 8). DUN : Hitaura, Bhimphedi : 13 ♂♂, 1 ♀, 2 unsexed (May 6-28, June 9).

We noted this wren-warbler common in the tarai, bhabar and dun of central Nepal. It occurred in small flocks during March, but in breeding pairs during May-June on scrub, grass, etc., in jungle clearings and along the edges of forests.

Scully (1879) did not include it in his list. Ripley (1950b, pp. 402-403) reported it from western (up to *c.* 1525 m.), central (including the Nepal Valley) and eastern (up to *c.* 365 m.) Nepal. Rand & Fleming (1957, p. 169) found it in western through eastern Nepal from the tarai up to *c.* 1370 m.

March birds are in very worn winter plumage. One of them (♂, March 5) has the wing in moult.

Late May and June birds had fully breeding gonads.

Colours of soft parts: Iris and edges of eyelids dull brownish orange; bill black ; legs and feet yellowish brown, paler on the hinder aspect of legs; claws horny ; pads white, sometimes with a light brownish wash.

Measurements :

	17 ♂♂	2 ♀♀	2 unsexed
Wing :	44, 46 (2), 46.5, 47 (6), 47.5, 48 (4), 49 ,—	43, 47	43, 47
Tail :	45 (3), 46.5, 47 (3), 47.5, 48 (3), 49, 50, 50 +, 52 +, 55, —	—(2)	39, 45
Bill :	12.5, 13 (4), 13.5 (7), 14 (3), — (2)	13 (2)	13 (2)

*607. **Prinia rufescens rufescens** Blyth. Beavan's Wren-Warbler.

Hodgson's collection provides the only record of the occurrence of Beavan's Wren-Warbler in Nepal. Although there were no specific entries of this species in the catalogues of Hodgson's collection (Gray & Gray, 1846; Gray, 1863), two specimens (one ex Indian Museum) of Hodgson were listed by Sharpe (1883, p. 256).

608. **Prinia criniger criniger** Hodgson. Brown Hill Warbler.

DUN : Hitaura, Bhimphedi : 8 ♂♂, 4 ♀♀,1 subad. ♀ (March 13, May 6-29). MARKHU VALLEY : Deorali : 1 ♂ (April 28). NEPAL VALLEY : Thankot : 1 ♂ (April 13).

The Brown Hill Warbler was found by us in small numbers in central Nepal from *c.* 455 to 1525 m. It occurred in low bushes and scrub.

Polunin (1955, p. 893) reported it from the Trisul and Langtang valleys, central Nepal, at *c.* 1830-2745 m. in summer. Rand & Fleming (1957, p. 170) found it in western, west-central and eastern Nepal at *c.* 1370-2135 m. in winter.

Three of my male specimens taken April 13, 28 and May 6, have long (winter) tails in summer plumage.

The rectrices of two male specimens (May 8, 22) are very worn; those of a female (May 11) are in moult; while in another female bird (May 24) the lateral tail feathers are in moult, but the central ones very worn.

Measurements :

	10 ♂♂	4 ♀♀
Wing :	55, 56, 56 +, 57 (2), 58 (2), 58.5 (2), 59	47, 49, 50, 51
Tail :	90, 92 +, 95, 96 (2), 105, 112 (2), — (2)	74, 84, — (2)
Bill :	14.5, 15 (4), 15.5 (4), —	14 (3), 14.5

Deignan (1957a, p. 25) has shown that *Prinia polychroa* and *P. criniger* are best treated as separate species.

*609. **Prinia gracilis lepida** Blyth. Indian Streaked Wren-Warbler.

The only post-Hodgsonian record of the Streaked Wren-Warbler from Nepal is due to Proud (1955, p. 65) who observed it as a very common bird at *c.* 915 m. on the new road west of the Nepal Valley.

610. **Prinia cinereocapilla** Moore. Hodgson's Wren-Warbler.

DUN : Hitaura : 9 ♂♂, 4 ♀♀, 3 unsexed (May 13-29).

This wren-warbler was found by us to be common in the central dun during May, frequently occurring together with or at locations adjacent to those of *P. hodgsoni rufula.*

Neither Scully (1879) nor Ripley (1950b) reported it from Nepal, but Rand & Fleming (1957, p. 170) obtained it only in western Nepal.

The presence and amount of rufous on the head in my specimens is somewhat variable. These variations may be grouped as follows:

(*a*) A little rufous present, grey feathers fresh.

Rufous may be present on the forehead and along a narrow line over each eye (1 ♂, May 22); or only along a narrow line

over each eye (1 ♂, May 22); or only on forehead (1 ♂, May 26); or on lores only (2 unsexed, May 28, 29).

(*b*) Mixed rufous and grey, some worn some fresh (2 ♂♂, May 14); or all worn feathers (1 ♀, May 16); rufous may be very pale (1 ♀, May 23); or it may be very much reduced (1 ♂, May 29; 2 ♀♀, May 13, 22).

(*c*) Rufous completely absent, grey feathers fresh (3 ♂♂, May 16, 18, 22; 1 unsexed, May 22).

The precise significance of these variations is not understood from my material. Perhaps a study of the plumage sequence from juvenile to adult may explain the variations.

A male specimen (May 14) has the forecrown in moult. One of its right tail feathers, the one next to the central, is also growing. A female (May 23) has its forehead and forecrown moulting. Another male (May 18) has its central tail feathers moulting. The female bird mentioned above and an unsexed specimen (May 22) both have their outer tail feathers growing, the central ones being already grown.

Colours of soft parts : Iris and edges of eyelids yellow ochre with a pinkish tinge ; bill black ; legs and feet yellowish brown ; claws horny ; pads white.

Measurements :

	9 ♂♂	4 ♀♀	3 unsexed
Wing :	42, 42.5 (2), 43, 44 (3), 45, 46	42 (3), 43	42, 44, 45
Tail :	40 (2), 41, 43 (2), 44, 50, —(2)	39, 40, 41.5, 44	45, 47 +, —
Bill :	13 (2), 13.5 (2), 14 (3), —(2)	13.5 (2), —(2)	13, 14 (2)

*611. **Prinia flaviventris flaviventris** (Delessert). Yellowbellied Wren-Warbler.

Hodgson's collection of the Yellowbellied Wren-Warbler constitutes the sole record of its occurrence in Nepal.

*612. **Prinia atrogularis atrogularis** (Moore). Blackthroated Hill Warbler.

Stevens's (1924a, p. 1029) report from the Mai Valley, eastern Nepal, forms the only record of the occurrence of the Blackthroated Hill Warbler in Nepal since Hodgson's time.

*613. **Cisticola exilis tytleri** Jerdon. Yellowheaded Fantail Warbler.

The first and the only record of the Yellowheaded Fantail Warbler from Nepal is to be credited to Rand & Fleming (1957, p. 169) who reported it from western Nepal at *c.* 275 m. in December.

*614. **Cisticola juncidis cursitans** (Franklin). Streaked Fantail Warbler.

The post-Hodgsonian records of the Streaked Fantail Warbler from Nepal consists of Proud's (1949, p. 708) observation in the Nepal Valley as a common bird from April to September, and Rand & Fleming's (1957, p. 169) report as a common bird in the western and eastern tarai in winter.

(To be continued)

Some Reptiles of South India

(A Reprint)

BY

R. H. BEDDOME

(*With two plates*)

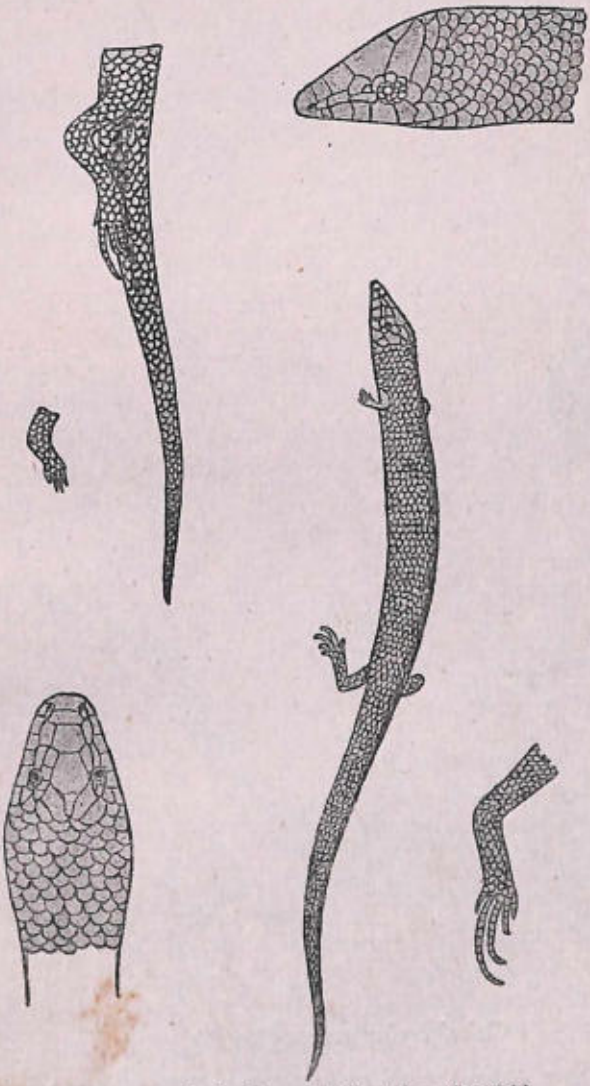
[In the *Madras Monthly Journal of Medical Science*, 1870-1, Major R. H. Beddome published a series of three papers describing 17 new species of reptiles from south India. In 1935 Dr. Baini Prashad, then Director, Zoological Survey of India, sent the Society a typed copy of the three papers with the photographic reproductions of the accompanying plates, prepared from the only traceable set of the journal which was available at the Madras Medical College, Madras. As the papers are of considerable importance, they are being reprinted for the use of research workers. The names used by M. A. Smith in the second edition of FAUNA OF BRITISH INDIA, Reptilia and Amphibia, volumes II (1935) and III (1943), are indicated in parentheses under each name. For the Caecilians reference is made to Boulenger's FAUNA volume on Reptilia and Amphibia (1890).—EDS.]

Descriptions of some new Lizards from the Madras Presidency, with 2 Plates. By Major R. H. Beddome, Officiating Conservator of Forests, Madras.

[From the Madras *Monthly Journal of Medical Science*, Vol. I. pp. 30-35, (1870), Art. II.]

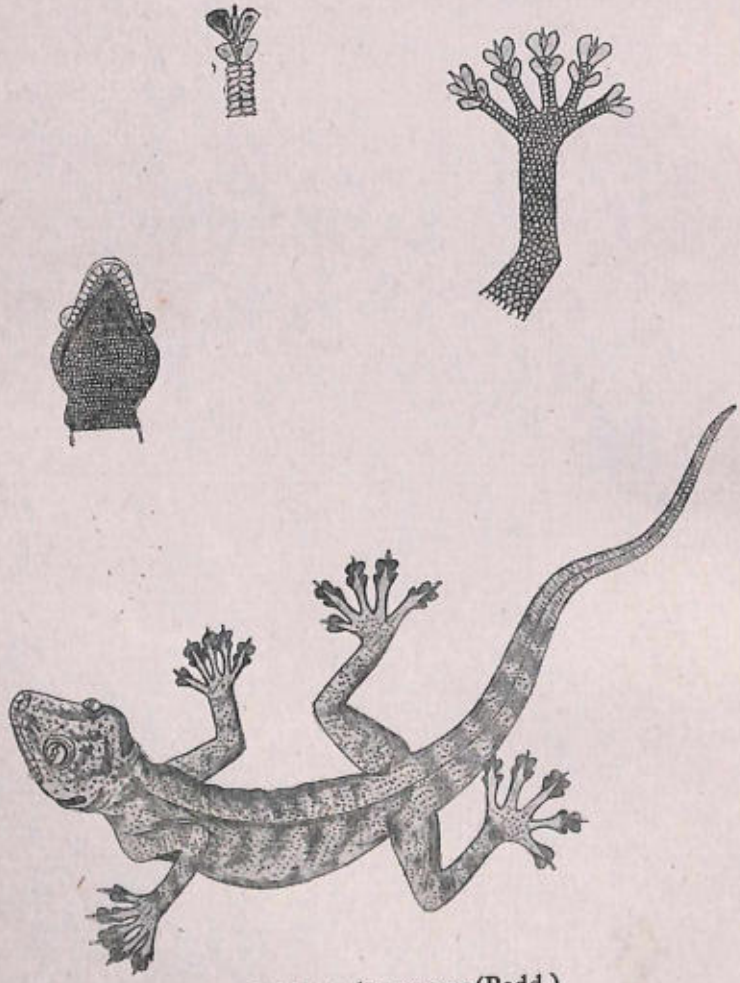
Sphenocephalus ? pentadactylus (Bedd.). [*Chalcides pentadactylus*. **2**: 350].

The anterior legs minute and fitting into a groove, fingers five, the third slightly longer than the fourth, first and fifth very small; posterior legs well formed, toes five, the fourth longer than the



Sphenocephalus? *pentadactylus* (Bedd.).

(Reproduced from *Madras Monthly Journal of Medical Science*, Vol. 1, 1870)



Calodactylus aureus (Bedd.).

(Reproduced from *Madras Monthly Journal of Medical Science*, Vol. 1, 1870)

third, the fifth very small; form slender. four and quarter inches long. as thick as a goose quill, two-thirds cylindrical, flat and laterally angled beneath as far as the vent; the body and tail covered with small smooth lustrous hexagonal scales, with a median row of broader subcaudals; upper lip covering the mouth, eyes minute, surrounded by small scales; no external trace of ears; nostrils in small single shields let into the posterior side of the rostral, with a small post-nasal behind each, and two large shields in the loreal region between the post-nasal and the eye; rostral square behind, a single prae-frontal narrow and a parallelogram in shape; post-frontal single six-sided, vertical broader behind; occipitals rounded behind, with a small shield between them, which is let into the posterior base of the vertical; five plates (some divided) over the eye, and between it and the vertical and post-frontal; upper labials 8-9, the fourth and fifth below the eye, some large shields over the posterior ones; the distance between the axils of the fore and hind limbs is a little more than one and three-quarter inch; colour of a uniform dark brown; hind limbs a little more than half an inch long; fore limbs very slender, and not quite a quarter inch long.

On the sandy banks of the Kuddle Poondy, a tidal river near Beypore. Described and figured from a unique specimen in the Madras Museum collected by Mr. Carter. It is very similar to Mr. Blyth's *Sphenocephalus tridactylus* from the Punjab, but as it has five fingers and toes instead of three, and the shields of the head differ considerably, it will probably have to be formed into a new genus. The eyes were injured, and I could not detect whether the lower eyelid was transparent or not. (See Plate I.)

Calodactylus (Bedd.). [*Calodactylodes* Strand, 1926 (1928), **2**: 77].

A new genus of Geckos. Gen. Char.: Fingers and toes 5-5, *dilated in their whole length, with two series of small transverse plates beneath; the thumbs and the first toes ending in a single pair of flat plates, with the claw between them; the other four fingers and toes provided with two pairs of similar plates, one pair terminal and the other pair one-third down the finger or toe, and separated from the terminal pair by several rows of the smaller scales: no cutaneous appendage.*

Calodactylus aureus (Bedd.). [*Calodactylodes aureus*, **2**: 78].

Head and back uniformly granular, with very small scales, some few of which are very slightly enlarged; scales of the belly small nearly square in about thirty transverse series; eye large, without eyelids, pupils elliptic erect (shaped thus); nostrils behind each

angle of the rostral, with two plates between them; fourteen upper labials, last two very small, thirteen lower ones; opening of the ear about quarter the size of the eye, not denticulate; no femoral or preanal pores, no plates on the chin beneath except the lower labials; length 6½ to 7 inches, of which the tail is 3¼ to 3½; length of fore limbs 1½ inches, hind limbs 1⅞ inches; of a brilliant golden colour, freckled with brown over the whole of the upper surface (the yellow colour turns nearly white in spirits).

Amongst rocks in dark shady ravines on the Tripatty hills in North Arcot. (See Plate II.)

Gymnodactylus marmoratus (Bedd.). [*Cnemaspis beddomei* (Theobald), 1876, **2**: 71].

Of stout form, body and tail coarsely granular, some of the scales enlarged but not spinous; of a dark colour, almost black, clouded with greyish white markings, or sometimes grey, clouded with black markings; belly uniform greyish; tail uniform greyish brown, or sometimes with black and grey alternate bands; pores eight, in a continuous line across the preanal region, and occupying the same breadth as the vent; outer scales in the same row, and 18-20 scales of the two anterior and some scales of the posterior rows enlarged flat and white; one enlarged white scale at the base of the tail on each side of the vent; some of the subcaudals considerably enlarged, very irregularly six-sided; rostral plate large, grooved behind, with two small plates behind the nasal organs; upper labials 6-8, the first very large the last 2-3 very small; lower labials 6-7, the median lower labial very large, produced back into a square base and entirely separating the chin shields; pupil round; length up to 3½ inches, of which the tail is 1.

Under stones on the South Tinnevelly and Travancore hills, 3-5,000 ft.

Gymnodactylus gracilis (Bedd.). [*Cnemaspis gracilis*, **2**: 74].

Of slender form, with rather elongated head, grey coloured, tail banded with black, body with a row of white blotches along the centre of the back, and sometimes with irregular cross bands of black markings; belly pearl coloured, with very minute black dots on the scales; limbs and toes banded with black markings; body coarsely granular, with some of the scales considerably enlarged, but scarcely spinous; regular rows of spines on the thick part of the tail; subcaudals enlarged; femoral or preanal pores none; 6-7 upper

labials, six lower ones; median lower labial large angled behind, rostral moderate; pupil round; total length up to $2\frac{1}{4}$ inches.

Under stones on the Palghat hills.

Gymnodactylus Wynadensis (Bedd.). [*Cnemaspis wynadensis*, **2**: 69].

Head and body finely granular, many of the scales on the latter being enlarged but not spinous; tail without any spines, rounded, tapering; subcaudals large, ventral scales small, nearly round; preanal scales very small; femoral pores five, rarely only four on each thigh; upper labials 5-6, the first very large, others gradually smaller, last two minute; lower labials 6-8; rostral large grooved behind with several small scales behind it; pupil round; length 3-$3\frac{1}{2}$ inches; colour blackish, with brown mottlings, sometimes a white line from the back of each eye to shoulder; grey beneath.

In the moist forests of Wynad, found under stones in the day time.

Gymnodactylus ornatus (Bedd.). [*Cnemaspis ornata*, **2**: 70].

Head and body covered with fine granular scales, some of those on the latter being enlarged about four times, but not spinous; tail without any enlarged scales or spines; some of the subcaudals enlarged; belly with about 34 rows of nearly round scales; preanal pores seven in front of the preanal region; opening of the ear small, pupil round; seven upper and seven lower labials; median lower labial large, narrow and square behind, with one plate behind it and two plates between it and the first lower labials; length three inches, of which the tail is one and a half; of a brown colour, with an indistinct row of white black-edged spots down the centre of the back, a white band black-edged anteriorly, across the neck, just in front of the shoulders; a white line through the lower part of the lower labials which extends to beyond the ear, but not to the cross band on the nape; a similar white band from the cleft of the mouth to the ear; a die-shaped white mark on the centre of the head between the eyes, and a large ✓ shaped white mark on the posterior part of the head, which has a black spot in the lower part of it, and is joined on each side by a white line which proceeds from the eye, (in a single female specimen the band across the nape and the black spot in front of it are conspicuous, but the other markings are faint or obsolete). South Tinnevelly hills at no elevation, under rock, in dry jungles.

angle of the rostral, with two plates between them; fourteen upper labials, last two very small, thirteen lower ones; opening of the ear about quarter the size of the eye, not denticulate; no femoral or preanal pores, no plates on the chin beneath except the lower labials; length 6½ to 7 inches, of which the tail is 3¼ to 3½; length of fore limbs 1½ inches, hind limbs 1⅞ inches; of a brilliant golden colour, freckled with brown over the whole of the upper surface (the yellow colour turns nearly white in spirits).

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Under stones on the South Tinnevelly and Travancore hills, 3-5,000 ft.

Gymnodactylus gracilis (Bedd.). [*Cnemaspis gracilis*, **2**: 74].

Of slender form, with rather elongated head, grey coloured, tail banded with black, body with a row of white blotches along the centre of the back, and sometimes with irregular cross bands of black markings; belly pearl coloured, with very minute black dots on the scales; limbs and toes banded with black markings; body coarsely granular, with some of the scales considerably enlarged, but scarcely spinous; regular rows of spines on the thick part of the tail; subcaudals enlarged; femoral or preanal pores none; 6-7 upper

labials, six lower ones; median lower labial large angled behind, rostral moderate; pupil round; total length up to $2\frac{3}{4}$ inches.

Under stones on the Palghat hills.

Gymnodactylus Wynadensis (Bedd.). [*Cnemaspis wynadensis*, **2**: 69].

Head and body finely granular, many of the scales on the latter being enlarged but not spinous; tail without any spines, rounded, tapering; subcaudals large, ventral scales small, nearly round; preanal scales very small; femoral pores five, rarely only four on each thigh; upper labials 5-6, the first very large, others gradually smaller, last two minute; lower labials 6-8; rostral large grooved behind with several small scales behind it; pupil round; length 3-$3\frac{1}{2}$ inches; colour blackish, with brown mottlings, sometimes a white line from the back of each eye to shoulder; grey beneath.

In the moist forests of Wynad, found under stones in the day time.

Gymnodactylus ornatus (Bedd.). [*Cnemaspis ornata*, **2**: 70].

Head and body covered with fine granular scales, some of those on the latter being enlarged about four times, but not spinous; tail without any enlarged scales or spines; some of the subcaudals enlarged; belly with about 34 rows of nearly round scales; preanal pores seven in front of the preanal region; opening of the ear small, pupil round; seven upper and seven lower labials; median lower labial large, narrow and square behind, with one plate behind it and two plates between it and the first lower labials; length three inches, of which the tail is one and a half; of a brown colour, with an indistinct row of white black-edged spots down the centre of the back, a white band black-edged anteriorly, across the neck, just in front of the shoulders; a white line through the lower part of the lower labials which extends to beyond the ear, but not to the cross band on the nape; a similar white band from the cleft of the mouth to the ear; a die-shaped white mark on the centre of the head between the eyes, and a large ✓ shaped white mark on the posterior part of the head, which has a black spot in the lower part of it, and is joined on each side by a white line which proceeds from the eye, (in a single female specimen the band across the nape and the black spot in front of it are conspicuous, but the other markings are faint or obsolete). South Tinnevelly hills at no elevation, under rock, in dry jungles.

Hemidactylus aurantiacus (Bedd.). [*Hemiphyllodactylus typus aurantiacus*, **2**: 108].

Head, body, and tail covered with numerous small granular scales, none of which are enlarged; tail without any spines, snout very short and obtusely rounded; nine upper labials, last three very small, 9-10 lower ones, no shields on the chin beneath, except the labials; belly covered with rows of small rounded scales, no femoral or preanal pores, pupil elliptic, erect, shaped thus ⋕ , subcaudals not enlarged, brown with black streaks on the neck and anterior portion of the body, and black blotches on the centre and posterior portion; tail orange coloured, blotched with black, belly white, with minute brown dots; length 2¾ inches, of which the tail is 1½.

Shevaroys, under stones about Yercaud and elsewhere, at an elevation of 4,000 feet. I have a single specimen of apparently the same species, but somewhat larger and of thicker build, from the Anamallays, at 5,500 feet elevation.

Hemidactylus reticulatus (Bedd.). [**2**: 94].

Head uniformly granular, body granular with some scales enlarged and conical; tail with rows of spinous tubercles near the base; preanal pores 7 in front of the preanal region; nine upper labials, three last very small, 7-8 lower labials; opening of the ear small; 32 longitudinal series of scales across the belly; pupil very narrow, elliptic, erect; length 2½ inches, of which the body is 1½, and of stout form; colour reddish grey, with a large net pattern of black markings, the enlarged conical scales being reddish.

Colegal, under stones about rocky ground.

Ateuchosaurus Travancoricus (Bedd.). [*Ristella travancorica*, **2**: 331].

Supranasal shields none; each scale with two heels, a large single prae-frontal in contact with the rostral and vertical, the latter shield being very narrow behind; occipitals two pair, a large diamond shaped shield between the posterior pair, and one large temporal on each side of the posterior pair; five superciliary shields, with the superciliary region generally very convex; opening of the ear very small, and not fringed; scales in 26 longitudinal series; limbs rather feeble, the third and fourth toes nearly equal in length; the fore legs do not reach the eye when laid forward; preanals and subcaudals not enlarged; length 3½ inches, of which the body is 1⅝; colour of a uniform nacreous brown above, pearl coloured beneath.

Travancore hills, Wynad, and the Anamallays up to 5,000 feet.

Mocoa Travancorica (Bedd.). [*Leiolopisma travancoricum*, **2**: 304].

Supranasal shield none, the lower eyelid with a round transparent space, a single prae-frontal is in contact with the rostral as well as the vertical; four superciliary shields with a row of very small shields between them and the eye; anterior occipital single or rarely double, a diamond shaped shield between the upper part of the posterior pair of occipitals; ear without tubercles or denticulations; vent with a pair of large anals; subcaudals broad, scales in 22 longitudinal series; limbs feeble, the fore legs extend nearly to the eye, the hind leg rather more than half way to the axils of the fore; the fourth hind toe is a quarter or a little more shorter than the third; greenish olive above, and very shining; a narrow black band sometimes broken into spots down the centre of the back, disappearing on the tail, and irregular or wanting on the neck; sides blackish, belly pearl coloured; tail bluish beneath, the black band down the back is sometimes entirely absent. Travancore hills and Wynad.

Cabrita Jerdoni (Bedd.). [**2**: 375].

Two loreals, snout more pointed than in *C. Leschenaultii*; posterior occipitals joined into one large shield with four raised lines on it; small scales on the front margin of the ear; dorsal scales keeled about five times as large as in *Leschenaultii*; lower eyelid transparent; upper labials seven, the four first without ridge, fifth very large and under the eye, lower median labial large, seven lower labials; six pair of large chin shields behind the lower median labial; the three first meet, the fourth is the largest, and the sixth is rather small; ventral scales in six longitudinal and twenty-six transverse series; vent covered with a large central scale; femoral pores twelve on each thigh; brown with two reddish white longitudinal bands on each side as in *Leschenaultii*, but not so distinct and not edged with black, two rows of black blotches down the centre of back, between the two white bands; a lateral white band on each side from the snout to the axils of the hind legs, running below the eye and through the tympanum; throat and chin speckled with black underneath; tail reddish brown; length five inches, of which the tail is three and a half.

In *C. Leschenaultii*, there is a pair of posterior occipitals with a small shield between them in this species the posterior occipitals form one large shield with four high raised corrugated lines along it, and all the shields of the head are much more corrugated than in *Leschenaultii*, and in the latter, the four first labials are furnished with a lateral ridge, and are bent over at the sides.

Only a single specimen of this interesting lizard was procured between Colegal and Caverypooram. In its large scales it much resembles an *Ophiops*, but has a distinct lower eyelid.

An *Ophiops*, which I take to be *O. Jerdoni* (Blyth), is very abundant near the banks of the Tamboodra, north of Adoni, on red soil; and I have found the same species at Pothanore. It is very similar in colouration to the *Cabrita* here described and the scales of the back are similar in size, it however wants the lower eyelid, and differs in the shields of the head and has a much shorter tail, and only 8-9 femoral pores on each side. A casual observer, however, might take the two to be the same species. Whilst this is passing through the press I have discovered a new species of *Ophiops* on the tops of the Bramahgherries (5,000 feet elevation).

* * * *

Descriptions of new Reptiles from the Madras Presidency. By Major R. H. Beddome, Conservator of Forests.

(In continuation of Article II, Vol. I)

[From the *Madras Monthly Journal of Medical Science*, Vol. II, No. IX, pp. 169-176 (1870). Art. XIII.]

Cercaspis Travancoricus (Bedd.). [*Lycodon travancoricus*, **3**: 259].

Rostral deeply grooved below, not much produced back between the anterior frontals, anterior frontals small, not half the size of the posterior, vertical shield-shaped three-sided pointed behind, occipitals longer than the vertical pointed behind, loreal much longer than high, preocular reaching the surface of the head and touching the post-frontal and vertical, eight upper labials, 3rd, 4th and 5th enter the orbit, two post-oculars, scales in 17 rows quite smooth, with small apical groove, ventrals angled at the sides, 66 entire subcaudals, or a few of them double towards the apex of the tail; total length 15 inches, of which the tail is $2\frac{3}{4}$; colour black, with white transverse bars, belly uniform whitish, very like *Lycodon striatus*, but with entire subcaudals.

Travancore hills, Attraymallay, 5,000 feet elevation—under stones, rare; it has quite the colouration of *Lycodon striatus*. Two specimens were found, one of which had all the subcaudals single, and the other had the first 38 entire, and the 28 small ones towards the apex of the tail double.

Melanophidium bilineatum (Bedd.). [**3**: 66].

Fifteen rows of smooth scales, tail compressed (as in *Plectrurus*) ending in a single point, head rather elongate, snout rounded, mouth large, produced back to a level with the eye over the ocular shield, eye very small, no supra-ocular, a median groove, belly and back uniform bluish black, very nacreous and assuming all the colours of the rainbow in the sun, a broad yellow streak from the snout to the tail on each side, which occupies the whole of the second scale from the abdominals and half the first and third scales, subcaudals 14 pair, total length eight inches, as thick as a goose's quill.

This very lovely species was found near the summit of the Peria peak in the Wynad, elevation 5,000 feet and also at a similar elevation on the Tirrhioot peak, both under stones.

Silybura Canarica (Bedd.). [*Plectrurus canaricus*, **3**: 72].

Scales in 15 rows, anal large bifid, subcaudals 12, abdominals about 154, snout obtuse, rostral triangular behind produced back between the nasals, nasals forming a suture behind the rostral, vertical four-sided very pointed behind, eye rather large in front of a large ocular shield, pupil round, caudal disk laterally compressed (as in *Plectrurus*), each scale with 3-5 inconspicuous keels and ending in two sharp spines one above the other. Very variable in its marking, but generally of a brownish colour, with only the anterior portion of the trunk variously streaked, blotched and dotted with yellow, tail always yellow beneath. Length of largest specimen 16 inches, girth of trunk $1\frac{1}{2}$ inches. This species has only 15 rows of scales as in *macrolepis*, but its caudal disk differs from that species, and it must be arranged in a different section, as I look upon all the species with a flat caudal disk like *Silybura Shortii* as sectionally (if not specifically) distinct from the species with the tail of *Plectrurus*.

South Canara, very common on the top of the Kudra Mukh, a mountain 6,000 feet high, under stones and in heaps of rubbish. No Uropeltidae were met with on the Ghats north of the Kudra Mukh, though most careful search was made every day under stones. On the eastern coast, the most northern limit at which I have detected this tribe, is the Golcondah hills near Vizagapatam, where, in a fortnight's search, I found a single specimen of *Silybura Elliottii*, and *Silybura Beddomii* is scarce on the Nullay Mallays near Kurnool. Uropeltidae or rough-tails, are, I believe, confined to the mountains or the forests very near their base. I have occasionally found *Rhinophis sanguineus* in the plains of Malabar, but then always in

the dense forests not far from the Ghats, and *Silybura Elliottii* and *Beddomii* are found on the table-land of Mysore, elevation about 3,000 feet; all the other species have only occurred to me on the mountains, and I believe Dr. Günther is in error in giving the neighbourhood of Madras as a locality for *Silybura Elliottii*.

Pseudophiops monticola (Bedd.). [*Ophisops beddomei* (Jerdon) 1870. **2**: 378].

Nostrils lateral in the lower part of a large nasal shield, with two small post-nasals, the lower one the larger, but both together not equalling the nasal, loreal region concave, loreals two, the posterior much the larger and separated from the eye by several small shields; nine upper labials, the fifth very large and under the eye, eight lower labials all nearly equal; medial lower labial very large, six pairs of chin shields (exactly the same as in *P. Jerdonii*), the three first pair forming sutures, the sixth very small; anterior frontals one small pair about the size of the nasal or rarely three shields, the intermediate one being larger than the two lateral; posterior frontals three, the intermediate one being the smallest, rarely only two, vertical superciliaries and occipitals as in *P. Jerdonii*, but the shield between the post-occipitals is rather larger than in that species, and all the head shields are longitudinally plicated as in *P. Jerdonii*, but more warty; femoral pores 10 on each side, none in the preanal region; a single large preanal shield, with a second one behind it about half its size (as in *P. Jerdonii*); scales of the back in 25-26 rows, acutely keeled except in the two rows adjoining the abdominal scales; keels more prominent towards and on the tail, and forming continuous raised ridges; abdominal scales large and smooth in six rows. Colour uniform brownish above, with sometimes a paler indistinct streak along each side of the back from the post-occipitals to the tail, and a more prominent whitish streak along each side from the ear to the hind leg; belly uniform whitish.

On the summit of the Bramagherries in Wynad in grassy places, elevation 5,000 feet, common, and in the plains in South Canara near Sooleay, very rare; the single specimen found in the plains differed from the mountain form in having no intermediate shield between the post-frontal, whereas it is present in all the specimens collected on the Brumagherries; but these latter have some of them only two anterior frontals, whereas others have three. This species is not so prettily coloured as its congener *P. Jerdonii*, which is of a more reddish brown, has the four white streaks very distinct, and

numerous black spots on the back and sides. The latter species is very common in the plains near the Tumbudra river north of Adoni. I have also found it at Coimbatore, and Dr. Jerdon found it at Mhow, and he has lately sent it to me from the Punjab under the name of *Ophiops bivittata*, but he changes this name in his 'Notes on Indian Herpetology' (published in the Asiatic Society's Journal) to *Pseudophis Theobaldi*, and states that it differs from *P. Jerdonii* in the post-frontals being separated by a small shield, and in the third pair of chin shields forming a suture instead of being separated by small scales; but in my very numerous specimens of *P. Jerdonii*, I find both these differences very general. Dr. Jerdon has established the genus *Pseudophiops* for these Indian species as they differ in having the rostral in a single plate followed by two nasals, instead of between two plates followed by three nasals as in the typical *Ophiops*; he proposes the name of *Beddomii* for this species, but I had already distributed it under the name of *monticola*.

Fam. SEPSIDAE. **Sepsophis**. New genus.

Sepsophis punctatus (Bedd.). [**2**: 353].

Muzzle rounded, rostral large square behind, nostril in the front of a minute shield in a notch at the hinder side of the rostral plate, and just over the first labial, supra-nasals one large pair contiguous, anterior frontal large, pointed in front and square behind, post-frontal six-sided, vertical similar to the post-frontal, anterior occipitals three, post-occipitals two, very much longer than broad, five large plates over the eye, loreals two, region not concave; six upper labials, fourth under the eye; five lower labials; eye small, lower eye-lid transparent; no external ears; median lower labial large, square behind; first chin shield single, followed by three pair, the first of which form a suture together; scales of the back, sides and belly all equal and similar, smooth, imbricate and rounded behind, in 22 transverse series round the trunk, and thirteen round the tail; two large anal plates; body and tail of nearly equal thickness throughout, the end of the tail being nearly as thick as the head, and ending with a single rounded shield (perhaps injured and grown over); no external limbs, but a minute fin-like pointed process about half a line long let into a groove at the position where the fore-legs should be, and a depression in the body on each side of the vent, which is occupied by several very small scales; total length nearly

six inches, of which the tail is 1¾; circumference ⅞ths of an inch; portion of the trunk, eventually running into two regular lines of minute dots, which become four lines towards the end of the tail; sides very black, belly grayish, with black spots on the scales.

A single specimen of this very curious limbless lizard was found at Darakondah on the Golcondah hills near Vizagapatam (elevation 3,000 feet), under a stone: a long search did not reward me with a duplicate example.

Gymnodactylus speciosus (Bedd.). [*Gymnodactylus collegalensis* Beddome, 1870, **2**: 56].

Of stout form, body finely granular, all the scales being of the same size; scales of the tail larger, of a reddish brown colour, with three broad white transverse bands, one across the neck, one across the middle of the back, and one just in front of the hind legs, each being a quarter inch broad, or half the width of the interspaces of ground colour, and edged with black; crown of the head white, with six reddish brown blotches, three across the occipital region, the centre one of which is elongated, two across the vertical region, and one on the frontal region; belly uniform whitish, chin beneath blotched or maculated; tail with four transverse white blackedged bands as on the body; femoral or preanal pores none; subcaudals not enlarged; rostral large, groove behind with two small plates behind it; pupil erect, ✠ shaped; upper labials eight, two last very small; lower labials seven, medial lower labial large, pointed behind, first pair of chin shields rather large, forming a suture behind the medial lower labial, second pair about half the size, total length 3¼ inches.

In a tope near Erode, very rare.

Gymnodactylus Collegalensis (Bedd.). [**2**: 56].

In every respect as in *Gymnodactylus speciosus*, but with a very different colouration; ground colour, pale grayish, with four dark brown 8-shaped marks edged with white across the body, and a transverse band of large spots between each marking; head with eight irregular dark brown blotches on a light ground; tail with about six 8-shaped transverse blotches, becoming indistinct towards the tip.

Under stones on the lower slopes of the Balarangams in dry forests near Yellundur.

These two lizards agree in every respect, except in colouration, which, however, is very different; they are both beautifully marked

species, and must be very rare. Only a single specimen of each has been obtained, and considerable search and expense has not rewarded me with a duplicate of either.

Gymnodactylus maculatus (Bedd.). [*Cnemaspis sisparensis* (Theobald), 1867, **2**:69].

Of a stout form, body and tail rather finely granular, some of the scales of the body being rather enlarged, but those of the tail all uniform, no spines, subcaudals enlarged; of a brown colour, with regular transverse bands of oblong dark coloured spots across the body, and bands across the tail; rostral large grooved behind, with two small plates behind it; seven upper labials, the seventh very minute; nine lower labials, the last 3-4 very minute; lower medial labial large triangularly pointed behind; chin shields 2-3 small pairs not forming sutures; pupil round; femoral pores eight on each thigh in two continuous lines, no pores or enlarged scales on the preanal region; toes very long, slender and laterally compressed; total length four inches, of which the tail is $2\frac{1}{4}$.

At Sholakal, the foot of the Sispara ghat, under logs and stones.

Gymnodactylus nebulosus (Bedd.). [**2**: 56].

A very small species of rather stout form, muzzle short, rounded, body and tail finely granular, many of the scales on the former being enlarged, scales on the latter uniform; subcaudals not enlarged; no spines; no femoral or preanal pores; of a dull brown colour, beautifully clouded with irregular dark blotches, which are edged with white. In some specimens the markings are almost obsolete, and in others they form transverse bands; rostral large, grooved behind followed by two small shields; upper labials nine, last two very small; lower labials 8-9, last 2-3 very small; medial lower labials not very large, pointed behind, first pair of chin shields large, and forming a suture behind it; pupil erect, ⊕ shaped; total length $2\frac{1}{4}$ inches.

Golcondah hills near Vizagapatam, under stones at 2,000-3,500 feet elevation, rare.

From the Anamallays, I have what I take to be the *Euprepes (Tiliqua) macularius* of Blyth, it is uniform bronzed olive green above, and white spotted on the sides of the body and tail, each scale 5-keeled, otherwise differing in no way from *Euprepes rufescens*. From the higher ranges of the Balarangams, I have a very beautiful *Euprepes*, it is bronzed olive green above with numerous black spots

on the body, particularly on the posterior portion; sides white-dotted, each scale seven keeled, but differing in no other way from *Euprepes rufescens*. I cannot look upon either of these varieties as specifically distinct from *Euprepes rufescens* of Cantor, though they may both rank as varieties, in which case the species must be described as 3-7 keeled. The colouration of my numerous examples of the ordinary three-keeled form are much more varied than what is described by Günther. In my *Cabrita Jerdoni* (described in the January number of this Journal), the nostrils are in the lower part of single shields, the pair of which meet and form a suture between the rostral and single anterior frontal; behind each nasal plate and in front of the anterior loreal are two very small post-nasal plates, the posterior frontals have a very small intermediate shield. I add this additional description as this lizard is not a true *Cabrita*, and will form a new genus between *Cabrita* and *Pseudophiops*, which may be called *Cabritopsis*.

Eumeces Dussumierii. [*Lygosoma dussumieri* Dum. & Bibr., 1839. **2**: 286].

Forty longitudinal rows of scales, eight of which run along the back, 66 transverse series between the axils of the fore and hind legs, those immediately behind the fore legs being very small; belly uniform white, tail red, a black streak running from the axils of the fore legs to the axils of the hind legs; sides with a broad jet black streak, margined with white, commencing at the eye and becoming lost about the middle of the tail, the black colour occupying the width of 4-4½ scales; back fulvous with two longitudinal series of black blotches, forming continuous lines on each side of the back; nasals lateral in a single rather square plate, followed by two loreals and one ante-ocular; anterior frontal or intra-nasal single, square in front and pointed behind; post-frontals one pair, square in front and pointed behind; vertical triangular in front, produced into a long point behind between the supra-oculars; supra-ocular region much swollen, and covered with four large plates, the first of which is equal in size to the other three; anterior occipitals two, the two together forming a triangle; post-occipitals two, posterior margin much broader than anterior; one intermediate shield; ears large, oval not denticulate, but the anterior margin scaly; some of the subcaudals enlarged; feet with warty excrescences, fourth toe a third longer than the third; upper labials seven, none of which enter the orbit, as there are small scales between them and the eye, sixth labial much the largest; seven

lower labials, medial lower labial square behind, followed by a single broad chin shield, behind which again are four pair, the first only of which forms a suture; lower eyelid scaly; total length 5¾ inches, of which the tail is four.

This very beautiful species, which has been confounded by Dr. Günther with *Eumeces Indicus* of Gray, is, I believe, the *? Lygosoma dussumierii* of Dum. and Bibr. I have lately found it in Malabar, at Nellicottah, between Nullumbur and the foot of the Carcoor ghat.

Caecilia Malabarica. [*Uræotyphlus malabaricus* (Beddome), Boulenger's Reptilia & Batrachia: 518].

Body short, total length 5½ inches, as thick as a goose's quill, terminating in a pointed tail, which is prolonged to about 1/7th of an inch beyond the vent; body and tail surrounded by 238 folds, almost every one of which meet under the belly; snout flattened and shelving downwards, subnasal grooves at the edge of the flattened snout below, but rather in front of the nasals.

Malabar—rare, a much smaller species than the common *C. oxyura*, and differing in its snout and the annular rings.

Epicrium carnosum (Bedd.). [*Gegenophis carnosus*, Boulenger's Reptilia & Batrachia: 513].

Head very much depressed; eyes quite invisible; labial groove much nearer the nasal than the eye; point of tail quite rounded, not prolonged more than ½ a line or a line beyond the vent; annular folds 120, quite continued round the body and belly throughout the whole length; total length seven inches, with a circumference about as thick as a crow's quill; of a uniform bright fleshy colour when alive, fading to a reddish brown in spirits.

Peria peak, Wynad, at an elevation of about 5,000 feet; under stones, rare.

I have lately found the beautiful *Gymnodactylus deccanensis* of Günther in South Canara, at Hospet (nearly sea level), and at the top of the Codachy Parwat (5,000 ft.). The cross bars are a brilliant yellow, but turn white after the animal is put into spirits; it is evidently a very rare species, as during a tour of more than a month I only obtained two specimens. It has no femoral or preanal pores.

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Descriptions of new Reptiles from the Madras Presidency. By Major R. H. Beddome, Conservator of Forests.

(*In continuation of Art. XIII, Vol. II, p.* 176)

[From the *Madras Monthly Journal of Medical Science*, Vol. IV. (1871).]

Callophis pentalineatus (Bedd.). [*Callophis nigrescens* Günther, 1862, **3**: 422].

7 upper labials, 2 post-oculars, 1 ante-ocular; of a cherry colour with 5 longitudinal black streaks from the neck to the end of the body, and 3 along the upper part of the tail, the middle streak is the broadest, the lowest streak is between the 1st and 2nd scales from the abdominals, the 2nd between the 3rd and 4th, the 5th row of scales is untouched by any of the black streaks, the broad, central streak occupies the whole of the centre row of scales along the top of the back and part of the row on each side of it, belly uniform cherry red, neck black, head with black markings.

This very beautiful species I lately discovered at Peermede on the Travancore hills (3,500 feet elevation); it grows to 3 feet long with a circumference of not more than a man's little finger.

Melanophidium punctatum (Bedd). [**3**: 66].

Snout obtuse, rostral shield rather small simply convex nearly as high as broad, nasals large forming a suture behind the rostral, vertical hexagonal nearly as broad as long with an obtuse angle in front and an acute angle behind, eye in a large shield, no supra-orbital or post-ocular, the first pair of lower labials form a suture together behind the median shield and are followed by one large and one small pair of chin shields, the median line running between all three. Scales in 15 rows, shining and smooth or more or less covered with small glandular raised blotches, ventrals 186-191, twice as broad as the adjoining scales, shining smooth or glandular, anal large bifid, terminal horny scale about 2 lines long, bicuspid in adults, slightly rough on the sides, above concave with a serrated ridge on each side, back uniform bluish-black shining nacreous and exhibiting all the colours of the rainbow, belly and sides whitish, each of the 3 lower scales on each side with a very regular oblong black blotch forming 3 very regular parallel lines on each side, each ventral with a large parallelogrammoid black blotch (transverse with the oblong blotches of the side), subcaudals 15-17 pair each with a black blotch.

This very beautiful Uropelt I have only lately discovered in Travancore, one adult specimen was found under a stone in the Mutikuli vayal, a little valley on the Asamboo range (4,500 feet elevation), in company with a large specimen of *Tropidonotus Beddomii*, it was 18 inches long; another adult and a young one were afterwards found at Peermede, where it is said to be not uncommon, the former of these was found under a stone with a fine *Riopa punctata*, and immediately on being put in spirits it disgorged a large worm.

SCINCIDAE

Ristella Gray

Scales smooth or 2-keeled, supra-nasals none, nostril in a single nasal shield, ears distinct supra-orbicular, not toothed or fringed, lower eyelid scaly, subcaudals enlarged, limbs 4, toes 4-5, the palatal notch is placed far backwards.

This genus is indicated by Gray in his CATALOGUE OF LIZARDS, p. 85, but has been overlooked by Günther.

Ristella Travancorica (Bedd.). [**2**: 331].

Muzzle obtusely conical, rostral very much broader than high, a large single prae-frontal in contact with the rostral and vertical, the latter produced into an acute angle behind, occipitals 2 pair, a diamond shaped shield between the posterior pair, superciliary region generally rather convex, with 7 shields, the first and last very small, 6 upper labials, loreal region rather concave, the nasal shield above the 1st labial and followed by 3 shields in the loreal region, lower labials 5, the large median shield is followed by a single chin shield and this is followed by 3 pair of shields, the 1st of which form a suture together, the 2nd are separated by 1 small shield and the 3rd by 3 small shields, the forelegs reach to beyond the ear, hind legs small (5-6 lines in length), 3rd and 4th toes nearly equal, the 4th being slightly the larger, body surrounded by 25-26 rows of scales perfectly smooth, or those of the back and sides very prominently 2-keeled, or with only a faint indication of the keels, some of the scales on the sides of the tail with 3-4 keels, the anterior 8-9, subcaudals scarcely enlarged, posterior ones much enlarged; total length 4½ inches, body up to 1½ inches long, tail 3 inches, uniform bronze above and iridescent, or often each scale with a small apical black dot, chin and throat white or black or blotched with black and

white, sides more or less mottled with black and white, the black generally predominating, belly uniform whitish, tail black beneath or white, or mottled with black and white, legs generally mottled.

This lizard is common throughout the moist jungles of the western chain of ghats in the Madras Presidency (2-5,000 ft. elevation). I formerly described it in this Journal as an *Ateuchosaurus*, not observing that it had only 4 toes on the fore feet, and when I lately found it on the Anamallays with perfectly smooth scales and observed the peculiarity of the toes, I did not connect it at first with my *Ateuchosaurus*. I now find from a careful examination of a large number of specimens, that though the scales are generally prominently 2-keeled, they are sometimes perfectly smooth, and in other specimens faint keels are only to be detected under a lens; it has always 4 toes only on the fore feet, and it appears to be referable to the genus *Ristella* of Gray.

Gymnodactylus planipes (Bedd.). [*Cnemaspis littoralis* (Jerdon), 1853, **2**: 76].

Of slender form, snout elongate, body and tail uniformly granular without tubercles, pupil round, subcaudals enlarged, 8 upper labials, the 2 last being very minute, 6 lower labials, median shield very large angular behind and separating the chin shields of which there are 2 small scale-like pair, femoral pores 16-17 on each thigh, none in the preanal region, the plates on the lower portion of the fingers and toes large and flat, the terminal one much dilated and 3 times as large as the others; maximum length 2¾ inches, of a greyish colour with a prominent black blotch on the nape of the neck and generally a row of white black edged spots down the back.

I have only met with this curious little species in the dry Teak forests near Nellicootah below the Nilgiris (on the western side), where it is found on trees in the day-time. Its peculiar feet almost inclined me to constitute a new genus for it.

Algal Flora of Jodhpur and its Environs

I. Charophyta[1]

BY

S. K. GOYAL[2]

Department of Botany, Jaswant College, Jodhpur

(*With two plates*)

INTRODUCTION

Very little is known about the algal flora of Rajasthan State. Blatter & Hallberg (1918-20) listed a few species of *Chara* from Kaylana near Jodhpur. Ghose (1934) and Godbole (1951) recorded a few species from Sambar Lake. Singh (1949) studied the ecology of the subaerial algae of Mt. Abu. Bhandari (1952) listed about 107 species of algae from Jodhpur and its environs. He (1955) also described some abnormalities in *Characiosiphon rivularis* Iyengar, collected from Umed bund near Jodhpur.

The object of the present series is to give a systematic account of the algal flora of Jodhpur and its environs, in Rajasthan State. This communication deals with the critical descriptions of the Charophyta flora and includes 5 species of *Chara* and 1 of *Nitella*.

The area under consideration is semi-arid. The maximum and minimum temperature, relative humidity, and rainfall during the period of investigation are given in the Table below.

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[1]Part of the thesis submitted for the M.Sc. Degree in Botany, University of Rajasthan, 1960.

[2]Present address: Algal Laboratory, Division of Botany, Indian Agricultural Research Institute, New Delhi-12.

TABLE

METEOROLOGICAL DATA OF JODHPUR FROM OCT. 1958 TO DECEMBER 1959 SHOWING RAINFALL, TEMPERATURE, AND RELATIVE HUMIDITY

Year	Month	Mean Maximum temperature (°C.)	Mean Minimum temperature (°C.)	Percentage Relative Humidity	Rainfall (mm.)
1958	Oct.	34.6	20.6	33	2.6
	Nov.	31.2	15.5	31	25.4
	Dec.	26.6	12.4	38	0.7
1959	Jan.	24.3	9.7	28	0.0
	Feb.	27.4	11.5	21	1.2
	March	36.2	18.7	11	0.0
	April	39.7	23.6	12	0.5
	May	41.7	27.2	18	9.6
	June	40.3	28.7	33	55.8
	July	35.6	26.5	60	101.1
	Aug.	31.7	24.9	67	92.1
	Sept.	32.9	24.3	63	103.7
	Oct.	35.7	22.2	34	0.1
	Nov.	30.5	15.0	24	4.5
	Dec.	27.3	11.1	25	0.0

The mean maximum temperature was 41.7°C. in May and mean minimum temperature was 9.7°C. in January. The relative humidity was minimum in the hot summer months (March to May) and maximum during the monsoon months (July to September).

SYSTEMATIC ENUMERATION

1. **Chara braunii** Gmelin, Flor. Badens. Alsat. (Suppl.), 646, 1826; Groves & Bullock-Webster, British Charophyta **2** : 11, t. 26, 1924. (= *C. involucrata* Roxb.; *C. coronata* Ziz.; *C. coronata* var. *coromandelina* Br.; *C. coronata* var. *braunii* Br.)

Monoecious, incrusted, incrustation annular and stout, internodes usually of the same length as the branchlets or longer, stem and branchlets entirely ecorticate, whorls of 8-12 branchlets, usually fewer;

stipulodes well developed, in a circle, equal in number to the branchlets and alternating with them ; branchlets usually straight, sometimes incurved, 4- to 6-segmented ; gametangia produced at 2 or 3 lower branchlet nodes, the uppermost segment extremely short, sometimes not longer than the surrounding bract cells; bract cells variable in number and size, usually 4 to 6, exceeding or not exceeding the length of the oogonia, posterior bract cell lacking ; gametangia produced at lower 2 or 3 nodes but never at the base of the whorl; antheridia solitary or in pairs, 277.78-380.12 μ in diameter ; oogonia ellipsoidal, solitary or in pairs, each with an antheridium below ; oogonium 804.10-1052.64 μ long, 321.86-453.22 μ broad; spiral cells form 10-12 convolutions, coronula 190.04-263.16 μ broad at the base ; oospore ellipsoidal, black, with 8-11 prominent ridges, 511.70-544.94 μ long and 292.4-336.36 μ broad (Plate II, fig. 17,18, and 20-22).

Habitat : From Ratanada tank in Jodhpur (10-1-60) ; from Moti Kund near Jodhpur (10-6-52) (leg. M. M. Bhandari).

The oogonia and oospores are slightly smaller in this material and it differs from the south Indian plants (see Sundaralingam, 1959) in having incrustations.

Zaneveld (1940) distinguishes six varieties under this species, viz. var. *braunii*, var. *schweinitzii*, var. *coromandelina*, var. *perrottetii*, var. *oahuensis*, and var. *kurzii*, of which var. *coromandelina* and var. *kurzii* are known from India (Sundaralingam, 1959).

2. **Chara corallina** Willd. In Mem. Acad. Berlin 83, t. 2, f. 2, 1803.

Monoecious, plants 6 to 30 cm. long, very stout, incrusted ; internodes usually smaller than the branchlets, occasionally longer ; stem and branchlets entirely ecorticated ; whorls of 6-8 branchlets ; stipulodes rudimentary but elongate, acute in younger parts, in one series, as many as the branchlets and alternating with them ; branchlets variable in size, $\frac{3}{4}$ to $1\frac{1}{2}$ inches of 4 to 6 segments, uppermost segments being very short ; bract cells 3-4, long, acute, never developed at the ultimate node ; antheridia and oogonia solitary or two together on one or two lowest branchlet nodes and in large numbers at the base of the whorls of branchlets ; antheridia 350.88-526.68 μ in diameter, situated either by the side of the oogonium or below it, oogonium very large, ovate oblong, 866.2-1109.6 μ long, 701.76-958.0 μ broad ; coronula 114.56-146.2 μ high, 190.6-219.30 μ broad at the base ; oospore black with 7 to 8 prominent ridges, 657.8-716.58 μ long, 511.70-544.94 μ broad (Plate II, fig. 23-26).

Habitat : Collected from Akhey Raj Ji's Tank (20-10-59) and from Kaylana (1952) (leg. M. M. Bhandari).

The oogonia and oospores are slightly smaller in this material.

3. **Chara brachypus** Braun. In Hooker's J. Bot. **1** : 298, 1849 ; Braun & Nordstedt p. 185, 1882; Zaneveld **4** (1) : 199, ff. 15, 1-d, 1840 ; Sundaralingam in Proc. Indian Acad. Sci. **49**B : 39, 1959.

Monoecious ; incrusted throughout, 15 to 20 cm. long ; stem moderately stout ; internodes of the same length or smaller than the branchlets ; triplostichous ; cells of the secondary rows as broad as the cells of the primary series ; spine cells solitary, conical ; whorls of 8-10 branchlets ; stipulodes in two rows, well developed, elongated, acuminate, 8 in number, upper longer than the lower ; branchlets corticated, 8 to 10 segments, lowest very short, one to two uppermost also very short and ecorticated ; bract cells 4, anterior pair elongated, about half as long as the oogonium ; antheridium 232.54-299.4 μ in diameter.

Gametangia on the lower 1-3 segments of the branchlets ; oogonium more or less cylindrical, 730.5-877.2 μ long, 438.6-501.6 μ broad ; spiral cells forming 9 convolutions ; coronula 117.04-146.2 μ long, 190.06-293.15 μ broad; cells conical; oospore oval, black, 438.9-482.46 μ long, 307.02-350.88 μ broad, showing 10-12 ridges, outer membrane thin, rigid and densely granulate (Plate I, fig. 1-4).

Habitat : From Mahadev Ji's Tank near Jodhpur Fort on Jaswant Memorial Road (10-12-1959).

This form agrees with the type. The south Indian forms are somewhat shorter and have ecorticate apical segments of the branches (Sundaralingam, 1959 ; see Agharkar & Kundu, 1937).

Two varieties of this species are known, viz. var. *gracilescens* and var. *ehrenbergiana*, of which the former was recorded from Madras.

4. **Chara zeylanica** Willd. in Mem. Acad. Berlin, 86, t. 2, f. 1, (= *C. verticillata* Roxb. ; *C. gymnopus* Br. var. *macilenta* Br., *C. gymnopus* var. *ceylonica* Br. ; *C. polyphylla* var. *ceylonica* Br.)

Monoecious ; incrusted ; stem moderately stout ; internodes exceeding sometimes 2-3 times the branchlets ; stem corticate ; cortex triplostichous, regular ; spine cells conical or acuminate, whorls of 8-10 branchlets ; stipulodes in two rows, well developed, cylindrical, acuminate ; branchlets incurved, of 4 to 8 segments, lowermost segment very short and ecorticate, upper one also ecorticate ; bract cells 4, well developed, conical ; bracteoles always exceeding the fruits ; fructifications usually not produced at the first branchlet nodes ; antheridia 292.4-350.88 μ in diameter ; oogonia 657.90-730.0 μ long, 438.6-511.70 μ broad ; spiral cells showing 12-14 convolutions ; coronula usually spreading, 102.34-131-67 μ high, 173.04-204.68 μ broad at the base ; oospores black with 10-11 ridges, 453.22-511.70 μ long, 292.4-405.30 μ broad (Plate I, fig. 9-12).

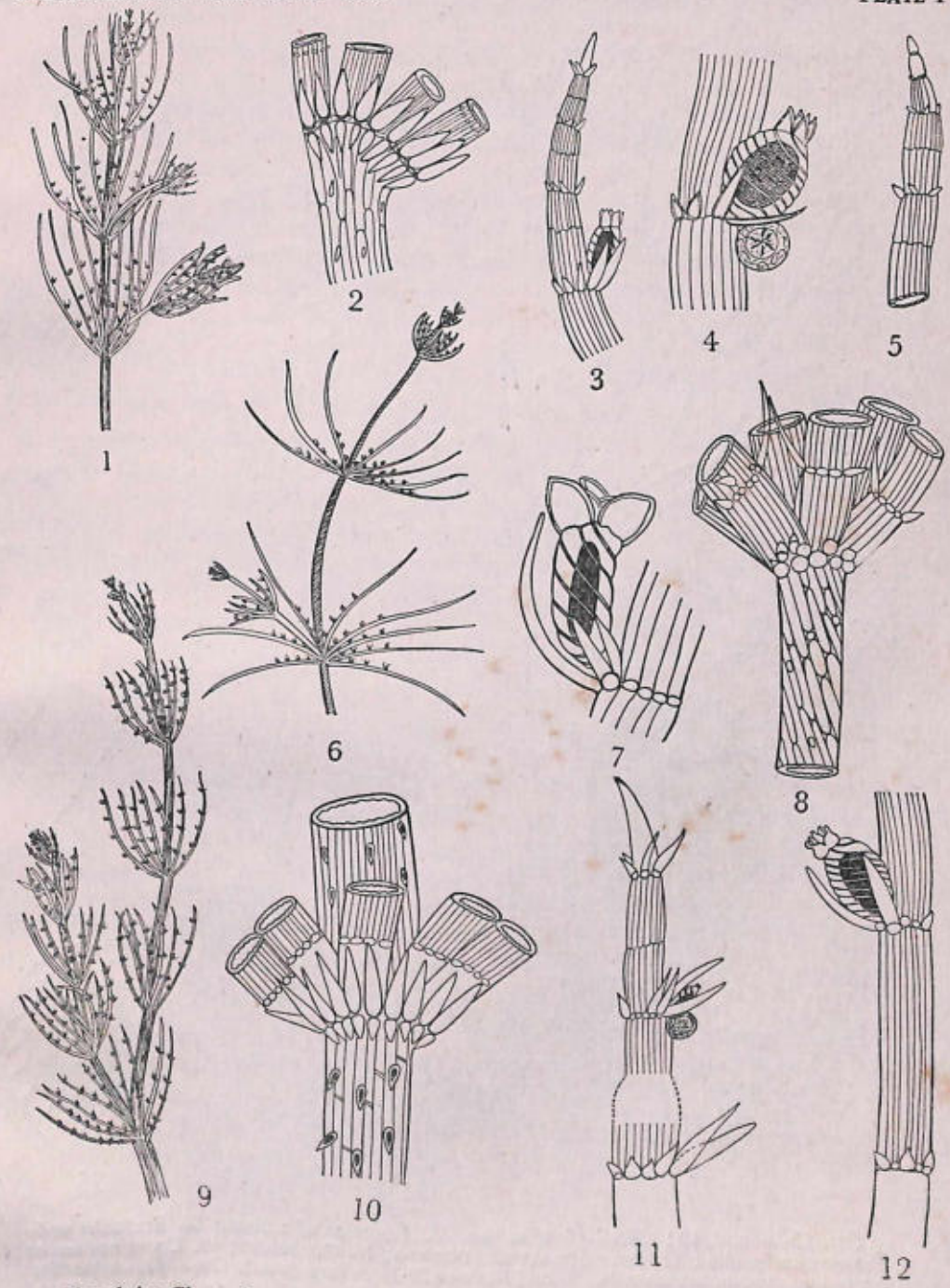

FIG. 1-4 : *Chara brachypus* Br. 1. A portion of a plant ; 2. Stem node ; 3. Portion of a branchlet ; 4. Branchlet node with oogonium and antheridium. FIG. 5-8 : *Chara fragilis* Desv. 5. Upper portion of the branchlet enlarged ; 6. A portion of a plant ; 7. Branchlet node with oogonium enlarged ; 8. A stem node. FIG. 9-12 : *Chara zeylanica* Willd., 9. A portion of a plant ; 10. Stem node ; 11. Branchlet node showing the lowermost node and two uppermost nodes ; 12. Base of a branchlet with oogonium.

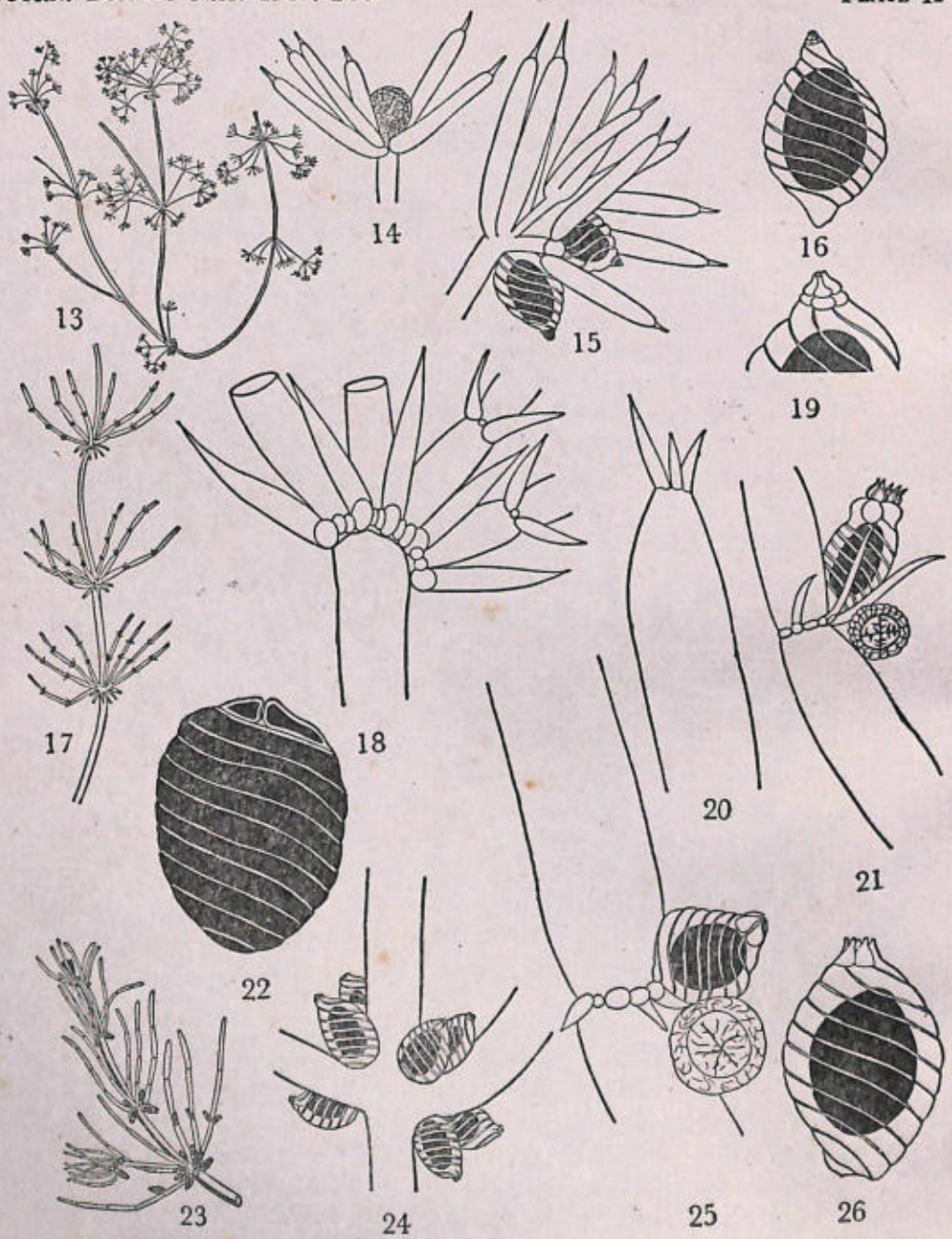

FIG. 13-16 and 19: *Nitella hyalina* Ag. 13. A portion of a plant; 14. Branchlet node showing antheridia; 15. Branchlet showing oogonia; 16. Oogonium; 19. Upper portion of oogonium showing crown cells. FIG 17-18 and 20-22: *Chara braunii* Gm. 17. A portion of a plant; 18. Stem node; 20. Apex of a branchlet; 21 Branchlet showing oogonium and antheridium; 22. Oospore. FIG. 23-26. *Chara corallina* Willd. 23. A portion of a plant; 24. Stem node; 25. Branchlet node showing oogonium and antheridium; 26. Oospore.

Habitat : From Kaylana along with *Oedogonium crosdalae* Jao (21-10-1959).

This is a common and extremely variable species. 5 forms are known from India, viz. f. *macilenta*, f. *inconstans*, f. *hildbrandtiana*, f. *humboldtii*, and f. *corassavica*.

Braun created a large number of varieties under *Chara zeylanica*. Zaneveld (1940), however, differentiated two distinct categories based on whether the branchlets, spine cells, and the bract cells are longer or shorter. This species has been found to have quadriscutate antheridia (Groves, 1931 ; Sundaralingam & Francis, 1958).

5. **Chara fragilis** Desv. A. Br. in Flora **18** : 68, 1835, pro parte ; Groves & Bullock-Webster **2** : 64, t. 43, 1924.

Monoecious ; stem slender, incrusted or not, internodes of about the same length as the branchlets ; corticated, triplostichous ; cortex regular spine cells rudimentary and rounded ; whorls of 7-8 branchlets, branchlets ecorticate, diplostichous, spreading straight, incurved or recurved, 4-10 segments, the upper 1-3 segments ecorticate ; bract cells, usually 8 ; bracteoles usually do not exceed the oogonia ; antheridia and oogonia solitary, produced at the two or three lowest branchlet nodes ; antheridia 232.54-350.88 μ in diameter ; oogonia ellipsoid, 877.2-906.44 μ long, 467.84-511.70 μ broad ; spiral cells showing 13-15 convolutions ; coronula 146.2-175.86 μ high ; 190.06-219.30 μ broad at the base, slightly spreading, oospore blackish with 11-14 ridges, 526.32-555.56 μ long, 336.46-395.74 μ broad (Plate I, fig. 5-8).

Habitat : From Mahadeo Ji's tank near Jodhpur Fort on Jaswant Memorial Road (10-1-60) and from Mandore (10-12-59) (leg. M. M. Bhandari).

6. **Nitella hyalina** (DC.) Agardh, Syst. Alg. 126, 1824. (= *Chara condensata* et *C. interrupta* Ruprecht, Sym. Hist. Pl. Ross. 78, 1845).

Monoecious ; 20 to 25 cm. long ; stem very slender, 28 to 35 μ thick ; internodes about 2-4 times the length of the branchlets ; three rows of branchlets in each whorl, one row of primary branchlets having two rows of accessory branchlets, one above and another below ; primary branchlets 7-8, one to three times furcate ; each branchlet is further divided into rays ; primary rays $\frac{1}{2}$ to $\frac{3}{4}$ of the branchlet ; rays, at first furcation 6-10 of which few remain unbranched ; at the second 4-6, of which some again furcate into 3-5 quarternary rays ; dactyls of equal size, uniformly two-celled, the lower cell slightly tapering towards the base of the upper cell, which is small, narrowly conical, and pointed ; upper accessory branchlets once furcate or remain as such, while the lower ones furcate 1-2 times.

Antheridia and oogonia usually borne at the furcation of all the branchlets, but usually absent at the first furcation of the primary branchlets; antheridia 321.86-365.76 μ in diameter, oogonia solitary, 438.6-511.76 μ long, 336.26-350.68 μ broad; spiral cells showing 8-9 convolutions; coronula upto 58.48 μ high, 73.10 μ broad at the base; oospore 336.26-409.36 μ long, 292.4-340.88 μ broad; membrane yellowish brown, finely granulate (Plate II, fig. 13-16, 19).

Habitat: From Kaylana near Jodhpur (21-10-59).

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The Management of India's Wild Life Sanctuaries and National Parks

BY

E. P. GEE, M.A., C.M.Z.S.

PART IV

(With two black-and-white plates)

[*Continued from Vol.* **54** (1) : 21]

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INTRODUCTION

This paper forms the fourth and concluding part of the series, Part I having appeared in the Society's *Journal*, Vol. 51, No. 1 (December 1952), Part II in Vol. 52, No. 4 (April 1955), and Part III in Vol. 54, No. 1 (December 1956).

Since writing the last paper, the writer has visited Europe twice, the United States of America and Canada once, and many places throughout the subcontinent of India—many of these for the second or third time—in order to study wild life management and in order to see the conditions prevailing in national parks and sanctuaries.

A Preliminary Note on Terminology

This note has been written in the hope that it will give publicity to the need for adopting a uniform, standard and correct terminology in sporting and conservation circles in India. It is, in fact, a tabulated statement of the relevant terms officially approved by the Indian Board for Wild Life during the last nine years, as far as possible in conformity with international practice.

Full understanding and wide acceptance of these terms and their meanings in India cannot but contribute to the good cause—the continuance of wild life both for the present and for future generations.

1. General. A short fact-finding survey to consider the various words used in India and other parts of the world relating to game, wild life and so on would not result in the answer that it is a mere academic quibble over slightly differing terms. Rather it would show that each of these words has its own definite meaning, and that each is used for an entirely different purpose.

There is, of course, no suggestion that the usage or interpretation of words by any single individual or organization should be forcibly thrust on others: rather it is a matter of necessity for a standard and uniform system of terminology to be adopted, to the advantage of all concerned.

In fact, it will be found that not only the serious wild life conservationist but also even the happy-go-lucky sportsman has to choose the right word even in ordinary conversation, if he is to avoid confusion in his own mind as well as in the minds of others! For apart from the fact that certain words have definite and distinct meanings, some words have come to be officially adopted by certain countries for specific purposes. In certain words, moreover, there has been a gradual evolutionary change in their meaning, or they have been discarded altogether.

2. Protection. Take the word 'protection' for example Correctly it means 'guarding and defending against danger and

injury'. Even recently it was somewhat loosely used by several organizations when they meant 'preservation'. For instance there was the International Union for the Protection of Nature. But objections were raised that 'protection' implies a total closing or locking up (of resources) so as to prevent use (of them). So the word 'protection' came to be dropped by this organization in favour of the word 'conservation', and I. U. P. N. became the International Union for the Conservation of Nature. The word 'protection' continues, of course, to be used: for example in India partial protection of certain species is done by closed seasons and restricted shooting. Total protection is done by sanctuaries or by legally prohibiting the killing or maiming of a particular species at any time and in any place.

In addition to the above, after the Indian Board for Wild Life made a recommendation dated February 1955 a 'protected area' is now officially recognised as 'an area constituted by an order of a State Government in India to give protection to wild life in places other than parks and sanctuaries. It refers chiefly to areas near River Valley Projects and other irrigation works, in and around large towns and sacred places'.

3. PRESERVATION. Preservation means 'saving or maintaining from injury or destruction; keeping safe and undisturbed for private and public use'. It is correctly used now by various societies in relation to game and wild life.

Incidentally a 'preserve' is 'ground set apart for protection of game or for shooting of game', and is generally used in India for the private (game) preserves of the former princes, if they still exist.

4. CONSERVATION. Originally 'conservation' meant 'preservation and preventing waste, a meaning which came to be associated with locking up resources and preventing their use'. Nowadays it has a broader meaning—'the effort to increase and sustain the supply of resources we now need and will continue to need for generations to come'. Briefly it could now be said to mean 'planned management and wise use of natural resources'.

5. GAME. There is still a lot of confusion about when the term 'game' or 'wild life' should be used. This is surprising because there is a very big difference between them! The term 'game' refers to 'those species of mammals, birds etc. which are hunted or shot either for trophies or for their meat or for sport, or for a combination of any of these'.

In pre-Independence days the sanctuaries of India were called 'game sanctuaries' because they were created by the former Provincial Governments to stop game animals from becoming extinct, and to keep the numbers of game animals at a high level—mainly for the benefit of sportsmen, for big and small game shooting. In those days the modern concepts of general nature conservation do not seem to have reached India.

In recent years, especially since the formation of the Indian Board for Wild Life in 1952, the distinction between 'game' (animals and birds which are shot by sportsmen) and 'wild life' (which embraces all wild animals, birds etc.) has been officially adopted. In a resolution at the Meeting of the Indian Board for Wild Life at New Delhi in February 1958 it was agreed 'that the term "game" should be replaced by the term "wild life" in all cases where conservation of nature was concerned. The term "game" should, however, continue to be used where sport or shooting legislation was concerned'.

In some of the smaller and very local newspapers one sometimes reads the absurd term 'games sanctuaries', which conjures up thoughts of wild animals playing badminton or football! Still more absurd, but with potentially interesting implications, was the statement of a Forest Beat Officer in western India who, when describing a jheel with water birds such as snipe, said 'In the old days British officers used to come here and play small games'!

6. WILD LIFE. The term 'wild life' includes all mammals, birds, reptiles etc. as opposed to 'game' which includes only those mammals, birds, etc. which are shot for trophy, meat or sport. This word is usually spelt 'wildlife' in the U.S.A. and Canada. Fishes are, of course, wild life, but are often not included in wild life management unless specified (cf. U.S. Fish and Wildlife Service). In India the policy of the Indian Board for Wild Life has been not to deal with fishes except when they happen to come within the management of sanctuaries and national parks.

Wild life in its widest possible sense would also include plant life, but at the inaugural session of the Indian Board for Wild Life in 1952 it was agreed that vegetation would not officially be included in 'wild life' except when it provides cover or food for mammals, birds, reptiles etc. But special provision was made for medicinal plants in the resolution: 'Special "preservation plots" may be constituted where plants of medicinal value or species of special botanical interest may need to be preserved along with or without wild life'.

Incidentally, good wild life conservationists are not at all opposed to sportsmen or to shooting of game: they are only trying to stop the indiscriminate and often illegal slaughter of animals and birds, in order that there may be a sustained surplus for bona fide sportsmen to shoot legally—both now and in subsequent years.

'Wild life' is, of course, a collective noun, and singular. One is apt to shudder when one reads in small local newspapers the absurdly coined plural 'wild lives'!

7. RESERVES. In India a 'reserve' is '(reserved) forest, or an area in which wild life is protected, by being so constituted under the Indian Forest Act or other forest law'. Internationally, however, 'nature reserves' or 'natural reserves' are areas which can be of various special categories, and these have not been officially adopted in India. Most 'reserves' or reserved forests in India in which reasonable numbers of wild life are found have by now been up-graded into wild life sanctuaries.

8. PROTECTED AREAS. The term 'protected area' has been officially adopted by the Indian Board for Wild Life when in 1955 a resolution was passed: 'Protected Areas. In many States there may be areas where it may be considered expedient:

(i) to afford special protection to wild life, in order to enable species of wild life which are on the verge of extinction to re-establish themselves,

(ii) to afford protection to wild life attracted to water impounded in River Valley Projects and to other irrigation works,

(iii) to afford protection to wild life in and around large towns and sacred places.

Such areas may be constituted by an Order of the Government which may also lay down the degree of protection.'

It should be noted that the protection of wild life does not necessarily imply the protection of vermin. Those wild animals and birds etc. which are injurious to other animals, or to the long-term interests of man, can be kept under control, or even destroyed altogether in extreme cases, in certain places.

9. WILD LIFE SANCTUARIES. The term 'wild life sanctuary' in India is 'an area constituted by the competent authority in which killing, hunting, shooting or capturing of any species of bird or mammal is prohibited except by or under the control of the highest authority in the department responsible for the management

of the sanctuary'. In India a sanctuary is usually created by an Order or Gazette Notification of the State Government.

The weakness of a sanctuary in India is that it can be 'de-sanctuarised' merely by another Order or Gazette Notification of a State Government, as it is not safeguarded by any proper legislation. Many of the better wild life sanctuaries of India have by now been up-graded into national parks by the States concerned.

10. NATIONAL PARKS. The definition of a national park in India as defined by the Indian Board for Wild Life at its inaugural session in 1952 is: 'An area dedicated by statute for all time, to conserve the scenery and natural and historical objects of national significance, to conserve wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations, with such modifications as local conditions may demand.'

In most countries of the world a national park can only be created by the national, central or federal government of the country. But under the Constitution of India, 'wild life' is a State Subject and not a Concurrent or Central Subject, and therefore a State Government can constitute a national park in its State Legislature—preferably subject to certain standards which are now being drawn up by the Indian Board for Wild Life.

At the moment some States have created national parks, and some have not. Therefore a wild life sanctuary of one State need not necessarily be inferior to a national park of another State.

RECOMMENDATIONS OF THE INDIAN BOARD FOR WILD LIFE ON WILD LIFE SANCTUARIES

Various resolutions relating to wild life sanctuaries and national parks have been passed by the Indian Board for Wild Life and its Executive Committee at successive meetings from 1952 to 1961. These are to be found scattered here and there among resolutions on other subjects in the Proceedings of the nine meetings, and it has been considered advisable to extract them and publish them in a compact form in the order in which they were passed.

The relevant resolutions on wild life sanctuaries are as follows:

'The creation of wild life sanctuaries (or wild life refuges) of such size and in such numbers which the needs for the preservation of wild life, more particularly of the species which have become scarce or which are threatened with extinction, may demand.

'The expression "wild life sanctuary" shall denote an area constituted by the competent authority in which killing, hunting, shooting, or capturing of any species of bird or animal is prohibited except by or under the control of the highest authority in the department responsible for the management of the sanctuary. The boundaries and character of such a sanctuary will be kept sacrosanct as far as possible. Such sanctuaries should be made accessible to visitors.

'While the management of sanctuaries does not involve suspension or restriction of normal forest operations, it would be generally desirable to set apart an area of one to about twenty-five square miles within a sanctuary where such operations may not be carried out, to ensure the nursing up of wild life undisturbed by human activities. Such sacrosanct areas may be declared as *abhayaranya*, i.e. a forest where animals could roam without fear of man. Such a sanctuary within a sanctuary would also ensure the preservation of plant life unspoiled and undisturbed.

'In the management of sanctuaries, control should be exercised over elements adverse to the maintenance of wild life including destruction of vermin and predators. In the case of any difficulty, expert advice may be obtained from the Indian Board for Wild Life.

'In the event of a sanctuary being located in one State contiguous to a sanctuary in another State, the desirable co-ordination may be effected through the Indian Board for Wild Life.

'That buffer belts of sufficient width be declared around all sanctuaries within which no shooting, other than that required for legitimate crop protection, will be permitted and within which no professional graziers will be allowed to establish their cattle pens . . . and that State Governments be requested to inoculate systematically and periodically domestic cattle in the neighbourhood of national parks, sanctuaries and reserves where and when necessary.'

(Inaugural Session, Mysore, 1952)

'Wild life sanctuaries are areas ordinarily set apart by an Order of the State Government for the purpose of preserving wild life. The management of such sanctuaries is adequately dealt with under Resolution 6: "Protection of Nature and Wild Life" of the Mysore Session of the Board held in 1952. The Board recommends that sanctuaries conforming to the standards laid down under Resolution 6 (b) of the Mysore Conference may be constituted as such.

'In many States there may be areas where it may be considered expedient:

(i) to afford special protection to wild life, in order to enable

species of wild life which are on the verge of extinction to re-establish themselves,

(ii) to afford protection to wild life attracted to water impounded in river valley projects and to other irrigation works,

(iii) to afford protection to wild life in and around large towns and sacred places.

Such areas may be constituted by an Order of the Government which may also lay down the degree of protection.'

(Second Session, Calcutta, 1955)

'That the State Governments take suitable steps for providing sufficient food and cover to wild life in the sanctuaries.'

(Fourth Session, Ootacamund, 1961)

Recommendations of the Indian Board for Wild Life on National Parks

There has been a slight but significant evolutionary change in the policy concerning legislation to be adopted for national parks in India. In 1952 and 1953 it was hoped that by a slight revision of Schedule VII of the Indian Constitution it would be possible to get national parks placed on List III (the Concurrent List). Later it was found that this was not possible, and so then became apparent the anomaly that national parks, essentially an all-India affair, were a State subject and would have to be created by Acts of the State Legislatures.

In order to ensure the national character of such parks and uniformity in the various States, it was then decided to draw up a Model Bill which would serve as a basis on which States could frame their own legislation for national parks. This model bill was circulated to all States for comment and suggested amendments, and was then vetted by the Law Ministry. In its finalised form it was sent to all States in February 1957.

The relevant resolutions on national parks in the Proceedings of the successive meetings of the Indian Board for Wild Life and its Executive Committee are as follows:

'The creation of national parks in conformity with the general objectives laid down by the International Union for the Conservation of Nature and affiliated bodies.

'Provided that should a State create a national park, the advice of the Indian Board for Wild Life will be taken to ensure its national character.

'The term "national park" for this purpose would generally denote "an area dedicated by statute for all time, to conserve the scenery and natural and historical objects of national significance, to conserve wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations, with such modifications as local conditions may demand".

(Inaugural Session, Mysore, 1952)

'It is also essential that there should be uniformity in the management of national parks and the standards to be maintained should be of a high order. The main reason for the non-establishment of national parks in the country is that the State Governments are not in a position to finance wholly by themselves the establishment of national parks. National parks, the establishment of which has been recommended separately, may not come into being without central advice and assistance from the centre. In the United States "national parks" is a federal subject and such parks are entirely financed and controlled by the Federal Government. The Central Government was contemplating amendment of the 7th Schedule of the Constitution (list of Union, State, and Concurrent Subjects) on the recommendation of the Commodity Controls Committee. Advantage of this fact should be taken and, therefore, recommends to the Central Government that the subject of "national parks" be added to List III (Concurrent List) in Schedule VII of the Constitution.'

(Executive Committee, Kanha, 1953)

'National parks are areas set apart by an Act of the competent Legislature for permanent preservation. Such areas may have for their objective the preservation of one or more of the following features: geological, pre-historical, historical, archaeological, scenic, faunal, and floral.

'It is not an essential condition of national parks that there should be no human intervention. Where it is desired to exclude human intervention altogether, it may be possible to set apart a suitable part within the national park—*sanctum sanctorum*—which may receive absolute protection.

'Such parks are not to be created lightly.

'In framing proposals for the constitution of national parks, the Board considers it desirable that State Governments should consult it and avail themselves of the technical knowledge and experience at its disposal.

'The Board recommends further that legislation to be enacted in various States for the creation and management of national parks should follow a common pattern. In order to facilitate this the Board will prepare and circulate a model draft bill.

'In order to ensure the national character of such parks, the Board recommends that in the authority set up under the legislation the Central Government and the Board be represented through the Inspector General of Forests or his nominee.'

(Second Session, Calcutta, 1955)

'The Executive Committee resolved to advise the State Governments that pending the constitution of any sanctuaries into national parks, any attempt that might be made to change their existing character or whittle away their resources in any way should be guarded against.

'The Committee also authorised the Secretary to examine the feasibility of suggesting to the State Governments the desirability of referring their National Parks Bills to the Centre before presentation to the State Legislatures.

'The Committee examined the draft Model Bill clause by clause and made a number of suggestions in the bill and requested the Inspector General of Forests to take into consideration the suggestions made and redraft the bill, also incorporating any suggestions that might be received from the members within the next 10 days. Thereafter, the bill was to be vetted by the Ministry of Law and circulated to State Governments.

(Regarding the point whether it would be desirable to call these parks 'national' as these parks were to be constituted by State Governments) 'the whole idea was to give a national character to the park. Some standards on a national level were to be laid down for all the parks even though they were to be constituted by the State Governments in different States. A national character could be secured by having the Central Government's representation on the Board of Management. Furthermore, there was a proposal to give some financial aid to the parks by the Government of India. It would therefore be in the fitness of things to call them national parks.'

(Executive Committee, Ootacamund, 1955)

'Model Bill for constitution of national parks which may be suitably adapted or added to, to provide for any special or local requirements. This Model Bill aims only at ensuring that the technical

requirements will be fully covered in any State legislation regarding "state parks". As will be seen, it is considered best that each park in a State should be so constituted by a separate Act of the State Legislature. It would follow that any alteration or alienation of the area of the park would also require sanction of the Legislature.

'As the bill provides exclusively for action by the State in respect of an area entirely within the State, these parks, it is considered, may be designated as "state parks". Where a State would elect to dedicate any park so constituted for use for national purposes and agree to the management and control of the park to be put on a national basis, such dedicated parks could be adopted as "national parks".'

(Central Government letter with model bill, February 1957)

'In keeping with international practice, the Committee decided that the national parks and sanctuaries should be kept open to visitors only from dawn to dusk.'

(Executive Committee, Shivpuri, 1959)

'The Board recommended that national parks may also be set up under the Acts of the State Legislatures, but before naming them as national parks the approval of the Board may be obtained. The Board will grant such approval only to such parks that will fulfil certain minimum requirements.'

(Fourth Session, Ootacamund, 1961)

Standards for National Parks in India: A Statement of National Park Policy

I. Definition

National Parks are areas 'dedicated by statute for all time, to conserve the scenery and natural and historical objects of national significance, to conserve wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations, with such modifications as local conditions may demand'.

From this definition, passed at the Inaugural Session of the Indian Board for Wild Life in 1952, it follows:

1. That national parks must be areas of national significance to India as a whole, and of importance to the rest of the world, and not areas of mere local significance.

2. That the natural scenic beauty of the area must be carefully preserved so that it will remain unspoilt and unimpaired for the enjoyment of future generations. This means that there should be no forest operations such as the extraction of timber and planting of plantations in a national park, unless they can be justified on the basis of the very pressing economic needs of the country. In areas of outstanding beauty or holding valuable fauna, where it may not be possible to forego such forest operations (where they are already being done), the natural scenic beauty should be preserved as far as possible, and certain areas should be left strictly protected as 'inner sanctuaries' or *abhayaranya*.

3. That the existing and indigenous wild life of the area must be strictly preserved for the enjoyment of future generations. This implies that no 'foreign' or exotic species of fauna or flora should be introduced, though a species which once existed in the area and has within historical times become extinct can be re-introduced if an expert ecological study of the area favours such a step. A national park may preserve either rare and valuable species of fauna in danger of extinction, or typical fauna representative of the region, or a combination of both.

4. That development of the area must be carefully planned and executed so as to provide for its enjoyment by the public and by foreign visitors in such a way as to leave the natural scenic beauty and wild life unimpaired for future generations. This means that access roads should be made, and roads and paths inside the park for the use of visitors. And that rest houses and suitable accommodation should be provided. And that motor transport, riding elephants, boats and so forth be provided as local conditions may demand.

5. That national parks, wherever possible, must be of such size as to make them viable and ecological units, and comprehensive units embracing the amount of territory required for effective administration and for the continuance of the representative fauna and flora.

II. Legislation

As wild life is a State subject, the legislation for the creation of parks will be enacted by the State Legislature concerned. It is considered advisable that there should be a separate Act of the State Legislature for each park, and not a general Act or an enabling Act for several parks. It is recommended that the model bill, as drawn up by the Indian Board for Wild Life and approved of by the Law

Ministry, should be used as a basis for any State legislation, in order to ensure uniformity and an all-India character in the parks of the country.

As the term 'national' has a country-wide, all-India significance, it is recommended to State Governments that the standards as laid down should be strictly adhered to, and that the approval of the Indian Board for Wild Life be obtained before designating a park as a national park. A park in a State can then be dedicated to the nation, and become a national park. Existing national parks in the country which are up to the standards laid down should remain as originally constituted.

III. Administration

In administering national parks it is recommended:

1. That for each national park, or for the national parks of each State, there should be a Management or Advisory Board or Committee consisting of members of the Government and Forest Department, eminent conservationists, representatives of public interests and so on. At any time considered desirable, the advice of the Indian Board for Wild Life should be sought.

2. That national parks be administered with the primary objective of conserving the scenic beauty and wild life in their natural state, and of preserving and safeguarding all objects within them. And that management, control, modifications and other such human intervention be done only under expert advice and in conformity with the standards as laid down.

3. That, wherever possible, buffer belts or buffer zones of sufficient width be constituted outside the boundaries of national parks, in order to ensure their inviolability—especially against poaching, grazing by domestic cattle, cattle-borne diseases, cutting of vegetation and so on.

4. That undesirable commercial activities and non-conforming recreational activities be avoided, as violations of the standards as laid down. Fishing with rod and line for sport, subject to local regulations, is permissible in national parks.

5. That carefully planned and restricted forest operations be permitted only when there are overriding reasons to justify them, such as the pressing economic need for timber and the revenue derived from it. In such cases steps must be taken to preserve the scenic beauty and to set aside preservation plots, inner sanctuaries or *abhayaranya*.

6. That roads and paths be constructed to enable visitors to see and enjoy the scenic beauty and wild life and for the purpose of administering and protecting the area, with the least interference with the natural scenery.

7. That buildings for accommodation of visitors and staff be constructed, but that they be as unobtrusive as possible and in harmony with their surroundings. While luxury for visitors is not recommended or desirable, there should be a high standard of the basic requirements of the present-day traveller.

8. That appropriate steps be taken to provide publicity to attract visitors from within the country and tourists from abroad. In addition, full information on each park should be available in the form of a well-illustrated booklet, which will be of use not only to visitors but also for educational purposes. The services of guides should be available, if required by foreign visitors. Picture postcards and other mementoes should be available for sale, if there is a demand for them.

9. That every step taken in the development and use of national parks conforms to the standards, so that the area may be left unimpaired for the enjoyment of future generations. If ever any doubt may arise, the ultimate interests of the people of the whole country and of future generations should be taken into account.

Forest Fires and Wild Life

1. *General*

First of all, it is not possible to generalise on the subject or to formulate a forest fire-control policy which would be acceptable to all countries, or even to all regions in any one country. Only intensive studies conducted in each region, even in each individual reserved forest, sanctuary or national park could enable one to come to any definite policy decision for a particular place.

For instance, what might be the fire-control policy in certain forests or national parks of Canada may not be suitable for parts of Africa or India, where the local conditions of climate, environment and wild life are totally different.

Broadly speaking, it should be recognised that where such conditions exist that a forest fire could be very sudden, very widespread, and involving a very large area, then the fire hazard is very great and the potential loss to wild life, as well as to timber, very considerable.

2. *United States and Canada*

Such dangerous conditions exist in parts of the United States and Canada, that elaborate precautions are taken in parts of these two countries to fight fire. In some of the national parks of these two countries, where there are vast areas of pine forests, fire-control is done not so much to save the timber (for this is not exploited as a forest resource) but to prevent disfigurement of the park and to protect the wild life from destruction.

Here it should be mentioned that it is generally admitted by wild life conservationists in the United States and Canada (as well as in Africa and India) that: (i) nearly all wild life species 'are dependent upon habitats which have not reached the limit of floral succession, i.e. are sub-climax'; (ii) fire is one of the chief causes of a sub-climax vegetation; and (iii) grazing mammals require sub-climactic grasses and reeds, and browsing mammals need an adequate supply of broad-leaved trees and shrubs which are not often associated with a climax growth in some parts of the world.

Forest fires can be divided into two types: man-caused (either deliberate or accidental) and lightning-caused (natural). In the United States the official policy of the National Park Service is 'to reduce the number of man-caused fires to the smallest attainable minimum, and to combat any fire which occurs, regardless of size, origin, or location . . . Lightning causes few fires in eastern areas because the deciduous vegetation is usually green when lightning storms occur. In the western areas lightning and man-caused fires are of about equal occurrence.'

As the result of this policy a peculiar position has arisen in some of the national parks of the United States, for instance in Yellowstone. Many years of fire suppression have resulted in a considerable amount of dead and highly imflammable trees, branches and leaves lying on the ground all over the park. Thus, by suppressing all localised and small fires a situation has arisen in which, should a fire occur, it might become so serious and so widespread as to do far more damage at one time than would have been done by all the intermittent localised fires. There arose a controversy in Yellowstone as to whether lightning-caused, natural, localised fires should not, after all, be allowed to run their course as they have done since time immemorial, and as to whether complete fire-suppression is not actually an undesirable act of intervention by man in the course of nature.

3. *Africa*

Fire-suppression and controlled burning have been the subject of much discussion in many parts of Africa. Perhaps the most interesting case in this continent is the history of the controversy in the former Belgian Congo. For many years the Belgian Government practised the ideal of complete non-intervention, with a minimum of wild life management. As part of this policy, man-caused fires—and also lightning-caused fires—were rigidly suppressed, thus producing a climax type of vegetation quite unsuitable for the herbivorous animals which exist there in large numbers.

This was particularly so in the Parc National Albert, where through the centuries many of the antelopes and other mammals of the Rwindi Plain had become specialised for existence in and on sub-climax type of vegetation brought about by natural fires. It turned out that these were poorly adapted to the climax growth which followed the elimination of burning. Thus, to suppress fires altogether was not really a policy of non-intervention but was in fact an act of intervention by man. The Belgian authorities realised this, and reversed their policy and permitted fires to run their course in the Parc Albert—to the benefit of the wild life of that park.

In the Serengeti National Park of Tanganyika in East Africa an interesting case occurred where burning proved beneficial to wild life conservation. African villagers living outside the park boundaries in the region of Sereneri burned off some of their grazing areas in order to attract the park animals outside the park where they could shoot them. The Park Warden cleverly countered this move by burning off a large area within the park boundaries—with great success.

In South Africa controlled burning of the veldt has been done in order 'to improve' the grazing by destroying the dense high grass of the previous year. It has been found in the Kruger National Park, however, that 'the growth of the new and palatable shoots is soon checked, and in a short time the tender current growth on unburned veldt, while less conspicuous to the human eye, is considerably taller and probably more abundant'. Consequently an investigation was conducted to determine the facts. An ample area, however, was still being burned to provide material for study.

4. *India*

In this subcontinent most of the wild life is found in or near the reserved forests, which are generally protected against man-

caused and lightning-caused fires in order to conserve the timber. One method of fire-suppression is controlled burning of the highly inflammable grassy areas inside and around forests, often conducted in the early part of the dry season when the fire hazard is less. This 'cold burning' done in these grassy areas is undoubtedly essential for the existence of the herbivorous mammals, which thrive on the resultant sub-climax type of vegetation.

In Kaziranga Sanctuary of Assam, burning of the dense tall elephant-grass is done in patches each year, thus providing suitable areas of sub-climax grasses and reeds for grazing and also leaving areas of climax growth which provide necessary cover for the wild life of the sanctuary.

In Jaldapara Sanctuary of north Bengal controlled burning somehow came to be suspended for some years, resulting in a climax type of impenetrable vegetation unsuitable for the purpose for which the sanctuary was intended—the preservation of the Indian rhinoceros and other herbivorous wild life. This fault, I understand, has now been remedied and controlled burning has again been instituted.

An opinion was recently expressed by a Chief Conservator of Forests of a south India State that burning of forest areas reduces the numbers of certain undesirable insects, such as ticks. Probably some beneficial insects might also get destroyed, and this could be a subject of further research.

From a forestry point of view I understand that the natural regeneration of certain trees in India is actually benefited by controlled burning, while that of others is adversely affected. From the wild life standpoint, the burning of climax growth in patches and thus producing areas of sub-climax vegetation would be generally desirable—except when such burning occurred during the breeding season of birds and certain mammals.

A further benefit derived from the burning of climax grass and scrub undergrowth in national parks and sanctuaries is the improved visibility for the visitors who come to see wild life. As the economic or tourism value of wild life as a forest crop is very great, it is important to have open areas where herbivorous mammals, as well as their predators, can be seen and photographed by visitors.

5. *Summary*

Burning of vegetation, either man-caused or lightning-caused, can be destructive to wild life if uncontrolled or too widespread. On the other hand restricted and localised natural fires or controlled

burning, especially of tall dense grasses and undergrowth, will produce the sub-climax type of vegetation not only beneficial to but often essential for the existence of herbivorous mammals and other wild life.

Controlled burning of scrub and grassy areas in and around forests and sanctuaries, therefore, should continue to be practised in India whenever it is found, after careful study of local conditions, that it will be beneficial to wild life and not detrimental to other interests.

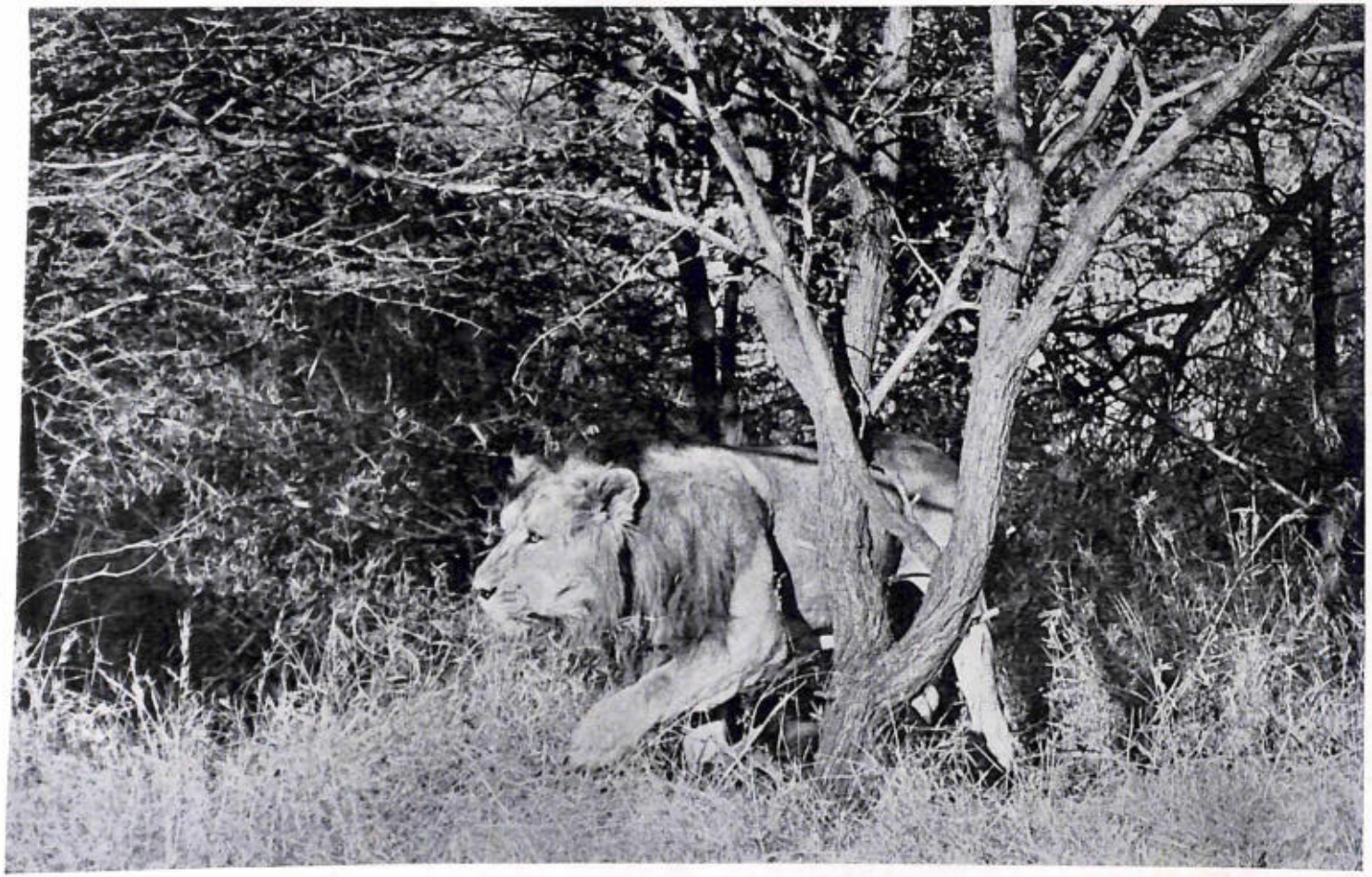
Moving Rare Species to Alternative Localities

It is the policy of the Indian Board for Wild Life to find suitable alternative homes in India for some of the rarer species. In the case of the Indian lion, for example, it was resolved at the Inaugural Session of the Board at Mysore in December 1952 that an additional locality be found for this species, *within its former range* and with suitable conditions of environment.

As a result of this resolution, it was subsequently proposed to move a few lions from the Gir Forest in north-west India into the Chakia Forest in Uttar Pradesh. This was not a case of introducing a new species into an area, but of re-introducing a species into a suitable locality within its former range and with suitable conditions of environment, which is in accordance with the accepted principles of present-day wild life management. (The reason why 'suitable conditions of environment' have to be searched for within the former range is that climatic and vegetative conditions in India have changed considerably in the last thousand years or so. Regions in the north-west, once green and fertile and holding such mammals as the rhino, have now become barren wastes.)

Subsequently, however, there has been a suggestion put forward that rare species from other parts of India be obtained for re-stocking sanctuaries which to some extent have become depleted of wild life by poaching. For example, it was once suggested that a few Indian rhino from north-east India be introduced into Periyar Sanctuary in Kerala; and that a few swamp deer from Uttar Pradesh, musk deer from Kashmir, brow-antlered deer from Manipur, and chinkara from north and central India could well be introduced into Mudumalai Sanctuary in Madras.

Now let us examine these suggestions. It is obvious that the musk deer, which is a species of very high altitudes near the snow line and which feeds on mosses, lichens, and such-like vegetation, would not thrive in Mudumalai. It is also, of course, doubtful if the



The Indian Lion

(Photo : E. P. Gee)

The Gaur or Indian Bison

(Photo : E. P. Gee)

chinkara, which is an animal of dry and open regions, would thrive there. Therefore, musk deer and chinkara can be ruled out.

On the other hand it is possible that rhino, swamp deer, and brow-antlered deer would thrive in Mudumalai or Periyar, for these species do well in zoological gardens in other countries. But is it desirable to introduce these species as new species into these two sanctuaries which may become national parks in the near future?

The stated object of introducing new species into Mudumalai was that it 'will not only sustain the interest in wild life but also attract tourist traffic'. The object of introducing the rhino into Periyar was 'to make the sanctuary more popular with visitors and tourists'.

Thus, the objective in these two cases appeared not to be to provide suitable alternative homes for rare species so that they may stand more chance of survival. If this was the primary motive, then it could very strongly be argued that there are far more suitable 'alternative homes' for the swamp deer in central and north-east India, and for the rhino and brow-antlered deer in north and north-east India 'within their former range and with suitable conditions of environment'.

The real motive was to bring these species from north and north-east India with a view to attracting more visitors and tourists to their sanctuaries. Now, is this type of human intervention, i.e. introducing new species in order to attract more visitors, permissible in a wild life sanctuary or national park? Certainly not, by the present-day internationally accepted principles and standards of national park administration.

At the meeting of the Executive Committee of the Indian Board for Wild Life held at Periyar in January 1957 it was resolved that in such cases a thorough ecological study of the conditions both of the present home of a species (such as the Kaziranga home of the rhino) and also the proposed receiving sanctuary (possibly Periyar) should always precede any definite plans for such moves. This is a correct decision, but unfortunately it implies that if the ecological studies indicated that the species (say rhino) would thrive when moved from the supplying area (say Kaziranga) to the receiving area (say Periyar), then the introduction could take place. The resolution does not take into account the principles which govern national park administration and which do not permit the introduction of new species from outside.

Both Mudumalai and Periyar are valuable wild life sanctuaries with prospects of being created as national parks in the foreseeable

future. Now, the emphasis in the case of national parks and wild life sanctuaries is placed on conserving the *native* wild life, on preserving the *existing character* of the place, on preserving the *typical or representative fauna and flora* in an area maintained unspoilt for future generations. It is not permissible, according to internationally accepted principles and standards, to allow human intervention such as the introduction from outside of new species.

One of the most valuable and interesting facts about the Gir Forest is that it contains the Indian lion now living, as it did in former days and possibly since time immemorial, as a wild animal in its *natural* habitat. Similarly, Kaziranga houses the Indian rhino in its *natural* habitat, just as it probably did many thousands of years ago. The brow-antlered deer of Manipur live in their last marshy stronghold on the Logtak Lake—in their primeval *natural* habitat.

The fauna of south Indian sanctuaries, also, hold a similar unique position as being *truly representative* of the region in which they are found, having existed there from time immemorial. Now to put rhino from Kaziranga into Periyar, or brow-antlered deer from Manipur into Mudumalai, and so on, or conversely to put 'bison' from Periyar into the Gir Forest, or chital from Mudumalai into Kaziranga would be a case of putting species into places where they have never formerly existed. Such an intervention would be tantamount to violating the *pristine integrity* and *natural sanctity* of these fine places. No longer would the original fauna be seen in its *natural and original habitat*, but a miscellany of wild animals from different parts of the sub-continent would be grouped together haphazardly, in the manner of zoological parks.

In any case the introduction of, say, a pair of rhino into Periyar would not solve the problem of how to provide more attraction to visitors—unless these creatures after importation were confined in an enclosure at the side of the lake and artificially fed by hand, as in a zoological park. For rhino are solitary beasts and great wanderers. They would probably not remain as a pair, but would wander far afield as individuals and would be rarely if ever seen by anyone—that is if they survived being shot by poachers or by cultivators in defence of their crops.

Similarly, the introduction of a pair, or even several pairs, of swamp deer into Mudumalai would not provide the answer to the problem. They would probably disperse and be rarely seen by visitors—even if the wild dogs were systematically reduced or exterminated beforehand. They would also probably fall very easy

victims to tiger and leopard, especially after capture, transportation and introduction into a strange and new habitat. Like the rhino, swamp deer and brow-antlered deer are great wanderers.

The same objections would apply to any proposal to re-introduce rhino into the Corbett National Park or into the Hazaribagh National Park, where they are believed to have once existed. If let loose into these parks, rhino would be sure to wander far afield into the cultivated areas and destroy the crops of villagers not accustomed to such beasts. Even if they survived the wrath of the villagers, any calves born would run a grave risk of being killed by tigers—rhino calves appear to be a favourite food of tigers in Kaziranga.

At this point it should perhaps be admitted that these three species could not so increase in numbers as to become a nuisance or harmful pest as in the case of the red deer in New Zealand and the reindeer in Alaska. The objection to the introduction of these three species from north and north-east India into south India would seem to be based on the fact that they would be a failure and therefore a waste of money, in addition to being a violation of the principle of not introducing new species into any area.

The two last-mentioned objections (failure and waste of money) would seem to apply to the recent proposal to introduce nilgai into Bandipur Sanctuary from some part of Madhya Pradesh. When the pair were placed in a ring fence near the sanctuary, even the cow could not be left in the same enclosure as the bull as the latter tried to kill his prospective mate. When turned loose into the sanctuary, it seemed probable that they would separate, and ultimately fall victims to tigers in this new habitat.

A further objection to such introductions is that 'there is evidence that parasites and diseases of introduced mammals are at least partly transferred with their hosts to new biota'.

If it is becoming increasingly difficult to find wild life in certain sanctuaries, and if it is required by the authorities administering these places that there should be more wild life for visitors to see, then surely the first and foremost thing to do is to reduce poaching and other illegal shooting both in the neighbourhood of the sanctuaries and also within the sanctuaries themselves.

Surely it would be advisable to preserve the integrity of these two potential national parks of Periyar and Mudumalai, and not to allow the high standards of wild life management adopted at the Mysore Session of the Indian Board for Wild Life to lapse into oblivion.

It is essential that these high standards be rigidly preserved. This subject has been thoroughly examined by other countries which have been studying the conservation of nature over a great number of years. May India not fail to profit from the experience of other countries, and may she continue to follow the highest standards of internationally accepted national park administration.

Summary

Rare and vanishing species can be safeguarded by moving a few individuals to a new locality; but this new locality should, if possible, be *within the former range* and with suitable conditions of environment. Such a move should always be preceded by a careful ecological study of the conditions both of the supplying and of the receiving localities.

In sanctuaries and national parks where wild life has become depleted through poaching, the first step should always be to put an end to poaching and to re-habilitate the depleted wild life.

Introduction of new species into a new locality is usually a failure and a waste of money—unless accompanied by undesirable, expensive and artificial protective measures.

One of the internationally accepted standards of sanctuaries and national parks is that the *native* wild life should be conserved, and that no non-native species should be introduced. It is desirable that this standard should be maintained in India.

Forest Department Plantations within Sanctuaries (and National Parks)

The definition of a national park in India as laid down by the Indian Board for Wild Life at its inaugural session at Mysore in 1952 is: 'An area dedicated . . . to conserve the scenery and natural . . . objects . . .' Therefore it would appear to follow that the planting of trees and shrubs in a sanctuary or national park should be avoided.

Also, one of the generally accepted principles of wild life conservation and management of national parks and sanctuaries is that the planting of trees within a sanctuary or park would amount to an act of human intervention or interference with nature which would be undesirable.

But in certain countries, such as India, where over-grazing by domestic cattle or excessive felling for timber and firewood has

resulted in the disappearance of vegetative cover and forests, it may be advisable—even desirable—to resort to afforestation. For in this case such afforestation or plantation work in a sanctuary might be necessary in order to remedy the much greater interference by man in the past, which has resulted in bare and arid conditions, soil erosion and so on.

If it is a case of felling existing uneconomical forest and replacing it with trees of commercial value, then each case would have to be judged on its own merits. If a State Government could justify the planting of such plantations in a sanctuary on the ground of pressing economic needs, this might take precedence over purely wild life considerations. But if such plantations can be avoided or if the plantations can be outside the sanctuary to serve as a buffer zone, this will be very much more desirable.

However, in doing any kind of afforestation or plantation work inside sanctuaries, the following points could well be observed in order to achieve the best results with the minimum amount of disturbance to the natural beauty of the place:

1. Plantations should as far as possible be on or near the edges of the sanctuary. This helps as a method of demarcation of the boundaries and as a protection against illegal incursion by cultivators, grazers and poachers. (This has been tried out with success at Laokhowa Sanctuary in Assam.)

2. Plantations should as far as possible (except in the case of those on the boundaries which would follow the direction of the boundaries) be irregular and natural-looking in shape. In other words they should avoid regular square and rectangular patterns and straight lines, so as to make the resultant artificially-produced forest later on appear to be a natural one.

3. The introduction of exotic species of trees and shrubs should be avoided. If those indigenous, local species which are most beneficial were to be planted, this would be very commendable.

4. If the plantations could be of mixed species, with a few trees which are beneficial to wild life—such as those with berries palatable to birds or suitable for their nesting, or with leaves palatable to herbivorous animals, and so on—this would assist in justifying the project.

The Holding of Wild Life Photographic Exhibitions[1]

1. The exact definition of the term 'wild life' should be given in the rules governing entries for the exhibition. If entomological and botanical subjects are to be included, this should be clearly stated; otherwise it might be assumed that the entries should include only mammals, birds, reptiles and fishes. Different sections can be arranged for each branch of wild life, if considered advisable.

2. The term 'wild life' should be further defined, so as to exclude all entries depicting captive or tame animals such as are found in zoos. Only photographs of genuine wild animals taken in a state of nature, i.e. in their wild state, should be entered. If required, a separate section or class can be made for photographs of animals which are captive or tame. Alternatively, the exhibition could be termed a 'natural history exhibition', and then photographs of captive or tame animals could be included—but in this case it should be clearly stated on both the entry forms and on the photographs that the subject was in captivity.

3. The panel of judges should comprise an odd number, preferably five; and these judges should have had ample experience of photographing the subject of the exhibition, namely wild life. Among the judges should be at least one person with sufficient knowledge of natural history to judge the biological merit of entries. (If wild life is to include entomological and botanical subjects, then an appropriate proportion of the judges should have had experience of this type of photography.)

4. In judging wild life photographs the following important points should always be looked for:

(*a*) The main subject should be critically sharp.

(*b*) Composition: the main subject should be nicely placed and lighted, and properly balanced.

(*c*) At least some of the natural habitat should be shown.

(*d*) There should be detail in both highlight and shadow.

(*e*) The print should be nicely but plainly mounted, and any spots or dust marks carefully retouched so that they cannot be seen. Any particularly objectionable highlight should be toned down.

(*f*) The picture should have natural history interest. Other things being equal, preference should be given to subjects of greater biological interest, such as pictures of rarer wild life, or wild life seen in interesting circumstances.

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[1] My acknowledgements are due to Eric J. Hosking, F.R.P.S., and Lt.-Col. C. L. Boyle for help in compiling this section.

5. Marks for each entry might be given in the following proportion:

Technical and artistic excellence [Clause 4 (*a*) to (*d*)]	40%
Biological interest of subject and habitat [Clause 4 (*f*)]	40%
Presentation, mounting, touching, etc. [Clause 4 (*e*)]	20%

6. The judges themselves may submit photographs for the exhibition, but they should leave the room when their own entries come up for selection. Alternatively, a special section of the exhibition could be arranged to consist entirely of the work of the judges.

Procedure in Reporting Cases of Poaching, Bombing of Fish, etc.

In many cases no action is taken by the authorities, to whom reports of poaching or bombing have been sent, owing to the fact that either insufficient data have been given or the report has been incorrectly submitted. The following note is intended to assist the would-be reporting members of the public in correct reporting and thereby assisting in preserving wild life and in ensuring a continuance of bona fide sport for the future.

1. How to report an incident

(i) It is necessary to give all possible information as to witnesses of the incident or malpractice, exact location, exact date, exact time and all available clues as to the identity of the alleged culprit (s).

(ii) It is necessary to submit the report as soon as possible after the incident or malpractice has occurred.

(iii) It is advisable to write the report in factual and correctly phrased language, as the report may be copied to others and referred to subsequently.

(iv) It is advisable to give reasons for reporting, e.g. *firstly* as a well-wisher of India desiring to co-operate with the authorities in the prevention of law breaking, *secondly* to preserve a fast-vanishing national asset from wanton destruction, and *thirdly* to ensure the continuance of sport for bona fide sportsmen who obey the laws and take out permits, licences, etc.

(v) It is advisable to request, in return for one's help in reporting, acknowledgement of the report. In some cases one could also ask for intimation in due course as to what action has been taken. Even better, personal contact could sometimes be established with the authorities in the matter. If no acknowledgement of a report is

received, a reminder should be sent with a copy to the next senior officer for information. If, after that, no reply is received a copy of the full report should be sent to the Head of the Department concerned, with covering letter. For this it is advisable to type extra copies of the report in the first instance.

2. To whom reports should be sent

In those States in which there is a separate Wild Life or Game Department, all reports should be sent to the Officer or Warden concerned. In States where there is no separate Department for Wild Life, this subject usually falls under two different administrative departments—the Forest Department and the Civil Authorities (Police).

(i) National Parks, Wild Life Sanctuaries, Game Reserves, Reserved Forest and so on come under the jurisdiction of the Forest Department. Reports of incidents or malpractices in these places should be sent to the Forest Officer in charge of the place. If Beat Officers (lowest in status) are omitted, the next higher officer is the Range Officer. Above him is the Divisional Forest Officer. Above him is the Conservator of the Circle. At the head of the Department is the Chief Conservator of Forests (in some States there are variations of this title). Above him is the Forest Minister.

(ii) Outside those places under the Forest Department as listed in No. (i), all places usually fall under the jurisdiction of the Civil Authorities and the Police. Therefore the report should be sent to the local Magistrate concerned, i.e. the Sub-Divisional Officer (or equivalent), the Deputy Commissioner (or Collector). Above these Officers is the Commissioner (in some States). Above him is the Chief Minister.

In North-east India there are additional administrative areas:

(i) North East Frontier Agency, containing four Frontier Divisions of Kameng Frontier Division, Siang Frontier Division, Luhit Frontier Division and Tirap Frontier Division. Reports should be sent to the nearest officer of the Frontier Division concerned, either Forest or Civil—preferably the former. Above him is the Director of Forests, N.E.F.A., Shillong.

(ii) Naga Land. For offences in this State reports should be addressed to the Forest Officer, Naga Land, Manipur Road P.O. Above him is the Commissioner, Naga Land, Kohima P.O.

(iii) Hills Districts under VI Schedule in Assam. These Hills Districts are United North Cachar and Mikir Hills District, United

Khasi and Jaintia Hills District, Garo Hills District, Mizo Hills District, etc. Reports on offences in Reserved Forests in these Districts should be sent to the Divisional Forest Officer concerned. For offences outside the Reserved Forests in these Districts, reports should be addressed to the Forest Officer of the District Council concerned, or to the Chief Executive Member of that District Council.

3. Service Personnel

If Service Personnel are suspected of an offence, a report should be sent to the Commanding Officer of the Unit concerned (with a copy to the local Divisional Forest Officer). The Chiefs of Staff of the three Services have pledged their full support for the enforcement of the Game Laws, Shooting Rules, etc. among their personnel, who are bound to obey these in the same way as civilians are. Service personnel have no special rights or privileges with regard to shooting and fishing in Reserved Forests and elsewhere, and must take out permits and licences from the authorities in just the same way that civilians must do. In the case of Army Personnel, if no satisfaction is received from the Commanding Officer, a report may be sent to the Sub-Area or Area Commander, or in extreme cases to the Adjutant General's Branch of Chief of Army Staff, New Delhi. Reference may be made to Army Orders 214/56 and 593/57, and to the Notices published in Army Orders dated 24-12-55 and 25-8-56. In these Notices it is said that disciplinary action will be taken against personnel who offend the game laws of a State or for misuse of Government ammunition/explosives. In the Notice dated 25-8-56 the relevant extract from the Indian Fisheries Act, 1897, Section 4 (1), is reproduced: 'If any person uses any dynamite or other explosive substance in any water with intent thereby to catch or destroy any of the fish that may be therein, he shall be punishable with imprisonment for a term which may extend to two months, or with fine which may extend to two hundred rupees.'

4. Additional Recommendations

(i) It is recommended that a copy of a report be sent to any person who is closely concerned, for information only, if it is known that this will help matters.

(ii) If, in spite of correctly reporting a clear-cut case, no action is taken even when sent in the last instance to the Head of the Department, then the matter should be taken up with the Minister

concerned. Ultimately, if no action is taken, the matter should be reported to the Honorary Regional Secretary, of the Region concerned, Indian Board for Wild Life, or to the Secretary, Indian Board for Wild Life, Ministry of Agriculture, New Delhi. Publicity of the whole case may also be given in the Press, to invoke public support—for public opinion is by far the strongest ally of all in the fight against wanton destruction of a valuable national asset.

Many people, when they see or hear of poaching, bombing, etc. being done, are apt to become either angry (sometimes writing an irate letter to someone), or frustrated (sometimes taking no action at all). Such people usually say to themselves: 'What is the use of reporting? Nothing will be done about it. The authorities themselves have a hand in the racket!'

But if the above suggestions in correct reporting are fully followed by sportsmen, naturalists and other members of the public, it is certain that appropriate action will in most cases be taken, because all Government Departments are pledged to enforce the game laws etc. In most cases action will be taken by the first officer to whom the report is sent, and there should be no need for the subsequent suggested procedure.

If a member of the public remains silent and indifferent and does not report a case, he is to some extent acquiescing in the misdeed. If he does report, he is not only doing his duty as a good citizen but also he is actively contributing to the preservation of a valuable but fast-vanishing national asset.

Information Tables for Sanctuaries, National Parks, etc.

Seasonal, climatic, sociological, ecological and other conditions vary so much even from place to place in the same country, that some system of tabulating information as to the times of the year when suitable conditions may be encountered for particular objectives becomes desirable.

Nearly everyone is familiar with the seasonal and climatic variations of the country, or at least the region, in which he has resided for some time. But a visitor from Europe or North America can be very little aware of the changing conditions from region to region of countries in Africa and Asia, and vice versa.

In many parts of Africa and Asia there are one or more rainy seasons during which some of the parks/reserves become quite inaccessible. These rainy seasons are often preceded by dry, hot and dusty periods, to be followed by spring-like or summer-like con-

ditions. Even if the seasonal and climatic conditions of a given region or country could be fully ascertained in advance, there are many other conditions which are not altogether dependent on seasons and climate, but which vary according to altitude, existence or otherwise of water, types of terrain and vegetation, migrations of certain species of wild life and so on.

For instance, in East Africa there are two short rainy seasons with varying rainfall in different parts of the country; and during these wet spells certain parks/reserves may be closed to the public. Is it not desirable to know beforehand exactly when these rainy seasons occur, and which parks are closed for which periods, and what the conditions are like immediately before and after these rainy spells?

Also in Ceylon there is a north-east monsoon and a south-west monsoon, but exactly when do these occur? It is reported that both the main parks of the country are closed during September—a month of not excessive rainfall. Information Tables, with index numbers 0 to 5, would appear to be most desirable in order to convey to intending visitors when they can best visit the parks of this country.

Also in India, as another example, it is essential that intending tourists and visitors should know that the Corbett Park is closed from June to October, and Kanha Park impossible to visit from the middle of July to the middle of November. At this very season, however, Dachigam and Shivpuri are at their best, and other places are well worth visiting during these months in India. In the case of India's bird sanctuaries it is essential to know that the breeding of water birds in Ranganthittoo is usually at its best in June, July and August; Keolaleo Ghana usually at its best in August, September and October; and Vedanthangal usually at its best in November, December, January and February.

Accordingly it is suggested that a Table be drawn up for each sanctuary/park/reserve, giving such general information as to show the months of the year in which visitors with varied interests can visit these places to their best advantage. Only by such means can visits be successfully planned by persons from far-away countries without frustration, disappointment and unnecessary expense.

At first sight it might appear that there would be a danger of too much crowding of visitors during the months which are shown on the Table to be the most suitable months for a visit. In actual experience, however, exactly the opposite is the result. For by studying the appropriate Table beforehand visitors would see at a

glance that certain months are more popular with the general public, and they themselves could avoid these rush months—especially if certain other months are favourable for particular objectives and individual interests.

For instance some national parks in South Africa are very crowded during certain school holiday periods. A careful study of Tables giving information about these parks would reveal that this crowded season could be avoided, with entirely satisfactory results. Again the crowded vacation season fills some of the national parks of North America during the months of July and August, while June and September are almost as good but very much less crowded and the best months for photography of wild animals in them are actually April and October.

Particular items can be shown in the Tables for persons with special interests, e.g. the flowering times of lower and higher altitude flowers, autumnal colours, best months for fishing in rivers and in lakes, best months for mountaineering and so on. As these times often differ from those which attract the greater holiday crowds, there would be a wider selection of months resulting in less crowding and less disappointment for persons with special interests. The information contained in these Tables will be of benefit both to those with scientific or specialised interests as well as to the general public.

Thus, so far from resulting in overcrowding during the rush months, such Tables would actually produce a levelling-out effect, both to the benefit of the sanctuary/park/reserve administration and to the visitors themselves. Many other questions affecting personal clothing to be worn, equipment to be taken and so on can be effectively and concisely answered in such a Table.

In the first place, a separate Table is necessary for each sanctuary/park/reserve, to be drawn up by the administrative officers and those best acquainted with local conditions. Then a comprehensive Table showing the sanctuaries/parks/reserves of a country, preferably region by region, giving monthly index figures only, could be made, thus enabling visitors to plan beforehand a tour to include several places in the order in which the most favourable conditions for their particular objectives could be found. If such Tables could be internationally accepted and standardised, considerable advantages would result.

A Table for a sanctuary/park/reserve, once made, need not remain as a rigid and permanent fixture: amendments and modifications can be made after a study both of human and of wild life interests. In cases

where disturbance by visitors might be harmful, such as the breeding seasons and localities of rare species, this item of information could be excluded from the Table. Improvements in all-weather roads and accommodation may enable an up-grading of a low-indexed month to a higher rating to be made.

Two specimen Tables are given: (i) a Table for Kaziranga Sanctuary in India, with which the writer has been closely associated for over thirty-four years, and (ii) a comprehensive Table for the whole of India showing the chief wild life sanctuaries region by region.

BEST MONTHS OF THE YEAR FOR VISITING KAZIRANGA SANCTUARY, ASSAM

(Altitude 250 feet above sea level, Annual Rainfall 80 in)

Month	Index*	Weather	Temperature in C°. Max.	Min.	Remarks
January	4	Fine, cool	75	45	Early morning mists. Dry. Afternoon visits better.
February	5	Fine, cool	80	55	Grass being burnt off. Best time.
March	5	Fine, cool	85	60	Grass burnt off. Best time.
April	4	Showers, warm	90	65	New grass growing up. Good time.
May	3	Rains start	95	70	Conditions uncertain. All right if dry.
June	2	Rains	95	75	Only small areas of Sanctuary may be visited, where a few rhino graze.
July	2	Rains	95	75	do.
August	2	Rains	95	75	do.
September	2	Rains	95	75	do.
October	3	Rains finish	90	65	do. Improving.
November	4	Fine, cool	85	55	Swamps boggy, grass high in places. Improving.
December	4	Fine, cool	75	50	Early morning mists. Drier. Afternoon visits better.

* Key to Index Numbers: 5 = Best time of all; 4 = Nearly as good; 3 = All right, but less good; 2 = Possible, not fully recommended; 1 = Just possible at times, not recommended; 0 = Impossible, or not allowed, or closed.

A COMPREHENSIVE TABLE SHOWING THE BEST MONTHS OF THE YEAR FOR VISITING INDIA'S WILD LIFE SANCTUARIES AND NATIONAL PARKS

Month	Gir Forest	Keolaleo Ghana	Dachigam	Corbett Park	Chandraprabha	Kanha Park	Shivpuri Park	Hazaribagh Park	Jaldapara	Kaziranga	Manas	Bandipur	Ranganthittoo	Mudumalai	Vedanthangal	Periyar
January	5	2	1	3	4	3	4	4	4	4	5	4	2	4	5	5
February	5	2	1	4	5	4	5	5	5	5	5	4	2	5	4	5
March	5	1	3	5	5	4	4	5	5	5	5	4	2	5	3	5
April	5	1	4	5	5	5	4	5	5	4	3	5	2	5	2	4
May	5	1	5	4	4	5	4	5	4	3	2	5	2	5	1	4
June	3	1	5	0	3	4	4	3	2	2	1	4	4	3	0	3
July	1	4	5	0	3	1	5	2	1	2	1	3	5	2	0	2
August	1	5	5	0	2	0	4	2	1	2	1	3	5	2	1	2
September	1	5	5	0	2	0	4	2	1	2	1	3	3	2	2	2
October	2	5	5	0	3	0	4	2	2	3	3	3	2	3	3	2
November	3	2	3	1	3	1	4	3	3	4	5	4	2	4	4	3
December	4	2	1	2	4	3	4	4	4	4	5	4	2	4	5	4

This system of Information Tables has (commendably) been adopted by the Indian Board for Wild Life and recommended for use to all State Governments. It has been utilised in full by the Department of Tourism, Government of India, in its recently published *Wild Life Sanctuaries in India.* The system has been sent to the International Union for the Conservation of Nature, which has acknowledged its great possibilities. It has also been sent to the National Park Service of America and to the Department responsible for the administration of national parks in Canada: both these countries have expressed their deep interest in the possibilities of such a system.

If this system of Information Tables, with index numbers from 0 to 5, could be universally adopted throughout the world in all guide books and leaflets, there is no doubt that a great deal of work and time would be saved—to the great advantage of everyone concerned with the administration of parks, and to the benefit of travel agencies and the general public.

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(Concluded)

Botanical Explorations in the Erstwhile Tehri Garhwal State—III

BY

RAJ KUMAR GUPTA[1]
Government College, Tehri

[*Continued from Vol.* **54** (4) : 886]

INTRODUCTION

Since no previous work had been done and no collections made from this area, this study has been taken up after the study in the Bhillangna Valley made earlier by the author (Gupta 1956, 57).

The area taken up for exploration includes Tehri town (746 m.) situated on the left bank at the confluence of rivers Bhillangna and Bhagirathi; Pratapnagar (2350 m.) the summer capital of the former Tehri Garhwal State about 14 km. from Tehri town; Chandrabhadni peak (2500 m.) towards Deoprayag (491 m.) and Surkhanda peak (2938 m.) which is the place where the ridge coming down from Mt. Bandarpunch meets after a zigzag course between Yumna and Uttarkashi forest divisions. From Surkhanda peak three prominent spurs take off, one running westwards via Mussoorie to the banks of River Yumna, the other two to the banks of River Ganga enclosing between them the River Hinul which meets the Ganga at Shivpuri.

Collections from these areas were made by the author during different months during the years 1956 and 1957, and the plant specimens have been identified at the Central National Herbarium, Calcutta.

VEGETATION

Earlier workers like Troup (1921), Champion (1936), Heske (1929), and Dudgeon & Kenoyer (1925) classified the vegetation of west Himalayas in relation to the climatic zones, but it was later found that the forests occurring in identical climates on different strata are

[1] Present address: French Institute, Pondicherry.

different. Mohan & Puri (1957) and Puri (1950) have revealed a closer relationship of plant communities with soil and geology in other parts of Himalayas. More recently Gupta (1959) classified the vegetation of Tehri Garhwal in relation to rock and soil.

The following types of vegetation can be distinguished from the area:

Chir-pine on quartzite and limestone. Forests of *Pinus roxburghii* Sarg. predominate round about Tehri, Nagni, and Chamma, on all metamorphic rock formations including slate, quartzite, and limestone. It prefers a deep, sandy, well-drained silicious soil. It has also been noticed that the growth and regeneration of chir-pine is good on northern slopes of the hills while on southern slopes poor quality of chir is met with.

In pure chir forests *Pinus roxburghii* is the only tree species in the upper canopy, but in mixed forests it is associated with *Anogeissus latifolia* Wall., *Albizzia stipulata* Boiv., *Dalbergia sissoo* Roxb., *Acacia catechu* Willd., and *Bauhinia purpurea* Linn.

The shrub flora varies in different environmental conditions, being chiefly composed of *Carissa opaca* Stapf., *Dodonaea viscosa* Linn., *Mallotus philippinensis* Muell. & Arg., *Zizyphus mauritiana* Lamk., *Berberis ceratophylla* G. Don., *Pyrus pashia* Buch.-Ham., *Indigofera gerardiana* Wall., and *Euphorbia royleana* Boiss. on hard rocky precipices.

Herbaceous growth is generally present which is not dense, but may consist of *Micromeria biflora* Benth., *Leucas aspera* Spreng., *Cynoglossum wallichii* G. Don., *Myractis wallichii* Less., etc., with a few grasses like *Chrysopogon montanus* Trin. ex Spreng., *Dicanthium annulatum* (Forsk.) Stapf., *Themeda anathera* (Nees ex Steud.) Hack., and *Heteropogon contortus* (Linn.) Beauv. ex R. & S., etc.

These forests have been considered as climatic climax by Champion (1936). Dudgeon & Kenoyer (1925) consider them as edaphic climax. Osmaston (1922) is of the view that they are not the true climatic climax but kept in equilibrium by the action of periodic fires which are the result of biotic influences. This view is based on the comparative immunity of this species to damage by fire than any exceptional dryness of the soil peculiar to the chir forests. The present author also feels that the above status of chir-pine is true and that they may be regarded as a *bio-edaphic climax* showing a secondary succession to the oak climax and are seral in nature.

Quercus incana *on limestone.* Above the limit of *Pinus roxburghii* level *Quercus incana* Roxb. occupy the foothills and the

low-lying valleys along the *nalas* and *khuds*. In cool and temperate aspect it is chiefly associated with *Lyonia ovalifolia* (Wall.) Drude, *Myrica nagi* Thunb., *Pyrus pashia* Linn., *Rhododendron arboreum* Smith., *Benthamidia capitata* (Wall.) Hara., and *Pinus roxburghii* Sarg. in varying proportions according to the degree of exposure to light and moisture content of the soil.

The main shrubs are *Berberis aristata* DC., *Viburnum cotinifolium* Don., *Daphne bholua* Ham. ex Don., *Deutzia corymbosa* R. Br., *Myrsine africana* Linn., *Jasminum humile* Linn., *Desmodium tiliaefolium* Don., etc. *Rosa moschata* Mill. and *Rubus ellipticus* Smith are most conspicuous of the climbers.

On rocky precipitous areas, the growth is stunted and the undergrowth is also scanty. The best type of oak is found on deep, fertile and moist soil in cool shady aspects. Since the oaks form the best fodder for the cattle of the inhabitants, it is extensively lopped and cut for fuel and for cheap agricultural implements. Various degraded scrub stages of oak, dry and moist type, can be seen within the area. Chir-pine comes in the *Quercus incana* climax when it is maltreated by felling, burning, and lopping. When looped extensively from a distance, most of the ban forests show distinct strips in the lower side reduced to a bushy growth, while the upper sides are left in a flourishing condition.

The undergrowth also varies according to the local conditions. Where the soil is fresh and well drained, plants like *Viola canescens* Wall., *Fragaria nubicola* Lindl., *Galium rotundifolium* Linn., *Geranium nepalense* Sweet, *Geranium wallichianum* Sweet, *Rubia cordifolia* Linn., and various fern species are common; where the soil is dry and in hot aspects species of *Berberis*, *Indigofera*, *Desmodium*, *Sarcococca saligna*, etc. are most important.

Cedrus deodara *and* Pinus wallichiana *forests on schist, phyllites, and flood plain deposits.* Though no natural groves of *deodar* and *kail* are present in this area, it is mixed with *Quercus incana* Roxb. towards Pratapnagar and is the result of biotic influences or peculiar conditions of the rock and soil.

Towards Surkhanda *Pinus wallichiana* A. Jones mixes with Silver Fir *Abies spectabilis* (D. Don.) Spach., and its chief associates in this zone are *Populus ciliata* Wall., *Prunus cornuta* Wall., *Juglans regia* Linn., *Betula cylindrostachya* Wall., *Quercus dilatata* Lindl., *Quercus semecarpifolia* Smith, *Aesculus indica* Colebr., *Acer* sp., and *Picea smithiana* (Wall.) Boiss.

The undergrowth is chiefly of *Daphne bholua* Ham. ex Don., *Viburnum cotinifolium* Don., *Viburnum mullaha Ham.* ex Don., and *Lonicera quinquelocularis* Hardw.

Mixed oak conifer forests. Between *Quercus incana* and *Quercus semecarpifolia* level *Quercus dilatata* mixes with these two species of oak and is seldom found as a pure community. It is associated with other broad-leaved species such as *Lyonia ovalifolia* (Wall.) Drude, *Acer pictum* Thunb., *Celtis australis* Linn., *Juglans regia* Linn., *Populus ciliata* Wall., *Ulmus wallichiana* Planch., *Carpinus viminea* Wall., etc. Conifers like *Cedrus deodara* and *Pinus wallichiana* are commonly associated with them at many places. Species covering the ground include *Berberis aristata* DC., *Myrsine africana* Linn., *Prinsepia utilis* Royle, *Daphne bholua* Ham. ex Don., *Lonicera quinquelocularis* Hardw., and *Pilea scripta* Wedd., etc.

Pure patches of *Quercus semecarpifolia* can be seen towards Surkhanda but not very common and are chiefly associated with *Abies spectabilis, Picea smithiana, Aesculus indica,* and *Taxus wallichiana* Zucc., etc. Sometimes *Arundinaria falcata* Nees and *Arundinaria spathiflora* make dense thickets in the forest.

West-Himalayan conifer forests on morainic deposits. Pure forests of *Abies spectabilis* and *Picea smithiana* are present on the moraines in other parts of the district but not found in this part, extensively, except at Surkhanda. *Betula utilis* Don. and other plants of the sub-alpine level cannot be seen in this area. At the top of the hills in open grassy slopes plants like *Pedicularis pectinata* Wall., *Anemone rivularis* Buch.-Ham., *Drosera lunata* Buch.-Ham., *Ranunculus laetus* Wall., *Taraxacum officinale* Wigg., *Senecio chrysanthemoides* DC., *Parnassia nubicola* Wall., *Potentilla nepalensis* Hk. f., and *Corydalis cornuta* Royle were observed to occur frequently.

LIST OF THE SPECIMENS COLLECTED

The plants given in the following list have been collected from the area. The reference numbers given after each specimen refer to the herbarium sheets possessed by the author and the duplicates are preserved in the Central National Herbarium at Calcutta. Every effort has been made to adjust the nomenclature of the plants according to the latest findings on the subject; plants marked with an asterisk have not been described by Collett in FLORA SIMLENSIS.

Ranunculaceae

Clematis grata Wall.

Climbing shrub. Flowers cream-coloured and fragrant; August. Common at Pratapnagar. (*Gupta* 782)

Thalictrum rostellatum Hk. f. & Th.

Herb with 3-lobed orbicular leaves. Flowers white; August. Common at Chamma. (*Gupta* 400)

Anemone obtusiloba Don

Herb with white flowers tinged with blue near the base; May-Aug. In ban-oak forests, everywhere. (*Gupta* 759B)

Anemone vitifolia Ham.

Herb with robust pubescent stem. Flowers white; June-Sept. In oak forests at Surkhanda and Pratapnagar. (*Gupta* 549, 563, 748, 753)

Ranunculus diffusus DC.

Herb covered with soft hairs. Flowers bright yellow; May-Sept. In shady places at Surkhanda and Pratapnagar.

Ranunculus laetus Wall.

Perennial with long closely adpressed hairs. Flowers bright yellow; May-Sept. At 1500 m. (*Gupta* 460, 461)

Aquilegia vulgaris Linn. var. **moorcroftiana** Wall.

Pubescent perennial. Flowers yellow-green; June-Aug. In ban-oak forests at Pratapnagar and Kaudia. (*Gupta* 105A)

Magnoliaceae

***Michelia champaca** Linn.

Evergreen tree. Flowers pale-yellow; April-June. Cultivated at Tehri in the compound of Government College and Motibagh.

Menispermaceae

***Pericampylus glaucus** (Lam.) Merrill (*Pericampylus incanus* Miers.)

Climbing shrub. Flowers in 2-3-chotomous cymes; July-August. At Tehri. (*Gupta* 7)

Stephania rotunda Lour.

Climbing shrub. Flowers green-yellow with narrowly wedge-shaped sepals; July-August. (*Gupta* 475, 476)

Cissampelos pareira Linn.

Climbing pubescent shrub. Flowers small; May-August. At Tehri climbing on *Carissa opaca* and *Rhus parviflora*. (*Gupta* 479)

Berberidaceae

Berberis ceratophylla G. Don. (*B. lycium* Royle)

Shrub, leaves with small teeth, upper surface bright green, lower pale. Flowers yellow; April-May. At Tehri in chir forest. (*Gupta* 202)

Cruciferae

Arabis glabra Crantz

Herb with hairy radical leaves, disappearing soon. Flowers white; May-July. On way to Chandrabahadni Peak. (*Gupta* 155)

Cardamine oxycarpa Hk. f. & Anders. (*C. hirsuta* Linn.)

Annual with small white flowers; petals twice as long as the very small sepal; March. At Tehri near Simlasu. (*Gupta* 159)

Capparidaceae

Cleome viscosa Linn. (*C. icosandra* Linn.)

Annual viscidly pubescent herb. Flowers yellow; June-Sept. A common weed, in waste places and rubbish heaps at Tehri during rainy season. (*Gupta* 258)

Violaceae

Viola canescens Wall. (*V. serpens* Wall. var. *canescens* Wall.)

Densely pubescent herb with short stem producing long leafy runners. Flowers lilac; April-Nov. Common on damp places in ban forest. (*Gupta* 620)

Polygalaceae

Polygala tatarinowii Regel (*P. triphylla* Buch.-Ham.)

Weak-stemmed herb. Flowers pink; August-Oct. Near palace at Pratapnagar. (*Gupta* 800)

Caryophyllaceae

***Silene indica** Roxb.

Dichotomously-branched herb. Flowers white, petals 2-fid. Common in shady places at Tehri and Pratapnagar. (*Gupta* 722, 733, 741)

Polycarpaea corymbosa Lamk.

Pubescent much-branched herb. Flowers white, crowded, petals shorter than sepals; July-August. On way to Chandrabhadni. (*Gupta* 186)

Hypericaceae

Hypericum perforatum Linn.

Perennial with 2-angled stem. Flowers yellow, black dotted on the margin of petals; April-October. At Pratapnagar and Chamma. (*Gupta* 814)

Hypericum elodeoides Choisy

Perennial with stoloniferous stem. Flowers yellow; July-August. In shady and damp places. (*Gupta* 671, 1098)

Hypericum dyeri Rehder (*H. lysimachioides* Wall.)

Shrub with 4-sided branches. Flowers yellow; April-June. In Simlasu reserve forest and on way to Chandrabhadni. (*Gupta* 138, 668)

Malvaceae

Malva rotundifolia Linn.

Herb with a decumbent stem. Flowers pale lilac with dark streaks; June. At Tehri from the compound of Government College.

***Malvastrum coromandelianum** Garcke (*M. tricuspidatum* A. Gray)

Erect branched herb. Flowers yellow; August. In waste places at Tehri. (*Gupta* 90, 194, 418)

***Abutilon graveolens** Wt. & Arn. var. **hirsutum** G. Don

Copiously hispid undershrub. Flowers large, orange-coloured; June-August. Common weed at Tehri. (*Gupta* 104)

Sida veronicaefolia Lamk. (*S. humilis* Willd.)

Low stellately hairy herb. Flowers pale yellow; August-October. Common weed at Tehri. (*Gupta* 252)

***Hibiscus pungens** Roxb.

Perennial shrub, stem with scattered black spots. Flowers yellow with purple centre; May-July. In forests and shady places on way to Pratapnagar. (*Gupta* 655)

Linaceae

Reinwardtia trigyna (Roxb.) Planch.

Erect shrub. Flowers yellow, solitary axillary; April-May. On roadsides at Tehri. (*Gupta* 188)

Geraniaceae

Geranium nepalense Sweet

Perennial pubescent herb; branches rooting at the joints. Flowers pale purple; May-September. On way to Chandrabhadni, Chamma, and Pratapnagar. (*Gupta* 152, 427, 454)

Geranium ocellatum Camb.

Pubescent annual. Flowers pink with dark purple base of the petals forming almost a black spot at the centre of the flowers; March-May. At Pratapnagar. (*Gupta* 439)

Geranium wallichianum Sweet

Hairy perennial. Flowers blue-purple; July-September. Very common in the oak forests everywhere. (*Gupta* 647, 682, 783)

Impatiens scabrida DC. (*I. cristata* Wall.)

Erect pubescent herb. Flowers yellow, spotted with brown excluding the spur. Lip funnel-shaped, abruptly contracted into cylindrical spur; July-Sept. At Pratapnagar. (*Gupta* 684, 786)

Rutaceae

Boenninghausenia albiflora Reichenb.

Perennial with leaves having a strong disagreeable smell when crushed: locally called *pissumar*. Flowers white; July-September. Common in the ban-oak forests during rainy season. (*Gupta* 547, 661, 665)

Murraya koenigii (Linn.) Spreng.

A small gland-dotted shrub. Flowers white; May-June. The leaves have strong disagreeable smell when crushed, called *gandéla* locally. In damp places. (*Gupta* 300)

Zanthoxylum alatum Roxb.

Shrub, stem with long and sharp prickles. Flowers yellow; April-June. In hot valleys up to 1600 m. (*Gupta* 457)

Meliaceae

Cedrela serrata Royle

Tree with longitudinal fissures on the bark. Flowers pink; May-June. Often planted along the roadsides at Tehri.

Aquifoliaceae

Ilex dipyrena Wall.

Small tree. Flowers small in axillary clusters; April-June. In oak forests. (*Gupta* 167)

Vitaceae

Ampelocissus divaricata (Wall.) Planch. (*Vitis divaricata* Wall.)

Pubescent shrub. Flowers red-brown; June. On way to Chandrabhadni. (*Gupta* 230)

Tetrastigma serrulatum (Roxb.) Planch. (*Vitis capreolata* D. Don.)

Shrub with creeping wiry stem. Flowers yellow-green; July-September. Near Surkhanda. (*Gupta* 630)

Sapindaceae

Cardiospermum halicacabum Linn.

Climbing annual. Flowers white; August-September. On Chandrabhadni road. (*Gupta* 233)

Sapindus mukorossi Gaertn.

Large tree. Flowers small, purple; May-July. Cultivated in Motibagh.

Dodonaea viscosa Linn.

Evergreen shrub. Flowers yellow; June-September. On way to Tipri on the hillsides, also cultivated as a hedge plant at Tehri.

Anacardiaceae

Rhus parviflora Roxb.

Shrub covered with soft red-brown tomentum. Flowers pale yellow; May-June. Common at Tehri; extensively lopped for fodder. (*Gupta* 99, 175)

Rhus cotinus Linn.

Shrub. Flowers pale purple in hairy drooping panicles; April-May. In open shady places in Simlasu reserve. (*Gupta* 119B)

Malvaceae

Malva rotundifolia Linn.

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Shrub with creeping wiry stem. Flowers yellow-green; July-September. Near Surkhanda. (*Gupta* 630)

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Large tree. Flowers small, purple; May-July. Cultivated in Motibagh.

Dodonaea viscosa Linn.

Evergreen shrub. Flowers yellow; June-September. On way to Tipri on the hillsides, also cultivated as a hedge plant at Tehri.

Anacardiaceae

Rhus parviflora Roxb.

Shrub covered with soft red-brown tomentum. Flowers pale yellow; May-June. Common at Tehri; extensively lopped for fodder. (*Gupta* 99, 175)

Rhus cotinus Linn.

Shrub. Flowers pale purple in hairy drooping panicles; April-May. In open shady places in Simlasu reserve. (*Gupta* 119B)

Leguminosae

Atylosia scarabaeoides Benth.

Pubescent trailing herb. Flowers yellow in axillary clusters; July-Sept. In oak forests at Pratapnagar. (*Gupta* 973)

Atylosia mollis Benth.

Densely pubescent trailing herb. Flowers yellow in racemes; July-Sept. In oak forests at Pratapnagar. (*Gupta* 696)

Moghania vestita (Grah.) O. Ktze. (*Flemingia vestita* Benth. ex Baker)

Procumbent hairy shrub. Flowers bright red; August-Sept. At Pratapnagar. (*Gupta* 729)

Moghania strobilifera (Linn.) St. Hill. ex Jack. (*Flemingia strobilifera* R. Br. var. *fruticulosa* Wall.)

Procumbent shrub. Flowers pink in small clusters enclosed in folded bracts; August-Oct. Pratapnagar. (*Gupta* 673, 726)

Abrus pulchellus Wall.

Branched climber. Flowers pink in small racemes; August-Sept. (*Gupta* 180)

Desmodium tiliaefolium G. Don.

Erect shrub. Flowers pale pink; July-August. At Tehri. (*Gupta* 805)

Desmodium floribundum (D. Don.) G. Don.

Shrub with hairy stem. Flowers pale pink; June-Sept. On Chamma-Mussoorie road. (*Gupta* 492)

***Desmodium laxiflorum** DC.

Undershrub. Flowers pink; July-Sept. On Chamma-Mussoorie road. (*Gupta* 440)

***Desmodium podocarpum** DC.

Densely pubescent herb. Flowers pink; July-Sept. On Chamma-Mussoorie road near Kanatal. (*Gupta* 509, 545)

***Desmodium microphyllum** (Thunb.) DC. (*D. parvifolium* DC.)

Densely pubescent trailing herb. Flowers in racemes; August-October. At Tehri. (*Gupta* 136, 950)

Indigofera enneaphylla Linn.

Perennial with silvery pubescent stem. Flowers bright red; January-Dec. Common at Tehri after the rains in grass. (*Gupta* 79)

Indigofera dosua Buch.-Ham.

Densely hairy shrub. Flowers bright red; May-June. Common in grassy areas and fire terraces. (*Gupta* 115)

***Indigofera linifolia** Retz.

Silvery pubescent annual. Flowers red; July-Sept. At Tehri. (*Gupta* 226)

Lespedeza gerardiana Grah.

Densely pubescent shrub. Flowers pale yellow; August. In chir forests at Tehri. (*Gupta* 664)

Lespedeza sericea (Thunb.) Miq.

Densely pubescent shrub. Flowers white-purple; July-August. On Mussoorie-Chamma road. (*Gupta* 429)

Campylotropis eriocarpa (DC.) Sch. (*Lespedeza eriocarpa* DC.)

Pubescent shrub. Flowers deep purple-red; September. In ban-oak forests. (*Gupta* 801A)

***Lespedeza variegata** Camb.

Undershrub with crowded leaves. Flowers pale purple; August. At Tehri. (*Gupta* 801B)

Trifolium repens Linn.

Slender herb with procumbent stem. Flowers white tinged with pink; April-July. In grassy areas everywhere. (*Gupta* 522, 775)

Argyrolobium flaccidum Jaub. & Spach.

Small erect shrub. Flowers yellow; May-September. At Pratapnagar, Chamma and Nagni. (*Gupta* 412, 419, 435, 438, 445, 456, 846)

Cassia mimosoides Linn. var. **wallichiana** DC.

Procumbent perennial. Flowers yellow; August-November. On grassy slopes at Tehri. (*Gupta* 450)

Cassia tora Linn. (*C. obtusifolia* Linn.)

Shrubby annual. Flowers yellow in sessile pairs in the axil of the leaves; July-Sept. Common weed in the blanks during rains. (*Gupta* 13)

Cassia fistula Linn.

Small tree. Flowers yellow in drooping racemes; May-June. Cultivated at Tehri and wild in sub-tropical deciduous forests in the valleys at Narendranagar and elsewhere. (*Gupta* 2102)

Mimosa himalayana Gamble (*M. rubicaulis* Lamk.)

Prickly pubescent shrub. Flowers purple at first and then changing to white; August-Sept. On fallow and grassy lands upto 1500 m. at Tehri. (*Gupta* 21)

Rosaceae

Prunus cerasoides D. Don. (*P. pudum* Roxb.)

Moderate-sized tree. Flowers pink or rose coloured fading to white; March. Cultivated or wild in the outskirts of the villages. (*Gupta* 465)

Pyrus pashia Buch.-Ham.

Small tree, branchlets ending with a spine. Flowers white, tinged with pink; April-May. (*Gupta* 254, 631)

Potentilla leschenaultiana Ser.

Robust herb with thick villous rootstock. Flowers yellow; July-Oct. Pratapnagar. (*Gupta* 122, 812)

Potentilla nepalensis Hk. f.

Perennial. Flowers dark crimson; July-August. Common in the oak forests and on top of Surkhanda. (*Gupta* 579, 678, 683)

Potentilla fragarioides Linn.

Perennial. Flowers yellow; July-Sept. Common at Tehri and on Mussoorie-Chamma road. (*Gupta* 94, 470)

Potentilla fulgens Wall. (*P. splendens* Wall.)

Densely hairy perennial. Flowers orange-red; August-Oct. Locally called *bajradanti*. On the open places. (*Gupta* 690, 718)

***Potentilla reptans** Linn.

Small glabrous perennial, rootstock with runners. Flowers yellow; August-Sept. At Pratapnagar.

***Potentilla microphylla** Don. var. **achileaefolia** Hook. f.

Tufted perennial, leaflets pointing, obliquely forwards and upwards, almost perpendicular to the plane of leaf. Flowers small, yellow; September. At Pratapnagar. (*Gupta* 568)

***Agrimonia pilosa** Ledeb.

Hairy perennial. Flowers yellow; July-Sept. In ban-oak forests. (*Gupta* 675, 701)

Prinsepia utilis Royle

Spiny shrub, spines leaf-bearing. Flowers white; April-November to February again. On roadsides and in abandoned fields. (*Gupta* 178, 637)

Spiraea vaccinifolia Don

Pubescent shrub. Flowers white; May-August. On roadsides. (*Gupta* 658, 659)

Pyracantha crenulata (Don.) Roemer. (*Crataegus crenulata* Roxb.)

Spiny shrub, leaves crowded on lateral branches. Flowers white; May-June. On abandoned fields and roadsides. (*Gupta* 133)

Geum elatum Wall.

Softly hairy perennial. Flowers yellow; Sept.-Oct. At Tehri and Pratapnagar. (*Gupta* 110)

Rubus ellipticus Smith.

Tomentose shrub, with trailing branches. Flowers white; March-April. At Tehri. (*Gupta* 63)

Saxifragaceae

Saxifraga moorcroftiana Wall. (*S. diversifolia* Wall.)

Perennial. Flowers yellow; August-Sept. On open places at Surkhanda peak. (*Gupta* 491)

Pergenia ligulata (Wall.) Engl. (*Saxifraga ligulata* Wall.)

Herb with thick rootstock. Flowers red-white; March. On rocks at Tehri, Pratapnagar and Chamma. (*Gupta* 371)

Parnassia nubicola Wall. ex Royle

Perennial. Flowers white; August-Sept. In open grassy slopes at Pratapnagar and Surkhanda. (*Gupta* 553)

Crassulaceae

Tillaea pentandra Royle

Small annual with procumbent stem. Flowers pink; July-Sept. On rocks at Pratapnagar. (*Gupta* 559, 762)

Sedum linearifolium Royle var. **sinuatum** Hamet. (*S. trifidum* Wall.)

Succulent herb. Flowers pale pink; August-Sept. On rocks and trees trunks. (*Gupta* 650, 763)

Sedum multicaule Wall.

Succulent herb. Flowers yellow; July-August. On rocks and trees. (*Gupta* 572)

Droseraceae

Drosera peltata Sm. var. **lunata** (Ham.) C. B. Clarke. (*D. lunata* C.Bc.)

Erect herb with semi-circular leaves having glandular hairs. Flowers white; August-Sept. On open grassy slopes at Pratapnagar and Surkhanda up to 3000 m. (*Gupta* 501)

Myrtaceae

Punica granatum Linn.

Large shrub, branches armed. Flowers red; April-May. Common at Tehri, wild.

Onagraceae

Oenothera rosea Ait.

Herb. Flowers pink; July-October. Common at Pratapnagar and Chamma. (*Gupta* 442)

***Oenothera** sp. (**glaucus** Mich.)

Herb. Flowers pink; July-Sept. At Pratapnagar near the palace. (*Gupta* 697, 711)

***Oenothera biennis** Linn.

Herb. Flowers yellow; July-Sept. Common near the palace at Pratapnagar. (*Gupta* 92)

Cucurbitaceae

***Trichosanthes anguina** Linn.

Twining herb. Flowers white; August. Common at Tehri. (*Gupta* 11)

Begoniaceae

Begonia tenella Don. (*B. amoena* Wall. ex A. DC.)

Succulent herb. Flowers pale pink; July-August. At Pratapnagar. (*Gupta* 560)

Umbelliferae

Bupleurum candollii Wall.

Perennial. Flowers yellow, bract leaf-like; July-Sept. Common at 2000 m. everywhere. (*Gupta* 222, 505)

Bupleurum longicaule Wall. ex DC.

Shrub-like herb. Flowers yellow, bract prominent; August-Sept. Common at Pratapnagar. (*Gupta* 672)

Bupleurum tenue Don.

Herb. Flowers yellow, bract lanceolate; July-Sept. Up to 2700 m. (*Gupta* 399, 500, 760, 810)

***Bupleurum setaceum** Fenzel

Herb. Flowers yellow, bract lanceolate; July-Sept. Up to 2700 m. (*Gupta* 660)

Sanicula europaea Linn.

Erect herb. Flowers small white in heads; June-August. Common at Pratapnagar and Kanatal. (*Gupta* 487)

Pimpinella diversifolia DC.

Hairy herb with pinnate leaves. Flowers white; July-Sept. Common between 1200-3000 m. (*Gupta* 424, 428, 477, 483, 517, 519, 720, 780)

Pimpinella acuminata C.Bc.

Perennial. Flowers white with 1-5 bracts; July-Sept. Common between 1200-2500 m. (*Gupta* 727)

Selinium tenuifolium Wall.

Perennial, stem hollow and grooved. Flowers white, bracts 1-8; July-Oct. Between 1800-2000 m. (*Gupta* 982)

***Selinium payraceum** C.Bc.

Perennial resembling the above species, but the leaves are less compound. Flowers white; August-Oct. At 2000 m. Pratapnagar. (*Gupta* 794)

Trollis japonica (Houtt.) DC. (*Caucalis anthriscus* Scop.)

Erect annual. Flowers pale pink; June-July. Between 900-2700 m.

Araliaceae

Hedera nepalensis Koch. (*H. helix* auct. non Linn.)

Shrub, climbing by means of adhesive roots. Flowers yellow-green; Sept.-Oct. Common on ban-oak trees. (*Gupta* 626, 634)

Caprifoliaceae

Zabelia triflora (R. Br.) Makino (*Abelia triflora* R. Br.)

Shrub. Flowers pale pink; May-June. (*Gupta* 198)

Viburnum cylindricum Ham. (*V. coriaceum* Blume)

Shrub with pubescent young shoots. Flowers white; May-June. On way to Surkhanda. (*Gupta* 540)

Rubiaceae

Oldenlandia coccinea Royle

Slender herb. Flowers bright red; August-Sept. On grassy slopes up to 1500 m.

Leptodermis lanceolata Wall.

Shrub, leaves foetid when crushed. Flowers white, sometimes tinged with purple; June-Sept. Common on roadsides. (*Gupta* 397, 651, 792)

Rubia cordifolia Linn. var. **munjista** Miquel (*R. cordifolia* sensu Hook. f. non Linn.)

Climbing perennial. Flowers red, tinged with green; July-Aug. In shady moist places. (*Gupta* 771)

Galium rotundifolium Linn. (*G. elegans* Wall.)

Trailing herb. Flowers white, tinged with green; July-Aug. (*Gupta* 97, 120, 432)

Galium mollugo Linn. ssp. **asperifolium** (Wall.) Kitmura (*G. asperifolium* Wall.)

Trailing perennial. Flowers red; September-Oct. Common in oak forests in moist places. (*Gupta* 209, 400, 444, 480, 568, 682)

Valerianaceae

Valeriana jatamansi Jones (*V. wallichii* DC.)

Perennial. Flowers white tinged with pink; March-April. Common up to 3000 m. (*Gupta* 161, 628)

Valeriana hardwickii Wall.

Perennial with pubescent rootstock. Flowers white; July-Sept. Between 1200-3000 m. (*Gupta* 156)

Dipsacaceae

Dipsacus inermis Wall.

Robust herb. Flowers white in solitary head; July-October. Common in the ban-oak forests. (*Gupta* 507, 790)

Morina longifolia Wall.

Shrub. Flowers deep pink; July-September. In ban-oak forests. (*Gupta* 781)

Compositae

Vernonia cinerea Less.

Pubescent herb. Flowers purple; August-September. Weed at Tehri. (*Gupta* 93, 431)

Ageratum conyzoides Linn.

Hairy herb. Flowers pale blue; May-Sept. Common weed at Tehri. (*Gupta* 183, 811, 818, 971)

***Myriactis nepalensis** Less.

Hispidly hairy herb. Flowers yellow; June-Sept. At Pratapnagar. (*Gupta* 721, 791)

Myriactis wallichii Less.

Pubescent herb. Flowers with yellow ray florets and white disc florets; June-Sept. Up to 1200 m. (*Gupta* 746)

Solidago virga-aurea Linn.

Pubescent herb. Flower of outer series white, inner yellow; June-Sept. Common at Pratapnagar. (*Gupta* 732, 797, 808)

Erigeron alpinus Linn.

Biennial or perennial herb. Flowers with reddish pappus; May-Aug. At 2200 m. (Gupta 124, 639, 731)

***Erigeron canadensis** Linn.

Annual herb. Flowers with dirty white pappus; May-August. Up to 2000 m. (*Gupta* 401, 402, 408, 423, 710)

Erigeron multiradiatus Benth.

Pubescent annual. Flowers with dirty red pappus; August-September. Between 2000-2700 m. (*Gupta* 320)

Youngia japonica DC. (*Conyza japonica* Juss.)

Softly hairy herb. Flowers pale yellow; July-Sept. Up to 1500 m. (*Gupta* 430, 441, 443)

Conyza stricta Willd.

Pubescent herb. Flowers yellow; August-Sept. Up to 2000 m. (*Gupta* 221, 468)

***Anaphalis perfoliata** Wall.

Herb with white flowers in head; July-September. (*Gupta* 552, 566)

Anaphalis busua (Ham.) Handel.-Mazzetti. (*A. araneosa* DC.)

Softly hairy herb, woolly. Flowers white; September. Surkhanda. (*Gupta* 485, 669)

Anaphalis cinnamomea C.Bc.

Softly hairy herb, lower surface of leaves cinnamon-red. Flowers white; September. At Surkhanda. (*Gupta* 524, 531, 736, 756)

Anaphalis contorta Hook. f.

Decumbently branched herb. Flowers white, bracts often pale purple; August-September. At Surkhanda and Pratapnagar. (*Gupta* 670, 740)

Vicoa indica (Willd.) DC. (*Vicoa auriculata* Cass., *Jacoba indica* O. Ktze.)

Roughly pubescent herb. Flowers orange-yellow; Sept.-Oct. Common weed at Tehri. (*Gupta* 239, 421, 449, 667)

Xanthium strumarium Linn.

Common weed of the waste places at Tehri. (*Gupta* 473)

Eclipta prostrata Linn. [*E. alba* (Haask.) Linn.]

Roughly pubescent herb. Flowers white; April-Sept. Common weed at Tehri. (*Gupta* 257)

Sclerocarpus africanus Jacq.

Pubescent herb. Flowers yellow; July-August. Weed in the rice fields at Tehri. (*Gupta* 405, 425)

Bidens biternata (Lour.) Merr. et Sherff. (*B. pilosa* Linn.)

Robust herb. Flowers yellow; ligules white. Sept.-Oct. Common at Tehri. (*Gupta* 208, 498)

Galinsoga parviflora Cav.

Weak-stemmed herb. Flowers with yellow disc; January-Dec. Common weed at Tehri near houses. (*Gupta* 29, 433, 516)

Achillea millefolium Linn.

Erect pubescent herb. Flowers white; August-Oct. Pratapnagar. (*Gupta* 704)

Artemisia roxburghiana Besser. (*A. hypoleuca* Edgew.)

Shrub-like herb with creeping rootstock. Flowers greenish white; August-Sept. Near Chamma at 1700 m. (*Gupta* 407)

Artemisia scoparia Waldst.

Shrub-like herb. Flowers tinged with green; Sept.-Oct. Common weed at Tehri. (*Gupta* 240)

Artemisia parviflora Roxb.

Hairy herb. Flowers yellow, tinged with green; Sept.-Oct. Up to 2000 m. (*Gupta* 680, 750)

Senecio chrysanthemoides DC.

Shrub with yellow flowers; August-Sept. Up to 2000 m. Common at Tehri and Pratapnagar. (*Gupta* 551, 574, 671, 813)

Senecio rufinervis DC.

Shrub-like herb with tomentose branches. Flowers yellow; August-Sept. Up to 2700 m. (*Gupta* 745)

Echinops niveus Wall.

Tall thistle-like herb. Lower surface of leaves cottony white. Flowers in solitary globose heads; August-Sept. At Tehri and on way to Pratapnagar. (*Gupta* 653)

Hieracium vulgatum Koch.

Perennial with milky juice. Flowers yellow, August-Sept. On way to Chandrabhadni. (*Gupta* 109)

Taraxacum officinale Wigg.

Perennial with milky juice. Flowers yellow in solitary heads; March-Nov. Common everywhere up to 5000 m. (*Gupta* 35, 78, 744)

Lactuca macrorhiza Hk. f.

Perennial with thick woody rootstock. Flowers grey-blue; August-Sept. Common at Pratapnagar. (*Gupta* 814)

Lactuca dissecta Don.

Tufted herb. Flowers pale blue; August-Sept. (*Gupta* 654)

Sonchus oleraceus Linn.

Succulent herb. Flowers yellow; July-Oct. Weed in the fields. (*Gupta* 172, 182)

Sonchus arvensis Linn.

Succulent herb. Flowers yellow; July-Oct. Common weed in the fields at Tehri. (*Gupta* 415, 420)

Siegesbeckia orientalis Linn

Herb clothed with crisped hairs. Flowers yellow; Sept.-Oct. Common up to 2000 m. (*Gupta* 39)

***Chrysanthemum incutianum** Turez.

Herb with white flowers. Escape near Pratapnagar palace. (*Gupta* 696, 698)

***Dahlia gracilis** Ortz. var. **superba**

Herb with yellow and red flowers. Escape near Pratapnagar palace. (*Gupta* 526)

***Zinnia palmari** Gray

Herb with purple-white flowers. Escape near Pratapnagar palace. (*Gupta* 705)

Campanulaceae

Campanula colorata Wall.

Roughly hairy herb. Flowers pale lilac; May-Oct. Common on moist places at Pratapnagar. (*Gupta* 656, 728, 766)

Ericaceae

Rhododendron arboreum Smith

Tree conspicuous by its bright red flowers during March to May. (*Gupta* 632)

Plumbaginaceae

Plumbago zeylanica Linn.

Diffused, rambling undershrub. Flowers white; June-August. In open scrub forests up to 1200 m. (*Gupta* 207)

Primulaceae

Primula denticulata Smith

Herb with pale lilac flowers during March to April. In ban-oak forests. (*Gupta* 639, 640)

Androsace rotundifolia Hardw.

Glandular hairy herb. Flowers pink on tufted scapes; April-June. On rocks near Tehri. (*Gupta* 91)

Androsace sarmentosa Wall.

Softly hairy herb, runners rooting and forming rosettes of leaves at the end. Flowers pink; June-August. (*Gupta* 108)

Lysimachia alternifolia Wall.

Slightly pubescent herb. Flowers yellow; June-Sept. At Tehri up to 1300 m. (*Gupta* 403, 409, 413, 472)

Lysimachia pyramidalis Wall.

Glabrous herb. Flowers pale purple; June-Oct. In chir forests up to 1200 m. (*Gupta* 406, 411, 463)

Lysimachia lobelioides Wall.

Glabrous herb. Flowers pale purple or white; May-July. In chir forests at Tehri. (*Gupta* 119A)

Myrsinaceae

Myrsine africana Linn.

Pubescent shrub with small flowers; March-May. Common in the chir forests. (*Gupta* 150)

Apocynaceae

***Vinca major** Linn.

Evergreen shrub with lilac flowers; March-June. In shady places at Pratapnagar. (*Gupta* 633)

Gentianaceae

Gentiana argentea Royle

Small herb with blue flowers; April-May. In shady places on grassy slopes. (*Gupta* 641)

Swertia purpurascens Wall.

Erect herb. Flowers pale red-purple with complete dark ring at the base of petals; Sept. On grassy slopes at Tehri. (*Gupta* 173)

Swertia chirata Ham.

Robust herb with terete branches. Flowers green-yellow, tinged with purple; Sept.-Nov. In ban-oak forests. (*Gupta* 809A)

Swertia paniculata Wall.

Erect herb. Flowers white with 2 purple blotches at the base of petals; Sept.-Oct. In ban-oak forests. (*Gupta* 861)

Swertia cordata Wall.

Erect herb. Flowers yellow-white, margin of petals marked with short pale purple streaks; August-September. At Tehri. (*Gupta* 1102)

Boraginaceae

Heliotropium strigosum Willd.

Small procumbent perennial. Flowers white; July-Sept. Common weed at Tehri. (*Gupta* 116)

Trichodesma indicum R. Br.

Rough annual. Flowers pale blue turning to pink; Sept.-Oct. Common weed at Tehri. (*Gupta* 21171)

Cynoglossum micranthum Desf.

Erect herb. Flowers pale blue; June-August. Common up to 2500 m. (*Gupta* 244, 898)

Cynoglossum zeylanicum Thunb. ex Lehm. (*C. furcatum* Wall.)

Erect hairy annual. Flowers pale blue; June-Sept. At Tehri and Pratapnagar. (*Gupta* 119C)

Cynoglossum wallichii G. Don.

Erect hairy herb. Flowers blue; July-Oct. At Tehri. (*Gupta* 231, 298)

Cynoglossum glochidiatum Wall.

Erect hairy herb. Flowers dark blue; July-Oct. Up to 2700 m. (*Gupta* 533)

***Cynoglossum denticulatum** A. DC.

Erect softly hairy herb. Flowers blue; Sept. At Tehri. (*Gupta* 533B)

Convolvulaceae

Ipomoea purpurea Lamk.

Twining herb. Flowers large pink; August-Sept. At Tehri. (*Gupta* 708)

Evolvulus alsinoides Linn.

Softly hairy herb. Flowers white; March-Oct. Common weed at Tehri. (*Gupta* 189, 205)

Solanaceae

Solanum nigrum Linn.

Erect annual. Flowers white; Sept.-Oct. Up to 2000 m. (*Gupta* 187)

Nicandra physaloides Gaertn.

Erect annual. Flowers blue; July-Sept. On roadsides up to 2000 m. (*Gupta* 649, 715)

***Datura metel** Linn. (*D. fastuosa* Linn.),

Coarse minutely pubescent herb. Flowers whitish purple; August-Sept. Common weed of waste places.

***Nicotiana tabacum** Linn.

Viscidly pubescent herb. Flowers pink; March-June. Common on waste places at Tehri, escape. (*Gupta* 177, 210)

Scrophulariacae

Verbascum thapsus Linn.

Herb densely clothed with soft yellow hairs. On waste places.

Mazus surculosus Don.

Small-tufted herb. Flowers pale blue; May-Oct. At Tehri. (*Gupta* 123)

Sopubia trifida Buch.-Ham.

Slender pubescent herb. Flowers yellow; June-Oct. At Tehri. (*Gupta* 743)

Leptorhabdos parviflora Benth. (*L. benthamiana* Walp.)

Erect herb. Flowers pale pink; August-Oct. Pratapnagar. (*Gupta* 730)

Pedicularis carnosa Wall.

Pubescent herb. Flowers bright pink; August-Sept. In open grassy places at Surkhanda peak. (*Gupta* 497, 507, 648)

Gesneraceae

Didissandra lanuginosa C. Bc.

Perennial with small stem. Flowers pale blue; August-Sept. Up to 2000 m. (*Gupta* 145)

Bignoniaceae

Amphicome emodi Lindl.

Perennial. Flowers white; May-July. Up to 1500 m. (*Gupta* 625)

Acanthaceae

Pteracanthus alatus (Wall. ex Nees) Brem. (*Strobilanthes alatus* Nees)

Erect shrub. Flowers dark blue; August-Oct. Above 2000 m. (*Gupta* 486, 506, 520)

Goldfussia dalhousiana Nees (*Strobilanthes dalhousianus* C. Bc.)

Erect shrub. Flowers dark blue; June-Sept. Common at Pratapnagar near the palace. (*Gupta* 686, 778)

***Rostelularia procumbens** (Linn.) Nees (*Justicia procumbens* Linn.)

Procumbent herb. Flowers in dense cylindric spikes; July-Sept. Common at 1200 m. (*Gupta* 496)

Barleria dichotoma Roxb. (*Barleria cristata* Linn.)

Hairy erect herb. Flowers lilac. Common at Pratapnagar. (*Gupta* 820)

Adhatoda vasica Nees

Erect shrub. Flowers white, dotted with pink; December-April. Common weed at moist places in Tehri. (*Gupta* 765)

Dicliptera roxburghiana Nees var. **bupleuroides** Nees

Diffuse herb. Flowers deep blue; May-Dec. Common on roadsides. (*Gupta* 765B)

Verbenaceae

Verbena officinalis Linn.

Perennial. Flowers lilac; April-June. At Pratapnagar and Chamma. (*Gupta* 809B)

Lantana indica Roxb.

Roughly hairy shrub. Flowers variously coloured; April-June. Common weed at Tehri; difficult to eradicate.

Lantana camara Linn. var. **aculeata** Moldenke

Roughly hairy shrub with recurved prickles. Common weed at Tehri. (*Gupta* 21120)

Callicarpa macrophylla Vahl.

Densely tomentose erect shrub. Flowers pink; July-Nov. Along the ravines. (*Gupta* 250)

Vitex negundo Linn. var. **incisa** Clarke

Grey pubescent shrub. Flowers blue-purple; March-June. On roadsides up to 2000 m. (*Gupta* 414)

Labiatae

Isodon plectrantholdes Schrad. ex Kudo. (*Plectranthus rugosus* Wall.)

Stellately pubescent shrub. Flowers white, upper lip of corolla purple; March-Oct. Common between 1000-2500 m. (*Gupta* 699)

Plectranthus gerardianus Benth. var. **graciflora** Benth. (*P. graciflora* Benth.)

Erect shrub. Leaves red-brown when dry. Flowers white; August-Sept. Common between 1000-3000 m. (*Gupta* 962)

Plectranthus striatus Benth.

Pubescent herb. Flowers white; August-Oct. Near Pratapnagar and Kanatal. (*Gupta* 815)

Colebrookea oppositifolia Smith

Erect tomentose shrub. Flowers while in cylindric spike; Oct.-Feb. Common at Tehri. (*Gupta* 105B)

Elsholtzia fruticosa (Don.) Rehder. (*E. polystachya* Benth.)

Pubescent erect shrub. Flowers pale yellow; August-Oct. Up to 3000 m. associated with *Indigofera* on grassy slopes. (*Gupta* 562, 675)

Origanum vulgare Linn.

Erect herb, clothed with short hairs. Flowers pink; August-Sept. Common between 2000-3500 m. (*Gupta* 118, 434, 502, 739)

Calamintha clinopodium Benth.

Shortly hairy herb. Flowers pink; July-September. Common between 1200-3600 m. (*Gupta* 488, 525, 776, 802, 816)

Scutellaria grossa Wall.

Pubescent shrub-like herb. Flowers dark blue; June-Oct. Between 1800-2000 m. (*Gupta* 139, 543, 670, 681, 767)

Scutellaria linearis Benth.

Pubescent tufted herb. Flowers pale purple; March-June. Between 1000-2400 m. (*Gupta* 130)

Prunella vulgaris Linn. (*Brunella vulgaris* Linn.)

Hairy perennial. Flowers white-purple; March-Oct. Pratapnagar. (*Gupta* 798)

Craniotome versicolor Reichenb.

Softly hairy herb. Flowers white, pink, or yellow; August-Oct. Common in shady places in ban-oak forests. (*Gupta* 779)

Stachys sericea Wall.

Erect herb covered with long silky hairs. Flowers pink spotted with purple; July-Oct. (*Gupta* 535)

***Stachys tibetica** Vatke

Perennial with pink flowers; September. At Pratapnagar. (*Gupta* 436, 777)

Leucas lanata Benth.

Perennial with softly woolly stem. Flowers white; June-Oct. Common weed at Tehri. (*Gupta* 228, 234, 416)

Ajuga bracteosa Wall.

Softly hairy herb. Flowers pale blue; April-Oct. Common between 600-2000 m.

Plantaginaceae

Plantago major Linn.

Stemless perennial. Flowers green, crowded in cylindric spikes. April-Oct. Common at Pratapnagar. (*Gupta* 148, 417, 774)

Nyctaginaceae

Boerhavia diffusa Linn. (*B. repens* Linn.)

Diffused, branched herb, with pink flowers; January-Dec. Weed of cultivation. (*Gupta* 248)

Amaranthaceae

Deeringia amaranthoides (Lamk.) Merrill. (*D. celasioides* R. Br.)

Climbing undershrub. Flowers pale green-yellow; July-Oct. Common at Tehri. (*Gupta* 200)

***Amaranthus gracilis** Desf. (*A. viridis* Linn.)

Erect herb. Flowers green in lax clusters; September. In waste places up to 1500 m. (*Gupta* 243)

***Amaranthus spinosus** Linn.

Spiny annual. Flowers green in clusters on long spikes; July-Oct. Weed of waste places. (*Gupta* 201)

***Pupalia lappacea** Moq.

Straggling undershrub. Flowers green; September-Oct. Up to 1000 m. (*Gupta* 176, 192, 216)

Aerua sanguinolenta Blume. (*A. scandens* Wall.)

Grey tomentose climbing undershrub. Flowers silvery white; July-Oct. Common at Tehri. (*Gupta* 151, 821)

Achyranthes bidentata Blume

Straggling undershrub. Flowers green, tinged with purple; May-Oct. Common between 1200-2000 m. (*Gupta* 539, 557, 773)

Polygonaceae

Polygonum amplexicaule Gaertn.

Erect herb with pink or deep red flowers; July-Oct. Common in oak forests. (*Gupta* 504, 521, 735)

Polygonum alatum Ham.

Erect herb with white-purple flowers; January-Dec. On moist places and roadsides up to 1200 m. (*Gupta* 495, 503, 725, 755, 764)

Polygonum hydropiper Linn.

Prostrate herb rooting at lower joints. Flowers pink; July-Oct. Up to 2000 m. (*Gupta* 95, 407, 464)

Polygonum recumbens Royle

Prostrate herb. Flowers white in axillary clusters; July-Sept. Up to 2000 m. (*Gupta* 424, 422, 318, 387, 784)

Polygonum capitatum Ham.

Perennial with trailing stem. Flowers pink in dense heads; June-Nov. On rocks and roadsides. (*Gupta* 1522)

Rumex orientalis Benth.

Erect herb. Flowers crowded in whorls; July-Oct. Between 1500-2000 m. (*Gupta* 459)

Rumex hastatus Don.

Erect herb, leaves hastately 3-lobed. Flowers polygamous in small whorls; May-Oct. Common up to 2500 m. (*Gupta* 141)

Lauraceae

***Lindera pulcherrima** Benth.

Large tree, leaves 3-nerved beneath. Flowers in 5-6-flowered umbels; March-April. Between 1200-3000 m. (*Gupta* 627)

Thymelaeaceae

Daphne bholua Ham. ex Don. (*D. papyracea* Dcne., *D. cannabina* Wall.)

Evergreen shrub. Flowers white; March-April and Nov. Common in deodar and oak forests between 1200-3000 m. (*Gupta* 162, 164, 636)

Wikstroemia canescens Meissn.

Small shrub. Flowers yellow; April-June. On roadsides. (*Gupta* 657, 785, 806)

Loranthaceae

Taxillus vestitus (Wall.) Danser. (*Loranthus vestitus* Wall.)

Robust woody parasite. Flowers rusty outside; Oct.-March. On *Quercus incana* trees at Pratapnagar. (*Gupta* 643, 663)

Viscum nepalense Spreng. (*V. articulatum* Burm., *V. liquidambricolum* Hayat)

Much-branched leafless parasite. Flowers sessile, in 3-flowered spikes; July-Oct. On trees of *Pyrus pashia, Benthamidia capitata*, etc. (*Gupta* 635)

Euphorbiaceae

*Euphorbia hirta Linn.

Prostrate annual; involucral gland globose. Common weed at Tehri. (*Gupta* 190, 224)

Euphorbia maddeni Boiss.

Erect annual. Involucre solitary in the forks of branches. Flowers May-July. (*Gupta* 197)

*Sarcococca hookeriana Baill. (*S. pruniformis* Lindl. var. *hookeriana*)

Evergreen erect shrub. Flowers yellow in short axillary racemes; March-May. (*Gupta* 803)

Sarcococca saligna (Don.) Muell. & Arg. (*S. pruniformis* Lindl.)

Evergreen erect shrub. Flowers yellow; March-May. (*Gupta* 787)

Andrachne cordifolia Muell. & Arg.

Small shrub with green flowers; July-Sept. (*Gupta* 544, 687)

Urticaceae

*Celtis cinnamomea Lindl.

Evergreen tree. Flowers pale yellow. Near Chamma. (*Gupta* 458)

Cannabis sativa Linn. var. indica Lamk.

Erect herb. Flowers yellow-green; July-August. On roadsides and waste places. (*Gupta* 199, 478)

*Morus laevigata Wall.

Tree with ovate-lanceolate leaves. Fruit yellowish white, small. On the sides of river Bhillangna near Tehri. Planted. (*Gupta* 467)

Ficus foveolata Wall.

Climbing or creeping shrub. Figs warty globose; June-July. Up to 2000 m. (*Gupta* 645)

Urtica parviflora Roxb.

Erect herb covered with stinging hairs. Flowers green; Aug.-Oct. Common on abandoned fields up to 2000 m. (*Gupta* 213)

Urtica dioica Linn.

Erect herb, covered with stinging hairs. Male and female flowers on separate plants; June-Sept. On abandoned fields. (*Gupta* 453, 717)

Girardiana zeylanica Dcne. (*G. heterophylla* Dcne.)

Robust herb with stinging hairs. Leaves deeply lobed. Flowers June-Sept. Near fields and waste places. (*Gupta* 716)

Pilea umbrosa Wedd.

Hairy erect herb. Flowers green; June-Sept. Near water-courses up to 2000 m. (*Gupta* 512, 713)

Pilea scripta Wedd.

Glabrous erect herb. Flowers green in axillary panicles; June-Sept. Near water streams. (*Gupta* 546)

Cupuliferae

Quercus incana Roxb.

Large tree. Flowers in catkins; May-July. Common between 1000-2500 m., but lopped extensively for fodder and fuel. (*Gupta* 174)

Quercus dilatata Lindl.

Large tree. Male spikes drooping, female short; April-Aug. Between 2000-3000 m. with *Quercus incana* at the lower level and *Quercus semecarpifolia* at higher levels. (*Gupta* 662)

Salicaceae

Salix tetrasperma Roxb.

Small tree, branches silky. Flowers in drooping catkins coming after the leaves; Feb.-April. On river banks and moist places. (*Gupta* 466)

Orchidaceae

Spiranthes sinensis (Pers.) Ames. (*S. australis* Lindl.)

Terrestrial with pink flowers crowded in spiral spike; Sept. On open grassy slopes up to 3000 m. (*Gupta* 677)

Herminium angustifolium Benth.

Terrestrial, roots with 2 small tubers. Flowers green in spike; Aug. Between 1200-2500 m. (*Gupta* 532, 756, 772)

Habenaria intermedia Don.

Terrestrial. Flowers green-white; July-Aug. At Chandrabhadni. (*Gupta* 103)

Satyrium nepalense D. Don.

Terrestrial with tuberous roots. Flowers pink, bract tinged with pink; July-Sept. Between 1200-3000 m. (*Gupta* 359, 514, 541, 685, 738)

Epipactis royleana Lindl.

Terrestrial with creeping rootstock. Flowers red with yellow centre; Sept. (*Gupta* 759A)

Scitamineae

***Roscoe purpurea** Smith

Herb with thick rootstock. Flowers lilac, tinged with pink. Common up to 3000 m. (*Gupta* 751)

Hedychium spicatum Buch.-Ham. var. **acuminata** Wall.

Herb with thick horizontal rootstock. Flowers pale yellow, fragrant; August. (*Gupta* 584)

Haemodoraceae

Ophiopogon intermedius Don.

Herb, stem clothed with remains of old leaves. Flowers white, tinged with lilac. July-Aug. On rocks between 2000-4500 m.

Dioscoreaceae

Dioscorea deltoidea Wall.

Herb twining to the left. Flowers in spike; May-July. Up to 2000 m. (*Gupta* 260)

Liliaceae

Smilax aspera Linn.

Climbing shrub, branches grooved, prickly. Flowers white; Sept.-Nov. Up to 2000 m. (*Gupta* 511, 536)

Commelinaceae

Commelina coelestis Willd.

Robust herb. Flowers blue in spikes; July-Oct. Common at Tehri. (*Gupta* 688)

Commelina cristata Schult.

Herb with leafy stem. Flowers blue in clusters; July-Aug. (*Gupta* 508)

Araceae

***Arisaema tortuosum** Schott.

Herb with 2-3 leaves; leaflets 5-18, petiole mottled with purple. Spathe pale green, spadix appendage like the tail of a rat; June-July. At Tehri. (*Gupta* 101, 542)

Cyperaceae

Eriophorum cosmosum Wall.

Grass-like herb with brown spikelet. (*Gupta* 212)

Cyperus compressus Linn.

Tufted annual with green spikelet. (*Gupta* 214B)

Cyperus rotundus Linn.

Perennial with wiry rhizome. Spikelet red-brown. Up to 2000 m. (*Gupta* 242A)

Gramineae

Digitaria cruciata (Nees) A. Camus. (*Paspalum sanguinale* Lamk. var. *cruciatum* Hook. f. *D. pruriens* Büse)

Stem with branched base, rooting at the joints. (*Gupta* 267, 286)

***Panicum miliaceum** Linn.

Stem tufted, leafy up to the panicle. At 300 m. (*Gupta* 241)

Setaria glauca (Linn.) Beauv.

Erect stem. Spikelet pale brown, tinged with purple. At 2500 m. (*Gupta* 455)

Erianthus fulvus Nees ex Steud.

Perennial. Spikelet glabrous, basal hairs white, concealing the spikelet. (*Gupta* 796)

Chrysopogon fulvus (Spreng.) Chois. (*Andropogon monticola* Forsk.)

Perennial. Spikelets in 3's on solitary geminate spike. (*Gupta* 817)

Neyraudia arundinacea (Linn.) Henr. (*N. reynaudiana* Keng., *N. madagascariensis* Hook. f. var. *zollingeri*)

Perennial. Spikelet purple-brown. (*Gupta* 168, 193)

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The Genus *Anisops* (Hemiptera: Notonectidae) in Ceylon

BY

C. Y. LEONG AND C. H. FERNANDO

Department of Zoology, University of Malaya, Singapore

(*With three plates*)

INTRODUCTION

Anisops is the commonest genus of the Notonectidae in south-east Asia. In Ceylon it is very widespread, occurring chiefly in the low country. In spite of its commonness it has been recorded only on a few occasions. Distant (1906, 1911) mentioned one species '*Anisops fieberi*' and described a new species *Anisops ali*. Lundblad (1933) mentions *Anisops ali* Distant and *Anisops nasuta* Fieb. as occurring in Ceylon. Brooks (1951) records one species *Anisops breddini* Kirk. from Ceylon. Fernando (1959, 1961a) recorded three species, *Anisops batillifrons* Lundb., *A. crinita* Brooks, and *A. nivea* (Fabr.). Mendis & Fernando (1962) have mentioned eight species from Ceylon. The present paper is a report on material collected by one of the authors (C.H.F.) in Ceylon. A short account of the genus *Anisops* with keys to the genera of Notonectidae and the Ceylonese species of *Anisops* are also included. Brief mention is made of the biology of *Anisops* in south-east Asia, especially its occurrence at artificial lights and in isolated habitats.

BIOLOGY

A large number of species of *Anisops* occur in south-east Asia. They constitute the most abundant species among the large back-swimmers (Notonectidae). They live chiefly in the shallow water of ponds and the edges of lakes. Sometimes they are also found in slow-running streams. They are predaceous in habits and feed largely on small arthropods. In south-east Asia they are numbered among the important enemies of mosquito larvae (Dempwolff, 1904;

Hinman, 1934; and Laird, 1956). Some species are extremely mobile and fly from pond to pond. They have been recorded in isolated habitats in many taxonomic works and also by Laird (1956) and Fernando (1959). They sometimes fly to artificial lights (Brooks, 1951; and Fernando 1961a, 1961b). Hale (1924) records large numbers of *Anisops* flying off from a lake early in the morning. Fernando (1961a) recorded two species, *Anisops batillifrons* and *A. nivea*, flying in the morning in Ceylon. It is likely that *Anisops* fly mainly at dawn.

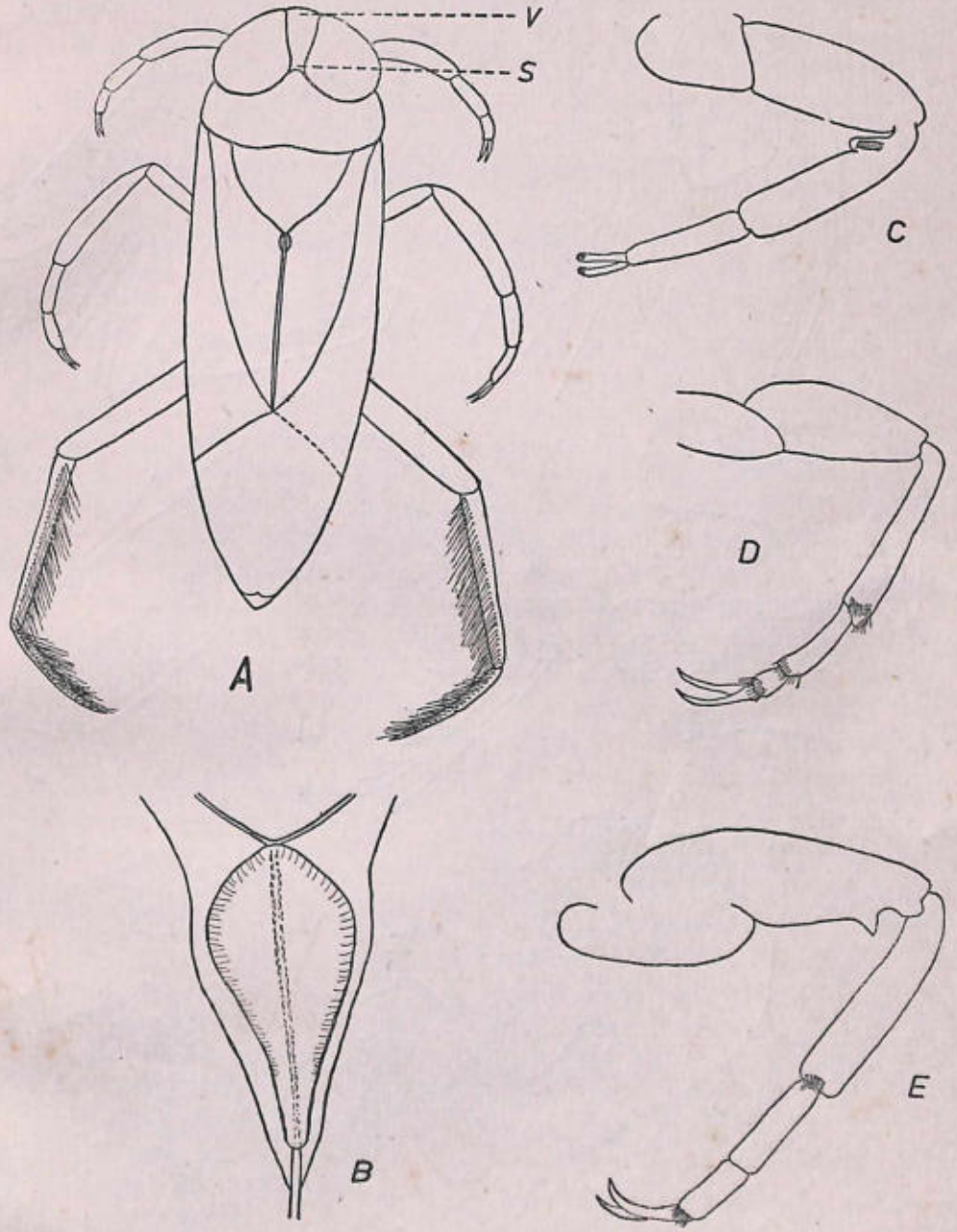
Eggs are inserted into the soft parts of plants (stems and leaves). Stridulation has been recorded in some species. Little is known of the biology of *Anisops* in south-east Asia. The only detailed accounts are those of Hale (1923) in Australia and Poisson (1926) in Africa.

Taxonomy

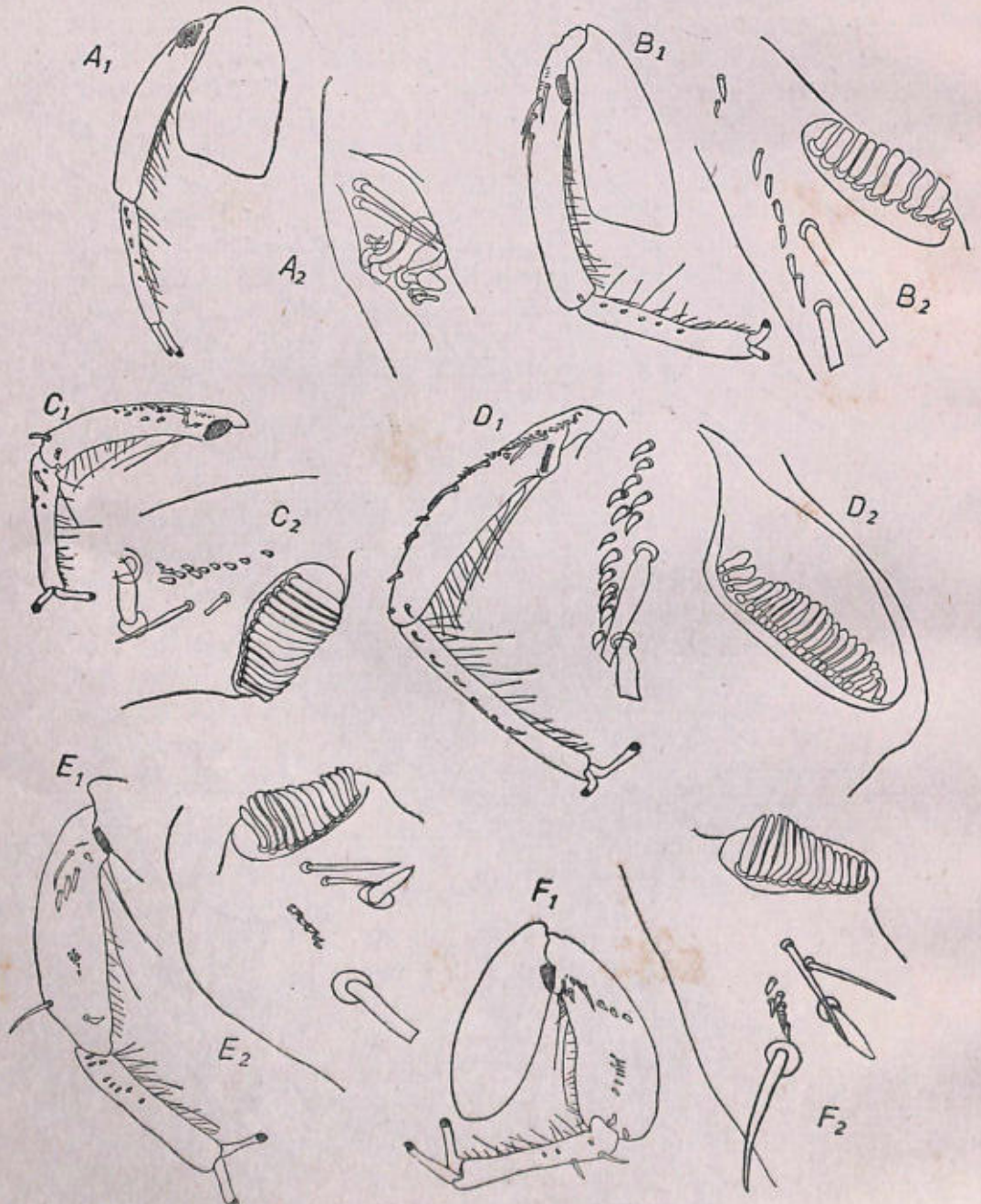
Whilst the generic diagnosis of *Anisops* has proved relatively easy, specific diagnosis was based on unsatisfactory characters like colour and size. This led to considerable confusion until Brooks (1951) revised the genus including all species so far described. He made use of the chaetotaxy of the fore-legs of the male, the shape of the rostral prong and the facial tubercle which were used by earlier workers. He also utilised the shape of the labrum and the femur of the first leg of the male as additional features to be relied on for specific diagnosis. In the present paper we have compared our material with the excellent descriptions of Brooks (1951) and used easily observable characters for illustration to make diagnosis accurate and easy for the Ceylonese species. Since Brooks (1951) has given detailed descriptions of all the species we have recorded, we have given only the important diagnostic features for each species.

The Notonectidae are represented in Ceylon by three genera: *Anisops*, *Nychia*, and *Enithares*. A key to the separation of these is given below:

1. Hemelytral commissure with a hair-lined pit (Plate I, A-B) .. *Anisops*
   Hemelytral commissure without a hair-lined pit .. 2
2. Femur of middle leg with antapical protuberance (Plate I, E) ..
   Eyes not holoptic .. .. *Enithares*
   Femur of middle leg without antapical protuberance (Plate I, D)
   Eyes holoptic .. .. *Nychia*



A. Dorsal view (diagrammatic) of *Anisops* (s=synthlipsis, v=vertex); B. Enlarged view of hair-lined pit of *Anisops*; C. Diagrammatic drawing of fore-leg of male *Anisops*; D. Diagrammatic drawing of middle leg of male *Nychia*; E. Diagrammatic drawing of middle leg of *Enithares*.



The chaetotaxy of fore-legs of the males of: A_1 & A_2. *Anisops breddini*; B_1 & B_2. *Anisops exigera*; C_1 & C_2. *Anisops nivea*; D_1 & D_2. *Anisops barbata*; E_1 & E_2. *Anisops bouvieri*; F_1 & F_2. *Anisops extendofrons.*

The genus *Anisops* is further easily recognised by the one-segmented tarsi of the male fore-legs. These bear bluntly rounded tarsal claws. There is also a stridulatory comb on each fore-leg (Plate I, C). A generalised drawing of *Anisops* is shown in Plate I, A.

Ceylonese Species

In the present paper eight species are recognized as being found in Ceylon, namely *Anisops ali* Distant, *A. batillifrons* Lundb., *A. bouvieri* Kirk., *A. extendofrons* Brooks, *A. barbata* Brooks, *A. exigera* Horv., *A. nivea* (Fabr.), and *A. breddini* Kirk.

Anisops ali Distant

No specimens of this species were available to us. *Anisops ali* is known only from the female and there is the possibility that it is the synonym of *Anisops allaudi* Poisson[1] (personal communication by I. Lansbury, Hope Department of Entomology, Oxford).

The type locality of this species is Diyatalawa and a brief description is given by Distant (1911) which has been transcribed by Brooks (1951).

Anisops batillifrons Lundb.

The following material was available to us: 3 males, Kadahapoda, Kurunegala District, 29-7-57; 5 females, 22nd mile Kurunegala-Maho Road, 14-7-57; 1 male, 5 females, Wilpattu 23-6-52; 3 males, 5 females, Habarana, 7-3-57; 1 male, 3 females, Divulapitiya, Nattandiya, 28-7-57; 3 males, 2 females, Watupitiwela, 9-11-56; 5 males, 6 females, Thunmodera, Nattandiya, 21-6-57; 2 males, Kotadeniya, 13-10-57; 1 male, 1 female, Kiniyama, 3-5-58; and 3 females, Nugegoda, 16-11-57.

The male measures 5.2-6.8[2] in length and 1.3-3.1 in breadth. The females are 5.5-6.5 long and 1.5-1.9 broad. This species is easily the commonest in the collections we have examined. It is easily recognized by the short cephalic projection (Plate III, E), and the chaetotaxy of the male fore-leg (Plate III, C-D).

Anisops batillifrons has been recorded in Ceylon by Fernando (1959, 1961a). It is a widely distributed species occurring in

[1] From Reunion I. Eds.
[2] All measurements in mm.

Formosa, Hainan, China, Burma, Assam, India, Philippines, Okinawa, and Ceylon. It is likely that earlier records of the species were confused with those of *Anisops bouvieri*, the females of which are indistinguishable from *A. batillifrons*, and *A. nasuta* which it resembles superficially.

Anisops batillifrons flies readily and has been recorded in isolated habitats by Fernando (1959) and at light (Fernando, 1961a). It is often found in paddy fields (Fernando, 1959).

Anisops bouvieri Kirk

Only a single male from Mandativu, Jaffna Peninsula, 5-12-57, was available for study besides a pair of mounted fore-legs of a male. We have also measured a female collected in Malaya.

The male measures 6.8 including the cephalic projection and is 1.9 broad. The female is 6.5 long and 2.0 broad.

Though the females of *Anisops bouvieri* and *A. batillifrons* are indistinguishable, the males of *A. bouvieri* can be easily separated from *A. batillifrons* by the longer, acuminate cephalic projection (Plate III, F), and the chaetotaxy of the male fore-legs (Plate II, E_1-E_2).

Anisops bouvieri is widely distributed in south-east Asia. It occurs in New Guinea, Malaya, Siam, Burma, Assam, India, and Ceylon. It is a very mobile species and has been recorded at light in India by Brooks (1951).

Anisops extendofrons Brooks

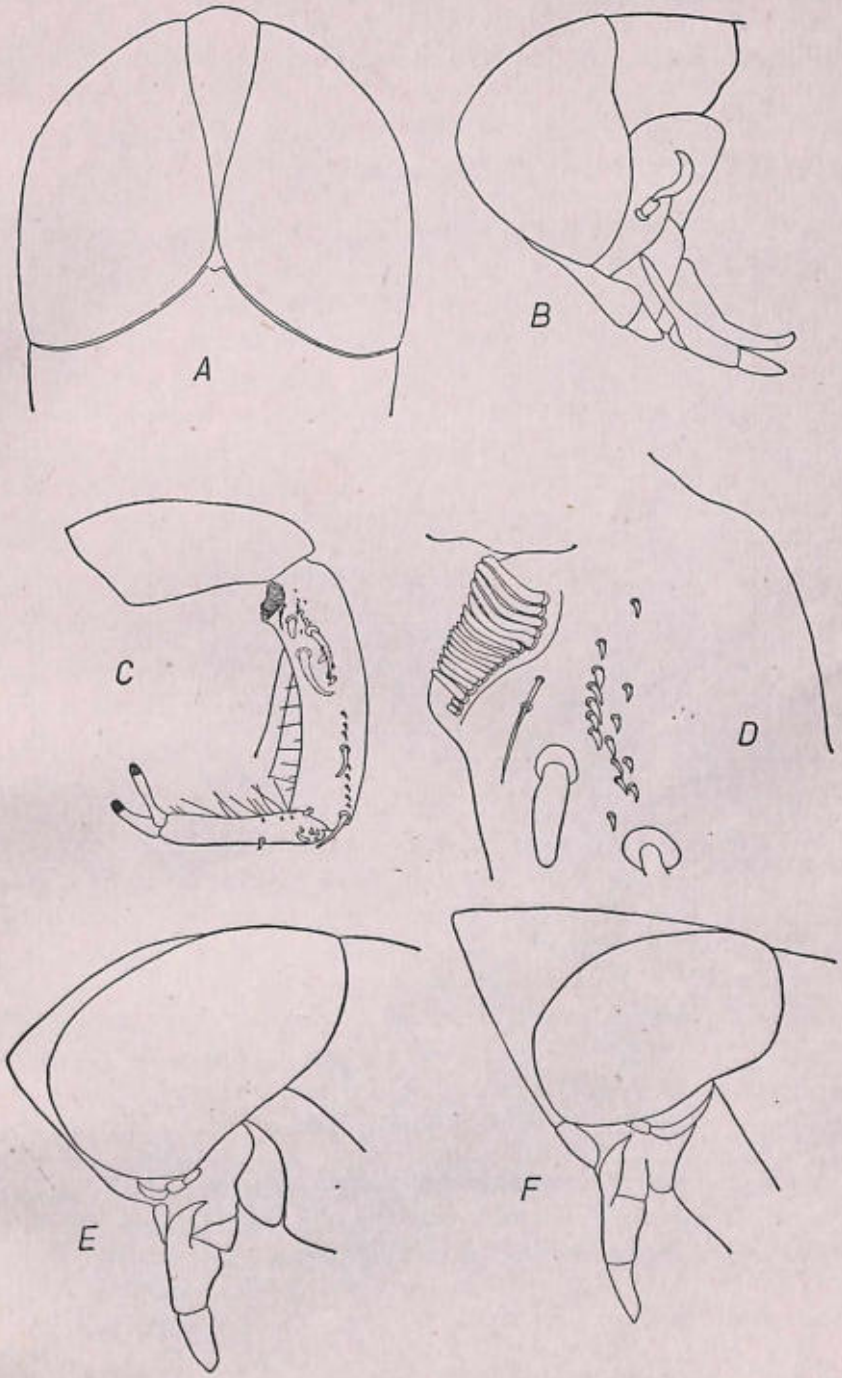
Only a pair of mounted fore-legs of the male was available from Ceylon. The specimen was collected from Ambalantota on 22-5-57. According to Brooks (1951) the male measures 6.4-6.8 in length and 1.5-1.7 in breadth. The females are 6.0 in length and 1.8 in breadth.

This species resembles *Anisops bouvieri* very closely and the males have a long cephalic projection. It can however be distinguished from *A. bouvieri* by the chaetotaxy of the male fore-legs (Plate II, F_1-F_2).

Anisops extendofrons has so far been recorded only from two localities in India (Brooks, 1951). This is the first record of this species from Ceylon, except the mention of its occurrence by Mendis & Fernando (1962).

Anisops barbata Brooks

One male and one female of this species was available to us besides a pair of mounted fore-legs of the male. The former were



A-B. *Anisops breddini*: A. Dorsal view of head to show holoptic eyes; B. Profile of head. C-E. *Anisops batillifrons*: C. Chaetotaxy of male fore-leg; D. Enlarged view of stridulatory comb; E. Profile of head. F. *Anisops bouvieri*: Profile of head.

collected in Ratmale on 14-7-57, and the latter from Maradamaduwa on 24-6-52.

This species is the largest of the Ceylonese *Anisops*. It has a wide synthlipsis, a character it shares with only one other Ceylonese species, namely *Anisops nivea*.

The male measures 9.0 long and 2.6 broad. The only female in our collection was sent to Mr. I. Lansbury of the Hope Department of Entomology, Oxford, who kindly identified this species for us.

Anisops barbata can be easily identified by its large size (over 8.0). The chaetotaxy of the male fore-leg is shown in Plate II, D_1-D_2. This species occurs in Burma, India, Java, Formosa (Brooks, 1951), Malaya (Lansbury, personal communication), and it is recorded here for the first time in Ceylon.

Anisops exigera Horv.

The following material was examined: Ratmale, 1 male, 1 female, collected on 14-7-57. Besides this we have examined a pair of mounted fore-legs of the male from the same locality.

The male measures 5.0 in length and 1.5 in breadth. The female measures 6.0 in length and 1.5 in breadth. *Anisops exigera* is a relatively small species and has a narrow synthlipsis and no cephalic projection. It resembles *Anisops nivea* superficially but can be distinguished from this species by the narrow synthlipsis. The chaetotaxy of the male fore-leg is shown in Plate II, B_1-B_2.

Anisops exigera is so far known from the type series from N. Guinea and occurs in south and central India (Brooks, 1951). It has been recorded in Malaya by us and reported from Ceylon by Fernando (1961a) as *A. crinata*.

Anisops nivea (Fabr.)

The following material was available to us for study: 1 male, Wilpattu, 23-6-52; 2 females, Habarana, 7-3-57; 3 females, Kadahapoda, 29-7-57. Besides this we have examined a pair of mounted fore-legs of the male from Wilpattu 23-6-52.

The male measures 6.0 in length and 1.5 in breadth. The female measures 6.0-6.9 in length and 1.5-2.0 in breadth. *Anisops nivea* resembles *A. barbata* in having a wide synthlipsis but can be separated from the latter by its small size. The chaetotaxy of the male fore-leg is shown in Plate II, C_1-C_2.

Anisops nivea occurs in Sumatra and India (Brooks, 1951). It has also been collected by us in Malaya and has been recorded in Ceylon by Fernando (1961a).

Anisops breddini Kirk.

Three females from Lahugala Tank collected on 14-4-58 were available for study, besides a pair of mounted male fore-legs. We have also measured a single male from Malaya.

The male measures 5.5 in length and 1.5 in breadth. The female is 5.0-6.0 in length and 1.2-1.4 in breadth.

This species is easily recognized by the holoptic eyes (Plate III, A). The second rostral segment of the male is produced into a flap-like process extending beyond the third and fourth rostral segments (Plate III, B). Superficially this species resembles *Nychia* sp. but has a hair-lined pit on the hemelytral commissure and the typical one-jointed tarsi of the male.

Anisops breddini occurs in India, Burma, Ceylon (Brooks, 1951). It is the commonest species in Malaya. It has been recorded at light in Malaya by Fernando (1961b).

KEY TO MALES OF CEYLONESE SPECIES OF *Anisops*

The following simple key has been drawn up for the males of the Ceylonese species of *Anisops*. We have omitted *Anisops ali* whose male is unknown and *A. nasuta* whose presence in Ceylon is doubtful.

1.	Eyes holoptic	*A. breddini*
	Eyes not holoptic	2
2.	Synthlipsis wide, one-third or more the anterior width of vertex	3
	Synthlipsis narrow, less than one-third the anterior width of vertex	4
3.	Large, more than 8.0 mm. long	*A. barbata*
	Less than 8.0 mm. long	*A. nivea*
4.	Cephalic projection present	5
	Cephalic projection absent	*A. exigera*
5.	Cephalic projection more or less acuminate	6
	Cephalic projection short, pointed	*A. batillifrons*
6.	Chaetotaxy of first male leg as in Plate II, E_1-E_2 ..	*A. bouvieri*
	Chaetotaxy of first male leg as in Plate II, F_1-F_2 ..	*A. extendofrons*

OTHER SPECIES IN CEYLON

'*Anisops fieberi*' has been recorded by Distant (1906). This is indeterminate and probably *Anisops nivea*. *Anisops nasuta* has been recorded by Lundblad (1933), but we consider that this is probably an error and refers to *Anisops batillifrons*. *Anisops nasuta* does not occur in India and seems restricted to the Pacific, and the Malaya Archipelago, whilst *A. batillifrons* is a widespread species, occurring in India.

SUMMARY

Eight species of *Anisops* are recognised as being present in Ceylon. Specimens of all of them except *Anisops ali* have been examined and short notes of important diagnostic structural features are given.

A short account of the biology of *Anisops* and the distribution of the Ceylonese species has been included, with records of the occurrence of members of the genus at light and temporary habitats.

Keys to the genera of Notonectidae and the Ceylonese species of *Anisops* are given.

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Studies on the Freshwater Oligochaeta of South India

I. Aeolosomatidae and Naididae

PART 3

BY

K. VANAMALA NAIDU

Government Arts and Science College, Chittoor (A.P.)

(With eleven text-figures)

[*Continued from Vol.* **59** (1) : 145]

4. Genus **Stylaria** Lamarck, 1816

Generic characters : Prostomium with long proboscis. Eyes present. Dorsal setae from VI on, each bundle with hairs and simple-pointed, nodulus-less needles. Ventral setae all alike, with proximal nodulus, proximal part bent and with weak proximal prong. Pharynx and oesophageal glands present. Stomach present. Coelomocytes present. Commissural vessels present. Nephridia start in VI or VII. Atria with prostate glands. Penial setae present. Spermathecae present.

KEY TO ALL THE KNOWN AND VALID SPECIES OF STYLARIA

Proboscis projecting from a notch between 2 lateral lobes; proximal part of ventral setae with 2 sharp bends; hair setae with serrations — [1] *lacustris*

Proboscis projecting from tip of the pointed prostomium; proximal part of ventral setae with 1 sharp bend; hair setae smooth — *fossularis*

9. **Stylaria fossularis** Leidy, 1852

Fig. 9 A-H

Stylaria lacustris (L.) Stephenson, 1913b, pp. 739, 744; Yamaguchi, 1958, pp. 292-293.

Stylaria fossularis Leidy. Chen, 1944, p. 6; Chu, 1945, pp. 194-206, fig. 1-8; 1946, pp. 229-239, fig. 1-7; Sperber, 1948, pp. 149-151.

[1] Species not recorded in the Indian sub-continent

Material examined : Many worms collected from the Bugga stream, Cuddapah in January 1956.

Worms pale white with very transparent body wall, and delicate, short hairs, more on prostomium and anal segment. Eyes crescentic, blackish purple, at the base of prostomium on either side of the mouth. Prostomium proper semi-circular, 0.16 mm. long, with a conspicuous, thin antero-median proboscis (Fig. 9A), 1.4 mm. long, 0.07 mm. and 0.02 mm. broad at the base and apex respectively.

Dorsal setae begin in VI, 1-2 hairs and 1-3 needles per bundle, hairs simple, straight, longer than the body diameter, 300-420 μ long; needles single pointed, straight 63-70 μ long, anodulate. Ventral setae (Fig. 9B) all of one type, bifid, 6-10 per bundle, decreasing to 2 per bundle in hind segments, longer anteriorly, 91-126 μ long, length gradually decreasing posteriorly, with proximal nodulus (D:P::18:13), single proximal bend, distal prong very much longer, thicker and hooked than the rudimentary proximal prong. Lengths of setae of a bundle vary.

Pharynx in II-IV, wide, bright yellow, partly eversible through the mouth. Oesophagus in V-VI, thin. Stomach in VII-IX, distinctly barrel-shaped. Intestine from XII on. Gut ciliated, flame-like ciliary vibration and vigorous anti-peristalsis occur in intestine. Chloragocytes from VI, greyish. Coelomocytes absent; brownish spherical oil globules present in coelom. Contraction and relaxation of proboscis wall decreases and increases the volume of the proboscis.

Brain (Fig. 9C) incised deeply behind and less deeply in front. Blood colourless. Dorsal vessel lateral, and mid-dorsal anteriorly. Simple contractile vessels 3 pairs in III-V.

Nephridia begin in VII or VIII, 2 (occasionally 1) per segment. Nephridium (Fig. 9D) in two segments, its pre-septal ciliated, nephrostome in the anterior, and post-septal duct partly enclosed in glandular mass and opening by nephridiopore in front of the ventral bundles in the posterior of the two segments.

Worms without budding zones are very rare in January. Those developing sex organs also form budding zones, and go through asexual reproduction repeatedly until sexual maturity, when fission is suspended. A proboscid prostomium and 5 anterior segments for the posterior zooid and some hind segments for the anterior zooid are budded off by the budding zone before fission.

Testes and ovaries paired, ovoid, white structures on either side of the oesophagus in V and VI respectively. Sperm sac, a back-pouching of septum 5/6, extends to X or XI. Seminal funnels cup-shaped (Fig. 9E) in V, followed by thick-walled vasa deferentia entering atria (Fig. 9E) in VI. Atrial ampullae ovoid with irregular exterior, open by short ducts ventro-laterally in VI. Ventral setae of VI modified into penial setae (Fig. 9F), 2-3 per bundle, 84-91 μ long, 4-5 μ thick. Ovi-sac,

a back-pouching of septum 6/7, extends to XI or XII when full with ova (Fig. 9H). Female funnels small on septum 6/7, open into ovi-sac. Clitellum not very distinct, body wall of V-VII thicker than the others. Spermathecae (Fig. 9G) club-shaped, do not enter sperm sac, with their openings ventro-laterally in V.

l(living) = 4-5 mm., (chains) 8-9 mm.; d(living) = 0.3 mm.; s = 30-35 followed by slender undifferentiated zone ; n = 19-23, 21 common.

Lengths of setae in μ and position of nodulus in the ratio D : P : :

	II	III	IV	V	VI	VII	VIII	IX	X
Hair :	—	—	—	—	—	—	420	—	308
Needle :	—	—	—	—	63	63	63	63	63
Long crotchet	126 24 : 12	115.5 22:11	112 21:11	108.5 20:11	108.5 19:12	105 18:12	112 19:13	108.5 18:13	108.5 18:13
Short crotchet	108.5 21:10	98 18:10	101.5 19:10	101.5 18:11	94.5 16:11	94.5 16:11	94.5 16:11	91 16:10	94.5 16:11

Distribution in Indian sub-continent : Calcutta, Bhim Tal (N. India); Lahore (Pakistan). Now recorded from Cuddapah (S. India).

Habits : Worms live in filaments of *Spirogyra* and other algae, feeding on the decaying vegetable matter. No tube formation. They swim with brisk wriggling movement in horizontal plane.

Remarks : The present worms have no coelomocytes, in which they agree with Chen (1940). In coelomic fluid brownish spherical oil globules are seen, which may have been mistaken for coelomocytes by Stephenson (1909a). A distinct stomach is present, in which they agree with Yoshizawa (1928), Stephenson (1923), but differ from Chen. Needles are longer, 63-70 μ long as against 40-50 μ long found in literature.

5. Genus **Haemonais** Bretscher, 1900

Generic characters : Eyes absent. Dorsal setae hairs and bifid crochet-like needles, originally beginning in VI and as worms mature hairs and needles are lost in a number of anterior segments. Ventral setae of anterior segments differ in shape from the posterior setae. Dorsal vessel lateral. Vascular plexus in anterior segments. Coelomocytes present. Clitellum absent between male pores. Vas deferens entering atria antero-dorsally. Prostate absent. Penial setae present.

10. **Haemonais waldvogeli** Bretscher, 1900

Fig. 10 A-C

Haemonais waldvogeli Bretscher. Lastočkin, 1924, p. 5 ; 1927, p. 66 ; Sperber, 1948, pp. 154-155, fig. 18C, 27B ; 1950, p. 70.

Haemonais laurentii Stephenson. Marcus, 1944, pp. 63-64, fig. 51, 52. Du-Bois Raymond Marcus, 1947, pp. 5-6 ; 1949, pp. 2-3, fig. 1-2.

Material examined : Many worms collected from the Langford Town tank, Bangalore, in May 1958.

Worms of moderate size, light brown, tapering anteriorly. Prostomium triangular, without sensory hairs. Eyes absent.

Dorsal setae, in mature worms, start in any segment from XVII to XX, 1 hair and 1 needle per bundle, hair slightly S-shaped, 130-140 μ long, slightly longer than needles ; needles (Fig. 10A) bifid, S-shaped, crotchet-like, with distal nodulus (D : P : : 12 : 15), 91-98 μ long, 4 μ thick, outer tooth thinner and longer than inner. Ventral setae (Fig. 10B, C) 2-3 per bundle, 84 μ long in II and III, decreasing to 80.5 μ in IV and V ; 87.5 μ long in VI, increasing to 94.5 μ in VIII and gradually diminishing to 80.5 μ long in the middle and posterior segments ; in II-XVIII longer and slender, with proximal nodulus (D : P : : 15 : 12), distal prong longer and thinner than proximal ; from XIX backwards more curved with distal nodulus (D : P : : 11 : 13), distal prong thinner and shorter than proximal.

Pharynx in II-IV, wide. Oesophagus from V, thin, insensibly continues into intestine. Stomach absent. Anus dorsal. Chloragocyte dark brown, start from II, absent in III. Intestinal anti-peristalsis and ascending ciliary vibration occur. Coelomocytes spherical, of different sizes, clumping into masses on septa of anterior segments. Septa well developed and unperforated ; no septal glands.

Brain incised in front and behind.

Blood red. Dorsal vessel ventrally attached to left of gut up to VI and mid-dorsal in II-V. Anterior segments have a network of longitudinal and transverse vessels below the parietes, the former closer to one another than the latter, which are 2 pairs per segment.

First nephridium in VIII with its nephrostome to the left in VII ; pre-septal funnel with a ciliated nephrostome, passes into a thin neck, and pierces through septum and connects post-septal, latter consisting of a long cylindrical body followed by a thin, long ciliated coiled duct, partly free and partly enclosed in gland tissue before opening by nephridiopore.

Budding zone proliferates a prostomium and 5 anterior segments to posterior zooid, and several hind segments to anterior zooid before fission. As budding is going on, the dorsal setae of anterior segments of the posterior zooid are gradually shed, first hairs, then needles ; and later thick, short, curved ventral setae are gradually replaced by thin, long, less curved setae. Sexual worms not encountered.

l (p.) = 6 mm. ; d (p.) = 0.4 mm. ; s = 42+undiff. region ; n=31-37.

Distribution in Indian sub-continent : Agra (N. India) ; Lahore (Pakistan). Now recorded from Bangalore (S. India).

Habits : No swimming. Live in soft mud ; not tube-dwelling.

Lengths of setae in μ and the position of nodulus in the ratio D : P : :

	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
H :	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N :	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1C :	84 15:9	84 15:9	80.5 14:9	80.5 14:9	87.5 14:11	87.5 15:10	94.5 15:12	91 15:11	84 14:10	84 15:9	84 11:14	91 12:14	80.5 10:13	84 11:13
2C :	80.5 14:9	17 15:7	77 13:9	77 13:9	85 14:10	87.5 15:10	87.5 15:10	87.5 14:11	80.5 10:13	80.5 10:13	77 10:12	77 10:12	80.5 10:13	77 10:12
3C :	—	—	—	—	80.5 14:9	87.4 14:11	84 11:13	77 10:12	73.5 9:12	80.5 10:13	73.5 9:12	73.5 9:12	73.5 9:12	77 9:13

	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV	XXV	XXVI	XXVII	XXVIII	XXIX
H :	—	129.5	129.5	129.5	140	140	112	133	133	133	129.5	129.5	126	136.5
N :	—	94.5 12:15	91 11:15	91 11:15	94.5 11:16	98 12:16	94.5 11:16	94.5 12:15	91 11:15	91 11:15	91 11:15	91 11:15	94.5 12:15	94.5 12:15
1C :	80.5 10:13	84 11:13	80.5 11:13	84 12:12	80.5 10:13	84 11:13	80.5 11:12	80.5 11:12	80.5 11:12	80.5 11:12	80.5 11:12	80.5 11:12	84 12:12	84 12:12
2C :	77 10:12	77 10:12	77 10:12	80.5 10:13	77 10:12	77 10:12	80.5 11:12	77 10:12	77 10:12	80.5 10:13	80.5 10:13	77 10:12	84 12:12	80.5 10:13
3C :	77 9:13	77 9:13	73.5 9:12	77 10:12	77 10:12	73.5 9:12	80.5 9:14	73.5 8:13	77 9:13	77 9:13	77 9.13	77 9:13	77 9:13	77 9:13

Remarks : Needles of this form are shorter, 91-98 μ long, than those of Lahore worms, 105 μ long (Stephenson, 1915) and Russian worms, 105-115 μ long (Lastočkin, 1924 ; Malevich, 1929).

Haemonais ciliata Hayden (1922) agrees in all characters with *H. waldvogeli* except for the presence of pigmentation at both ends of the pharynx, the ciliation of the body surface in a number of anterior segments, and the vascular system, 'more like the usual naid type than that of *H. waldvogeli*', with contractile loops in most of the segments, IV-XX. These characters of the vascular system are peculiar and hence need reinvestigation.

Haemonais laurentii Stephenson of Chen (1940) with the dorsal bundles starting in II, if it is not a case of worms regenerating the anterior end, is certainly a distinct species.

6. Genus **Branchiodrilus** Michaelsen, 1900

Generic characters : Eyes absent. Anterior segments with transverse brown stripes. Dorsal setae from IV, V or VI, hairs in anterior segments and hairs and simple-pointed needles in hind segments. Ventral setae all alike or of anterior segments slightly different from those of posterior segments. Branchial processes from IV, V or VI onwards on a number of anterior segments. Stomach absent. Dorsal vessel lateral. Vascular plexus in anterior 5 segments ; gill bearing segments have a pair of transverse vascular loops each, which enter into the gills. Coelomocytes present. Clitellum in V-VIII. Vasa deferentia entering atria on their antero-dorsal face. Prostate absent. Atrial duct surrounded by gland cells. Penial setae present.

Till recently two species of this genus were known only from Asia, *Br. semperi* and *Br. hortensis* from India ; *Br. hortensis* from Japan (Yamaguchi, 1938, 1953) and from China (Chen, 1940). Dahl (1957, pp. 1155-57) described *Br. cleistochaeta* Dahl from the French Cameroons in Africa. With its discovery in Africa, the genus is known for the first time outside Asia.

KEY TO ALL THE KNOWN AND VALID SPECIES OF BRANCHIODRILUS

A-1 Needle setae of posterior segments curved distally ... *semperi*

A-2 Needle setae of all segments with straight tips ..

B-1 Ventral setae of all segments of one type only ; with equally long prongs ; usually one hair projecting freely in posterior branchial segments .. *hortensis*

B-2 Ventral setae of two types, anterior ones with equally long prongs, posterior ones with distal prong longer than proximal ; all hairs enclosed in gills .. [1] *cleistochaeta*

[1] Species not known from the Indian sub-continent.

11. **Branchiodrilus semperi** (Bourne, 1900)

Fig. 11 A-F

Branchiodrilus semperi (Bourne). Sperber, 1948, pp. 156-157.

Material examined : Many worms collected from the Bugga stream, Cuddapah in January 1954 ; from the Kandakam tank, Bellary, in April 1954.

Worms large, brown, with dorso-lateral gills starting from V in Bellary specimens and VI in Cuddapah specimens, 1 pair per segment, extending to the middle of the body. Pre-branchial region appears thicker than the region following it in the moving worms. Dark grey pigmentation is irregular in anterior 14 or 15 segments, besides regular transverse bands covering blood vessels in anterior gill region. Prostomium bluntly triangular. Anus postero-dorsal (Fig. 11 A, B). No eyes. Anterior segments shorter than succeeding ones.

Gills about 50 pairs of 40 μ thick, ciliated, cylindrical hollow structures arising as dorso-lateral projections of the body wall with slight constrictions at the place of attachment. Each encloses an inverted U-shaped blood vessel. First pair 0.75 mm. long, when turned forwards stops short of the tip of the prostomium ; second pair 1 mm. long and reaches well in front of prostomium. Gills decrease in length posteriorly and at about 40th segment they are mere tubercles, gradually disappearing by about the 50th segment.

Dorsal setae from V or VI, 1-2 hairs and 1-2 needles per bundle, embedded in gills and free in tuberculate segments and others ; straight, smooth, 332-504 μ long, twice as long as needles, shorter than body diameter ; needles (Fig. 11 C, D) single pointed, anodulate, straight and simple anteriorly, and peculiarly bayonet-shaped with distal curve, 120-210 μ long, posteriorly. Ventral setae (Fig. 11 E, F), bifid, 1-3 per bundle, in II-V thinner than rest, 73.5 μ long in II, decreasing gradually to 52.5 μ in V ; nodulus median (D : P : : 9 : 9 or 10 : 11), distal prong thinner and longer than proximal ; in others nodulus distal (D : P : : 11 : 14 or 14 : 18), 73.5-87.5 μ long in VI, increasing gradually to 113.7 μ in succeeding segments, prongs equally long, distal half as thick as proximal.

Pharynx in II-VI, wide. Oesophagus from VII, thin, insensibly passing into wide sacculated intestine. Stomach absent. Intestinal anti-peristalsis occurs ; no postero-anterior ciliary vibration. Chloragogues from VI, brown, meagre on oesophagus. Septa perforated ; septal glands absent. Coelomocytes granular, opaque, colourless, spherical, largest 14 μ wide.

Blood yellowish red. Dorsal vessel contractile, laterally attached to left of the gut up to VII and mid-dorsal in 6 anterior segments. Ventral vessel non-contractile, mid-ventral. Branchial segments have paired

contractile lateral loops enclosed in gills and connected to dorsal and ventral vessels. In segments with branchial tubercles and subsequent ones, lateral loops are short, non-contractile and at the base of tubercles ; in pre-branchial region they form an irregular plexus.

First nephridium in XII with its pre-septal funnel in XI on anterior face of septum 11/12 ; a short neck passes and connects post-septal, latter consisting of a fusiform, granular body followed by a long coiled ciliated duct opening by nephridiopore ventro-laterally.

Budding zones develop one at a time, starts as a slight constriction about the middle of the body, later a narrow strip of undifferentiated region is formed for the anterior zooid in front of the zone. Budded hind segments of the anterior zooid do not develop gills until after they are fully formed. Budding zone provides an undifferentiated region for anterior zooid, and prostomium and 5 head segments for posterior zooid before fission.

Sexual worms not encountered.

l (p.) = 8.5-11.5 mm. ; d (p.) = 0.6-0.7 mm. ; s = over 100 + undiff. region ; n = 64-68.

Lengths of setae in μ and position of nodulus in the ratio D : P : :

	II	III	IV	V	VI	VII	VIII	IX	X	XI
Hair	—	—	—	—	332.5	339	504	402.5	402.5	402.5
Needle	—	—	—	—	140	210	210	210	122.5	129.5
Crotchet 1	73.5 10:11	66 9:9	59.5 9:8	52.5 7:8	87.5 11:14	101.5 13:16	103.2 14:15.5	101.5 13:16	113.7 14:18.5	112 14:18
Crotchet 2	—	—	—	—	73.5 9:12	98 12:16	98 13:15	91 12:14	110.2 14:17.5	106.7 14:16.5

Recorded only from Madras (S. India). Now recorded from Cuddapah and Bellary (S. India).

Habits : Swimming absent. Live in mud ; not tube-dwelling.

7. Genus **Dero** Oken, 1815

Subgenus *Dero* Oken, 1815

Sub-generic Characters : No eyes. Prostomium bluntly triangular. Dorsal setae from IV or VI ; ventral setae of II-V sharply differentiated from others. Pharyngeal glands present ; chloragogues begin in VI, brownish or greyish ; intestinal anti-peristalsis and ascending ciliary action occur. Coelomocytes absent. Septa developed ; septal glands present. Dorsal vessel contractile, ventrally to left for most part, mid-dorsal in anterior 6 segments ; ventral vessel non-contractile, mid-ventral. First nephridium in VII (rarely in VIII) with pre-septal

nephrostome in VI (rarely in VII) connected by a neck to the post-septal, consisting of a fusiform ampulla followed by a long coiled ciliated duct, partly enclosed in gland tissue, opening by nephridiopore ventrally. Budding zone provides prostomium and 5 anterior segments to the posterior zooid, and some hind segments and branchial organ to the anterior zooid before fission. Sperm-sac and ovi-sac, back-pouchings of septa 5/6 and 6/7, extend backwards, former within latter. Spermathecae 1 pair in V, their pores lateral to or in front of ventral setae in V. No penial setae.

KEY TO ALL THE KNOWN AND VALID SPECIES OF DERO

A-1 Dorsal setae beginning in IV ; branchial fossa with 5 pairs of gills .. *dorsalis*

A-2 Dorsal setae beginning in VI, branchial fossa with more or less than 5 pairs of gills

B-1 Branchial fossa with 7-40 pairs of gills

C-1 Needle teeth fine and equal ; 8 pairs of gills .. **evelinae*

C-2 Proximal tooth of needles weak or vestigeal ; 7 pairs of gills .. * *multibranchiata*

C-3 Proximal tooth of needles slightly thicker than distal, about 40 pairs of gills .. * *botrytis*

B-2 Branchial fossa with 4 pairs of gills

D-1 Needle teeth unequal ; distal tooth longer than proximal .. *digitata*

D-2 Needle teeth fine and about equal

E-1 Dorsal bundles with 1 hair and 1 needle in all segments .. *cooperi*

E-2 Dorsal bundles with 2 hairs and 2 needles in anterior and middle segments .. *indica* sp. nov.

E-3 Dorsal bundles with 3-4 hairs and 3-4 needles in anterior and middle segments .. *zeylanica*

B-3 Branchial fossa with 2-3 pairs of gills

F-1 Hairs bayonet-shaped and plumose

G-1 Needles bifid, nodulus 1/5–1/6 from distal end .. *plumosa* sp. nov.

G-2 Needles trifid, nodulus 1/4 from distal end .. *pectinata*

F-2 Hairs simple

H-1 Needles palmate .. *palmata*

H-2 Needles with 3-4 intermediate teeth between strongly diverging main teeth .. * *asiatica*

H-3 Needles simply bifid

I-1 Needle teeth equal; ventral setae of II-V longer than the rest

J-1 Stomach beginning in VIII *nivea*

J-2 Stomach beginning in IX or X .. * *obtusa*

I-2 Needle teeth unequal, proximal longer and thicker than distal .. *sawayai*

* Species not known from the Indian sub-continent.

12. **Dero dorsalis** Ferronière, 1899

Fig. 12 A-H

Dero dorsalis Ferronière. Sperber, 1948, pp. 162-165 ; 1950, pp. 70-71, fig. 22.

Material examined : Many worms collected from the Bugga stream, Cuddapah in April 1954 ; from the Balaji tank, Kakinada, in July 1956.

Worms of medium size, yellowish. Segmentation clear.

Dorsal setae from IV, 1 hair and 1 needle, rarely 2 of each, per bundle ; hairs (Fig. 12A) bayonet-shaped, 245-266 μ long, shorter than body diameter, needles (Fig. 12B) bifid, sickle-shaped, with strong distal nodulus (D : P : : 9 : 20), 84-102 μ long, with minute teeth, outer longer and thicker than inner. Ventral setae (Fig. 12C, D) 4, 3 and 2 per bundle in anterior, middle and posterior segments respectively ; in II-V, less curved than in others, with median nodulus (D : P : : 15 : 15 or 16 : 15) and prongs about equal in thickness, distal $1\frac{1}{3}$ times longer than proximal ; in others nodulus distal (D : P : : 14 : 16), distal prong thinner and longer than proximal. In II longest, 112-122.5 μ long and in others 91-112 μ long, gradually decreasing behind. Nodular position and seta length vary from seta to seta in each bundle.

Branchial organ (Fig. 12E, F) has 5 pairs of ciliated foliate gills in fossa ; I pair in supra-anal diverticulum broader than long, II and III pairs on inner surface of lateral margins, ventral and lateral to I, IV and V pairs on the floor of fossa. Anterior margin of fossa entire and ciliated posterior margin with non-vascular, non-contractile, short, broad, flat and diverging palp-like processes, which curl and close over branchial fossa in contraction.

Pharynx in II-III wide, with glands. Oesophagus in IV-VIII, thin and wavy, continuing into straight, thin intestine in IX. Intestine wide

and sacculated from X. Stomach absent. Chloragogues greyish. Septal glands in IV and V.

Brain (Fig. 12G) incised deeply posteriorly and less deeply anteriorly.

Blood red. Contractile vascular vessel 9 pairs in VI-XIV. In branchial organ (Fig. 12F) ventral vessel divides into 2, branches run along margins of fossa supplying 5 branchial vessels in each half ; branchial vessels loop in gills and on emerging from them, unite to form dorsal vessel.

First nephridium (Fig. 12H) in VII, its nephrostome in VI.

One budding zone common, when two, second budding zone always appears in posterior zooid.

Sexual worms not encountered.

l (p.) = 7-9.5 mm. ; d (p.) = 0.35-0.4 mm. ; s = 60-70 followed by undifferentiated zone and branchial organ ; n = 36 and 42 in 2 worms.

Lengths of longest setae in μ and position of nodulus in the ratio D : P : :

	II	III	IV	V	VI	VII	VIII
Hair	—	—	245	245	266	—	262.5
Needle	—	—	84 7.5:16.5	94.5 9:18	99.7 9:19.5	101.5 9:20	98 8:20
Crotchet	122.5 17:18	108.5 16:15	108.5 16:15	105 15:15	101.5 14:15	112 14:18	105 14:16

	IX	X	XI	XII	XIII	XIV
Hair	252	—	248.5	245	238	234.5
Needle	98 9:19	101.5 10:19	101.5 9:20	98 10:18	98 8:20	87.5 8.5:16.5
Crotchet	106.7 14:16.5	105 13:17	105 14:16	99.7 15:13.5	98 14:14	98 12:16

Distribution in Indian sub-continent : Madras, Trivandrum (S. India). Now recorded from Cuddapah and Kakinada (S. India).

Habits : These worms are the largest among the species of *Dero* in the locality and live in soft mud without tubes, along with *Aulophorus michaelseni*, *Dero digitata* and *D. indica*. Swimming absent.

Remarks : Present worms agree in the absence of stomach with Madras worms (Stephenson, 1925a), but disagree with Travancore worms (Aiyer, 1930). Stephenson describes 4 pairs of gills from a single worm with branchial organ from Madras. Aiyer describes 5 pairs of

gills. Present worms have 5 pairs of gills and agree with Aiyer's description. Body length is within 10 mm., while Aiyer gives it between 10-18 mm. and Chen (1940) between 10-30 mm.

13. **Dero digitata** (Müller, 1773)

Fig. 13 A-H

Dero limosa Leidy. Brode, 1898, p. 142. Lastočkin, 1918, p. 62 ; Cordero 1931a, p. 349 ; 1931b, p. 334 ; Chen, 1944, p. 7 ; Causey, 1953a, p. 55.

Dero incisa Michaelsen. Pointner, 1911, p. 632.

Dero digitata (Müller). Pointner, 1911, p. 632. Lastočkin, 1924, p. 5 ; 1927, p. 66 ; Sperber, 1948, pp. 165-178, fig. 19 A-E, 27A, pl. XIV, fig. 2-5, pl. XV, XVI, XVII, XVIII, fig. 1-3, 6 ; 1950, p. 71, pl. III, fig. 1, 2. Causey, 1953a, p. 55.

(?) *Dero digitata* (O. F. Müller). Sperber, 1958, p. 49.

Material examined : Numerous worms collected from the Bugga stream, Cuddapah, in September and November 1953, March 1954 and May 1955 ; from the Balaji tank, Kakinada, in November 1956 ; from the Kandakam tank, Bellary, in April 1954 ; from the Ulsoor tank, Bangalore, in May 1958.

Worms medium-sized, reddish, epidermis with uniform orange-red or pink pigment, concentrated in head segments and branchial organ. Body surface covered with slender fuzzy outgrowths. Prostomium with sensory hairs.

Dorsal setae from VI, 1 hair and 1 needle per bundle ; hair slightly bayonet-shaped, 140-182 μ long, shorter than diameter of body ; needle (Fig. 13 A) bifid, sickle-shaped, 59.5-63 μ long nodulus distal (D : P : : 5 : 13), distal tooth $1\frac{1}{2}$ times longer, thicker and straighter than proximal. Ventral setae (Fig. 13 B, C) of II-V, 4-5 per bundle, longer, thinner and straighter than those of others, 91-94 μ long, nodulus proximal (D : P : : 16 : 10), prongs equally thick, diverging, distal $1\frac{1}{2}$ times longer than proximal ; from VI on, 4 setae per bundle, decreasing to 3 and 2 posteriorly, 70-73.5 μ long. Length of distal prong and position of nodulus varies from seta to seta in each bundle. Distal prong slightly longer than proximal, nodulus about middle (D : P : : 10 : 11) in outer seta, distal prong is shorter than proximal and nodulus distal (D : P : : 6 : 12) in inner seta ; with intermediate lengths of distal prong and position of nodulus in other setae of the bundle.

Branchial organ (Fig. 13 D, E) has 4 pairs of ciliated gills, 1 dorsal and small, 1 lateral and 2 ventral, all foliate. Anterior margin of fossa entire, convex and ciliated ; posterior margin prolonged into a flat non-ciliated lip.

Pharynx in II-IV, wide with eversible dorsal diverticulum. Oesophagus in V-VIII, thin. Stomach in IX or IX-X. Intestine starts in X or XI. Gut ciliated. Chloragogues brownish. Septa well developed, septal glands in IV-VI.

Brain (Fig. 13 F) incised in front and behind.

Blood is red. Contractile lateral vessels 5 pairs in VI-X.

First nephridium (Fig. 13 G) in VII.

Budding zone normally single in a worm.

Clitellum from ½V-VII (2½ segments). Gonads absent but sexual cells of both sexes present in sexually mature worm with clitellum. Epidermis between spermathecal openings bright yellow. Sperm-sac and ovisac extend to IX and XI respectively when full, former lying in latter. Male and female funnels not observed. Atrial ampulla (Fig. 13H) ovoid, thick-walled with its ectal duct opening at the place of ventral bundle of VI. No penial setae. Spermathecae (Fig. 13H) ovoid, thick-walled with openings lateral to ventral bundles of V.

l(p.) = 2.5-3.5 mm. ; d(p.) = 0.25-0.3 mm.; s = 25-40 + undiff. region and branchial organ ; n = 17-25.

Lengths of longest setae in μ and positions of nodulus in the ratio D : P ::

	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
Hair	—	—	—	—	175	161	182	175	140	175	175	178.5
Needle	—	—	—	—	59.5 5:12	61.3 5:12.5	63 5:13	59.5 5:12	63 5:13	63 5:13	63 5:13	63 5:13
Crotchet	94.5 16:11	94.5 17:10	91 16:10	91 16:10	70 10:10	70 10:10	73.5 10:11	73.5 10:11	73.5 10:11	73.5 10:11	70 10:10	70 10:10

Distribution in Indian sub-continent : Trivandrum and Kottayam (Travancore, S. India). Now recorded from Cuddapah, Bellary and Bangalore (S. India).

Habits : When left in a vessel with large quantity of water, the worms settle in groups with their tubes attached parallel to one another on the wall near the surface of water, evidently for respiratory purposes. Swim with spiral movement. Live in tubes of mucus and sand.

Commensals : Sessile vorticellids are found attached to setae of the hind segments of worms.

Remarks : There is great deal of confusion regarding *Dero digitata* as it was described as a distinct species by every writer on trivial characters of the branchial organ. On examining 8 species of *Dero* and particularly the group of closely related species *D. digitata, D. cooperi, D. indica* and *D. zeylanica,* it boils down that proper identity is possible only when characters of the needle setae are considered.

Two species with 4 pairs of gills with dorsal bundles composed of 1 simple hair and 1 bifid needle starting in VI, can easily be separated into *D. digitata* with unequal needle teeth distal longer than proximal tooth, and into *D. cooperi* with short equal teeth in needles. Thus *D. limosa* from S. India (Aiyer, 1930), from Germany (Schuster, 1915,

pp. 16-17), from N. America (Mayhew, 1922), from Japan (Kondo, 1936), from China (Chen, 1940), *D. incisa*-like from Lake Akero 'tjarn (Sperber, 1948, p. 175) with distal needle tooth longer than proximal are synonyms of *D. digitata*.

The characters of setae of the present worms and of *D. digitata* (*D. limosa*) from S. India and China are similar; those of Sweden and N. America differ in being larger.

Setal characters of *D. kawamurai* and *D. tanimotoi* from Japan (Kondo, 1936); *D. michaelseni* from Russia (Svetlov, 1924); *D. incisa* from Germany (Michaelsen, 1903); *D. intermedius* (Cragin, 1887); *D. acuta* (Bousefield, 1887); *D. phillippinensis* (Semper, 1887, Bousefield, 1886, Vaillant, 1890) are not available. Lengths of setae of *D. michaelseni* and *D. incisa* (Michaelsen, 1903) agree very closely with the European form. The setae of *D. kawamurai* and *D. tanimotoi* are larger than those of the Asiatic form and approach the European and N. American form.

D. incisa from Abyssinia (Stephenson, 1932) resembles *D. digitata* in the absence of incision in the dorsal margin of the branchial organ; in having similar branchial organ, and in the form of setae (length unknown), but differs in having very fine needle teeth. This was found living together with *D. cooperi* in the same locality. Stephenson examined them together and described them as two different species. It is possible that the needle teeth are equal in length, which Stephenson may have failed to observe in the present worms. Hence this may be *D. cooperi*.

14. **Dero indica** sp. nov.

Fig. 14 A-G

Material examined: Many worms collected from the Bugga stream, Cuddaph in October 1953, March-May 1955, January 1956; from the Balaji tank, Kakinada in July 1956; from the Langford Town tank, Bangalore in May 1958.

Worms of medium size, sturdy and pale red. Eyes absent. Prostomium bluntly triangular with sensory hairs.

Dorsal setal bundles start in VI, each bundle with 2 hairs and 2 needles in segments of anterior half, 1 hair and 1 needle in others; hairs (Fig. 14 A) 226-280 μ long, shorter than body diameter and bayonet-shaped; needles (Fig. 14B) bifid, 87.5-105 μ long, sickle-shaped with nodulus a third from distal end, teeth strong, outer longer than inner. Hairs and needles of a bundle alternate. Ventral setae (Fig. 14 C, D) of II-V, 4 per bundle, longer, thinner and straighter than those of others, 112-126 μ long, prongs equally thick, diverging, distal prong $1\frac{1}{2}$ times as long as proximal, nodulus about middle (D:P::18 : 18 or 19 : 17); in

others, 3-4 per bundle, 80.5-102 μ long, nodulus distal (D:P :: 11 : 16), distal prong thinner and slightly longer than proximal.

Branchial organ (Fig. 14 E, F) funnel-shaped with postero-dorsal opening, its anterior border ciliated, flat, convex and entire; posterior margin non-ciliated, flat, broad, entire with a conspicuous transverse dark brown band in older fossae. Gills 4 pairs, foliate, ciliated; I pair short, ovoid and flat, arise from supra-anal diverticulum; II pair broad, flat, arise from inner surface of lateral margins; III and IV pairs long, flat, spindle-shaped, spring from floor of fossa, one behind the other. In full expansion I pair curl up and bend forward, II pair distend on either side, III and IV extend laterally and posteriorly, when branchial organ resembles a flower. In contraction I pair is not seen, II, III and IV pairs appear like knobs.

Pharynx in II-IV, wide and yellow. Oesophagus in V-VIII and wavy. Stomach in IX-½X, barrel-shaped. Intestine thin in XI-XII, wide and sacculated behind, and opens in branchial fossa. Chloragogues from VI, brownish. Ascending ciliary action and anti-peristalsis occur in intestine. No coelomocytes. Septa well developed, septal glands in IV and V.

Brain incised in front and behind.

Blood orange-red. Dorsal vessel contractile, mid-dorsal in I-V and ventrally attached to gut on left side from VI on, covered by chloragogues. Ventral vessel non-contractile, formed by the union of branches of dorsal vessel in II, mid-ventral all along, divides into 2 marginals, running along lateral margins of fossa supplying vessels to gills. Branchial vessels form loops in gills and on emerging from them, unite to form the dorsal vessel. Contractile lateral vessels 5 pairs in VI-X, connect the above vessels. Dorsal vessel gives off lateral vessels to form a plexus in pharyngeal region.

First nephridium (Fig. 14 G) in VII, its pre-septal funnel with a ciliated nephrostome in VI, connected by a thin duct to post-septal, consisting of a brown fusiform ampulla followed by a highly coiled, ciliated duct partly free and partly passing through gland tissue, opening by nephridiopore ventro-laterally in the middle of the segment.

Budding occurs with 1 (rarely 2) budding zone; I budding zone appears between the last segment with 2 hairs and 2 needles per bundle and first segment with 1 hair and 1 needle; II zone appears about the middle of posterior zooid after its anterior segments have developed 2 hairs and 2 needles, again between last segment with 2 hairs and 2 needles and first segment with 1 hair and 1 needle per bundle. Budding zone produces 5 head segments and prostomium for posterior, and several hind segments and branchial organ for anterior, zooids before fission.

Sexual worms not encountered.

Lengths of setae in μ and positions of nodulus in the ratio D : P ::

	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
Hair 1	—	—	—	—	269.5	273	280	226	280	273	245	255.5	252	245
Hair 2	—	—	—	—	269.5	—	245	182	—	273	234	—	182	—
Needle 1	—	—	—	—	105 10:20	98 10:18	98 11:17	101.5 10:19	101.5 10:19	101.5 11:18	94.5 10:17	94.5 9:18	98 9:19	87.5 9:16
Needle 2	—	—	—	—	105 10:20	91 9:17	96.3 10:17.5	105 10:20	91 9:17	— —	92.5 9:17.5	87.5 9:16	91 8:18	— —
Crotchet 1	126 18:18	122.5 17:18	119 17:17	119 17:17	94.5 11:16	101.5 13:16	101.5 12:17	94.5 11:16	94.5 11:16	87.5 10:15	91 12:14	91 10:16	91 12:14	91 11:15
Crotchet 2	126 18:18	119 17:17	115.5 17:16	115.5 16:17	91 11:15	101.5 12:17	98 12:16	91 10:16	94.5 11:16	87:5 10:15	91 10:16	87.5 9:16	91 11:15	91 10:16
Crotchet 3	122.5 16:19	119 17:17	115.5 17:16	115.5 16:17	91 11:15	101.5 12:17	91 10:16	91 10:16	91 11:15	87.5 10:15	87.5 10:15	84 9:15	87.5 10:15	87.5 9:16
Crotchet 4	119 16:18	115 16:17	112 16:16	112 16:16	91 11:15	94.5 11:16	91 10:16	87.5 9:16	87.5 9:16	84 9:15	84 9:15	84 9:15	84 9:15	87.5 9:16

l (living) = 6.5-8.5 mm. ; d (living) = 0.35-0.40 mm. ; s = 36-70 ; n = 24-32.

Type : The type specimen is being deposited with the Zoological Survey of India, Calcutta.

Habits : Live in soft black mud without tubes along with *Branchiodrilus semperi*, *Dero digitata*, *Branchiura* sp., *Limnodrilus socialis*, *Aulophorus hymanae* and *A. furcatus*. They coil into spirals when touched or disturbed. Swim by spiral movements.

Taxonomic discussion : Of the 14 species known for the sub-genus *Dero*, the present species closely resembles *D. digitata* and *D. zeylanica*. In having 2 hairs and 2 needles per bundle in the anterior and middle segments, this species is intermediate between *D. digitata* with 1 hair and 1 needle, and *D. zeylanica* with 3-4 hairs and 3-4 needles per bundle. In the possession of large conspicuous needle teeth, it differs from *D. digitata* and *D. zeylanica* both with minute needle teeth. In having long and more curved prongs in the ventral setae of the head segments, it further differs from *D. zeylanica* with shorter and less curved prongs and in having divergent prongs, it differs from *D. digitata* with nearly parallel prongs. Hence this is assigned the status of a new species.

Diagnosis of Dero indica *sp. nov :* No eyes. Dorsal setae from VI onwards, 2 hairs and 2 needles per bundle in anterior and middle segments, 1 hair and 1 needle behind. Hairs bayonet-shaped ; needles bifid with distal tooth longer than proximal. Ventral setae of II-V 4 per bundle, nodulus middle, prongs diverging, distal thinner and longer than proximal. Stomach in IX-½X. No coelomocytes. Septal glands in IV-V. Dorsal vessel ventrally attached to gut on left side ; lateral contractile vessels 5 pairs in VI-X ; vascular plexus in pharyngeal region. Branchial organ with dark brown band on posterior margin, 4 pairs of foliate gills, 1 dorsal, 1 lateral and 2 ventral. Budding present ; 5 head segments are budded.

15. **Dero zeylanica** Stephenson, 1913

Fig. 15 A-K

Dero zeylanica Stephenson. Sperber, 1948, pp. 178-179.

Material examined : Many worms collected from the Bugga stream, Cuddapah in May and December 1955 ; from the Handri River at Kurnool in April 1958 ; from the Brucepettah tank, Bellary in April 1954 ; from the Sewage canal at Bangalore in May 1958.

Worms of moderate size, sturdy and light brown with ends yellowish. Prostomium with sensory hairs.

Dorsal setae from VI on, each bundle with 3 hairs and 3 needles (occasionally 4 hairs and 4 needles) in anterior, 2 hairs and 2

needles in middle and 1 hair and 1 needle in posterior segments. Hairs slightly bayonet-shaped, 210-250μ long, shorter than body diameter. Needles (Fig. 15 A) bifid, sickle-shaped, 82-91μ long, with distal nodulus (D : P : : 9 : 17), teeth small, distal longer than proximal. Hairs and needles of each bundle arranged in a row alternating with each other. Ventral setae (Fig. 15 B-D) in II-V, 4-6 per bundle, longer, thinner and straighter than others, 108-115μ long nodulus median (D : P : : 16 : 17), prongs diverging, distal slightly longer than proximal; in others, 4-6 setae per bundle, 80-94μ long, nodulus distal (D : P : : 10 : 16), prongs equally thick, distal prong slightly longer than proximal.

Branchial organ (Fig. 15 E, F, G, H, I) with an ovoid postero-dorsal fossa, anterior margin flat, convex, entire and ciliated ; posterior margin flat, non-ciliated, entire with transverse brown band in older fossae. Gills 4 pairs, foliate ; I pair dorsal, ovoid, flat, arise from supra-anal diverticulum, curl upwards and forwards when relaxed ; II pair large, broad, arise from inner surface of lateral margins, stretch sideways in expansion ; III and IV pairs are triangular, spring from floor of fossa, one behind the other, stand upwards slanting to sides in distension.

Pharynx in II-IV, wide, ciliated, with dorsal diverticulum protrusible as a disc through mouth. Oesophagus in V-VIII, thin and wavy. Gland cell aggregations occur on gut in IV and V. Stomach in IX-X, fusiform. Intestine thin in XI-XII, wide and sacculated behind ; anus in branchial fossa. Chloragogues greyish brown. Septa well developed; septal glands absent.

Brain (Fig. 15 J) widely and deeply incised in front and less deeply behind.

Blood orange-red. Efferent branchial vessels unite into dorsal vessel, and runs forward giving rise to non-contractile simple loops up to XI, contractile vessels 5 pairs in X-VI and divides into 2 branches, which unite with ventral vessel. Ventral vessel divides posteriorly into 2 marginals and traverse dorso-lateral border of fossa supplying afferent vessels to gills. Pharyngeal vascular plexus is formed by anastamoses of lateral loops of dorsal vessel.

First nephridium (Fig. 15 K) in VII.

First budding zone usually appears between last segment with 3 hairs and 3 needles and first segment with 2 hairs and 2 needles ; and second zone appears in posterior zooid between last segment with 2 hairs and 2 needles and first segment with 1 hair and 1 needle normally.

Clitellum in $\frac{1}{2}$V-VII ($2\frac{1}{2}$ segments). Worms with clitellum have no gonads, resorbed after production of sex cells. Sperm-sac and ovi-sac extend to IX and XIII respectively. Sperm funnels laterally on anterior face of septum 5/6, followed by thin vasa deferentia entering

thin-walled, ovoid atrial ampullae, opening by short thick ectal duct ventrally in VI. Ventral setae of VI absent ; no penial setae. Oviducal funnels and ducts not observed. Spermathecae club-shaped, enter sperm-sac when full, and open laterally to ventral bundles of V.

l (p.) = 5-7 mm. simple, 10-12 mm. chains ; d (p.) = 0.3-0.4 mm. ; s = 28-82 ; n = 23-29.

Lengths of longest setae in μ and position of nodulus in the ratio D : P : :

	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Hair	—	—	—	—	248.5	245	238	248.5	203	234.5	227.5
Needle	—	—	—	—	94.5 9:18	91 9:17	94.5 10:17	91 9.17	91 9:17	89.3 8.5:17	87.5 8:17
Ventral seta	115 16:17	112 15:17	108 15:16	108 15:16	94 11:16	92.8 10:16.5	91 10:16	94.5 11:16	94.5 11:16	92.8 11:16	91 10:16

Distribution in Indian sub-continent : Kandy, Ceylon ; Trivandrum, S. India. Now recorded from Cuddapah and Bangalore, S. India.

Habits : Worms live in soft black mud along with *Limnodrilus socialis, Aulodrilus remex, Dero indica,* etc. Rarely found in tubes of mucus, sand and clay. Swim by slow spiral movement.

Remarks : Present worms differ from Ceylon worms (Stephenson, 1913a) and Travancore worms (Aiyer, 1930) in (1) lesser dimensions of body and setae (2) lesser value of n (23-29 as against 31-33) ; (3) greater number of contractile vascular vessels (5 pairs as against 4 pairs).

16. **Dero cooperi** Stephenson, 1932

Fig. 16A-I

Dero limosa Leidy. Stephenson, 1914, pp. 330-332, fig. 6 ; 1923, pp. 88-89 ; Mehra, 1920, pp. 457, 458.

Dero incisa Michaelsen. Schuster, 1915, pp. 17, 18, 67, fig. 8-9. Stephenson, 1932, pp. 234-236, fig. 6, 7.

(?) *Dero quadribranchiata* Černosvitov, 1937, pp. 145-147, fig. 25-30.

Dero cooperi Stephenson. Sperber, 1948, pp. 179-180.

Dero bonairiensis Michaelsen, 1933, pp. 336-338, pl. I, fig. 3-6.

Material examined : Many worms collected from the Bugga stream, Cuddapah all round the year; from the Balaji tank, Kakinada in July 1956 ; from the Ulsoor tank, Bangalore in May 1958.

Worms small, pale red, with epidermal orange spots lateral to dorsal bundles in all except head segments. Prostomium with sensory hairs. Body surface covered with short, thin out-growths.

Dorsal setae from VI, 1 hair and 1 needle per bundle. Hairs slightly bayonet-shaped, 182-210 μ long, shorter than body diameter. Needles (Fig. 16A) bifid, sickle-shaped, 70-77 μ long, nodulus distal

(D : P: : 7 : 14), with teeth equal and short. Ventral setae (Fig. 16 B, C, D) of II-V, 4-5 per bundle, straighter, thinner and longer than others, 105-125 μ long, nodulus proximal (D : P : : 20 : 14), prongs nearly parallel, distal thicker and 1½ times longer than proximal ; in others 3-5 setae per bundle, 71-77 μ long, nodulus distal, distal prong thinner, equally long or longer than proximal. Position of nodulus, length of distal prong vary from seta to seta in the bundle from VI onwards.

Lengths and position of nodulus in a bundle.

	Seta length	Position of nodulus D : P : :
(1)	73.5 μ	10:11
(2)	73.5 μ	9:12
(3)	73.5 μ	9:12
(4)	70.0 μ	6:14

Branchial fossa (Fig. 16 E, F, G) with anterior margin flat, broad, ciliated and slightly convex ; posterior margin prolonged into flat, convex lip, which is spout-like in contraction. Gills 4 pairs, ciliated ; 1 dorsal, digitiform ; 1 lateral, 2 ventral, both foliate. Ventral surface of branchial organ has epidermal thickenings.

Pharynx in II-IV, wide with dorsal diverticulum protrusible as a bulb. Oesophagus in V-VIII, thin and wavy. Stomach in IX-X, fusiform. Intestine thin in XI, wide and sacculated from XII on. Gut ciliated. Chloragogues greyish brown. Septa well developed, septal glands in III-V.

Brain (Fig. 16H) deeply incised in front and behind.

Blood red. Contractile vessels 5 pairs in VI-X, near posterior septa. Dorsal vessel bears non-contractile simple lateral loops from XI on.

First nephridium (Fig. 16 I) in VII with its nephrostome to the left in VI. Post-septal composed of a greenish grey fusiform ampulla followed by a long, coiled, ciliated duct, anterior ⅓ free and thin-walled, middle ⅓ enclosed in gland tissue and posterior ⅓ thick-walled, swelling into a vesicle before opening by nephridiopore in front of the left ventral bundle.

One budding zone formed at a time.

Clitellum from ½V-VII (2½ segments). In sexually mature worm, after proliferation of sex cells, gonads disappear and alimentary canal degenerates. Sperm-sac and ovi-sac extend to IX and XI respectively when full, former within latter. Seminal-funnel cup-shaped, ciliated followed by short, thick ventral ejaculatory duct opening at the situation of ventral bundles of VI. No genital setae. Spermathecae large, ovoid with short ectal duct, opening in a shallow depression in front and lateral to ventral bundles of V.

l (p.) = 3-4.5 mm. ; d (p.) = 0.30-0.35 mm. ; s = 33-51 + undiff. region and branchial organ ; n = 18–27.

Lengths of longest setae in μ and position of nodulus in ratio D : P : :

	II	III	IV	V	VI	VII	VIII	IX	X
Hair	—	—	—	—	182	210	210	196	210
Needle	—	—	—	—	71.7 6.5:14	71.7 6.5:14	73.5 7:14	77.0 7:15	70.0 7:13
V. seta	122.5 21:14	119.0 20:14	119.0 20:14	115.5 19:14	73.5 10:11	77.0 10:12	77.0 10:12	77.0 10:12	77.02 10:1

Distribution in Indian sub-continent : Agra (N. India) ; Lahore (Pakistan). Now recorded from Cuddapah and Bangalore (S. India). First record for south India.

Habits : Live in tubes of mucus, sand and mud ; protrude either end from tube. Swim with spiral movement.

Remarks : In all naids with ventral setae of II-V longer, slender and straighter than those of the rest, the nodulus as a rule is proximal. Stephenson (1932) in his original description of *Dero cooperi* states that the nodulus is median. This obviously is a mistake. He was examining preserved specimens and probably he could not clearly see the position of the nodulus in the anterior ventral setae. The present worms have proximal nodulus in the setae of II-V as in other Deros.

Lengths of setae of *D. bonairiensis* from West Indies (Michaelsen, 1933), *D. limosa* from Lahore, Pakistan (Stephenson, 1914, 1915c) agree with those of *D. cooperi* ; and they are synonymous with the latter. *D. incisa* from Germany (Schuster, 1915, p. 17) with longer setae is also *D. cooperi*.

D. quadribranchiata Černosvitov (1937) from Argentine has hairs and needles as *D. cooperi* (*D. incisa*) from Europe but has comparatively shorter needles with small equal teeth, and more accentuated lateral angles in its branchial organ. This probably is a distinct species and needs reinvestigation.

17. **Dero nivea** Aiyer, 1930

Fig. 17 A-C

Dero nivea Aiyer. Sperber, 1948, pp. 184-186, fig. 19G, pl. XVIII, fig. 4 ; 1950, p. 72, pl. 4 ; 1958, p. 49, fig. 5-7.

Material examined : Many worms collected from the Bugga stream, Cuddapah in January 1956.

Worms small and yellowish. Prostomium with sensory hairs.

Dorsal setae start in VI, 1 hair and 1 needle per bundle. Hair simple, nearly straight, 94.5-105 μ long. Needle (Fig. 17A) bifid, sickle-shaped, 35-45.5 μ long, with minute equal teeth and distal nodulus (D : P : : 3.5:9). Ventral setae (Fig. 17 B, C) from II on, 4 per bundle,

decreases to 2 posteriorly ; in II-V, setae have proximal nodulus (D : P : : 12 : 8.5 or 10 : 7), longer and thinner than others, length decreases from 71.8 μ in II to 59.5 μ in V ; distal prong nearly twice as long as proximal ; in others nodulus distal (D : P : : 7 : 13 or 4 : 14), length decreasing from 70 μ long in VI to 61 μ posteriorly ; prongs equally long, distal thinner than proximal. Length, thickness and curvature of setae and position of nodulus vary from seta to seta in a bundle.

Branchial organ resembles the sketch of branchial organ of Aiyer (1930). It is narrower in contraction and wider in relaxation than the region in front of it, with anterior margin flat, convex, ciliated, wavy ; posterior margin non-ciliated, entire with sensory hairs, curl downwards in distension. Gills 3 pairs, short and stumpy ; 1 pair arises from supra-anal diverticulum, II and III pairs arise from floor of fossa. In contraction fossa closes withdrawing gills and posterior lip-like margin trails behind.

Pharynx in II-IV, wide. Oesophagus in V-VII, thin and sinuous. Stomach in VIII, fusiform. Intestine thin in IX, wide and sacculated from X on. Chloragogues brownish, Septal glands in IV-VI.

Brain incised in front and behind.

Blood tinged red. Contractile lateral vessels 3 pairs in VI-VIII, close to posterior septa.

First nephridium in VIII.

Budding commonly occurs by 1 budding zone.

l (p.) = 2.0-2.5 mm. ; d (p.) = 0.14 mm. ; s = 18-24 ; n = 14-15.

Lengths of longest setae in μ and position of nodulus in ratio D : P : :

	II	III	IV	V	VI	VII	VIII	IX
Hair	—	—	—	—	94.5	115.5	105.0	105.0
Needle	—	—	—	—	43.5 3.5:9	45.5 3.5:9.5	45.5 3.5:9.5	43.5 3.5:9
V. seta	71.8 13:8.5	63.0 11.5:6.5	59.5 10:7	59.5 10:7	70.0 7:13	70.0 7:13	70.0 7:13	68.2 7:12.5

Distribution in Indian sub-continent : Trivandrum (Travancore, S. India). Now recorded from Cuddapah, south India.

Habits : Not tube-dwelling. Swim briskly by spiral movement.

18. **Dero sawayai** Marcus, 1943

Fig. 18 A-G

Dero sawayai Marcus. Sperber, 1948, p. 186.

Material examined : A few worms collected from the Ulsoor tank, Bangalore in May 1958.

Worms small, delicate and pale yellow. Prostomium with sensory hairs.

Dorsal setae start in VI, 1 hair and 1 needle per bundle. Hair bayonet-shaped, smooth, 80.5-100μ long. Needle (Fig. 18A, B) 35μ long, with strong nodulus about a third from distal end, inner tooth longer and thicker than the outer. Ventral setae (Fig. 18 C, D) 4 per bundle, decreasing to 2 posteriorly; in II-V longer, thinner and straighter than rest, 66-71 μ long, nodulus proximal (D : P : : 13 : 8), prongs slightly diverging, outer thinner and 1½ times as long as inner; in others 38-45μ long, nodulus distal (D : P : : 5 : 7), outer thinner than inner prong. Position of nodulus, thickness and length of seta vary from one to another in a bundle.

Branchial organ (Fig. 13 E, F) broad and tapers behind; with 2 pairs of gills, small, digitiform; 1 dorsal and 1 ventral, invisible in contraction.

Pharynx in II-IV, wide. Oesophagus in V-VII, thin. Stomach in VIII, distinct and abrupt. Intestine thin in IX and X, wide and sacculated in succeeding segments. Chloragogues brownish. Septal glands in IV-VI.

Blood yellowish. Contractile vascular vessels 2 pairs in VI-VII close to posterior septa. Stomach with a plexus of transverse vessels as in *Chaetogaster*. Head segments also have a plexus formed by vessels from dorsal vessel.

First nephridium (Fig. 18 G) in VII to the left.

One budding zone develops at a time in a worm.

Sexual worms not encountered.

l (p.) = 2 mm.; d (p.) = 0.2 mm.; s = 26 + undiff. zone and branchial organ; n = 14.

Lengths of longest setae in μ and position of nodulus in ratio D : P : :

	II	III	IV	V	VI	VII	VIII	IX
Hair	—	—	—	—	80.5	84.0	84.0	98.0
Needle	—	—	—	—	35.0 2:8	35.0 2:8	35.0 2:8	35.0 2:8
V. seta	70.0 12:8	73.5 13:8	70.0 12:8	66.5 12:7	45.5 5:8	45.5 5:8	43.7 5.5:7	42.0 5:7
,,	68.3 12:7.5	73.5 13:8	70.0 12:8	66.5 12:7	45.5 5:8	42.0 5:7	42.0 5:7	40.2 4.5:7
,,	68.3 11.5:8	70.0 12:8	66.5 12:7	66.5 12:7	42.0 4.5:7.5	38.5 4:7	42.0 4.5:7.5	40.2 4.5:7
,,	66.5 11:8	66.5 12:7	66.5 12:7	— —	38.5 4:7	38.5 4:7	38.5 4:7	38.5 4:7

Distribution in Indian sub-continent : Now recorded from Bangalore, (S. India), for the first time.

Habits : Construct attached mucus tubes and live in them. Swim by brisk wriggling movement.

Parasites : Four ovoid sporocysts containing immature spores of unidentified microsporid sporozoan are found in the coelom of IX and X.

Remarks : Transverse vascular plexus on stomach similar to one seen in *Chaetogaster* is seen in these worms unlike in the Brazilian worms (Marcus, 1943). Characters of setae agree with the South American specimens.

19. **Dero plumosa** sp. nov.

Fig. 19 A-H

Material examined : A few worms collected from the Bugga stream, Cuddapah in 1954, May and December 1955 ; from the Kandakam tank, Bellary in May-June 1954.

Worms slender, pale white and nearly transparent, smallest of all Deros. Prostomium bluntly triangular, longer than broad with sensory hairs. Body surface covered by delicate outgrowths. Eyes absent. Segments of anterior $\frac{1}{3}$ of body are longer than others.

Dorsal setae start in VI, 1 hair and 1 needle per bundle. Hair (Fig. 19A) bayonet-shaped with a row of close-set oblique barbs on convex border in distal $\frac{2}{3}$ of shaft giving appearance of a feather, 77-87.5μ long, twice as long as needle and shorter than body diameter ; barbs longer at base decrease in length towards apex, absent near the tip. Needle (Fig. 19 B) bifid, somewhat bayonet-shaped, 36.8-38.5 μ long, with nodulus distal (D : P : : 2.5 : 8.5) and minute teeth. Ventral setae (Fig. 19C, D, E) 4 per bundle, decreases to 3 and 2 posteriorly ; in II-V twice as long, less curved and more slender than rest, with proximal nodulus (D : P : : 15 : 10), 70-87.5 μ long, prongs equally thick, distal $1\frac{1}{2}$ times as long as proximal ; in others 36.8-43.8 μ long, with distal nodulus (D : P : : 5 : 7) distal prong thinner and shorter than proximal.

Branchial organ (Fig. 19 F) wider than preceding region, anterior margin convex and ciliated; posterior margin converging to a point and non-ciliated. Gills 2 pairs, digitiform, ciliated, anterior pair short and lateral ; posterior pair long and ventral, project far beyond fossa in expansion, anterior pair upwards and sideways, posterior pair slightly upwards and backwards.

Pharynx in II-III, wide with dorsal diverticulum eversible through mouth for feeding. Oesophagus in IV-VII, thin and sinuous. Stomach in VIII, fusiform. Intestine thin, bent in IX, wide and sacculated in succeeding segments ; anus in branchial fossa ; intestinal anti-peristalsis and ascending ciliary action occur. Chloragogues greenish

brown, start in VI. Septa thin and complete ; septal glands in IV and V, transparent. No coelomocytes.

Brain (Fig. 19 G) incised deeply in front and behind.

Blood yellowish. Dorsal vessel ventro-lateral mostly and mid-dorsal in head segments ; collects blood from gills and pumps forward. Ventral vessel non-contractile, mid-ventral, supplies blood to gills. Contractile lateral vessels 2 pairs in VI-VII.

First nephridium (Fig. 19 H) in VII, its nephrostome in VI ; post-septal with fusiform, brown, granular ampulla followed by a thin long, ciliated duct running obliquely to left side, bends over and passes to right, partly through gland tissue, forms a coiled mass before opening by nephridiopore in front of and slightly median to right ventral bundle.

Budding zone buds some hind segments and branchial organ to anterior zooid and prostomium and 5 anterior segments to posterior zooid before fission.

Clitellum from ½V-VII (2½ segments). Sexual cells present and gonads absent in sexually mature worms. Sperm-sac and ovi-sac extend to VIII and IX respectively, former within latter, when full. Atrial ampullae ovoid with thick ejaculatory ducts, opening in the position of ventral bundles of VI. Penial setae absent. Male and female funnels not observed. Spermathecae twice as long as broad, open in front of ventral setae of V.

l (p.) = 1.2-1.5 mm. ; d (p.) = 0.15 mm. ; s = 19-25 + short formative zone and branchial organ ; n = 14-17.

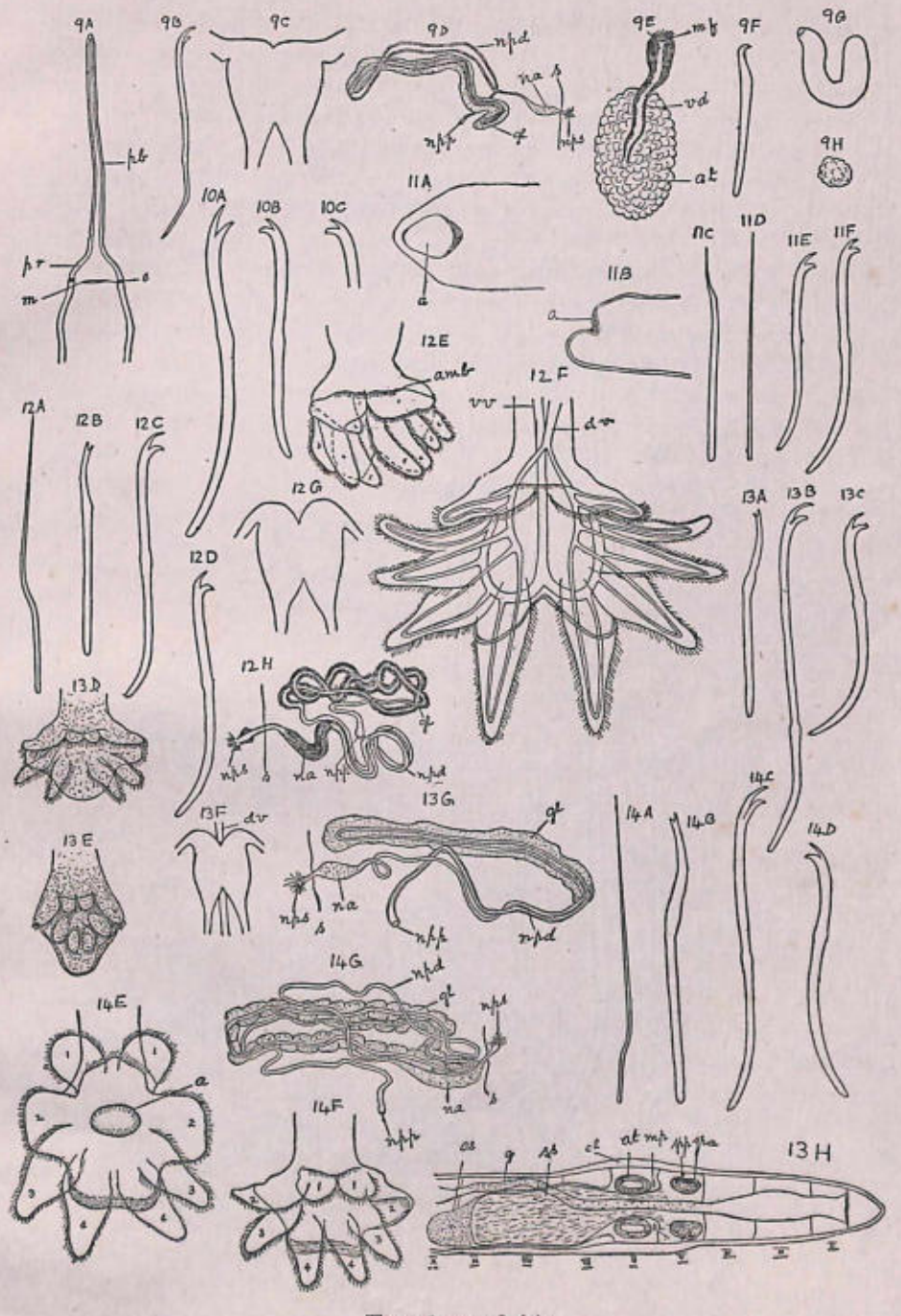
Length of setae in μ and position of nodulus in the ratio D : P : :

	II	III	IV	V	VI	VII	VIII	IX	X	XI
Hair	—	—	—	—	77	80.5	84	80.5	87.5	80.5
Needle	—	—	—	—	36.7 2.5:8	38.5 2.5:8.5	38.5 2.5:8.5	38.5 2.5:8.5	38.5 2.5:8.5	38.5 2.5:8.5
V. seta	87.5 15:10	84.0 15:9	80.5 14:9	77.0 13:9	— —	42.0 5:7	42.0 5:7	42.0 5:7	42.0 5:7	42.0 5:7
,,	80.5 14:9	77.0 14:8	73.5 13:8	70.0 12:8	— —	36.8 4:6.5	38.5 4:7	38.5 4:7	38.5 4:7	38.5 4:7

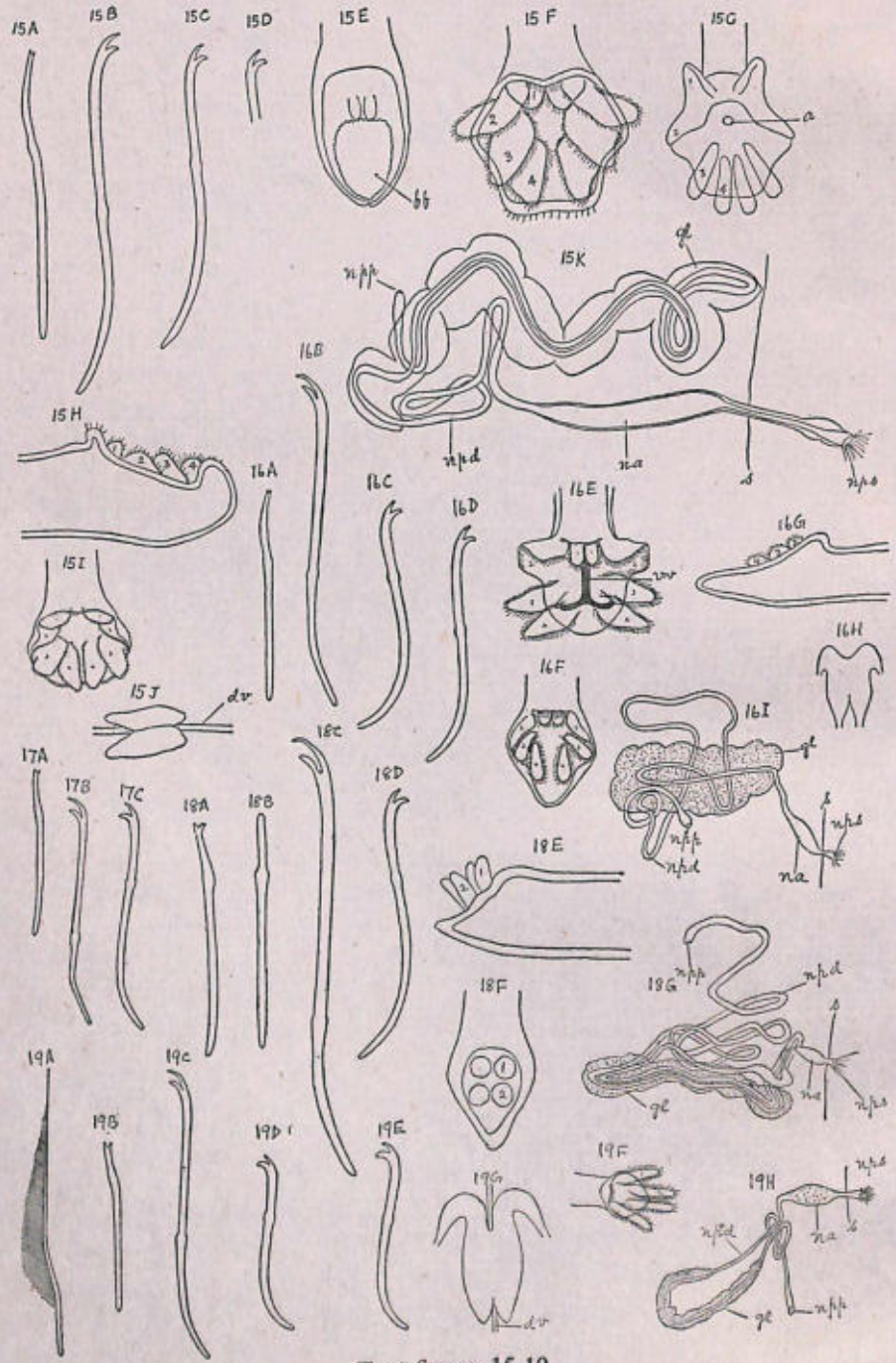
Type : The type specimen is being deposited with the Zoological Survey of India, Calcutta.

Habits : Live in transparent gelatinous tube covered with sand and mud, tubes fused parallel to one another. Swim by brisk serpentine movement resembling wriggling.

Taxonomic Discussion : This species very closely resembles *Dero pectinata* Aiyer. In having bifid needles it differs from the latter with trifid (pectinate needle, which character gives its specific name). This was first taken for *D. pectinata* because of the presence of



Text-figure 9-14
For explanations see p. 546.



Text-figure 15-19

For explanations see p. 546

peculiar plumose hairs, but its bifid needles in place of trifid needles made me examine several fresh setal preparations to make sure of the absence of trifid needles. In the original diagnosis and description (Aiyer, 1930) stray presence of bifid needles is not indicated, and here again no trifid needle is seen in these worms. Further the nodulus in needles is less distal (D : P : : 2.5 : 8.5) than in *D. pectinata* (D : P : : 2.5 : 11.5). Hence this is considered as a distinct species.

Diagnosis of Dero plumosa *sp. nov.*: No eyes. Prostomium bluntly triangular. Dorsal setae begin in VI, 1 plumose hair and 1 bifid needle per bundle. Ventral setae 2-4 per bundle, in II-V twice as long as those in others. Branchial organ with 2 pairs of digitiform gills. Stomach in VIII, fusiform. Septal glands 2 pairs in IV-V. Coelomocytes absent. Dorsal vessel ventrally attached to the left of gut. Contractile lateral vessels 2 pairs in VI-VII. First nephridium in VII. Five head segments budded during asexual reproduction. Clitellum from ½V-VII. Atrial ampulla ovoid with thick ejaculatory duct. Penial setae lacking. Spermathecae twice as long as broad.

(*To be continued*)

Explanations to Text-figures 9—14.

Fig. 9. *Stylaria fossularis* Leidy : A. Anterior end of the worm; B. Ventral seta of II × 160 ; C. Brain ; D. Nephridium ; E. Seminal funnel, vas deferens and atrium ; F. Penial seta × 330 ; G. Spermatheca ; H. Immature ovum. Fig. 10. *Haemonais waldvogeli* Bretscher : A. Needle seta × 540 ; B.-C. Ventral setae × 410 ; Fig. 11. *Branchiodrilus semperi* (Bourne) : A. Posterior end of the worm (dorsal view) ; B. Posterior end of the worm (lateral view) ; C. Needle seta of the posterior segment × 330 ; D. Needle seta of the anterior segment × 330 ; E. Ventral seta of II × 500 ; F. Ventral seta of XV × 500. Fig. 12. *Dero dorsalis* Ferroniére : A. Hair seta × 160 ; B. Needle seta × 330 ; C. Ventral seta of II × 330 ; D. Ventral seta of XVI × 330 ; E. Branchial organ (preserved) ; F. Branchial organ (relaxed) ; G. Brain ; H. Nephridium. Fig. 13. *Dero digitata* (Müller) : A. Needle seta × 530 ; B. Ventral seta of II × 530 ; C. Ventral seta of middle segment × 530 ; D. Branchial organ (relaxed) ; E. Branchial organ (contracted) ; F. Brain ; G. Nephridium ; H. Sexual organs. Fig. 14. *Dero indica* sp. nov. : A. Hair seta × 530 ; B. Needle seta × 530 ; C. Ventral seta of II × 530 ; D. Ventral seta of a posterior segment × 530 ; E. Branchial organ relaxed under cover glass ; F. Branchial organ (fully relaxed) ; G. Nephridium.

Explanations to Text-figures 15—19.

Fig. 15. *Dero zeylanica* Stephenson : A. Needle seta × 530 ; B. Ventral seta of II × 530 ; C. Ventral seta of VI × 530 ; D. Distal end of the ventral seta of the posterior segment × 530 ; E. Branchial organ of preserved worm ; F. Branchial organ moderately relaxed ; G. Branchial organ fully relaxed ; H. Branchial organ moderately relaxed (lateral view) ; I. Branchial organ (contracted) ; J. Brain ; K. Nephridium. Fig. 16. *Dero cooperi* Stephenson : A. Needle seta × 530 ; B. Ventral seta of II × 530 ; C and D. Ventral seta of middle and hind segments ; E. Branchial organ fully relaxed ; F. Branchial organ contracted ; G. Branchial organ moderately relaxed (lateral view) ; H. Brain ; I. Nephridium. Fig. 17. *Dero nivea* Aiyer : A. Needle seta × 560 ; B. Ventral seta of II × 460 ; C. Ventral seta of VI × 460. Fig. 18. *Dero sawayai* Marcus : A. Needle seta × 990 ; B. Needle seta (front view) × 990 ; C. Ventral seta of II × 1060 ; D. Ventral seta of the middle segment × 1060 ; E. Branchial organ moderately contracted ; F. Branchial organ relaxed (lateral view) ; G. Nephridium. Fig. 19. *Dero plumosa* sp. nov : A. Hair seta × 500 ; B. Needle seta × 660 ; C. Ventral seta of II × 500 ; D and E. Ventral setae of VII × 660 ; F. Branchial organ fully relaxed ; G. Brain ; H. Nephridium.

a : anus ; amb : anterior margin of branchial fossa ; at : atrial ampulla ; bf : branchial fossa ; cl : clitellum ; dv : dorsal gill ; e : eye ; g : gut ; gl : gland ; m : mouth ; mf : male funnel ; mp : male pore ; na : nephridial ampulla ; nd : nephridial duct ; npp : nephridiopore ; nps : nephrostome ; os : ovi-sac ; pb : proboscis ; pr : prostomium ; s : septum ; spa : spermathecal ampulla ; spp : spermathecal pore ; ss : sperm-sac ; vd : vas deferens ; vn : ventral nerve ; 1 : I pair of gills ; 2 : II pair of gills ; 3 : III pair of gills ; 4 : IV pair of gills.

A Revision of Indian Mugilidae

PART II

BY

SAROJINI R. PILLAY

Central Inland Fisheries Research Institute, Calcutta

(With two plates)

[*Continued from Vol.* **59** (1): 270]

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Genus **Mugil** Linnaeus

Mugil Linnaeus, Syst. Nat., ed. 10, vol. **1**, p. 316, 1758 (genotype, *Mugil cephalus* Linnaeus) (European Ocean).

Cephalus Lacépède, *Hist. Nat. Poiss.* **2**, p. [illegible] 1800, new name on Plumier M.S. (genotype, *Mugil cephalus* Linnaeus).

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Ello Gistel, Handbuch der naturgeschichte fur alle Stande, p. 356, 1850 (1847), and Naturgeschichte des Thierreichs, p. 109, 1848 (considered a synonym of *Mugil* Linnaeus by Whitley, *Austr. Zool.* **6**, (3), p. 251, 1930).

Liza Jordan & Swain, *Proc. U.S. Nat. Mus.* **7**, pp. 261 and 262 (1884), 1885. (genotype, *Mugil capito* Cuvier) (Mediterranean and seas of Europe).

Ellochelon Whitley, *Australian Zool.* **6**, pt. 3, p. 251, 1930 (genotype, *Mugil vaigiensis* Quoy & Gaimard) (Waigiou).

Valamugil Smith, *Ann. Mag. Nat. Hist.*, series 11, **14**, p. 841. (1947) 1948.

No spine on opercle; lips terminal and without fleshy lobes and papillae; nostrils in level with upper rim of orbit or slightly above

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Valamugil Smith, *Ann. Mag. Nat. Hist.*, series 11, **14**, p. 841. (1947) 1948.

No spine on opercle; lips terminal and without fleshy lobes and papillae; nostrils in level with upper rim of orbit or slightly above

it. Symphysial knob present. Teeth present or absent on lips and when present may be distinct or embedded. Pre-orbital with or without slight notch on the anterior edge. Mouth protrusible.

KEY TO THE SPECIES OF THE GENUS *Mugil*

1.	Symphysial knob single	...	*M. carinatus* Valenciennes
	Symphysial knob double	... 2	
2.	End of maxilla visible when mouth is closed	... 3	
	End of maxilla not visible when mouth is closed	... 5	
3.	Breadth of upper lip greater than distance between nostrils	...	*M. macrolepis* Aguas
	Breadth of upper lip not greater than distance between nostrils	... 4	
4.	A notch present on the ventral aspect of the lower lip just below the symphysial knob	...	*M. parsia* Hamilton
	Notch absent on the ventral aspect of the lower lip below the symphysial knob	...	*M. tade* Forskål
5.	Pre-orbital reaching beyond angle of mouth	... 6	
	Pre-orbital not reaching beyond angle of mouth	...	*M. cephalus* Linnaeus
6.	Elongated pointed scale present in axil of pectoral	... 7	
	Elongated pointed scale not present in axil of pectoral	...	*M. vaigiensis* Quoy & Gaimard
7.	Teeth present on lip	...	*M. cunnesius* Valenciennes
	Teeth absent on lip	...	*M. seheli* Forskål

(1) **Mugil carinatus** (Ehr.) Valenciennes

Mugil carinatus (Ehr.). Valenciennes (in Cuvier & Valenciennes), *Hist. Nat. Poiss.* **11**, p. 148, 1836 (Red Sea). Day, *Fish. India* p. 349, 800, 1876-1888 (Malabar; Bombay); *Fauna Brit. India, Fishes* **2**, p. 344, 1889 (W. coast of India).

Mugil klunzingeri Day, *Proc. Zool. Soc. London*, p. 264, 1870 (Bombay); *Fish. India* (*Supplement*) p. 800, 1888 (Bombay); *Fauna Brit. India, Fishes* **2**, p. 343, 1889 (Seas of India).

D. IV, 1 + 8; A. III + 9; V. I + 5; P. 14—15; C. 14—16; L. l. 30—34; L. tr. $10\frac{1}{2}$—$11\frac{1}{2}$.

Head either equal to height of body or greater. Head higher than broad. Snout higher than long and broader than high. Diameter of

orbit less than length of snout or occasionally equal to it. Inter-orbital distance greater than diameter of orbit. Insertion of D_1 nearer base of caudal than to tip of snout. Origin of pelvic fins nearer origin of anal than to tip of snout. Length of caudal peduncle greater than width of head, but less than height of head. Least height of caudal peduncle less than width of head. First spine of D_1 longer than the second spine. Insertion of pectoral fin in middle of body or sometimes slightly above middle. Caudal fork not very deep.

Proportionate measurements: vide Appendix B.

Scales: 30-34 on the longitudinal and 10-12 on the transverse series. 22-25 pre-dorsal scales. No elongated scale in axil of pectoral. Bases of all fins except D_1 covered with scales. Scales on body cycloid in young, ctenoid in adults.

Orientation of fins: Insertion of D_1 above 9th-11th, of D_2 above 20th-21st, and of anal below 19th-20th scale of the longitudinal series. Pelvic fins inserted below 5th-7th scale and reaching to the 11th-13th scale and the pectoral fins reach to the 9th-11th L.l. scale.

Upper lip somewhat thick and forms tip of snout and part of dorsal profile. This lip bears a single row of teeth. Lower lip very thin. Pre-orbital hardly bent, is serrated and tapering to a point at the extremity. Nostrils in level with the upper rim of orbit, the posterior more than twice as big as the anterior. They are closer to each other than the anterior is to the upper lip or the posterior to the orbit. The posterior nostril is closer to the orbit than the anterior is to the upper lip. Symphysial knob single. Adipose eyelid present, often equally developed anteriorly and posteriorly; but sometimes better developed posteriorly. End of maxilla visible when mouth is closed.

Colour: Greenish grey dorsally, silvery on the sides and below. Dorsal, caudal and pectoral fins with fine black spots on their basal halves.

Material: 1 specimen from Bombay Z.S.I. No. 1407 (Day's original of pl. 74, Fig. 2, FISH. INDIA); 2 specimens from Sind—Z.S.I. Nos. 1398 & 1399 (from Day's collections); 2 specimens from Karachi—Z.S.I. Nos. 1810/1 & 1825/1 (from the collections of W. D. Cumming).

Remarks: Valenciennes (Cuvier & Valenciennes, 1836) described Ehrenberg's type specimen as having a very much depressed snout, the suborbital notched and produced into a strong spine or keel on each corner of mouth, maxillary visible, dorsal sufficiently sharp,

fins small and scaly and the caudal slightly forked. According to him the scales have small elevations which form 3 or 4 raised keeled lines on each side of the body. Day (1888 and 1889) while describing this species from Indian waters did not mention about the keeled lines on the body, but remarked that the middorsal row of scales immediately in advance of the first dorsal fin are raised to form a keel 'for some little distance'. This particular character is evident in the original specimen described by him (and featured in pl. 74, fig. 2 of the FISHES OF INDIA), which is available in the collections of the Zoological Survey of India, but is absent in two other specimens, also from Day's collections, that are available in the Zoological Survey of India collections. Moreover, the original distinguishing characters given by Valenciennes, viz. the presence of keeled lines on the sides of the body and the pre-orbital 'produced to a spine' have not been commented upon by Day. However, Day's original specimen agrees with the descriptions of Valenciennes, except that there is no evidence of the keeled lines on the sides.

M. klunzingeri Day appears to be only an exceptionally broad specimen of *M. carinatus* Valenciennes. Day's description of this species agrees fully with his own description of *M. carinatus* except in the proportionate height of body. Only one specimen of *M. klunzingeri* was available to the present author for comparison. This specimen agrees in all respects with Day's original specimen of *M. carinatus*. Unfortunately, however, it has not been possible to compare the relative height of body of the two species, since all Day's specimens of *M. carinatus* and the specimen of *M. klunzingeri* had the abdomen slit for preservation. Since the viscera had been removed, the edges of the body wall had curled in and it was found impossible to measure the body height of these specimens. In respect of all the other characters complete agreement is present between the two species and so they have been considered synonymous. It is of interest that Day himself first described his *M. klunzingeri* under *M. carinatus* Valenciennes.

Distribution: Type locality: Red Sea. In the Indian sub-continent, the species has so far been recorded only from Bombay and Malabar on the west coast of India and from Karachi in Sind, West Pakistan. Outside the sub-continent, it has been recorded only from the Red Sea. This is not a common species in any of these areas.

(2) **Mugil macrolepis** (Smith) Aguas

Mugil macrolepis Smith, *Illustr. Zool. S. Africa* **4**, pl. 28, fig. 2, 1849 (S. Africa); Roxas, *Philipp. J. Sci.* **54**, p. 415, pl. 1, 1934 (Mangarin, Mindoro, Philippines).

Mugil borneensis Bleeker, *Nat. Tijds. Ned.-Ind.* **2**, p. 201, 1851 (East Indies); Day, *Fish. India*, p. 357, 1878-'88 (Seas of India); *Fauna Brit. India, Fishes* **2**, p. 353, 1889 (Seas of India—Madras, Calcutta).

Mugil adustus Bleeker, *Nat. Tijds. Ned.-Ind.* **5**, p. 503, 1853 (East Indies).

Mugil Troschelii Bleeker, *Nat. Tijds. Ned.-Ind.* **16**, p. 277, 1858-59 (Java).

Mugil troschelii Günther, *Cat. Fish. Brit. Mus.* **3**, p. 448, 1861 (Ceylon; Borneo); Day, *Fauna Brit. India, Fishes* **2**, p. 355, 1889 (Seas of India).

Mugil poicilus Day, *Proc. Zool. Soc. London*, p. 33, 1865; *Fish. Malabar*, p. 140, 1865 (Cochin); *Fish. India*, p. 351, 1878-1888 (Bombay).

Mugil cunnamboo Day, *Fish. Malabar*, p. 141, 1865 (Malabar).

Mugil troschellii Day, *Fish. India*, p. 358, 1888 (Malabar).

Mugil poecilus Day, *Fauna Brit. India, Fishes* **2**, p. 345, 1889 (Bombay & West Coast of India).

Liza troscheli Jordan & Seale, *Bull. U.S. Bur. Fish.* **25**, p. 217, 1906 (Apia & Pago Pago, Samoa).

Liza borneensis Kendall & Goldsborough, *Mem. Mus. Comp. Zool. Harv.* **26**, p. 258, 1911 (Pacific); Herre, *Mem. Indian Mus.* **13**, p. 347, 1941 (Andamans); Devasundaram, *J. Zool. Soc. India* **3**, p. 24, 1951 (Chilka Lake).

Liza troschelli Whitehouse, *Madras Fish. Bull.* **15**, p. 89, 1922 (Tuticorin); Devasundaram, *J. Zool. Soc. India* **3**, p. 24, 1961 (Chilka Lake).

Mugil troscheli, Weber & de Beaufort, *Fish. Indo-Austr. Archipelago* **4**, p. 248, 1922 (East Indies); Pillay, *J. Bombay nat. Hist. Soc.* **51**, p. 382, 1953 (Cochin & Ennore backwaters).

Liza macrolepis, Herre, 1940-'41 Exped. (the Philippines); *Mem. Indian Mus.* **13**, p. 347, 1941 (Andamans).

D. IV. 1 + 8 ; A. III + 9 ; V. 1 + 5 ; P. 14—16 ; C. 14 ; L. l. 28—33 ; L. tr. 9—11.

Length of head usually equal to and sometimes greater than height of body. Head as broad as high, or sometimes broader than high. Snout broader than high and higher than long. Diameter of orbit half or more of the inter-orbital distance. Insertion of D_1 usually nearer base of caudal than to tip of snout; but occasionally in large specimens, is midway between the two. Origin of pelvic fins nearer origin of anal than to tip of snout. Length of caudal peduncle equal to the height and width of head, or occasionally slightly greater. Least height of caudal peduncle usually less than height and width of head; but sometimes equal to these. The 1st spine of D_1 longer than the 2nd. Insertion of pectoral varying, sometimes slightly below or above middle of body. Caudal fork not very deep.

Proportionate measurements: vide Appendix B.

Scales: 28-33 on the longitudinal and 9-11 on the transverse series. 18-21 pre-dorsal scales. No elongated scale in axil of pectoral.

The bases of all fins except D_1 covered with minute scales. Scales on body are cycloid in young and ctenoid in adults.

Orientation of fins: Insertion of D_1 above the 10th-11th, of D_2 above the 20th-23rd, and of anal below the 18th-21st scale of the longitudinal series. The pelvic fins inserted below the 4th-6th reach to the 11th-13th scales, and the pectorals reach to the 8th-11th L.l. scales.

Upper lip somewhat thick, has minute teeth and forms tip of snout, but does not form part of the dorsal profile. Lower lip very thin. Pre-orbital bent and serrated on both anterior and ventral margins. Nostrils above dorsal rim of orbit, the posterior much larger than the anterior. The distance between the two is less than that of the anterior from the upper lip and of the posterior from the orbit, both of which are equal. Symphysial knob double. End of maxilla visible when mouth is closed. Adipose eyelids present.

Colour: Olivaceous-grey on back, silvery on the sides. Fins grey, the ventral fins whitish.

Material: 2 specimens labelled *M. borneensis* from Day's collections, Z.S.I. No. 1412 (from Calcutta) and Z.S.I. No. 1416 (from Madras); one specimen Z.S.I. No. 1423 from Bombay (*M. poecilus*, Day's original of pl. LXXV, fig. 4, 1888).

2 specimens from the Chilka Lake, Z.S.I. No. F. 9471/1 (labelled *M. borneensis*) and F. 9472/1 (labelled *M. troschelii*), Chilka Survey collections; 1 specimen from S. Andaman, Z.S.I. No. F. 72/2 (*M. troschelii* from H. S. Rao's collection).

22 freshly preserved specimens, collected from Ennore (Madras) and 12 from Cochin.

Remarks: In Day's (1878 and 1889) descriptions of the Indian species of *Mugil* there are three species, *M. borneensis* Bleeker, *M. troschelii* Bleeker, and *M. poecilus* Day, which are merged here and considered synonymous with *M. macrolepis* A. Smith.

Pillay (1953) has shown that *M. poecilus* Day is not in any way different from *M. troschelii* Bleeker. The only significant distinguishing character given by Day was the presence of round black spots on the scales of *M. poecilus* Day. These spots were found by Pillay (1953) to be only groups of growing algae. Day's *M. poecilus* could not, therefore, be held valid and had to be merged with *M. troschelii* Bleeker.

Several authors have noticed marked similarity between *M. borneensis* Bleeker, and *M. troschelii* Bleeker. Jordan & Seale (1905) considered the two synonymous and described the specimen under

the name *Liza troscheli*. Whitehouse (1922) found it very difficult to refer his specimens (collected from Tuticorin) to either of the two species, as they answered to the descriptions of both. However, he also finally described them under the name *Liza troschelli*. Roxas (1934) has found *M. troscheli*, and *M. borneensis* to be synonymous with *M. macrolepis* A. Smith. In view of the above, the species described from Indian waters as *M. troscheli*, and *M. borneensis* are to be considered synonymous with *M. macrolepis*, the latter name getting the priority[1].

Distribution: Type locality: S. Africa. In India the species is distributed from Kathiawar on the western coast, down the coasts of Bombay, Malabar, Travancore-Cochin, and round to Gulf of Mannar and up the east coast of Madras to Chilka Lake; also in the sea around Andaman Islands. The species does not occur in Bengal waters.

The distribution of this species extends from the east coast of Africa and Madagascar to China, Japan, and the Marshall and Tuamotu islands through Ceylon, the East Indies, and Philippines.

The maximum size of this species recorded is 28 cm.

(3) **Mugil parsia** Hamilton

Mugil parsia Hamilton, *Fish. Ganges*, p. 215, pl. 17, fig. 71, 1822 (River Hooghly); Day, *Fish. Malabar*, p. 142, 1865 (Malabar); *Fish. India*, p. 350, pl. LXXV, fig. 2, 1878-1888 (Hooghly, Calcutta); *Fauna Brit. India, Fishes* **2**, p. 344, 1889 (Seas & estuaries of India); Pillay, *Proc. nat. Inst. Sci. India* **17**, p. 414, 420, 1951 (W. Bengal); Sarojini, *Proc. nat. Inst. Sci. India* **19**, p. 437-445, 1953 (Hooghly, Sundarbans, Midnapore coast, Visakhapatnam).

Mugil dussumieri Cuvier & Valenciennes, *Hist. Nat. Poiss.* **11**, p. 147, 1836 (Coromandel coast & Bombay); Day, *Proc. Zool. Soc. Lond.*, p. 352, pl. 74, fig. 4, 1870; *Fish. India*, p. 352, pl. LXXIV, fig. 4, 1878-1888; (Hooghly, Calcutta); *Fauna Brit. India, Fishes* **2**, p. 347, 1889 (Seas, estuaries & rivers of India); Herre, *Mem. Indian Mus.* **13**, p. 348, 1941 (Andamans).

Mugil subviridis Cuvier & Valenciennes, *Hist. Nat. Poiss.* **11**, p. 115, 1836 (Ganges); Günther, *Catal. Brit. Mus.* **3**, p. 423, 1861 (Coast of Malabar, Madras); Day, *Fish. Malabar*, p. 138, 1865; *Fish. India*, p. 353, 1878-1888; *Fauna Brit. India, Fishes* **2**, p. 348, 1889; Hora, *Mem. Indian Mus.* **5**(2), p. 766, 1923 (Chilka Lake); Devasundaram, *J. Zool. Soc. India* **3**, p. 23, 1951 (Chilka Lake).

Mugil macrolepis Bleeker, *Nat. Tijds. Ned.-Ind.* **3**, p. 422, 1852 (Borneo) (nec. Smith) (name preoccupied).

Mugil cantoris Bleeker, *Verh. Batavia Genoot.* **25**, p. 100, 1853 (River Hooghly, Calcutta).

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[1] John (1955) has attempted to retain *M. borneensis* and *M. troscheli* as separate species. But as seen from the discussions here, the distinctions drawn by her are based on extremely unstable characters.

Mugil sundanensis Bleeker, *Nat. Tijds. Ned.-Ind.* **4**, p. 265, 1853 (Sumatra); Day, *Fish. Malabar*, p. 138, 1865 (Sea of Malabar).

Mugil oligolepis, Bleeker, *Nat. Tijds. Ned.-Ind.* **16**, p. 275, 1858 (Batavia); Day, *Fish. India*, p. 358, 1878-1888 (Sundarbans); *Fauna Brit. India, Fishes* **2**, p. 355, 1889.

Mugil valenciennesii Bleeker, *Nat. Tijds. Ned.-Ind.* **16**, p. 277, 1858-1859 (East Indian Archipelago).

Mugil nepalensis Günther, Cat. Brit. Mus. **3**, p. 424, 1861 (Nepal).

Mugil compressus Günther, *Cat. Brit. Mus.* **3**, p. 451, 1861 (New South Wales).

Mugil meyeri Günther, Ann. Mag. Nat. Hist. **9**, p. 439, 1872 (Luzon; Celebes).

Mugil olivaceus Day, *Fish. India*, p. 357, 1878-1888; *Fauna Brit. India, Fishes* **2**, p. 354, 1889 (Sea & rivers of India).

Mugil jerdoni Day, *Fish. India*, p. 352, 1878-1888 (Malabar); *Fauna Brit. India, Fishes* **2**, p. 347. 1889 (Sea of India); Whitehouse, *Madras Fish. Bull.* **15**, p. 84, 1922 (Tuticorin); Hora, *Mem. Indian Mus.* **5**(2), p. 766, 1923 (Chilka Lake); Devasundaram, *J. Zool. Soc. India* **3**, p. 23, 1951 (Chilka Lake).

Liza compressa Jordan & Seale, *Bull. U.S. Bur. Fish.* **25**, p. 218, 1906 (Samoa).

Liza oligolepis, Jordan & Richardson, *Bull. U.S. Bur. Fish.* **27**, p. 244, 1908 (Panay).

Mugil stevensi Ogilby, *Ann. Qd. Mus.* **9**, p. 17, 1908 (Gold Is., Queensland).

Mugil tadopsis Ogilby, *Ann. Qd. Mus.* **9**, p. 27, 1908 (Moreton Bay).

Liza dussumieri Thomson, *Austr. J. Mar. Freshw. Res.* **5**, p. 97, 1954 (Madras; Ellice Is.; New Guinea; Papua).

D. IV. 1+8 ; A. III+9 ; V. 1+5 ; P. 15—16 ; C. 14 ; L. l. 29—23 ; L. tr. 9—11.

Length of head greater than height of body. Head as broad as high or sometimes broader than high. Length of snout less than its height. Snout broader than high. Diameter of orbit equal to or slightly less or greater than the length of snout. Inter-orbital distance greater than diameter of orbit. Insertion of D_1 in relation to tip of snout and base of caudal varying. Origin of pelvic fins nearer origin of anal than to tip of snout. Least height of caudal peduncle less than the height and width of head; but the length of caudal peduncle in relation to these measurements is varying. 1st spine of D_1 longer than 2nd. Insertion of pectoral in middle of body or slightly above middle. Caudal fork not very deep.

Proportionate measurements: vide Appendix B.

Scales: 29-32 on the longitudinal and 9-11 on the transverse series. 18-21 pre-dorsal scales. No elongated pointed scale in axil of pectoral. Bases of all fins except D_1 covered with minute scales. Scales on body cycloid in young and ctenoid in adults.

Orientation of fins: Insertion of D_1 above 9th-11th, of D_2 above 18th-21st and of anal below 17th-20th L.l. scale. Pelvic fins inserted

below 4th-5th and reach to the 11th-13th scale of the longitudinal series. Pectoral reaches to the 7th-8th scale in this series.

Upper lip somewhat thick with a single row of teeth and forming tip of snout, but only a very insignificant part of the dorsal profile. Lower lip thin and with rounded granulations on the inner aspect. Pre-orbital bent and is serrated on the anterior and ventral margins. Anterior nostril below dorsal margin of orbit but the posterior nostril is in line with it; posterior nostril larger than the anterior and the distance between the two is almost equal to that of the anterior from the upper lip and the posterior from the orbit. Symphysial knob double. Adipose eyelid present, broader posteriorly than anteriorly. End of maxilla visible when mouth is closed.

Colour: Brownish grey dorsally with a tinge of green posteriorly. The sides silvery becoming silvery white ventrally. Large-sized specimens caught from the sea usually have a few faint stripes along the longitudinal row of scales on the upper half of body. These stripes are not evident on small-sized fish or on fish caught from less saline waters. Fins greyish white. Margin of caudal dark.

Material: The following have been studied from the named collections in the Zoological Survey of India: *M. parsia:* 1396, F. Day (Calcutta); F. 1436/1 and F. 1437/1, I. H. Burkill (Akyab, Burma); *M. dussumieri:* 1413, F. Day (Bombay); 1414 and 1415, F. Day (Madras); 1417, F. Day, original of pl. 74, fig. 4, of FISHES OF INDIA, 1878 (Madras); *M. oligolepis:* 2143, F. Day, original of pl. 69, fig. 2 of FISHES OF INDIA, 1898 (Sundarbans, Bengal); *M. jerdoni:* 1404 and 1405, F. Day (Madras); F. 9474/1 and F. 9475/1, Chilka Survey (Chilka Lake); unnumbered specimen, N. P. Panikkar (Travancore); *M. olivaceus:* 2142, Day, original of pl. 76, fig. 1 of FISHES OF INDIA, 1878.

Specimens of *M. subviridis* were not available in the collections of the Zoological Survey. Over one hundred specimens of *M. parsia* collected from Bengal waters and from the Coromandel coast and a few specimens of *M. subviridis* obtained from Chilka have been studied.

Remarks: The synonymy of *M. dussumieri* Valenciennes with *M. parsia* Hamilton has been discussed in detail in the earlier paper (Sarojini, 1953). From the present study it is seen that *M. subviridis* Valenciennes, *M. oligolepis* Bleeker, *M. jerdoni* Day, and *M. olivaceus* Day are all to be considered synonymous with *M. parsia* Hamilton.

The original descriptions of *M. subviridis* by Valenciennes (Cuvier & Valenciennes, 1836) are of a highly superficial nature. Though

the type specimen described was from the Malabar coast, he had also obtained specimens from the Ganges and from Pondicherry on the East Coast. Day's subsequent descriptions of the species (Day, 1888 and 1889) show clearly that he considered this species to be very similar to *M. dussumieri* Valenciennes. John's (1955) recent diagnosis of this species appears to be defective in the number of soft rays in the anal fin, the presence of an axillary scale and the number of L.l. scales.

It has not been possible for the author to examine the type specimen or holotypes of *M. oligolepis* Bleeker. But, the original specimen described by Day as *M. oligolepis* Bleeker (collected from the Sundarbans) is available in the collections of the Zoological Survey of India. Examination of this specimen and Day's descriptions (Day, 1888 & 1889) strongly indicate that this species should be considered synonymous with *M. parsia* Hamilton. The slight variations evident in the descriptions fall well within the range of variations normally seen in *M. parsia.*

M. jerdoni, and *M. olivaceus* both of which were first described by Day, do not show any significant differences from his own descriptions of the other allied species which form synonyms of *M. parsia* Hamilton. The examination of the type specimen of *M. olivaceus* in the collections of the Zoological Survey of India has confirmed that it cannot be considered a separate species. Two specimens of *M. jerdoni* collected by Day from Madras, were also available for comparison.

The morphometry of these various species are presented in Table I (p. 574).

Distribution: In India *M. parsia* is a common species, distributed on the west coast south of Bombay and all along the east coast, entering tidal rivers and estuaries. It is the commonest mullet in Bengal waters. It has been recorded from the Andamans also.

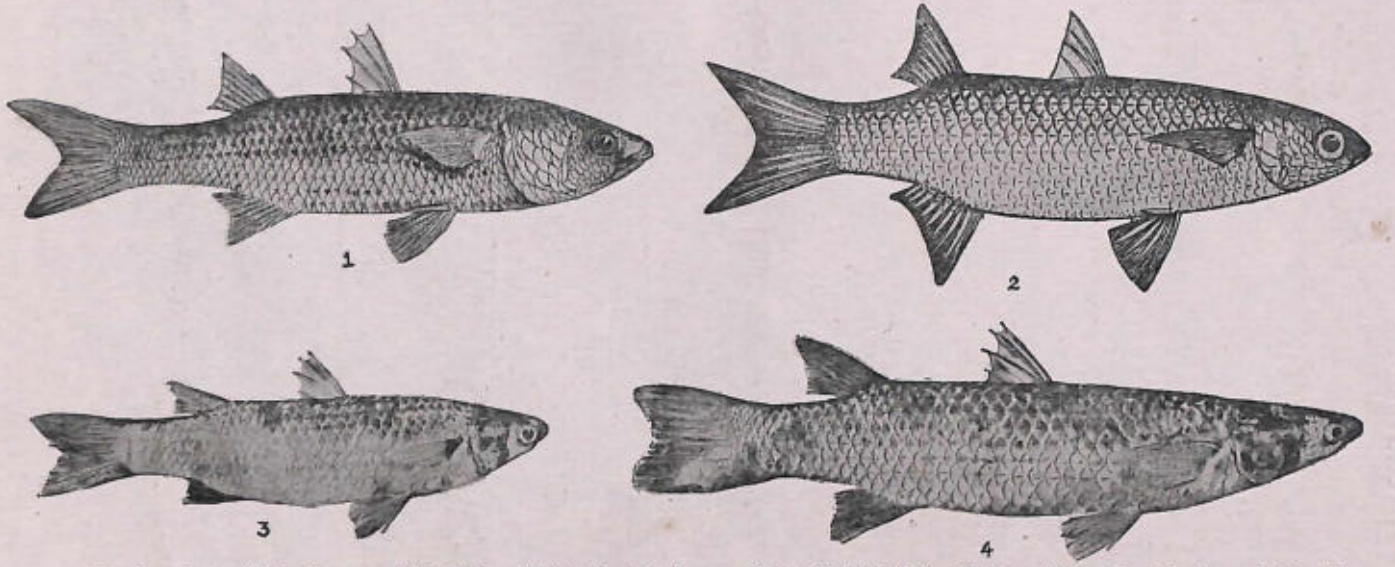
Outside India its distribution is restricted to the Indo-Pacific area, where it occurs in the sea and brackish waters in Indonesia, Philippines, Thailand, Hong Kong, New Guinea, Guam, Australia, Ceylon, and Karachi.

The maximum size attained by this species is about 33 cm.

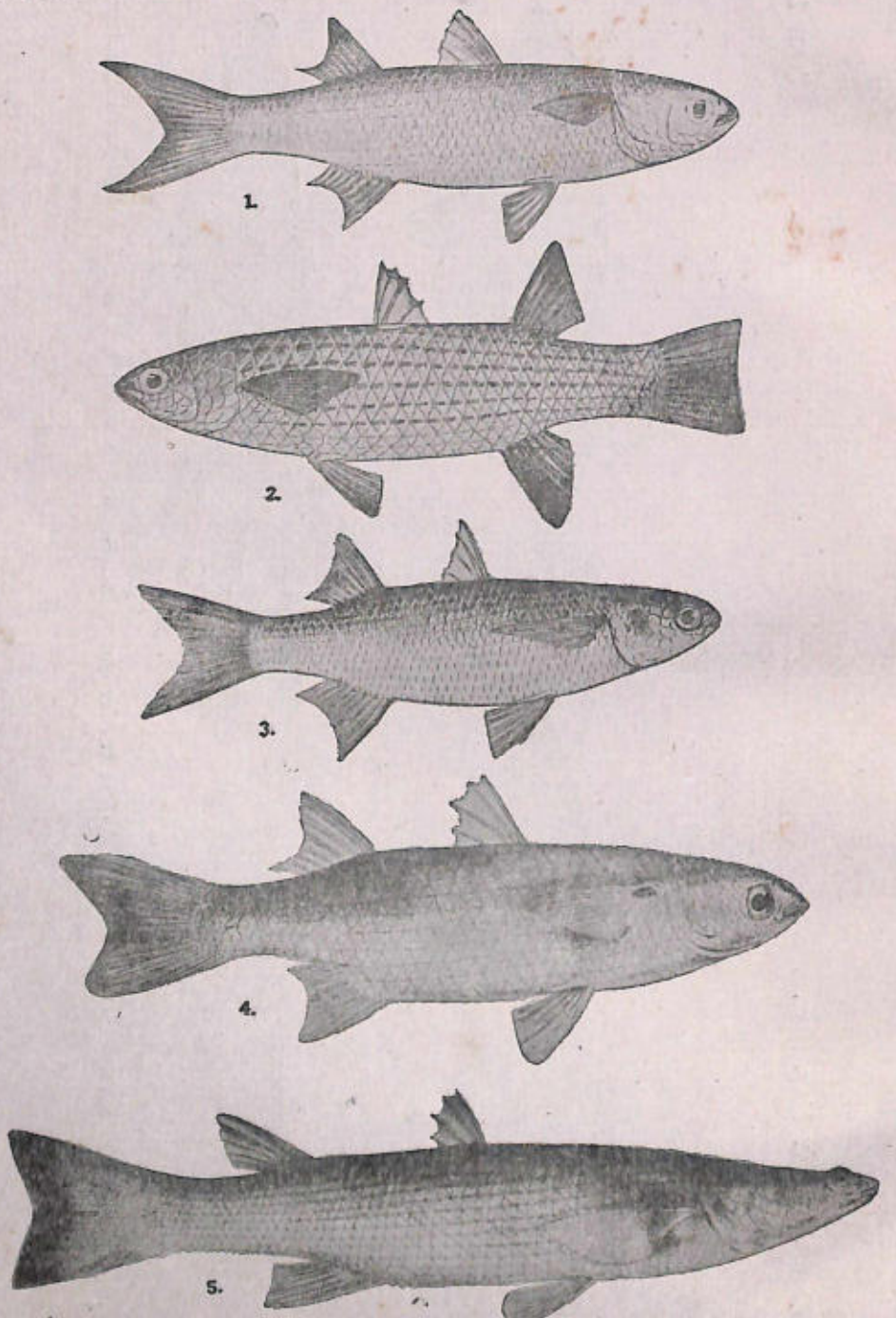
(4) **Mugil tade** Forskål

Mugil crenilabris tade Forskål, *Descript. anim.* **14**, p. 74, 1775 (Arabia).

Mugil tade Cuvier & Valenciennes, *Hist. Nat. Poiss.* **11**, p. 114, 1836 (Red Sea); Day, *Fish. India (Supplement)*, p. 350, 1888; *Fauna Brit. India, Fishes* **2**, p. 344, 1889 (Hooghly, Calcutta); Herre, *Mem. Indian Mus.* **13**, p. 348, 1941



1. *Mugil carinatus* Valenciennnes (After Day, 1878) ; 2. *Mugil macrolepis* A. Smith (After Smith, 1949); 3. *Mugil parsia* Hamilton; 4. *Mugil tade* Forskål



1. *Mugil cephalus* Linnaeus (After Smith, 1949) ; 2. *Mugil vaigiensis* Quoy & Gaimard (After Smith, 1949) ; 3 *Mugil seheli* Forskål (After Smith, 1949) ; 4. *Mugil cunnesius* Valenciennes (After Day, 1878) ; 5. *Rhinomugil corsula* (Hamilton) (After Day, 1878)

(Andamans); Devasundaram, *J. Zool. Soc. India* **3**, p. 21, 1951 (Chilka Lake); Pillay, *Proc. nat. Inst. Sci. India* **17**, p. 414, 419, 1951 (W. Bengal); ibid. **20**, p. 189, 1954 (Sea coast & estuaries of W. Bengal).

Mugil planiceps, Cuvier & Valenciennes, *Hist. Nat. Poiss.* **11**, p. 122, 1836 (Calcutta); Bleeker, *Verh. Batavia Gen.* **25**, p. 101, 1853 (Bengal); Günther, *Catal. Brit. Mus.* **3**, p. 428, 1861 (Calcutta; Ceylon; Penang; China); Day, *Fish. India*, p. 350, 1878 (Hooghly, Calcutta); Whitehouse, *Madr. Fish. Bull.* **15**, p. 82, 1922 (Tuticorin).

Mugil cephalotus Cantor (nec. Cuv. & Val.), *J. Asiat. Soc. Bengal* **18**, p. 1077, 1850 (Penang).

Mugil bontah Bleeker, *Nat. Tijds. Ned.-Ind.* **13**, p. 336, 1857 (Java).

Mugil belanak Bleeker, *Nat. Tijds. Ned.-Ind.* **13**, p. 337, 1857 (Java); Day, *Fish. India*, p. 351, 1878-1888; *Fauna Brit. India, Fishes* **2**, p. 345, 1889 (Bombay).

D. IV. I + 8 ; A. III + 9 ; V. I + 5 ; P. 15—17 ; C. 14—15 ; L. l. 30—35 ; L. tr. 10—11.

Length of head greater than height of body. Head broader than high. Snout conspicuously compressed, broader than long and longer than high. Diameter of orbit less than length of snout, but equal to it in young ones. Inter-orbital distance conspicuously greater than diameter of orbit. Insertion of D_1 nearer base of caudal than to tip of snout. Origin of pelvic fins nearer origin of anal than to tip of snout. Length of caudal peduncle about equal to width of head or sometimes slightly greater. Least height of caudal peduncle less than height of head. First two spines of D_1 usually of equal length, second spine being sometimes shorter. Insertion of pectoral slightly below middle of body. Caudal fork not deep.

Proportionate measurements: vide Appendix B.

Scales: 30-35 on the longitudinal and 10-11 on the transverse series. 18-19 pre-dorsal scales. There is only a short blunt scale in the axil of pectoral. Bases of all fins except D_1 covered with minute scales. Scales on body cycloid in young and ctenoid in adults.

Orientation of fins: Insertion of D_1 above the 10th-12th, of D_2 above the 20th-23rd, and of anal below the 19th-22nd L.l. scale. The pelvic fins are inserted below the 5th-6th and extend up to the 12th-13th L.l. scale. The pectoral reaches the 8th-9th scale of the longitudinal series.

Upper lip somewhat thick and forms the tip of snout and to a slight extent, part of dorsal profile. It has a single row of teeth. Lower lip thin and with granulations on the inner aspect. Pre-orbital very slightly bent at the extremity and is serrated on the anterior and ventral edges. Nostrils above upper rim of orbit, the posterior larger than the anterior. The distance that separates them is equal

to that of the anterior from the upper lip and greater than of the posterior from the orbit. Symphysial knob double. Adipose eyelid present, broader posteriorly than anteriorly. End of maxilla visible when mouth is closed. Not more than $\frac{1}{4}$ of eye forms part of dorsal profile.

Colour: Olivaceous above, silvery below, with 5-7 indistinct longitudinal marks on the upper half of body. Caudal fin edged with black, other fins light. Coloration is subject to slight variation in different environments. The stripes on the body are not evident in young specimens.

Material: From the collections in the Zoological Survey of India: *M. planiceps:* Dept. Cat. 189, F. Day (Calcutta); 2147, F. Day (Calcutta); *M. belanak:* 8440/1, Annandale (Chilka).

Large number of specimens of *M. tade* from the sea and estuaries of Bengal have also been studied.

Remarks: Day (1889) and Pillay (1951) have commented on the identity of *M. planiceps* Bleeker with *M. tade* Forskål. The present study confirms that the two are synonymous. Weber & de Beaufort have considered *M. belanak* Bleeker as a synonym of *M. tade* Forskål. One specimen in the collections of the Zoological Survey of India, labelled *M. belanak*, comes well within the range of variations observed in *M. tade* Forskål.

Distribution: Type locality: Arabia. In India this is one of the economically important species, more so on the east coast than on the west. It occurs on the Bombay and the Malabar coasts, but is not very common in the backwaters of Travancore. On the east coast, however, the species occurs in large numbers all along the coastline, entering estuaries and backwaters. The species occurs in the sea around the Andamans also.

Outside India the species has been recorded from the Red Sea, Sokotra, Ceylon, East Pakistan, Penang, Malacca, China, Marianas, and Guam. Though Weber & de Beaufort (1922) stated that this species occurs in the Philippines and in Australia, Herre (1953) in his checklist of Philippine fishes, and Thomson (1954) in his paper on the Mugilidae of Australia, have not included this species.

The maximum size attained by this species is about 70 cm.

(5) **Mugil cephalus** Linnaeus

Mugil cephalus Linnaeus, *Syst. Nat.*, ed. 10, p. 316, 1758 (European Ocean); Russell, *Fish. Vizag.* **2**, p. 64, 1803 (Sea, Vizagapatam); Hamilton, *Fish. Ganges*, p. 119, 1822 (Ganges); Pillay, *Proc. nat. Inst. Sci. India* **17**, p. 414, 1951 (W. Bengal); Devasundaram, *J. Zool. Soc. India* **3**, p. 21, 1951 (Chilka Lake).

Mugil albula Linnaeus *Syst. Nat.*, ed. 12, p. 250, 1766 (Charleston, S. Carolina).

Mugil öûr Forskål, *Descript. Anim.*, p. 74, 1775 (Red Sea).

Mugil cephalotus Cuvier & Valenciennes, *Hist. Nat. Poiss.* **11**, p. 110, 1836 (Pondicherry); Whitehouse, *Madras Fish. Bull.* **15**, p. 80, 1922 (Tuticorin).

Mugil japonicus Schlegel, *Fauna Japonica, Pisces*, p. 134, pl. 72, 1846 (Nagasaki); Bleeker, *Verh. Bat. Gen.* **25**, p. 41, 1853 (Bengal).

Mugil macrolepidotus, Richardson, *Ichth. China and Japan*, p. 249, 1846.

Mugil bontah Bleeker, *Verh. Batavia Genoot.* **25**, p. 48, 1853 (Bengal).

Mugil dobula Günther, *Cat. Brit. Mus.* **3**, p. 420, 1861 (Perth, W. Australia; Aneiteum).

Mugil cunnesius Day, *Fish. Malabar*, p. 136, 1865 (Sea of Malabar, Cochin) (nec. Cuv. & Val.).

Mugil oeur Klunzinger, *Abhandl. Zool.-bot. Gesell. Wien* **20**, p. 829, 1870; Day, *Fishes of India*, p. 353, 1878; *Fauna of Brit. India, Fishes* **2**, p. 348, 1889 (Bombay).

Mugil perusii Hutton, *Fishes of New Zealand*, p. 36, 113, 1872 (New Zealand).

Mugil occidentalis Castelnau, *Proc. Zool. Acclim. Soc. Vict.* **2**, p. 135, 1873 (Port Philip).

Mugil grandis Castelnau, *Res. Fish. Austr.*, p. 32, 1875 (New South Wales).

Mugil mulleri Klunzinger, *S. B. Akad. Wiss. Wien* **80**, p. 395, 1879.

Mugil gelatinosus Klunzinger, *S. B. Akad. Wiss. Wien* **80**, p. 395, 1879.

Mugil marginalis De Vis, *Proc. Linn. Soc. N.S.W.* **9**, p. 870, 1885.

Mugil marginatus Saville-Kent, *Great Barrier Reef*, p. 294, 1893 (Barrier Reef).

Mugil hypselosoma Ogilby, *Proc. Linn. Soc. N.S.W.* **22**, p. 74, 1897 (Tasmania).

Mugil our Jordan & Snyder, *Proc. U.S. Nat. Mus.* **23**, p. 744, 1901.

D. IV, I + 8; A. III + 8; V. I + 5; P. 16–18; C. 18–20; L. l. 37–42; L. tr. 13–15.

Length of head conspicuously greater than height of body. Head broader than high. Length of snout less than its own height and the width of snout greater than its height. Diameter of orbit less than length of snout and less than half of inter-orbital distance. Insertion of D_1 in relation to tip of snout and base of caudal varying. Origin of pelvic fins nearer origin of anal than to tip of snout. Length of caudal peduncle less than width of head but not less than height of head. The least height of caudal peduncle less than height of head. The first spine of D_1 longer than the second. Insertion of pectoral fin above middle of body. Caudal fin deeply forked.

Proportionate measurements: vide Appendix B.

Scales: 37-42 on the longitudinal series and 13-15 on the transverse. Pre-dorsal scales 23-25. Elongated axillary scale present in axil of pectoral fin. The bases of all fins except D_1 covered with minute scales. Scales on body cycloid in the young, and feebly ctenoid in adults.

Orientation of fins: Insertion of D_1 above 12th-14th, of D_2 above 24th-27th, and of anal below 23rd-26th scales of the longitudinal series. Insertion of pelvic fins below 6th-8th L.l. scale, reaching to the 13th-16th scale of this series. Pectoral fin reaches to 9th-12th L.l. scale.

Teeth present on both jaws in a band. Upper lip terminal, forming tip of snout and part of dorsal profile. Pre-orbital not bent and is serrated on both anterior and ventral edges. Distance of anterior nostril from upper lip is less than its distance from the posterior nostril and equals the distance of the latter from rim of orbit. Anterior nostril is below the level of the eye while the posterior is above it. Symphysial knob double. Adipose thickening over the orbit is conspicuously well developed in the adults, more than in any other species of Mugilidae. End of maxilla is concealed when the mouth is closed.

Colour: Dark greyish brown dorsally, lighter on the sides which are dull silvery. The ventral aspect is whitish. There are 5-7 horizontal bands along the lateral row of scales. Fins are grey, except the pelvics which are dull yellowish. There is a dark blue blotch on the base of pectoral. The body coloration is variable according to the environment. In marine environment the coloration is not so dark as in less saline waters.

Material: 4 specimens labelled *M. cephalotus* in Day's Collections—Z.S.I. Nos. 1934 & 2137 (from Madras) and Z.S.I. Nos. 1408 & 2145, from Bombay); 6 specimens labelled *M. oeur*—Z.S.I. No. F. 8464/1 (in Zugmayer's Collections from Baluchistan), Z.S.I. Nos. F. 9454/1, F. 9455/1, F. 9456/1, F. 9458/1 & F. 9461/1 (Collections from Chilka); 35 fresh specimens collected from the sea at Jaunput (Midnapore district, West Bengal) and Narakkal in Cochin.

Remarks: The specimens named *M. cephalotus* by Day are referrable to *M. cephalus*. Day (1878) has recognised *M. cephalotus* Valenciennes as synonymous with *M. oeur* Forskål, the descriptions of which are in complete agreement with that of *M. cephalus* Linnaeus.

Distribution: Type locality: European oceans. This species has almost a world-wide distribution, occurring in the Atlantic, Pacific and Indian Oceans. In India it occurs all along the coast in the sea, ascending backwaters and tidal rivers, and is one of the common mullets of Indian waters. Outside India this species has been recorded from Carolina Islands, Babuyan Islands, Java, Borneo and New Guinea in the East Indian regions (where it is not very common),

Philippines (rare), Japan (excessively common), Hawaiian Islands, Guam, Marshall Islands, Honolulu, Hong Kong and Swatow in China, South Carolina, Red Sea, the east and west coasts of Australia and New Zealand.

M. cephalus grows to about 90 cm. in length.

(6) **Mugil vaigiensis** Quoy & Gaimard

Mugil vaigiensis Quoy & Gaimard, *Voy. 'Uranie', Zoologie*, p. 337, pl. 59, fig. 2, 1825 (Waigiou).

Mugil macrolepidotus Rupell, *Atlas Reise, Nordl. Afrika, Fische Rothen Meeres*, p. 140, 1828 (Red Sea).

Mugil melanochir (Koch & Van Hasselt) Cuvier & Valenciennes, *Hist. Nat. Poiss.* **11**, p. 143, 1836 (Java; Guam).

Mugil peddaraki Cuvier & Valenciennes, *Hist. Nat. Poiss.* **11**, p. 137, 1836 (Coromandel coast); Bleeker, *Verh. Bat. Gen.* **25**, p. 48, 1853.

Mugil rossii Bleeker, *Nat. Tijds. Ned.-Ind.* **7**, p. 45, 1854 (Cocas Island).

Mugil waigiensis Günther, *Cat. Brit. Mus.* **3**, p. 435, fig. 9, 1861 (Red Sea; Sea of Pinang; East Indian Archipelago; N.W. Australia; S. Australia); Day *Fish. Malabar*, p. 144, 1865 (Sea of Malabar, entering fresh water); *Fish. India*, p. 359, 1878 (Bombay); *Fauna Brit. India, Fishes* **2**, p. 356, 1889.

Mugil ventricosus Castelnau, *Rec. Philad. Exhibition*, p. 32, 1875.

Mugil delicatus Jouan, *Mem. Soc. Nat. Sci. Cherbourg* **21**, p. 333, 1878.

Liza vaigiensis Jordan & Seale, *Bull. U.S. Bur. Fish.* **25**, p. 175-455, 1906 (Samoa); Herre, *Mem. Indian Mus.* **13**, p. 347, 1941 (Andamans); Thomson, *Austr. J. Mar. Freshw. Res.* **5**, p. 102, 1954 (Australia, Queensland; Great Barrier Reef; Madras).

Liza waigiensis Seale, *Occas. Papers Bishop Mus.* **4**, p. 15, 1906 (South Pacific); Whitehouse, *Madras Fish. Bull.* **15**, p. 95, 1922 (Tuticorin).

Mugil rossi Weber, *Siboga Exped.* 57, *Fische*, p. 138, 1913 (East Indies).

Mugil ogilbyi Fowler, *Proc. Acad. Nat. Sci. Phila.* **70**, p. 5, fig. 2, 1918 (Philippines).

Ellochelon vaigiensis Whitley, *Austr. Zool.* **6**, p. 250, 1930 (Waigiou); Smith, *Ann. Mag. Nat. Hist.* **11**, p. 840, 1948 (S. Africa).

D. IV, I + 8 ; A III + 8 ; V. I. + 5 ; P. 16—17 ; C. 14 ; L. l. 25—29 ; L. tr. 9—12.

Length of head greater than height of body, head broader than high. Length of snout less than its own height, and its width greater than the height. Diameter of orbit less than length of snout and about half of inter-orbital distance. Origin of pelvic fins nearer origin of anal fin than to tip of snout. Origin of D_1 nearer base of caudal than to tip of snout. Length of caudal peduncle less than the width and height of head. Least height of caudal peduncle less than height of head. 1st spine of D_1 longer than the 2nd. Insertion of pectoral in middle of body.

Proportionate measurements: vide Appendix B.

Scales: 25-29 scales on the longitudinal series and 9-12 on the transverse. 15-16 predorsal scales. No elongated scale in axil of pectoral fin. Bases of all fins except D_1 covered with minute scales. Scales on body ctenoid in adults.

Orientation of fins: Insertion of D_1 above 8th-9th, of D_2 above 17th-19th, and of anal below 15th-17th scales of the longitudinal series. Insertion of pelvic fins below 3rd-4th scale and they reach upto the 9th-11th L.l. scales. Pectoral reaches to the 7th-8th L.l. scale.

Teeth scattered, embedded externally on upper lip. Upper lip forms tip of snout and part of dorsal profile. Pre-orbital bent and serrated on anterior and ventral margins. Nostrils large, the posterior only slightly larger than the anterior. Distance of posterior nostril from orbit less than that of the anterior from upper lip, the distance between the two nostrils being less than either of these. Nostrils are in level with the dorsal margin of orbit. Symphysial knob double. Adipose thickening not present over eyes. End of maxilla visible (in some only slightly) when the mouth is closed. Caudal fin only very slightly forked (lunate).

Colour: Olive-brown dorsally, merging to dull yellowish brown and silver on the sides. Light on the ventral aspect. Fins are pale yellowish grey at the bases, changing to dark grey towards the outer margins. Pectoral fin almost black except along the ventral margin which is dull pale yellow. Dark horizontal bands on sides formed by groups of pigment spots arranged length-wise on each scale.

Material: 3 specimens in Day's collections in the Z.S.I.: Z.S.I. No. 2041 (from Akyab), Z.S.I. No. 2042 (from Bombay), and Z.S.I. No. 2141 (from Madras); and 25 fresh specimens collected from Krusadai Islands (Pamban).

Remarks: Thomson (1954) states 'adipose eyelid rudimentary, not obtruding onto eye' and 'distinct patches of gelatinous adipose tissue are present both in front and behind the eye'. In the 31 specimens examined during this study, it has not been possible to detect the presence of adipose thickening and so on this point the author differs from Thomson (1954) and is in agreement with the observations of the others, Günther (1861), Day (1889), Weber & de Beaufort (1922), Whitley (1930), Smith (1948) and Schultz (1953) who have stated that there is no adipose eyelid in this species.

Distribution: Type locality: Waigiou[1]. This species occurs in the sea and tidal rivers from the east coast of Africa to the East

[1] South Pacific.

Indies, China, Philippines, and east to the Marshall and Tuamotu Islands and south to Australia.

In India the species occurs all along the west coast, and on the east coast up to Madras. It does not occur in the Chilka Lake or in the coastal waters of Orissa and Bengal.

The maximum size of this species recorded from Indian waters is just over 30 cm. But it has been known to grow to 55 cm. (Thomson, 1954).

(7) **Mugil cunnesius** Valenciennes

Mugil cunnesius Valenciennes (in Cuvier & Valenciennes), *Hist. Nat. Poiss.* **11**, p. 114, 1836 (Vizagapatam & Bombay; Moluccas); Day, *Fish. India*, p. 349, 1878-88 (Bombay); *Fauna Brit. India, Fishes* **2**, p. 342, 1889; Devasundaram, *Journ. Zool. Soc. India* **3**, p. 22, 1951 (Chilka Lake).

Mugil speigleri Bleeker, *Nat. Tijds. Ned.-Ind.* **16**, p. 279, 1858-1859 (Java); Günther, *Cat. Brit. Mus.* **3**, p. 435, 1861 (after Bleeker); *Day, Fish. India*, p. 348, 1878-88 (Bombay); *Fauna Brit. India, Fishes* **2**, p. 342, 1889; Devasundaram, *nat. Inst. Sci. India* **17**, p. 414, 1951 (W. Bengal); Devasundaram, *J. Zool. Soc. India* **3**, p. 22, 1951 (Chilka Lake).

Mugil supposítus Day, *Fish. Malabar*, p. 143, 1865 (Sea—Cochin, Malabar). (nec. Günther).

D. IV, I + 8 ; A. III + 9 ; V. I + 5 ; P. 14–16 ; C. 14–15 ; L. l. 33–38 ; L. tr. 10–12.

Length of head less than height of body, or sometimes equal to it. Head higher than broad. Length of snout distinctly less than its height which in turn equals its width. Diameter of orbit equal to, or often greater and sometimes less than length of snout. Diameter of orbit more than half of inter-orbital distance. Insertion of D_1 in relation to tip of snout and base of caudal varying. Origin of pelvic fins nearer origin of anal than to tip of snout. Length and least height of caudal peduncle less than width and height of head. 1st spine of D_1 longer than the 2nd, but sometimes equal. Insertion of pectoral above middle of body. Caudal fork not very deep.

Proportionate measurements: vide Appendix B.

Scales: 33-38 on the longitudinal and 10-12 on the transverse series. 19-22 pre-dorsal scales. A pointed elongated scale present in axil of pectoral fin. Bases of all fins except of D_1 covered with minute scales. Scales on body cycloid in young as well as in adults.

Orientation of fins: Insertion of D_1 above 11th-13th, of D_2 above 21st-25th and of anal below 19th-23rd scale of the longitudinal series. Pelvic fins inserted below 6th-7th and reach to the 13th-16th L.l. scales. Pectoral fins reach to the 12th-14th L.l. scales.

Lower lip thin with a single row of teeth. No distinct teeth on upper lip which forms tip of snout and part of dorsal profile. Pre-

orbital bent only at the extremity and serrated on both anterior and ventral margins. Nostrils above level of eye, the posterior larger than the anterior. The distance of the posterior nostril from the orbit is less than of the anterior from the upper lip, which in turn is less than the distance that separates the two. Symphysial knob double. Adipose eyelid present, broader posteriorly than anteriorly. End of maxilla not visible when mouth is closed.

Colour: Olivaceous-grey on back, silvery on sides with a tinge of green on the upper half. Silvery white on the ventral aspect. Fins yellowish at the base, the rest grey with dark margins. In young fish the back is more greenish than in adults and there are dark pigment spots arranged in a single row along the myotomes which are clearly visible as dark lines a little while after death, and remain so even when preserved in formalin. These lines are not evident in large sized fish in the fresh condition; but when presrved in formalin, they appear as faint lines.

Material: 5 specimens in the collections in the Zoological Survey of India labelled *M. speigleri*—Z.S.I. No. 1406 (in Day's collections from Bombay); Z.S.I. Nos. F. 9507/1, F. 9508/1, F. 9509/1 & F. 9510/1 (in the Chilka Survey collections from Chilka Lake); 6 specimens in the collections of the Zoological Survey of India labelled *M. cunnesius*—Z.S.I. Nos. F. 9262/1, F. 9263/1, F. 9497/1, F. 9501/1 & F. 9502/1 in the Chilka Survey collections (from Chilka Lake); and Z.S.I. No. F. 2508/1 (in Annandale's collections from Cohin); and fresh specimens collected from the sea and estuaries of West Bengal and specimens collected from Cochin.

Remarks: M. cunnesius was described by Russel from the sea of Vizagapatam (Visakhapatnam, Coromandel coast), as a '*Mugil* with a lanceolate scale at the pectoral and ventral fins; three spines in the anal fin; tail sub-lunate'. He, however, did not give it a specific name. Valenciennes (Cuvier & Valenciennes, 1836) discussed the taxonomic position of this species which he named *Mugil cunnesius*. He distinguished the species by 'the pointed scale of its pectoral, by the maxillary which is near to the head, the sub-orbital neither visibly notched, neither dentate nor truncate; the small head which is convex, the short snout which occupies only $\frac{1}{4}$ of the length of head and is equal to the diameter of eye; height of body 4, and length of head $5\frac{1}{2}$ times in the length and the jaws that are almost equal'. From an examination of the named collections in the Zoological Survey of India I found that there was striking similarity between the specimens named *M. cunnesius* Valenciennes and *M.*

speigleri Bleeker. Day's (1878 & 1889) descriptions of the two species from Indian waters do not show any significant differences between the two. The differences in the proportionate measurements mentioned are very slight and fall well within the intra-specific ranges usually seen in the species of *Mugil*. The only difference of any taxonomic value is firstly in his statement that in *M. speigleri* the maxilla is 'uncovered' and in *M. cunnesius* it is entirely concealed or just visible. It is of interest that in specimen No. 1406 in the Zoological Survey of India collections, which was purchased from Day as *M. speigleri*, the maxilla is not visible when the mouth is closed. Day's (1878 & 1889) *M. speigleri* has 40-42 L.l. scales while *M. cunnesius* has only 33-35. But Weber & de Beaufort (1922) give 42-43 L.l. scales for *M. cunnesius* and *c.* 40 for *M. speigleri*.

In the large number of specimens examined by me it is seen that the number of L.l. scales is greatly varying and ranges for both the species overlap considerably. In none of the specimens of either species examined were there more than 38 L.l. scales present. Devasundaram (1951) has described the two species separately, and the only distinguishing character given by him is the relative length of the pectoral fin. The present study has shown that this feature is not constant and overlaps to an appreciable degree.

The morphometric comparison of the two species in respect of the various characters is given in Table II (p. 575). As can be seen, the value of P obtained is greater than O.l. in respect of all the measurements.

Distribution: Type locality: Bombay and Vizagapatam, India; Malaccas. In India the species is distributed on both the west and east coasts, from Baluchistan to West Bengal.

Outside India, the species has been recorded from the Red Sea, Abyssinia, Dutch South New Guinea, sea of Penang and Singapore in the Malay Peninsula, Indonesia, Shanghai, Philippines, and Queensland in Australia.

The maximum size to which this species grows is about 30 cm.

(8) **Mugil seheli** Forskål

Mugil crenilabis seheli Forskål, *Descript. Anim.* p. 73, 1775 (Lohaja, Red Sea).

Mugil caeruleo-maculatus Lacépède, *Hist. Nat. Poiss.* **5**, p. 385 & 389, 1803 (Mauritius); Day *Fish. India*, p. 356, 1878 (Andamans); *Fauna Brit. India, Fishes* **2**, p. 351, 1889.

Mugil seheli Cuvier & Valenciennes, *Hist. Nat. Poiss.* **11**, p. 113, 1836; Day, *Fish. India*, p. 355, 1878; *Fauna Brit. India, Fishes* **2**, p. 350, 1889.

Mugil cylindricus Cuvier & Valenciennes, *Hist. Nat. Poiss.* **11**, p. 132, 1836; Bleeker, *Verh. Bat. Gen.* **23**, p. 9, 1850 (Java).

Mugil axillaris Cuvier & Valenciennes, *Hist. Nat. Poiss.* **11**, p. 139, 1836; Bleeker, *Nat. Tijds. Ned.-Ind.* **4**, p. 280, 1858-59 (East Indies); Day, *Proc. Zool. Soc. London*, 1869, p. 300, 1870 (Malabar).

Mugil melanicranus Richardson, *Rep. Brit. Assn.* 1845, p. 248, 1846 (Canton).

Mugil caeruleomaculatus Bleeker, *Nat. Tijds. Ned.-Ind.* **2**, p. 484, 1851 (Riouw).

Mugil parsia Bleeker, *Nat. Tijds. Ned.-Ind.* **3**, p. 166, 1852 (Borneo) (nec. Hamilton, 1822).

Mugil barbonicus Bleeker, *Nat. Tijds. Ned.-Ind.* **15**, p. 279, 1858; ibid. **16**, p. 375, 1859 (East Indies).

Mugil bleekeri Günther, *Cat. Brit. Mus.* **3**, p. 445, 1861 (Rivers of Banka).

Mugil decem-radiatus Günther, *Cat. Brit. Mus.* **3**, p. 452, 1861 (Coasts of Batavia & Timor).

Mugil delicatus Alleyne & Macleay, *Proc. Linn. Soc. N.S.W.* **1**, p. 341, 1877 (Cape York).

Liza caeruleomaculatus Jordan & Seale, *Bull. U.S. Bur. Fish.* **25**, p. 217, 1906 (Samoa); Herre, *Mem. Indian Mus.* **13**, p. 347, 1941 (Andaman Islands); Devasundaram, *J. Zool. Soc. India* **3**, p. 23, 1951 (Chilka Lake).

Liza caeruleo-maculata Whitehouse, *Madras Fish. Bull.* **15**, p. 93, 1922 (Tuticorin).

Liza seheli Herre, *J. Pan-Pacif. Res. Instn.* **8**, p. 3, 1933 (Sandakan, N. Borneo); *Mem. Indian Mus.* **13**, p. 347, 1941 (Andaman Ils.).

Valamugil seheli Smith, *Ann. Mag. Nat. Hist.* (11) **14**, p. 840, 1948 (S. Africa); Thomson, *Austr. J. Mar. Freshw. Res.* **5**, p. 108, 1954 (Cape York; Great Barrier Reef; Samoa; Bombay).

D. IV, I + 8 ; A. III + 9 ; V. I + 5; P. 15–16; C. 16 ; L. l. 35–38 ; L. tr. 11–13.

Length of head equal to or less than height of body, occasionally greater especially in young ones. Head higher than broad, occasionally as broad as high. Length of snout less than its height, which, in turn is less than the width. Diameter of orbit more than half of inter-orbital distance in young specimens but is only half in large-sized fish. Insertion of D_1 nearer base of caudal than to tip of snout. Origin of pelvic fins nearer origin of anal fin than to tip of snout. Length of caudal peduncle less than width of head. 1st spine of D_1 longer than the 2nd spine. Insertion of pectoral above middle of body. Caudal deeply forked.

Proportionate measurements: vide Appendix B.

Scales: 35-38 on the longitudinal series and 11-13 on the transverse. 18-20 pre-dorsal scales. Elongated pointed scales present in axil of pectoral. The bases of all fins except D_1 covered with minute scales. Scales on body cycloid in young as well as old specimens.

Orientation of fins: Insertion of D_1 above 11th-12th, of D_2 above 23rd-24th, and of anal below 21st-23rd L.l. scale. The pelvic

fins inserted below 5th-7th and reach to the 13th-14th scale of the longitudinal series. Pectorals reach the 10th-13th L.l. scale.

Upper lip thick and forms tip of snout but does not form part of dorsal profile. Lower lip thin. Lips without teeth. Pre-orbital slightly bent and mildly serrated on anterior and ventral margins. Nostrils well separated, the distance between them being greater than the distance of the posterior from the orbit, which again is greater than the distance of the anterior from the upper lip. Posterior nares larger than the anterior and slit-like in appearance; adipose eyelids absent. End of maxilla not visible when mouth is closed. Symphysial knob double.

Colour: Brownish dorsally with a greenish tinge on back. Silvery on sides and below. Pectoral with a bluish spot. On the upper half of body of large specimens the scales have dusky centres, forming indistinct longitudinal lines.

Material: 2 specimens labelled *M. caeruleomaculatus* in the collections of the Zoological Survey of India—Z.S.I. Nos. 1425 (in Day's collections from Andamans) and F. 9473/1 (from Chilka Lake—Chilka Survey).

One specimen labelled *M. seheli*—Z.S.I. No. F. 69/2 in D. D. Mukherji's collections from Port Blair, Andamans.

Remarks: There has been considerable overlapping in the characters attributed to *M. seheli* Forskål and *M. caeruleomaculatus* Lacépède by the various authors. Fowler (1928) considered the latter to be a synonym of *M. seheli*. But this did not find approval of certain later authors like Smith (1935) who considered the two to be separate species. Thomson (1954) did not find any significant difference between the two species and, therefore, considered *M. caeruleomaculatus* Lacépède to be a synonym of *M. seheli* Forskål. Examination of the specimens in the named collections of the Zoological Survey of India did not show any significant difference between the two. One large-sized specimen of *M. caeruleomaculatus* (25.7 cm. in standard length) had two distinct patches of teeth on the tongue, but in a smaller specimen of the same, and in another small specimen of *M. seheli* examined, it was not possible to detect the presence of teeth on the tongue. It is inferred, therefore, that the teeth become evident only when the fish have reached sufficiently large size. This obviously overcomes the objection of Smith (1935) to the merger of the two species. The present author, has, in view of the above considered *M. caeruleomaculatus* Lacépède as a synonym of *M. seheli* Forskål.

Distribution: Type locality: Lokajae, Red Sea. In India this species has been recorded from Kathiawar and Bombay coasts in the west, Gulf of Mannar and the east coast of Madras, Chilka Lake and the Andaman Islands. This species has not so far been recorded from Bengal waters or from Malabar coast.

Outside India, its distribution extends from the Red Sea to the Indian coast, coast of S. Africa, East Indies, Indian Ocean—west Pacific, Hawaii and Marshall Islands, New Guinea, Australia and Hong Kong, and Canton in China.

This species grows to over 30 cm. in length.

Genus **Rhinomugil** Gill

Rhinomugil Gill, *Proc. Acad. Nat. Sci. Philad.*, 1863, p. 169 (genotype, *Mugil corsula* Hamilton) (River Ganges, Bengal).

No spine on opercle; lips ventral, without lobes and papillae. The distinguishing feature of this genus is that the upper lip does not form tip of snout or part of dorsal profile, but is distinctly ventral, overhung by the snout. The mouth, therefore, is conspicuously ventral in position. The nostrils are situated low on the side of head, in level with the ventral rim of orbit. Symphysial knob present. Teeth indistinct, anterior edge of pre-orbital without notch. Mouth protrusible. End of maxilla concealed.

Thomson (1954) has assigned *Squalomugil* Ogilby to the synonymy of this genus. But since in his descriptions he states that the mouth is not protrusible, I have not considered *Squalomugil* Ogilby as a synonym of *Rhinomugil* Gill, even though in most other characters there seems to be close affinity between the two.

Monotype: Rhinomugil corsula (Hamilton).

Rhinomugil corsula (Hamilton)

Mugil corsula, Hamilton, *Fish. Ganges*, pp. 221, 381, pl. ix, fig. 97, 1822 (River Ganges, Bengal); Günther, *Cat. Brit. Mus.* **3**, p. 460, 1861 (Calcutta); Day, *Fish. India*, p. 354, 1878-1888; *Fauna Brit. India, Fishes* **2**, p. 349, 1889 (Calcutta; Burma); Hora, *J. Bombay nat. Hist. Soc.* **40**(1), pp. 62-68, 1938 (Bengal); Pillay, *Proc. nat. Inst. Sci. India* **17**, p. 414, 1951 (W. Bengal).

Liza corsula Chaudhury, *Mem. Indian Mus.* **5**(6), p. 498, 1917 (Chilka Lake); Hora, *Mem. Indian Mus.* **5**, p. 766, 1923 (Chilka Lake); Devasundaram, *J. Zool. Soc. India* **3**, p. 25, 1951 (Chilka Lake).

D. IV, 1 + 8; A. III + 9; V. I + 5; P. 13—15; C. 15—16; L. l. 48—53; L. tr. 15—17.

Length of head conspicuously greater than height of body. Head broader than high. Length of snout greater than its height, but less

than its width. Diameter of orbit less than length of snout and almost equal to or slightly less than the inter-orbital distance. Insertion of D_1 nearer base of caudal than to tip of snout. Origin of pelvic fins nearer origin of anal than to tip of snout. Length of caudal peduncle greater than width of head and either equal to or slightly greater than height of head. Least depth of caudal peduncle less than height of head. The first two spines of D_1 are of equal length. Insertion of pectoral fin below middle of body. Caudal fork not very deep.

Scales: There are 48-53 scales on the longitudinal and 15-17 on the transverse series. Pre-dorsal scales 25-27. No elongated scale in axil of pectoral fin. The bases of all fins except D_1 are covered with minute scales. Scales are cycloid in young and strongly ctenoid in adults.

Orientation of fins: Insertion of D_1 above 16th-18th and of D_2 above 33rd-34th scales of the longitudinal series. Anal commences below 25th-28th lateral scale. Insertion of pelvic fins below the 8th, and they reach to 16th-19th L.l. scale. Pectoral fin reaches to 13th-15th L.l. scale.

Upper lip does not form tip of snout or part of dorsal profile. Mouth distinctly ventral and protrusible. Pre-orbital is not bent and is serrated on both anterior and ventral edges. Pre-orbital does not reach beyond angle of mouth. Its extremity pointed and without concavity. Nostrils almost equal in size and are situated below the dorsal rim of eye almost in level with the ventral rim. The posterior nostril very close to the orbit, the anterior nearer to the upper lip than to the posterior. Adipose eyelids present in adults. Eye prominent and bulging, more than $\frac{3}{4}$ of which forms part of the dorsal profile. End of maxilla concealed when mouth is closed. Symphysial knob feebly double.

Colour: Dull olive-brown dorsally gradually becoming light on the sides. Dull white on the ventral aspect. Fins with greyish tinge.

Material: Named collection in the Zoological Survey of India: *M. corsula:* 2140, F. Day, original of pl. 71, fig. 6 of *Fishes of India*, 1878 (Calcutta); 313, May Sladen (Mandalay): Several specimens collected from the Sundarban area were also studied.

Remarks: Day (1889) has stated that this species has no adipose eyelids. Though in the young stages these are absent, in fairly large-sized specimens the adipose thickenings are clearly visible, being

more prominent behind the eye than in front of it. These encroach to some extent over the eyes in large-sized fish.

Distribution: Type locality: River Ganges. Day (1889) has indicated the rivers and estuaries of Bengal and Burma as the habitat of this species. It has been observed during the course of this investigation that the species occurs in the sea off the Midnapore coast of Bengal in fairly large numbers. So in fact the sea, estuaries, and rivers form the natural habitat of the species, which is also found far above the tidal influence. In India this species has been recorded only from the Ganges; and outside India it is known to occur only in the rivers and estuaries of Burma, thus having a very limited distribution.

This species is known to attain a length of about 46 cm.

Doubtful Species

Of the 27 species described by Day (1889) 24 have been dealt with in the foregoing pages. Of these only 12 species are retained as valid, the others having been merged or obscured according to the taxonomic principles involved. However, there still remain three species, the systematic status of which could not be assessed with certainty for want of sufficiently well-defined and exhaustive descriptions, or authoritatively named specimens. These are, *M. amarulus* Valenciennes, *M. kelaartii* Günther, and *M. buchanani* Bleeker. It appears from a close perusal of the literature on these species that they may not remain valid as independent species. The relevant points are discussed below.

1. **Mugil amarulus** Valenciennes

Valenciennes (Cuvier & Valenciennes, 1836) gave the following distinguishing features for this species: 'compressed body, head very much smaller than the height of body, the front slightly convex, the sub-orbital truncated bluntly without notch, one axillary scale above pectoral'. These characters are strongly reminiscent of the characteristic features of *M. cunnesius* Valenciennes. The author stated that there was no spot or blotch on the pectoral in his specimens which were only 2-3 inches in length. It may be pointed out in this connection that even in *M. cunnesius* the dark spot at base of pectoral is absent in young specimens and becomes evident only in the fingerling stage. Day (1878 and 1889), however, mentions the

presence of a dark spot on base of pectoral of his *M. amarulus*. Whitehouse (1922) states that he found it difficult to distinguish this species from *M. troscheli*. This might be because he did not study the original descriptions of Valenciennes which certainly show a greater affinity towards *M. cunnesius* than towards *M. troscheli*.

2. **Mugil kelaartii** Günther

Günther's description of this species is based on two specimens 4½ inches long, one of which was obtained from Point de Galle in Ceylon and the other from the Philippines. Day's (1878 and 1889) descriptions of this species are very similar to his descriptions of *M. speigleri* and *M. cunnesius*. Whitehouse (1922) has drawn attention to this point and expressed considerable difficulty in distinguishing the species from *M. cunnesius* of Day. However, he assigned his specimen to *M. kelaartii* Günther, based on certain affinities to Günther's descriptions and on the argument that since *M. kelaartii* was present in the sea off Ceylon, it must be present at Tuticorin also. But his descriptions show that his specimens were extremely similar to *M. cunnesius* Valenciennes. Earlier in his paper he remarks: 'I have found it impossible to recognise *Mugil cunnesius* (Cuv. & Val.) though Dr. Chaudhuri identifies this species from specimens sent to him from Tuticorin.' It is possible, therefore, that he prejudged the identity of his specimens. This raises the doubt as to whether *M. kelaartii* Günther is present in Indian waters at all. Though Day has included 'seas of India' in the habitat of the species, it is possible he meant the sea south of Ceylon (after Günther) since in his time Ceylon formed an integral part of India. Apart from Whitehouse's (1922) record, there is no other to show that *M. kelaartii* is present in Indian waters.

It is, however, of interest here to point out that *M. kelaartii* Günther may not any longer be a valid species but only a synonym of *M. engeli* (Weber & de Beaufort, 1922, and Roxas, 1934).

3. **Mugil buchanani** Bleeker

The type specimen of this species is said to have been collected from the River Hooghly. Though Bleeker's (1853) description of this species is not very clearly defined, the figure reproduced by Smith (1948) shows that this species has certain distinctive features peculiar to it, such as the shape and disposition of the fins. Day (1878) remarked that this species is the same as *M. ceylonensis* of Günther. Though he observed that he had examined the type specimen of

Bleeker, he did not make it clear whether his descriptions were based on Bleeker's specimen, or on Günther's, or whether he had been able to collect any from Hooghly (the type locality) or from any other part of India. The present author has not come across this species in the Hooghly or any other river system or in the coastal waters of Bengal during the extensive surveys of the mullet fishery of Bengal. Apart from Bleeker's (1853) there is no other record of this species from Indian waters. Even outside India its distribution is greatly restricted and it is known to occur only in East Africa (Smith, 1935 and 1948) and Marianas (Pellegrin, 1898, and Fowler, 1928). Thomson (1954) has recorded it from Australia, but states that only one specimen could be referred to this species. In the absence of specimens for scrutiny and of any comprehensive description of the species, it is not possible to examine further its systematic position in relation to Indian Mugilidae.

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Please turn over for Tables I and II, and Appendix B.

TABLE I

Morphometry of *Mugil parsia* and species synonymous with it

Character	*M. parsia*					*M. jerdoni*					*M. oligolepis*		*M. olivaceus*		*M. subviridis*	
	N	Range	Mean	σ	S. E.	N	Range	Mean	σ	S. E.	N	Range	N	Range	N	Range
Total length ..	100	4.60-5.34	4.963	0.16351	0.01635	5	4.50-4.88	4.64	0.0222	0.06663	—	—	—	—	1	4.73
Length of head / Standard length ..	100	3.67-4.36	4.050	0.15037	0.01504	5	3.56-4.24	3.89	0.0842	0.12977	2	3.26-3.51	1	4.35	2	3.75-3.95
Length of head / Total length ..	100	4.53-6.38	5.066	0.39987	0.03999	5	4.24-5.65	4.74	0.5206	0.32267	—	—	—	—	1	4.73
Height of body / Standard length ..	100	3.59-5.09	3.991	0.63544	0.06354	5	3.51-4.66	3.95	0.1434	0.16934	2	3.80-4.1	1	3.61	2	3.83-4.0
Height of body / Length of head ..	100	3.00-4.00	3.463	0.28613	0.02861	5	3.37-4.46	3.76	0.0656	0.11454	2	2.9-3.7	1	2.73	2	1.55-1.68
Diameter of eye / Inter-orbital distance ..	100	1.33-1.88	1.600	0.10034	0.01003	5	1.37-2.0	1.67	0.1494	0.17286	2	1.30-1.5	1	1.47	2	1.56-1.58
Diameter of eye / Diameter of eye ..	100	3.45-10.33	6.393	1.67581	0.16758	5	7.0-8.0	7.25	0.5397	0.32854	1	8.0				
Anterior adipose eyelid / Diameter of eye ..	100	2.55-7.75	3.470	1.00293	0.10029	5	5.0-7.0	6.08	0.1120	0.04899	1	5.0				
Posterior adipose eyelid / Length of head ..	100	1.44-1.68	1.532	0.09893	0.00989	5	1.42-1.69	1.56	0.0032	0.25298	2	1.31-1.36	1	1.61	2	1.46-1.50
Height of head / Length of head ..	100	1.42-1.59	1.499	0.36987	0.03699	5	1.42-1.57	1.52	0.0352	0.08391	2	1.57-1.61	1	1.53	2	1.46-1.50
Width of head / Length of head ..	100	1.94-2.42	2.193	0.10037	0.01004	5	2.0-2.45	2.24	0.0061	0.34928	2	2.23-2.5	1	2.38	2	2.40-2.61
Inter-orbital distance / Length of head ..	100	1.16-1.44	1.314	0.07105	0.00711	5	1.30-1.44	1.36	0.00995	0.44609	1	1.20	1	1.40	2	1.23-1.35
Length of pectoral fin / Length of head ..	100	1.19-1.65	1.396	0.20488	0.02049	5	1.3-1.57	1.44	0.02295	0.06775	2	1.61-1.87	1	1.63	2	1.56-1.71
Length of caudal peduncle / Length of head ..	100	1.37-2.23	1.970	0.10641	0.01064	5	1.85-2.2	2.02	0.00355	0.02675	1	2.50	1	2.38	2	1.95-2.09
Least height of caudal peduncle / Total length ..	100	4.63-6.47	5.146	0.50031	0.05003	5	4.70-5.37	4.85	0.0031	0.02490	—	—	—	—	1	4.95
Length of caudal fin / Length of caudal peduncle	100	1.13-1.75	1.404	0.93141	0.09314	5	1.31-1.47	1.39	0.23785	0.21813	1	1.33	1	1.46	2	1.21-1.27
Least height of caudal peduncle / Standard length ..	100	1.84-2.17	1.965	0.08978	0.00898	5	1.84-1.96	1.89	0.0012	0.01549	2	1.87-1-90	1	1.89	2	1.95-2.02
Snout to D_1																

TABLE II

Biometric comparison of *Mugil speigleri* and *Mugil cunnesius*

Character	*M. speigleri*					*Mugil cunnesius*							
	Range	Mean	N	σ	S.E	Range	Mean	N	σ	S.E	σd	t	P
Total length / Standard length	4.54-5.00	4.72	10	0.18256	0.05773	4.54-4.85	4.64	7	0.10383	0.03924	0.07641	1.04694	<0.3
Length of head / Standard length	3.61-3.86	3.81	10	0.13216	0.04180	3.48-4.12	3.703	7	0.22166	0.08378	0.08377	1.27731	<0.2
Length of head / Total length	4.40-4.88	4.68	10	0.21929	0.06935	4.36-4.85	4.62	7	0.23484	0.08876	0.11127	0.53923	<0.5
Height of body / Length of head	3.75-3.87	3.80	10	0.06025	0.01910	3.25-3.80	3.71	7	0.15320	0.05790	0.05355	1.68065	<0.1
Diameter of orbit / Inter-orbital distance	1.62-1.68	1.636	10	0.02490	0.00787	1.30-1.78	1.600	6	0.19126	0.07808	0.061327	0.58666	<0.5
Diameter of eye / Diameter of eye	8.00-8.50	8.125	10	0.15222	0.0481	6.33-13.0	8.233	7	0.54600	0.09002	0.09475	1.13985	<0.2
Anterior adipose eyelid / Diameter of eye	4.0-5.33	4.40	10	0.60133	0.19016	3.16-6.0	4.851	7	0.99755	0.07703	0.38884	1.15995	<0.2
Posterior adipose eyelid / Length of head	1.28-1.40	1.366	10	0.04806	0.01520	1.26-1.50	1.391	7	0.07463	0.02821	0.029785	0.83935	<0.4
Height of head / Length of head	1.45-1.57	1.508	10	0.04025	0.01272	1.43-1.70	1.548	7	0.08899	0.03364	0.031984	1.25078	<0.2
Width of head / Length of head	2.2-2.38	2.312	10	0.06418	0.02049	1.94-2.43	2.271	7	0.14360	0.05427	0.05159	0.60101	<0.5
Inter-orbital distance / Length of head	1.11-1.23	1.148	10	0.05070	0.01792	1.03-1.13	1.087	7	0.03873	0.01581	0.02517	1.62892	<0.1
Length of pectoral fin / Length of head	1.72-1.93	1.80	10	0.08040	0.02542	1.55-2.06	1.849	7	0.02896	0.01095	0.03173	1.54459	<0.1
Length of caudal peduncle / Length of head	2.21-2.40	2.244	10	0.5333	0.01686	2.00-2.29	2.199	7	0.06433	0.02431	0.028632	1.57177	<0.1
Least height of caudal peduncle / Length of head	1.24-1.32	1.280	10	0.0888	0.00281	1.00-1.42	1.244	7	0.12162	0.04597	0.03860	0.93262	<0.3
Least height of caudal peduncle / Standard length	1.89-2.09	2.014	10	0.05733	0.01813	1.88-2.01	1.98	7	0.02033	0.00768	0.02260	1.50429	<0.1
Snout to D_2 / Standard length	1.35-1.40	1.372	10	0.0422	0.01335	1.30-1.40	1.352	7	0.01140	0.04309	0.03942	0.50734	<0.6
Snout to D_2													

Appendix B

Proportionate Body Measurements of Indian Mugilidae

Character	*Sicamugil cascasia*	*Sicamugil hamiltoni*	*Plicomugil labiosus*	*Mugil carinatus*	*Mugil macrolepis*	*Mugil parsia*	*Mugil tade*	*Mugil cephalus*	*Mugil vaigiensis*	*Mugil cunnesius*	*Mugil seheli*	*Rhinomugil corsula*
Total length / Length of Head	4.40-5.00	4.25-5.50	4.50-5.40	3.90-4.50	4.30-5.30	4.55-5.70	3.90-5.25	4.24-5.00	4.26-5.00	4.54-5.50	4.10-5.50	4.50-4.75
Standard length / Length of head	3.53-3.63	3.50-3.64	3.47-5.00	3.31-4.10	3.21-4.40	3.26-4.45	3.60-4.00	3.61-3.83	3.30-3.81	3.48-4.12	3.20-4.30	4.03-4.10
Total length / Length of head	4.50-5.25	4.50-5.00	4.33-5.25	—	4.30-5.30	4.24-6.38	4.00-6.70	4.32-6.00	4.64-5.25	4.36-5.00	4.06-5.60	6.00-6.50
Standard length / Height of body	4.08-4.14	3.77-4.00	3.10-3.28	3.62-4.20	3.40-4.30	3.20-5.09	4.20-5.20	4.50-4.75	3.67-4.07	3.45-4.10	3.20-4.40	5.15-5.36
Length of head / Height of body	3.40-4.00	3.50-4.33	3.00-4.00	4.12-4.57	2.80-4.30	2.90-4.57	2.20-7.00	3.45-6.00	1.84-2.28	3.25-4.00	3.40-4.80	6.40-7.00
Inter-orbital distance / Diameter of orbit	1.09-1.37	1.25-1.62	1.51-1.75	1.57-1.85	1.20-2.10	1.25-1.88	1.00-3.00	1.66-3.07	3.51-5.10	1.30-1.78	1.60-2.00	1.00-1.50
Length of head / Diameter of eye	1.45-1.62	1.56-1.75	1.42-1.58	1.42-1.52	1.33-1.68	1.31-1.68	1.53-2.03	1.50-1.73	1.55-1.66	1.26-1.50	1.38-1.53	1.95-2.00
Length of head / Height of head	1.60-1.72	1.92-2.00	1.47-1.65	1.42-1.82	1.42-1.75	1.42-1.63	1.43-1.52	1.33-1.60	1.28-1.58	1.43-1.70	1.44-1.61	1.52-1.64
Length of head / Width of head	2.61-3.16	2.66-2.80	1.95-2.11	2.30-2.90	2.28-2.54	1.94-2.70	2.30-2.72	1.78-2.47	1.78-2.09	1.94-2.43	2.00-2.40	5.33-5.57
Length of head / Inter-orbital distance	1.26-1.36	1.75	1.00-1.05	1.25-1.38	1.16-1.70	1.16-1.55	1.00-1.60	1.02-1.77	1.13-1.31	1.03-1.23	1.15-1.22	1.00-1.05
Length of head / Length of pectoral fin	1.60-1.90	1.40-1.66	1.60-1.90	1.55-1.80	1.42-2.00	1.19-1.87	1.39-1.64	1.49-1.78	1.75-2.14	1.55-2.06	1.54-1.96	1.18-1.45
Length of head / Length of caudal peduncle	2.50-2·53	2.15-2.40	2.05-2.11	1.76-2.78	1.81-2.33	1.37-2.50	1.50-2.40	2.25-2.71	1.75-2.09	2.00-2.40	1.60-2.30	2.28-2.43
Length of caudal peduncle / Least height of caudal peduncle	1.33-1.41	1.36-1.60	1.11-1.25	1.33-1.65	1.00-1.44	1.13-1.75	1.30-1.40	1.46-1.81	1.00-1.12	1.00-1.42	1.06-1.50	1.57-2.06
Total length / Least height of caudal peduncle			5.25-5.50	6.57-	5.00-5.91	4.50-6.50		3.50-5.00	4.66-4.74	4.54-4.96	4.96-5.07	
Standard length / Length of caudal fin	2.20-2.23	1.88-1.91	1.70-1.76	1.94-1.98	1.80-2.20	1.75-2.17	1.90-2.00	1.88-2.03	1.80-1.85	1.88-2.09	1.91-1.94	1.86-1.88
Standard length / Snout to D_1	1.28-1.32	1.31-1.38	1.23-1.42	1.28-1.35	1.28-1.34	1.22-1.37	1.28-1.30	1.32-1.36	1.23-1.27	1.30-1.40	1.31-1.35	1.29-1.30
Standard length / Snout to D_2	2.40-2.55	2.37-2.45	2.27-2.47	2.36-2.67	2.36-2.55	2.22-2.73	2.45-2.64	1.41-2.66	1.08-1.31	2.39-2.73	2.41-2.51	2.45-2.53
Standard length / Snout to pelvic fin	1.35-1.38	1.32-1.44	1.34-1.41	1.32-1.39	1.34-1.42	1.32-1.40	1.37-1.38	1.36-1.41	1.29-1.36	1.26-1.51	1.33-1.39	1.43-1.46
Snout to anal fin												

Note : For Convenience of reference the first three columns which have already appeared in Appendix A at p. 270 are included here.

Life-history and Habits of the Leaf Worm, *Nausinoe geometralis* (Guenee) (Pyraustidae: Lepidoptera)[1]

BY

S. KANAKARAJ DAVID AND S. VENUGOPAL

Agricultural College and Research Institute, Coimbatore

(*With one text-photograph*)

INTRODUCTION

Although several insects affecting the jasmine crop (*Jasminum* spp.) have been recorded in south India (Ramachandra Rao, 1930; Ramakrishna Ayyar, 1940) some of the destructive ones remained unnoticed until recently. The importance of these latter insects was brought to light by one of the authors (David, 1958). The Leaf Worm, *Nausinoe geometralis* (Guenee), (Pyraustidae: Lepidoptera), is one of them; it infests the plants in many localities in south India and damages them to a considerable extent. Since the biology and habits of the insect in this area are not known, a study was undertaken in the Agricultural College and Research Institute, Coimbatore, during the years 1957 and 1958 and the features of interest noted are presented below.

HISTORICAL

Hampson (1896), the first to record the Leaf Worm in the Indian region, included it in the genus *Lepyrodes* Guenee. There seems to be no further mention of it in Indian literature. In the present investigation it was noted in Coimbatore and was identified by Dr. Tams through the courtesy of the Director, Commonwealth Institute of Entomology, London.

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[1]Communicated by the Dean, Agricultural College and Research Institute, Coimbatore.

Distribution

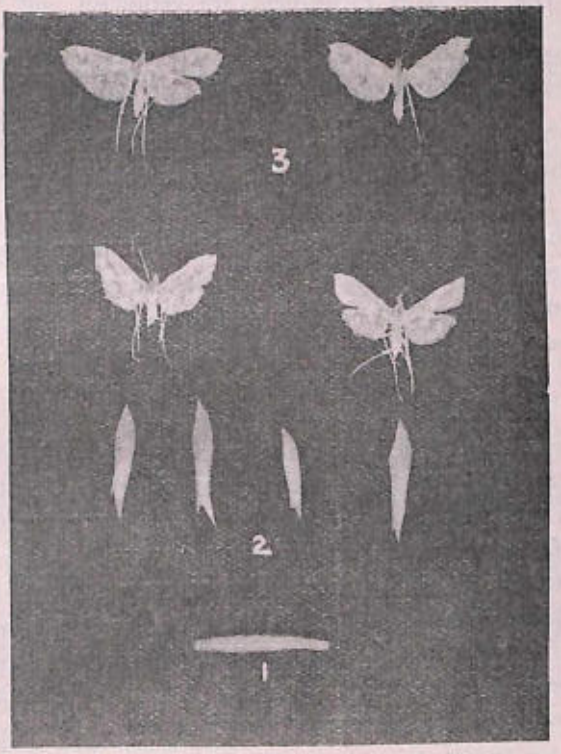
The range of occurrence of the insect given by Hampson (1896), includes west Africa, the whole of India, Ceylon, Burma, Java, Formosa, China, and Australia. In India the localities where it had been collected are not given. So far as south India is concerned, the collection of insects in the Agricultural College and Research Institute, Coimbatore, which fairly represents the insects of the region, does not include this species. Since, as stated above, considerable attention has been paid to the insects affecting Jasmine in south India, a conspicuous insect of this type which damages the plant in a marked manner could not have been easily overlooked. It has, therefore, to be concluded that the insect has spread to this region only recently. As there is no reference to this insect even from other parts of India, it has to be regarded as rare. Currently it has been collected in Cuddalore in the north-east, Coimbatore in the mid-west, and Kovilpatti in the southern parts of Madras State, and in Pattambi (Palghat District) in the central part of Kerala State.

The Insect and its Immature Stages

The moth. The adult moth (Text-photo. 3) is about 10 mm. in length with a wing expanse of 22 mm. for the largest specimen, which is slightly smaller than the 26 mm. quoted by Hampson (1896). The yellow, filiform antennae reach the tip of the wings. The palpi are yellow and fluffy and project in front of the large, black eyes. The abdomen is purplish brown interspersed with dorsal and lateral white patches in each segment; it is slightly swollen in the middle and tapers towards the anal end. The wings appear brownish but are marked with yellow and black transverse lines; the fore wing has five large irregularly elongated white spots and four small circular ones, while the hind wing has five large spots and one small spot.

The moth generally rests by hanging under the lamina of a leaf. It chooses leaves on the outermost portions of plants and faces away from the shaded, bushy stem, evidently preferring to face the open, lighted space. The wings are held half open at an angle of about 45° with the abdomen. It gets disturbed easily by the approach of a person or the shaking of the plant, and flies away in a quick and zigzag manner. It flies only a short distance and alights in another portion of the plant. It is usually active during the day and many can be seen flying about when the plant is shaken.

The egg. The moth lays eggs singly on the laminae of the leaves, either on the upper or the lower surface. It does not appear to



The Leaf Worm, *Nausinoe geometralis* : 1. The larva; 2. Pupae ; 3. Adults.

discriminate between the tender and older leaves, as the eggs are found on any portion of the plant in the field. The egg is greenish yellow, translucent, circular, and flat. It measures about 1 mm. in width and can only be distinguished with difficulty on the leaf. Occasionally three or four eggs may overlap each other. In captivity the moth laid only 15 to 20 eggs in all.

The larva. The caterpillar which hatches out from the egg measures about 6 mm. and is slender with a light yellow colour. The head is as long as broad, and narrower than the body. It undergoes 4 moults and becomes full-grown when it measures about 20 mm. in length (Text-photo, 1). It turns green, with the head having a brownish wash and with smaller or longer dark longitudinal bands on the dorso-lateral aspect of the thorax and abdomen. Thin,

white, short hairs are found on the abdomen surrounded by dark, thin, circular lines which, however, may not be developed in some cases. Each segment of the abdomen bears three tubercles with dark spiracles. The five pairs of prolegs are yellowish and have circular crochets.

The caterpillar attacks the leaves of the plant mostly in the lower bushy and shaded portions. Occasionally, however, it appears also on the terminal tender shoots. It webs the leaves in an open and loose manner. The threads of silk are seen like cobweb on the surface of the leaves or between the leaves. Faecal pellets get entangled in some places and make the web appear dirty. The web gets extended over the adjacent leaves as the successive generations of caterpillars feed on other leaves in the vicinity. Thus a composite web of loose connecting strands over the whole branch or a number of side branches is developed, which stands out characteristically in the infested plants.

The caterpillar is found on the upper or lower surface of the leaves and scrapes only the parenchymatous matter in the early as well as in the later stages. Several caterpillars may feed at one time on different portions of the same leaf. In severe cases the webbings become a nest which harbours several caterpillars almost in a gregarious manner. The skeletons of the leaves, riddled with small holes in some places, dry up in course of time but are held intact in the webbing. If the plant is left undisturbed the area of attack increases to a considerable extent.

The pupa. The insect pupates in the loose silk strands of the webbing, suspending the pupa in them. When the caterpillar is about to pupate it comes to rest on the web, mostly in a horizontal position and in rare cases vertically. Further strands of silk are added to the head and anal regions so as to make these portions thick and strong. It then contracts itself into a smooth, green, spindle-shaped, naked pupa held in position by the pointed ends, which are attached to the silk threads. The swollen portion of the pupa is broadest in the anterior third and tapers to both ends. The fore part is sharply conical while the hind one is elongate and gradually diminishes in size. The appendages stand out distinctly and fall only slightly short of the full length of the pupa (Text-photo, 2). In two or three days the pupa turns yellow and looks like a dry leaf; it remains like this till the moth emerges.

Life and Seasonal History

Observations on the life and seasonal history of the Leaf Worm made during the last two years in Coimbatore showed that it occurs all through the year on the plants in gardens. The density of population increases from May onwards and reaches the peak in July. It continues to be heavy up to December and diminishes thereafter till it reaches the lowest level in April.

In laboratory rearing the life cycle of the insect was found to range from 22 to 24 days in the monsoon season of July and August. The egg, larval, and pupal periods lasted 3 to 4, 12 to 15, and 6 to 7 days respectively.

Food Plants of the Insect

In south India the insect has been so far noted only on Jasmine and is here taken to be monophagous. It may be noted here that the food plant of the insect had not so far been known in India. Among the different species of Jasmine it occurs on *Jasminum sambac* and *J. flexile* quite commonly, but only occasionally has been noted on *J. auriculatum*. Stray incidence of the insect has been noted on *J. grandiflorum* but *J. malabaricum* was not affected.

Ecology

In Coimbatore the insect occurred on the terminal shoots during periods of dry and sunny weather in summer, and in bushy portions in dense foliage with elaborate webbing in the rainy season. Even heavy rains did not have any deleterious effect on the progress of the insect. The distribution of the insect in south India given above shows that the insect breeds with equal ease both in the warm and dry plains of the east and the rainy and humid hills of the west.

Natural Enemies

Although the Leaf Worm occurs in rather great abundance in this area, no regular parasites have been obtained from any of the stages of the insect so far. However, stray pupal cases of *Apanteles* sp. were noted in the webbings in the plants and it is believed that *Apanteles* attacks the insect in its larval stage.

Several instances of fresh attacks of the insect in terminal portions of the plant with the characteristic feeding and webbing were found arrested and the caterpillars were missing. This would appear to be due to the predatory activities of spiders and mantids which visit

the plants often. Some spiders live in the rolled-up leaves of the plant itself and account for the disappearance of various insects which affect the plants. However, when the insect lives in its extensive webbings, it appears to be fairly free from the inroads of predators.

Economic Status

As stated above the characteristic feeding of the insect reduces the leaves to mere veins which dry away in course of time. When the density of population increases the severity of damage is considerably increased. Consequently the vitality of the plant is reduced which tells upon the growth of the plant and the production of buds. *J. sambac* being a slow grower suffers more from the attack than *J. flexile* which easily overcomes the infestation by rapid and extensive production of new shoots. When the insect attacks the terminal shoot, only the second or the third leaf is damaged, leaving the top shoot to grow in the normal way, but the vigour of the shoot is much reduced.

Control of the Insect

When the infestation of the insect becomes severe, it becomes necessary to institute control measures. A fairly heavy infestation occurred in September on *J. sambac*. DDT 0.1%, BHC 0.05%, and Parathion (Folidol) 0.025% were sprayed in different portions of the affected area of the garden and were compared against untreated ones. It was found that the plants treated with insecticides were kept free from the infestation for the next one month; later the infestation in the untreated plants also dwindled.

Acknowledgements

The writers are grateful to the Director, Commonwealth Institute of Entomology, London, for kindly identifying the insect. Their thanks are due to the Director of Agriculture, Madras, and the Government Entomologist, Coimbatore, for the facilities given for pursuing the studies.

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The Bats of Central and Western India

PART II

BY

A. BROSSET

(*With 9 maps and 4 plates*)

[*Continued from Vol.* **59** (1) : 57]

Family MEGADERMATIDAE

Genus *Megaderma*

Megaderma spasma Linnaeus 1758

Measurements (in mm.) :

		Localities							
		Kanheri △ ♂	Kanheri △ ♀	Kanheri △ ♀	Kanheri △ ♀	Khandala □ ♂	Talewadi ○ ♂	Kankoli Taluka ○ ♂	Gersoppa ○ ♀
	Forearm	61	57.5	59	58	55	54	56	57
2nd finger	Metacarpal	43	45	44	44	42	43	47	45
	1st Phalange	3	3	2	3	3	3	3	3
3rd finger	Metacarpal	40	37	38	40	36	38	39	40
	1st Phalange	22	22	22	22	22	22	22	22
	2nd Phalange	45	42	46	45	43	40	40	45
4th finger	Metacarpal	43	43	42	45	42	43	45	44
	1st Phalange	12.5	13	12.5	14	12	13	13	12
	2nd Phalange	18	20	19	21	20	20	20	21
5th finger	Metacarpal	48	45	47	50	46	48	50	59
	1st Phalange	15	15	15	15	15	15	14	15
	2nd Phalange	19	19	19	17	17	17	17	18
	Tarsus	32.5	32	32	30	32	30	32	30

Description

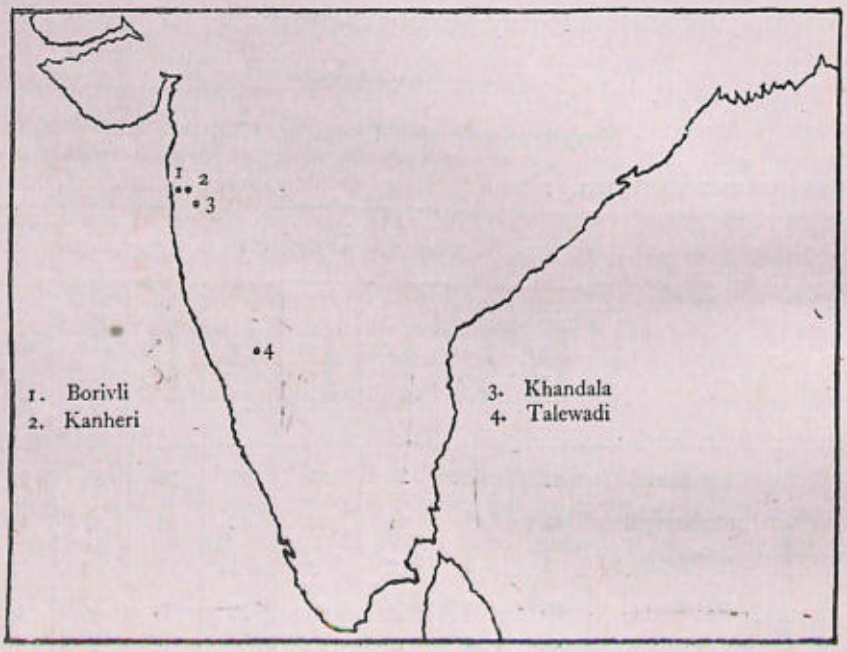
Unmistakable. The size of the forearm and the shape of the nasal leaflets easily separate *Megaderma spasma* from the closely allied species *Megaderma lyra.*

General Distribution

Ceylon, peninsula of India, Burma, Tenasserim and Indo-China, Siam, Malay States, Sumatra, Java, Borneo.

Distribution in western and central India

This species was seen only in a few places in the Ghats and in the coastal areas. It appears to be rare and localized.



Map 12. Localities where *Megaderma spasma* were studied

Ecology

This bat seems to be a species of humid and forested countries. Its ecology would be complementary to that of *M. lyra.* We never saw both species side by side. In fact, although *Megaderma lyra* may be met almost anywhere, it is found in areas drier than those occupied by *Megaderma spasma.*

The Diurnal Biotope

TABLE OF DIURNAL BIOTOPES OF *Megaderma spasma*

Locality	Date of observations	Size of the colony	No. of specimens captured	Nature of biotope
Kanheri	The whole year	From 4 to 27, usually a dozen	17	In a secluded dungeon
Khandala	?	?	1	Observed by A. Navarro in the house of the Jesuit Fathers
Talewadi Cave	May	4-6	3	Large natural cave in wild and forested country

Natural caves seem to be its primitive haunt (e.g. colony at Talewadi). Later the species has adapted itself to anthropic biotopes, e.g. Buddhist Caves at Kanheri and houses in Khandala. The size of the biotope, the extent of the humidity, and the proximity of human activities do not appear to be important factors in the ecology of this species. The vicinity of large forests is the only constant character of its diurnal biotope.

Nocturnal Territory

At the Kanheri Caves, I obtained some data on feeding territory and the nocturnal behaviour of *Megaderma spasma*. In June, July, and August 1960, on several occasions I watched the bats at sunset and during the first part of the night when they regularly came back to eat some of their larger food inside the caves. They also settled outside on protuberances of the cliffs, always visiting the same places under which their distinctive guano and the wings of moths could be seen. At Kanheri, a number of such places were observed, all within 500 m. of their diurnal haunts. These observations also indicate that the feeding territory is not far from its diurnal roost.

Field Characters in Roosting Places

When resting, this species appears very similar to the larger *Megaderma lyra*. The capture of a specimen is the best method of being sure of its identity.

The colonies observed were not numerous—from 4 to 27. The individuals were hanging from the ceiling, usually scattered but also sometimes in 'packs'. In Kanheri, I took several photographs of these 'packs' of *Megaderma spasma*.

Nocturnal Flight

This species is a very nocturnal one. The *Megaderma* take to wing only about 30 minutes after sunset. The start is made one by one, or two

by two, but the bats do not hunt immediately after departure ; instead, they come back to the cave, go out, come again, fly around the porch, etc. After some time, they disappear but never for a long time.

The nocturnal flight is fast, very low, almost touching the ground. I saw individuals exploring the surface of the rocks. Very often, the *Megaderma* perches under a rock or under a branch of a tree. Some observations of A. Navarro in Khandala confirm what I saw myself in Kanheri.

Food

This species brings its prey into the diurnal haunt, and the ground under the colony is strewed with varied remains. I saw at Kanheri a very great number of wings belonging to large grasshoppers and moths of different species. I never saw remains of beetles or small vertebrates, which are caught and eaten by the closely allied species *Megaderma lyra*. The food of *Megaderma spasma* consists exclusively of large insects.

Reproduction

Rut Period. The rut seems to be in December and January. Nevertheless, no remarkable change was noticed in the appearance of the external genital organs, but at this time of the year pairs in the position of copulation can be seen (cf. Brosset, Sexualité et reproduction des chiroptères de l'ouest et du centre de l'Inde. *Mammalia*, in press).

I dissected three females on 9 January 1960. In the uterus of one of these was a small foetus 3 mm. in length. In the others, no foetus was visible.

Pregnancy, and Birth of the Young

The duration of pregnancy is still not ascertained. The births of the young are not simultaneous as is the case in the greater number of insectivorous Indian bats, but take place in the course of about two months. The first newly-born young was seen in the first week of April, and the last one on the 5th June. The periodicity of reproduction is not as strict as it is for many species.

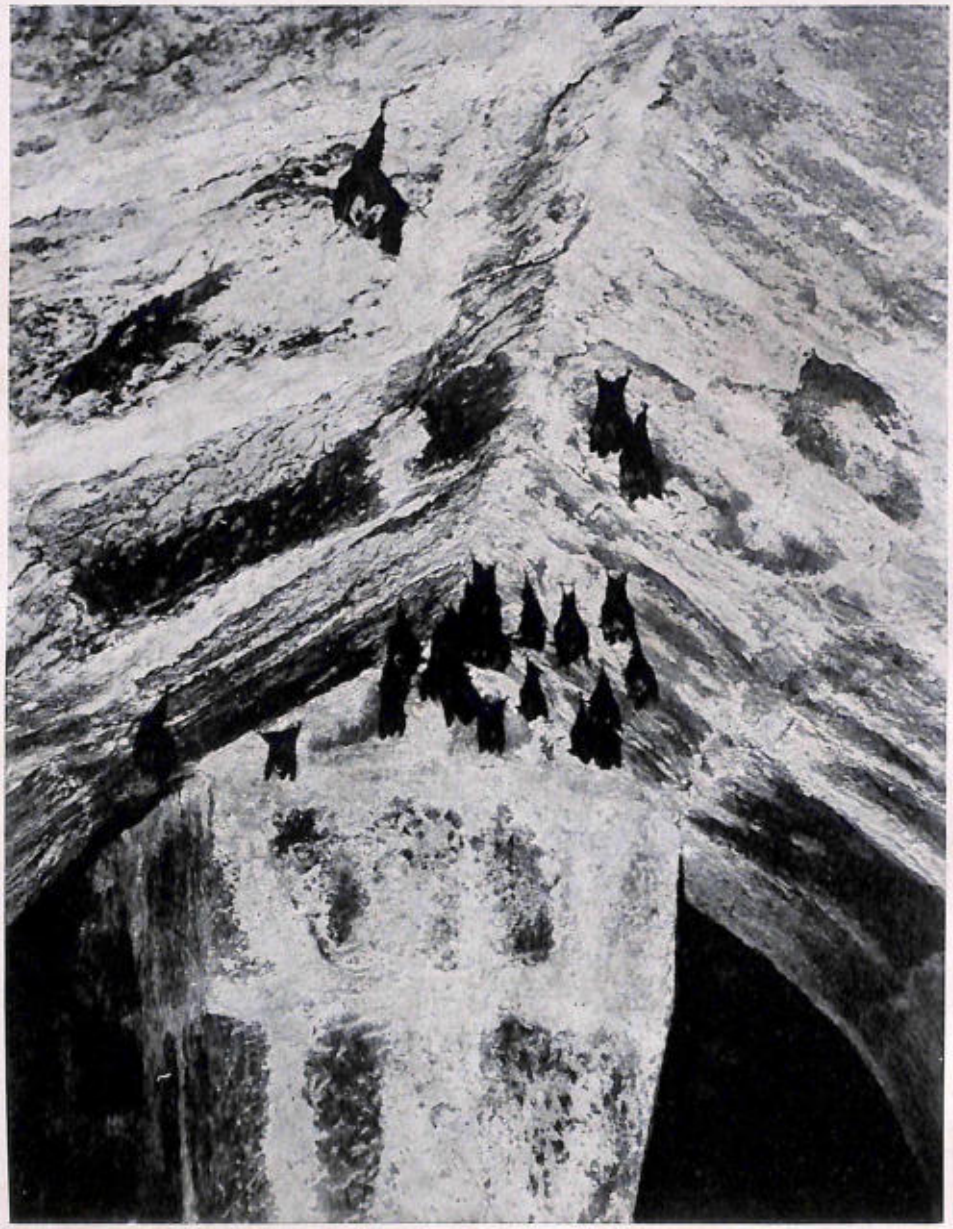
The number of young is usually one. But two were found by Wroughton and myself. Wroughton says that gemellar birth occurs once for six normal parturitions of a single young. But Wroughton does not say how many parturitions he recorded. I saw personally one female carrying two young and 11 females with only one.

The Young

In Kanheri Caves, the young show great differences in size, and certainly each female knows, feeds, and carries her own young. The young keeps itself strongly fixed by the mouth to the false dugs of the mother. It grows quickly and, when it is 45 days old, seems almost as

Colony of *Megaderma spasma* at Kanheri (August, 1960)

(Photo : A. Brosset)



Megaderma lyra in typical diurnal biotope at Aurangabad (1960)

(Photo : A. Brosset)

big as the adult. In spite of its weight, the mother continues to carry the young from one place to another if disturbed in the diurnal haunt. But during the night the young remains alone hanging from the ceiling. If strong enough, it trains itself to fly inside the cave and sometimes appears at the entrance for a short outing. The mother comes back frequently to bring to the young some big insect, moth or grasshopper. These insects are given completely intact, and it is the young which cuts off the wings and masticates the prey without the help of its mother. This behaviour was observed at Kanheri Caves on several occasions.

For *Megaderma spasma* a mixed diet, i.e. milk and insects, begins certainly early and continues till the young reach their full size. In fact, it is not rare to see a suckling young almost as big as the mother. The young becomes independent when about two months old.

Social Life and Migrations

The number of individuals in the colony of Kanheri Caves is very variable and they often change from one diurnal haunt to another, even if not disturbed. I give below the result of a few observations of individuals made in 1960:

Date	No. of Individuals
9 January ..	.. 21
6 February ..	.. none
3 March ..	.. 1
15 April ..	.. 14
20 July ..	.. 20
16 August ..	.. 27
13 November ..	.. 13
5 December ..	.. none

On 9 January, the whole colony was caught for examination. There were 10 females and 11 males only.

We had made an attempt to ring these bats. The forearm of the *Megaderma* is too big for the rings suitable for small birds, and these rings were fitted around the feet. Unfortunately, it seems that the bats succeeded in destroying the rings and for this reason it was not possible to follow these bats individually.

Inter-specific Associations

At Kanheri, the *Megaderma* cohabit with Blanford's Rats, toads, and big geckos (*Hemidactylus maculatus*). Even a python was found in the vicinity of the colony of bats. But the other bats, numerous in these caves, seem always to avoid the cave inhabited by the colony of *Megaderma spasma*.

At Talewadi, *Otomops wroughtonii* and *Rhinolophus lepidus* cohabit with *Megaderma spasma*. But, as the cave is wide and has ramifications,

the presence of these species together is not really significant concerning their social affinities.

Megaderma lyra Geoffroy 1810

Measurements (in mm.) :

		Localities							
		Aurangabad △ ♀	Aurangabad △ ♂	Belgaum △ ♀	Aurangabad △ ♂	Aurangabad △ ♀	Aurangabad △ ♂	Bijapur Fort □ ♂	Versova (Salsette) □ ♂
	Forearm	64.8	66	67	65	66	65	68	67
2nd finger	Metacarpal	55	55	55	52	52	54	57	53
	1st Phalange	11	10	10	10	10	11	9	9
3rd finger	Metacarpal	47	47	47	47	47	47	47	46
	1st Phalange	26	26	29	29	26	27	28	27
	2nd Phalange	51	47	51	50	50	47	52	51
4th finger	Metacarpal	52	53	51	51	50	50	52	51
	1st Phalange	18	16	18	16	16	16	16	16
	2nd Phalange	24	23	23	22	22	24	23	21
5th finger	Metacarpal	57	56	59	56	55	55	55	55
	1st Phalange	20	19	19	19	19	19	17	18
	2nd Phalange	19	20	20	21	20	20	21	20
	Tarsus	34	36	34	35	34	34	33	33

Description

Similar to the previous species, but slightly larger and the shape of the nasal leaflets is different. The skull is noticeably bigger, and there is no tail.

The subspecies *caurina* (Anderson & Wroughton, 1907) cannot be maintained. In fact, we collected many specimens in the area assigned to the subspecies *caurina*, but the greater number are bigger and have the size of *Megaderma lyra lyra*. The small size of the specimens from which the race *caurina* was described is due to individual variations only. We consider that all *Megaderma lyra* of central and western

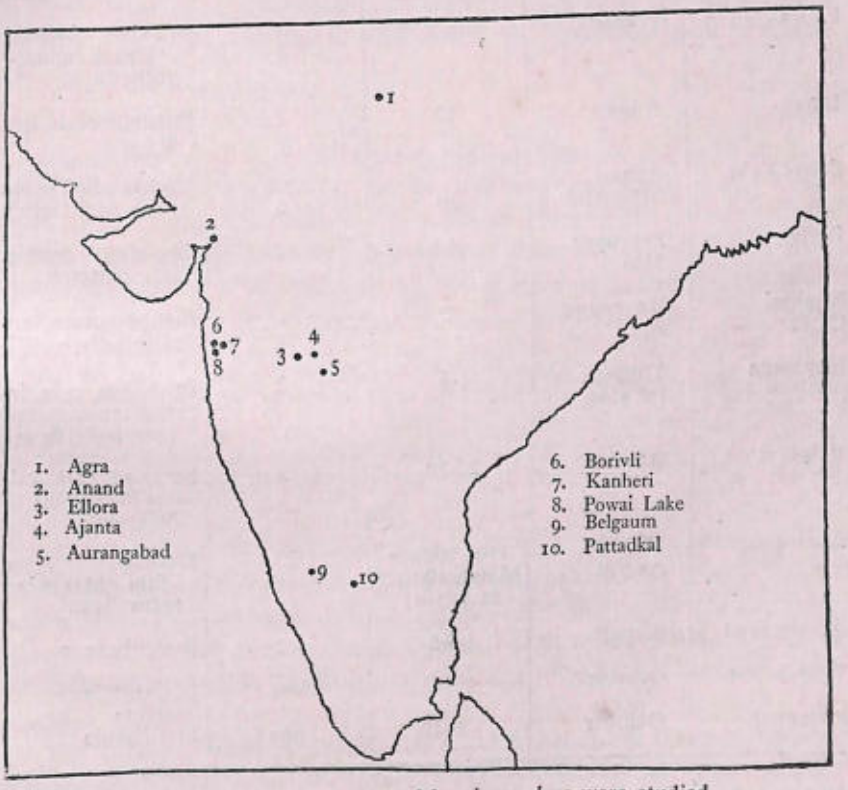
India are *lyra lyra* and the subspecies *caurina* has therefore to be struck off the checklist of Indian bats. (See preceding Table of Measurements.)

Biogeographical Distribution

Approximately south of China, Sikkim, peninsula of India, Burma, Malay States.

Distribution in western and central India

Common species with wide distribution. Nevertheless, it seems to avoid hilly countries, and was not met with in the Ghats.



Map 13. Localities where *Megaderma lyra* were studied

The Diurnal Biotope

Megaderma lyra are completely adapted to anthropic biotopes, e.g. hypogean temples, old buildings, wells, artificial undergrounds. This species is an eclectic one and inhabits undergrounds of different types. Elements of the biotope, as origin, size, shape of the cavity, degree of humidity, structure of walls and ceilings, do not interfere in the ecology of this bat.

TABLE OF DIURNAL BIOTOPES OF *Megaderma lyra*

Locality	Date of observations	Size of the colony	Number of specimens capture d	Nature of Biotope
Agra	April	6	1	Artificial underground in the fort
Ajanta	March	15-20	6	Buddhist cave No. 3. In a dungeon
Ellora	August	20-30	5	In the 'Kailasa' artificial underground
Ellora	August	12	1	Buddhist cave. In a dungeon
Powai Lake	August September	10	3	Underground in the ruins of a factory
Borivli	February May	4-6	2	Hypogean temple. In a dungeon
Kanheri Caves	November April	2	1	In the caves, erratic individuals
Elephanta	Throughout the year	1-4	2	In the last cave, irregular presence of a few individuals
Belgaum	October	25-30	2	Series of dark cellars in the fort of Belgaum
Aurangabad	March August	1500-2000 in March 100-150 in August	20	Underground in the 'Bibi Makbara' mausoleum
Aurangabad	August	4-6	2	Buddhist cave
Vijayanagar	October	10-12	none	In a temple
Pattadkal	October	8-10	none	In a temple

Nocturnal Territory

In Aurangabad, we saw these bats hunting in the immediate vicinity of the diurnal haunt to which they come back regularly to eat the big prey that they catch.

On the other hand, this species possesses special places where they regularly rest and eat during the night, most often arches or ceilings of buildings. This is a general habit of both species of Indian *Megaderma*. Under these nocturnal roosts are usually seen a lot of remains of prey

and the special guano of this species. By the existence of such places one can appreciate the extent of the territory of a colony of *Megaderma*. This extent does not seem wide, but spreads out to about one mile around the diurnal haunt (observations made in Aurangabad).

This bat is a very nocturnal one. We saw individuals leaving undergrounds at Aurangabad more than one hour after sunset. The first appeared after complete darkness only.

Field Characters

Bat of large size with very long ears, a mobile head, living usually in small colonies. Individuals are seen hanging from ceilings. They are shy. If caught, this bat defends itself with extreme vigour and bites severely.

Hunting Flight and Food

Megaderma lyra is a celebrated species because its diet consists partially of small vertebrates, birds, reptiles, mammals, etc., a case quite unique in the Chiroptera. The observations of the author confirm the previous records and bring several precise data concerning the nature of prey and the method adopted by this species in catching vertebrates.

We collected the following data on the nature of prey :

Nasik : Two wings of pipistrelles, pluckings of a crag martin.
Elephanta : Tails and pieces of skins of young rats, several pluckings of crag martin.
Belgaum and Ellora : Pluckings of crag martin.
Aurangabad : Pluckings of crag martin, wings of pipistrelles, a number of legs of frogs.

These remains were collected under the roosts of *Megaderma*. The possibility of other predators having carried them to the place has to be excluded. In Aurangabad, for instance, the remains of the food were lying deep in the undergrounds and on small muddy islands. It is certainly *Megaderma* that bring and eat small vertebrates at such places.

The question which arises is : how can a bat catch terrestrial vertebrates ? The observation of *Megaderma* hunting and the nature of the prey suggest the solution. The hunting flight is very different from the flight of the other species (*M. spasma* excepted). This bat flies around almost touching the ground, or the walls of the cliffs. *Megaderma lyra* when hunting explores, not the open air as the *Pipistrellus* or *Taphozous* do, but the surface of obstacles. Several observations, especially in Aurangabad, were made on this special flight.

Nature of the Vertebrates captured

Wroughton notes that *Megaderma* catch and eat geckos, a reptile living on walls and cliffs. In five cases observed by me the remains of

birds belonged to the Dusky Crag Martin, *Hirundo concolor*. The feathers, especially the remiges and rectrices, were not fully developed, and these birds were evidently taken out of nests. The nest of *Hirundo concolor* is an open cup of mud fixed to a cliff.

The legs of frogs are found during the monsoon. In India, this is the period of the year for the reproduction of the batracians, when certain species keep themselves during the night on vertical rocks, below cisterns or patches of water, and call.

On the other hand, the pipistrelles, one of the prey of the *Megaderma*, frequently rest on the surfaces of walls during the nocturnal flights.

Putting together these observations, we can deduce confidently the methods of hunting of *Megaderma lyra*. Geckos, crag martins, frogs, and other bats are caught on walls and cliffs. The prey is taken by surprise: nocturnal sleep for crag martins, breeding behaviour for frogs, time of rest and perhaps of semi-torpidity for *Pipistrellus*.

Vertebrates are only a part of the diet of *Megaderma lyra*; big insects are also eaten. We found under the roosts remains of grasshoppers, moths, large Coleoptera. Only the body is utilized and the wings are abandoned by the bat. Humayun Abdulali found under roosts of *Megaderma lyra*: wings of the Tussor Silk Moth (*Eupterote* sp.), and the moths *Ophideres fullonica* and *Ophiusa coronata*, and also the hindwings of an Acridid grasshopper.

Reproduction

Sexual organs. The testes never show a large development. The old females have false dugs very visible. The mature stage is reached at probably two years. In Aurangabad in March I saw immature females of one year old mixed with pregnant adult females[1].

Parturition

One young born 15 April. The periodicity seems strict in *Megaderma lyra*, and the young of a colony, as we saw in Aurangabad, do not differ greatly in size. Growth is fast. The mothers carry young even as big as an adult.

At Aurangabad, after the rearing of the young, the huge colony is dispersed, and small colonies probably formed by individuals coming from the 'Bibi Makbara' are seen in caves in the vicinity, and even in the houses in the town (observations made in August 1960).

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[1] K. R. Ramaswamy of Karnatak University, Dharwar (Mysore) in a paper submitted to the Second All-India Congress of Zoology states that in specimens from Agra (Uttar Pradesh), Nagpur and Bhandara (Vidarbha region—Maharashtra State) spermatogenic activity commences in July and reaches its peak in the latter part of October and November.—Eds.

We noticed that young and immature individuals are found regularly with adults and do not form separate colonies.

Social Life

This is a gregarious species, forming colonies from two to 1000-1500 individuals. Colonies of 15-20 are the most frequent.

Intra-specific Association

No case of sexual segregation is recorded for *Megaderma lyra*. Males and females are found together.

Inter-specific Associations

No other bat was seen in the huge colony of the ' Bibi Makbara ' in Aurangabad. Nevertheless, in several places we saw *M. lyra* associated with varied species : *Hipposideros fulvus, H. speoris, Rousettus leschenaulti* in Elephanta ; *Rhinopoma hardwickei, Hipposideros speoris, Taphozous kachhensis, Rhinolophus* sp., or *Hipposideros fulvus* in Pattadkal.

Hibernation

Certainly, this species does not hibernate. The individuals observed were always active and shy.

Association with Man and future of the Species

The biogeographical extension of the species had been undoubtedly facilitated by human constructions, which are now practically the only diurnal haunt of this bat.

The presence of *Megaderma lyra* is never a great disturbance for man. To compensate the capture of some small birds, it destroys a lot of big insects, and the action of this large and strange bat towards the natural balance of the species is probably a benefit for agriculture.

Family RHINOLOPHIDAE

Genus *Rhinolophus*

Rhinolophus rouxi Temminck 1835

Measurements (in mm.):

		Localities							
		Khandala □ ♀	Borivli □ ♀	Sirsi ○ ♂ No. 988	Sirsi ○ ♂ No. 899	Sirsi ○ ♀ No. 1010	Sirsi ○ ♂ No. 897	Lohogad △ ♀	Karnala △ ♂
	Forearm	48	48	48	48	49	48	49	48
	Second finger	38	38	37	38	38	37	39	37
3rd finger	Metacarpal	34	37	34	35	35	35	37	34
	1st Phalange	16	16	15	15	16	15	15	15
	2nd Phalange	24	25	23	24	23	23	25	25
4th finger	Metacarpal	35	36	36	35	36	37	36	34
	1st Phalange	11	11	11	12	12	12	11	11
	2nd Phalange	12	13	12	14	14	14	14	14
5th finger	Metacarpal	32	33	36	35	36	37	35	35
	1st Phalange	11	12	11	13	13	12	11	11
	2nd Phalange	14	13	12	13	13	13	13	13
	Tarsus	21	21	21	21	21	22	22	21
	Tail	25	25	25	25	25	25	25	25

The skull measurements are as follows :

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Karnala △ ♂	23	10	16	10	11

Description

The shape of the nose immediately points out this bat as being a Rhinolophidae. The existence of central and vertical leaflets, known as the sella and the lancet, separate the genus *Rhinolophus* from the closely allied genus *Hipposideros*, which possesses only flat leaflets, without central protuberance.

Three species of *Rhinolophus* inhabit western and central India : *Rhinolophus luctus*, *Rhinolophus lepidus*, and *Rhinolophus rouxi*. The last may be easily separated as being much bigger than *lepidus*, and much smaller than *luctus* (see measurements).

Two different types of colour have been observed in the adult *rouxi* :

Type grey-brown, more or less dark.

Type golden-orange, very bright. This phase of colour is not the commonest.

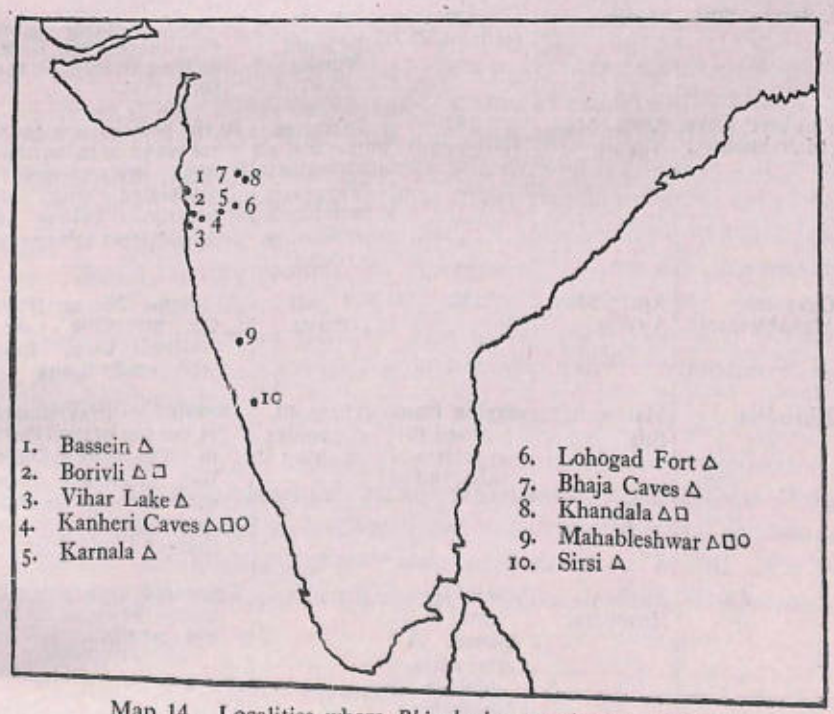
Intermediate individuals, red-brown, have been seen in several places. All the young are dull grey.

General Distribution

Approximately : Ceylon, peninsula of India, Nepal, Darjeeling, south of China.

Distribution in western and central India

The area of *Rhinolophus rouxi* is narrowly restricted to areas with heavy rainfall. The species is a common one in the Ghats, at all levels, in Kanara and in the Konkan. But the Deccan, Gujarat, Madhya Pradesh, and all regions of the dry and continental central part of India seem out of the range of the distribution of *Rhinolophus rouxi*.



Map 14. Localities where *Rhinolophus rouxi* were studied

The Diurnal Biotope

TABLE OF DIURNAL BIOTOPES OF *Rhinolophus rouxi*

Locality	Date of observations	Size of the colony	Number of specimens captured	Nature of biotope
Karnala	Nov.-May July	1-3	5, all males	Very small underground, dark with a patch of permanent water in the bottom near Funnel Hill
Kanheri Caves	All over the year	1-5	7, all males	Scattered in different small and dark caves, along the stream
Kanheri	July	60-80	22, all males	Colony seen a single time in a dungeon of a cave, along the stream
Bhaja	February, March, June	2-5	1 male	In a deep, but a very scanty natural underground, near the Buddhist caves
Bassein Fort	December April	400 (estimated) in December. 25-30 in April	32, all females	Artificial underground, low, wet and muddy, *c.* 70 m. long, under the fortifications
Lohogad Fort	March	3-400 (estimated)	14, all pregnant females	In two artificial caves excavated in the rock, at the entrance of the fort
Robbers' Cave (Mahableshwar)	April, May, August	250 (estimated)	2 females only. But all are females in May, each individual carrying one young	In the bottom of a natural cave with permanent water inside, associated with an enormous colony of *Miniopterus schreibersi*
Cave near Mahableshwar	April, May, August	150	17, all males	At about 200 m. from the preceding cave. Natural cave, low, with ramifications
Khandala	March, May, July	varying from a dozen to at least a thousand	About 40, all females in May	Deserted railway tunnel at the top of the Ghats in Khandala. These bats occupied large excavations of the ceiling, where there is no light and no draught
Vihar Lake	August, November	Several hundred in August. A few individuals in November	2 males	Cemented underground, under the ruins of an old factory
Jogeshwari	August	Several	1 male	In the Hindu caves

Ecology

The diurnal haunt is established in subterranean cavities, dark, often of small size, but with a high degree of humidity and without draught. It is the classical biotope of the numerous species belonging to the genus *Rhinolophus* which spread all over the old world — Asia, Africa, and Europe. The cavity may be artificial or natural. Shortridge found colonies living in hollow trees in North Kanara.

Nocturnal Territory

Rhinolophus rouxi is a forest species. All colonies observed were situated in forest, or in places where the trees are numerous, like Bassein. The weakness of the flight of these bats indicates that the nocturnal territory is around the diurnal haunt.

Field Characters

In the diurnal haunt: *Rhinolophus rouxi* is a bat of middle size, living in subterranean cavities, sometimes isolated or in small groups, sometimes in large colonies. In the colony, the individuals are never agglomerated in clusters, but are scattered on the ceilings of the cavities, from where they hang like cocoons.

From close quarters, one can notice the pointed ears, continuously moving, and the characteristic nasal leaflets.

This bat is rather shy, and usually flies away when the observers are at 3 or 4 metres from the roosting place.

In the hunting territory: *Rhinolophus rouxi* is a very nocturnal bat, which appears only about 30 minutes after sunset. The flight is rather slow, low, with continual turns. This bat hunts in the glades, above paths in the forests, and around the bushes. It explores the foliage, and frequently perches under tiny branches to eat some big prey. These observations were made in Mahableshwar and Khandala.

In the hunting ground, the *Rhinolophus* were always observed flying alone. On the contrary, the *Hipposideros* which appear quite similar were seen hunting in groups. This difference, if constant, may be a good character to separate the *Rhinolophus* and the *Hipposideros* in the hunting territory.

Food

At Mahableshwar I saw an individual eating a grasshopper of middle size. The wings of the prey were cut close from the body, and fell down. Moths and grasshoppers, insects very common in the biotope of *Rhinolophus rouxi*, are probably the principal food of this species.

Reproduction

Rut Period: The colony seen in Bassein on 6th December was

a colony of females exclusively. In an adult male dissected on 13th November, the epididymis was empty of spermatozoa. In connection with the time of the parturition, which is in April, and the duration of the pregnancy which can be estimated at 60-70 days for the species of the genus *Rhinolophus*, we can presume that the spermatogenesis in the male and the oestrus in the female take place during a short period, in January-February.

Birth of the Young

The females give birth to a single young (at least 150 precise observations). The periodicity of the parturition is strict, and all adult females deliver around 15th April.

Lohogad Fort: 14 females collected on 20 March 1960 had large foetuses. The date of birth was estimated as 10 April.

Robbers' Cave: About 150 females were seen on 4 May 1960 each carrying one young about 20 days old, i.e. born on 15 April.

Khandala: In 1960 and 1961, I and Bro. A. Navarro observed hundreds of females carrying one young each, whose date of birth was estimated as 15 April.

The Young

The young keeps itself firmly fixed to the mother, sometimes to the pectoral dugs, more often to the false teats under the pubis. The growth of the young seems fast, but the mother continues to carry the young even as big as itself. Sexual maturity is reached after one year. In July I got in Khandala, amongst adults, females obviously born the previous year and still immature. These observations are in conformity with what is known about the biology of the European and African species belonging to the genus *Rhinolophus*.

Intra-specific Association

The social life of this bat is made remarkable by its vigorous sexual segregation during the greatest part of the annual sexual cycle. The males are met isolated, or in small groups, or rarely in colonies of a few dozen individuals. The females gather in big colonies of several hundred individuals, from where the males are completely excluded (cf. the Table of Diurnal Biotopes of *Rhinolophus rouxi*).

We may notice that this sexual segregation in bats is a regular and general behaviour in cold and temperate countries like Europe (cf. Lasteret-Brosset et Caubere for France). On the contrary, in tropical India this sexual segregation in bats is exceptional and concerned, so it

seems, only with species of the genus *Rhinolophus* and perhaps *Rhinopoma*.

Inter-specific Associations

In Asia as in Europe and Africa association of several species of *Rhinolophus* in the same colonies is common. For instance, in the west and south of the Palaearctic Region *Rhinolophus ferrumequinum* and *Rhinolophus euryale* are regularly living in good understanding in the same roost.

In tropical India exists the same phenomenon. *Rhinolophus rouxi* associates itself regularly with *Rhinolophus lepidus*. This is the case in the colonies of Khandala, Lohogad, Karnala, and Mahableshwar.

Hibernation

Rhinolophus rouxi is a hibernating species, even in tropical countries. So, in August 1960, in a cave near Mahableshwar, Humayun Abdulali and I had the opportunity to observe many individuals in a state of complete hibernation. Cooling experiments were also made with several individuals of this species. The tested individuals fell into deep torpor after a few hours at 8°. They do not suffer from these experiments and recover the normal state at the end of the artificial cooling.

In the Palaearctic Region, and even in Nepal where I was able to observe the fact myself, the periods of hibernation were principally in connection with the rhythm of the seasons. It seems that in tropical countries hibernation which only a few species undergo is influenced by individual rhythms independent of the seasons, and is conditioned by purely internal factors. The reader who is interested in this problem is invited to refer to another work where this question is studied (cf. Brosset, L'hibernation chez les chiroptères Tropicauax. *Mammalia*, December 1961).

Finally, regarding hibernation of *Rhinolophus rouxi*, I draw attention to the fact that the biology of the different species of the very large group of bats belonging to the genus *Rhinolophus* seems the same throughout their immense area of distribution. So, the ecology, the behaviour, the social life, and the reproduction of a typical Palaearctic species, such as the Greater Horseshoe Bat, *Rhinolophus ferrumequinum*, are very similar to those of the Indian species, *Rhinolophus rouxi*, in spite of the great distance separating the two species.

Rhinolophus lepidus Blyth 1844

Measurements (in mm.) :

		Localities						
		Khandala □♀	Mahableshwar △♂	Panchgani △♂	Karnala △♂	Lohogad △♀	Delhi △♂	Kanheri △♂
	Forearm	37	42	38	42	41	40	38
	2nd Finger	29	32	29	31	31	31	30
3rd finger	Metacarpal	27	30	27	29	30	29	29
3rd finger	1st Phalange	12	11	11	12	12	12	11
3rd finger	2nd Phalange	17	18	17	17	17	18	17
4th finger	Metacarpal	28	31	29	30	31	30	29
4th finger	1st Phalange	9	8	9	9	9	9	9
4th finger	2nd Phalange	11	11	9	11	10	10	9
5th finger	Metacarpal	28	30	29	30	31	30	29
5th finger	1st Phalange	9	10	9	11	10	10	9
5th finger	2nd Phalange	12	12	13	13	13	13	12
	Tarsus	13	17	15	17	16	17	16
	Tail	16	18	15	20	17	20	17

The skull measurements are as follows :

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Karnala △ ♂	18.5	8.5	11.5	6	7.5

Description

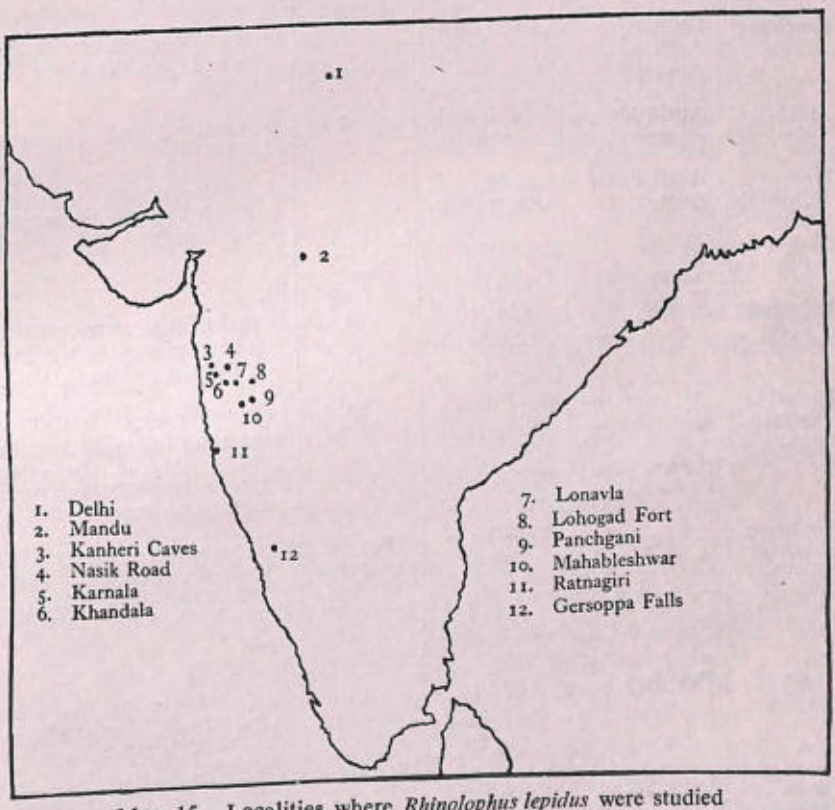
Similar to the preceding species, but much smaller. At close quarters the shape of the nasal leaflets is different. This bat also possesses several types of coloration : a grey-brown type, a fawn colour type, and a pale grey type. The pale grey type of specimen is normal from the dry part of northern India (Delhi). It is a constant fact not only for the birds, but also for the bats that the colour of the populations which inhabit dry countries is paler than that of those of the same species living in humid areas.

General Distribution

Oriental species, found in India, south of China, Burma, etc. Aellen recently gave the description of this species for Afghanistan.

Distribution in western and central India

Widely distributed. It seems that the species can be met with in all places where quiet and dark cavities secure suitable diurnal haunts for it.



Map 15. Localities where *Rhinolophus lepidus* were studied

The Diurnal Biotope

Similar to the diurnal biotope of the other species of *Rhinolophus*, quiet and dark subterranean cavities without draught.

The diurnal haunts observed are situated in forested country, or in places with numerous trees and bushes.

Hunting Territory

Frequent observations have been made on the nocturnal behaviour of *Rhinolophus lepidus* in Kanheri, Khandala, and Mahableshwar.

TABLE OF DIURNAL BIOTOPES OF *Rhinolophus lepidus*

Locality	Date of observations	Size of the colony	No. of specimens captured	Nature of biotope
Karnala	November, February-May, July	3-5 at each visit	5	Very small artificial underground near Funnel Hill
Kanheri	All over the year	3-4 at each visit	11	In the dungeons adjacent to the main caves
Panchgani	February-April, August	3-5 at each visit	3	In the natural caves, at the base of the cliffs above the village
Mahableshwar	April, May, August	4-6 at each visit	2	In a natural cave of small size
Near Robbers' Cave, Mahableshwar	April, May, August	50 (estimated)	10	In a natural cave, relatively dry, with low ceiling and ramifications
Lohogad Fort	March	300-400 (estimated)	8	In two artificial caves excavated in the rock, at the base of the walls of the fort
Tunnel at Khandala	All over the year (observations by Navarro and Brosset)	More than a thousand	*c.* 40	Deserted railway tunnel at the top of the Ghats. The bats gather in the large excavations of the walls and the ceiling
Reversing station in Khandala	?	Very large	Several specimens in the collection of A. Navarro	Colony observed by A. Navarro 20 years ago. Artificial underground serving as a passage for big water pipes
Ruins of Mandu	February	60-80	16	One colony and isolated individuals hibernating in old buildings and undergrounds
Caves of Mandu	February	100-150 (estimated)	7	Colony in the dark and humid part of these caves
Tuglakabad Fort (near New Delhi)	April	6-8	3	In subterranean silos

The hunting territory is probably very small, and close to the haunt. At Kanheri, the individuals living there were observed on several occasions hunting at the entrance to the caves, and even under the porches in case of heavy rains. I saw in Mahableshwar another individual

exploring the foliage of the same tree for at least one hour. The hunting territory seems very well marked, and one can see individuals of this species hunting regularly at the same place every sunset.

Field Characters

In the diurnal haunt. Small horse-shoe bat, hanging from the ceiling of cavities, sometimes isolated or in scattered groups, sometimes in very compact clusters. At human approach it actively moves its nose and ears, trying to localize the intruder with its 'radar'. This species is usually rather shy.

In the hunting territory. Like others of the genus, *Rhinolophus lepidus* hunts alone. The identification of this species is easy. Its very small size, its slow, low, and fanciful flight and its short, broad, and rather transparent wings make its silhouette very peculiar. But its manner of hunting is still more unmistakable. Usually, the bat explores the foliage of the trees, coming and going through the branches, with frequent stops to pick up an insect on a leaf. The behaviour of this bat hunting reminds one of the sphyngid moths, hovering in one spot while searching for the nectar of the flowers and passing suddenly from one clump of plants to another. Often, this small *Rhinolophus* perches under a branch, probably to rest or to eat big prey. It also hunts frequently under porches and verandahs, especially during the rains, and on several occasions in Mahableshwar and Khandala I saw individuals entering into houses during the night.

Food

In Mahableshwar I had the opportunity of observing for a long time an individual eating insects attracted by an electric light on the verandah. It appears that all small insects, e.g. mosquitoes, small moths, and Coleoptera are preyed upon by this bat.

Reproduction

Spermatozoa have been observed in the epididymis of a male dissected in January. On 19 February 1961, I found many pairs in Mandu made up of two individuals in the mating position. These bats were in a state of torpidity and their examination was easy. We also verified that several pairs were made up of individuals of the same sex, and the significance of this behaviour remains unknown.

Two adult females dissected in February had no visible foetus. As the birth of the young takes place in the beginning of May, the duration of pregnancy is probably rather short (60-70 days ?).

Parturition

The periodicity is strict. All the young – one per female—are born at the beginning of May.

At Lohogad Fort 8 females taken at the end of March were all in the same state of pregnancy.

The enormous colony of *Rhinolophus lepidus* was observed regularly in 1960 and 1961 by Bro. A. Navarro and myself. Each female seen at the end of May was carrying one young. No case of reproduction was noticed during other seasons.

Social Life

The social life shows an interesting peculiarity. The formation of clusters, where individuals from a dozen to several hundreds are pressed close together, is the normal manner of grouping for many Vespertillionidae, like *Miniopterus schreibersi* for instance. It is extremely rare in the genus *Rhinolophus*, and only *Rhinolophus lepidus* is known to have such a behaviour.

Inter-specific Associations

A. Navarro who collected a number of specimens in the colony at Khandala noticed that males and females live in separate clusters in May-June. Nevertheless, the sexual segregation which is the rule practically all over the year for *Rhinolophus rouxi* is not a permanent behaviour in *R. lepidus*. In fact, in colonies observed during spring and winter in Mandu, Lohogad, and Mahableshwar, adult males and females were mixed.

Hibernation

Rhinolophus lepidus is a characteristic hibernating species in tropical India. Several observations made on the hibernation of this bat are given below :

Panchgani. On 28 February 1960 one individual was deeply hibernating.
Robbers' Cave, Mahableshwar. On 7 August 1960 several individuals collected were in a state of complete hibernation.
Mandu. On 20 February 1961 about 60 individuals were observed in complete hibernation.
Khandala, W. Ghats. Bro. A. Navarro and myself regularly observed hibernating individuals during the whole annual cycle.

In Mandu, a cluster of 18 *Rhinolophus lepidus*, all deeply hibernating, was observed and photographed. This is an unusual observation as in the other cases there were individuals active and hibernating mixed together. This proves that hibernating rhythms are individual and not due to climatic or other external factors.

Rhinolophus luctus beddomei Anderson 1905

Measurements (in mm.) :

		Localities							
		Bhaja △ ♂	Bhaja △ ♂	Khandala □ ♂	Bhaja □ ♂	Khandala □ ♀	Khandala □ ♀	Khandala □ ♀	Karla □ ♀
	Forearm	62	61	58	59	63	61	62	60
	2nd finger	41	41	42	42	45	44	43	41
3rd finger	Metacarpal	38	38	39	39	42	38	38	39
3rd finger	1st Phalange	21	23	22	22	25	25	25	24
3rd finger	2nd Phalange	35	32	31	33	38	36	35	35
4th finger	Metacarpal	45	45	40	44	44	44	44	45
4th finger	1st Phalange	12	12	12	12	16	14	14	14
4th finger	2nd Phalange	22	23	22	23	23	22	22	20
5th finger	Metacarpal	44	46	47	43	50	49	50	45
5th finger	1st Phalange	12	13	11	12	14	13	14	14
5th finger	2nd Phalange	24	23	22	24	25	24	25	24
	Tarsus	32	32	30	31	32	32	34	31
	Tail	40	40	?	?	?	?	?	?

The skull measurements are as follows :

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Bhaja ♂	27	13	17	10.5	12

Description

Rhinolophus luctus is a large species with long and woolly fur, a big head and well-developed nasal leaflets. The pointed ears immediately separate this bat from the *Megaderma*, which are of the same size but show very long, rounded ears.

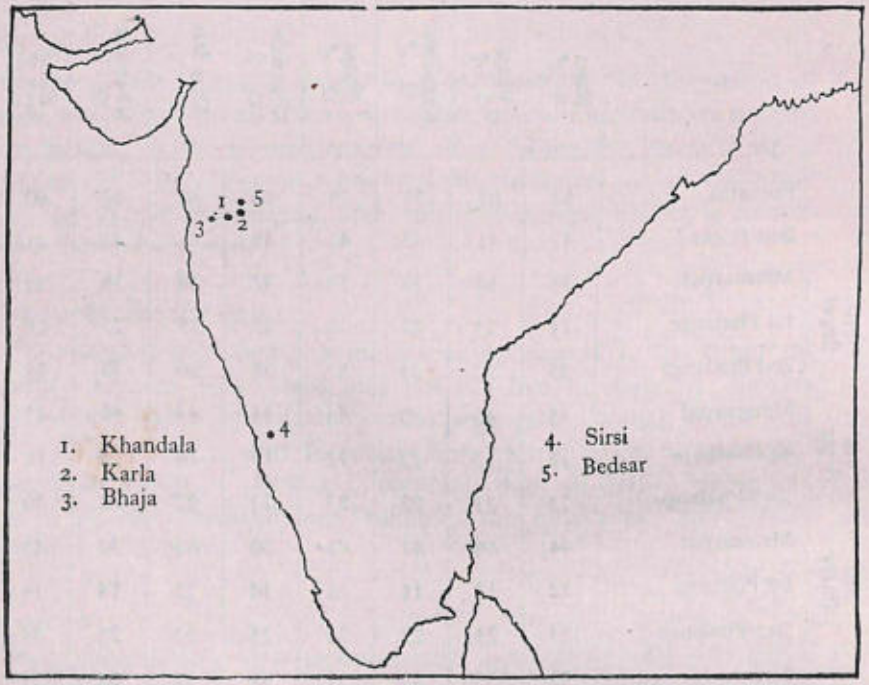
Several good subspecies are known. The race *beddomei* characterized by its relatively small size inhabits the mountain ranges of western and south India, and Ceylon.

General Distribution

South of China, India, Nepal, Sikkim, Burma, Tenasserim, Malay States, Sumatra, Java, and Borneo.

Distribution in western and central India

Narrowly limited to the forested area of the Ghats at 600-800 m.



Map 16. Localities where *Rhinolophus luctus* were studied

The Diurnal Biotope

TABLE OF DIURNAL BIOTOPES OF *Rhinolophus luctus*

Locality	Date of observations	Size of the colony	Number of Specimens captured	Nature of biotope
Karla	September, August, May, December	One or two at each visit	2	Buddhist caves of Karla (observations of A. Navarro in 1938-45, of H. Abdulali in December 1948, and myself in 1959-61)
Bedsar	June	1	Nil	Buddhist caves of Bedsar
Khandala	?	One or two at each visit (*fide* A. Navarro)	4	Observations and captures made by A. Navarro in old barracks, houses, and tunnels
Bhaja	January, March, May, June	One or two at each visit	3	In the dungeons adjacent to the Buddhist caves

This species is a rare one, represented in western India by a small number of individuals only. The ecological requirements seem very precise, and this bat is localized in a narrow area.

The Buddhist caves of Bhaja, Karla, and Bedsar are regularly the haunt of a few individuals. A. Navarro got specimens in old barracks, and houses in Khandala. Shortridge observed *Rhinolophus luctus* in hollow trees in North Kanara. The species is an eclectic one for the diurnal biotope, and it is the ecological surrounding (nocturnal and feeding territory) which determines the localization of this big bat.

Field Characters

In the diurnal haunt. Big horse-shoe bat, of a dark colour in appearance, hanging isolated in a secluded corner of some dungeon, cave, or old building, in the Ghat mountains.

In the hunting territory. No personal observations but, for the Himalayan subspecies, Capt. Hutton states that 'it commences its flight early in the evening and does not soar high'.

Reproduction

The little information collected is as follows :

Karla. 22 May 1934, A. Navarro observed a female carrying young. On 16 May 1961, I observed a female at the same place carrying one young.

Social Life

Rhinolophus luctus is an unsociable mammal. The other species of *Rhinolophus* usually gather in large colonies, but *Rhinolophus luctus* on the contrary lives alone or in pairs, and does not associate in communities. This behaviour quoted by Hutton, Shortridge, Navarro, and myself is rare among bats.

Hibernation

In western India, hibernation was not observed in nature, but the biology of this species is not sufficiently known. Probably, this horse-shoe bat hibernates in the Himalayas. Individuals experimentally cooled entered into a state of deep hibernation. The species possesses hibernatorial aptitudes, like the other species of the genus *Rhinolophus* (cf. Brosset, L'hibernation chez les chiroptères Tropicauax. *Mammalia*, December 1961).

Subfamily HIPPOSIDERINAE

Genus *Hipposideros*

Hipposideros speoris Schneider 1800

Measurements (in mm.) :

		Localities						
		Khandala □ ♂	Gadag ○ ♂	Gersoppa ○ ♂+ ○	Gersoppa ♀	Gersoppa ○ ♂+	Elephanta △ ♂	Elephanta △ ♂+
	Forearm	51	51	51	51	50	52	52
	2nd finger	39	40	39	39	39	41	42
3rd finger	Metacarpal	36	37	37	36	37	39	39
3rd finger	1st Phalange	15	15	14	14	14	16	16
3rd finger	2nd Phalange	17	17	16	17	17	18	18
4th finger	Metacarpal	34	34	32	32	35	37	38
4th finger	1st Phalange	12	12	11	11	11	13	13
4th finger	2nd Phalange	10	10	10	10	8	13	12
5th finger	Metacarpal	33	32	32	32	32	33	33
5th finger	1st Phalange	12	13	13	13	13	15	15
5th finger	2nd Phalange	10	10	8	10	10	11	11
	Tarsus	22	21	19	20	20	23	23
	Tail	26	26	22	16	16	25	28

The skull measurements are as follows :

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Badami ♂	20	11	13.5	7.5	9

Description

The examination of the nasal leaflets immediately differentiates *Hipposideros* from a *Rhinolophus*. The last vertebra is free out of the tail, this character being unique amongst the Rhinolophidae of western India.

The species of *Hipposideros* in western and central India are : *H. speoris, H. bicolor, H. lankadiva,* and *H. galeritus*. The measurement

of the forearm is enough to distinguish *H. speoris*, which is bigger than *bicolor* and *galeritus*, and much smaller than *lankadiva* (see Table of Measurements). The ears are pointed in *speoris*, long and rounded in *bicolor*, short and pointed in *galeritus*.

Three phases of coloration exist in *Hipposideros speoris* :

A yellowish brown type—the commonest,

A bright yellow-orange type—8 ♀♀ in the BNHS collections belong to this type, and

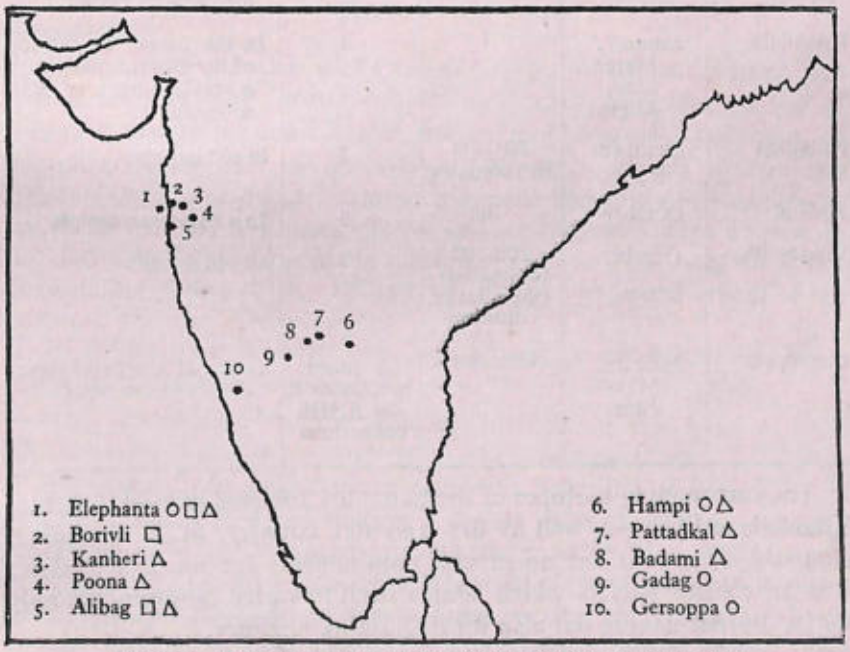
A grey type—the colour of the young and immature individuals.

General Distribution

India, Ceylon, Borneo, Timor.

Distribution in western and central India

A common species in the Konkan, North Kanara, and southern Mysore. It is not known from Gujarat, and generally speaking not to the north of a line from Bombay to Hyderabad. *Hipposideros speoris* seems to inhabit only the southern and central part of the country.



Map 17. Localities where *Hipposideros speoris* were studied

The Diurnal Biotope

Caves and old buildings. The primitive haunt of this bat was probably natural caves, but the species is today very well adapted to all sorts of constructions and excavations made by man. The size of the haunt, the degree of humidity, the height of the ceilings, and the darkness

seem to be some of the points of importance which decide the localization of this bat.

TABLE OF DIURNAL BIOTOPES OF *Hipposideros speoris*

Locality	Date of observations	Size of the colony	Number of specimens captured	Nature of biotope
Elephanta	The whole year	350	186	In an artificial cave
Alibag	May	1000 (estimated)	4	In a natural cave on a hill behind Alibag
Borivli	?	Numerous	2	In a hypogean temple (observations of Bro. Navarro. The colony is not in existence today.)
Poona	January	20-30	5	Artificial cave of small size, on a hill, about 25 km. west of Poona
Khandala	January, March, May, August	?	4	In the tunnel on the top of the Ghats, mixed with a great number of *Rhinolophus*
Pattadkal	October	300-400 (two colonies)	2	In old temples
Badami	October	200	5	In a hypogean temple
Vijayanagar	October	500-700 (estimated) (three large colonies)	3	In old temples
Gersoppa	January, May-June	Numerous ?	A dozen specimens in the BNHS collections	In an old temple (observation of Shortridge)

The surrounding biotopes of the haunt are forested hills—Elephanta, Khandala, Alibag—as well as dry and flat country, as in Pattadkal. *Hipposideros speoris* has no precise requirements for its localization ; it is an eclectic species which adapts itself to varied biotopes, not only for its diurnal haunts but also for its hunting territory.

Field Characters

In the diurnal haunt. Gregarious species living in colonies from about 20 to about 1000 individuals. These *Hipposideros* keep themselves hanging from the ceilings of caves or buildings, always in the darker parts of the haunt. They do not form clusters and the individuals of a colony are scattered, and not in contact with each other.

At human approach, they turn their heads in all directions, vividly moving their muzzles and their ears, and fly away when the observer is about 1 or 2 metres from them.

In the hunting territory. In Badami, I had the opportunity of observing under favourable conditions, a colony of this species in its hunting territory. These bats leave the diurnal haunt about 10 minutes after sunset. The nocturnal territory is in the immediate vicinity of the haunt. Contrary to *Rhinolophus* which hunt isolated, *Hipposideros* hunt in groups of 10 to 15 individuals. They fly close to the ground, almost touching rocks and bushes, with a slow but very skilful flight, with continual changes of direction. If the observer keeps himself motionless, these bats come to hover a few centimetres from his face and his body, perhaps out of curiosity or, more probably, attracted by mosquitoes which besiege the unfortunate naturalist.

Food

In Badami, we saw individuals of the species catching mosquitoes and flies.

Reproduction

External sexual characters. In autumn and winter, the scrotum of the male grows considerably thick, and forms a sort of muscular capsula of considerable size. The biological significance of this phenomenon was not observed in the other species of bats and remains to be elucidated. During the same seasons, due probably to the sexual activity, the penis grows, and its size may reach 15 mm. in certain individuals. The young male, less than a year old, does not show these peculiarities. During the spring, the sexual organs of the adult male become normal again.

In old females, the false teats are often very developed, one being much bigger than the other.

Rut Period. The young do not mate in the first year of their life, but only during the second, as could be observed from a number of immature males and females caught in February at Elephanta. I had under controlled observation a female ringed as an immature in November 1959 ; she was seen carrying one young in May 1961.

The spermatogenesis in the male seems short. An adult male dissected on 2 December 1960 had no spermatozoa in the epididymis, and two females had no spermatozoa in the vaginal duct. Each of two other adult females dissected on 11 February 1961 had a just visible foetus, and a third no visible foetus. The rut certainly takes place in January.

Parturition

The periodicity is absolutely strict for this species, and all females deliver together in May. The first to do so were observed around 5th May, and the last around the 25th of the same month.

A single young is the rule. About 200 females carrying one young have been noticed in Elephanta and Alibag, and no case of twins has been met with.

Growth of the Young

The young are born naked, and have their eyes closed ; the skin is of a greyish shade.

When it is not suckling, the young keeps itself firmly fixed by its mouth to the false teats on the pubis of the mother, who carries her young continuously. The position of the young in relation to that of the mother is inverted, giving both a good equilibrium.

When 35-45 days old, the young reaches three-fourths of its adult size, and ceases to be carried by the mother. Juvenile mortality seems low in this bat, and no dead young were found under the roosting places. Young, less than one year old, are grey with visible immature sexual organs, and are easily separable at the first glance from adults.

Social Life

The social life of *Hipposideros speoris* is quite well studied in the colony at Elephanta which was regularly visited, and where 186 individuals were caught. Of these 151 were ringed in November 1959 and February 1961 with the co-operation of the Bombay Natural History Society.

There is no sexual segregation in *Hipposideros speoris*. During the whole annual cycle males and females are found together. Nevertheless, as is the rule in colonies of bats, the sex-ratio is not balanced in the colony at Elephanta. The details of individuals ringed are

15 November 1959 : 18 ♂♂, 54 ♀♀
11 February 1961 : 24 ♂♂, 55 ♀♀.

The females are more than twice as numerous as males during a period which is the mating time. I cannot find a satisfactory explanation for this disparity. In fact, at the same period of the year, the males are more numerous in certain colonies of *Hipposideros* (cf. *Hipposideros bicolor* and *H. lankadiva, infra*).

As already said, the young remain with the adults after weaning. In autumn and spring, the population of this bat at the Elephanta colony reduces itself to about a third of its total number.

Inter-specific Association

Hipposideros speoris is a sociable species which associates itself with a number of other species :

Rousettus leschenaulti and *Hipposideros bicolor* in Elephanta,
Rousettus leschenaulti and *Taphozous melanopogon* in Alibag,
Hipposideros lankadiva in Gersoppa, and
Taphozous kachhensi and *Rhinopoma hardwickei* in Mysore.

These variable associations are certainly due to ecological convergence, and not due to psychological attractions.

Displacements and Migrations

H. speoris is a sedentary species, which inhabits the same biotope during the whole annual cycle, and probably many individuals keep to it during a whole lifetime. So, the individuals ringed at the beginning of the present studies were regularly observed at the same place during 1960 and 1961. The number of ringed individuals was half in February 1960, and only a quarter in May 1961. This decreasing percentage seems to be normal, owing to the birth of two generations of young, and natural loss of individuals from old age, sickness, or predators.

Hibernation

H. speoris never hibernates in the natural state. Experimental studies made with individuals of this species proved that *H. speoris* does not possess hibernatorial faculties ; it remains active even if artificially cooled.

Hipposideros bicolor fulvus Gray 1838

Hipposideros bicolor pallidus Andersen 1918

Both these subspecies which differ only by the colour of their fur are studied together.

Description

A *Hipposideros* of small size, with long and rounded ears. The nasal leaflet is small and square.

Three types of coloration exist in western and central India :

A fulvous type. The individuals of this type which are to be included in the subspecies *fulvus* inhabit the humid parts of the country, e.g. Konkan, Ghats, and North Kanara.

A pale grey type. This coloration is special to the subspecies *pallidus* which inhabits the dry areas like the Deccan (Aurangabad), northern Gujarat, and as it seems through the specimens of the BNHS collections the whole of north-western part of India.

A golden-orange type. Very bright. Was seen both in the area of the subspecies *fulvus* (in Lonavla), and in the area of the subspecies *pallidus* (in Aurangabad). This golden-orange type is rare, and is purely an individualistic character. In fact individuals of this type are associated with a great majority of normal individuals in the same colonies.

A female collected in Mahableshwar has the posterior margin of the leaflet unrounded, but in the shape of a trident. This abnormal specimen reminds one by its appearance of a closely allied Rhinolophid, *Asellia tridens*, which inhabits the Asiatic and African deserts. Nevertheles

the other characters of external morphology are those of *Hipposideros bicolor.*

Measurements (in mm.) :

		Localities						
		Hipposideros bicolor fulvus					*Hipposideros bicolor pallidus*	
		Godhbunder □ ♂	Bombay △ ♂	Bombay ○ ♀	Kanara No. 1241 ♀	Elephanta △ ♀	Aurangabad △ ♂	Bochasan △ ♂
	Forearm	41	39	40	40	42	42	41
	2nd finger	32	32	32	32	32	33	32
3rd finger	Metacarpal	29	28	29	29	29	29	29
3rd finger	1st Phalange	18	18	18	17	18	18	17
3rd finger	2nd Phalange	20	20	20	20	20	20	20
4th finger	Metacarpal	31	30	29	32	32	32	30
4th finger	1st Phalange	13	12	12	13	12	13	13
4th finger	2nd Phalange	12	11	10	10	11	11	11
5th finger	Metacarpal	32	30	29	32	32	32	31
5th finger	1st Phalange	14	14	14	14	14	14	14
5th finger	2nd Phalange	15	13	15	15	15	14	13
	Tarsus	16	17	17	17	18	17	16
	Tail	31	27	28	28	31	25	26

The skull measurements are as follows :

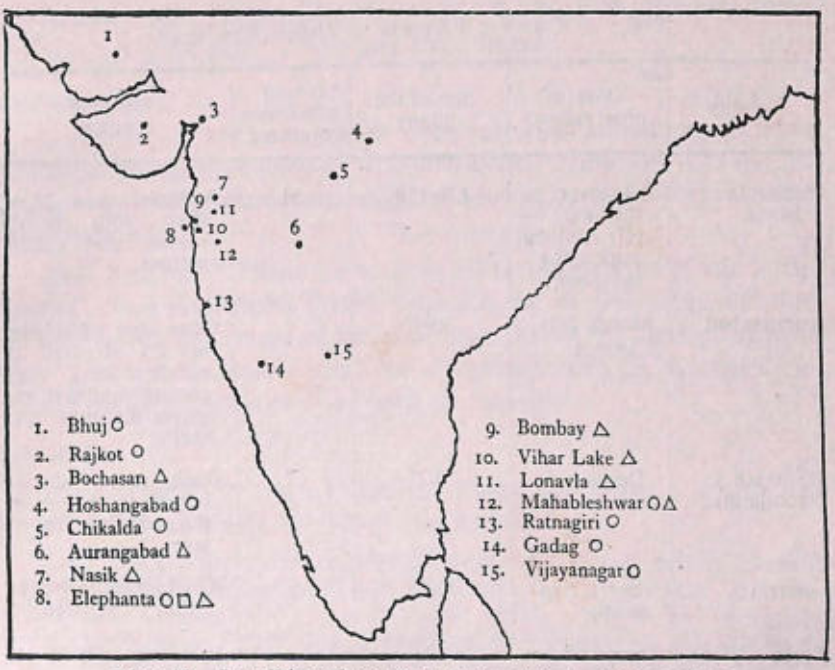
	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Aurangabad ♂	19	9.5	12	7	8

General Distribution

India, Ceylon, Burma, Tenasserim, Lower Siam, Formosa, and Nicobar Islands.

Distribution in western and central India

A common species all over the area studied.



Map 18. Localities where *Hipposideros bicolor* were studied

Diurnal Haunt and Nocturnal Territory

As we can see from the above Table of Biotopes, *Hipposideros bicolor* is a very eclectic species which adopts all sorts of cavities for the diurnal rest. Even inhabited houses are selected as haunts by this bat, and colonies can be found in a busy city like Bombay. The ecological elements surrounding its biotope are of little importance, and the species has been observed in the most varied biotopes, such as dry plains, forests, at the highest level of the Ghats, as well as on small islands in the sea. *Hipposideros bicolor* having no special ecological requirements, may be found all over western and central India.

Field Characters

In the diurnal biotope. Very similar to *Hipposideros speoris*. The disposition of the individuals in the colonies and their reactions to human approach are the same. But from close quarters, the rounded and long ears easily separate *Hipposideros bicolor* from *Hipposideros speoris*, the latter having the ears pointed and shorter.

In the hunting territory. The behaviour of a colony of this species hunting in the nocturnal territory was observed several times under favourable conditions in Aurangabad. These *Hipposideros* flew away from the porcupine holes which are used by them as a diurnal haunt a long time before complete darkness. At first they flew

TABLE OF DIURNAL BIOTOPES OF *Hipposideros bicolor*

Locality	Date of observations	Size of the colony	No. of specimens captured	Nature of biotope
Elephanta Island	All over the year (H. Abdulali during the monsoon)	120-250	81	Artificial cave 25 m. deep with several rooms and ramifications
Aurangabad	March, July, August	30-40	1	Open cave with holes at the bottom in which foxes and porcupines dwell, and where the bats take shelter
Bochasan (Gujarat)	December	10-12	2	Dark room of an inhabited house in the middle of a village
Lonavla	August, September	30-35	5	Artificial underground about 15 m. deep
Karla	May	12	3	In a dungeon of the Buddhist caves
Bombay	August, October, December	25-30	11	Cemented underground under the house of the Governor (Raj Bhavan, Malabar Hill)
Vihar Lake	August	8-10	1	Cemented underground under the ruins of a factory
Mahableshwar	April, May, August	100-150 in April, 30-40 in August	17	Natural cave with low ceiling and several ramifications
Bombay-Nasik Road	May, August	30-35	1	Deserted railway tunnel in the Ghats

under the porches of the caves for about 10 minutes before they left for hunting. The hunting ground is in the immediate vicinity, and individuals of the party continually came back for a moment to the diurnal haunt. On 29 August 1960, one hour after sunset, the whole colony had returned home and was resting on the ceiling of the porch; the time of nocturnal activity is certainly curtailed by a number of rest intervals during which the individuals gather in the diurnal biotope.

The flight is slow, low, and fluttering. This *Hipposideros* hunts very close to the ground, and flies in groups of four or five together, like

the closely allied *Hipposideros speoris*. Its weak dentition indicates that this bat is an eater of soft and small insects.

Reproduction

Annual sexual cycle. The external sexual organs show no noticeable changes during the annual cycle. Until one year old, the young are sexually immature, and reproduction begins certainly after the first year only.

Rut Period. There are no external manifestations of rut in this species. Two adult males dissected on the 2nd of December had their epididymis flat and empty of spermatozoa. From the date of birth of the young, we can assume that the spermatogenesis in the males and the oestrus in the females takes place in January.

Parturition

The periodicity is strict, and all the young are born in April. The following data may give an idea to the reader :

Elephanta : Two females dissected on 19 March 1961 were heavily pregnant. On 16 May 1961 about 30 young were seen, which were about 20-30 days old.

Mahableshwar : On 16 May 1960 about 50 females were seen with young 30-40 days old.

Karla : On 15 May 1960, five females were seen with young about 35-40 days old.

Each female gives birth to a single young, which is carried by the mother firmly fixed to the false teats, till it reaches the adult size.

Social Life

No sexual segregation was observed in this species. Males and females were mixed together in all the colonies studied. In Elephanta, where half of the colony has been ringed, the account of the captures is as follows :

15 November 1959 : 28 ♂♂, 12 ♀♀
11 February 1960 : 19 ♂♂, 9 ♀♀

The males are more numerous than the females at Elephanta, 47 ♂♂ and 21 ♀♀ only. It is exactly the inverse proportion for the sex ratio of *Hipposideros speoris* which inhabit the same cave. The origin of this frequent unbalanced sex-ratio in colonies of bats remains unknown, the more so because sometimes it is the males which are more numerous and sometimes the females.

Inter-specific Associations

Hipposideros bicolor is not a very sociable mammal. This bat usually forms small colonies, which do not associate with other species. Nevertheless, associations with *Hipposideros speoris* (at Elephanta), and

Rhinolophus rouxi (at Vihar Lake, Khandala, and Mahableshwar) have been observed.

Migration

H. bicolor is a sedentary species. The ringed individuals are regularly seen in Elephanta all over the year. The colony at Elephanta was studied by Humayun Abdulali twenty years ago. This *Hipposideros* like many other species of bats, shows remarkable constancy in keeping to its favourite haunts.

Hibernation

This species never hibernates. If artificially cooled, it dies after a few hours.

Hipposideros galeritus Cantor 1848

Measurements (in mm.) :

		Localities					
		Bombay ○♂	Kanheri △♂	Kanheri △♂	Kanheri △♂	Badami △♀	Bedsar △♂
	Forearm	45	46	46	46	47	47
	2nd finger	38	38	38	37	39	38
3rd finger	Metacarpal	35	34	34	34	35	35
	1st Phalange	15	16	15	15	16	16
	2nd Phalange	18	20	22	20	22	22
4th finger	Metacarpal	36	35	35	34	36	36
	1st Phalange	11	11	11	11	11	11
	2nd Phalange	9	11	10	10	10	10
5th finger	Metacarpal	30	31	30	30	31	30
	1st Phalange	14	13	14	13	14	14
	2nd Phalange	11	12	12	12	12	12
	Tarsus	16	19	20	19	20	20
	Tail	25	33	34	26	32	34

The skull measurements are as follows :

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Badami ♀ ..	17	9	11	6	7

Description

A small *Hipposideros* with dark fur, short and pointed ears (see Plate VI). The size is smaller than that of *Hipposideros speoris*, and the shape of the ears separates it immediately from *Hipposideros bicolor*.

At least two types of colour phase exist in *Hipposideros galeritus* :

A dark type. Brown, with blackish membranes.
A pale type. Grey with sepia coloured membranes.

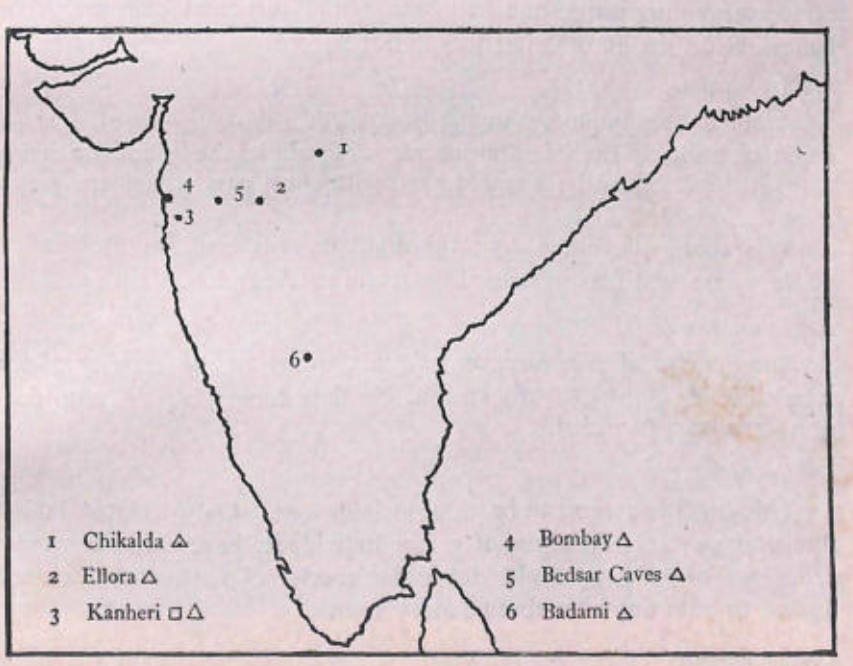
The former type inhabits the humid area of Konkan, and the latter the dry area of the Deccan and Mysore (Chikalda, Badami).

General Distribution

India, Ceylon, Malay States, Sumatra, and Borneo.

Distribution in western and central India

Probably all over. Nevertheless, this bat is rare everywhere, and its populations seem to be formed by a very small number of individuals.



Map 19. Localities where *Hipposideros galeritus* were studied

The Diurnal Biotope

TABLE OF DIURNAL BIOTOPES OF *Hipposideros galeritus*

Locality	Date of observations	Size of colony	Number of specimens captured	Nature of biotope
Kanheri	February, March, April, June, August November	Isolated individuals (all males)	6	The dungeons adjacent to the principal caves
Chikalda	December	1	1	A dark corner in a tower of the fort
Bedsar Caves	June	1	1	A dungeon adjacent to the principal cave
Ellora	August	4	3	A dungeon adjacent to the principal cave
Badami	October	3	3	An old and dark temple

The haunts observed were all in artificial caves or rooms, dark and of small size. For the hunting territory the bat seems to have no special ecological requirements, and had been found in varied biotopes. The behaviour on the hunting territory is not known.

Field Characters

A small Rhinolophid, hanging isolated in a dark corner of a small room or cavity. The bat appears especially dark, the silhouette being elongated and ended by a round head with short ears which are continuously moved.

This species is rather shy ; the flight is agile and skilful.

Japanese mist nets were used to obtain specimens.

Reproduction

The biology of *Hipposideros galeritus*, owing to the scarcity of the species, remains insufficiently known. No data concerning the reproduction have been recorded.

Social Life

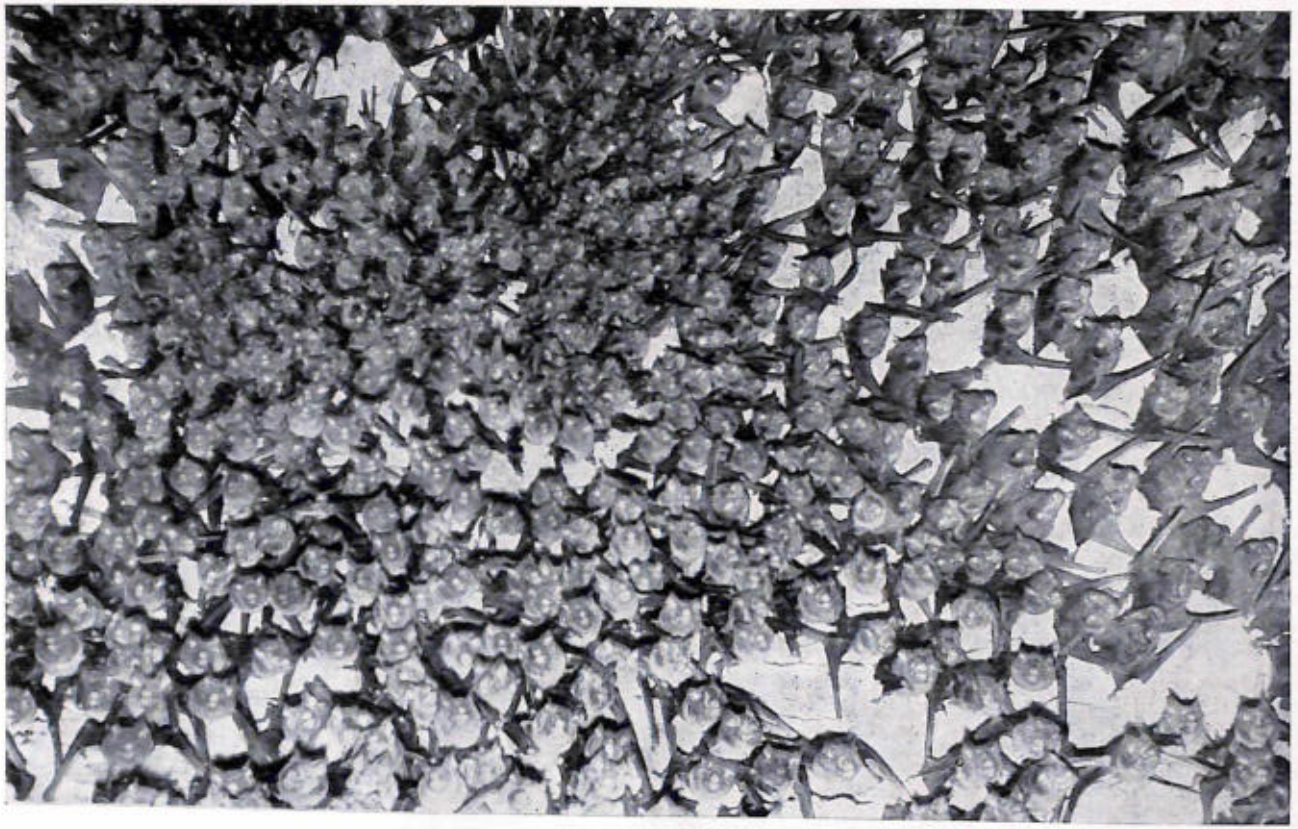
This small bat seems to be an unsociable one. Only isolated individuals, or very small colonies of a few individuals have been observed. *Hipposideros galeritus* avoids the other species of bats, and does not appear to have any inter-specific associations.

Displacements

The individuals seen in August at Ellora were not in this place about five months earlier. Six isolated individuals were collected in Kanheri, the single individual caught at each visit occupying the same place where

Hipposideros galeritus

(Photo : A. Brosset)



Colony of *Hipposideros lankadiva* at Mandu (1961)

(Photo : A. Brosset)

another had been collected during a preceding visit. These are probably displacements of the species from one diurnal haunt to another.

Hibernation

Very improbable. Experiments have proved that individuals of this species die if artificially cooled.

Hipposideros lankadiva Kelaart 1850

Measurements (in mm.):

		Localities							
		Mandu	Mandu	Mandu	Mandu	Vijayanagar	Gersoppa	Gersoppa	Vijayanagar
	Forearm	83	83	87	83	82	83	80	81
	2nd finger	64	64	66	62	58	58	58	57
3rd finger	Metacarpal	54	54	55	54	55	56	56	55
3rd finger	1st Phalange	27	27	27	30	26	26	26	25
3rd finger	2nd Phalange	25	25	28	29	25	25	26	25
4th finger	Metacarpal	52	52	55	55	55	55	56	56
4th finger	1st Phalange	20	20	20	20	20	21	20	20
4th finger	2nd Phalange	15	15	13	14	13	13	13	15
5th finger	Metacarpal	49	48	52	52	48	51	50	49
5th finger	1st Phalange	22	21	21	21	20	21	20	20
5th finger	2nd Phalange	12	14	15	14	13	13	13	12
	Tarsus	34	33	33	33	33	33	32	32
	Tail	35	36	39	35	35	40	35	35

The skull measurements are as follows :

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Mandu ♂ ..	31	19	23	13·5	16
Mandu ♂ ..	31	19	23·5	14	16

Description

A very large *Hipposideros*, much bigger than the closely allied species. The dentition is extremely strong.

A number of colour types have been noticed :

A fulvous brown type. This is the ordinary type.

A reddish brown type. Numerous individuals possess this type

A grey-brown type. This colour phase exists in a few specimens in the BNHS collections. These specimens originate from Vijayanagar.

A bright red type. This colour, which is quite extraordinary for a mammal has been noticed in several individuals in Mandu.

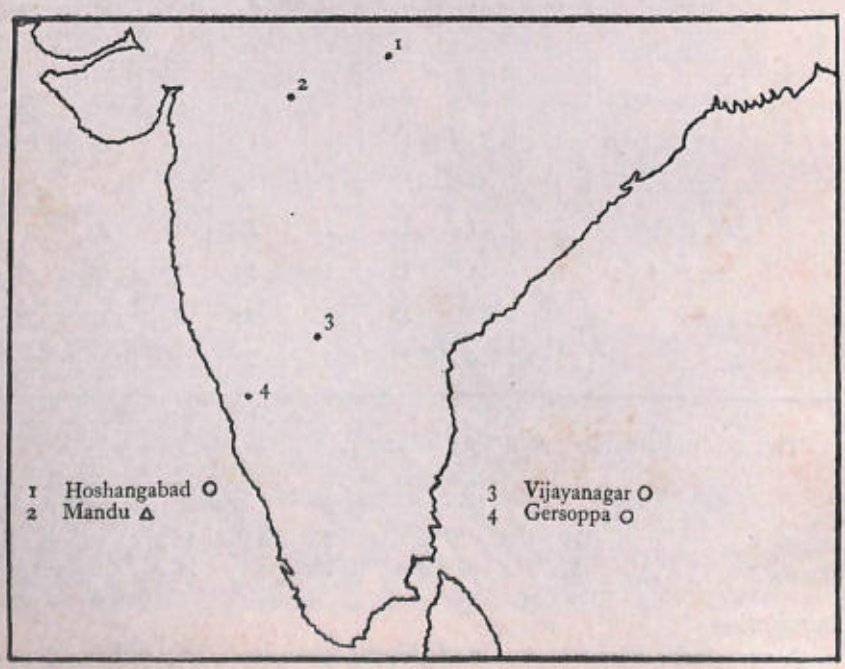
A creamy type. Very pale. This rare type of coloration has been observed in a few individuals in Mandu.

Intermediate individuals between these types are frequent.

Andersen had described several subspecies : *mixtus* (1918) for eastern Mysore, *unitus* (1918) for the Central Provinces, *schistaceus* (1918) for Vijayanagar, and *indus* (1918) for Gersoppa. As only four colonies were known in India in 1918, we can remark that Andersen created one special subspecies for each known colony of *Hipposideros lankadiva* where specimens have been collected. The principal differences between these so-called subspecies is the colour of the fur—an extremely variable factor as we saw in individuals living in the same colony. Till more serious information is available on this question I consider the subspecies created by Andersen as being without real existence.

General Distribution

India and Ceylon.



Map 20. Localities where *Hipposideros lankadiva* were studied

Distribution in western and central India

This species lives, it seems, in enormous colonies. But these colonies are rare, and very far from each other. No record of this bat is known in Maharashtra and Gujarat States.

The Diurnal Biotope

TABLE OF DIURNAL BIOTOPES OF *Hipposideros lankadiva*

Locality	Date of observations	Size of colony	Number of specimens captured	Nature of biotope
Mandu	February	5000-7000	91	Subterranean retreats with numerous ramifications under the 'Champa Baoli', the old palace of the deserted capital.
Vijayanagar	July, August	'Plentiful' (observations of Shortridge)	Several specimens in the BNHS collections	In the Pattabhiram Swami Temple. This colony was not in this place in October 1960, and seems to have disappeared.
Gersoppa	February, July	'Plentiful' (observations of Shortridge)	do.	In an old temple

Shortridge had observed two colonies in old temples. The colony that I discovered in Mandu inhabits the vast undergrounds. These *Hipposideros*, more or less crowded, were hanging from the ceiling, or hooked themselves on the stones by their limbs in the deeper and darker parts of the cavity. A considerable quantity of guano lies on the ground. The *chaukidars* and villagers refuse to approach this enormous colony of big bats. Superstitions are probably the reason of their fear which is a good thing for the tranquillity of this very remarkable colony.

Nocturnal Territory

According to Shortridge *Hipposideros lankadiva* is 'frequently a high flyer'. In Mandu, the surrounding country is made up of forest hills, and lakes, and no precise information could be collected on its hunting territory.

Food

The species does not abandon remains of food in the diurnal haunt. Pieces of wings and elytra have been found in the guano. Coleoptera are eaten, and the very strong dentition probably allows the mastication of big and hard insects.

Reproduction

Two females dissected on 20 February were not pregnant. Young have been observed in Gersoppa in June. More information on the reproduction of *Hipposideros lankadiva* would be useful.

Social Life

This species forms clusters, where hundreds of individuals are closely pressed. This sort of association had not been seen in other species of Indian *Hipposideros*.

Nevertheless, as may be seen in our photograph (Plate VII) big groups of scattered individuals have also been observed.

The sex-ratio in Mandu was far from balanced. In 91 captures, only 19 were females. Perhaps another colony, occupied especially by the females, exists in the surroundings. All individuals of the colony were fully adult.

Hibernation

On 19 February 1961, the members of the camp organized in Mandu as well as the naturalist photographers were informed that the whole colony of *Hipposideros lankadiva* was in a period of non-activity. During the day it was easy to photograph the bats many times from close quarters, and get specimens with the hand as numerous as necessary for study. These bats were in a state of semi-torpor but not in hibernation. The eyes of the bats were open, and they were moving their nose and their ears at human approach, but were flying away only after being touched.

During the two following nights, we observed the behaviour of the colony. The bats did not hunt during this period, and did not go out of the underground. Only a few hundred were flying inside the cavity, making temporary clusters not far from the entrances. Two individuals collected and dissected early in the morning had their digestive tubes completely empty.

A genus of bats which does not hibernate certainly passes over prolonged periods of rest. In the course of these periods they do not eat and do not leave the diurnal biotope during the night. Similar observations have been made on *Taphozous melanopogon* and *Rhinopoma hardwickei*. It seems that reabsorption of the enormous quantities of fat that certain species collect at the root of the tail, is connected with prolonged periods of inactivity.

(*To be continued*)

Reviews

1. VIII BULLETIN OF THE INTERNATIONAL COUNCIL FOR BIRD PRESERVATION. Edited by Prof. S. Dillon Ripley and others. pp. 124 (24×15 cm.). 1 coloured and 12 black and white plates, and one map. Tokyo, 1962. The International Council for Bird Preservation. Price 15*s*.

This Bulletin covers the XIth and XIIth Conferences of the International Council for Bird Preservation held at Helsinki, Finland, in 1958 and at Tokyo, Japan, in 1960. It is really the first formal information which we have regarding the resolutions passed at the 2 conferences, at both of which India was represented by Dr. Sálim Ali. Many problems were discussed, some of them of particular importance to us:

1. Protection of Birds of Prey. Legislation in most countries is antagonistic to the birds of prey. In spite of widely-held beliefs to the contrary, many of the birds of prey are useful in different ways. It has been suggested that the laws in the different countries be carefully studied and recommendations be made for suitable alterations.

2. Effect of Pesticides. It was reported that, under the malaria control and technical-aid programmes, insecticides were widely distributed in the south-east Asian countries, and these were often used without proper care, thus leading to the destruction of wild life. In view of the danger of pesticides to human beings and animals and the unexplored after-effects, including the development of mutants, resistant strains of insects and other organisms, the International Council for Bird Preservation opposed the use of pesticides without thorough previous research as to their biological effects and urged the encouragement of additional research and investigation.

3. Birds which are a Menace to other Species. The problem of some birds being a menace to other species, especially the Herring-Gull, was discussed. In the Common Crow, we have an example of an extremely destructive scourge to birds and their eggs.

Other matters discussed included the problem of oil pollution (which fortunately does not affect India), the protection of the larger Bustards in various parts of the world, the standardisation of the conditions as regards shipments of live birds, and the prohibition of

trade in small birds as delicacies (apparently prompted by the import of tinned sparrows from Japan into Great Britain).

In spite of the statutory restrictions, an appreciable number of Peacock and Junglefowl feathers are smuggled out of India. The Bombay Natural History Society had suggested that the importing countries, particularly the U.S.A., should co-operate to the extent of prohibiting the import of these feathers. The Council has called for information from all the countries, so that international co-operation could be sought.

Several interesting reports on the position of bird life in different countries are included, as well as notes on specific species. The report of the Indian National Section refers particularly to the Pinkheaded Duck and the Great Indian Bustard. Reference is made to persons seeing a male Pinkheaded Duck on a jheel 40 miles south of Simla on 28th and 29th February 1960. The report was published with due caution, but it may be worthwhile mentioning that at a personal meeting, the author admitted that the two days were actually from after dusk to before sunrise on the following morning, the observations being made by torchlight!

The Netherlands National Section reported an interesting method of removing 3 species of gulls and the lapwing (*Vanellus vanellus*) from airfield runways where they were an appreciable menace to aircraft. The distress calls of these four species have been recorded and before the take-off or landing of the plane, these are broadcast via an amplifier, causing all the birds to disappear from the runway.

The booklet is excellently got up and has some interesting photographs. One hopes that the Indian Section of the Council will meet more often and in addition to passing resolutions be able to persuade the different State Governments as also the Centre to prepare and enforce suitable legislation in all the aspects of bird protection.

H.A.

2. SPIDERS, MEN, AND SCORPIONS. By Theodore H. Savory, M.A., F.Z.S. pp. 191 (21×15 cm.). 15 plates in black and white. London, 1961. University of London Press Ltd. Price 30*s*.

There can be few branches of natural history which have a book devoted exclusively to the story of their development. SPIDERS, MEN, AND SCORPIONS is a somewhat deceptive title for a very scholarly

history of Arachnology, excluding Acarology of which the author says: '. . . Acarology (is) in a different category, attracting a different type of zoologists, whose attitude to their work and its applications is undeniably strange to the devotees of the spiders and scorpions named in the title of this book'. This strikes me as an unfortunate attitude to take to applied science. Although Acarology is too vast a subject to be covered in this book, it should be remembered that here—as well as in the rest of Arachnology—collection, preservation, and description are the basis of all further work. Academic interest in a subject is not lessened because it happens to have an applied significance.

Spiders attracted the attention of the ancient Greeks, and were immortalised by Ovid in the legend of Arachne. The first scientific approach to the subject was that of Aristotle, who in his A HISTORY OF ANIMALS described with a surprising degree of accuracy the courtship and web-spinning of spiders. He knew that scorpions produce live young, and was aware of the existence of pseudo-scorpions—'in books other small animals are found, some of which are like scorpions without tails'.

In the Middle Ages spiders became notorious, in particular the tarantula (*Lycosa tarantula*). Its bite was supposed to induce alarming behaviour in its victims, who could only be cured by music and dancing. Outbreaks of 'tarantism' became common in southern Europe, where this spider is found, and it was a long time before it was generally recognized that this species is harmless. Finally, tarantism was dismissed as a hysterical phenomenon. The venom of spiders can, however, cause serious discomfort. An article in *World Health Organization Bulletin* for 1954, quoted in a recent Miscellaneous Note in this *Journal*, gives a more sober account of the effects of the venom of the south-European *Latrodectus tredecimguttatus* on man and animals. These effects include writhing and convulsions. Perhaps Mr. Savory is being somewhat hard on the mediaeval victims of tarantism; they might not have been pretending, their symptoms may have had some physical cause although they blamed the wrong spider.

The history of Arachnology in India begins with Pocock. Though he worked all his life in London he studied collections brought from the East, and the result was a volume on spiders in the FAUNA OF BRITISH INDIA series. R. W. G. Hingston deservedly gets honourable mention for his beautifully designed experiments, and the delightfully readable manner in which his observations are recorded. The only

contemporary worker mentioned is A. P. Mathew of University College, Trivandrum. Very recently, however, M. S. Mani has added to our knowledge of arachnology with his list of spiders, scorpions, and pseudo-scorpions from the north-west Himalaya.*

A history of arachnology is incomplete without mention of Mr. Savory's own considerable contribution. I hope that in future editions some other arachnologist will add a chapter rectifying this omission. The book could also do with a much more complete bibliography.

R.R.

3. DIRECTORY OF ZOOLOGICAL TAXONOMISTS OF THE WORLD. Compiled by Richard E. & Ruth M. Blackwelder. pp. xvii+404 (23.5×15.5 cm.). Carbondale, Illinois, 1961. Southern Illinois University Press for The Society of Systematic Zoology. Price $10.00.

This is a most useful compilation intended to enable one to get in touch with persons competent to advise and help in the identification of the many forms of animal life. Over 9000 taxonomists are listed. It was obviously impossible to check upon the qualifications of each party, and all those who returned the forms sent to them, either directly or on recommendation, have been included; asterisks mark those whose names were received from third parties, and from whom no direct information was obtained.

In the first hundred pages, the taxonomists are listed under groups, commencing with fossil forms, cave faunas, parasites of different hosts, Protozoa, and ending with mammals. Each group is again divided into smaller groups and, where the information warrants, re-distributed under World, Nearctic, Neotropical, Palaearctic, Oriental, etc. Only about 150 entries cover taxonomists from India, Pakistan, and Ceylon, and these include 30 for fishes, 5 for amphibians, 6 for reptiles, and 4 each for birds and mammals. In several cases, one person is mentioned under more than one head!

The compilers describe how the information was collected and recorded in the form of a card index from which a preliminary typescript was prepared; from this at a later stage a final typescript was prepared on a special typewriter and kept up-to-date as further information was received, till finally it was printed off by a process of photographic reproduction, thus eliminating printer's devils.

It is hoped that this wonderful piece of work will be widely and profitably used in India.

H.A.

4. AFRICAN HANDBOOK OF BIRDS, Series Two : Birds of the Southern Third of Africa, Vol. I. By C. W. Macworth-Praed, M.A., F.Z.S., M.B.O.U. and Capt. C. H. B. Grant, F.Z.S., M.B.O.U. pp. xxiv+688 (22×14 cm.). 38 coloured and 11 plates from photographs; marginal distribution maps and drawings. London, 1955, Longmans Green & Co. Ltd. Price 50*s*. net.

The book is a companion volume in the excellent series on African birds which have been already noticed in the pages of this *Journal* [Series I, Vol. I in **51** (3) at p. 709 and Vol. II in **53** (2) at p. 242] and forms Volume I in the second series covering the birds of the southern third of the African Continent. The plan of the book is identical with that of the earlier volumes. 573 species comprising all non-passerine and three families of passerine birds are described concisely with brief notes on their distribution, habitat, habits, breeding, food, and calls. The 38 beautiful coloured plates prepared by several gifted artists, the excellent photographic reproductions, and the sketches of birds and distribution maps given marginally to the text should prove a boon to the casual bird watcher as well as the serious student. It is unfortunate that, to keep the cost of production within reasonable limits, so many species are crowded on a plate. This has resulted in loss of clarity in some instances and has almost reduced out of existence some of the smaller species in 'mixed bags'.

A book on African birds is of more than casual interest to the Indian ornithologist from the close faunal affinity that exists between the two regions. Approximately half the genera described in the present volume occur in India, though nature has been prodigal, as for example among the Hornbills, in the number and variety of species in Africa. It is of interest that the only other species of the genus *Rhinoptilus*, besides our own Jerdon's Courser, occurs in Africa. The habitat of both species appears similar and it is reasonable to assume that Jerdon's Courser also is crepuscular and given to considerable local movements as its African cousin, and may yet be rediscovered in India if the factors of habitat and habits are carefully kept in mind by its explorers.

The book has its share of 'name changing', for example the Yellow Wagtails familiar to all as *Motaciila* are reverted to *Budytes*. It is a pity that taxonomists are nowadays becoming more and more finicky, shifting names around faster than a nervous cat does her litter. However necessary some may consider it to be, it is most disconcerting to the non-specialist who cannot help but feel a sense of loss to see the old familiar names disappear. Luckily this is not for long; most of them come back when the wheel has turned a full circle!

Not enough praise can be given for the effort that has gone into the production of this volume. Both as a reference work and as a field handbook it is of immense value. We await with interest the appearance of the second volume in the series.

J.C.D.

5. THE WEALTH OF INDIA : A DICTIONARY OF INDIAN RAW MATERIALS AND INDUSTRIAL PRODUCTS. RAW MATERIALS. Vol. VI: L-M, pp. xxxi+483+xiv (27.7×21.5 cm.). 14 plates and 185 text-figures. New Delhi, 1962. Council of Scientific and Industrial Research. Price Rs. 40 or 80*s*.

The Sixth Volume of the WEALTH OF INDIA series deals with raw materials that fall in the alphabetical category L-M. It is written with the same care, knowledgeability, and concern for painstaking detail that characterises the previous five volumes, and it should be of interest to the general reader as well as to the student. There is an elaborate system of references and cross references that should prove useful to the researcher who wishes to pursue any topic further, but the ordinary reader should find himself more than content with the material in the volumes themselves.

The subject of these volumes includes the plants, animals, and minerals to be found in India. It gives accounts of their main groups and even, at times, proceeds to subsidiary groups. The animals of the L-M category, lions, monkeys, mongooses, etc., are rather perfunctorily dealt with, but that is to be expected—indeed, one wonders how they find a place at all in this book. On the other hand, there is a particularly good, well-illustrated article on Molluscs.

Actually—but this may be merely a matter of personal taste—I find the articles on fruits, and on Minerals, the best and the most

rewarding. Thus, while dealing with Mangoes—and here the book touches a subject of peculiar interest and importance in India, and often missed in many Natural History Encyclopaedias compiled outside India—the author gives a comprehensive description of the tree and its fruit, its distribution, and its varieties; here is a full and accurate account of its cultivation (it may come as a surprise to a good many readers to learn that, within India, the tree thrives in a wide variety of climates and soils), its propagation, planting, irrigation, flowering and fruiting, diseases affecting it and their eradication, and finally of their marketing—'the majority of growers pack large-sized attractive fruits on the top, and small, diseased or damaged fruits at the bottom of the basket', a fact only too well known by prospective buyers!

Several other fruits and plants are dealt with in an equally full and knowledgeable fashion, and one of the more praiseworthy features of the book is the care that has been taken in detailing modern developments in the cultivation and use of the plants, e.g. in the article on the Manihot we learn that Tapioca macaroni has been recently developed by the Central Food Technological Research Institute, Mysore.

The many diagrams and photographs are almost uniformly good, clear, and well chosen, and I have seldom seen a finer collection of line drawings than the one in this volume. In passing, I might mention that it seems a pity to have produced such a fine, well got-up volume, and then to have spoiled the general effect by the tasteless and ugly outer binding used—but that, of course, hardly matters. The book itself is a good and scholarly work, and it should prove a very popular reference book for any library, inside and outside India.

R.J.K.

6. A BIBLIOGRAPHY OF INDOLOGY, Vol. II: INDIAN BOTANY, Part I. Authors A-J. Compiled by V. Narayanaswami. pp. xlii+370 (24.5×16.3 cm.). Calcutta, Government of India, 1961. The Librarian, National Library. Price Rs. 8.00.

This is the Second volume in a tentative list of 56 in the series belonging to the project of A BIBLIOGRAPHY OF INDOLOGY taken in hand by the National Library, the first volume being on Indian Anthropology. This, the first part of a very elaborate work, includes

5374 entries covering the authors alphabetically from A-J, their work being mentioned against each name. The second part is expected to cover authors from K-Z, and a third part will contain the index. The bibliography covers the period 400 B.C. to 1958 and part of 1959 A.D. It thus covers a vast period and a vaster field in the various branches of Botany for a single compiler. This reviewer is personally aware of the immense labour undertaken by the compiler Mr. Narayanaswami during his life-long service in the Botanical Survey of India, at the Indian Botanical Gardens, Calcutta, for extracting information from the rich treasures, often neglected and unappreciated, of books, periodicals, pamphlets, drawings, etc. in the library attached to the Gardens. To any serious worker in that institution Mr. Narayanaswami's labour of love—though then incomplete—was a useful guide. That this work is now available to active botanists is a matter of joy to Mr. Narayanaswami's many friends, pupils, and admirers.

It is to be regretted that even the review copy contains faults of binding. Section 22 at pp. 169-176 appears at a wrong place and is repeated. Entry No. 2343, i.e. Chopra, R.N., would appear to refer to a person different from the three earlier ones, though there is nothing in the set-up which would suggest this. Similarly 2584 and 2585 refer to two different persons. Perhaps it may be worthwhile devising some other means of distinguishing between different persons. Some references have escaped vigilance during production, e.g. this reviewer's article published in this journal in Vol. 50 on pp. 428-30. The reviews of books by some authors are included but not by all. Journals such as *Economic Botany* and *Qualitas Plantarum Materia Vegetabiles* should have found a place in the BIBLIOGRAPHY. Works in vernacular, e.g. Bambhdai, G. K.: VANASPATI SRISTTI, in Gujarati, a treatise in economic botany in four volumes, could have been included if the compiler had been able to visit libraries in western India. It is obvious that the proofs have been seen under the strain of illness as mentioned by the publisher. However, these little omissions and other defects do not deprive this very painstaking work of its utility and importance. Parts II and III will be eagerly awaited by Indian botanists as well as all others interested in Indian Botany.

P. V. BOLE

7. THE BIRDS OF SIKKIM. By Sálim Ali. pp. xxx+414 (25.5×17 cm.). 9 half-tone, 17 colour plates and 41 line drawings. Madras, India, 1962. Oxford University Press. Price Rs. 30.

The publication of yet another regional faunistic book on birds of the Indian area, by Dr. Sálim Ali, is a long-awaited event. Dr. Sálim Ali not only writes well, but has a comprehensive approach towards his subject, which always insures that his publications will maintain the highest standard and, in addition, be continuously readable. The country of Sikkim, sandwiched between Tibet on the north, Nepal on the west, Bhutan on the east, and the adjacent Indian State of West Bengal, is a fascinating area with a great and diverse variety of biotopes. From the heights of the snow-capped mountains of over 27,000 feet, down to the lowlands of the jungle- and farm-covered plains of the lower Teesta River, this small country of some 2818 square miles possesses a relatively tremendous avifauna. Although classically Darjeeling and 'native Sikkim' have served as the type locality for many of the species of birds described from the Himalayan chain, relatively little recent work has been done in this area, and it was a significant event when Dr. Sálim Ali and Mr. Loke Wan Tho arranged, with the generous co-operation of the Sikkim Government, to make an avifaunal survey. It seemed most appropriate, therefore, when after the completion of the survey, conversations ensued with the Government of Sikkim which resulted in a subvention to insure the publication of the report.

This book is of great value to distributional-minded ornithologists and ecologists as it incorporates many scattered and difficult-of-access field notes by earlier workers from the time of Mandelli on, which have been scattered in the literature often in rather inaccessible form. From the zoogeographic point of view, Sikkim is particularly interesting not only because it spans such a wide variety of altitudinal zones, but also because it is on the western extremity of the area in the Himalayas where the more saturated, more richly coloured eastern subspecies tend to commence to trend into the more western, paler, lighter coloured subspecies. This general trend of darker coloration in the east to paler coloration in the west has been noticeable to all the investigators of the Himalayan vertebrate fauna since the days of Gould. Sikkim, with its dense rainfall and its heavy jungle cover is an area, like Bhutan and Assam, which harbours dark, richly-coloured populations of animals within its borders. This correlation between humidity and more saturated appearing colours of plumage or pelage has often been referred to as Gloger's hypothesis. It is a significant aspect of the appearance of the animals which inhabit Sikkim as compared with those which inhabit Nepal and the Himalayas of Uttar Pradesh.

The introductory part of Dr. Sálim Ali's book is of particular

interest in that it delineates and describes the forms of terrain and the altitudinal zones. Following this, there are short sections on migration and on the literature on Sikkim birds, after which there is a general account arranged in systematic order of the species of birds found within the country. In each case in the account there is a description of the appearance of the bird, its status and habitat in Sikkim, followed by an account of its distribution outside the State, and then a section on general habits. Following this is a section on nesting, if in the country, and then a general summary of which related species, if any, may occasionally be met within the State.

In each family there is at least one species represented in a full description of this sort. Sometimes, as in the case of ducks, a shorter paragraph refers to relatives of the species described, which may be found more or less commonly within the borders of the country, presumably in migration. Sometimes the treatment of these species seems unequal in that certain species which obviously live in Sikkim, as well as that one described *in extenso*, are treated in a shorter, more condensed manner. For example, on page 5 the Indian Sparrow-Hawk, *Accipiter nisus melaschistos*, receives a page and a third of description, as well as a bold heading giving its name. Following this there is merely a paragraph in small bold type on the Crested Goshawk, *Accipiter trivirgatus indicus*, which is also a resident in Sikkim, even though it is said to be rare. I am not entirely clear on why Dr. Sálim Ali has decided to describe the Indian Sparrow-Hawk so extensively, and give such a small write-up to the Crested Goshawk. Here and there similar discrepancies occur throughout the text. For example, on page 9, Bonelli's Hawk-Eagle, *Nisaëtus fasciatus*, is described *in extenso* while the Booted Hawk-Eagle, *Hieraëtus pennatus*, receives the smallest paragraph and treatment.

Some forms, which I had always believed to be birds occurring in Sikkim, seem to have been left out entirely. One of these is the problematical *Psittacula intermedia*, Rothschild's Parakeet, which is said to have been collected in 'native Sikkim'. Another is the Hanging Parakeet, *Loriculus*. One or two of the nightjars also seem to have been omitted, but perhaps in some cases this is deliberate, so as not to have too many species of the same families listed ? Or, perhaps, there may be no actual record which Dr. Sálim Ali had been able to track down of the occurrence of such forms as *Caprimulgus affinis monticolus*. In any case, some of the additional species are referred to in the Appendix by Dr. Sálim Ali, although not all seem to have been treated.

I am glad to see that some stability is going to be possible in India, both in the arrangement of the birds and also in their common names. In this connection, it is important to point out, as far as India is concerned, the Shahin Falcon is the form *peregrinator*, in spite of what has recently been published by two other ornithologists.

An Index, in addition to the aforementioned Appendix, completes the volume.

It is a delight to record the appearance of this volume on THE BIRDS OF SIKKIM, and all of us who value Dr. Sálim Ali's capable field notes and encyclopaedic knowledge of the birds of India, will welcome the appearance of this splendid volume.

The plates, by various artists, add greatly to the handsomeness of this volume, and are also nearly as comprehensive as the text. For the first time in some years, a number of the rarer and less-illustrated species of the Himalayas are here delineated in an excellent manner.

S. DILLON RIPLEY

Miscellaneous Notes

1. TIGER TRAILS : A STORY OF COMMERCIALISED SHIKAR

To what depths can Indian shikar be brought when it involves foreign sportsmen? It has fallen to my unfortunate lot to throw a little light on the whole sorry situation, because the incident below happened to a shikar firm in which I was a partner.

This firm was called Tiger Trails, and I was tempted to join it because one of the partners appeared to have a fine record as a shikari and was, by all appearances, a great sportsman. On paper, this man was so much better than most in the hunting field that I stood down almost entirely from the shikar side and contented myself with running the camps. To suggest that we should write into the partnership agreement a clause binding the partners to observe the forest rules seemed completely unnecessary.

The very first shoot opened my eyes. We had thoroughly discussed the matter of shooting from jeeps at night and were both agreed that this would not under any circumstances ever be part of our policy. Even so, the jeep started to go out night after night right from the first day, and there was no doubt that it was prowling the forest roads. Then I discovered that some animals had been taken into Betul for skinning without my knowledge. That seemed suspicious, and a few enquiries tended to confirm my fears that animals were being shot at night by spotlight. The result was that at the end of the shoot some registered letters passed between myself and the partner in charge of shikar.

At this stage I normally should have got out of the firm fast, but our next client was Robert Ruark, the American author. There were two reasons why I particularly wanted to meet Bob Ruark. The first was that as a would-be writer myself it would be worth-while to meet someone from the front rank of contemporary American literature. The second reason was to try and correct the unfortunate impression of shikar that Ruark had obviously been given on his first shoot in India in 1956, on returning from which he wrote an article for *The Saturday Evening Post* entitled, 'Shooting Tigers in India is like

Shooting Rabbits from a Sherman Tank'. I was going to do everything I could to prevent another article like that.

Just before Ruark arrived (April 1962), I extracted a promise from my partner to the effect that there would be no shooting from jeeps at night. I also warned him that I was going to ask Ruark for his co-operation in this matter the moment he reached camp. The result was disastrous. With the jeep firmly anchored in camp every night, not a single animal was shot and very few were even sighted for the first twelve days. Nor did this surprise me; the efforts going on during the day to bring animals up to the gun seemed to me unlikely to succeed for a number of reasons. Bob Ruark noticed this and, to start with, he looked on in astonishment. Then he got annoyed. 'What has happened to my much vaunted and highly paid shikari?' he asked. To all intents and purposes, this shikari had now given up the unequal struggle and was spending a great part of the day on his bed.

On the 13th day the whole sorry mess boiled to a head. That morning I had told my partner that Ruark was getting restless and that he wanted me to take over the shikar side unless things improved. The answer came that same evening. Just at dusk the jeep screamed into camp trailing a cloud of dust. My partner was excited, and in a breathless voice told Ruark to get ready at once. 'If we go now we can shoot a leopard in 20 minutes', he promised.

In an hour the jeep was back. Bob got out and came to where his wife and I were having a drink in front of the bungalow. He was looking very thoughtful. 'I didn't shoot at it,' he said, 'Why not?' I asked. 'There was something wrong—it just didn't behave like a leopard.' We were still discussing it two hours later. Bob could not get the idea out of his head that he had been invited to fire at a dead leopard. To this, however, I could not agree. I just could not believe that a professional shikari would ever try a stupid trick like that on a sportsman of Bob Ruark's experience.

At 11.30 we were still talking outside the bungalow. The shikari had not put in an appearance the whole evening and had apparently gone to bed. Without warning I heard the jeep start up. I raced out and caught it before it could get away. In answer to my question about where it was going at this time of night, I was informed that it was a trip 'to look at tiger baits'. That convinced me. It also confirmed a remark that Ginny Ruark had made just a short while before: 'If the jeep goes out tonight, you can be quite sure it's going to bury a dead leopard'. I took the key and the rotor from the jeep

and later, when everybody had gone to bed, went out on my own to see what I could find.

It lay about 40 yards off a forest road. A fine big leopard laid out as though it was crouched down by a bush. I judged it to have been dead for the best part of a day.

To use his own words, Bob blew his top when the leopard was brought in to the bungalow. Then, in words I could do nothing but agree with, he ordered the perpetrator of this outrage from the camp.

At this stage the matter should have ended. Bob was anxious to go on with his shoot if I took over the hunting. Although quite willing to do this, I suggested to my partner that he might be reinstated if he made Bob a sincere apology. He wouldn't hear of it. He felt that he had been 'grossly insulted' by being turned out of camp and that his reputation had suffered irreparable damage. The dead leopard was waved aside as of little account, and I was warned that 'Mr. Ruark has not heard the last of this'.

He hadn't indeed, and what followed still makes me blush with shame. A part of Bob's bill was owing, and this he told me he would normally have paid without a second thought. But what about the trick with the dead leopard? And what about his highly paid shikari spending most of his time snoring on his bed? Once again I could do nothing but agree with him, but as I was now expecting trouble from the other side, I advised Bob to come with me to the District Magistrate and put everything on record. This he did.

When it was known that no more of the bill was to be paid, the firm of Tiger Trails in the form of the other partners really distinguished itself. Still taking the attitude of injured innocence, and still ignoring the dead leopard, express wires were sent to the American Consulate and to the Government of India Tourist Office asking that Ruark be stopped when he reached Bombay. What the Tourist Office thought I cannot imagine, for at this time the firm had still not received recognition. In addition to the two wires, there was good reason to believe that an attempt would be made to seize Bob's luggage on Betul station. To save him this embarrassment, he was smuggled out through Itarsi Junction late at night with the help of Dr. Moss of the Swedish Mission at Parda.

This story made the headlines in some 130 American papers through Bob Ruark's syndicated column. He certainly pulled no punches and there was no reason why he should. It must have been a nasty jolt for the Government of India which in all innocence was

involved too. But the worst effect of all was undoubtedly on Indian shikar in general. For the past 12 years a picture of shikar as it is today has been building up in the minds of sportsmen abroad. With tales in glossy magazines of tigers shot at night from jeeps and of bison gunned down over water-holes, the picture has seldom been a good one. To it was now added a dead leopard solemnly laid out for an unsuspecting and trusting client to shoot at—surely the most damning brush stroke of all.

In fairness there should be a footnote. On his previous shoot Bob had shot three tigers but no leopard. This time, therefore, leopard was his first objective, and I had this at the front of my mind as soon as I took over. On the second night a big male leopard killed a bait which had been tied by a pile of shrub-sprinkled rocks to one side of a cultivated field. The next day a hide was made on the ground 50 yards from the dead buffalo. Bob and I arrived at 5 o'clock and almost at once heard a leopard calling from a strip of jungle near by. It went on calling, and it was soon apparent that at least one and possibly two other leopards were about. When the day faded the scene was lit by a rising quarter moon. Soon after 8 o'clock a leopard glided swiftly past the kill. It did this several times during the next hour, on each occasion disappearing into the shadows cast by the rocks. It was still calling at frequent intervals and showed no signs of settling down to feed.

We had decided to sit until 9.30, and if no chance had come by then, we were going to get the leopards out the next day by a neat method Bob had learned in Africa. No chance did come, so when it was time to go we left the hide quietly and set off for the forest road 300 yards away. We were almost there when our torches picked up eyes—the eyes of a leopard in a small patch of jungle 30 yards off the path. Bob knocked it flat with a 30.06, but as there were still signs of life I handed him his 20 bore loaded with buckshot. He gave the leopard both barrels.

Even after that it was still breathing, so now I suggested another shot from the rifle. The light from the moon was tricky, and if the leopard should suddenly get up it might not be easy to deal with it in this particular patch of jungle. It was at this moment that Bob found that a round had jammed in the magazine of his rifle after the first shot. For a few seconds I was unaware of this, and it was in those seconds that the leopard charged. It came at incredible speed and snarling like a fury. It slapped a paw at Bob but this just tore his shirt. A blow from the butt of the shot gun drove it off, but it

stopped within 20 yards. As it was whipping round to come again a blast of buckshot crumpled it to the ground. It dropped so suddenly that by all the rules it should have been dead, but we were not to know then that the ammunition for the 20 bore, bought fresh for this shoot in India, was in fact very old stock. The buckshot was hardly penetrating the leopard's hide and, although it was now lying as still as death, it was in reality only stunned by three pellets at the back of the head.

It had gone down in some brush and was difficult to see. By now the last of the rounds which had been brought for the 20 bore had been fired and Bob's rifle was still jammed. He was nevertheless still hurriedly striving to clear it even though it seemed beyond doubt that the leopard was very dead. It had absorbed terrific punishment from a 30.06 and four charges of buckshot. But all at once it was coming again, and with the speed of an animal that might never have been wounded. This time there was no stopping it.

I saw it spring at Bob's throat. Then they were both crashing to the ground. The rest was wild confusion. With only the light from the moon the leopard was just a blur of bared teeth and flashing claws. It had seized Bob by the arm, so the butt of the shot gun went smashing down on its head. This at last made it let go and turn to retaliate. As its head snapped round its mouth was wide open. With an empty gun there seemed to be only one thing to do and an instant later the barrels of the 20 bore were hard down its throat. This apparently was the right action. In a flurry of flailing legs the leopard flipped on its back and clawed wildly at the barrels of the gun. That enabled Bob to roll clear and spring to his feet.

His arm had been badly mangled and he was in considerable pain, but he set to at once to clear his rifle. How he did it one-handed I still do not know, but all at once came the rip of a bolt slamming home and then the blast of a shot. An instant later the leopard went limp and the fracas was over.

Since that night this affair has been the subject of much comment, and certain interests hurried off to high places with loud cries of 'inexperience' and that this sort of incident was spoiling the game. This really was only to be expected, but to the charge of inexperience I should like to say that this leopard was in sight from the moment it was wounded to the end of the fight. Never at any time was there any question of following up a wounded and invisible animal in the dark. It has been suggested that we should have withdrawn well away to a place of safety as indeed we could have done. But to have

Leopard Cat at closet

Leopard Cat resting

(Photos : F. Keppie)

done that would almost certainly have resulted in the leopard getting away either to die in agony or perhaps to become a menace to both stock and human life. If this is inexperience then I have to plead guilty and so would Bob Ruark.

It has also been said that our most elementary mistake was not to have climbed a tree and pot at the leopard from the safety of its branches. That of course we could have done as we could also have gone shooting bison over water-holes and rabbits from a Sherman tank. As it was we were already face to face with a wounded leopard, and if the plain truth has to be told it simply seemed to us more sporting to give it a fair fight on its own ground where the odds were about even. That we both got hurt was surely just part of the game and nothing that any sportsman would ever complain about. Certainly Bob Ruark never complained.

And he got a good story. Indeed, when I think of what he wrote about Sherman tanks and tigers after his first trip, it seems to me that some good did come out of this shoot after all.

MANDIKHERA ESTATE,
P.O. MATKULI,
PIPARIA, M.P.,
August 6, 1962.

HUGH ALLEN

2. A LEOPARD CAT (*FELIS BENGALENSIS* KERR) IN CAPTIVITY

(*With a plate*)

Of all the wild cats of Asia, the Leopard Cat (*Felis bengalensis* Kerr) is believed to be the most intractable and difficult to tame. My personal experience confirms this, and the four which I have kept at various times remained extremely wild. It is therefore all the more surprising to hear of the very pleasant experience of a tea planter couple of north Bengal, Mr. Keppie and his wife, who found a young leopard cat to be a very tame and lovable creature. I am very grateful to Mrs. Keppie for giving me the full story.

Apparently in March 1960 two kittens were brought from the forest near the Bhutan foothills when they were just a few weeks old. They would not take milk and were very wild, hissing and spitting every time attempts were made to feed them. Then a piece of raw meat was tried, and eagerly devoured. After that they were fed on raw meat and water, but they would take only very little milk.

After a month the weaker of the two kittens died. The remaining one became ill with 'loose motions' but was carefully nursed by Mrs. Keppie and dosed with sulphathalazole—each tablet broken into four pieces and each piece placed in a piece of raw meat. After three days of this treatment the kitten was cured. It seemed to appreciate the attention given to it, for after that it became very tame.

For house cleanliness a sand-box was placed in the mosquito room on the verandah where the kitten lived, but she (it was a female) would not use it, preferring a hole in the wooden floor. Later on, when the kitten found her way round the bungalow, she started using the outlet hole in the bath tub, and appeared to be happy near water 'for her habits'. One day she was found swimming up and down the bath tub filled with water. Another day she fell into the water-closet in the bath-room, and was later seen perched on the edge of the seat and using this item in the correct manner. Ever afterwards she used the water-closet in this way, thus eliminating that tiresome cleaning up usually encountered when wild creatures are kept in the house.

As she grew up she became very fond of the Labrador dog. During daytime she preferred to sleep on a tree and at night came in when called. Then she started spending much time in the tea bushes, and on returning to the bungalow in the evening she was kept in the bedroom for safety. She had evidently by this time become a very tame and affectionate pet.

But in October, when she was about eight months old, she began to show signs of restlessness. She disliked being shut up at night, and would sit at the window longing to be out in the darkness.

'Then one evening early in November, she came in as usual for her evening meal and then went out again, and I thought she wanted to play a bit more so I left her for a while; when I again went out to call her in, she kept on looking at me, and walking away towards the bushes, and then came back to me if I did not follow, almost asking me to go with her into the jungle, as if I was a jungle pal of hers. I left her for a while, and then when I went once again to call her in, she did not answer or come in ever again. . . . Then one or two labourers told my husband that they saw her with another cat, but *we* did not ever see her again to our great sorrow. I thought she may have returned some time to have her kittens but this she never did.'

UPPER SHILLONG,
ASSAM,
April 30, 1962.

E. P. GEE

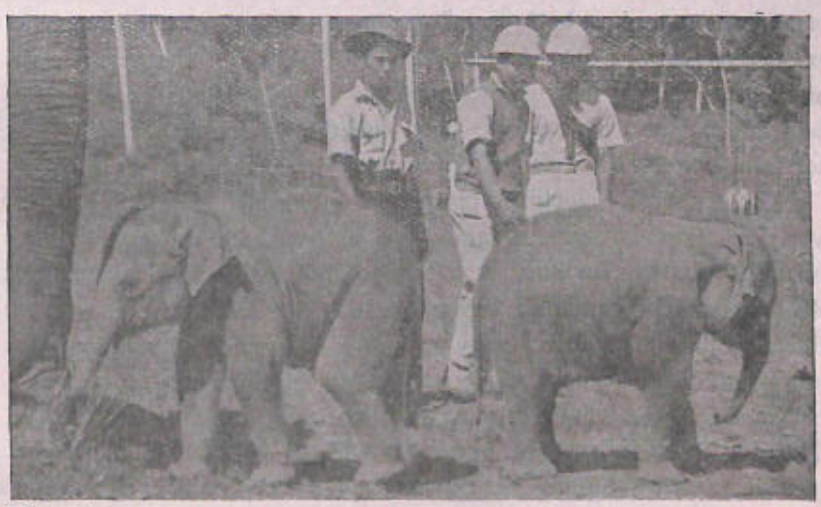
3. TWIN ELEPHANT CALVES AND INTERVAL BETWEEN BIRTHS OF SUCCESSIVE ELEPHANT CALVES

(*With a photograph*)

On 26 October 1961, a timber-working female elephant No. 918, Htwar Aye Ma, belonging to the State Timber Board, gave birth to twins, a male and a female, in the Indawgyi circle, Myitkyina Timber Extraction Division.

The male calf was dropped at 06.30 hours and the female calf at 10.00 hours. The male calf measured 2 ft. 9 in. and the female calf 2 ft. 8 in. at the shoulder.

The Forest Department maintains a register of all timber-working elephants. According to this register the age of the dam which gave birth to the twins was 26 years. She had previously given birth to a female calf on 10 June 1959. The *sin-ok* (head mahout) in charge of the elephant camp reported that the gestation period of the twins was 22 months. The dam was mated with a male timber-working elephant, No. 1744, Than Kyaw, from the same camp.



Twin Elephant Calves

This is the second record of the birth of twin elephant calves in Burma. The birth of twin elephant calves previously was recorded by Mr. Gordon Hundley in 'Twin Calf Elephants' (*J. Bombay nat. Hist. Soc.* **27** : 628-9).

Mr. A. J. Ferrier who was in Burma for 34 years with Messrs Steel Brothers & Co. Ltd. writes from Ayrshire, Scotland, on 10 April

1962: 'Hundley's Thoungyin Twins are well known as twin elephants are very rare in the first, and don't often survive in the second place.

'I believe that twins were born to a Steel's elephant in Prome in 1931 but they died at birth and I believe the B.B.T.C.L. had twins in the Chindwin some years later but they also died.

'I personally have never seen twin elephants.

'The size of the calves 2 ft. 9 in. and 2 ft. 8 in. at the shoulder is just a shade below average but single calves of this size and even less are born every year.

'The period between the birth of a single calf on 10 June 1959 and of the twins on 26 October 1961 is certainly surprising and is less than I have ever known. I remember a few cases of around two years and 7 months and never so little as two years and 3½ months.'

Mr. E. O. Shebbeare writes from Banbury, Oxon, England, on 4 April 1962:

'I think Sanderson is right in saying: "Elephants breed about once in two and a half years" (THIRTEEN YEARS AMONG THE WILD BEASTS OF INDIA : 61). He appears to base it on the relative size of the two calves sucking the same dam, also assuming gestation to take 22 months. This allows eight months after giving birth before her next heat—which sounds reasonable.

'Khedda work sometimes throws an independent light on this too when, as often happens, a family group forms the entire catch in a small stockade. Looking at the matriarch with all her surviving offspring (except perhaps a few of the older males) you will have no difficulty in placing her family in order and will generally get the impression that the normal interval is two or three years.'

Mr. E. P. Gee contributed an excellent note on this point entitled 'The Indian Elephant (*E. maximus*): Early Growth Gradient and Intervals between Calfing' (*J. Bombay nat. Hist. Soc.* **53** : 125-128).

25, INYA MYAING ROAD,
UNIVERSITY P.O.,
RANGOON, BURMA,
July 24, 1962.

TUN YIN

4. THE FUNCTION OF EXTERNAL GLANDS IN MAMMALS

A short note in *Nature* **193** (4817) : 799, of 24 February 1962, entitled 'Territorial Function of Chin Gland Secretion in the Rabbit, *Oryctolagus cuniculus* (L.)' by R. Mykytowycz, describes these animals in an enclosure as marking posts, grass, branches, edges of burrow entrances, walls and ceilings of cages, and even kittens and does during amatory behaviour with small amounts of the secretion. It is suggested that 'territorial marking is of value among gregarious species by advertising that the area is at present occupied and thus minimizing aggressive fighting'. Chin glands were found to be less developed in the hare, *Lepus europaeus* Pallas, which has a much larger home-range than the rabbit.

These observations are of interest as many of the larger wild mammals in India, e.g. sheep, goats, antelope, deer, etc., have prominent glands (infra-orbital, inter-digital, inguinal, etc.) whose function and significance still remains to be discovered.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
July 10, 1962.

EDITORS

5. ARE DOMESTIC ANIMALS OVERGRAZING THE KEOLADEO GHANA SANCTUARY IN RAJASTHAN?

(*With two plates*)

The seven-thousand acre Keoladeo Ghana Sanctuary is located near Bharatpur, north-eastern Rajasthan, about 100 miles south of New Delhi.

In late February 1962, I made a brief three-day visit to the sanctuary to photograph birds and add new species to my life list. The highlight of the 94 species identified was the thrill of seeing three Siberian Cranes (*Grus leucogeranus*), scarce winter visitors to India from North Asia. But the buffaloes, which are permitted to graze in the water on aquatic plants, frightened them off before I could photograph them.

Which brings me to the reason for writing this note—the live-stock. The Range Officer at the sanctuary informed me that there

are some 20,000 head of cattle (both cows and buffaloes) that daily, and throughout the year, graze in the sanctuary. Some of the effects of this grazing could be seen immediately. I can only imagine other effects which I did not have the time to examine.

The level unflooded ground has been packed hard by the constant trampling of thousands of heavy hoofs. There is very little understorey — young trees and shrubs necessary for reproduction — in the thorn forest. As a result, there probably will be slow replacement of the natural vegetation. (Plate II, 1)

In addition to wildfowl and waterbirds, the Keoladeo Ghana Sanctuary also harbours herds of cheetal, black buck, pig, and an occasional panther.

Depending on the food habits of the animals that live in the sanctuary, there may be competition for food — interspecific competition between species, or intraspecific competition within a single species. For example, if cows and blackbuck both graze the same plants in the same area, then interspecific competition results, and one or both species suffer. Or, if the population of buffaloes is too great then there will be intraspecific competition among the buffaloes, again to the detriment of the competitors. However, if all the species feed on different plants in the same area, or feed in different areas entirely, and assuming a sufficient supply of food, then there will be no competition.

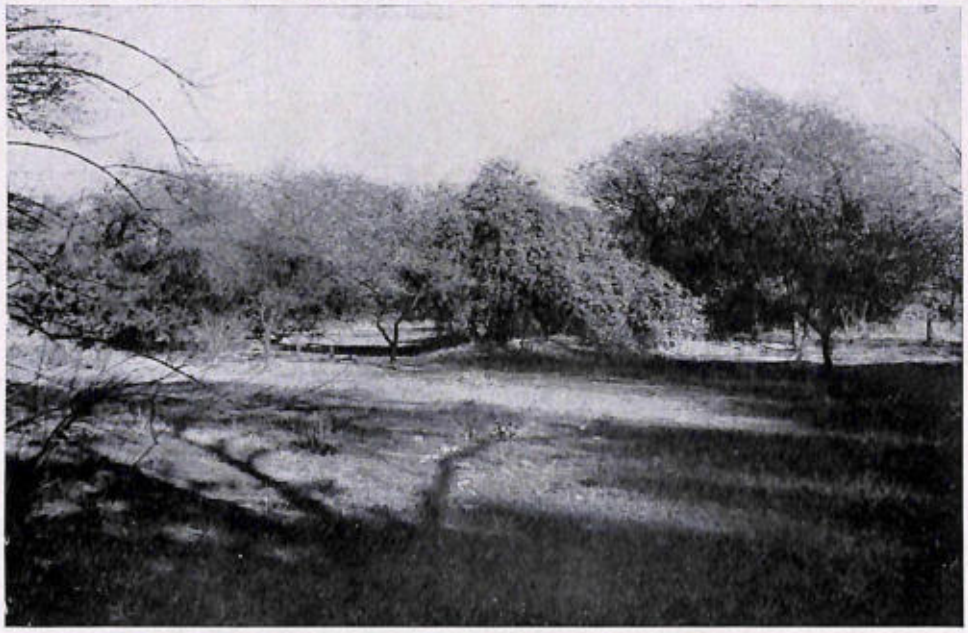
The question arises, therefore, can the range support all the animals? ('Range', as used in this paper, refers to an unfenced, naturally-vegetated area where livestock are permitted to forage freely for food.) To answer this a study of the food habits of the animals (do they graze or browse?) must be made, along with a determination of the favoured food plants and the carrying capacity of the range (the maximum number of animals the range can support).

However, regarding the present large population of livestock present in the sanctuary, I would like to adduce information from a study made in the United States.

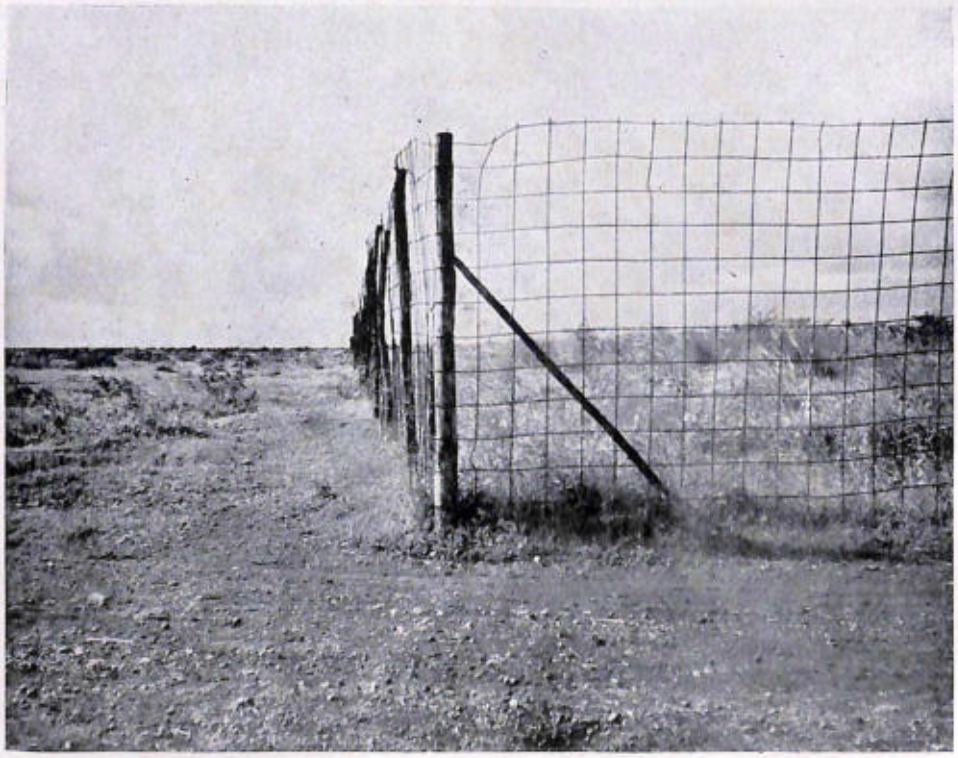
The Keoladeo Ghana area receives an average of 27 inches of rainfall each year. In tropical India, this amount of precipitation is considered semi-arid. In an area receiving 25-30 inches of rainfall in the United States (a sub-humid condition in temperate North America), it was found that eight to 15 acres of range *in good condition* were required to support *each* cow for an entire year (Chapline & Cooperrider, 1941). In contrast, it appears that at the

A portion of the marshy Keoladeo Ghana Sanctuary: Waterfowl, waders, and fish-eating birds frequent the area in thousands. Buffaloes may be found grazing and wallowing in the shallow areas. Perched in the background are darters and cormorants, while egrets feed in the water.

(Photo : Julian P. Donahue)



Semi-arid thorn forest in Keoladeo Ghana Sanctuary: Typical of the un-folded parts of the Sanctuary. In many places the trees are widely-spaced, and the ground is hard. The growth of grass is very sparse, and those which remain are probably of the less-palatable species.
(Photo : Julian P. Donahue)



An exclosure in Rajkot District, Gujarat: Within two years of the establishment of the exclosure the more favourable tall-grass food species have begun to dominate. Compare this with the area outside the exclosure, where excessive grazing has continued
Photo taken in early July 1957, about two weeks after onset of monsoon.
(Courtesy of the photographer : Roy L. Donahue)

Ghana Sanctuary each cow receives about a third of an acre of range, or less than one-twentieth of the range required to properly maintain an American cow without damage to either the range or the cow. Because of the difference between the North American and Indian situations, and also because these figures include the flooded as well as the unflooded portions of the Ghana, it is difficult to draw a satisfactory conclusion. However, it does appear that either the Indian cow and buffalo can thrive on a fraction of the food required by an American cow (which I do not believe) or that the range is being overgrazed.

Briefly, this is what happens when a range is overgrazed. When the vegetation is at its peak luxuriance (during the monsoon, in this case) there is usually sufficient food for a normal number of cattle. However, the cattle tend to choose the more palatable species as they graze, and shun the undesirable species. As a result, the choice food species are damaged so much by constant grazing pressure that they frequently fail to produce seed, which is vital to maintain natural revegetation. Only after the choice species have been grazed off do the cattle begin to put any pressure on the less palatable species which, by this time, may have produced seed. As a net result of this process, the less palatable species tend to multiply. The most palatable of these remaining plants are then eaten first and damaged, which encourages the even more unpalatable species. The process, one can see, is a vicious circle that, year by year, encourages the production of more and more weeds (Sampson, 1952).

If I understand correctly, the high livestock population of the Ghana is maintained throughout the year. This situation is largely a result of the protection of cattle by religious sentiment which, in India, complicates range-management greatly. When the range deteriorates in beef-eating countries, the cattle population is reduced to a level that the range can safely support. At the present time this cannot be done in India, and the cattle graze throughout the year. In a situation like this, unregulated and constant grazing is one of the most harmful methods that can be used. There are several systems of controlled, rotated, or regulated grazing that would be much more productive, both in terms of improvement of the range and more food for cattle (Sampson, 1952).

Unfortunately, there are other complicating factors involved, which I can only mention. The solution of these will have to be sought by those more qualified than I.

The buffaloes spend a large part of the day grazing on water

plants. Because the production of aquatic vegetation may be, and probably is, different from the production of terrestrial vegetation, a new problem is introduced: How many acres of aquatic vegetation are required to support a buffalo? Then again, the buffalo's grazing may be beneficial in that it prevents the aquatic plants from dominating and completely choking the bodies of water.

The livestock, particularly buffaloes, may also be beneficial in that they contribute nitrogenous waste to the water, thereby increasing the fertility of the water which must produce the enormous amounts of food necessary to maintain the huge bird populations—of course, the fertility of the water will increase only if some of the contributed waste is derived from terrestrial sources, in which case the land area suffers the loss of that material removed (D. C. Finfrock, personal communication). Or, as they graze, the buffaloes may destroy or disturb the nests and young of birds which nest on or in the aquatic vegetation, such as the Moorhen (*Gallinula chloropus*), Pheasant-tailed Jaçana (*Hydrophasianus chirurgus*), Purple Moorhen (*Porphyrio porphyrio*), Little Grebe (*Podiceps ruficollis*), White-breasted Waterhen (*Amaurornis phoenicurus*), and others.

Another point for consideration is whether the disturbance of the water by wallowing buffaloes, and the increased turbidity which results have adverse or beneficial effects on the aquatic animal and plant life.

Use of an exclosure is widely employed to judge the severity of overgrazing, and to demonstrate what the range can produce if it is properly managed. An exclosure is simply an area fenced to exclude livestock, so that the natural vegetation can be observed undisturbed. This method of study has been tried in India with surprising results. In Rajkot District, Gujarat, an exclosure just two years old demonstrated how rapidly the choice plant species repopulate an area (Plate II, 2). Herdsmen must be told how they will benefit from these studies, and how apparently wasted, lush vegetation will eventually actually result in more food for their animals. In some instances, the exclosure plots have been the object of local hostility, and clandestine attempts were made to burn the plots.

These are just a few of the questions and problems that arise when domestic livestock are permitted to range in the sanctuary, seemingly indiscriminately. Although the Ghana Sanctuary is '. . . protected by the Forest Department from the villagers' axe and other misuse . . .' (Bombay Natural History Society, undated page 2), I think an equally serious condition is allowed to persist — what

appears to be serious overgrazing, trampling and compaction of the soil, and destruction of natural habitat by livestock.

After the establishment of the Keoladeo Ghana Sanctuary through the persevering efforts of the Bombay Natural History Society, the Bird Wing of the Indian Board for Wild Life, and the Government of Rajasthan, it would be a travesty to permit the existence of an unnatural condition which detracts from the appreciation and effectiveness of this otherwise excellent sanctuary. Though the Forest Department has a vested interest in the cattle population (one rupee per year per cow, four rupees per year per buffalo), the choice must be made whether the forest and range—the proper development of which is apparently the prime function of the Department—are to suffer so that the coffers can be enriched. Eventually, a more productive forest and range should be more profitable if they are managed with proper, scientifically-backed judgment.

116, SUNDAR NAGAR,
NEW DELHI,
June 21, 1962.

JULIAN P. DONAHUE

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6. OCCURRENCE OF THE RED-BILLED, OR SHORT-TAILED, TROPIC BIRD (*PHAËTHON AETHEREUS INDICUS* HUME) AT BOMBAY

Rather late in the evening of 11 February 1962, in Versova Creek, Salsette Island, Bombay, I noticed a strange bird. It had all the appearance of a tern flying in a straight line over the extensive mangrove that covers the land from Manori Creek to Versova Creek.

As it approached closer, I observed that its tail resembled that of a parrot. At the point where the Versova Creek enters the sea it flew rather low, hovering over the water for some time. At that moment I noticed the colour of its bill to be orange-red, and the white and black patterns quite clearly visible showed it to be a Tropic Bird.

On 1st of July, a friend brought me a live sea bird that was caught on the hook as it was trying to swallow the bait of a fisherman's line, along the Marine Drive Avenue; and while trying to fly away, had got entangled with the line and was thus caught alive. Except for a long puncture inside its gullet, the bird was in perfect condition. I soon realized that it was the same bird observed at Versova Creek on the 11th of February 1962. It was the Red-billed, or Short-tailed, Tropic Bird, *Phaëthon aethereus* indicus Hume.

When skinning the bird, I noticed that one of its testes was large, about 17 mm. in length, and the other about 10 mm.; its stomach was altogether empty. The next day a number of ticks were noticed in its plumage. The fact that the bird was seen twice in February and July, together with the statement in the FAUNA that it breeds from March to April would suggest the possibility that this bird may have bred on some of the rocks that are not totally submerged during the high tides, along the sea coast from Alibagh to Virar.

ST. XAVIER'S HIGH SCHOOL,
BOMBAY 1.
July 28, 1962.

A. NAVARRO, S.J.

[The Mallophaga obtained by Br. Navarro were sent to Dr. (Miss) Theresa Clay, British Museum (Nat. Hist.), London, for identification, and her reply reads in part: 'There are two species of Mallophaga represented: one, *Saemundssonia* sp. is not the species usually found on *Phaëthon aethereus*, but appears to be near *S. upoluensis* (Rudow, 1870). Unfortunately, there is only one male and this is not in sufficiently good condition for exact determination. Further material from *Phaëthon a. indicus* is needed to show whether the population on this bird represents a new species. The second species is *Austromenopon becki* (Kellogg, 1906), family Menoponidae. This species appears to be parasitic on all the species of *Phaëthon*.'

Phaëthon indicus was described from the Mekran Coast and lays its single egg on bare rocks under the shelter of a ledge or in a crevice on the islands in the Persian Gulf. Sinclair (*J. Bombay nat. Hist. Soc.*, 1886, **1** : 168) stated that a white tropic-bird or 'Boatswain-

bird', *Phaeton candidus* or *Phaeton aetherius* is not uncommon on the Konkan coast, 16° to 21° north latitude, while Eha in 'The Natural History of a Voyage from Liverpool to Bombay' (ibid., 1888, **3**: 242) noted the species between Aden and Bombay.

Again Phillips (ibid., 1947, **46** : 612) saw it every day from 1st to 7th July 1945 between Aden and Karachi. Stray birds have been secured in Ceylon and the Laccadives.—EDS.]

7. EXTENSION OF THE RANGE OF GREY HERON, *ARDEA C. CINEREA* LINNAEUS

Dr. S. S. Godbole, Associate Professor of Anatomy and Curator of the Kasturba Medical College, Manipal, sent us a ring bearing Moskwa No. C-86541 obtained from a Grey Heron (*Ardea cinerea* Linn.) found in early April 1962 on the banks of the Suvarna River, Perampalli, Shivalli Panchayat, Udipi Taluk, South Kanara, Mysore State.

The Russian Bird Ringing Bureau report that the ring was placed on a young heron at Kazoty Lake on the lower reaches of the Talas River, Dzhambul Region, Kazakh S.S.R. (*c.* 70° S.×40° 48′ N.) on 30 June 1961.

Stuart Baker in the FAUNA **6** : 339 accepted two races of the Grey Heron (*Ardea cinerea* Linn.) in Indian limits, the typical form (type locality : Sweden) being said to be a casual straggler to Sind and Baluchistan, while the race *rectirostris* Gould (type locality : New South Wales, later restricted to India) ranges from Mesopotamia to Persia, India, Ceylon, Burma and further eastwards. Ripley in the SYNOPSIS (p. 12) extends the range of *cinerea* southwards to Kutch but does not mention the authority.

We do not have a sufficiently representative series to determine the plumages at different ages, but the present specimen is a darker grey above than the others in the same stage from peninsular India, which together with the place of original ringing leaves little doubt that this is of the typical race. This would therefore appear to be a considerable extension of the recorded range of *A. c. cinerea* in India.

This race is a well-known wanderer. In *Aquila*, the Journal of the Institute of Ornithology, Hungary, for 1960-61, pp. 92 and 121, reference is made to a young bird ringed at Kisbalaton 46° 40′ N. and 17° 15′ E. in Hungary on 5 August 1957, being recovered at

Bagimneda, French Sudan, in April 1958, some 4000 km. to the south-west, and another juvenile ringed at Roya, Vessicgorsk, Kalima District, S.S.R. (58° 30′ N. and 37° 30′ E.) on 24 June 1951 being found at Gyoma, Hungary on 10 June 1959, after 8 years.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
June 30, 1962.

EDITORS

8. INCREASE OF COTTON TEAL [*NETTAPUS COROMANDELIANUS* (GMELIN)] IN WESTERN INDIA

In Blanford's FAUNA (1898) the Cotton Teal [*Nettapus coromandelianus* (Gmelin)] was said to occur throughout the greater part of India, and the neighbouring countries to the east, but to be rare in Malabar, the Bombay Presidency, and Kathiawar and wanting in the desert parts of Rajputana, Sind, and the western Punjab.

Subsequent to this it was noted from several places in Gujarat but its rarity in Sind (Stuart Baker, INDIAN DUCKS AND THEIR ALLIES, 1921; Ticehurst, BIRDS OF SIND, 1923), Kutch (Abdulali, 1938, *J. Bombay nat. Hist. Soc.* **40** : 122), and Bombay (Ali & Abdulali, 1939, *J. Bombay nat. Hist. Soc.* **40** : 649) was not in doubt.

Up to about 1940, I had only seen the species twice near Bombay. On 2 January 1939, C. J. Rae reported a bird from Ghoti, Nasik District, and on 3 March 1940 I shot one of a pair at Madhmeshwar about 30 miles away from Nasik.

I then saw a pair at Powai, Salsette Island, in 1948, and noted them again on 30 November 1951 (4 at Shil, Thana), 10 May 1953 (6 at Kihim, Alibag), and 18 May 1954 (a pair at Kihim).

In subsequent years they have increased in numbers and may now be seen regularly in village tanks in the Konkan large enough to hold duck. At Madhmeshwar, Nasik District (Bombay Deccan) small flocks can now be seen on every trip.

In February 1959 and again in mid-March 1960, I had the opportunity of shooting in Kutch with M. K. S. Fatehsinhji. The Cotton Teal was very frequently seen on the small lakes over which we shot. There appears to be no doubt that this species has now spread to and well established itself in areas where it was rare and/or absent not many years ago. The bird is associated with weedy patches of

water and it may be worthwhile examining its food to ascertain if the distribution is associated with the seed of any aquatic plant which may be its staple food.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, HUMAYUN ABDULALI
BOMBAY 6,
July 10, 1962.

9. PALE HARRIER [*CIRCUS MACROURUS* (S. G. GMELIN)] TAKING A POND HERON [*ARDEOLA GRAYII* (SYKES)]

On 12 March 1962 while bird-watching with a group of students at Ambernath, Kalyan Taluka, Thana District, Bombay (Maharashtra) we saw a female Pale Harrier [*Circus macrourus* (S. G. Gmelin)] suddenly drop and capture a Pond Heron [*Ardeola grayii* (Sykes)] standing by the lakeside about 150 yards away from us. It continued its flight with its prey and settled some distance away. As I thought it unusual for a harrier to take so large a bird I shot it and its identity has been confirmed.

ST. XAVIER'S HIGH SCHOOL,
BOMBAY 1, A. NAVARRO, S.J.
June 21, 1962.

[Very little information is available regarding the food of harriers in India. THE HANDBOOK OF BRITISH BIRDS, 3rd impression, Vol. 3, p. 71, states that in addition to mice, field voles, water voles, frogs and lizards, small birds including buntings, larks, sparrows, pipits, and chicken were taken by harriers. In its winter quarters a Little Crake is mentioned in its food, but there appears to be no record of any bird as large as a Pond Heron having been captured by this species. The larger Marsh Harrier (*C. aeruginosus*) often picks up a dead or wounded duck.—EDS.]

10. THE GREY PARTRIDGE [*FRANCOLINUS PONDICERIANUS* (GMELIN)] EATING SNAKE

Dr. Harold Trapido of the Virus Research Centre, Poona, recently sent us the remains of a snake which Capt. H. A. Mohite had obtained in the gizzard of a Grey Partridge *Francolinus pondicerianus* (Gmelin) short near Dehu, Poona, Maharashtra State. The front

portion of the snake was digested, but the markings and scalation on the tail end showed it to be *Boiga trigonata* which must have been some nine inches in length. Partridges are omnivorous but I have been unable to find a record of one eating a snake!

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
May 4, 1962.

P. W. SOMAN

11. THE UNUSUAL BATH OF A LORIKEET [*LORICULUS VERNALIS* (SPARRMAN)] AND A MAGPIE-ROBIN [*COPSYCHUS SAULARIS* (LINN.)]

On the morning of 11 December 1961 I went from Kodaikanal, Madurai District, Madras, down to the 16-mile post on the road to the plains (9 miles ENE. Kodaikanal, map distance) to do some birdwatching. The area, at an elevation of 3900 ft. (*c.* 1200 m.) in the Palni Hills, consisted largely of banana plantations with an understorey of coffee. There were also patches of forest scattered throughout the area.

The day was overcast, and it had rained a few hours before, during the night. All the vegetation was wet and, as there was little or no wind, droplets of water remained on the vegetation.

The strange behaviour of a Lorikeet, *Loriculus vernalis* (Sparrman), then attracted my attention. The Lorikeet was standing on the midrib of a slightly-inclined banana leaf, on the surface of which some droplets of water had collected. Then the bird lay down and, still clutching the midrib with its toes, rolled its body in an arc along the surface of the leaf. The bird then stood up, fluffed its feathers, and repeated this cycle several more times—apparently taking a bath with the aid of the few drops of trapped moisture. After several minutes of this activity the bird departed. The bird was silent during the entire period of observation.

A short while later, in the same area, I got a glimpse of a Magpie-Robin, *Copsychus saularis* (Linnaeus), which seemed to be taking a similar bath, but this bird was utilizing the moisture standing on the leaf of an unidentified broadleafed tree.

116, SUNDAR NAGAR,
NEW DELHI,
August 14, 1962.

JULIAN P. DONAHUE

12. AN ORNITHOLOGICAL TRIP TO THE GULF OF KUTCH

In June, 1962, while discussing possible ornithological excursions with K. S. Dharmakumarsinhji we thought that a visit to the Chankha, Nora, Baida, Ajar, and other uninhabited islands at the western end of the Gulf of Kutch, in which area Lester many years ago suspected the nesting of Curlew (*Numenius arquata*), would be interesting.

The Department of Fisheries (Survey & Research), Government of Gujarat, were very co-operative and offered to place a launch at our disposal at Salaya near Jamnagar. Landings could apparently be made at high tide only. A trip planned for 28 June had to be cancelled at the last moment owing to unfavourable weather, but another was arranged for 28-30 July, and on Friday, 27 July, I arrived at Jamnagar, the launch having left for Salaya the previous day. Before we left for Salaya a message arrived that high winds had forced the boat to take shelter at Sikka half way down the Gulf, followed by messages from Y. S. Shivrajkumar of Jasdan and Mr. H. N. Acharya of Ahmedabad that they would not be able to join me at Jamnagar as scheduled. As the Society's Field Assistant, P. B. Shekar, had reached Jamnagar, I thought we would visit Sikka and decide if the trip was possible. The country between Jamnagar and Sikka was cultivated and studded with patches of scrub eminently suitable for partridge. Not a single partridge was seen along the 20-mile drive; local information was that all game birds and antelope had been shot out by the military personnel stationed in the neighbouring areas. Peafowl appeared to have been spared and in one village at least they were plentiful and tame — we stopped to watch a cock displaying (with his back to the wind) to two hens a few yards away, both of which appeared to be quite uninterested and unconcerned. The loud *pee-haon* of the cock uttered with the neck drawn back prompted similar calls from at least five other cocks, none of which was more than 300 yards away. When displaying, the chestnut wing quills are hung low near the ground, and quivered most of the time. During the 9 minutes that we watched the display the tail feathers were thrice vibrated, moving the larger tail (coverts) too.

At Sikka, there was still a high wind and Mohamed, an experienced assistant of the Fisheries Department, and Usman, in charge of the launch, were agreed that it would not be possible to go westward to Nora. However, they offered to take us to the islands around the Pirotan Lighthouse and work back to Jamnagar. They were sure that many birds nested on the islands. The 30-ton launch was resting high and dry in a tidal creek but with the rising of the tide at

about 11 a.m. we took off. A flock of 30-40 Whimbrel (*Numenius phaeopus*) was seen in the mangrove at Sikka, as also Curlew (*N. arquata*), Redshanks (*Tringa totanus*), and a few Marsh Sandpipers (*Tringa stagnatilis*). A flock of Blacktailed Godwits (*Limosa limosa*), several of which had rust-coloured breasts, passed over us and I saw a single Great Stone Plover (*Burhinus oedicnemus*). A little after we left the shore, large green 'islands' showed on all sides, but upon closer approach they turned out to be the tops of mangroves standing in several feet of water and with no dry areas on which plover or any other ground-breeding birds could nest. However, we saw several colonies of Painted Storks (*Ibis leucocephalus*). The nests were only a few feet above the water level and the birds, standing by their eggs and seen from a distance of about 20 yards, presented a most beautiful spectacle. In the adjacent mangrove numbers of Grey Herons (*Ardea cinerea*), Reef Egrets [*Demiegretta asha* (?)], Large (or Middle?) Egrets (*Egretta alba* or *intermedia*), White Ibis (*Threskiornis melanocephala*), and Darters (*Anhinga melanogaster*) were also nesting. As at other colonies of this kind, House Crows were present and waiting for a chance to steal an egg or a chick. Several crow nests were also seen in the mangrove swamp (one with two half-fledged young), indicating that the crows have colonised these 'islands'.

The Darter has always been treated as a freshwater bird and it is interesting to note that here some nested in tidal waters. An adult which dived and swam well was collected and found to have its wing quills moulting and hardly an inch and a half in length. This flightless condition has been noted in several species of duck, while wintering in India, but I have not seen it mentioned for any of the Phalacrocoracidae.

Without a small boat or canoe, the mangroves were impenetrable. We saw a countrycraft on a strip of sand along a large flat island just south of the Pirotan Lighthouse. The sand appeared to have been recently wetted but the boatmen assured us that the island was extensive and we pulled alongside the countrycraft which was loaded with sand. We dropped into waist-deep water and wading to the shore walked along the sand-strip towards the Lighthouse which appeared to be only a couple of miles away. The strip of sand bore a sparse growth of stunted *Salvadora persica* which bordered a large mangrove swamp. Here we saw old droppings of camel, and Curlew, Whimbrel, and Redshank frequently.

As the tide receded and exposed larger areas of mud, we returned

to the launch to consider further activities and found it high and dry and far from the water's edge. The sand-laden craft, we now learnt, had been there for four days and was waiting for a tide high enough to float it off! We were assured that it would be possible to take off on the night tide and we spent the rest of the day walking about the island. Several Gull-billed Terns (*Gelochelidon nilotica*) and Little Terns (*Sterna minuta*) were seen. Three specimens of the latter were collected, two with yellow bills tipped with black, and all black in the third which also showed immature plumage on the upper surface. The legs and feet were yellowish-green in all the specimens which together with the black shafts to the first three primaries, appeared to make them *saundersi*.

Single specimens of Oyster-Catcher (*Haematopus ostralegus*), Grey Plover (*Pluvialis squatarola*), and Little Green Bittern (*Butorides striatus*) were noted, as also a pair of Black-necked Storks (*Xenorhynchus asiaticus*). Small parties of Sand Plovers (*Charadrius leschenaulti*, and *asiaticus*) were seen; two *leschenaulti* collected had undeveloped gonads. Except for a glimpse of a bulbul, a Wren Warbler (Shekar reported an Ashy Wren Warbler), and a few swifts (*Apus affinis*) which hawked over the island for some time, no other birds were seen. As the tide dropped, large areas of mud were exposed and it was possible to walk on to an island half a mile away, which no doubt was similarly connected with the one beyond and so on.

A coral reef exposed many small and brightly coloured animals[1], including several octopuses (*Octopus* sp.) in shallow pools—the boatmen were quite familiar with the extraordinary manner in which the octopus would flow and disappear into narrow slits or crevices as soon as one of its arms had found and entered it. We also saw them throw out smoke-screens which were extraordinarily effective. At night we saw a pair of jackal and wondered what they did when the island was completely flooded.

The night tide failed to float us off and we were cheerfully informed that the next one would certainly do so. The following morning was also spent wandering around the island and anxiously waiting for the tide which took us off before noon. On the way to Jamnagar, we circled round an island colony of Painted Storks and had a better look at their nests and the other birds. The Reef Egrets nesting in the mangrove appeared to be much larger and darker than

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the birds usually seen in and around Bombay. Actually I shot the first bird which I saw at Salaya as after examination through glasses it appeared to me to be a species I had not seen before. The material available in Bombay does not permit a definite identification.

Except for a flight of Little Cormorants (*Phalacrocorax niger*) and a tern with a yellow bill and a long forked tail (*Sterna aurantia*) no other birds were seen. We reached Bedi Bunder at about 2 p.m. on Sunday, and flew into Bombay the following day.

Mr. Sukumaran of the Fisheries Department, Government of Gujarat, was with us all the time and we are grateful for the assistance received. It has not been possible to obtain a very clear indication of the islands, but several of the birds mentioned above and believed to be migrants into India are exceptionally early. Perhaps they may be found breeding on some of these little known places. I hope that it will soon be possible to reach these islands and settle the matter one way or the other.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, HUMAYUN ABDULALI
BOMBAY 6,
August 24, 1962.

13. SUPPLEMENTARY NOTES ON 'THE BIRDS OF GUJARAT' FROM BIRDS COLLECTED IN THE SURAT DANGS

In the *Journal of the Bombay Natural History Society* [Vol. **52** (2 & 3), August-December 1954, and **52** (4), April 1955] Dr. Sálim Ali published an excellent paper on 'The Birds of Gujarat'.

It is the purpose of this note to add a few supplementary notes to Dr. Ali's list of the birds in Gujarat State.

Through the courtesy of Mr. Charles E. O'Brien of the American Museum I have received photo copy lists of my first 238 specimens as identified and entered into the Museum catalogue; and more recently a list of the remaining 225 specimens in my collection (Collection numbers 239-463) as identified by Dr. B. Biswas of the Zoological Survey of India. From my total collection of 463 specimens 298 were collected in the Surat Dangs area. In all, 140 species of birds were collected in the Surat Dangs, but only the six species which represent some new information concerning the birds for the whole State of Gujarat will be mentioned here.

The systematic list below follows the same arrangement of families as listed in Dr. Sálim Ali's 'The Birds of Gujarat'.

Circus pygargus (Linnaeus) : Montagu's Harrier

Sálim Ali wrote: 'No specimens collected and not definitely identified in the field. . . . .' [*J. Bombay nat. Hist. Soc.* **52** (2 & 3): 400].

The following specimens were collected by me:

Sept. 18, 1954, Ahwa, Coll. No. 344, ♂.

Oct. 23, 1954, Pandwa, Coll. No. 362, ♀.

This species is an uncommon winter visitor in the Dangs.

Cuculus poliocephalus poliocephalus Latham : Small Cuckoo

This bird is not listed in the Survey report. One specimen was collected as follows:

Oct. 5, 1953, Mulchond, Coll. No. 136, ♀.

Cuculus micropterus micropterus Gould : Indian Cuckoo

This bird is not listed in the Survey report. One specimen was collected as follows:

July 14, 1954, Mulchond, Coll. No. 327, ♀, ovaries enlarged.

The fact that this specimen was in breeding condition would indicate that this species breeds in Gujarat State.

Pitta brachyura brachyura (Linnaeus) : Indian Pitta

The *Journal* states: 'Not seen or heard by the Survey between August and mid April, in Kutch, Saurashtra or Gujarat' [*J. Bombay nat. Hist. Soc.* **52** (2 & 3): 454].

The following specimens were collected:

July 4, 1954, Mulchond, Coll. No. 326, ♂, testes enlarged.

August 13, 1954, Mulchond, Coll. No. 333, imm.

The Pitta is fairly common during the monsoon months in the Dangs and breeds in this area.

Turdus citrina cyanotus (Jardine & Selby): Whitethroated Ground Thrush

Only one specimen was collected in the State of Gujarat and this represents 'the sole example met with by the Surveys.' [*J. Bombay nat. Hist. Soc.* **52** (4): 770].

The following specimens were collected:

March 20, 1954, Mahal, Coll. No. 259, ♂, testes not enlarged.

August 17, 1954, Mulchond, Coll. No. 337, ♀, ovaries enlarged.

This species is an uncommon resident in the Dangs.

Calandrella cinerea dukhunensis (Sykes) : Short-toed Lark

The following specimens were collected:

Oct. 20, 1954, Ahwa, Coll. No. 357, 358, ♂♂, testes not enlarged. Not listed in Survey report. Status uncertain in the Dangs.

The remaining 134 species of birds collected in the Surat Dangs, and now in the American Museum, agree with the species recorded in 'The Birds of Gujarat'. Some of the subspecies, as identified for me, are different from those recorded by Sálim Ali in his survey but their discussion does not come within the scope of this note.

DANGS RURAL BOARDING SCHOOL,
CHURCH OF THE BRETHREN MISSION, ERNEST M. SHULL
AHWA, VIA BILIMORA,
DANGS DISTRICT, GUJARAT STATE,
July 25, 1962.

14. NOTES ON BIRDS FROM SOUTH INDIA

The following notes on birds of south India may be of interest.

Ciconia episcopus (Boddaert) : The Whitenecked Stork

A pair of these birds have nested in a *Bombax* tree near the Aranya Nivas Hotel in the Periyar Game Sanctuary this year. This is an extremely uncommon occurrence as the bird is distinctly rare here and I have only once observed it at the Periyar Lake hitherto. The previous observation was made on 19 March 1961 when a pair of birds were seen flying overhead near to the present nesting site. I noticed an old nest in the same tree so it seems likely that the birds bred or attempted to breed here last year. At the time of writing the pair seem to be looking after young in the nest and it seems likely that they will be successful in rearing the brood as the nest is in an extremely inaccessible spot.

Halcyon pileata (Boddaert) : Blackcapped Kingfisher

I had the good fortune to see a pair of these kingfishers at a tank near Uthamapalayam in the Cumbum Valley of the Madurai District on the 24th and the 26th December 1961. As this place is far inland from the sea, over 100 miles, I think the occurrence of these birds there must be very unusual, and so this record may be

of interest. A single bird was seen at the same place on 15 April 1962.

Motacilla indica (Gmelin) : Forest Wagtail

Mr. P. J. Sanjeeva Raj noted the Forest Wagtail at Tambaram, Madras (Chingleput District, from 19 September to 17 October (*J. Bombay nat. Hist. Soc.* 1960, **57** : 220-1) presumably on their way south and then again from 11 to 28 April (ibid., 1961, **58** : 269) on their way back. I have the following dates of their arrival in the Peermade-Vandiperiyar District of Kerala at an altitude of *c.* 3000 ft.

1948	..	23 September
1949	..	19 September
1950	..	5 October
1951	..	7 October
1952	..	No record
1953	..	4 October
1954	..	No record
1955	..	No record
1956	..	5 November
1957	..	19 September
1958	..	No record
1959	..	21 September
1960	..	No record. The species seemed to be very scarce this year.
1961	..	No record

The reason for no record in certain years is because I was away from India. I have very few records of the date last seen in the district but it would seem that the bird passes through this district at the beginning of May because I have the following last seen records: 2 May 1954, 2 May 1955, 6 May 1961.

PAMBANAR ESTATE,
PEERMADE P.O.,
KERALA STATE, SOUTH INDIA,
March 24, 1962.

M. C. A. JACKSON

15. RECOVERY OF RINGED BIRDS

Ring No.	Species	Date of Ringing	Place of Ringing	Recovered on	Place of Recovery	Remarks
Moskwa C 32.154	*Ardea cinerea*	1/15-6-1952 juv.	Astrakhan-Zapovednik *c.* 45° 50′ N., Astrakhan Region.	December 1956	Shatra, Muntafik Liwa in SW. Iraq	The recovery was reported in *Iraq. nat. Hist. Mus. Publication* No. 14 : 20 (1958), and the information regarding the date and place of ringing subsequently received from the USSR.
Moskwa E 287-730	*Anas clypeata*	19-8-1955 ad. ♀	Astrakhan-Zapovednik *c.* 46° 14′ N. × 49° 00′ E.	December 1956	do.	ibid. This was recorded as a Grey Heron
Moskwa D 313-477	*Plegadis falcinellus*	3/4-7-1956 juv.	Kyzyl-Agach Zapovednik *c.* 39° N. × 48° 50′ E., Azerbaijan, USSR.	December 1956	do.	do.
Moskwa B 49.570	*Egretta alba*	5-7-1956 juv.	Nr. Primorsko-Akhtarsk *c.* 46° 03′ N. × 38° 09′ E., Krasnodar territory	19th Dec. 1957	60 km. E. of Mosul, Iraq	do.

Moskwa F 559-117	*Sturnus vulgaris*	25/29-5-1959 juv.	Nicolaevka, *c.* 53° 08′ N. × 47° 12′ E., Oulianovak, USSR.	22nd Feb. 1960	60 km. E. of Mosul, Iraq	do.
Moskwa C 57.137	*Nycticorax nycticorax*	28-5-1954 juv.	Kyzyl-Agach Zapovednik, *c.* 39° N. × 48° 51′ E., Azerbaijan. USSR.	5th April 1949	Near Baghdad, Iraq	The recovery was reported in *Iraq. nat. Hist. Mus. Publication* No. 18 : 33 (1960), and the information regarding the date and place of ringing subsequently received from the USSR.
Moskwa F 608-118	*Sturnus vulgaris poltaratskyi*	25-5-1959 juv.	Leninsk-Kuznetskii, *c.* 54° 40′ N. × 86° 10′ E., Kemerovo Region	3rd Jan. 1960	Lahore, West Pakistan	Reported by Mr. Mian Nasim Akhtar, 57 Haq Nawaz Road, Baghbanpur, Lahore, W. Pakistan.
Moskwa E 551-110	*Anas strepera*	18-7-1959 ad.	Kurgaldzhin Lake, *c.* 50° 30′ N. × 69° 35′ E., 150 km. SW. from Akmolinsk Kazakh SSR., USSR.	26th Feb. 1961	Srinagar, Kashmir	Reported by Col. H. Nedou, Srinagar.

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No.	Species	Date of Ringing	Place of Ringing	Recovered on	Place of Recovery	Remarks
Moskwa D 445.500	*Anas acuta*	20/25-7-1958 ad.	Kurgaldzhin Lake, *c.* 50° 30′ N. × 69° 35′ E., *c.* 150 km. SW. from Akmolinsk Kazakh SSR.	January 1959	Bodhnambal Jheel, 11 miles from Srinagar	Reported by Shri S.S. Gergan, Game Warden, Srinagar.
Moskwa D 102.165	*Anas acuta*	4-8-1946 ad. ♂	Near about Shilokhvost, Astrakhan State Sanctuary, delta of River Volga, Astrakhan District.	November 1947	50 km. south of Madras, S. India	Reported by the Bird Ringing Centre, USSR Academy of Sciences, Moscow, USSR.
Moskwa C 86541	*Ardea cinerea cinerea*	30-6-1961	Kazoty Lake on the lower reaches of the Talas River (*c.* 70° E, × 40° 48′ N.), Dzhambul Region, Kazakh SSR.	early April 1962	On the banks of the Suvarna River, Perampalli, Shivalli Panchayat, Udipi Taluk, South Kanara, Mysore State.	Obtained and reported by Dr. S.S. Godbole, Associate Professor of Anatomy and Curator, Kasturba Medical College, Manipal, South Kanara.

Bombay A-11523	*Passer hispaniolensis transcaspicus*	31-3-1962* ad. ♂	Bharatpur, Rajasthan, 27° 13′ N. × 77° 32′ E.	2nd June 1962	Near Chokpar (Chekinda), Georgievka District, Dzhamhul, region, Kazakh SSR, *c.* 43° 03′ N. × 74° 43′ E.	Reported by the Bird Ringing Centre, USSR Academy of Sciences, Moscow, USSR.
Bombay A-12039	*Passer hispaniolensis transcaspicus*	3-4-1962* ad. ♂.	do.	29th May 1952	do.	These are two of the 12 ringed birds found amongst 53,500 dead sparrows examined out of over 1.8 millions recently destroyed by poisoned grain, by the Djambul Plant Protection Station. All the others had been ringed in the same locality in previous years.

* These two birds were ringed in the course of BNHS/WHO Bird Migration Field Project

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
August 8, 1962.

EDITORS

16. NOTES ON SOME AMPHIBIANS OF THE DARJEELING AREA, WEST BENGAL

(With four plates)

Between 1958 and 1959 a small collection of amphibians was made in and around Darjeeling, 7200 ft. (2200 m.), Darjeeling District, West Bengal. The number of species found is small and I am inclined to believe that elevations ranging from 0 to 5000 ft. (*c.* 1500 m.) are likely to be more productive for variety of species.

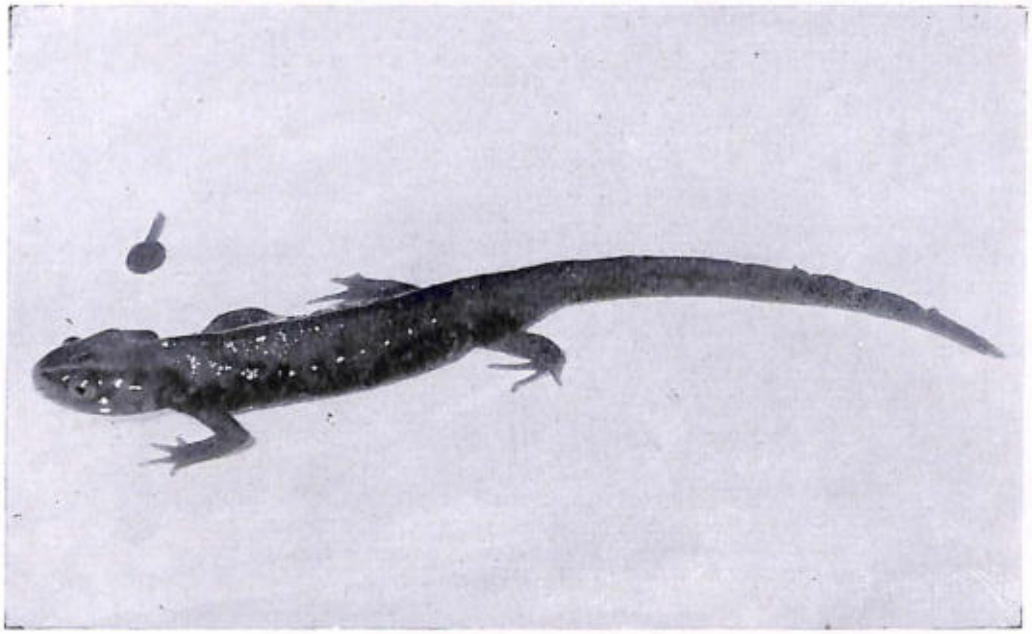
Tylototriton verrucosus Anderson : The Himalayan Newt (Plate I)

This is reported by Annandale to be abundant between 4500 ft. to 5000 ft. (*c.* 1400-1500 m.) in the Kurseong area. His statement that it is found in restricted areas is perhaps due to the fact that these secretive creatures are only seen during the breeding season in May when they congregate at pools to lay their eggs.

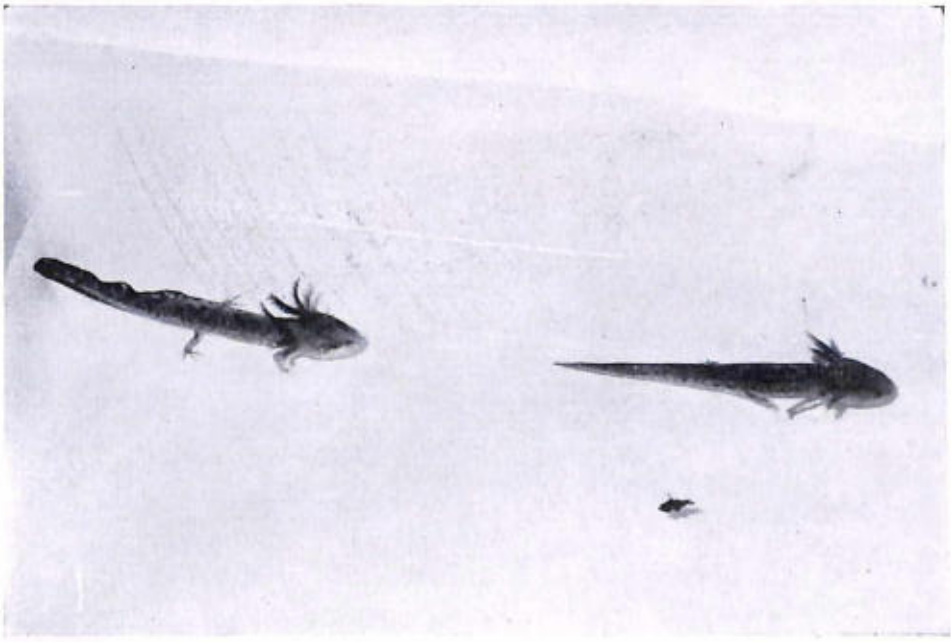
Specimens were collected from a perennial pool at an elevation of 6500 ft. (*c.* 2000 m.) at Sonada in May. I was reliably informed that newts have been observed breeding in this pool for several years and it appears to be one of the regular breeding sites. It may be noted here that Annandale observed them breeding in temporary rain-water pools at Kurseong. The newts were usually seen resting in water at the edge of the pool. Occasionally a newt would come up from the depths of the pool to capture tadpoles of the toad (*Bufo himalayanus*) swimming at the top. In captivity they stayed out of water, and remained motionless for considerable periods, becoming active only when earthworms, which they took readily, were put into the container. They were uniform brown in colour with the tail edge orange. They cast their skins approximately every fortnight. In amplexus the male approaches the female from below and holds her by hooking his forelegs over hers.

Tadpoles of the Himalayan Newt, which stay at the bottom were also collected from the same pool. They were olive-brown in colour, profusely speckled with darker markings. All the tadpoles collected were in the four-legged stage, and three of them metamorphosed in captivity. The change-over to the adult form is completed in two days during which the animal does not feed. Eight tadpoles varied in size from 39 mm. to 57 mm. agreeing with those described by Smith (*Rec. Ind. Mus.* **26** : 309). The juvenile newts measured 50, 48, and 55 mm.

TYLOTOTRITON VERRUCOSUS ANDERSON

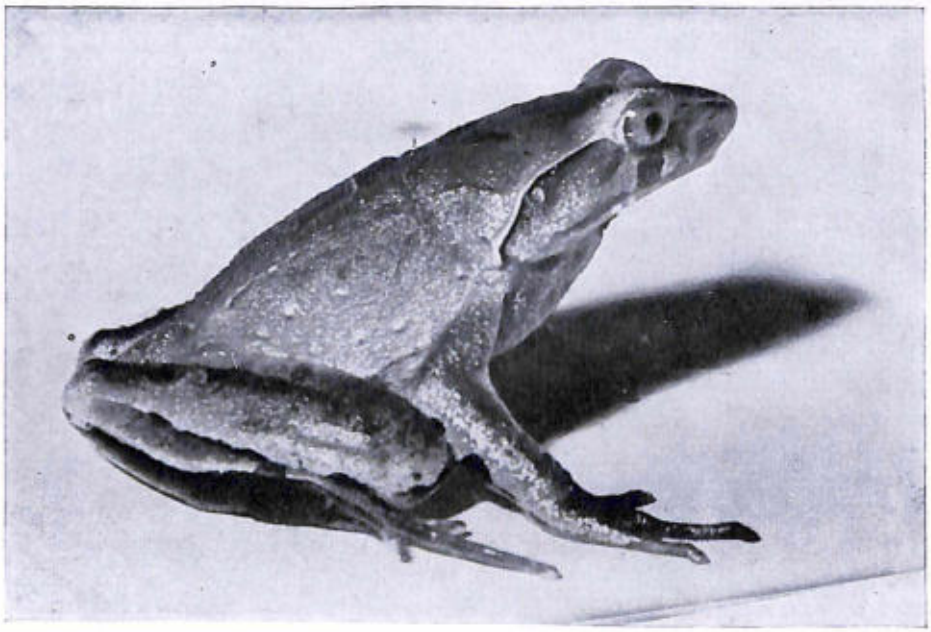


Adult



Tadpoles

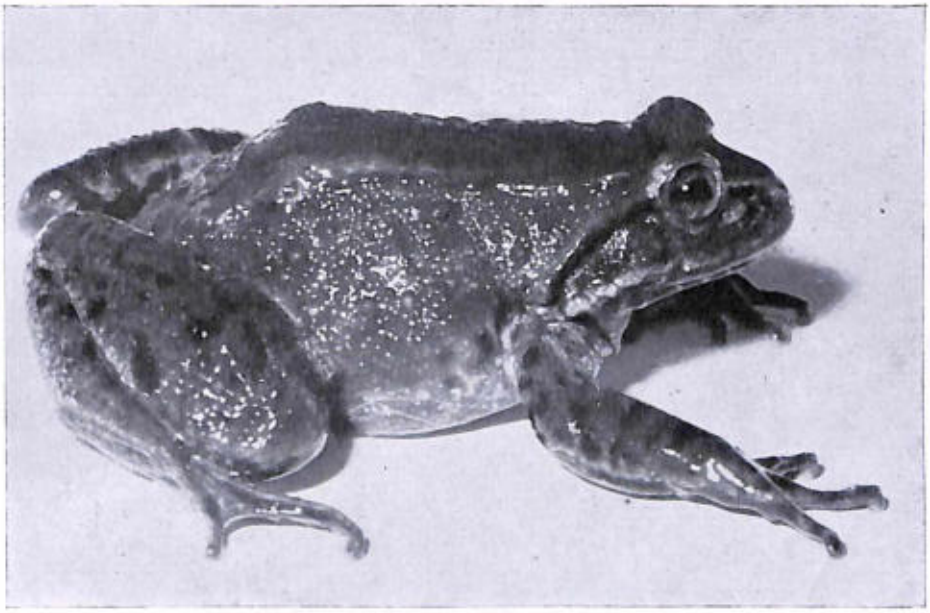
(Photos : Durga Das)



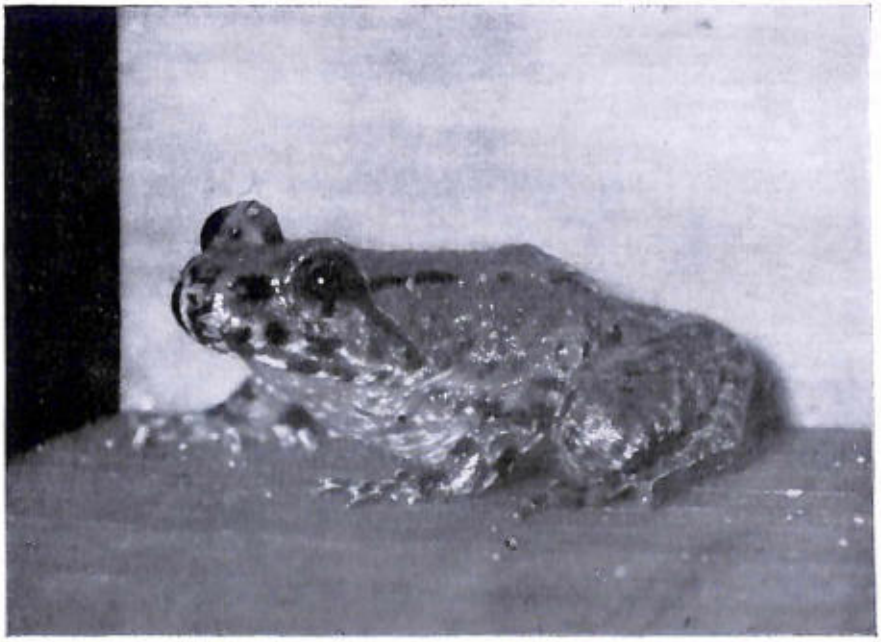
Megophrys major Boulenger

Megophrys parva Boulenger

(Photos : Durga Das)

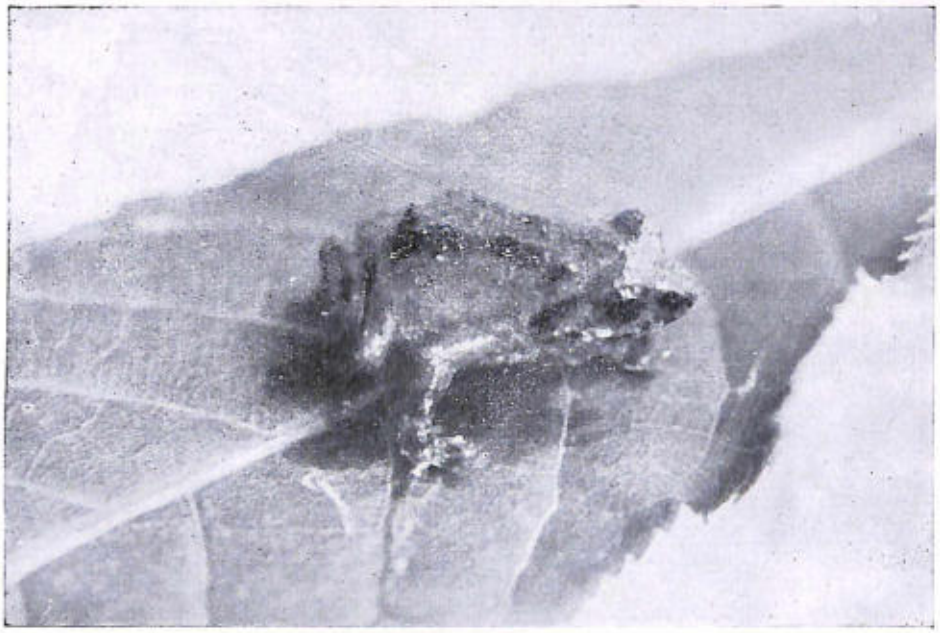


Rana liebigii Günther

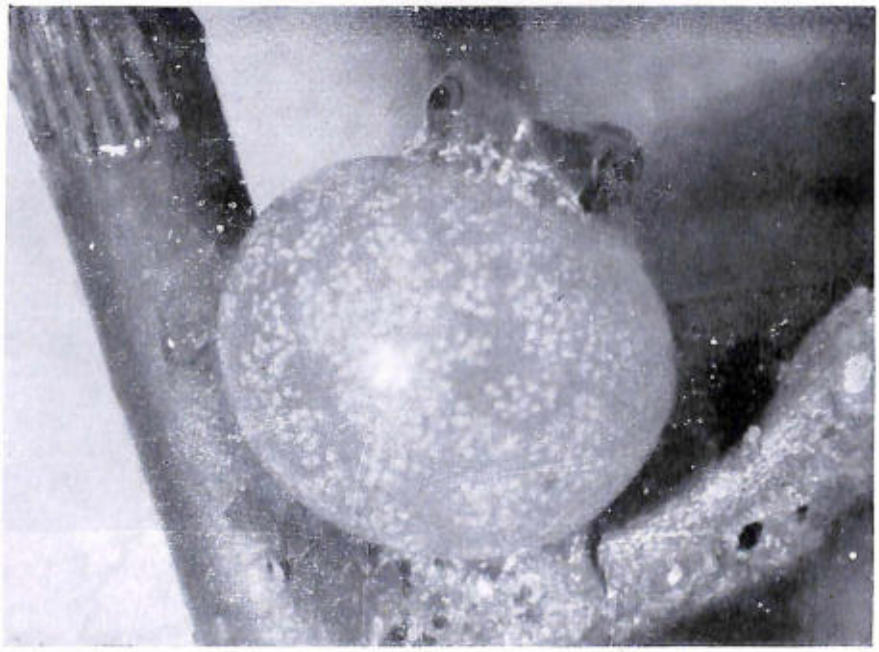


Rana annandalii Boulenger

PHILAUTUS ANNANDALII BOULENGER, MALE



At rest



Calling

(Photos : Durga Das)

Megophrys parva Boulenger (Plate II)

This Pelobatid toad is common in the vicinity of Darjeeling. The call resembles the sound produced by striking two stones together, and can be heard during the early part of the rainy season emanating from heavy undergrowth bordering hill streams.

In breeding males the inside of the thighs are bright red. The characteristic tadpoles with the funnel-shaped mouth were not found near Darjeeling, but were collected at an altitude of *c.* 5500 ft. (*c.* 1700 m.).

Megophrys major Boulenger (Plate II)

Only two specimens, both females, were collected, one at *c.* 5500 ft. and the other in a forested area at Darjeeling where its uniform brown coloration with darker markings perfectly matched the dry leaves on the forest floor. The Darjeeling specimen (80 mm.) collected in September had the ovaries dormant whilst the specimen (101 mm.) from the lower elevation collected in June had enlarged ovaries with eggs 2 mm. in diameter.

Bufo himalayanus Günther : The Himalayan Toad

This is the common toad in the Darjeeling area. Breeding begins as early as March and tadpoles are abundant in still pools during June-July. This species differs from *Bufo melanostictus* Schneider, the Common Indian Toad, only by the smaller tympanum (less than half diameter of eye as against $\frac{2}{3}$ in *melanostictus*). *Bufo melanostictus* was not noted in Darjeeling but has been collected at Kalimpong, 4500 ft. (*c.* 1400 m.). These toads retire to their winter shelters in late November and appear again in March.

Rana leibigii Günther : The Himalayan Bull Frog

This is common but rarely seen as it prefers forested area and streams with heavy vegetational cover at the sides. The four specimens collected were all females. There is considerable variation in colour from light brown to dark grey. The ovarian eggs are rather large averaging 5 mm. in diameter. In the Darjeeling area large numbers are caught as they are considered to be of medicinal value. This species has an altitudinal range from 4000 ft. to 13,000 ft. (*c.* 1200-4000 m.).

Rana annandalii Boulenger 1920 : Annandale's Frog

Tadpoles of this are common in almost all hill streams in the vicinity of Darjeeling during the monsoon. They are seen usually under rocks at the bottom of pools in the stream. The buccal disc

has papillae on the sides and two complete rows of papillae on the lower lip, which are used for holding on to rocks against the flow of the current. The adult is hard to find in the dense herbage by the side of streams. In this species the dorso-lateral glandular fold peters out at the shoulder as can be seen from the photograph in Plate III.

Philautus annandalii Boulenger 1906 : Annandale's Bush Frog

This is the commonest frog in the Darjeeling area during the months of May, June, and July, when hillsides resound to their call at night. The calling gradually goes down in intensity after July and ceases by September. The call which has a ventriloquistic effect can be syllabilised as *dik dikdik*. The vocal sac, which acts as a resonator is, when inflated, equal to or slightly larger than the frog in size.

They are mainly nocturnal but are sometimes heard during the day, when the sky is overcast and misty.

The frogs vary in colour being light or dark grey-brown or blackish-brown. The markings on the body are constant, consisting of a dark band between the eyes and a similar streak running from behind the eye along each side of the body on to the thigh and leg. Ventrally it is an immaculate white. The male has the inside of his thighs bright red in May, June, and July. The specimens collected varied in length from 17 mm. to 20 mm. Tadpoles were not collected.

This species has an altitudinal range of 3000 to 9000 ft. (*c.* 900-2700 m.).

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6.
August 22, 1962.

J. C. DANIEL
Curator

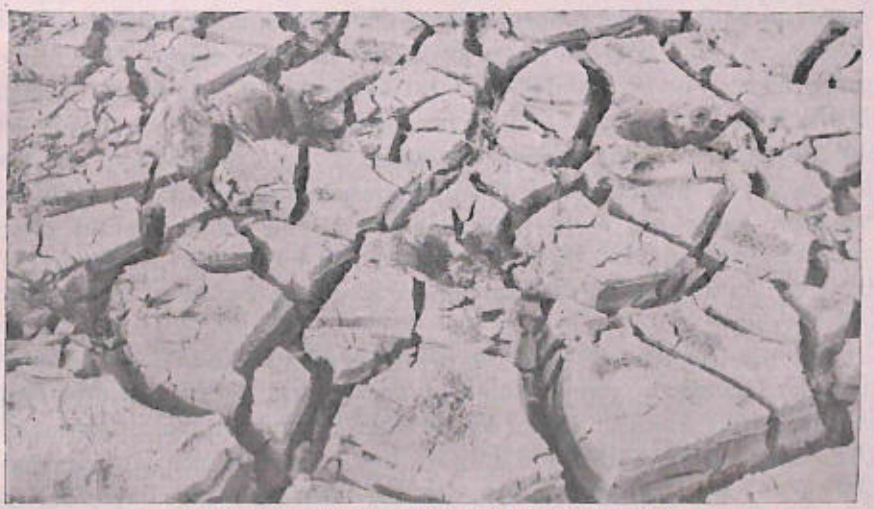
17. A NOTE ON THE NATURAL DESTRUCTION OF VALUABLE FISH SEED[1]

(*With a photograph*)

Most of the Indian carps are known to breed during the monsoon months from June to August, in shallow marginal areas of rivers. Their fecundity is very high, but much of the spawn is destroyed in large quantities at various stages of development and is

[1] Published with the kind permission of the Fisheries Development Adviser to the Government of India, New Delhi.

not available for recruitment to the fishery. Large scale destruction of breeders and juvenile fishes has been reported by various workers. Jhingran & Chakraborty (1958) have described in detail the loss sustained by the destruction of fingerlings in the River Ganga. This note describes two interesting observations on the large scale mortality of valuable fish seed at the egg stage, due to natural causes.



Impressions on soft mud left by stranded eggs

Narbada River. The senior author (SJR) while working in 'Boori' Narbada, a breeding ground in Narbada River of Madhya Pradesh, observed spawning taking place on the morning of 23-8-1957 (Rajan & Kaushik, 1958). Spawn collection nets were fixed and twenty lakhs of eggs were collected from 10 a.m. to 3 p.m., when the water stopped abruptly and there was no further collection that day. Early next day large quantities of eggs in an advanced stage of development were found stranded on the margins of the channel, in the soft mud. Spawn collection nets fixed in the channel, where the water was flowing, did not yield any results. About 22 lakhs of eggs were quickly collected from the soft mud with drag sheets. A large number, however, could not be collected as they hatched out and died, leaving egg impressions on the ground. These egg impressions were noticed from near Tamacheru village to Muriakhera village, a strip about 1½ miles long and 4 to 5 ft. wide, forming a closely fitted mosaic of uniform dots on the smooth and silky mud. On an average there were about fifty impressions in each square inch of mud.

In 1958 on the day of observation, the flow of water was continuous in 'Boori' Narbada and all eggs collected were by spawn collection nets fixed in the channel; the stranding of eggs was not noticed.

Manjira River. For the past three years (1959-61) the present authors have collected large quantities of eggs near Sardana village, on the Manjira River (a tributary of the Godavari) in Andhra Pradesh. The collection was being made in the river on the northern bank. Under normal conditions three good collections are made coinciding with the three floods in the river, during June, July, and August. In 1959 and 1961, large quantities of eggs were collected in the June flood; large numbers of eggs were however found stranded on the northern bank, leaving millions of deep impressions on the soft mud (see photograph). These impressions were not found on the southern bank; nor were they seen during the other months (July and August). In 1960 there were drought conditions in this area and the first flood came only in July; here again the egg impressions were not noticed.

The destruction of breeders and fingerlings, usually by human agencies, stands no comparison with the natural destruction described in this note. Since it is not practicable to prevent the stranding of the spawn, it is felt that the only method of saving such large quantities of valuable fish seed is by collecting them from breeding grounds.

CENTRAL FISHERIES EXTENSION UNIT,
HYDERABAD,
May 20, 1962.

S. J. RAJAN
D. VEERARAGHAVA REDDI

REFERENCES

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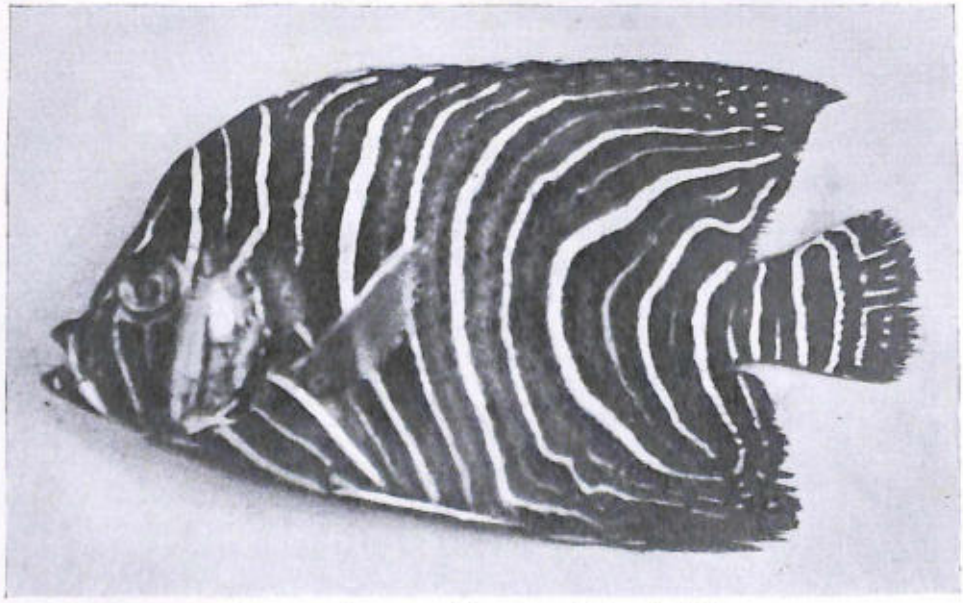
Rajan, S.J. & Kaushik, D.K. (1958): 'Boori' Narbada makes a good fish breeding sanctuary. *Indian Farming* 7 (12): 20-3.

18. A NOTE ON THE COLORATION OF *HALIEUTAEA STELLATA* (WAHL.)

(*With a plate*)

Halieutaea stellata (Wahl.), a representative of the interesting genus *Halieutaea* Cuv. & Val., the Pediculati or anglers, occurs in the seas of India and Malaya Archipelago. Day (1878) has given a figure of a specimen of this species, which he collected from Madras. The colour of the fish is described as pinkish.

Halieutaea stellata (Wahl.)



Pomacanthus semicirculatus (Cuv. & Val.)

Very recently a single specimen of this species was obtained at Porto Novo in fish catches with *thuri valai*, from about the six fathom line in the sea. In the diagnostic characters the specimen resembles very closely *H. stellata* described by Day (1878). But one striking difference is found in the coloration. The dorsal surface is pinkish, and the ventral deep pink. The most characteristic feature, however, is the presence of dark markings on the dorsal surface. The local Muslims decipher in these markings the words 'Muhammed-Hussain' in Arabic characters. Large numbers of Muslims have been visiting the Biological Station to see this specimen. This reminds us of what Norman (1958) has written regarding the markings on *Pomacanthus semicirculatus* (Cuv. & Val.), which caused considerable excitement in Zanzibar.

Apart from the validity of this, the markings are interesting as they have not been previously described either by Day (1878) or by Munro (1955). The markings do not fade in the preserved specimen unlike the pink background which fades rapidly in the preserved condition.

The specimen obtained in Porto Novo measures 16.8 cm. It is now preserved in the Ichthyological Museum of the Marine Biological Station, Porto Novo. A photograph of the specimen is reproduced. The 'tentacle' at the snout is retracted and does not appear in the photograph.

My thanks are due to Prof. R. V. Seshiya, Director, Marine Biological Station, Porto Novo, for his kind help and encouragement.

MARINE BIOLOGICAL STATION,
PORTO NOVO, S. INDIA, T. VENKATESWARLU
December 12, 1961.

REFERENCES

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Munro, I.S.R. (1955): The Marine and Fresh Water Fishes of Ceylon. Canberra.
Norman, J.R. (1958): A History of Fishes. London.

[Along with the photograph sent by T. Venkateswarlu, we reproduce one of the Koran, or Butterfly-Fish (*Pomacanthus semicirculatus*). The markings on the tails of some of the specimens can be read as *Shan-e-Allah* (Greatness of God). It is common in the Indian Ocean and specimens have been exhibited at the Taraporevala Aquarium, Bombay, to whom we are grateful for the photograph reproduced.—EDS.]

19. INTERTIDAL ECHINODERMATA OF BOMBAY[1]

(With two plates)

The taxonomy of echinoderms in Indian waters has attracted attention of scientists since the last seventy years. The collections of the Indian Marine Survey Ship 'Investigator' and those of the Indian Museum have been dealt with by Wood-Mason & Alcock (1891), Alcock (1893), Anderson (1894), Koehler (1898-1927). Koehler & Vaney (1905, 1908), and A. H. Clark (1909-1932). Bell (1886, 1887), Doderlein, Pearson (1903), Chadwick (1904), Herdman (1904), and H. L. Clark (1915) have published several reports on the echinoderms of Ceylon. Duncan & Sladen (1889), Carpenter (1889), and Brown (1910) have worked on the echinoderm fauna of Mergui Archipelago. Bell has described the echinoderms of the Andamans (1887), Bengal (1888), Tuticorin (1888), and the Laccadives and Maldives (1902). Lastly, Thurston (1887) and Gravely (1927) have worked on the echinoderms of Rameswaram and Krusadai respectively.

The echinoderm fauna of the west coast of the Indian subcontinent however, has not received much attention in the past, except for the records by Kurian (1953) of the echinoderms of Travancore (south India). The vast area north of this up to the Persian Gulf has remained unexplored, except for stray records of a few specimens from Karachi, Honavar, and Mangalore by Koehler (1927), and for the work of Patil (1953) at Karwar. The latter has, however, identified most of the specimens only up to their genera. It was, therefore, decided to make a representative collection of echinoderms from Bombay.

Collections were confined to the inter-tidal zone at various parts along the foreshore in Greater Bombay, viz. Cuffe Parade, Chowpatty, Worli, Mahim, Danda, and Versova. They were also extended to Manori which, although not within the limits of Greater Bombay, was included as it harbours large numbers of feather-stars, which were elsewhere collected only occasionally.

A total of 16 species, belonging to seven different orders and 10 families, comprises the present collection. None of these has so far been recorded from Bombay. Moreover, the species *Amphipholis*

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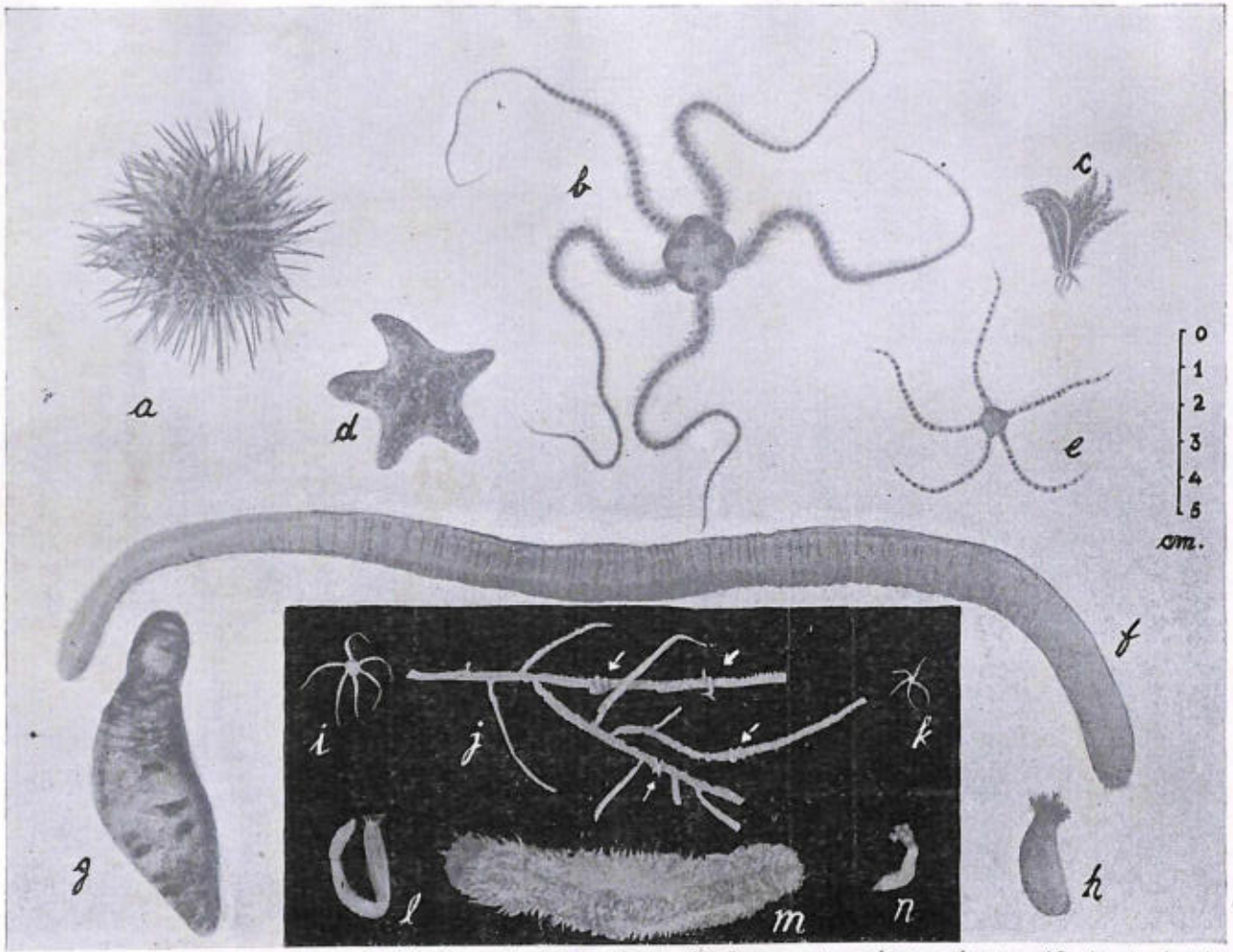
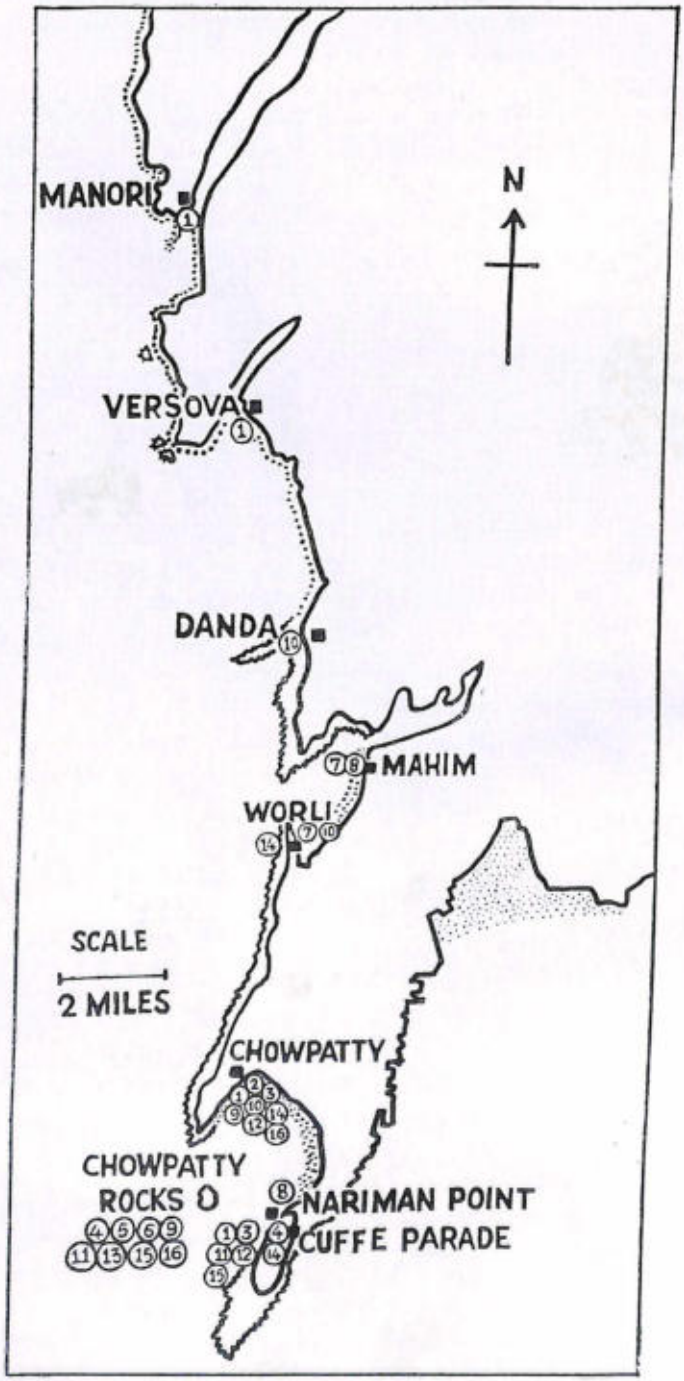
[1] The Echinodermata are characterized by radial symmetry, a calcareous exoskeleton in the form of plates or spicules usually beset with tubercles or spines, which give the phylum its name. Locomotion is by tube-feet. They are marine forms without exception, and none are colonial. They comprise the starfishes, sea urchins, sea cucumbers, brittle stars, and feather stars.—Eds.

Communicated by the Director of Fisheries, Maharashtra State.



(*a*) *Temnopleurus toreumaticus* ; (*b*) *Macrophiothrix aspidota* ; (*c*) *Lamprometra palmata palmata* ; (*d*) *Asterina lorioli* ; (*e*) *Ophionereis dubia*; (*f*) *Anapta gracilis* (?); (*g*) *Holothuria pardalis*; (*h*) *Athyone* sp., (*i*) *Ophiactis savignyi*; (*j*) *Ophiothela danae*, on a sea-fan ; (*k*) *Amphipholis squamata* ; (*l*) *Protankyra* sp. ; (*m*) *Actinocucumis typica* ; (*n*) *Thyone conjugens*

Specimen (*l*) has got shrunk during preservation and grows as large as specimen (*f*).



Map of Bombay showing localities where collections were made. The numbers correspond to those against the names in the systematic list.

squamata, Macrophiothrix aspidota, and the genus *Athyone* have not so far been recorded from India.

It will be seen from the following list that some of the forms have not been determined up to the species, due to difficulties experienced during preservation and identification, and due to the rarity of some species.

For example, one of the species of Cucumariids cannot be positively identified as it appears to have none of the ordinary skin spicules, although the curved rods and end plates in the tube feet and the spicules in the tentacles are present. It has been referred to the subfamily Thyoninae from the mosaic-like calcareous ring inside the introvert with long posterior prolongations. It appears to be allied to *Athyone transitoria* (Vaney), known from a single specimen 16 mm. long in the western Indian Ocean, which, too, has very few spicules.

One of the forms of *Thyone* also cannot be identified up to the species, as its small size precludes determination of the form of the calcareous ring.

Nor are the authors sure about the species of *Protankyra,* in which there are a number of Indo-Pacific species with very similar spicules.

The specimens of *Anapta* in the present collection resemble *Anapta gracilis,* but differ from the latter in having only four, instead of five, pairs of digits on the tentacles.

Some of the specimens of *Ophiactis savignyi* have less than the usual six arms; also, there is only one distal oral papillar on each side.

SYSTEMATICS

Subphylum PELMATOZOA

Class CRINOIDEA

Order ARTICULATA

Suborder Comatulida

Family Mariametridae

(1) **Lamprometra palmata palmata** (J. Müller)
Clinging to stones, sea-fans, etc.

Subphylum ELEUTHEROZOA

Class HOLOTHURIIDAE

Order ASPIDOCHIROTA

(2) **Holothuria pardalis** Selenka
Collected from mud under stones.

Order DENDROCHIROTA

Family Cucumariidae

(3) **Actinocucumis typica** Ludwig
Collected from mud under stones.

(4) **Athyone** sp.
Collected from mud under stones.

(5) **Thyone conjugens** (Semper)
Collected from mud under stones.

(6) **Thyone** sp.
Collected from mud under stones.

Order APODA

Family Synaptidae

(7) **Protankyra** sp.
Lying fully exposed on mud.

(8) **Anapta gracilis?**
Lying fully exposed on mud.

Class ECHINOIDEA

Subclass REGULARIA

Order DIADEMATOIDA

Suborder Camarodonta

Family Temnopleuridae

(9) **Temnopleurus toreumaticus** (Leske)
Collected from mud under stones, algae, etc.

Class ASTEROIDEA

Order SPINULOSA

Family Asterinidae

(10) **Asterina lorioli** Koehler
Collected from mud under stones.

Class OPHIUROIDEA

Order OPHIURAE

Family Amphiuridae

(11) **Amphipholis squamata** (Delle Chiaje)
Collected from mud under stones.

Family Ophiactidae

(12) **Ophiactis savignyi** (Müller & Troschel)
Collected from crevices of sponges.

(13) **Ophiactis** sp.
Collected from rock crevices.

Family Ophiothrichidae

(14) **Ophiothela danae** Verrill
Entwined around the stalks of sea-ferns.

(15) **Macrophiothrix aspidota** (Müller and Troschel)
Collected from mud under stones.

Family Ophiochitonidae

(16) **Ophionereis dubia** (Müller and Troschel)
Collected from sandy mud.

ACKNOWLEDGEMENTS

The authors wish to express their grateful thanks to Miss Ailsa Clark, of the British Museum of Natural History, London, for the identification of some of the forms and for confirmation of the identification of others. Thanks are also due to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State, for facilities for work at the Taraporevala Marine Biological Research Station, and to Dr. H. G. Kewalramani, Research Officer, for critically going through this paper.

TARAPOREVALA MARINE BIOLOGICAL
RESEARCH STATION,
BOMBAY,
June 21, 1962.

S. R. SANE
B. F. CHHAPGAR

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20. DRAGONFLIES AND BICYCLES

During 1959 and 1960 I made some observations on dragonflies attending bicycles at Ndumu in North-eastern Natal, South Africa, which are comparable with those of Mr. Harinarayan G. Acharya (*Journ. Bombay Natural History Society* **58** : 819-820). I also was 'too lazy to collect specimens', but I can state that they too were ordinary-looking insects of the suborder Anisoptera. So far as I am aware they flew a few inches ahead of my *front* (not the rear) wheel, but I must confess that I was too busy looking forward to know what was going on behind me. They, again, adapted their speed to mine in order to maintain a constant position with respect to the wheel.

However, there was an additional phenomenon which may indicate that the wheel *as such* (i.e. flashing spokes, whirring noise) was not the attractive stimulus. When I walked along the same sunny trails, the dragonflies would keep pace with my advancing feet, flying close to the ground a few inches ahead. In fact I sometimes thought that I would step on one, though of course this never happened. Thus it seemed that the insects were responding indiscriminately to the sight of a relatively large moving terrestrial object.

I discussed these matters with my colleague, Mr. Hugh Paterson, and we finally arrived at a conjecture that this might be a hunting strategy of dragonflies. Almost everyone has seen Cattle Egrets waiting for cattle to stir up grass-hoppers, and there are other birds elsewhere that do much the same thing. Since dragonflies also prey on small flying game, why should they not have become adapted to attending large mammals for the sake of catching minute insects that these leviathans put to flight as they blunder along? Perhaps some

dragonflies have become adapted to the hind legs and others to the fore legs, which might explain their divergent orientation to bicycles.

P. O. Box 164,
Port of Spain,
Trinidad, W. Indies,
July 8, 1962.

C. BROOKE WORTH

21. NOTES ON THE RED COTTON BUG (*DYSDERCUS CINGULATUS* FABR.)

Clad in scarlet livery with black facings, the Red Cotton Bug (*Dysdercus cingulatus*) is at all times, a very conspicuous insect. Its slow nonchalant gait almost suggests that it is 'aware' of its aposematic coloration. Seasonally, it is very common on the islands of Bombay and Salsette and further afield. Under favourable circumstances the ground is literally covered with a living carpet of a red and black pattern. Its abundance and periodicity coincides with the flowering and fruiting of certain Bombacaceae and Malvaceae, particularly the species of *Bombax* (*malabaricum* and *insigne*) and the introduced Silk Cotton Tree, *Ceiba pentandra*. These trees normally produce a large amount of silk cotton and numerous seeds. The silk, an aid in seed dispersal, is taken advantage of by the bugs for a safe parachuting to earth from the tops of the trees and as a means of effecting their own wide dispersal. The annual prolificity of the bugs is usually in proportion to the fecundity of the trees.

The annual appearance and abundance of the bugs varies from year to year in response to the climatic conditions governing the flowering and fruiting of the trees. In some years the ground is literally scarlet with the vast numbers of bugs on its surface; in other years the bugs may be few and far between and, on rare occasions, entirely absent. The adult stages of the insect feed almost exclusively on the fallen seeds, thereby constituting a natural check on the host plants.

In the season of 1940, *Bombax* flowered most profusely but, for some unaccountable reason, the majority of the fruit produced dried up before reaching maturity. Examination of some of the fruit led me to suspect a fungus or virus as responsible, but I could not establish the cause with any degree of certainty. A black mould was found in some of the pods but this could have developed after their drying. In 1941 a similar calamity befell the *Bombax* but the 'attack'

was not as severe as in the previous year. Both seasons were marked by a diminution in the bug population to be seen.

Normally, in the areas mentioned, *Bombax* fruit matures in March, just in time to catch the 'March winds' to aid in the dispersal of its seeds cradled in silk. The winds are fairly regular and strong, and assist many plants in seed dispersal. The 'arrival' of the bugs coincides with this period. Where they come from or where they have been in retreat since the end of the previous monsoon rains awaits solution[1].

At first the bugs appear to arrive singly, but gradually their numbers increase prodigiously. On first 'arrival', the males preceding the females, the insects usually shelter under foliage and remain there apparently fasting. The 'retreat' is soon broken and the bugs begin to move about freely—they are seen everywhere, on the ground, on the trunks of trees, and on the vegetation generally. Mating soon ensues.

In 1941, the first cotton bugs were seen at Andheri on 26 March. Just odd ones were seen here and there. On 6 April I made a note in my diary: 'No profusion of cotton bugs yet. A very few flying about.' Their numbers were decidedly fewer than in the previous year. On 12 April I noted that most of the bugs were pairing and that the *Bombax* silk was drifting about. I also noted that the 'March winds' did not blow strongly as they usually do. On 19 April I made an entry to the effect that the bugs had left the ground and had assembled on the branches and twigs of *Bombax*. This movement from the ground to the trees led me to suspect that the eggs are laid on the twigs. The discovery of newly hatched nymphs in some of the pods partly confirmed this suspicion, but in the absence of more facts the matter must be left over for further observation[2].

To continue with my notes. On 22 April the first young ones were observed, i.e. ten days after general mating and about four days after the adults had taken to the trees. The young moved around in the lint of indehisced pods. The nymphs are cradled to the ground in the lint on the bursting of the pods. On reaching the ground the

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[1] According to Fletcher (1919, *Proc. III Ent. Meeting, Pusa*, p. 262) and Lefroy (1909, INDIAN INSECT LIFE, p. 691) the bugs feed on the seeds of almost all malvaceous plants and thus get food all through the year ; they move to *Bombax* which seems to be their most favourite food, as soon as it comes into bloom.—EDS.

[2] According to Hem Singh (1923, *J. & Proc. Asi. Soc. Bengal* **19** : 35) and T. V. R. Ayyar (1941, HANDBOOK OF ECONOMIC ENTOMOLOGY, p. 248), the eggs are laid on the ground and the young nymphs on hatching go to their food in large numbers.—EDS.

nymphs begin their 'terrestrial' existence and large numbers may be seen clustered round fallen seeds of *Bombax*. In a normal season the ground would soon be red with bugs. The adults cluster round fallen seeds also, but they 'prefer' to walk around with a seed dangling from the proboscis. Even bugs in copula may be seen each with a seed at the tip of the proboscis. Examination of discarded seeds reveals that the hard shell is perforated by numerous fine punctures and the contents are sucked dry.

On 18 May 1941 I noted that the young were almost the size of the adults, but with only wing-pads—a very few already had wings. The same day some were observed pairing near the Powai Lake, Salsette. This may indicate the possibility of a second brood in the same season, but it was not clear whether the mating pairs were adults of the previous season or insects which had reached maturity during the current season.[1]

Soon after the monsoon rains set in the bugs 'disappear' and very few are to be seen on the ground. During the rains I have occasionally noticed these bugs clustered in large numbers on *Breynia patens* and other plants but, apparently, not feeding. Incidentally, *B. patens* is frequently infested with another plant bug during the rains, namely *Chrysocoris purpurens* (?). A point of interest about this species is that when heat is applied to the body of the living insect the brilliant green changes rapidly to a metallic blue as it normally does in collections, and on cooling changes back to the original green. Reverting to the cotton bug, after the rains are over the cotton bug is very rarely seen till the new season sets in. It would be interesting to know where this species spends the resting season. Incidentally, I have often found other species of plant bugs clustered together in hollows or along the branches of trees, in a quiescent state, during the winter months. Disturbance did not spur them on to any great activity. They were definitely lethargic. Like the cotton bug, many of these bugs are not gregarious outside the resting period. But, I have never come across the Red Cotton Bug spending the winter months in such a manner.

At Andheri, I recorded the first appearance of *Bombax* flowers on 1 February 1942. On 21 February I made a note that no Red Cotton Bugs had been observed till then. In the garden of the Prince of Wales Museum, Bombay, I observed a number of Red

[1] According to Hem Singh (1923, *J. & Proc. Asi. Soc. Bengal* **19** : 17) the bugs feed and breed continuously and where there is no severe cold have a number of generations during the year ; in the colder tracts the adults hide in crevices of the soil during the winter.—Eds.

Cotton Bugs (a large number for the small area) in copulation on the Hollyhocks on 26 February 1942. There were still no signs of bugs at Andheri. On 2 March 1942 I noticed that the first single bugs were seen at Andheri and that the *Bombax* trees now had young fruit. On 7 March very few bugs were seen in copula in the Museum grounds, and still none appeared at Andheri—they had all 'gone'. No bugs were seen. On 9 March there were very few adults on the Hollyhocks at the Museum, but newly hatched nymphs were observed inside the calyxes of the flowers and fruit. Many Bloodsuckers (*Calotes versicolor*) were in attendance on the Hollyhock bed at the Museum, some on the ground and some on the plants. The lizards were feeding on the bugs. Although the lizards took a comparatively heavy toll during this period, many bugs took to wing. By 11 March all adults had disappeared.

On 15 March 1942 I noted that no bugs were seen over a wide area at Andheri. At the same time I wrote: 'Conditions same as last year. March winds not strong—occasional gusts.' Although *Bombax* flowered somewhat earlier than in the previous year (1941), a large majority of the fruit dried up long before reaching maturity.

On 20 March, and 3 and 4 April numbers of bright red nymphs appeared on the Hollyhocks in the Museum grounds. At Andheri no bugs were recorded. On 7 June I found some nymphs, 4 to 5 mm. long at Andheri. They appeared in small numbers under a few of the *Bombax* trees. There was no carpet of bugs as in more normal years. In the meantime, the nymphs at the Museum had matured and disappeared from the locality. No other bugs were seen in any other part of Salsette Island that I visited. The Red Cotton Bug season was a complete failure in keeping with the fruiting season of *Bombax* which had also failed.

These few random observations clearly indicate that, in the areas referred to, the Red Cotton Bug is largely dependent on the successful flowering and fruiting of *Bombax* for its well-being; and that the vagaries of the weather control the life-cycle of both the plants and the insects.

Among the more noticeable enemies of the Red Cotton Bug, I have already mentioned the Common Bloodsucker (*C. versicolor*). This lizard appears to feed on this bug when other insects are in short supply. The Forest Bloodsucker (*C. rouxi*) preys largely on the Red Cotton Bug when in season. Few birds ever take the Red Cotton Bug. The visits of the migratory Bay-banded Cuckoo (*Penthoceryx s. sonnerati*) appear to coincide with the Red Cotton Bug season and

during this period it subsists almost exclusively on these bugs. The stomach contents of one of these birds yielded thirty undamaged bugs and the remains of many others[1]. The bugs are usually collected on the branches and twigs of the *Bombax*.

In addition to vegetable food the bugs may frequently be seen feeding on the carcase of one of their own fellows but this does not appear to be deliberate cannibalism, as they do not appear to kill one another but just feed on a dead comrade that they may find[2]. I have not observed these bugs feeding on any plant tissue other than seeds.

An excellent account by Maxwell-Lefroy of the life-history of the Red Cotton Bug appears in Volume 2 of *The Memoirs of the Department of Agriculture of India.*

DOMINION MUSEUM,
WELLINGTON, NEW ZEALAND,
January 16, 1961.

CHARLES McCANN

22. ABDOMINAL MARKINGS ON A THOMASID SPIDER

(With a photograph)

Mr. Kalyan Gupta of Shillong has sent us the photograph of a spider whose abdominal markings bear a remarkable resemblance to a human face.

The photograph was sent to Dr. B. K. Tikader of the Zoological Survey of India who identified the species as the Thomasid or Crab Spider, *Psitius sreepanchamii* recently described by him from Shillong in the *Journal of the Linnean Society*, 1962, **44** : 572. He states that 'the abdomen of the adult female looks like this photograph before oviposition'. Apparently the markings are evident only when the abdomen is distended. One is reminded in this context of the skull-like markings on the thorax of the Death's Head Hawk Moth.

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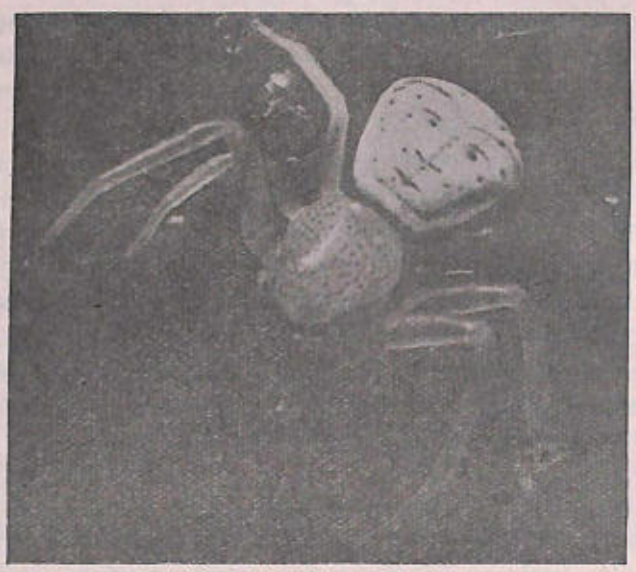
[1] According to D'Abreu (1919, *Proc. III Ent. Meeting, Pusa*, p. 867) the Red-vented Bulbul (*Molpastes haemorrhous*) is another bird recorded feeding on this bug.—EDS.

[2] According to Fletcher (1919, *Proc. III Ent. Meeting, Pusa*, p. 262) in the absence of their usual food the bugs turn cannibalistic and feed on their own species.—EDS.



Spider with 'Human Face'

Acherontia styx Westwood, though it is difficult to imagine how these markings benefit these animals.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
August 22, 1962.

J. C. DANIEL
Curator

23. STUDIES ON SOME SPIDERS OF THE GENUS *OECOBIUS* (FAMILY OECOBIIDAE) FROM INDIA

(With two text-figure)

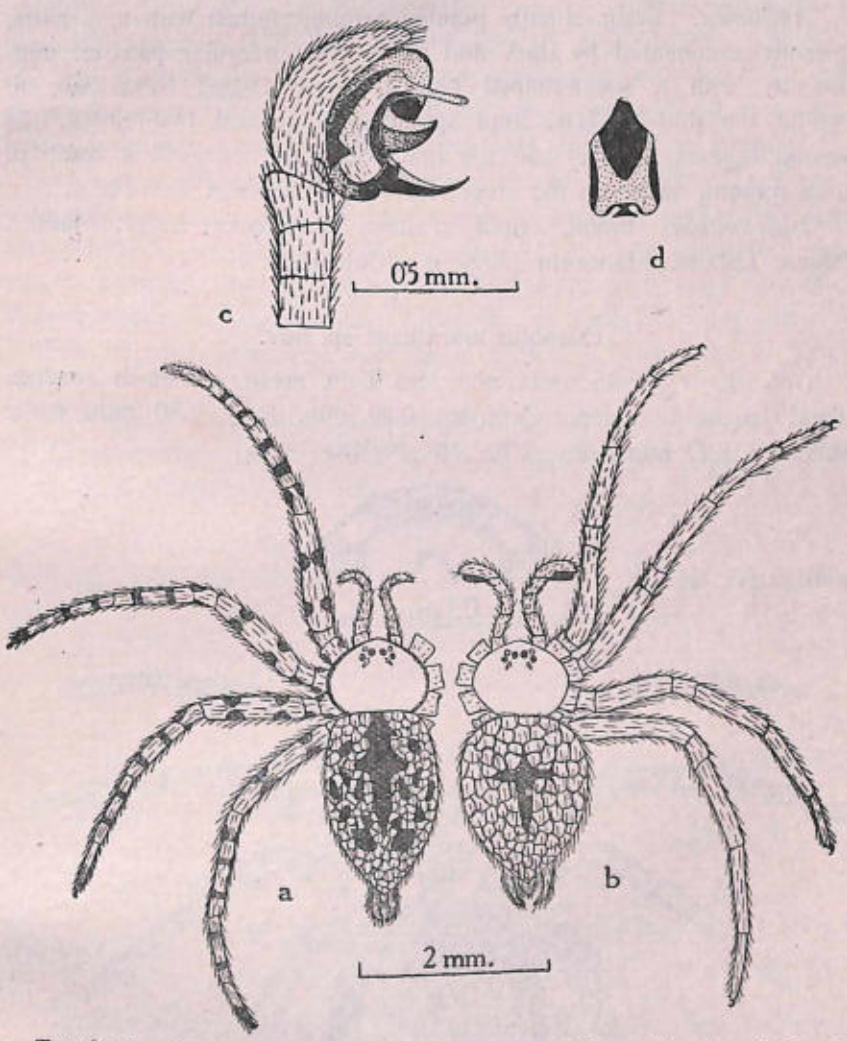
INTRODUCTION

Spiders of the family Oecobiidae are little known from the Oriental Region. They occur in crevices and corners in buildings and under stones. They like close proximity to man, so these spiders have been carried by man through baggage to other parts of the world from their original locality. One known and a new species of *Oecobius* are described here.

The type specimens will in due course be deposited in the collections of the Zoological Survey of India, Calcutta.

Oecobius putus O. P. Cambr.

General: Cephalothorax and abdomen light to deep brown, legs pale green. Total length 2.60 mm. Carapace 0.09 mm. long, 1.10 mm. wide; abdomen 1.80 mm. long, 1.10 mm. wide.



Text-fig. 1. *Oecobius putus* O.P. Cambr. : *a*. Dorsal view of female ; *b*. Dorsal view of male ; *c*. Male padipalp ; *d*. Epigyne

Cephalothorax: Wider than long, depressed on the centre but cephalic region slightly high and eyes group situated on the top, margin encircled by a deep brown line. Eyes unequal in size and dissimilar in form. The anterior median and posterior lateral eyes

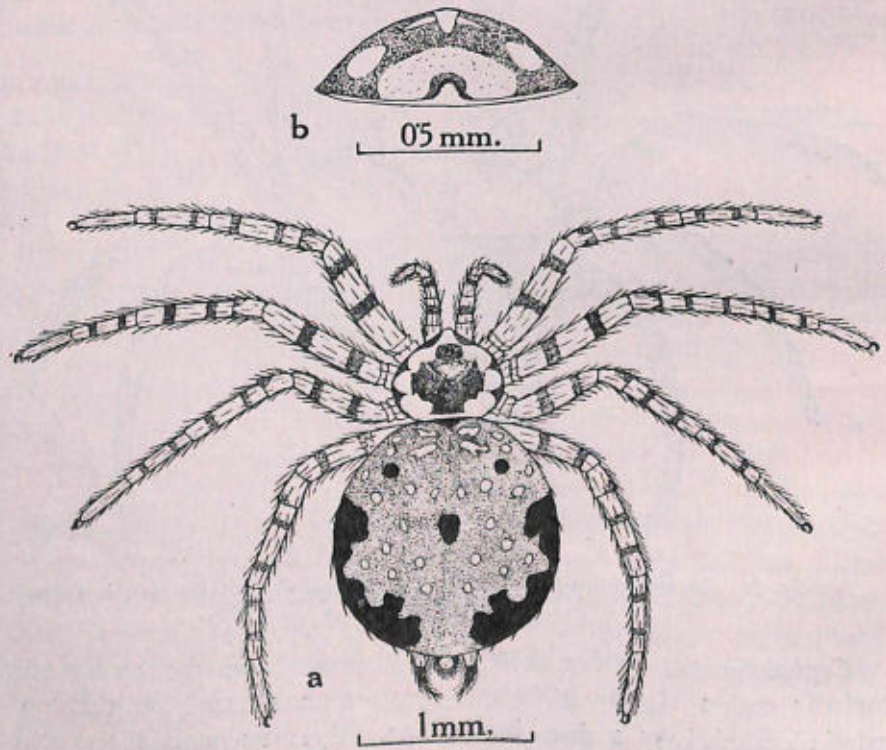
dark in colour and others pearly white; posterior medians triangular in size, both rows procurved but anterior row more procurved than posterior. Legs long, clothed with fine long hairs and all legs transversely banded with dark brown bands but in male no such bands. Male padipalp as in Text-fig. 1, *c*.

Abdomen: Long, slightly pointed behind, clothed with long hairs, dorsum ornamented by dark and chalk-white irregular patches, middorsally with a spear-shaped black area extending from base to behind the middle. The hind spinnerets long and two-jointed; the second segment longer than the first and furnished with a comb of long spinning tubes on the inner side. Epigyne as in Text-fig. 1, *d*.

Distribution: Egypt, Tripoli, Yemen, Tanganyika; India: Madras, Poona, Lahore, Mansahra (5000 ft.), Calcutta.

Oecobius marathaus sp. nov.

General: Cephalothorax and legs light green, abdomen reddish. Total length 1.90 mm. Carapace 0.60 mm. long, 0.80 mm. wide; abdomen 1.40 mm. long, 1.20 mm. wide.



Text-fig. 2. *Oecobius marathaus* sp. nov.: *a*. Dorsal view of female; *b*. Epigyne

Cephalothorax: Wider than long, depressed but cephalic region high and elevated, eyes group situated on the top of the elevated region, margin encircled by a deep brown line but this line not uniformly wide, only near the base of each leg with wide deep brown broader line, middle portion and ocular area with deep brown patches. Eyes unequal in size and dissimilar in form, the anterior median and posterior lateral eyes dark in colour and rest pearly white, posterior median triangular in size, both rows procurved but posterior row more procurved than anterior. Legs long clothed with fine long hairs and all legs transversely banded with dark-brown bands.

Abdomen: Slightly longer than wide, rounded behind, clothed with fine long hairs, dorsum ornamented by irregular chalk-white and black dots or patches as in Text-fig. 2, *a*. The hind spinnerets long and two-jointed, the second segment longer than first and furnished with a comb of long spinning tubes in the inner side; posterior $\frac{2}{3}$ portion of hind spinnerets with deep brown. Epigyne as in Text-fig. 2, *b*.

Holotype: One female; *paratype:* one female in spirit.

Type-locality: Jangli Maharaj Road (in side building), Poona. Coll. B. K. Tikader, 4-vi-1961.

ZOOLOGICAL SURVEY OF INDIA,
WESTERN REGIONAL STATION,
POONA,
August 13, 1962.

B. K. TIKADER

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24. A NEW LOCALITY FOR *GYMNOSPORIA BAILADILLANA* NARAYAN. & MOONEY

Gymnosporia bailadillana has been established by Narayanaswami, V. and Mooney, H. F. [1941, *J. Indian bot. Soc.* **20** (4): 191-193] on the basis of specimens collected by Mooney from Bailadilla Hill, Bastar State, Orissa (Type: H. Mooney, no. 890, in *Cal. Herb.* Other collections: Mooney, 390 and 900, in the dark glens and shady ravines or in open moist valleys on the Bailadilla Hill, between 3000 and 3500 ft.). Mooney later on in his Supplement

to the Botany of Bihar and Orissa [1950, p. 41] reported this species from Karlapet, Kalahandi State also, where it occurred in rocky ravines between 3000 and 3600 ft. and increased in abundance towards the head of the glens at 3500 ft., along watercourses but always on rocky, dry ground above the bank. As far as known to the authors the occurrence of *G. bailadillana* has so far been recorded from the above two localities only.

The authors have now collected fruiting specimens of *G. bailadillana* at Mahendragiri Hills of Orissa (18° 58′ N. latitude and 84° 26′ E. longitude), from the forest growth between Rajbasa and Kunti Daur at about 3000 ft. under ecological conditions similar to those of the previously known localities (G. S. Srivastava & party, 16-3-1959, coll. no. 58852, N.B.G. sheet no. 42425). The identification of these specimens have been confirmed by getting them matched at *Cal. Herb.*

G. bailadillana may be expected to occur anywhere in Bailadilla Hill—Karlapet—Mahendragiri tract between 3000 and 3600 ft. in ecological conditions stated above though it has not been collected many times. It may partly be because of its close resemblance with *G. rufa* Wall. var. *latifolia* Haines [Botany of Bihar and Orissa, 1921, *Part II*, p. 188] which too has been collected at the Mahendragiri Hills by the authors. It may be of advantage to note that the flowering and fruiting times of the two species are different. While *G. rufa* var. *latifolia* flowers and fruits March-April and Nov.-Dec. respectively, *G. bailadillana* flowers and fruits Nov.-Dec. and Jan.-March respectively.

The occurrence of *G. bailadillana* at Mahendragiri Hills is interesting for this may possibly be the easternmost boundary for the occurrence of this species.

The authors are thankful to Prof. K. N. Kaul, F.L.S., Director, National Botanic Gardens, Lucknow, for facilities of work and to Dr. S. K. Mukerjee, Keeper, Central National Herbarium, Sibpore, Howrah, for getting the identification of the specimens confirmed.

NATIONAL BOTANIC GARDENS,
LUCKNOW,
July 30, 1962.

S. L. KAPOOR
G. S. SRIVASTAVA

25. *CANSCORA DECUSSATA* ROEM. & SCH. : A NEW RECORD FOR BOMBAY STATE[1]

In the course of intensive botanical studies in the Ratan Mahal hills, an essentially unexplored area in Panch Mahal district, (Gujarat State), we collected some specimens of the genus *Canscora*. The distinctly winged nature of the calyx and the winged stem created a special interest. The plant has been identified as *Conscora decussata* Roem. & Sch. As far as can be ascertained from the available literature this seems to be a new record for Bombay State[1].

Canscora decussata Roem. & Sch. iii Mant. : 299, 1827. Hooker in Fl. Brit. Ind. **4** : 104, 1885. Gamble, Fl. Presidency of Madras **2** : 618 (Rep. ed. 1957). Trimen, Fl. Ceylon **3** : 185, 1895.

A small erect glabrous herb; stem 10-45 cm., 4 winged, the wings broader at the top. Leaves oblong-lanceolate, sessile, 3-nerved. Cyme rigid, erect, terminal, bracts at its bifurcations. Calyx distinctly winged. Corolla white, tube as long as calyx.

The plants were found inhabiting the steep slopes and the escarpments along the roadsides near Taramb Kach and Patan Mata in Panch Mahal district.

Flowering time: September-January.

Fruiting time: October-January.

Herbarium Specimen No.: Bedi 1517, 1518, 1519, 1520.

Critical Notes: Hooker mentions the plant as occurring throughout India; from Himalaya to Burma; abundant in Bengal plains. Not uncommon in Ceylon. During our explorations in various regions of Gujarat we have come across this plant for the first time. As far as we are aware no mention of the said plant has been made in any of the works on the flora of Bombay State.

The authors are indeed grateful to Dr. G. Taylor, Director, Royal Botanic Gardens, Kew, England, for the determination of the plant. Our thanks are also due to Rev. Fr. H. Santapau for critically going through the manuscript of this note.

DEPARTMENT OF BOTANY,
FACULTY OF SCIENCE,
M.S. UNIVERSITY OF BARODA,
BARODA,
July 21, 1962.

A. R. CHAVAN
S. J. BEDI

[1] The area implied includes the present States of Gujarat and Maharashtra.

[This is an interesting find for Bombay; the plant has a high repute in indigenous systems of medicine, and is at present in great demand for research into its biochemistry. The Botanical Editor of this Journal has found the plant very abundant, though highly localised, on the Eastern Ghats; in the Calcutta Botanic Garden at Sibpur, it is one of the commonest weeds growing on lawns and flower beds immediately after the monsoon.—EDS.]

26. GREGARIOUS FLOWERING OF *STROBILANTHES* AND BAMBOOS[1]

(*With a plate*)

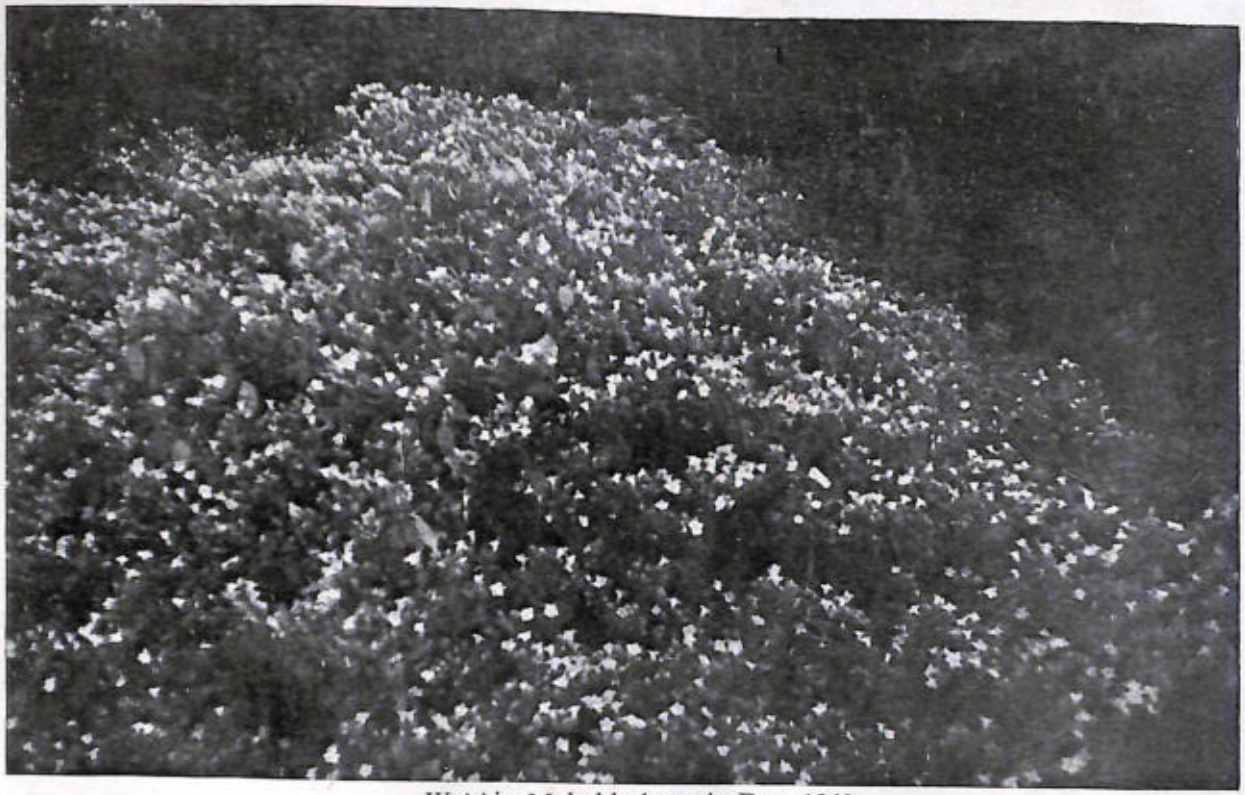
During the Christmas vacation of 1960 I visited Mahableshwar with a party of students; we had the good fortune of seeing one of the periodical general flowerings of *Thelepaepale ixiocephala* Bremek. (=*Strobilanthes ixiocephalus* Benth.), the plant locally known under the name of *Waiti*.

On the Mahableshwar plateau along most of the roads, paths, and 'rides' there were not just some plants in flower, but dense banks of plants profusely covered with white or very pale lilac flowers; along the Dhobi Waterfall ride the banks of flowers were almost uninterrupted especially on the inner side of the path, that is to say on the side away from the ravine; the same was the case in the undergrowth along Tiger Path or Falkland Ride and elsewhere. The accompanying photograph taken on this occasion will give an idea of the numerous flowers that could be seen on a single clump of plants.

SIZE AND SCENT OF *WAITI* PLANTS

We noted with interest that flowering seemed to be independent of the size of the plant; whilst some of the plants along the edges of the undergrowth might well reach over the head of a tall man and this was often the case, we did find specimens growing on the road itself and reaching but a few centimetres in size; even such minute plants sported one or more flowers, in fact in some cases we did count more flowers than leaves on these dwarf plants.

[1] In these notes I cite a number of plants by names that may appear strange to some readers. I have followed the nomenclature of Bremekamp, who has satisfactorily shown that the genus *Strobilanthes* Bl. in a restricted sense is confined to Sumatra and Java.



Waiti in Mahableshwar in Dec. 1960

(*Photo: H. Santapau, S. J.*)

Walking through such areas, one could perceive a very pleasant scent; this was so when going along the paths without touching the plants. If one touched the plants, then the scent became very powerful and seemed to emanate from the oily glands on the flowering branches. The whole inflorescence is fairly densely covered with hairs, each of which consists of a slender transparent stalk and a globular ball filled with oil; when hairs become old, the stalk may remain transparent or whitish, but the oil ball turns yellowish and more strongly scented. In general the scent is of a resinous type and rather pleasant and persistent.

In connection with the scent of this and other species of *Strobilanthes*, I may be permitted to copy a few remarks of F. C. Constable in *Kew Bulletin* of 1896: 'There was in the air a sweet resinous, pleasant odour from the buds[1]. My hands were covered with what they exuded, and . . . though I washed my hands three times, the pleasant scent remained.' These observations I have myself made on many occasions, and so can vouch for their correctness.

Honey from the *Waiti* Flowers

In the local bazaar we were informed that this general flowering meant a great crop of honey of higher quality than usual. The bazaar prices for honey might be an indication of the quality of the same: at the time of our visit, *Waiti* honey sold for Rs. 4.50 per lb., against Rs. 3.25 for *Jambul* and Rs. 3.50 for *Ghela* honey.

On several occasions we did note a few bees about these bushes, nothing remarkable for their numbers; perhaps this was due to the fact that we came out into the field in the early cool hours of the morning. But on one occasion at about noon along the Dhobi Waterfall ride we noticed great activity on the part of bees on *Waiti* shrubs, especially in spots where flowing water was available near the flowering plants. An intense hum was clearly audible before coming to the spot and after passing it, a clear indication that the bees were both very busy and very numerous.

The Flowering of *Waiti*

In many years of scouting through the jungles of the Western Ghats, I have noted that *Waiti* comes into flower more or less

[1] Constable is incorrect when he states that the scent came from the buds; the buds of the *karvi* plant, of which he was writing, have no scent; it is only the fruiting cones that give out this strong and pleasant scent.

regularly every year, with a real outburst or general flowering about every few years; however, I have not paid particular attention to the period between two general flowerings, as I have done for the other common shrub of the W. Ghats, the *Karvi* plant, *Carvia callosa* Bremek. (=*Strobilanthes callosus* Nees). I have gathered the following information from published sources on the *Waiti*. H. M. Birdwood (1) states that it flowers once in seven years; Talbot (15) that it flowers annually. There is no contradiction between these two statements: *Waiti* flowers more or less abundantly every year, but after six or seven years it comes into an explosion of flowers. Some friends, whom we met in Mahableshwar, were positive that there was a general flowering of *Waiti* in 1944 and in 1951-1952; there is certainly a general flowering at the time of writing (January 1961), and all these dates would seem to indicate a cycle of 7-8 years for a general flowering of *Thelepaepale ixiocephala*.

Gregarious Flowering of Karvi

There was a more or less general flowering of *Karvi* in Mahableshwar in the autumn of 1960; this is the plant that is listed in most of our floras under the name of *Strobilanthes callosus* Nees, and which in modern nomenclature is referred to as *Carvia callosa* Bremek. The general flowering did cover a large area in the western parts of India besides Mahableshwar; going out into the field with my students from September 1960 onwards, we noted the *Karvi* plant in flower in the National Park, Borivli, on many of the hill slopes at Khandala, in the higher parts near Mumbra, and elsewhere. In Khandala some of slopes did show a general flowering the year before, the rest of the area only came into flower in 1960. The *Karvi* plant is supposed to come into general flowering every 6-8 years, but opinions are not in complete agreement on the subject; Duthie writing in this Journal (5) said that *Karvi* flowers every 8-9 years, but added that the local population 'say that it flowers every three years'; Graham in his CATALOGUE (6) wrote that people on the W. Ghats 'have a tradition that it flowers once in 10 years'. As a rule, I have seen this coming into flower at a given area in the following manner: one year a few scattered plants come into flower; the following year there may be a general flowering; the third year a few scattered plants again come into flower. In short, there is a general flowering one year, preceded and followed by reduced flowering of a few plants. In Khandala there was a general flowering in 1944-45, another in 1950-51, a third in 1959-60.

Gregarious Flowering of Other Species of *Strobilanthes*

Phlebophyllum kunthianum Nees (=*Strobilanthes kunthianus* T. Anders.) of the Nilgiris, which because of its profusion of blue flowers has given the name to the hills, is said by Mrs. Robinson (8) to come to general flowering every 12 years, at least from 1826 to 1934, for which years she has produced records; A. F. Hutton (7) recorded it for the High Wavy Mountains in 1948; in 1959 at Kodaikanal I saw the plant in fruit all over the hills, obviously having flowered in 1958. The cycle of 12 years seems well established for *Phlebophyllum kunthianus*; the plant, according to Mrs. Robinson, flowers 'once in twelve years, with lesser outbursts of flowering in scattered areas at other times'; she further adds that on the Nilgiris, as it also happens in Mahableshwar, a gregarious flowering of *Strobilanthes* is accompanied by intense activity on the part of the honey bee, but the honey is more bitter than usual; in the Nilgiris this abundance of honey 'tempts hill bears to come in search of their favourite food'; we have not heard of bears in Mahableshwar.

Going through my field diaries for the last few years, I have found other references to general flowering of *Strobilanthes* species. There was a general flowering of *Nilgirianthus reticulatus* Bremek. (=*Strob. reticulatus* Stapf) in Mahableshwar in 1950; the plant was noted as particularly abundant in flower in the neighbourhood of the Lingmala Falls. A second general flowering was recorded also for Mahableshwar in October, 1958; in the open fields near Kate's Point and along the road to the same point for about a mile, *Nilgirianthus* was a charming sight. This species grows in small clumps, seldom over 1 m. in diameter, the plants themselves being about 60-75 cm. high; the flowers are profuse in number, and of an intense gentian blue colour. As in the case of *Karvi* and *Waiti*, so also with *Nilgirianthus* a few scattered plants may come into flower in years other than those of general flowering; this last year in December we saw a few plants in flower in the neighbourhood of Chinaman's Falls.

Causes of *Strobilanthes* Flowering

What is it that prompts *Strobilanthes* plants to come into flower at all after so many years of vegetative growth? What causes them to come into flower at one and the same time? I have been trying to find an answer to these questions, but regretfully I have to say that up to the present there is no satisfactory answer. Most of the species of *Strobilanthes* of Bombay behave like annual plants, even

though they live for several years; I mean to say, they grow vegetatively for a number of years, and then after flowering and fruiting but once, they die, just as the balsams and petunias of our gardens and other annuals do. The striking difference is that *Strobilanthes* lives for several years, and often attains sizes which one can only call gigantic; their stems are solid and woody, as is the case in common trees and shrubs. For this group of plants that live for several years and die soon after flowering and fruiting, the name 'plietesials' has been applied (Santapau, 10); this name can be applied with equal right not only to the *Karvi* and *Waiti* plants, but also to most bamboos, agaves, furcreas, etc. All these plants agree in one point: they live to attain large, even tree-like sizes, then flower and fruit but once and die; this flowering and fruiting only once is the habit of annual or ephemeral herbs!

In a number of cases it is agreed that flowering is, to some extent, due to climatic conditions; perhaps the previous season was particularly cold, or it was more wet, or perhaps more persistently dry than usual. This explanation has been suggested by some authors, for instance, for orchids. Some orchids do respond to the lowering of temperature after a hot summer, as happens for instance after a sharp shower just before the onset of the monsoon; experimentally this has been proved to be the case with some Malayan orchids, as shown by Burkill (3) and Coster (4). As regards *Strobilanthes*, van Steenis (14) writes: 'This is a most obscure phenomenon; hitherto no explanation has been offered for its appearance.'

From my own observations in the field, I find it very difficult to say that climatic or soil conditions are the cause of this general flowering of *Strobilanthes*. In a previous note in this Journal (Santapau, 9) I have recorded for Khandala that, e.g. in 1949, the top of Bhoma Hill was neatly and clearly divided by an invisible line: every plant on the west side was in flower, none of the east side was in flower that year, but came into flower the following year. Similarly in 1959 (Santapau 13) I recorded that the slopes of Echo Point in Khandala were in full bloom from the top to about the height of the Saddle, or the depression separating Echo Point from Bhoma Hill; lower down there was not a plant in flower; the following year, 1960, most plants from the Saddle downwards were in full bloom. It is difficult to understand that climatic or soil conditions were or could be so different on either side of such a very definite though imaginary line!

Size or even age does not seem to be responsible for flowering

either. Some of the *Karvi* plants in Khandala come into flower, apparently quite independently of the size of the plant; giants over 6 m. tall have been noted as covered with flowers on the main trunks, branches, and other parts; but also dwarfs only a few centimetres high were a mass of flowers (Santapau 11). This last winter in Mahableshwar we noted large shrubs of *Waiti*, as well as dwarfs only 8-15 cm. high, in full bloom. It was clear at once that such minute plants, growing along the sides of frequented paths or roads, could not be of the same age as the larger shrubs found at the edge of the undergrowth.

We say, then, in all honesty that simply we do not know what internal or external forces move these plants singly or individually to come into flower; we do not know what natural forces induce *Strobilanthes* plants to burst into flower over large areas of the country at one and the same time.

This same ignorance, I am sorry to have to confess applies also to bamboos; in the case of most species of bamboos we do not know what causes them to flower at the same time over large tracts of the forest, nor even how long it takes them to come into flower. Blatter (2) in a series of articles published in this Journal in 1929-30 gave the flowering cycle of bamboos as between some 15 and 45 years.

What Causes the Flowering of Bamboos

Blatter discussed at some length what may be the causes affecting bamboo flowering. One of the striking points he mentions is that perhaps due to very hard or unusual climatic conditions there is often a famine *preceding* the flowering of bamboos; such hard conditions may cause the usual crops to fail over large areas. There are extant records of crop failures over large parts of Maharashtra, when the local population could be saved by eating the seeds of *Bambusa arundinacea* and *Dendrocalamus strictus*, that came into flower after the failure of the crops. Forsyth, as quoted by Blatter, writes: 'The rare occurrence of the general seeding of the bamboo forest is a godsend to the aboriginal tribes . . . An abundant supply of wholesome grain is afforded, not only to the wild tribes but to multitudes of the poorer inhabitants of the open country and the cities around, who crowd to the spot to obtain the share of the heaven-sent provender. There is a proverb that this occurrence portends a failure of the common food staples of the country; but like many such it has not been verified by experience.'

In the summary of his discussion, Blatter confirms what has been stated above on *Strobilanthes*: 'It is scarcely necessary to repeat that flower-formation depends essentially on influences coming from the outer world. These external factors are the general conditions to which every vital process is subject. For flower-formation are characteristic the special combination and intensity of these factors, as light, nutritive salts, Carbon dioxide, Oxygen, absorption of water, transpiration, temperature, and perhaps others of which we are not conscious. It does not seem possible to analyse the constant and intricate co-operation of all these factors and to find out what exact effect is produced by each of them. Some facts, however, appear to justify the assumption that flower-formation is brought about in the first place by an increase in C-assimilation and by an absolute or relative decrease of certain nutritive salts, especially of those containing Nitrogen. We are thus allowed to assume that a certain concentration of those substances in the meristematic cells of the plant forms the necessary internal condition of reproduction. Every attempt to trace these relations more accurately and to define them more clearly, seems to be hopeless at the present moment.' This is certainly a subject that offers a fine challenge to our Plant Physiologists; the solution ought not to be as hopeless as Blatter made it appear thirty years ago.

Unexpected Results from Gregarious Flowering of Bamboos

In connection with the rare general bamboo flowering there is another point that might be of interest to our readers. I have gathered plenty of information on the subject from my own field observations and from contacts with various people all over India. When the bamboo flowers, we do not have greater activity on the part of bees; but we certainly have a most definite increased activity on the part of rats, mice, and similar vermin. A general flowering of bamboos attracts not only the poorer people of India, but is also accompanied by a highly increased population of rodents of all kinds. Such rodents can feed properly and easily, and so they reproduce in alarming numbers. This is the reason why in many parts of the country, where bamboos are abundant, the local people fear such general flowering; they know from past experience that in all probability such general flowering will be followed by a year of famine in the area. The armies of rodents, that have appeared during the year of plenty, will persevere in the field for one or more years; as there are no more bamboos to feed on, they go for cultivated crops, and may in fact be responsible for severe famine over large areas.

Humayun Abdulali tells me that in the monsoon following the gregarious flowering of bamboos (*Dendrocalamus stricta*) near Bombay in 1960, he discovered many specimens of the Little Indian Field Mouse, *Mus booduga* Gray, under logs and stones turned over in forest areas in search of frogs and reptiles. He did not remember ever finding these mice under similar conditions before.

Abnormal Flowering of *Strobilanthes*

To make this note complete, I may refer readers to my note in this Journal (Santapau, 12). On Echo Point at Khandala some plants were collected that had clearly come into flower the previous year, and *were not dead* when the next flowering season arrived; the remains of the fruit were still on the plant, but fresh leaves and buds for the next flowering season were also on the same plants. This is most unusual for *Strobilanthes*, though it is normal for most other shrubs and trees. It would show that the *Karvi* plants, though generally behaving as plietesials as mentioned above, can and do, at least on some occasions, behave like normal shrubs, bringing forth flowers and fruits on more than just one season.

Botanical Survey of India,
14, Madan Street,
Calcutta 13,
January 27, 1961.

H. Santapau, S.J.

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27. VIVIPARY IN BAMBOO, *MELOCANNA BAMBUSOIDES* TRIN.[1]

(With a plate)

With reference to the excellent article on 'Bamboo Fruits' published by D. Chatterjee in the *Journal* **57** (2) : 451-53 I give the following comments.

The author has stated on p. 453: 'The germination was so quick that it was even suspected that some fruits must have germinated while still on the tree. On careful examination, however, no *viviparous fruits* were noticed but the occurrence of this phenomenon cannot be altogether ruled out as stated by Gamble.'

A few clumps of this bamboo were planted a long time ago in Dehra Dun and, strangely enough, the profuse fruiting of *muli* bamboo here coincided exactly with its fruiting periodicity in Bengal (where it is native) in the summer-rainy season of the year 1960. During this period, extending over several months, I watched the fruiting of this bamboo and give the following observations which might prove useful to your readers and interest the botanists.

Melocanna bambusoides Trin. is essentially of a viviparous type. The pear-shaped, pointed fruits start appearing in great profusion (once in about 35 years' time) on the entire plant, and the fruiting period extends over several months. It is so profuse that the fruits appear at the nodes on the main clump, on the thin long branchlets, and even at the ground level springing up from the panicles arising out of the partially exposed rhizomes. The point of attachment of the fruit with the plant is so fragile that when they attain a little maturity and weight, a slight breeze or wind tends to shake off the fruits from the slender branchlets long before they can fully develop into the viviparous state. The fallen fruits of course start regeneration on the ground. Some of those fruits which are clinging close to the nodes on the main clump and near the ground level are not easily disturbed by the wind. Late in the season, when there is enough of humidity in the atmosphere, these fruits get a chance of developing into a good sizeable fruit with a 6-8 inches long shoot growing out of the broader end while still on the tree, thus establishing for certain the phenomenon of vivipary in this bamboo.

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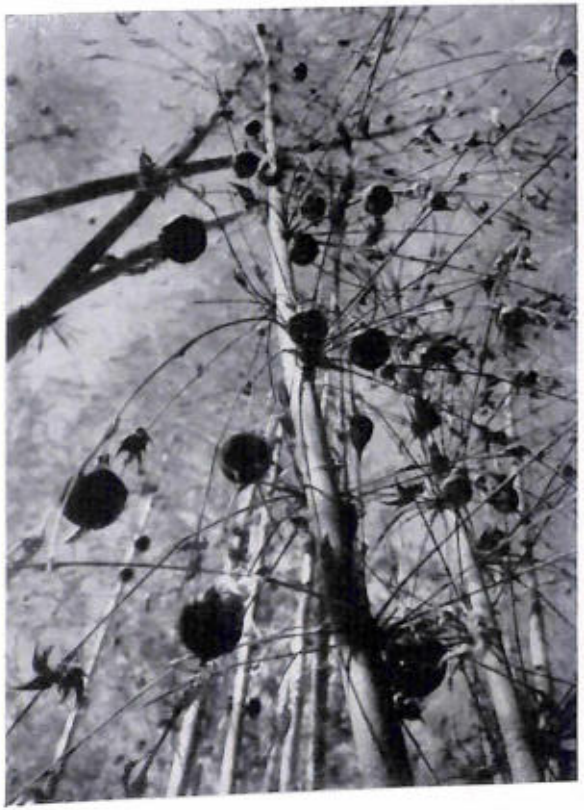
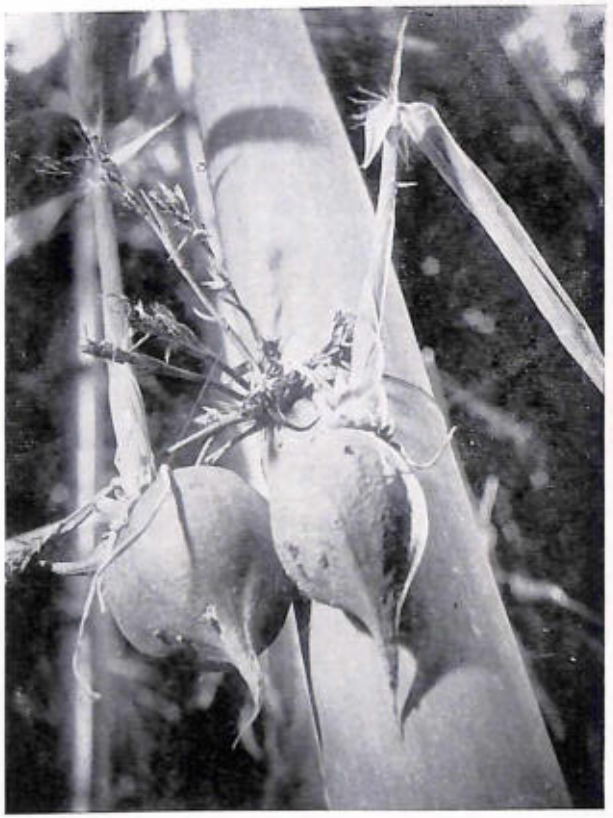
[1] Communicated by the Head, Division of Forest Botany, Forest Research Institute, Dehra Dun, U.P.

MELOCANNA BAMBUSOIDES TRIN.



Bamboo fruit in various stages of development



Viviparous fruits

(Photos : K. M. Vaid)

The accompanying two photographs amply illustrate my observations in establishing this fact.

FOREST RESEARCH INSTITUTE,
DEHRA DUN, U.P., K. M. VAID
May 30, 1962.

28. SOME NEW RECORDS OF *PLAGIOGYRIA* FROM INDIA

Plagiogyria is a genus of about 50 species of tropical ferns about 40 of which are Oriental. In India the genus is restricted to the hill regions of Assam and 4 species, viz. *P. distinctissima* Ching, (*P. adnata* Bl.), P. *glaucescens* Ching (*P. glauca* Bl.), *P. pycnophylla* Kunze, and *P. euphlebia* (Kunze) Mett., are reported by earlier workers (Beddome, 1892; Ching, 1958). During the course of a detailed morphological study of the genus *Plagiogyria* in India an extensive collection was made from various regions of Assam during the year 1958-1961. In addition to the four species already reported, four new species *P. triquetra* Mett., *P. communis* Ching, *P. simulans* Ching, and *P. virescens* (C. Chr.) Ching were collected. The present communication is a report on the occurrence of these species in India and details regarding them are given below. Specimens of all the species reported here are deposited in the Herbarium of the National Botanic Gardens, Lucknow. In the accompanying list the number following the name of each species refers to the collection number of the Herbarium, which is followed by the locality of the collection, the name of the collector, and the date of collection.

(1) **Plagiogyria communis** Ching. NBG 77007. Elephant Falls (1500 m.), Shillong, Assam. Mr. Prakash Chandra. 18 May 1961.

A large fern, often over a metre tall, growing in dense clusters on the sides of streams in semi-marshy surroundings. The dense clusters of roots enveloping the rhizomes make it appear stump-like. The rachis and stipe are tetragonal. The pinnae are closely placed, and possess serrate margins.

Occurs more or less abundantly in the vicinity of Elephant Falls.

(2) **Plagiogyria simulans** Ching. NBG 77008. Elephant Falls (1500 m.), Shillong, Assam. Mr. Prakash Chandra. 18 May 1961.

A medium-sized fern of deeply shaded, semi-marshy areas near streams and rivulets, forming small isolated clusters. Full grown plants are 50-60 cm. tall. The stipe and rachis are tetragonal. The

pinnae are more or less closely placed, lanceolate falcate, and with sharply toothed margins.

More or less abundant.

(3) **Plagiogyria triquetra** Mett. (*Stenochlaena triquetra* J. Smith). NBG 77359. Shillong Peak (1600 m.), Khasi & Jaintia Hills, Assam. Dr. B. K. Nayar, 17 November 1959.

A large fern, nearly 1.5 m. tall, growing in small clusters in deeply shaded, semi-swampy areas in the forest beds. The stipe is trigonal while the rachis is flat on the upper surface and smoothly rounded on the lower. Pinnae are loosely placed on the rachis, lanceolate falcate, and with subcrenate margins.

More or less frequent in the forest near Shillong Peak.

(4) **Plagiogyria virescens** (C. Chr.) Ching. NBG 77328 Pynursla (1300 m.), Khasi & Jaintia Hills, Assam. Dr. B. K. Nayar. 13 November 1959.

A medium-sized fern, growing in deeply shaded moist nallas in swampy soil. Full grown plants are 60-80 cm. tall. The stipe and rachis are tetragonal. Pinnae are loosely placed, and with serrate margins.

Rather abundant in the deep nallas around Pynursla village.

ACKNOWLEDGEMENTS

Thanks are due to Prof. K. N. Kaul for his encouragement, to Mr. Prakash Chandra for kindly supplying the material from his collections, and to Dr. B. K. Nayar under whose guidance this work is done.

PTERIDOLOGY LABORATORY,
NATIONAL BOTANIC GARDENS,
LUCKNOW,
August 6, 1962.

FARRUKH KAZMI

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1

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Turbinaria sp. from Okha

Fig. 1. Entire plant with branched holdfast, ×1.4; Fig. 2. A fertile specimen (Note the branched receptacles), ×1.4; Fig. 3. A vegetative specimen, ×1.4; Fig. 4. A single leaf-like appendage with branched receptacles, ×1.4

29. *TURBINARIA* FROM OKHA

(*With one plate*)

On a recent trip for collecting marine algae at Okha and Dwarka, the writer with the help of his student Shri P. G. Abraham obtained at Okha three specimens of *Turbinaria* (Phaeophyceae, Fucales), one of which was an entire plant (Fig. 1). They were all washed ashore. As far as I am aware (I am thankful to Professor M. O. P. Iyengar and Dr. T. V. Desikachari for confirming this information) *Turbinaria* has not been officially reported from Okha and Dwarka. This genus is widely known and reported from the southern coasts of India. Thus, this finding can be considered as an interesting one as Okha and Dwarka are famous for the richest algal vegetation in India. It is well known that Professor F. Børgesen and others have made extensive collections from these places since 1927.

The entire plant is stunted and measures about 7.0 cm. (Fig. 1). The holdfast is branched. The stem is unbranched but short spur branches are occasionally observed (Figs. 1, 2). Professor Wm. R. Taylor of the University of Michigan who is at present carefully studying the genus informs me that my specimens do not agree with the description of any completely single-stemmed species and appear to be young or stunted. The leaves are obpyramidal and measure about 1.0 cm. in length (Figs. 1, 3, 4). The petiolar part of the leaf has three ridges which bear spiny projections (Figs. 1, 4). The truncated end of the leaf has a flattened top with a fairly broad, rounded-triangular expansion having an aculeate-dentate margin. The cryptostomata are scattered (Fig. 4). Out of the three collected specimens two fertile ones (Figs. 1, 2) are similar while the sterile one appears to be different (Fig. 3). The leaves of the sterile one are generally vesicular at the upper region and longer and broader than those of the fertile ones. The branched receptacles are abundant and more or less axillary.

On the basis of my drawings Professor Taylor says that my specimen 'looks like *T. turbinata* (L.) Kuntze'. But I must admit that the specimens collected at Okha do not fully agree with the descriptions of this species. On the suggestion of Professor Taylor further collections and investigation on *Turbinaria* of Okha and Dwarka are being planned.

DEPARTMENT OF BOTANY,
UNIVERSITY SCHOOL OF SCIENCES, J. J. SHAH
GUJARAT UNIVERSITY, AHMEDABAD-9,
March 31, 1962.

30. ON SELF-CONJUGATION IN A NEW SPECIES OF *SPIROGYRA* LINK

(*With one plate*)

Until quite recently no case of self-conjugation by the formation of loops was known in the Zygnemaceae. Iyengar (1940, 1958a) was the first to report and describe in detail this type of conjugation in *Temnogametum tirupatiense* Iyeng. Later Singh (1958a, 1958b) observed this type of conjugation in *Sirocladium kumaoense* Randh. and *Zygnema terrestre* Randh. A similar type of conjugation was also reported by Randhawa (1959) in *Sirocladium maharashtrense* Randh. But as far as the author is aware, sexual reproduction by this method has not so far been recorded in any species of *Spirogyra*. Recently the author had the opportunity of collecting and studying a species of *Spirogyra* showing this type of conjugation from Palghat, Kerala State. The alga also seems to be new and a decription of it based on a study of living specimens is given below.

The alga was found growing intermingled with other algae including species of *Oedogonium*, *Zygnema*, *Spirogyra*, *Mougeotia*, *Bulbochaete*, *Scytonema*, etc. in very shallow water in exposed ditches constantly moistened by thin films of water spreading from a temporary pool and flowing into the Malampuzha reservoir near Palghat, Kerala State, in October 1961. The cells of the alga are 33-38.5μ broad, 225-630μ long, and with plane end walls. They are slightly dilated at their ends. Each cell has 2, rarely 3 chloroplasts coiled to the right making 3.5-7 turns (Plate, fig. 1).

The only method of sexual reproduction observed in this alga is by self-conjugation and this appears to be the normal regular method of conjugation in this species. Here the filaments coil before conjugation in a very intricate and irregular manner forming loops of various sizes and shapes (Plate, fig. 2). A varying number of cells situated at different places in the same filament are thus brought, somewhat parallel to each other or allowed to cross over others. Sometimes a limited number of cells lying in a series are brought parallel to other cells of the same filament by the bending of the latter through an angle of 180 degrees (Plate, fig. 8). In many cases these approximated cells develop into gametangia. Normally the cells which enter in conjugation are separated by one or more vegetative cells. But in certain cases the coiling may be very complicated and involve the conjugation of two or more pairs of gametangia. (Plate, fig. 3-4)

In a pair of conjugating cells the entire or at least the major part of the conjugation tube is constituted by the male gametangium. A tube which has established connection with the female cell is invariably broader towards its distal end and may reach a length of up to 65μ.

There is also a lateral expansion of the female gametangium before the dissolution of the wall separating the conjugants. Hence it is possible to make out the receptive cell even in the early stages of conjugation.

Stages in the formation of the male gamete, its movement towards the female cell through the conjugation tube and the process of gametic union are exactly similar to those recorded in the scalariform conjugation of other known species of *Spirogyra*.

After conjugation the zygospore is formed inside the female gametangium and when ripe is provided with a thick five-layered wall (Plate, fig. 9). The exospore is made up of two layers of which the outer is thin, firm, hyaline, and with a reddish violet hue on the outer surface, the inner colourless, mucilaginous, and with fine granules distributed towards its inner face. The mesospore is also two-layered. Its outer layer is firm, smooth, and pale yellow in colour. Its inner layer is thicker, rigid, light yellowish brown in colour, and irregularly reticulate, the ridges being thick and imperfectly dentate. The endospore is colourless, thin, and distinct. The mature zygospores are ellipsoid and with rounded ends. They are 56-66.5 μ broad and 82.3-112.5 μ long.

This alga resembles *Spirogyra corrugata* Transeau (Transeau, 1934) and *Spirogyra crenulata* Singh (Singh, 1938 b). The former was reported from China and U.S.A. and the latter from India. The features of similarity include: (1) the presence of plane cross walls, (2) the formation of the conjugation canal solely by the male gametangium, (3) the width of the cells ranging between 30 and 40 μ, and (4) the presence of two chloroplasts in each cell. The present alga, however, is sufficiently different from the two species mentioned above to be considered as a separate species. It differs from *S. corrugata* in the possession of usually longer vegetative cells, broader zygospores, and in the structure of the zygospore wall. In having a five-layered zygospore wall, the present alga comes nearer to *S. crenulata* than to *Spirogyra corrugata*, but is easily distinguished from the former by the relatively larger size of the vegetative cells, the shape and size of the zygospore, and the structure of the different layers of its wall. Again, the author's alga is unique in showing a peculiar type of conjugation so far not recorded in any other species of *Spirogyra*. These striking differences seem to warrant the establishment of a new species which may be called *Spirogyra palghatensis* sp. nov.

DESCRIPTION

Spirogyra palghatensis sp. nov.

Vegetative cells cylindrical, six to fifteen times as long as broad, 33-38.5 × 225-630 μ; end walls plane; chloroplasts generally 2, rarely 3 making 3.5 to 7 turns.

Filaments monoecious, conjugation unique in being brought about between cells situated apart from each other in the same filament through the intricate coiling of the intervening portions of the filament; conjugation tube wholly formed by the male gametangium, female cells swollen when mature; zygospores ellipsoid with rounded ends, 56-66.5 × 82.3-112.5 μ; spore wall of five layers, outer exospore hyaline, upto 1.5 μ thick, and with a reddish violet hue on the outer surface, inner exospore colourless, mucilaginous with finely granulated inner side, and up to 7.5 μ thick; outer mesospore thin, smooth, and pale yellow, inner mesospore light yellowish brown, irregularly reticulate, reticulations thick and imperfectly dentate; endospore colourless, thin and distinct.

Habitat. In very shallow water in ditches near Malampuzha reservoir, Palghat, Kerala in October 1961 along with species of *Oedogonium*, *Mougeotia*, *Spirogyra*, *Bulbochaete*, *Scytonema*, etc.

Type material of *Spirogyra palghatensis* has been deposited in the Herbarium of the Royal Botanic Gardens, Kew.

Spirogyra palghatensis sp. nov.

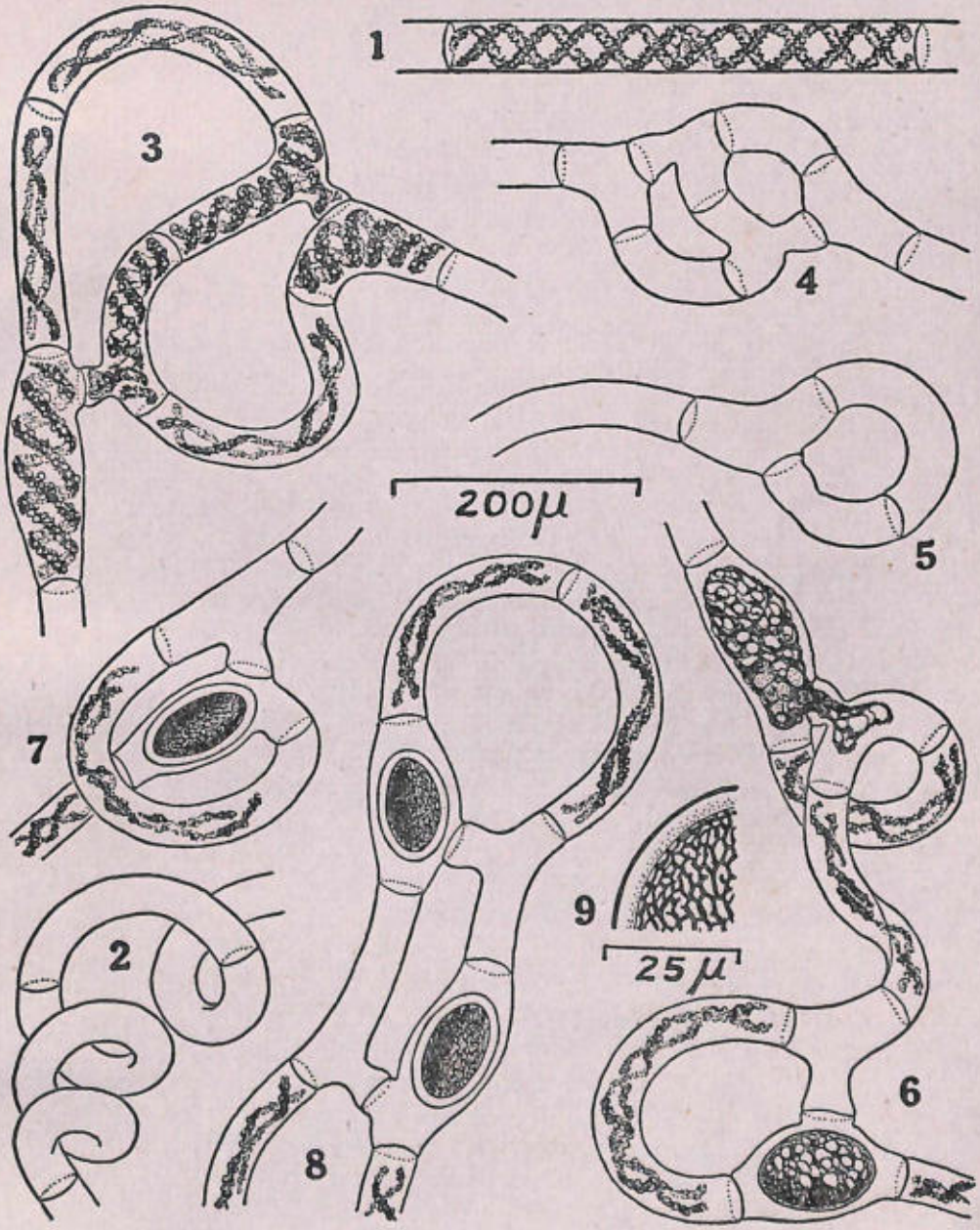
Cellulae vegetativae cylindricae, 6 plo. - 15 plo. longiores quam latae, 33 - 38.5 × 225 - 630 μ; parietes terminales plani; chloroplasta vulgo bina, raro terna, rotationes 3.5 ad 7 efficientia.

Filamenta monoica; conjugatio unica in eo quod efficitur inter duas cellulas eiusdem filamenti distantes sed in unum advectas per spiras multiplices partis filamenti interjectae. Conjugationis tubus penitus productus per gametangium masculum, cellulis foemineis ad maturitatem tumescentibus; zygosporae ellipsoideae, apicibus rotundatis, 56 - 66.5 × 82.3 - 112.5 μ; sporarum parietes quinque seriebus constant; exterius exosporium hyalinum, ad 1.5 μ crassum, externa facie rubro-violaceo colore tincta, exosporium interius incolorum, mucosum, ad 7.5 μ crassum, facie interna pulchre granulata; mesosporium exterius tenue, leve et pallido-luteum, interius vero pallide luteolo-brunneum, irregulariter reticulatum, reticulationibus crassis et imperfecte dentatis, endosporium incolorum, tenue et distinctum.

In aqua tenuissima in fossis ad cisternam Malampuzha Palghat, Kerala, mense octobri anni 1961 simul cum speciebus *Oedogonii*, *Mougeotiae*, *Spirogyrae*, *Bubochaetes*, *Scytonematis*, etc., a N. A. Erady. Typus lectus a N. A. Erady et positus in herbario Hortui Regii Kewensis in Anglia sub No. 1095.

Summary

The process of sexual reproduction in a new species of *Spirogyra*, *Spirogyra palghatensis* sp. nov., which comes near *S. crenulata* Singh



Spirogyra palghatensis sp. nov.

Fig. 1. Vegetative cell; Fig. 2. Part of a vegetative filament showing a stage prior to conjugation; Figs. 3-5. Early stages in self-conjugation; Figs. 6-8. Late stages in self-conjugation; Fig. 9. Surface view of a part of the Zygospore wall.

and *S. corrugata* Transeau is described. It is based on a study of living specimens collected at Malampuzha, Palghat, Kerala State. In this monoecious species the filaments show a peculiar tendency for coiling in a profuse and intricate manner before conjugation. Cells of the same filament which are brought close together as a result of coiling enter in conjugation. This type of self-conjugation is found to be a regular normal method of reproduction in this species.

ACKNOWLEDGEMENTS

The author's sincere thanks are due to Rev. Fr. Dr. H. Santapau for rendering into Latin the diagnosis of the new species.

GOVERNMENT VICTORIA COLLEGE,
PALGHAT, KERALA,
December 15, 1961.

N. A. ERADY

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31. USE OF AIR-GUNS BY MINORS

The Annual Report for 1961 of the British Section of the International Council for Bird Preservation makes an interesting reference to the problem of air-guns. Under British law, air-guns (and shot-guns!) may be used by children of any age and by people with no knowledge or experience of shooting—the only requisite being the possession of a shooting licence which can be purchased by anyone for a fee of 10 shillings per annum.

In India, the problem fortunately only covers the less powerful air-gun and, in the States of Maharashtra and Gujarat at least, the killing of almost all birds and animals by any means is prohibited except under a game licence and in accordance with the conditions thereof. The application for a game licence, however, requires details of the arms-licence, which not being available to persons under

18, prevents them from engaging in legitimate shooting until they are of age.

While there can be no doubt that the killing of birds by boys with air-guns should and must be stopped, I think it unreasonable and undesirable to prevent their legitimate participation in sport until they are 18 years of age. Many of the keener sportsmen commence their shooting activities at about 12 and, unless they begin early, they cannot give the matter the same interest and attention that makes the really good shikari or sportsman.

Recent issues of *The Indian Rifleman* contain reference to children of 12 and 14 doing well at rifle ranges—I do not know if they are covered by suitable licences.

In England, a private member of Parliament recently presented a Bill on the subject of Gun and Game Licences containing a clause which would prohibit children under 15 from using guns (including air-guns), except under the supervision of an adult. The Bill failed to pass the Committee stage in the House of Commons.

The change proposed by the Bill appears very reasonable and it is hoped that these matters will soon be suitably adjusted in India.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
July 10, 1962.

HUMAYUN ABDULALI

Gleanings

The Description and Naming of New Species

In *The Annals & Magazine of Natural History* for December 1961, in a note on the numerical data published in Volume III of his BIBLIOGRAPHIA ARANEORUM, Pierre Bonnet gives facts and makes suggestions relating to the systematics of Arachnology which may usefully be read and pondered over by systematists in other branches of natural science as well.

M. Bonnet points out that of the 45,140 species named in the period 1758-1939 as many as 17,634 have been found by subsequent workers to be invalid, and that of the 22,398 accepted species named during this period as many as 15,560 have not been collected again since their original discovery. So many species cannot all be rare and it is unlikely that any substantial proportion of them have ceased to exist. Are they really valid species, or have they already been described under some other name? He rightly comments on the enormous waste of labour involved, and presses for greater caution in describing new species. The four principles which he enunuciates, however, are rules of perfection which it will be difficult to enforce rigidly.

An Indian Orpheus

'In refreshing contrast to this cruel and unseemly procedure (shooting dazzled wild animals by night from motorcars) . . . was the delightful propensity of the Maharaj Rana of Dholpur for establishing friendly contacts with wild creatures. . . . . In his younger days he had been one of the finest small-game shots in India, but as he grew older he tired of killing and turned to the cultivation of amicable personal relations with birds and beasts. It became his habit to go unarmed into the jungle and, like a latter-day Orpheus, attract its denizens by dulcet sounds. Relying not upon musical instruments but upon his own delightfully modulated voice, he achieved almost incredible success. Shy sambhur stags and hinds eventually emerged from the thickets to take food from his hands, and wild birds would perch upon his shoulders.'

Sir Kenneth Fitze (1956): TWILIGHT OF THE MAHARAJAS

Notes and News

The XIIth International Congress of Entomology will take place in London from 8-16 July 1964, under the presidency of Professor O. W. Richards, F.R.S.

The Congress will be divided into twelve sections and emphasis will be placed on sessions organized around selected topics of current importance, to which contributions will be invited from intending members. Visits are being planned both to research institutes and to well-known collecting areas.

Full Membership is open to all at a fee of £8 sterling. Full Members' families and undergraduate students are eligible for Associate Membership at £4 but will not receive the printed Proceedings and may not read papers.

The languages of the Congress are English, French and German.

Persons wishing to attend the Congress, who have not received an invitation to attend, should inform Mr. Paul Freeman, Secretary, XIIth International Congress of Entomology, c/o British Museum (Natural History), Cromwell Road, London, S.W. 7, England.

* * * *

Mr. Julian Donahue of 237 Gunson, East Lansing, Michigan, U.S.A., would be glad to hear from persons who have collected Delhi butterflies.

* * * *

We congratulate Dr. M. L. Roonwal, Member of the Advisory Committee of the Society, on whom the University of Cambridge has recently conferred the degree of Sc.D.

* * * *

Dr. H. Santapau, Chief Botanist, Botanical Survey of India, accompanied by Dr. S. K. Mukherjee, Dr. M. A. Rau, Dr. T. S. Sadasivan, Dr. T. S. Mahabalé, and Dr. S. M. Sarcar, is leaving for the US.S.R. in September 1962. This visit is part of the programme of Cultural Exchange Agreement between the two countries and under which six Russian Botanists had visited India from 1 March to 31 May, 1961. The delegates will be the guests of the Soviet Government, and will be visiting the various laboratories and Botanical Gardens for study of the flora of that country and the methods of preservation and utilization of the same.

* * * *

The Society is in a position to distribute some small amounts for specific pieces of work in natural history. Members interested may write to the Honorary Secretary giving a précis of the work to be carried out and details of the expenditure likely to be incurred.

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