Journal of the Bombay Natural History Society

Vol. 59, No. 1

Editors
H. SANTAPAU, S.J., & HUMAYUN ABDULALI

APRIL 1962

Rs. 15

NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and subspecific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri.*

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8.20×5.60 cm. (No. 2 Brownie) and on glossy glazed paper.

6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name with the abridged titles of journals or periodicals underlined (italics), and titles of books *not* underlined (roman type), thus:

Banerji, M. L. (1958): Botanical Exploration in East Nepal. *J. Bombay nat. Hist. Soc.* **55** (2) : 243-268.

Prater, S. H. (1948): The Book of Indian Animals. Bombay.

Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Banerji, 1958).

9. *Synopsis:* Each scientific paper should be accompanied by a concise, clearly written synopsis, normally not exceeding 200 words.

10. *Reprints:* Authors are supplied 25 reprints of their articles free of charge. In the case of joint authorship, 50 copies will be given gratis to be distributed among the two or more authors. Orders for additional reprints should be in multiples of 25 and should be received within two weeks after the author is informed of the acceptance of the manuscript. They will be charged for at cost plus postage and packing.

EDITORS,
Journal of the Bombay Natural History Society.

91, Walkeshwar Road,
Bombay 6-WB.

CONTENTS OF VOLUME 59, NO. 1

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1962 APRIL | Vol. 59 | No. 1

The Bats of Central and Western India

PART 1

BY

A. BROSSET

(*With* 11 *maps and* 3 *plates*)

From 1860 to 1920, mammalogists such as Blyth, Dobson, Thomas, and Wroughton have studied the morphology of Indian bats. Their descriptions remain true today. From 1912 to 1920, the Mammal Survey of India arranged by the Bombay Natural History Society collected specimens in many places. From the Himalayas in the north to the furthest south, bats were systematically recorded from the principal types of biotopes existing in India, and good series of the many species can be seen today in several museums.

Apart from these attempts at description and classification, we may say that the older authors neglected to record data in the field. The collection of specimens often by non-scientific people, and the measurement of skulls and dry skins were the chief objects of their work. Wroughton excepted, they were apparently not interested in the habitat of the species that they described so carefully. Their conception of zoology was restricted. Nevertheless, we must admit that a sound systematic knowledge is always necessary for the progress of zoology. In this way, the older authors who studied Indian bats give us a very remarkable and fruitful systematic background, and in most cases it is difficult to improve on what they have done. The mammalogists interested in these animals have now to turn their mind from systematics, which can only be improved by minor details, to studies in the field, which offer a new and fascinating subject.

For these reasons, when I came to Bombay in August 1959, I selected bats as a subject for field work. I was well prepared to undertake such research, for during the last 10 years I have contributed a number of publications on the biology of bats, especially their ecology and their social life and reproduction, both in Europe and in Africa.

I was lucky from the very start to be helped in many ways by the Bombay Natural History Society, their library, collections, staff, and experience being placed at my disposal. I was thus easily introduced to the publications and collections of my predecessors, and given an indication of the species which I was likely to meet.

Bro. Navarro of St. Xavier's High School, who made a good collection of local bats some 20 years ago, was kind enough to entrust to me his collection and unpublished notes. I take this opportunity to express my gratitude to Mr. Humayun Abdulali, the Honorary Secretary of the Bombay Natural History Society, and to Bro. Navarro for their help and assistance in the course of the present work.

Geographical Extent of the Study

The area covered by the present study was primarily determined by the place of my residence, and it was mainly around Bombay that I had the opportunity to follow the annual cycles of several colonies of bats. In addition, the principal types of biotopes of western and central India were selected, and trips and camps were arranged to these places—latitude, altitude, rainfall, and vegetational cover were the factors which determined the choice of the localities visited. Specimens and data were systematically collected and recorded in the following places:

North Gujarat

Ahmedabad, Anand and neighbourhood, Baroda.

Konkan

Salsette Island, Alibag, Bassein, Arnala, etc.

North Kanara

Belgaum and Goa borders.

Arid enclave of Bellary

Badami, Pattadkal, Hampi.

Ghats at middle altitude (*c.* 800 *m.*)

Khandala and neighbourhood, Bhaja, Bedsar, Karla, Igatpuri and neighbourhood.

Ghats at high altitude (*c.* 1000-1200 *m.*)

Mahableshwar, Panchgani and neighbourhood.

Deccan

Poona, Junnar, Aurangabad, Ajanta, Ellora, Amraoti, etc.

Mountain ranges of central India

Chikalda.

Plateau border of central India

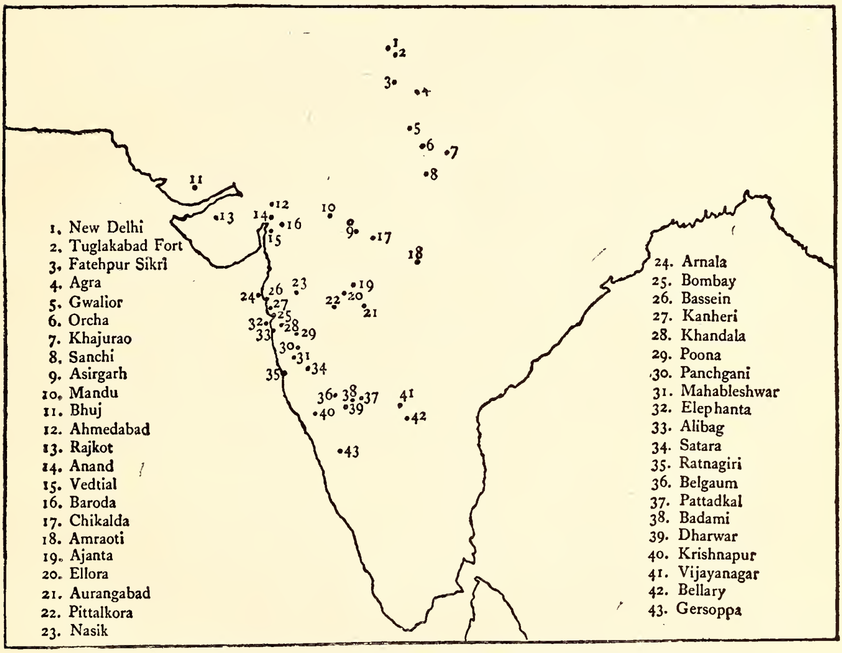
Mandu, Sanchi.

Border of the arid area of Rajasthan

New Delhi, Agra, Fatehpur Sikri.

Northern Madhya Pradesh

Jhansi, Orcha, Khajurao.



Map 1. Localities where Bats were studied during the present survey

General Comments

Bats in India are extremely common. Artificial or natural caves, old buildings, above and underground, and wells are the haunts of many individuals. Most Indian species are anthropophile and adapted to the human habitation, in contrast to what one observes in tropical

Africa. Even the tree-species, such as the Flying Fox *Pteropus giganteus,* are found living in middle of towns and villages. The species inhabiting hollows in trees in thick forests are poorly represented in India, and it may not be worthwhile searching for bats in the wild and secluded parts of the country.

Their smell and voices, peculiar to each family, can tell an experienced mammalogist of the presence and identity of bats. For instance, *Tadarida* colonies are very well concealed, but so noisy that I discovered several colonies only by hearing their voices. When searching for bats living in crevices and cliffs, looking down is more profitable than looking up. On the ground there are usually traces of guano which betray their presence. In every place visited observations were carried out at sunset and many useful data obtained. When the identity of the species was doubtful, I caught specimens with a Japanese mist net.

I also obtained many interesting data by visiting at night the diurnal roosting places of several species. In fact many bats return and occupy their diurnal biotope during the greater part of the night and interesting observations can be made at this time.

Methods used to obtain Specimens

In Europe bats can usually be caught without much difficulty, but in tropical countries it is not always easy as very few individuals hibernate. Several shy species cannot be caught by hand and almost all bats bite severely in self-defence. Shooting at sunset is difficult and costly. The 'game' is often missed or blown to pieces or lost in the grass and other vegetation. The gun can only be a complementary instrument and the best method is by nets. Three kinds of nets were used by me:

(*a*) A net similar to a butterfly net: This is made with pieces of fishing net, an iron-wire frame, and a handle of one or more bamboos. It is usually sufficient for work in caves and buildings. A large butterfly net properly handled could also be used for the capture of low-flying bats at sunset.

(*b*) Japanese mist nets were used to catch bats living in inaccessible crevices, when they were leaving their haunts at sunset. They were also used to catch bats hunting around at night.

(*c*) Large fishing nets were used for closing up the openings of caves or other roosting haunts when a large number of individuals had to be taken, e.g. for ringing.

Ringing

Only 253 individuals of 5 species were ringed. Valuable information regarding the smaller bats was recorded. Unfortunately the larger species, especially the *Megaderma* and the *Rousettus*, could not be satisfactorily ringed as they either bit off the ring or perished because of infection of the forearm.

General Scheme of Work

This paper is divided into two sections. In the first section the species are dealt with one by one; after a short description, the distribution in western and central India is noted in detail; this is followed by a note containing such information as was available regarding their ecology, food, field characters, reproduction, social life, hibernation, and migration. The second section will deal with the biogeographic affinities of the Indian bats, and will contain an analysis of the ecological factors that influence their distribution, reproduction cycles, hibernation, and migration and a comparison will be made with the information available for the European and African bats.

General Remarks and Explanations

Finally, to avoid misunderstanding, I give certain necessary definitions and explanations:

(*a*) *Measurements.* The soft parts of bats are difficult to describe in words and the differences between closely allied species can only be appreciated with fresh material for comparison. Unfortunately, dry skins in museums are often much shrivelled and their sizes may vary greatly, some individuals appearing twice as large as the others, due mainly to the technique of preservation. However, even if the specimen is completely rotten, the bones of the limbs retain their original sizes. For the purpose of identification, the basic measurements are those of the forearm and the metacarpal bones.

For each species, a table of these important and constant measurements is attached.

The size of adult bats varies only to a small extent. I have therefore limited the measurements to 6 to 10 specimens of each species chosen at random and from different areas.

The skull measurements of a few specimens are also given.

(*b*) *Description.* It has not been thought necessary to repeat the excellent descriptions of Dobson, Thomas, and Wroughton. New attempts at description would merely confuse what is already perfectly clear. I have only drawn attention to the more striking and easily visible characters which help to identify the bat and to separate it from closely allied species.

(*c*) *Subspecies in Bats.* The taxonomy of Indian bats at the species level appears to be well established today. In contrast to this the subspecies appear to be very confused. The trinomial classification which has given so valuable an impetus to ornithological study has been a failure with bats. Bats have few differences among themselves and most of the species have no valid races. This is true not only in India but also in other parts of the old world. The colour variations which are so often the basis of many subspecific differentiations are not due to any geographical factors but are individual variations, or due to the season, or their micro-biotope, and sometimes their social life. It is not unusual to observe two totally different types of coloration in two colonies of bats of the same species living side by side. Such differences cannot be accepted at a subspecific level, and the subspecies so described must be added to the debit side of the 'fanatics of systematics'. Nevertheless, it cannot be denied that certain species possess ecological subspecies differentiated by the colour of their fur, e.g. in India *Hipposideros bicolor* in dry areas is mainly greyish-white but dull yellowish-brown in the coastal plains.

The subspecies described on measurements are usually more reliable, although sometimes based on insufficient material and therefore liable to doubt.

In the present work, the subspecies is named only when sufficient material is available, while in other cases only the specific name is used.

(*d*) *Method of Treatment of each Species*

(i) Distribution. The general distribution is quoted from Ellerman & Morrison-Scott's CHECKLIST OF PALAEARCTIC AND INDIAN MAMMALS (1951), which has been the main source of information in this respect. For each species a sketch map covers the distribution in western and central India as recorded by the Mammal Survey, Bro. Navarro, and myself.

(ii) Field Characters. No attempt appears to have been made to describe the Indian bats in the natural surroundings. I have attempted to do this and also describe the hunting flight as far as possible with words.

(iii) Ecology. Following Verschuren, I give a table of diurnal biotopes for each species observed by me. This table includes the date, the estimated number of individuals in the colony, the number actually examined, and a short description of the biotope. As far as possible, data on the surrounding territory are also recorded.

(iv) F o o d. My notes on food are inadequate and the diet of only a few species is known. The insects taken at sunset are quickly digested and the stomach contents of the animals on the following day only show masticated pieces which cannot be easily identified.

(v) R e p r o d u c t i o n. Some information has been obtained regarding the reproduction of most of the species. The periodicity of their producing cycle, variations in external sexual characters, spermatogenesis, rut, pregnancy, and birth and growth of the young are analysed for each species as far as the information permits.

(vi) S o c i a l L i f e. Observations on bats in Europe had indicated many unexpected and extraordinary factors in their social life. It was interesting to ascertain whether tropical bats showed the same character. Sexual segregation, and specific and interspecific associations are studied.

(vii) H i b e r n a t i o n. I have published a more extensive note on the subject of hibernation in tropical bats in another journal (*Mammalia*, December 1961, in French). In the present paper the hibernation of Indian bats is analysed on the basis of experimental researches and observations in the field and a summary of the same is included.

(viii) M i g r a t i o n. Thousands of bats were ringed in Europe over the last 20 years, but there is no definite evidence that bats are migratory in the same way as birds. They only change their roosting places regularly in connection with the time of their hibernation and at different phases of the sexual cycle (see Eisentraut for Germany, Verschuren for Belgium, Brosset and Caubiere for France). Researches were made in the course of the present studies to know if the Indian bats show the same behaviour.

To conclude this introduction, I must say that the present work does not profess to be exhaustive, but is a preliminary approach to the study of the biology of Indian bats. Often the conclusions that I propose are provisional, because the data recorded are not enough. More information is to be collected to confirm or deny my suggestions. The biology of several species inhabiting India is still unknown. We only know of their existence and nothing more. An extensive field remains open to the zoologists and I hope that the present work will form a suitable basis for study in the future.

SECTION I

List of Species from Western and Central India

The taxonomy is mainly based on Ellerman & Morrison-Scott's CHECKLIST OF PALAEARCTIC AND INDIAN MAMMALS, with which I agree except for the genus *Myotis*. Even so, several subspecies cited in the CHECKLIST have been suppressed as being doubtful or unreliable. *Rhinopoma kinneari* is synonymised with *R. microphyllum*.

The following signs are used to indicate reference to the three main sources :

⊙ = Collections of the Bombay Natural History Society, and/or the reports of Mammal Survey of India.

□ = Collections and notes of Bro. A. Navarro.

△ = My own collections and notes.

MEGACHIROPTERA

Rousettus leschenaulti	.. Desmaret 1820	⊙□△
Pteropus giganteus	.. Brunnich 1782	⊙□△
Cynopterus sphinx	.. Vahl 1797	⊙□△

MICROCHIROPTERA

Rhinopoma hardwickei	.. Gray 1831	⊙□△
Rhinopoma microphyllum	.. Brunnich 1782	⊙□△
Taphozous perforatus	.. E. Geoffroy 1818	⊙□△
Taphozous melanopogon	.. Temminck 1841	⊙□△
Taphozous longimanus	.. Hardwicke 1821	⊙□△
Taphozous theobaldi	.. Dobson 1872	⊙△
Taphozous saccolaimus	.. Lesson 1842	⊙□
Taphozous kachhensis	.. Dobson 1872	⊙□△
Megaderma spasma	.. Linnaeus 1758	⊙□△
Megaderma lyra	.. Geoffroy 1810	⊙□△
Rhinolophus rouxii	.. Temminck 1835	⊙□△
Rhinolophus lepidus	.. Blyth 1844	⊙□△
Rhinolophus luctus beddomei	.. Anderson 1905	⊙□△
Hipposideros speoris	.. Schneider 1800	⊙□△
Hipposideros bicolor fulvus	.. Gray 1838	⊙□△
Hipposideros bicolor pallidus	.. Anderson 1918	⊙△
Hipposideros galeritus	.. Cantor 1848	⊙□△
Hipposideros lankadiva	.. Kelaart 1850	⊙□△
Tadarida aegyptiaca	.. E. Geoffroy 1818	⊙□△
Otomops wroughtoni	.. Thomas 1918	⊙△
Myotis peytoni	.. Wroughton & Ryley 1913	⊙
Myotis peshwa	.. Thomas 1915	⊙△
Pipistrellus coromandra	.. Gray 1838	⊙□△
Pipistrellus mimus	.. Wroughton 1899	⊙□△
Pipistrellus ceylonicus	.. Kelaart 1852	⊙□△
Pipistrellus dormeri	.. Dobson 1875	⊙□△
Hesperoptenus tickelli	.. Blyth 1851	⊙□△
Tylonycteris pachypus	.. Temminck 1840	⊙
Scotophilus temmincki	.. Horsfield 1824	⊙△
Scotophilus heathi	.. Horsfield 1831	⊙□△
Miniopterus schreibersi	.. Kuhl 1819	⊙□△
Kerivoula picta	.. Pallas 1767	⊙□

Suborder MEGACHIROPTERA
Family PTEROPIDAE
Genus *Rousettus*
Rousettus leschenaulti Desmaret 1820

Measurements (in mm.) :

	Localities								
	Elephanta □ ♀ ad.	Khandala □ ♂ ad.	Elephanta □ ♂	Khandala □ ♂	Khandala □ ♀ ad.	Mahableshwar □ ♀ ad.	Elephanta □ ♂ ad.	Khandala □ ♀ ad.	Khandala □ ♂ juv.
Forearm	81	86	82	78	75	72	83	78	55
2nd finger Metacarpal	32	35	35	32	30	35	34	34	30
2nd finger Phalange	13	14	13	14	14	14	15	13	14
3rd finger Metacarpal	49	54	51	50	48	47	55	53	43
3rd finger 1st Phalange	32	37	35	34	34	29	36	31	30
3rd finger 2nd Phalange	45	50	45	47	48	42	53	41	35
4th finger Metacarpal	48	53	50	49	49	46	54	45	42
4th finger 1st Phalange	25	31	28	26	26	25	25	25	20
4th finger 2nd Phalange	28	30	29	29	32	27	32	25	22
5th finger Metacarpal	45	51	50	45	44	45	53	44	39
5th finger 1st Phalange	24	26	28	26	25	27	26	24	19
5th finger 2nd Phalange	25	28	29	26	25	24	27	25	21
Tarsus	35	34	36	36	34	34	34	30	29

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Ad. ♀ △ Elephanta	38	23	31	15	18
Ad. ♀ △ Elephanta	40	24	31	17	17

Description

As can be seen, the measurements of this frugivorous bat are rather variable. The males appear heavier than the females. The young grow very slowly. The adult size and definitive shape of the skull are attained after more than a year. The young have two molars in the upper jaw, the second appearing very late. On the other hand, old individuals often lack teeth.

The fur is uniformly light-brown, sometimes yellowish. The colour differs with the sex and old males often have the flanks washed with dull grey. During the moult, in spring and summer, individuals almost completely naked are frequently seen.

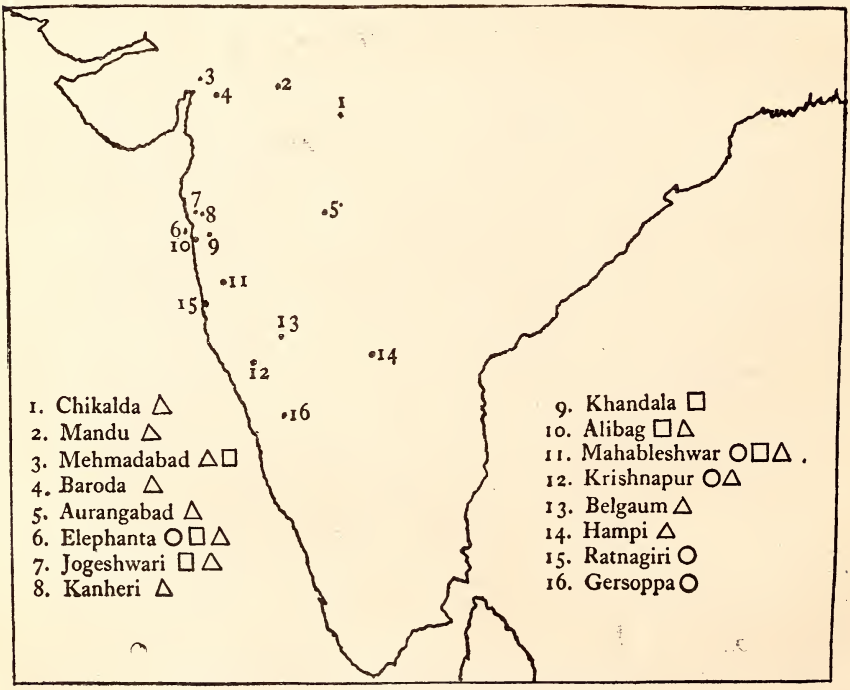
This bat smells of fermented fruits. It is the host of many parasites, *Thaumapsylla* (Fam. Ischnopsyllidae), *Eucampsipoda* (Fam. Nycteribiidae), etc.

The young can be confused with the other fruit bat *Cynopterus sphinx*, the number of teeth, the shape of the skull, and general appearance being similar. *Cynopterus*, however, usually has a whitish margin on the border of the ears, and the nostrils are clearly divergent.

Biogeographical Distribution of the Species

Nepal, Burma, Tenasserim, Kumaon, Rajputana, peninsula of India, Ceylon ? (conspecific with *Rousettus seminudus* ?), north Siam, Tonkin, Indo-China, southern China, and Java.

Distribution in western and central India



Map 2. Localities where *Rousettus leschenaulti* were studied

Rousettus leschenaulti is a common species. It occurs in all places, from the Konkan at sea-level to the top of the Ghats at Mahableshwar, in dry parts of Gujarat and in the humid forests of Kanara. It appears to require only:

(1) a quiet roosting place for the day, either underground, in caves, or in deserted buildings, and

(2) ripening fruits near by.

The Diurnal Biotope

This bat never lives in trees as *Cynopterus* and *Pteropus* usually do. Natural caves are the normal roosting sites of this species and are occupied wherever available. It has however adapted itself to diverse man-made constructions, as the following table will indicate:

TABLE OF DIURNAL BIOTOPES OF *Rousettus leschenaulti*

Locality	Date of visits to the biotope	Size of the colony	No. of specimens captured	Nature of biotope
Elephanta	All over the year (For the monsoon periods: H. Abdulali)	Varying from 2-3 individuals to 2000	61	Artificial cave with ramifications (forest area)
Kanheri Cave No. 1	All over the year	Estimated 100-200	2	Ancient Buddhist cave carved in the rock, in a forested area of Salsette Island
Kanheri Cave No. 3	All over the year	Varying from 2 to 50-80 individuals	27	ditto
Chikalda	December	Estimated 2000	11	Under a dome, in the ruins of the fort (forest area)
Alibag	March	10-15	1	A natural cave (forest area)
Mahableshwar	February, April-May, August	Estimated 500	3	In the Robbers' Cave (forest area). Natural cave
Hampi	October	20	4	Ruins (cultivated area)
Jogeshwari	February, August	Estimated 100-130	5	Artificial caves carved in a rock (still a place of very active religious worship)
Aurangabad	March	8-10	2	Buddhist caves carved in the rock (arid area)
Baroda	November	Estimated 80-100	1	In well in the park of the Maharaja's palace
Mehmadabad	December	1600 (counted on a photograph)	1	In well, with underground chamber (dry cultivated area)
Krishnapur	May	Big colony	3	Natural cave (forest area)
Mandu	February	Estimated 1000-2000	2	Several colonies in the mosque and ruins of the destroyed capital
Khandala	December to June	Big colony	several	1933-40, in disused rail tunnel (Navarro's observation). Now not existing

It will be noticed that natural caves (Mahableshwar and Krishnapur), artificial caves (Elephanta and Aurangabad), hypogean temples (Kanheri), ruins (Mandu and Chikalda), railway tunnels (Khandala), wells (Mehmadabad and Baroda) have all been used. Generally, the bat prefers large cavities with high ceilings. Complete darkness is not necessary but quietness is. If disturbed, it abandons its haunt very easily. Several haunts which have been kept under observation are regularly deserted over a period of several months and it is believed that this is due to non-availability of fruit in the immediate neighbourhood.

Nocturnal Territory

Trees bearing ripe fruit determine the nocturnal territory of the species and it is astonishing to notice the sudden appearance of bats where none were seen before, depending obviously on the ripening of fruits. They are guided by smell, and I know of at least one instance in which the *Rousettus* was accustomed to go into a flat in a large building in Bombay in search of ripe fruit and was actually caught eating a banana inside the kitchen at a place not visible from outside.

The animals are noisy and continue to scream while feeding, and this together with movements attract others from afar. At sunset, on many occasions, I have observed these bats suddenly deviate from a straight flight and turn to join a party already feeding in a fruit tree.

Fruit-eating bats appear to have a good memory. For about a month I observed about a dozen *Cynopterus sphinx*, four or five *Pteropus*, and three *Rousettus* feeding in a single *Ficus* tree. Every evening at sunset they flew without hesitation straight to the tree although it was more or less concealed by larger trees.

In western India, all three species of fruit bats may be feeding together in the same tree, the large Flying Foxes occupying the higher part of a tree and the two smaller species the lower area. This division of the feeding territory was observed in several places.

Fruit-bearing bushes and low trees are visited by *Rousettus* and *Cynopterus* and not by *Pteropus*.

Field Characters in Roosting Places

In their diurnal haunts, the species is easily identified, large bats in noisy colonies hanging from the ceilings of old buildings etc. The number of individuals in a colony range from a few to about two thousand. Their screams and smell are unmistakable. In the colony the individuals hanging side by side are more or less crowded and their large brilliant eyes separate them from the insectivorous species (cf. Plate I). At human approach, their reaction is almost always the same: the screams become louder and louder, and then suddenly stop when the observer is some 5 metres away. At this time some of the bats fly away. Often in the first rush, many individuals fall to the ground. If the haunt is spacious the bats do not fly out, but if the ceiling is low (as in the Robbers' Cave at Mahableshwar or at Elephanta) they abandon their retreat and take refuge outside on the cliffs and on trees, where they are often attacked by kites and crows, resulting in the loss of several individuals and considerable disturbance to the colony.

Their time of departure in the evening is variable. Many individuals fly away at sunset, but others may be seen at the diurnal haunt even after complete darkness has set in. The flight is heavy with slow strokes of the wings. The absence of a tail is distinctive. The *Cynopterus* has the same character, but it is usually possible to separate it by its swifter wing-beat, shorter body, and overall smaller size.

Social Life

Unfortunately, insufficient data were recorded to enable me to indicate any definite results. Ringing was not successful, as the bat either freed itself or died with infection on the forearm.

Usually, both sexes live together and no sexual segregation was recorded. Adults were caught together as under:

At Elephanta ..	10 females, 8 males (October) 6 females, 4 males (March)
At Kanheri ..	5 females, 2 males (August)
At Chikalda ..	6 females, 5 males (December)
At Mahableshwar ..	1 female, 2 males (May).

The colony at Elephanta which begins to form in the last days of January was worked with members of the Society's staff and on 11 February 1960, 33 adult males were captured against only a single female. The females appear to arrive after the males. At the end of March, we observed many females carrying young, with their number apparently equal to that of the males. When the females arrive, they are already pregnant; the difference in the time of arrival of the two sexes does not seem to have any relation to their sexual behaviour.

McCann records a huge colony at Tulsi Lake in which the males and females lived separately. Unfortunately, more detailed information is not available.

The young when free from maternal care live apart from the adults, behaviour very different from that of other bats but supported by the following observations:

(*a*) *Kanheri*: 2 or 3 young were regularly seen in several caves along with *Taphozous melanopogon* (8 were captured for examination at various times).

(*b*) *Elephanta*: 1 to 3 juveniles were regularly present from the end of October to the end of January when the adults were all absent (3 captured).

(*c*) *Mandu*: 8 to 10 juveniles were seen isolated together close to a large day-roosting colony of *Hipposideros* (February 1961, 2 captured).

(*d*) *Jogeshwari*: 15 to 20 juveniles together in August (5 captured).

(*e*) *Baroda*: Colony of 80 to 100 individuals, apparently juveniles (December).

These juveniles, which can easily be distinguished by their much smaller size, were never seen among adults in the many large colonies examined.

Inter-specific Associations

A number of different interspecific associations were noticed:

With *Hipposideros fulvus, Hipposideros speoris, Megaderma lyra* in Elephanta Caves.

With *Taphozous melanopogon* in Kanheri and Alibag caves.

With *Tadarida aegyptica, Hipposideros lankadiva, Taphozous melanopogon* in Mandu.

With *Rhinolophus rouxii* in Jogeshwari caves.

With *Taphozous longimanus* in Mehmedabad and *Taphozous kachhensis* in Aurangabad.

With *Rhinolophus lepidus* and *rouxii* in Khandala.

These associations appear to be entirely due to ecological convergence and no other reason.

Reproduction

External Organs. From December to October, the testes of the adult males are well developed with a maximum length of 28 mm. The penis is completely invaginated and does not appear externally. The mammae are in a lateral position and specially developed in old females.

Rut Period. The spermatogenesis seems to continue over a long time, probably from November to March. Two males dissected in March had spermatozoids in the epididymus, but none was noted in an adult dissected in October. The spermatogenesis may have a stop time, probably in summer and the beginning of autumn. Nevertheless, further studies are necessary.

Pregnancy and Birth of the Young

The duration of pregnancy is not known. McCann stated that it lasts 15 weeks, but does not give the basis of his assertion. From the data available, this species appears to have two periods of parturition every year, the first in March and the second in August, the latter concerning a small number. For the first statement, I have the following data:

Elephanta : At the end of March, hundreds of females with newly-born young.
Aurangabad: At the end of March, a few females with young.
Jogeshwari : Females with young born in March.
Kanheri : At the end of March, females with newly-born young.
Robbers' Cave, Mahableshwar: Females with young in early April.
Khandala : Females with young from March to May (Bro. Navarro).
Tulsi Lake : McCann noted a great number of newly-born young in March.

On the second parturition, we have the following data:

Kanheri : In early August 1960, 70 to 80 *Rousettus* came into Cave No. 3, where usually a few juveniles were living. This colony was made of adult males and females bearing young 2 or 3 days old (11 adults were caught, of which 3 were males and 8 females with young). In August 1961, a small number of females with newly-born young were again noted.

Elephanta : In October 1960, the colony was made up of about 2000 individuals, male and female adults and young of 2 sizes. The smaller ones, perhaps several hundreds, were more numerous and still hanging from their mothers' breasts. The larger ones may have been of the March generation, but it was not possible to determine whether they were the progeny of the females which had the small young—in fact, even in equatorial regions, where the periodicity of bat parturition is not very well marked, there is no evidence that the same female can have two deliveries in the same year. The presence of these young must be taken to modify to some extent my earlier remarks that the young do not live with the adults. The hypothesis that the females bearing in August were born in March the previous year is unlikely, as among those caught at Kanheri with new-born young in August there were at least three old individuals with worn dentition. The mortality among young is high and it is more likely that the second parturition is of females who lost their young in March and in whom the consequent stop of lactation is followed by a second oestrus.

The Young

In my experience, only a single one is born and this is confirmed by Navarro and McCann.

At birth, the young are fleshy pink and naked, being firmly fixed to the teats (which are commonly used as organs for fixation) in a transverse position. Mortality is heavy and the bodies of many newly-born young were seen in every nursery. At Kanheri, early in August, 7 were found on one day and a mother was also seen dead with a young still in the placenta.

As compared with the insectivorous species, the young grow slowly and are carried about by the mother for at least two months. The adult size is reached after one year. Juveniles of the March generation caught from August till November at Elephanta and Kanheri had a short skull (30 mm.) and in certain cases incomplete dentition.

The existence of separate colonies of immature individuals shows that the mature stage begins only after at least two years.

Migration

In the cold and temperate countries, bats change their roosting places often and regularly during their annual cycle. These movements are important, being associated with hibernation and sexual behaviour. In India, insectivorous bats are quite sedentary and no movements were noted for any species; it is different with *Rousettus leschenaulti,* and perhaps the other fruit bats too. *Rousettus* certainly has very definite movements and their appearance at, and disappearance from certain places at regular intervals is well known. Unfortunately, no information is available regarding the direction of their migration or the biological significance of their travels.

At *Elephanta*, the colony is formed in February, the males arriving first; on 11 February 1960 there were some 500 individuals. A little later the females arrive for their first parturition, which takes place at the end of March. At the end of October the colony migrates, and during November, December, and January the cave is devoid of this species, except for the few juveniles referred to earlier. My observations in 1959 and 1960 confirm those of Humayun Abdulali at the same place almost 20 years ago (*J. Bombay nat. Hist. Soc.* **47** : 522-526).

The colony at the railway tunnel at *Khandala* does not exist today, but Bro. Navarro's notes indicate that movements similar to those observed at Elephanta were noted here for several seasons some 20 years ago.

Food

McCann (*J. Bombay nat. Hist. Soc.* **41** : 805) lists the fruits eaten by this species.

General

There is no evidence of this species hibernating. Artificial cooling with a considerable fall of the internal temperature produces in it a torpid condition, but this is, I think, due to bad thermal regulation and there is no indication of a hibernatory tendency. In fact, the individuals experimentally cooled do not survive and the torpid state is probably due to enervation and intoxication (Brosset, *Mammalia*—L'hibernation chez les Chiroptères Tropicau—December 1961).

Many of the diurnal haunts are old monuments of archaeological interest. With the growing number of tourists, the managements have

Cynopterus sphinx resting in aerial roots of a banyan
(The arrow shows the bats)

Colony of *Rousettus leschenaulti*

(Photos : A. Brosset)

Colony of *Rhinopoma hardwickei*

Colony of *Rhinopoma microphyllum*

(*Photos* : *A. Brosset*)

been induced to drive away the bats (e.g. at Elephanta in 1961). As there is no doubt that their smell and droppings are unpleasant to the average tourist, we presume that these roosts will in due course be closed to them.

In some cases, the presence of *Rousettus* is a nuisance to industry. At the reversing station at Khandala, the steel pipes were deeply corroded by the acidity of their droppings and constructional work of some extent had to be undertaken for their exclusion.

Though often troublesome in its diurnal haunts, it feeds largely on forest berries and wild figs in the wilder parts of the country and is probably not so destructive to fruit gardens as the Flying Fox.

Genus *Pteropus*

Pteropus giganteus (Brunnich 1782)

This species is unmistakable and well known and measurements are not necessary. In spite of its large size and the fact that colonies are situated in the middle of towns and villages, the biology of the species is not at all well known. The present paper does not add very much information as I gave little attention to this species.

General Distribution

In Ceylon and peninsular India, it is widely distributed. In western and central India, it is very common and found all over.

Diurnal Haunts

During the day, this bat lives in colonies in large trees of different species. It has been seen in bamboo clumps also. No particular ecological conditions appear to be required; it was seen in dry and humid areas, and from sea-level to the top of the Ghats. A remarkable and very noticeable feature about its diurnal roost is its constant association with man. Colonies are always found in towns and villages and never in the forests or in the fields. Several colonies exist in the centre of Bombay, one of the most crowded towns in the world. In Gujarat, I saw a colony up in a tree alongside a noisy railway station and constantly troubled by the smoke from the engines. In spite of this apparent attraction for man, the animal is wary and the whole colony will fly away as soon as a man attempts to climb the tree.

Nocturnal Territory

They cover immense territories. Individuals from the colonies in Bombay fly several miles across the sea to Alibag and other places along the coast. About 20 minutes after sunset, the flying foxes leave their roosts one by one and at this time long lines consisting of individuals, all following one another in the same direction, may be seen. The same route is followed regularly, and from my flat in Bombay, I could see large numbers fly past at the level of my verandah (5th floor), at the same time and in the same direction, every evening. Like *Rousettus*, the *Pteropus* is helped in its search for fruit by a good memory for places, as also the noisy behaviour of other bats feeding on the trees.

Field Characters

When roosting in trees, the large size together with the continuous and loud noises make this species unmistakable. During the day, often with no apparent disturbance, individuals leave their roosts, fly around, and return. They seldom appear to be sleepy but are often busy fanning themselves with their half-open wings. McCann has suggested that this flapping is by the male to attract the female. This may be true, but it also seems to be in connection with the personal comfort of the bat which appears to fan itself during the heat. It is in fact doubtful that only males flap their wings for I have seen individuals, carrying young, performing the same action. Dobson and Prater have given good descriptions of the behaviour of this giant bat and those interested are invited to refer to their works.

Nocturnal Flights

The strokes of the wings are ample and slow, similar to those of the Buzzard. The flight is pitching, with occasional glides, which at first sight appears clumsy but is really faster than it seems.

Reproduction

Reproduction of the flying foxes in western India has been studied by Moghe, who found spermatozoa in the lumen and uterus in late August and early September. The pregnancy period is believed to be 140 to 150 days, parturition taking place in early February. In May, we saw half-grown young carried by their mothers. It is almost certain that the periodicity of the reproduction cycle is very regular and that only a single parturition takes place every year, at least in western India.

Migration

Not known, but migration is probable.

Hibernation

The species is always active and the question of hibernation must be excluded.

Association with Man

The flying fox is a great nuisance and often does considerable damage in gardens, especially to mangoes. The loud screaming noises which it makes must also be troublesome in the vicinity of the colonies.

Although these bats are eaten in many parts of the world, they are not regularly hunted.

Live individuals are often sold on the Bombay market as a supposed cure for rheumatism. The skin removed immediately after the animal is killed is applied to the ailing part of the human body and this, according to people who have the belief, offers an efficacious cure.

Genus *Cynopterus*

Cynopterus sphinx Vahl 1797

Measurements (in mm.):

		Localities						
		Hampi △ ♂ ad.	Belgaum △ ♀	Hampi △ ♂ juv.	Vedtial △ ♂ ad.	Anand □ ♂ ad.	Khandala □ ♂ ad.	Anand □ ♂ ad.
	Forearm	75	67	71	72	71	69	73
2nd finger	Metacarpal	30	25	28	29	30	27	31
3rd finger	Metacarpal	50	42	44	48	44	43	49
	1st Phalange	38	28	30	30	30	29	32
	2nd Phalange	43	35	40	43	46	44	49
4th finger	Metacarpal	47	38	40	44	43	39	43
	1st Phalange	25	23	23	24	25	23	24
	2nd Phalange	27	22	24	28	27	29	32
5th finger	Metacarpal	49	39	41	45	43	44	47
	1st Phalange	24	20	21	20	20	21	21
	2nd Phalange	24	19	23	22	22	23	24
	Tarsus	28	24	27	28	29	27	30
	Tail	12	15	15	12	13	15	15

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Adult ..	34	20	27	12	13
Young ..	27	17	21	9	11

Description

The dog-shaped head, the short ears with a white margin, and the divergent openings of the nostrils are unmistakable characteristics of this relatively small frugivorous bat.

Adult Male. The underparts are yellowish sometimes tinged with olive, the upper parts bright rufous. Such brightly coloured males represent on an average 25% of the individuals in the various colonies.

Females and Juveniles. Uniform yellowish grey, darker in the young. The females are sometimes as richly coloured as the males.

This bat is smaller but heavier than *Rousettus leschenaulti.* However, the young of both species are very similar and confusion can easily arise, particularly because the dentition of *Cynopterus* and young *Rousettus* is alike. The distinctive shape of the skull is also attained only after one year. In the young—6 to 8 months old—it is smaller and quite different in shape from that of the adult (cf. Table of measurements).

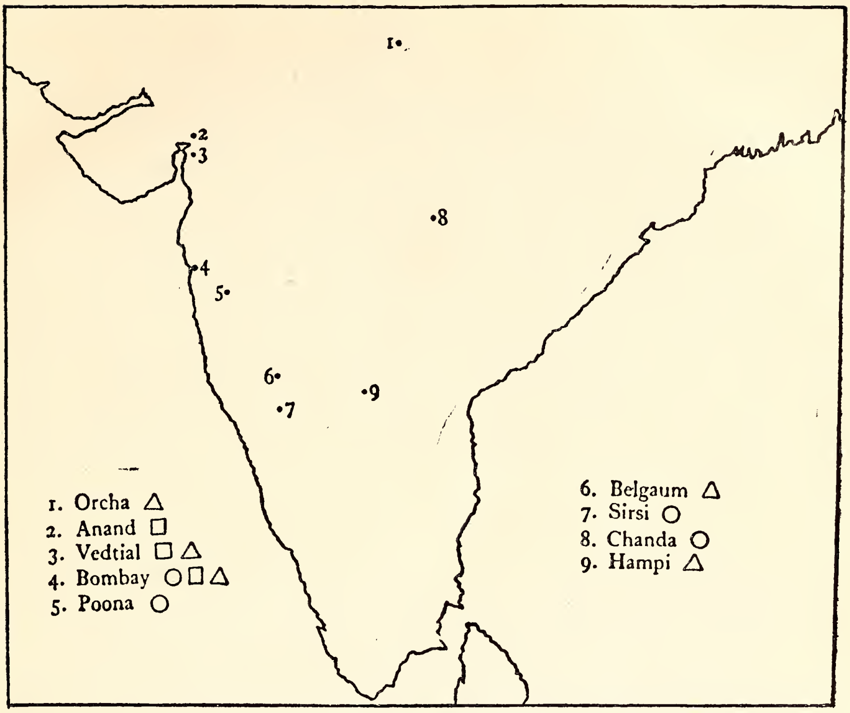
The smell of *Cynopterus* is mild. The bat carries numerous parasites.

General Distribution

Hainan, peninsular India (widely), Burma, Indo-China, Siam, Sumatra, Java, Bali, Timor.

Distribution in western and central India

A very common species found all over the area and in all sorts of biotopes.



Map 3. Localities where *Cynopterus sphinx* were studied

The Diurnal Biotope

TABLE OF DIURNAL BIOTOPES OF *Cynopterus sphinx*

Place	Period of the year	Size of Colony	Number of Specimens captured	Nature of biotope
Bombay	Aug.-Sep.	6-10	none	Flying away at sunset from the crown of a palm tree
do.	May	?	do.	do.
Khandala	February	?	do.	In a deep forested ravine; one individual flew away from *Ficus* (sp. ?) when a shot was fired under it
Bombay	August	?	do.	Two individuals flying away at sunset from a palm tree
Vedtial	December	8	6	In the aerial roots of a big Banyan (cf. Plate I)
Wadgaon	May	6-10	none	do.
Orcha	March	?	2	Under the roof of a deserted palace
Hampi	October	?	6	Under the bark of a *Ficus*

Like *Pteropus*, this species is arboreal but, while flying foxes expose themselves during the day, *C. sphinx* conceals itself and its roosts are difficult to find. It appears to have a preference for palm trees, hanging itself very high up at the base of the leaves. The colonies can be detected only by traces of their droppings or when they leave the roost at sunset. Banyans and other *Ficus* trees are also used, particularly when palm trees are not available in the vicinity. The species is therefore seen in different positions: encrusted against the aerial roots of the banyan, under the bark of trees, or simply hanging against a trunk or a branch. In all cases it is extremely well protected by its colour and is difficult to see. There are a few records of the species living in old buildings, and I have seen several in a deserted palace in Orcha, but such haunts are exceptional.

Nocturnal Territory

These bats were seen on trees with ripening fruits in heavy forests, in cultivated areas, as also in the midst of large cities.

They take to wing early in the evening, well before it is quite dark. Several individuals may feed together on the same fruit trees, but their visits to flowers appear to be solitary. In Bombay City, I had excellent opportunities of observing their visits to flowers in gardens well illuminated by electric lights. The bat did not settle on the flower but maintained itself in the air by swift wing-beats reminiscent of Sphyngid moths. It passed from one flower to another very swiftly and the same individual was seen exploring a group of flowers for more than an hour.

As stated above, when this species meets the other Megachiroptera on the larger fruit trees, its feeding territory is in the lower part of the tree.

McCann and Navarro have observed individuals flying away with a fruit in the mouth and settling high up on a palm tree where it was eaten. This bat can therefore be considered as responsible for seed dispersal.

Field Characters

During the day, a small fruit bat concealed in a tree is always a *Cynopterus*. The bright colour of the adults is another confirmation. At human approach the animal keeps silent and motionless but flies away when very closely approached. If captured, it emits a strong and peculiar cry. On the wing, *Cynopterus* appears smaller and faster than *Rousettus*.

Reproduction

I have no personal observations.

S. A. Vamburkar collected females in late pregnancy at Poona on 7 February 1956. The young specimens taken in North Kanara and Ceylon, whose skins are in the Bombay Natural History Society's collection, were probably born in March. It is however interesting that young probably born in September also exist in this collection. Like *Rousettus leschenaulti*, this species may have two periods of parturition in a year, one at the beginning of spring and another later. Moghe found young attached to the breast of the mother in July. He states that the period of gestation is 115 to 125 days.

Social Life

This species is not social.

Intra-specific Association

Males and females were found together in colonies observed at Hampi and Vedtial. Such colonies are probably always small, varying from two to a dozen individuals.

Inter-specific Association

C. sphinx does not associate itself with any other species.

Hibernation

Very improbable. All individuals seen were very active.

Association with Man

The species is probably a useful agent for pollination and seed dispersal. Wild figs, chikoos, and berries and fruits of many wild plants of no value are eaten. Around Bombay it is very destructive to chikoos. As it is silent and lives in trees, its presence is perhaps never a great nuisance. Nevertheless, Prater and several earlier authors have expressed the opinion that this species is a pest in gardens. Opinions may perhaps vary according to the locality in which it occurs.

Suborder MICROCHIROPTERA

Family Rhinopomatidae

Genus *Rhinopoma*

Rhinopoma hardwickei Gray 1831

Measurements (in mm.):

		Localities							
		Ahmedabad △ ♀	Vedtial □ ♂	Anand □ ♀	Badami △ ♀	Hampi △ ♀	Hampi △ ♂	Anand □ ♀	Badami △ ♀
	Forearm	57	58	63	57	59	57	62	60
2nd finger	Metacarpal	40	40	42	40	41	40	42	40
	Phalange	8	8	8	8	8	8	8	7
3rd finger	Metacarpal	41	41	43	40	40	39	42	42
	1st Phalange	8	8	9	8	9	9	10	9
	2nd Phalange	17	17	19	19	18	17	18	19
4th finger	Metacarpal	35	35	36	33	33	34	34	33
	1st Phalange	12	12	13	12	13	12	13	12
	2nd Phalange	11	11	12	10	10	10	10	10.5
5th finger	Metacarpal	37	38	41	39	39	38	37	39
	1st Phalange	12	12	12	12	12	12	12	12
	2nd Phalange	11	10	11	9	9	9	11	9
	Tarsus	28	25	30	29	29	29	28	27
	Tail	60	60	65	65	64	64	65	67

The skull measurements are as follows:

Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
18.5	11.3	12.6	7	8.5
18	11	12.5	7	8

Description

In the genus *Rhinopoma,* the tail is very long and slender, projecting three-fourths of its length beyond the uropatagium (Plate II). The muzzle is snout-shaped and these two very distinctive characters make it easy to identify a *Rhinopoma.*

The difficulty is to separate *Rhinopoma microphyllum* from *R. hardwickei.*

In the hand, *microphyllum* always shows a longer forearm with an average of 70 mm. against 60 mm. only in *hardwickei*. In the former species, the tail is shorter than the forearm and longer in the latter. Finally, the skull of *microphyllum* is always noticeably larger.

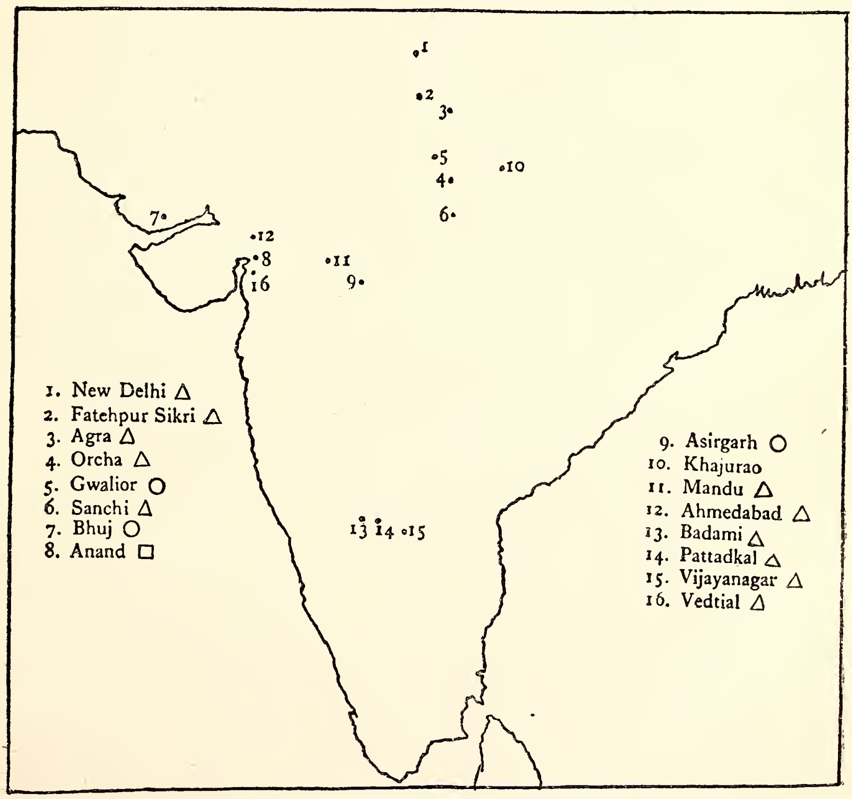
General Distribution

India, Pakistan, Lower Siam, Afghanistan, Arabia, Persia, Egypt and Sudan. Perhaps also the Sahara.

Distribution in western and central India

The distribution of the *Rhinopomas* in Africa and in Asia is associated with the xerothermic conditions being found in dry and semi-desert countries.

In western India, they are completely absent from the Ghats, the Konkan and Kanara, which are more or less forested and with heavy rainfall. Even the western parts of the Deccan (Poona, Aurangabad, Ajanta) are not inhabited by *Rhinopoma*, but bats of this genus are common in the north of Gujarat, the north of Madhya Pradesh and the north of the Mysore State. They are also known in Nagpur.



Map 4. Localities where *Rhinopoma hardwickei* were studied

The Diurnal Biotope

TABLE OF DIURNAL BIOTOPES OF *Rhinopoma hardwickei*

Locality	Date of observation	Size of colony	Number of specimens captured	Nature of biotope
Ahmedabad	November & June	70-80 in Nov. 25-30 in June	23	Dada Hari Well—a Moghul well with subterranean retreats
Ahmedabad	November	10-15	none	On the ceiling of a mosque
Badami	October	6 colonies of 5-40 individuals each	5	Colonies dispersed in old temples
Pattadkal	October	3 colonies of 10-30 each	2	Old temples, specially in the dark passages around shrines
Vijayanagar	October	80 colonies from 2 to 30 individuals each	3	Very numerous colonies in ruins of this ancient capital
Vedtial Anand Amod Chaklasi	December, April	Small colonies of 2-5 individuals	5	In inhabited houses in Gujarati villages (observations of Navarro and the author)
Mandu	February	4 individuals	1	In the 'Hindola Mahal' ruins of Mandu
Sanchi	March	15-20	14	Small underground recesses close to the Great Stupa
Orcha	March	?	3	In the underground recesses of deserted palaces—in association with *Rhinopoma microphyllum*
Khajurao	March	Isolated individuals	2	In old temples
Fatehpur Sikri	April	?	1	Several small colonies in dark rooms. Individuals observed in the very big colony of *Rhinopoma microphyllum* in the underground recesses.
Agra	April	Several colonies of 8-10	6	In dark rooms of the fort
Tuglakabad	April	?	1	In the underground portions of the fort. Associated with hundreds of *Rhinopoma microphyllum*.

This species is eclectic in its choice of diurnal haunts. The biotope may be wide or small, dark or well lighted. Proximity of humans is tolerated. In Gujarat, where all species of animals are protected by man, they live in houses and during the day keep themselves on the smoky walls of living rooms.

Unfortunately, no observations were made on its hunting territory. The flight is weak and it may be presumed that *Rhinopoma hardwickei* only hunts in the immediate proximity of its diurnal haunts.

Field Characters

The biotope of this species is impregnated with its unmistakable smell which indicates its presence before a single individual is seen.

Two different resting positions were noticed. It affixes itself to a wall with its forelimbs and is most frequently seen in this position (see Plate II). It also hangs from ceilings by its hindlimbs as the *Rhinolophus* does. At the approach of an intruder, the *Rhinopoma* nervously waves its free and very long tail. In silhouette, the bat is slender. The *Rhinopoma* has very long forearms and short fingers. These anatomical characters make them poor fliers. In its diurnal haunts, the *Rhinopoma*'s flight is slow and awkward.

Food

Remains of Diptera were seen in its guano. The teeth are weak and only fit for the mastication of small and soft insects.

No young were seen in October, November, December, February, March, or April. Females dissected in March or April had no foetuses. The colony at Ahmedabad seen in June consisted apparently only of males (16 examined). From these negative observations, we can infer that pregnancy and birth takes place between the end of April and the end of September, June being the time of parturition. The existence of young obviously born in June, in the B.N.H.S. collections, supports this deduction. Reproduction, however, appears to be very restricted.

The false dugs of old females are well developed and the young are undoubtedly carried by the mother in an inverted position as in the horseshoe bats.

I had the opportunity of seeing 2 *Rhinopoma* in a furious battle. While visiting a mosque at Ahmedabad in November, loud calls from the ceiling drew my attention to 2 individuals fighting with their forearms and biting each other in the manner of dogs. Not far away on the same ceiling, a third individual was settled and holding itself aloof.

Social Life

Rhinopoma hardwickei is a sociable species which gathers in small colonies—the largest seen was about 75 individuals. Usually, only 4 to 10 of these bats live together in the same diurnal biotope. But, the social group is in reality larger, because several small colonies are close to each other and constitute scattered elements of the same population. Thus, in the ruins of Vijayanagar I saw more than 80 colonies of this species in almost all of the monuments of this old capital. Possibly, we have here a single society of bats dispersed in many small groups. This type of grouping is rare in bats, but in India we have another example in the Emballonuridae, *Taphozous kachhensis.*

Sexual Segregation

In western India, the colonies are unfortunately far from Bombay, and it was difficult for me to follow regularly the behaviour pattern over the whole annual cycle. Nevertheless, two censuses made in different colonies showed that both sexes lived separately:

Sanchi, 23 March 1961—14 captures, all females.
Ahmedabad, 29 June 1961—16 captures, all males.

More observations are required to prove definitely that sexual segregation is the general rule in this species. It is hoped that Indian mammalogists residing in the north, where the species is common, will bring new observations on this problem.

Inter-specific Association

It is a well-known fact that in the desert areas of Asia and Africa, two species of *Rhinopoma*, one big and one small, live side by side in the same colonies. In India, this rule is also respected. North of the Tropic of Cancer, where two species of *Rhinopoma*, one small and one big, exist, they associate regularly in the same biotopes, a constant inter-specific attraction existing between *Rhinopoma hardwickei* and *R. microphyllum.*

South of the Tropic of Cancer only *Rhinopoma hardwickei* was observed. This species, however, showed a sociable disposition and its colonies are regularly mixed with other species, e.g. *Taphozous kachhensis, Taphozous melanopogon, Taphozous longimanus,* and *Hipposideros speoris.*

Hibernation

It seems that the *Rhinopoma* never hibernate. In the course of these studies, I never met any of these bats in a state of torpor. The mammalogical literature available to me does not mention hibernation in the genus *Rhinopoma*. Nevertheless, it is certain that these species have cycles of extended rest, during which they live on their biological reserves and do not hunt. In several places (Mandu and Ahmedabad) I had the opportunity to observe individuals staying in their diurnal haunts even during the night. One of these bats dissected in Ahmedabad had nothing in the digestive tube. I believe that such periods of rest are for the utilization of the enormous quantities of fat that certain individuals show at the base of the tail and in the uropatagium. In fact, the *Rhinopoma* seen resting during the night in the diurnal haunts were in all cases excessively fat. We shall see that other species show the same characteristics.

The Indian bats would have two different physiological processes which allow them to overcome periods of rest without food:

1. Normal hibernation: Vespertilionidae and Rhinolophidae.
2. Fat reabsorption: *Rhinopoma* and *Taphozous*.

It seems that the fattening of *Rhinopoma hardwickei* is a seasonal phenomenon. In November 1960, all the individuals observed in Ahmedabad were extraordinarily fat, the weight of the fat in many of them being equal to the weight of the rest of the body. In June 1961, at the same place, the 16 individuals captured were all thin. In February, in Mandu, one specimen dissected by me was moderately fat; those of Sanchi at the end of March were normal, neither fat nor thin. In NW. India, the reserve of fat would be formed in October at the end of the monsoon, when the insect food is plentiful. Progressively, these reserves are utilized during the winter and in spring, and the whole reserve of fat disappears in May-June.

We also noticed that the cycle of fattening varies in different geographical areas. Thus, in November 1960 the bats at Ahmedabad were extraordinarily fat and, at the same time, individuals of the same species 1000 km. to the south at Badami were normal with no reserves of fat.

I noticed also that another species *Taphozous kachhensis*, which has the similar capacity of accumulating fat but at the base of its tail, possesses exactly the same cycle of reserves. The individuals of the northern part of India are extraordinarily fat at the end of autumn, while at the end of spring all of them become normal. We saw that in October/November, *Rhinopoma hardwickei* were very fat in Ahmedabad and normal in Badami. Exactly, the same observation was made on *Taphozous kachhensis* in both places at the same time. These remarks prove that the fattening of these bats is under the influence of geographical factors.

Association with Man

While useful in destroying insects, the *Rhinopoma* are on the other hand a source of annoyance to the tourists visiting certain monuments where their smell is spread all over. Their guano and urine had certainly spoiled the frescoes of some of the old temples at Badami in north Mysore.

Rhinopoma microphyllum Brunnich 1782

Measurements (in mm.):

		Localities							
		Anand □ ♂ No. 97	Fatehpur Sikri △ ♀	Fatehpur Sikri △ ♂	Sanchi △ ♂	Fatehpur Sikri △ ♂	Gwalior ○ ♀ No. 675	Bhuj ○ ♂ No. 1768	Asirgarh-Nimar ○ ♂ No. 650
	Forearm	68	71	67	70	69	70	69	70
2nd finger	Metacarpal	46	46	45	45	47	45	46	47
	Phalange	5	5	5	5	4	4	4	4
3rd finger	Metacarpal	46	46	46	45	47	47	47	49
	1st Phalange	9	10	10	11	11	11	11	12
	2nd Phalange	20	19	19	19	20	18	18	19
4th finger	Metacarpal	38	39	39	37	39	39	37	39
	1st Phalange	14	16	16	16	15	16	16	17
	2nd Phalange	10	11	11	12	12	11	14	13
5th finger	Metacarpal	47	44	44	45	45	44	44	45
	1st Phalange	14	12	12	12	11	11	12	12
	2nd Phalange	8	10	10	10	8	8	10	9
	Tarsus	24	26	25	27	27	25	25	26
	Tail	65	48	48	60	55	65	50	50

The skull measurements are as follows:

Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
20	12	14	7	9
19	12	13	7	9

Description

Great variations of colour were noticed in this bat. They are of three main types:

Grey, more or less dull.

Tawny.

Reddish-brown.

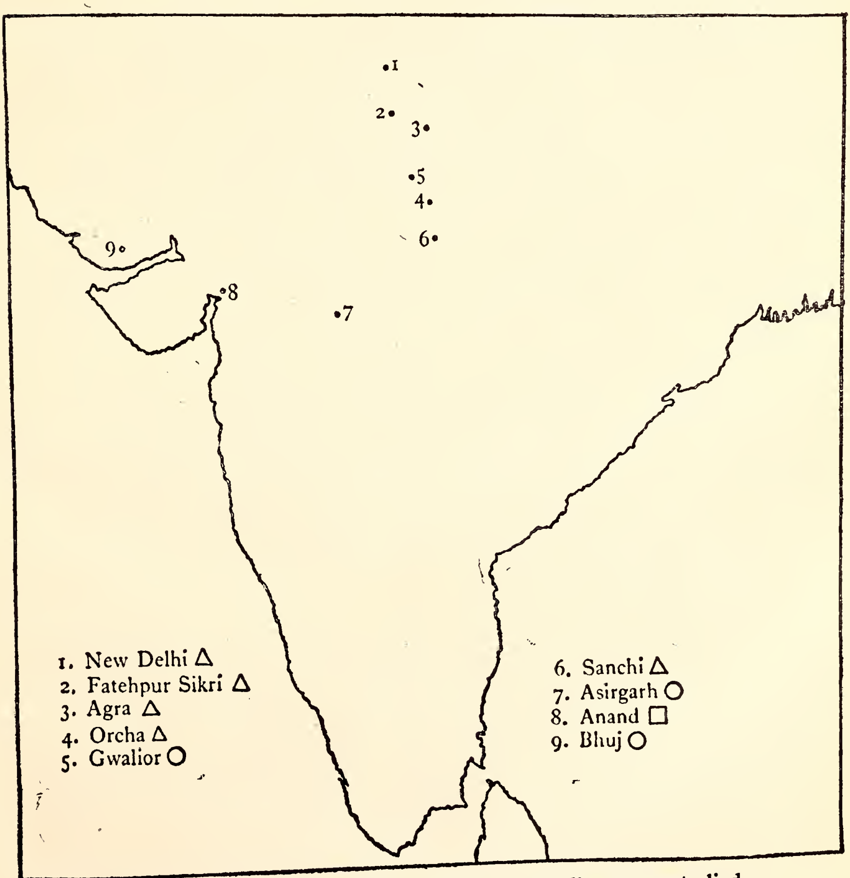
These types can be seen in individuals of the same colony and are individual variations with no systematic value.

This species was previously named *Rhinopoma kinneari* wrongly, but Aellen has recently shown that *kinneari* is conspecific with *microphyllum*.

Distribution

From Senegal to India, and in all arid and desert-like countries between the Tropic of Cancer and the 35th parallel.

R. microphyllum inhabits northern India, Rajasthan, Kutch, the northern part of Gujarat, the Punjab, the north-western part of Madhya Pradesh and Uttar Pradesh.



Map 5. Localities where *Rhinopoma microphyllum* were studied

Ecology

TABLE OF DIURNAL BIOTOPES OF *Rhinopoma microphyllum*

Locality	Size of colony	Number captured	Date of observations	Nature of biotope
Sanchi	10-12	2	End of March	Small underground caves near the Great Stupa
Orcha	1000-1500	8	do.	In old palaces, two colonies under roofs, one underground
Tuglakabad (New Delhi)	2000-3000	*c.* 30	April	In undergrounds of the fort
Fatehpur Sikri	2000-3000	10	do.	Undergrounds of the deserted capital

We crossed over the north of India in March and April 1961. This species was common there and we were able, during this short time, to collect some data on its ecology.

Nevertheless, more complete studies of their biological cycles remain to be worked out.

In Sanchi, scattered individuals were seen in a small area underground. In the other places, there were huge colonies in large undergrounds, where many rooms communicated with each other. (See Plate II). These artificial cavities are very dry. The guano and the extraordinary smell of these bats make it almost impossible for a human being to go there.

The nocturnal flight was not observed. But we can presume that, in accordance with its very short wing, *Rhinopoma microphyllum* is a weak flier.

Field Characters

It is difficult to separate *Rhinopoma microphyllum* and *Rhinopoma hardwickei* in the field. The difference in size cannot always be appreciated. It is the shape of the tail which is the best field character. The free tail is very slender and long in *hardwickei*, shorter and thicker in *microphyllum*. This character permits separation of the two species seen side by side.

Reproduction

In the first few days of April at Tuglakabad, Orcha, and Fatehpur Sikri, males and females were found mixed together. It was the period of rut, for in fact the sexual organs of both the sexes were more or less turgescent. Three females were dissected—one had a foetus just visible. The parturition probably takes place in June.

Intra-specific Association

Colonies of over 1000 individuals were seen in old monuments. These consisted of large numbers of individuals closely pressed together on the ceiling with a crowd of scattered individuals all round. Thus, the social life of *microphyllum* is different from that of the closely allied species *hardwickei*. The swarms in Tuglakabad and Fatehpur Sikri were not inside the undergrounds, but on well lighted arches close to the entrance. At the approach of an intruder, the swarm breaks up and the bats take shelter in the deeper parts of the undergrounds.

Inter-specific Association

This species is always mixed with *R. hardwickei*. It also associated with some other bats of the genus *Taphozous*, e.g. *T. melanopogon* in Orcha and *T. kachhensis* in Tuglakabad and Fatehpur Sikri.

Family EMBALLONURIDAE

Genus *Taphozous*

Taphozous perforatus Geoffroy 1818

Measurements (in mm.):

		Localities							
		Mehmadabad □ ♀ No. 196	Mehmadabad □ ♂ No. 214	Ahmedabad △ ♂	Ahmedabad △ ♀	Ahmedabad △ ♂	Ahmedabad △ ♂	Ahmedabad △ ♂	Ahmedabad △ ♂
	Forearm	60	59	60	61	63	63	60	60
	1st finger Metacarpal	51	51	50	51	54	51	50	50
3rd finger	Metacarpal	53	53	52	53	57	55	52	52
	1st Phalange	22	19	20	20	21	19	18	19
	2nd Phalange	25	23	24	25	26	25	22	24
4th finger	Metacarpal	41	42	41	42	42	45	41	41
	1st Phalange	12	12	12	12	13	12	12	12
	2nd Phalange	8	8	8	9	9	9	9	9
5th finger	Metacarpal	33	34	33	32	35	34	33	32
	1st Phalange	12	12	12	12	12	12	12	13
	2nd Phalange	8	10	9	8	9	9	9	9
	Tarsus	24	24	24	25	25	25	24	23
	Tail	21	29	26	30	25	25	25	26

The skull measurements are as follows:

		Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Ahmedabad	..	20	11	16	8	10
Ahmedabad	..	20	11	15	8	10

Description

Several species of Indian *Taphozous* have a very similar morphology. They are: *Taphozous melanopogon, Taphozous longimanus, Taphozous theobaldi,* and *Taphozous perforatus.* The skulls of these species are practically the same except of *theobaldi,* which is the same shape, but slightly bigger. It is difficult to separate specimens of these *Taphozous,* specially the females, and many mistakes can be seen in the collections concerning the arrangements and identification of bats of this difficult genus.

One can identify *T. perforatus* by the following characters:

1. The size is slightly but consistently smaller than in *melanopogon* and the forearm slightly bigger than in *longimanus* (see Table of Measurements).
2. The colour of the fur is pale grey below and duller on the back instead of dark brown to sandy grey in the other species.
3. The adult males and females are all of the same pale colour. The male has no beard as in *melanopogon,* and the gular sac so well developed in *longimanus* is not very visible in *perforatus.*
4. The tail is slenderer than in the other *Taphozous.*

This species has a weak but distinctive smell unlike the strong one in *longimanus.* During the autumn (November—Ahmedabad), the individuals collected were extraordinarily fat like the *Rhinopoma* and *Taphozous kachhensis,* but the fat is concealed under the heavy skin and not externally visible as in the previous species.

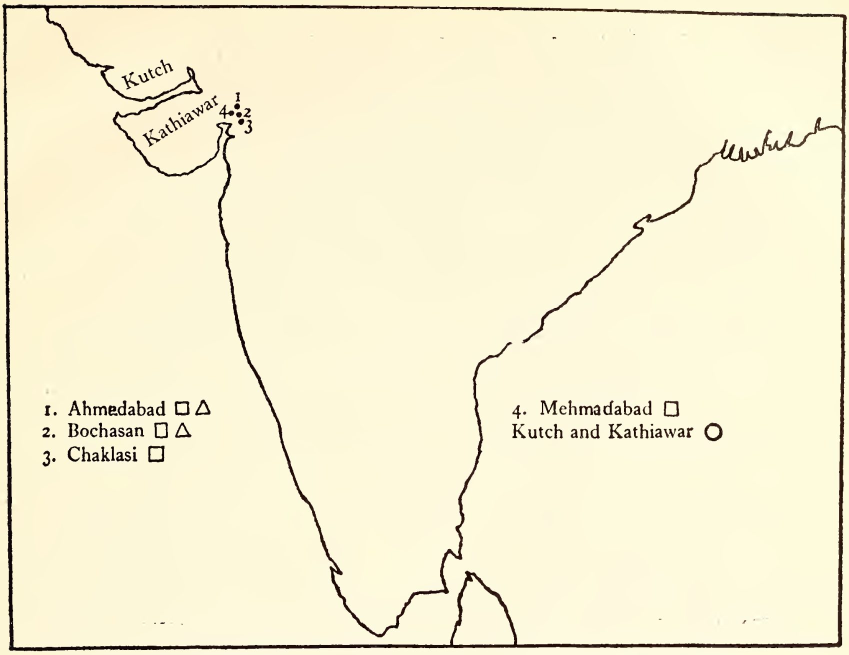
General Distribution

This species has a wide distribution over the arid and desert parts of eastern Africa and western India.

Distribution in India

In the zoological literature only Kutch and Kathiawar are mentioned, but Navarro and I have seen this species in Ahmedabad and some other places in northern Gujarat (see map).

In the eastern and southern parts of the above region, *Taphozous perforatus* disappears and its ecological place is occupied by the closely allied *Taphozous melanopogon.* The two species have never been seen living side by side. Where *perforatus* occurs, there are no *melanopogon* and vice versa.



Map 6. Localities where *Taphozous perforatus* were studied

Ecology

TABLE OF DIURNAL BIOTOPES OF *Taphozous perforatus*

Locality	Date of Observation	Size of colony	Number captured	Nature of biotope
Ahmedabad	November and June	2000 to 3000 in November 400 to 500 in June	65 in Nov. 7 in June	In November, a very huge colony in one mosque in the middle of the town. In June, several colonies in mosques and monuments.
Ahmedabad	November, December and June	Few individuals	7	In the Dada Hari Well (Colony also observed by Navarro 20 years ago)
Villages around Anand	December	Few individuals	2	In the inhabited houses—mixed with colonies of *T. kachhensis* (Observations made with A. Navarro)

In all cases, the diurnal haunts are in man-made constructions. These are not ruins, but monuments in good condition, not completely dark and where human beings are almost continuously present.

The biggest colony is situated in the middle of the large city of Ahmedabad.

Field Characters

This is a noisy species, very shy, and flies away at the least alarm and thus difficult to capture. The flight is fleet and swift. The type of the biotope, the social life, and the general appearance is the same as in *T. melanopogon* and it is not easy to separate them in their diurnal haunts.

Reproduction

A single young in May. On 15th June in Ahmedabad, hundreds of females were seen carrying young about 35 days old.

Intra-specific Associations

No segregation of sexes has been noticed. In Ahmedabad, where 72 individuals were captured, both sexes were seen in the same colonies. The species seems highly gregarious, although we saw small groups of 2 to 5 individuals mingling with other species.

Inter-specific Associations

Regularly, we saw this species associated with *Taphozous kachhensis*. Food, hibernation, and displacements have not been observed. Generally speaking, we need more information on this species, which appears restricted to the north-western part of India.

Taphozous melanopogon Temminck 1841

Measurements (in mm.):

		Localities						
		Chikalda △ ♂	Kanheri △ ♀	Chikalda △ ♂	Kanheri □ ♂	Kanheri □ ♂	Kanheri □ ♂	Kanheri □ ♀
	Forearm	65	69	65	65	63	67	63
	2nd finger	54	54	54	54	54	55	52
3rd finger	Metacarpal	60	58	57	57	57	60	54
	1st Phalange	22	22	20	20	22	23	22
	2nd Phalange	22	22	22	25	22	26	26
4th finger	Metacarpal	47	51	48	45	44	46	41
	1st Phalange	13	14	14	14	14	14	14
	2nd Phalange	9	9	9	8	8	8	8
5th finger	Metacarpal	35	40	37	37	35	37	33
	1st Phalange	12	14	13	14	13	13	13
	2nd Phalange	8	9	9	8	9	9	8
	Tarsus	26	28	24	25	24	27	24
	Tail	29	38	27	29	27	27	27

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower denta row
Kanheri ..	21.5	12.5	16	9	11
Mandu ..	21	12.5	16	9	10
Badami ..	21	12.5	16	9	10

Description

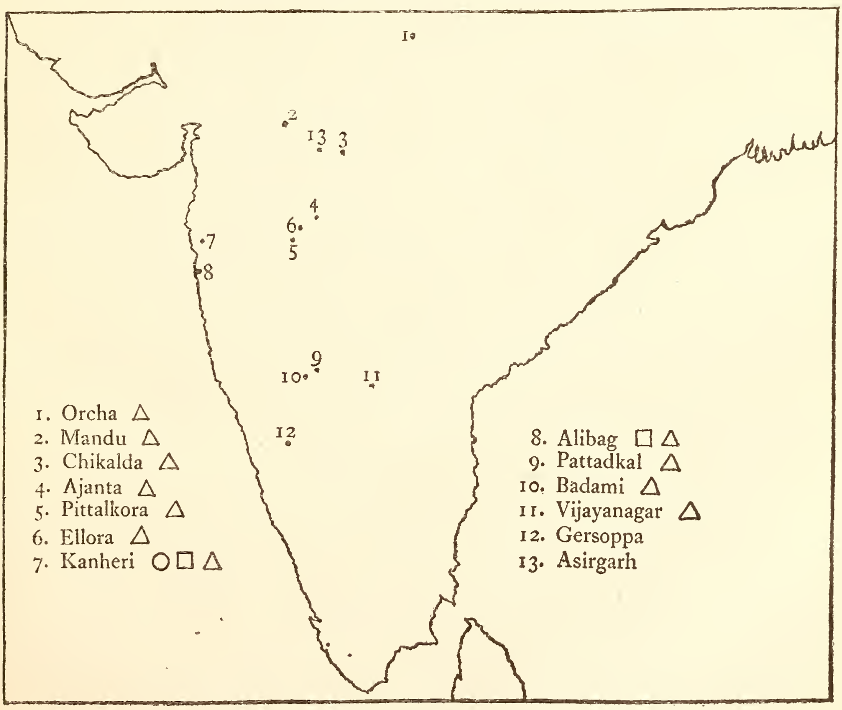
Polymorphic species, which appears variable in size and colour. These variations are in connection with sexes, age, and seasons.

Adult male. Sandy-yellowish grey, darker in summer and autumn. A black beard of long and thick hair under the chin.

Adult female. Fur brown, more or less reddish. No beard.

Young. Fur darker than that of the adults—dull grey, and similar in both sexes. In the young male, the beard appears at the age of 5 or 6 months. This beard is less thick and less black than in the adult.

This species has no gular pouch. But at the period of the rut small glands under the chin of the male produce a thick secretion which runs over the beard. The tail is rather thick and at its end is a slight swelling. There is only a weak specific smell. The other characters are the same as in the other *Taphozous*.



Map 7. Localities where *Taphozous melanopogon* were studied

General Distribution

Approximately Java, Malay States, Sumatra, Borneo, Laos, Indo-China, Yunnan, peninsular India.

Distribution in western and central India

A common species met in several places during this survey: Konkan, Deccan, mountain ranges of central India, north Mysore, and Madhya Pradesh. In the northern part of Gujarat, the closely allied species *T. perforatus* occupies the ecological niche of *T. melanopogon*. We saw no individuals at an altitude of more than 800 m. (Chikalda). The hills and rainy ranges of the Ghats also do not seem suitable for this species.

The Diurnal Biotope

It would appear that large vertical faults of the cliffs are the primitive biotope of this species (cf. my observations in Badami and Pittalkora). Later, *Taphozous melanopogon* adapted itself to the anthropic habitat, specially the ruins and the hypogean temples of large size. These diurnal biotopes have in common, numerous dark rooms with high ceilings. Human presence does not bother these *Taphozous*, even if often disturbed by man as in Kanheri and Ellora.

Taphozous melanopogon is a very sedentary species, which occupies the same haunts during the whole year. It seems, according to regular observations of several individuals bearing rings in Kanheri, that each individual possesses a special place—always the same in the colony. For instance, a ringed male was met about ten times consecutively during 4 months sitting exactly in the same prominence of rock. Its immediate neighbours, on the left and on the right, were also two adult males, regularly present at the same place. We shall see in the following pages that the places occupied by these *Taphozous* in their colonies seem determined by a special social hierarchy.

TABLE OF DIURNAL BIOTOPES OF *Taphozous melanopogon*

Locality	Period of Observation	Size of colony (estimated)	Number captured	Nature of Biotope
Kanheri Caves	The whole year	180-200	35-40	Chaitya No. 3—Buddhist Caves in hilly and forested country
Alibag	May	1000-2000	8-10	Natural cave in hilly and forested country
Chikalda	December	3000	9	Three different colonies in the ruins of an enormous fort
Badami	October	2000-3000	3	Several colonies in hypogean temples and large vertical faults in the cliffs
Pattadkal	October	150-200	2	In a temple—in a flat and cultivated area
Pittalkora	August	1000-2000	10	In the hypogean temples and big vertical faults of cliffs—(hilly country)
Ellora	March and August	3000-4000	15-10	Three big colonies—in the Kailasa, a Buddhist Temple, and in a Jain Temple—all hilly country
Mandu	February	3000-4000	15-20	Several colonies in ruins and mosques of this ancient and deserted capital
Orcha	March	2000-3000	8-10	Two colonies in rooms and undergrounds of the deserted palace of the Maharaja

Hunting Territory

The diurnal haunts were found generally in hilly and forested country, with a lake, a river, or a pond in the vicinity, where these bats can come to drink. The presence of water is always an important element in the biotope of all bats, specially during the rearing and suckling of their young. This is true even in temperate countries in Europe, where the females usually establish their nursery close to water.

As *Taphozous melanopogon* often come back to diurnal haunt in the course of the night (observations made at Kanheri), we can assume that their hunting territory is not far away.

Field Characters

Species highly gregarious, never isolated, living in numerous colonies. These bats attach themselves by the fore- and hind- limbs on the rocky walls and ceilings and never take refuge in crevices, except if disturbed. They are among the shyer bats of India, and often fly away when the observer is 10 m. from the colony. At first, they run along the wall in all directions and suddenly start flying with noisy flapping and shrill cries. Their capture is difficult.

The best field character is certainly the very visible black beard of the adult male, which even from afar makes this species unmistakable.

The nocturnal outings of the colony take place 25 to 30 minutes after sunset (Kanheri and Mandu). The starts are made in waves of three to a dozen individuals leaving together. During the suckling period in Kanheri, the females go hunting 15-20 minutes before the males. The nocturnal flight is straight, swift and pitching.

Reproduction

The rut is evidenced in the male by the state of the hairs of the beard which are massed together as pencils by a pitchy secretion. The upper parts of the breast are also partially deprived of hair, and the testes which are not visible during the period of sexual rest can now be seen under the skin.

The rut is evidenced in the male by the state of the haris of the copulation (?) at Kanheri on the 12th of March. In Mandu at the end of February two adult females dissected showed no foetuses. But in Ellora on 27th March, a female had a foetus 10 mm. long. On the same date in the colony at Orcha, I got two females with foetuses 18 mm. long.

In Kanheri, I regularly followed the reproductive cycle of the colony in 1960 and 1961. Parturition took place between the 20th April and 15th May. The females have a single young which they carry in a lateral position under the wing. For about 30 days, the young does not leave the dug of its mother, to which it is fixed continuously. When the young leave their mothers at the age of about one month, it is for ever. In spite of their very small size, the young can fly very well and show the same watchful behaviour as their parents. During this second period of their life, they were never seen to be carried by the adults. They stay in the diurnal haunt during the night, but do continual exercises of flight in the cave. The first hunting flights of the young were observed in Kanheri in 1960, around the 10th of July. On the 20th of July, we saw all the young flying out at sunset, although all had stayed in the cave during the night of the 12th of July. The duration of suckling would be about two months.

The juvenile mortality was observed in Kanheri Caves where the dead bodies lay on the flagstone and were easily collected. This mortality is high and we found 17 bodies in 1960 and again 17 in 1961; an average of 1/5th of the young died during the juvenile stages. The size of the forearm in all the dead juveniles was between 50 and 52 mm. in length. This is the size of individuals 30-40 days old, i.e. the stage at which they leave their mothers. Probably this is a difficult period for the young and great numbers perish—possibly due to difficulty in finding the mother.

One female caught in June was without young, and the external genital organs were suffering from some serious infection.

The periodicity of the reproductive cycle in *Taphozous melanopogon* is absolutely strict, and no pregnant females or young were noted at other times of the year.

Social Life

The social life of *Taphozous melanopogon* shows certain peculiarities which do not appear to have been recorded in bats before.

Intra-specific Associations

Adult males and females usually live together in the same colonies. Nevertheless, sexual segregation exists, the adult males being dispersed around a nucleus of females. If the shape of the colony is elongated—a colony formed at the top of a wall for instance—the males are seen occupying both extremities in a linear disposition. This is the case at the Kanheri Caves. I have enlarged on this new and very curious observation in another paper (A. Brosset—Sexualité et reproduction des chiroptères de l'ouest et du centre de l'Inde—*Mammalia*, in press).

Sometimes the males inhabit a separate place, but this is close to the colony of females. This was the case in the fort of Chikalda. One small colony exclusively of males (150-200) was discovered in a tower. A very big colony of females (estimated 1500-2000) existed in another tower only 50 m. away. The same condition was noted in Ellora in March 1960, where only males formed a huge colony in a Jain temple, with the females living separately in other temples. Nevertheless, in August, both sexes were seen together at Ellora.

After weaning, there is no dispersal of the young as has been observed for many species of vertebrates. In fact, the colony of Kanheri, which had 180-200 individuals in April, consisted of about 270 after the rearing of the young and this number was stable till October, when we got several young as big as the adults, but darker grey and without beards in the males.

Inter-specific Associations

Several species associate themselves with *Taphozous melanopogon:*

Rousettus leschenaulti in Kanheri
Rhinopoma microphyllum in Orcha
Hipposideros speoris and *Rhinopoma hardwickei* in Badami
do. in Pattadkal
Taphozous kachhensis in Ellora
Rhinopoma and *Rhinolophus lepidus* in Mandu

The colonies of bats seen in Pittalkora and Chikalda were of *Taphozous melanopogon* only. These associations are very variable and probably due to ecological convergences.

Food

No valuable information was obtained. This species does not bring insects into the diurnal haunt. Analysis of the guano gave only remains of prey too masticated to be identified.

Hibernation

Taphozous melanopogon is a vigilant and active bat, which certainly never hibernates. It seems that none of the Indian *Taphozous* are able to fall into torpor, even when cooled experimentally (Brosset, L'hibernation chez les chiroptères Tropicauax, *Mammalia*, December 1961).

Taphozous longimanus Hardwicke 1821

Measurements (in mm.):

		Localities								
		Khandala □ ♀	Elephanta □ ♂	Kaira □ ♂	Kaira □ ♀	Anand □ ♀	Anand □ ♂	Mehmadabad △ ♂	Ahmedabad △ ♂	Ahmedabad △ ♂
	Forearm	55	55	57	57	55	56	59	59	58
	2nd finger	55	55	56	57	55	56	57	55	55
3rd finger	Metacarpal	57	54	58	57	55	56	60	58	59
	1st Phalange	22	23	24	24	24	24	24	22	24
	2nd Phalange	25	25	25	25	25	26	23	23	25
4th finger	Metacarpal	45	42	43	45	45	45	48	45	44
	1st Phalange	11	12	12	12	12	12	12	12	13
	2nd Phalange	9	8	8	9	8	8	8	8	8
5th finger	Metacarpal	35	31	33	34	34	35	33	33	32
	1st Phalange	12	13	13	13	12	13	12	12	12
	2nd Phalange	10	10	10	10	10	9	9	10	9
	Tarsus	24	22	22	23	23	23	25	22	25
	Tail	32	24	32	33	25	29	30	28	25

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Ahmedabad ..	20	12.5	15	8	11
Anand ...	21	13	16	8	11.5

Description

Compared with the two previous species, this *Taphozous* shows few differences. The skull cannot be separated from that of *melanopogon* and *perforatus.*

The size of the forearm is slightly smaller than that of the other closely-allied species. The fur is darker brown, the hair being often speckled with whitish, especially on the back. The gular sac is very large in the male, smaller in the female.

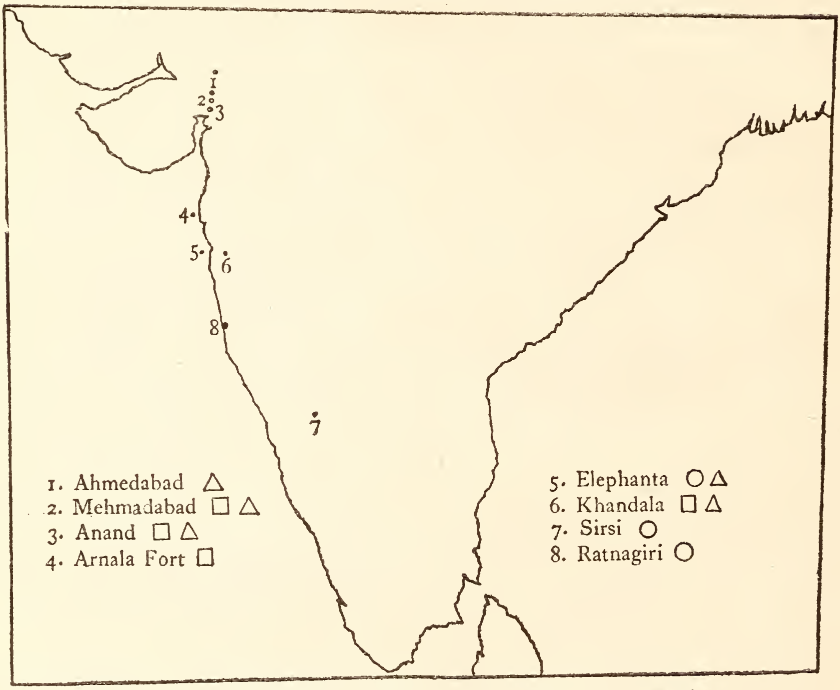
This bat possesses a strong *sui generis* smell, which is so peculiar that when known by the observer, it is sufficient to permit identification of the species at a distance.

General Distribution

Approximately: Ceylon, India, Burma, Tenasserim, Malay States, Sumatra, Java, Borneo.

Distribution in western and central India

Taphozous longimanus is known from the coastal part of the country and also from the Ghats.



Map 8. Localities where *Taphozous longimanus* were studied

Ecology

It is difficult to understand what factors determine the distribution of *Taphozous longimanus*. In fact, the xerothermic indices and the nature of the vegetational cover are completely different at Elephanta, Khandala and Ahmedabad, where this species was found. I believe that it is the territorial competition with other *Taphozous* which determines the presence of *longimanus*. We never saw *Taphozous longimanus* in the biotopes occupied by *melanopogon*, *perforatus* *kachhensis*, or *theobaldi*. It is the intolerance by *longimanus* of the presence of the other species which probably confines this bat to the habitats not occupied by the others. For instance, the Kanheri Caves, which contain many suitable places but give shelter to a colony of *melanopogon*, are never visited by *longimanus*.

The Diurnal Biotope

TABLE OF DIURNAL BIOTOPES OF *Taphozous longimanus*

Locality	Date of observation	Size of colony	Number captured	Nature of the Biotope
Ahmedabad	November	4	2	Dada Hari Well—a Moghul well with subterranean retreats
Mehmadabad	December	15-20	8	A Moghul well with subterranean retreats
Anand	December	1	none	In the open air—on the wall of a house
Anand	December	1	none	—
Anand	December	7	3	In the external corner of a roof
Arnala	January	3	none	In a dark room of the old fort.
Elephanta	March/June	7 and 5	2	In a room adjacent to the principal cave
Khandala	March, May, June	15-20	3	Under the roof of a mission (observations of A. Navarro and myself)

I noticed *T. longimanus* as an especially eclectic species for the diurnal haunt, which can be:

A cave—an old building—a well—a roof—the external surface of the wall of a house.

The latter is a biotope very rarely used by bats and it seems that only *Taphozous maritianus* of the Congo was known to stay in the open air during the day on the external walls of houses (ref. Verchueren). This biotope is completely lighted up and exposes the bat to the view of man and predators, requiring continual vigilance by this animal. The same remarks were made by Shortridge who wrote about numerous individuals seen near Dharwar: 'They hang up in rows under the eaves of the larger houses, quite exposed to the light, merely shifting their position if the sun shines directly on them . . . .'

Individuals living in hollows of trees were noticed by Gopalakrishna in the region of Nagpur, and by Phillips in Ceylon.

Hunting Territory

Hunting territories were observed at Anand and Khandala. The bats fly away early from the diurnal haunt, about 15 minutes before complete darkness. Each individual hunts alone, turning around over a well-margined territory, which seems the same every day. These territories are in the immediate vicinity of their diurnal haunts which are themselves included in the nocturnal territory of some individuals.

Field Characters

This bat clings to vertical walls. Contrary to the other *Taphozous*, this species can be observed in completely lightened places.

Although isolated individuals are frequently noted, *Taphozous longimanus* usually lives in small colonies of 2 to 20 individuals. If there are more than 3 or 4 bats together, they form a compact cluster (see Plate III).

At human approach, two different reactions have been noted:

(1) Upon the observer's close approach to the colony, all the bats suddenly fly away.

(2) In the same circumstances, the bats may escape by crawling away to take refuge in a hole or a crevice in the rock. This reaction is sometimes centrifugal, sometimes centripetal.

Nocturnal Flight

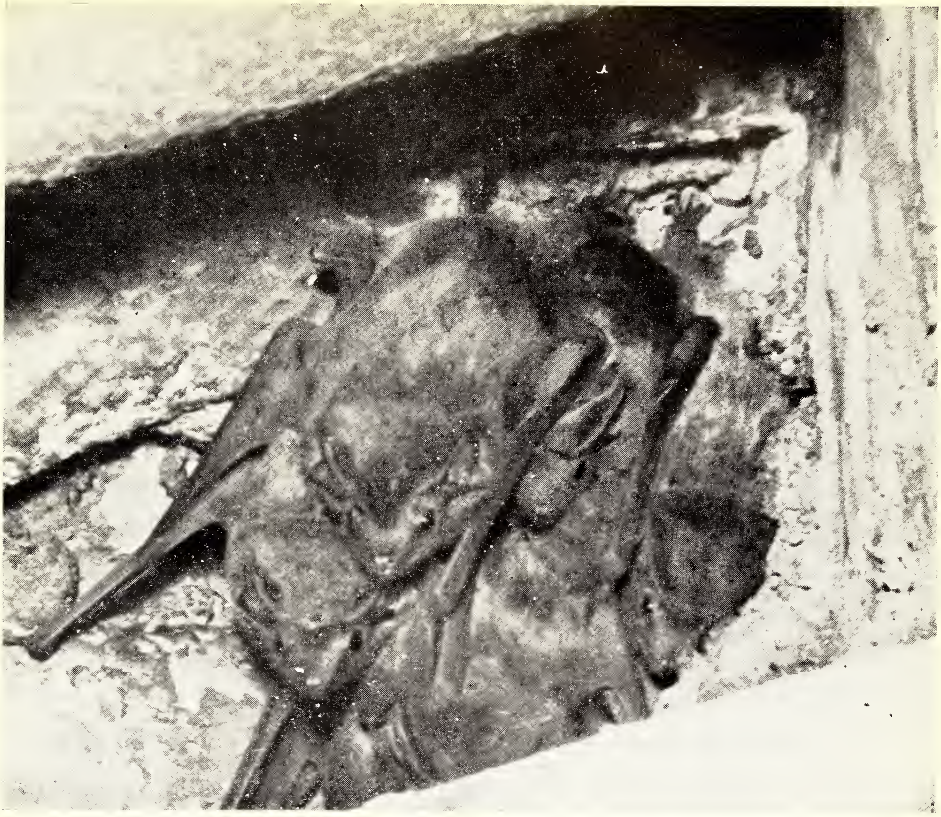
T. longimanus can be recognised easily at sunset. It is a bat with narrow wings and long tail, a solitary flier that spins around in one place at a height of about 25 m. The flight is passably fast and pitching.

Reproduction

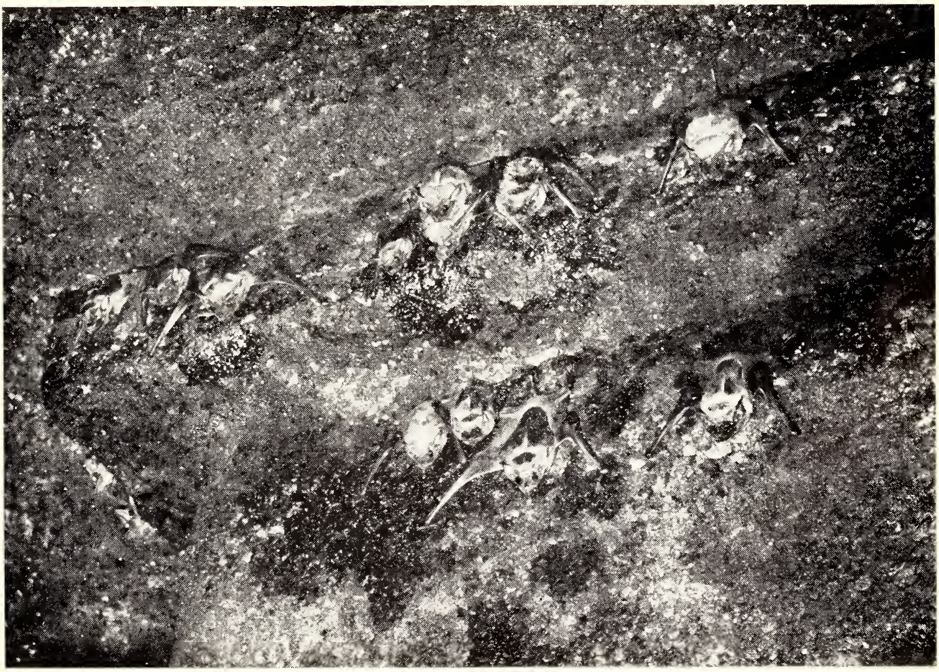
I did not record data on reproduction at any of the colonies that I observed.

We noticed in winter that a curious red secretion, which is perhaps in connection with the rut, is exuded by the gular sac. The smell of the secretion is very strong and disagreeable.

The reproduction of *Taphozous longimanus* had been studied by A. Gopalakrishna at Nagpur and Amravati. This work is especially important because it is probably the most detailed work on the re-



Colony of *Taphozous longimanus* in a corner of a roof



Colony of *Taphozous kachhensis*

(*Photos : A. Brosset*)

production of any Indian species, and also because these researches have given quite unexpected results. Observations in the field, together with physiological studies showed that this *Taphozous* breeds all through the year. Each female becomes pregnant more than once a year and most probably there is continuous breeding with pregnancies following in quick succession. The conclusions of Gopalakrishna are firmly supported by physiological examination of 135 females collected over six years.

The case of the reproduction of *T. longimanus* is unique, as far as we know, among the bats of the old world. The other Indian *Taphozous* like *melanopogon*, *perforatus*, and *kachhensis* show a normal cycle of reproduction as other bats: one liter born at a well-defined period of the year in April, May, and July respectively.

Readers desiring more details about the reproduction of *Taphozous longimanus* may refer to the work of A. Gopalakrishna [Observations on the Breeding Habits and Ovarian Cycle in the Indian Sheath-tailed Bat, *Taphozous longimanus* (Hardwicke). 1955, *Proc. Nat. Inst. Sci. India* **21 B** : 29-41].

Social Life

Taphozous of different species are usually found living in huge colonies. *T. longimanus* forms an exception, living isolated or in small colonies. Gopalakrishna had also noticed that this species is not colonial in habit. No sexual segregation was observed. Most often *T. longimanus* does not associate itself with other species. Nevertheless, in Ahmedabad and Mehmadabad, there were some *Rousettus* and *Rhinopoma* on the walls occupied by these *Taphozous*.

Hibernation

T. longimanus certainly does not hibernate. The nature of the diurnal biotopes, where the bat is often exposed to the view of predators, requires this species to be continuously watchful.

Taphozous theobaldi Dobson 1872

Description

Similar to the previous species, but bigger. The size of the forearm is sufficient to separate this bat from the closely allied species.

The skull is also similar in shape, but noticeably larger.

The colour of the fur is rather variable, being of various shades of reddish-brown. The adult male possesses a very distinct reddish-brown beard, a character which, it appears, has not been noticed previously. In one specimen collected, the reddish hairs of the beard are mixed with blackish. In one male, apparently young, there is no beard.

No gular sac in either sex. The metacarpal pouch is well visible.

Measurements (in mm.):

		Localities					
		Krishnapur (Belgaum Dist.) △ ♂	Krishnapur (Belgaum Dist.) △ ♂	Krishnapur (Belgaum Dist.) △ ♂	Krishnapur (Belgaum Dist.) ○ ♂	Krishnapur (Belgaum Dist.) ○ ♂	Asirgarh (Nimar) ○ ♂
	Forearm	73	73	71	71	72	72
	2nd finger	59	57	57	57	57	57
3rd finger	Metacarpal	62	63	62	62	64	61
	1st Phalange	25	24	24	23	24	24
	2nd Phalange	25	25	26	24	26	25
4th finger	Metacarpal	50	50	49	50	50	50
	1st Phalange	13	14	14	14	15	13
	2nd Phalange	8	8	8	9	9	8
5th finger	Metacarpal	40	40	38	40	40	40
	1st Phalange	14	14	14	14	15	15
	2nd Phalange	8	8	9	9	9	8
	Tarsus	28	29	29	26	27	28
	Tail	27	31	27	35	35	30

The skull measurements are as follows:

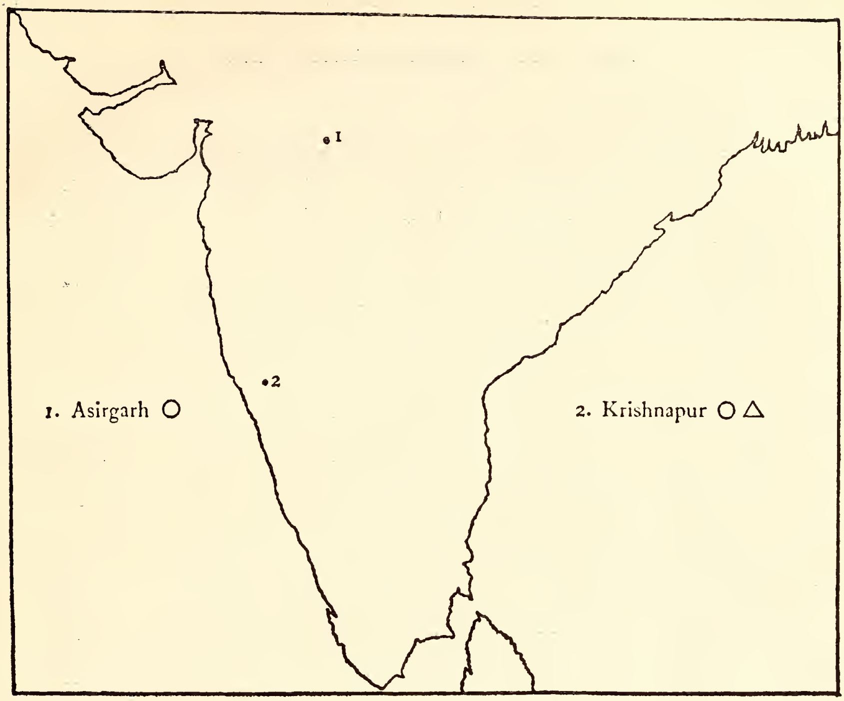
	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Krishnapur	24	14	19	10.5	13

General Distribution

India (probably rare), Tenasserim, Malay States, Java.

Distribution in western and central India

Known only from two places in the whole of peninsular India (see map).



Map 9. Localities where *Taphozous theobaldi* were studied

Biology

The biology of *T. theobaldi* in India remains practically unknown. In October 1911, C. A. Crump found two individuals at Asirgarh. The collector gave no details of the circumstances under which they were obtained. Of these, only one is traceable in the B.N.H.S. collection.

In May 1961, a short trip was organised jointly with the Bombay Natural History Society, to study the bats of North Kanara. During this trip, P. W. Soman, Junior Research Assistant of the Society, obtained the second record of *T. theobaldi* for India. This colony, apparently of some size, was found in the Krishnapur Caves, not far from the Goa border. This natural cave is situated in wild and forested country, and also held a colony of *Rousettus leschenaulti.* Soman secured seven specimens, all males; measurements and description of five of them are given above.

Subgenus *Saccolaimus*

Taphozous saccolaimus Lesson 1842

Measurements (in mm.):

		Bombay □ ♀	Anand □ ♀	Sirsi ○ ♂	Gers opp ○ ♀	Dhaurapur ○ ♀
	Forearm	71	70	72	71	72
	1st finger	66	67	66	65	66
3rd finger	Metacarpal	67	69	68	65	66
	1st Phalange	33	33	32	30	30
	2nd Phalange	32	34	31	30	31
4th finger	Metacarpal	50	51	50	50	52
	1st Phalange	21	24	22	22	23
	2nd Phalange	7	8	8	8	8
5th finger	Metacarpal	36	36	37	37	37
	1st Phalange	17	18	17	17	19
	2nd Phalange	11	12	11	8	12
	Tarsus	29	28	27	26	26
	Tail	29	26	30	30	25

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Bombay ..	25	16.3	21	11.3	13
Anand ..	27.5	16.5	21	12	14

Description

With this species, we start to examine the second group of *Taphozous* characterised by their large size, the presence of a gular pouch, and a skull very different from that of the first group. In India, this second group includes two species—*Taphozous saccolaimus* and *Taphozous kachhensis*.

Taphozous saccolaimus is a very dark black-brown species, completely black in certain specimens. The fur of the back and the head is often studded with curious small white patches (?). The lower parts are usually more brown-rufous and not so dull as the upper parts.

The shape of the wing differs from that in the other species (see measurements) in being very long and narrow. Males and females both possess a large gular pouch, but an immature specimen in the collection of A. Navarro has apparently none.

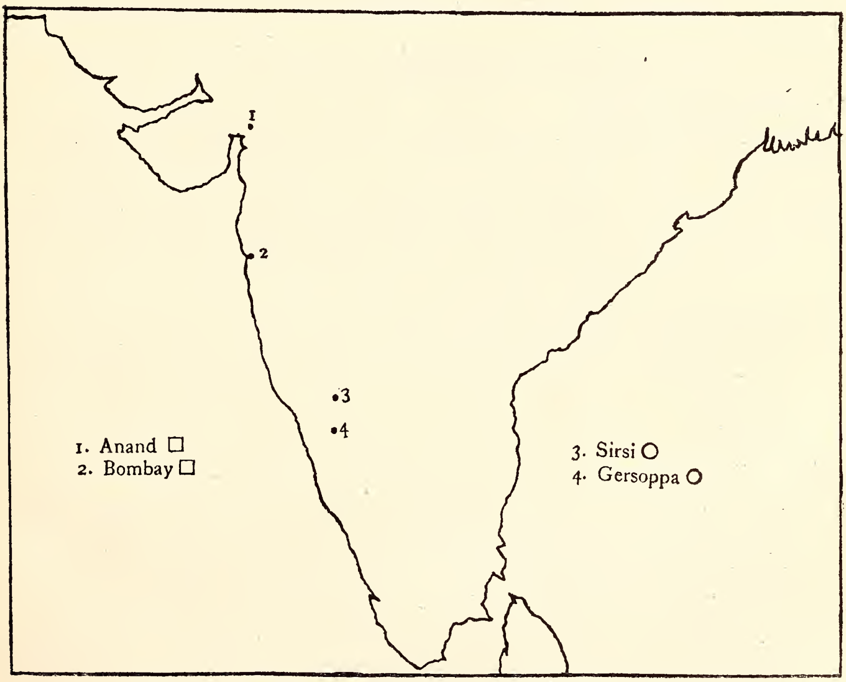
At the end of the tail are about ten hairs 1 cm. long. In the skull, the brain case is not raised higher than the facial block, as in the previous species, but both have a linear profile.

General Distribution

Ceylon, Malay States, Java, Sumatra, perhaps Burma, peninsula of India to Bengal.

Distribution in western and central India

A few specimens were recorded in the coastal area. (See map.)



Map 10. Localities where *Taphozous saccolaimus* were studied

Biology

Very little is known concerning the biology of this species. I never met an individual alive. The records of Bombay, Gersoppa, and Sirsi refer to bats shot or found accidentally.

Nevertheless, the specimen from Anand (Navarro collection) was discovered with two others in a hole in a palm tree. Phillips, from Ceylon, wrote that the hollows in decayed palm trees formed the normal diurnal habitat of this *Taphozous*, which indicated a very special ecology as compared with that of the other species of the genus.

According to Phillips, *Taphozous saccolaimus* live in small companies of five or six, both sexes together. It leaves its day's hiding place early in the evening. In Ceylon, the reproduction takes place in autumn.

Perhaps, this *Taphozous* is a common species all over the country. But living in small companies in the hollows of palm trees, its discovery and observation are especially difficult.

Subgenus *Liponycteris*

Taphozous kachhensis Dobson 1872

Measurements (in mm.):

		Chaklasi □ ♀	Anand □ ♀	Ajanta △ ♂	Ellora △ ♂	Badami △ ♂	Gwalior ○ ♂	Rajkot ○ ♂	Gwalior ○ ♂
	Forearm	68	68	77	75	72	72	74	74
	1st finger	60	58	65	62	59	59	60	61
3rd finger	Metacarpal	62	60	70	68	64	67	65	65
	1st Phalange	28	62	30	29	28	27	27	27
	2nd Phalange	35	34	32	32	35	33	33	30
4th finger	Metacarpal	49	50	54	53	51	51	53	52
	1st Phalange	16	16	18	16	15	17	16	17
	nd Phalange	10	10	10	9	9	9	9	9
5th finger	Metacarpal	42	43	47	44	43	46	45	43
	1st Phalange	14	14	17	16	14	16	16	15
	2nd Phalange	10	9	10	8	9	9	9	10
	Tarsus	29	28	31	30	30	28	32	30
	Tail	28	26	31	25	30	30	30	30

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Aurangabad ♂	28	17	21	12	14
Hampi ♂	26	16	20	11	14

This is one of the larger species of the genus *Taphozous* in India. Like *T. saccolaimus* it belongs to the group having a flat broad skull. The dentition is much stronger than that in *melanopogon, perforatus, longimanus,* and *theobaldi.*

The adult male possesses a large and deep gular sac 10 mm. broad, and in addition to this sac a deep circular gland of 4 mm. in the upper part of the chest. In the female, the gular sac is less visible and there is no gland on the chest.

The colour of the fur is of variable shades of yellowish-brown. The individuals seen in Ahmedabad were much more greyish than those of Aurangabad.

The specimens obtained in north Mysore (Vijayanagar) are noticeably duller than the northern population. Probably, a cline of coloration exists for this species, with darker individuals in the south.

During certain periods of the year, varying with the different localities, these *Taphozous* show enormous reserves of fat at the base of the tail and in the uropatagium which give, by transparency, an orange colour to the lower parts of these animals.

The *sui generis* smell of *Taphozous kachhensis* seems due to the disagreeable emanations produced by its urine and guano.

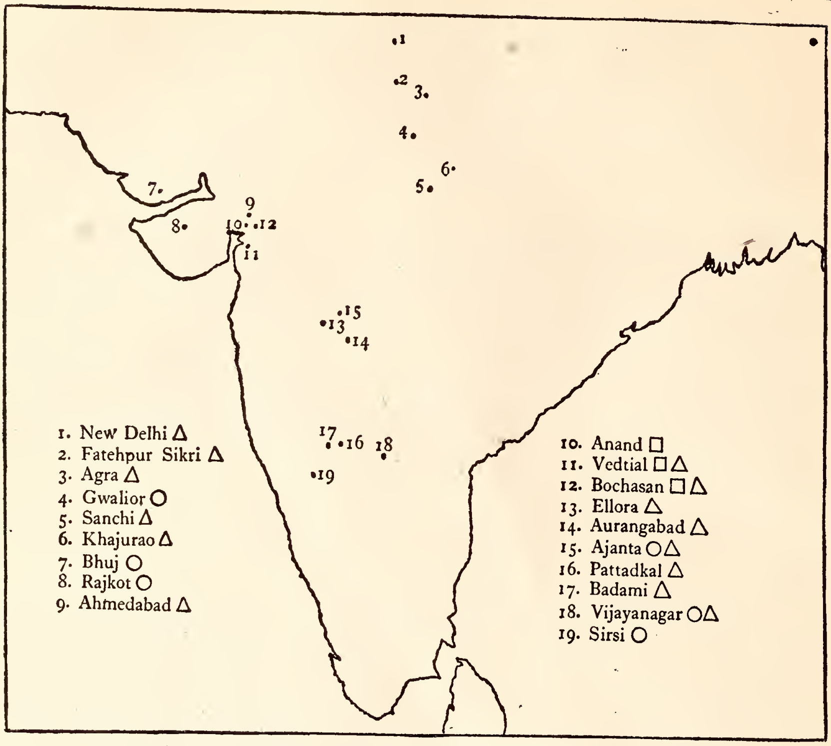
General Distribution

Sikkim, Burma, Malay States, Iraq.

Distribution in western and central India

It occurs over the whole area of the present survey, excepting the Konkan, the Ghats, and Kanara, where the humidity is too high for this species. (The records from Gersoppa in the Mammal Survey Report are doubtful.) No specimen in support of this statement can be traced in the collections of the B.N.H.S.

The presence of this bat is associated with the scarcity of rainfall. It appears where the annual precipitations are less than 50 inches. The species is common in north Gujarat, Agra and Delhi, Madhya Pradesh, the Deccan Plateau, and the arid portion of northern Mysore. As is often the case in the ecology of birds, the rainfall determines



Map 11. Localities where *Taphozous kachhensis* were studied

the distribution of several species of bats and amongst them is *Taphozous kachhensis.*

Diurnal Biotope

Until the species had adapted itself to human constructions, e.g. artificial caves, temples, and tombs, crevices in rocks constituted their original diurnal biotope. The most suitable places for this bat are old monuments with deep cracks and fissures where it can rest concealed and protected during the day, secure from disturbance and the attack of predators. Sometimes, *T. kachhensis* may be found, as at Ellora and Aurangabad, on the walls of caves without crevices.

The density of the population in a given area appears to be directly linked with the number of suitable 'lodgings' available for these bats. The more numerous the caves, the more abundant are *T. kachhensis.* At Ellora, a place famous for its many large caves and temples, we found some 800 individuals. The Aurangabad caves, with only six suitable cavities, give shelter to only 200 individuals. At Sanchi, only a small temple is suitable for these bats, and only

14 individuals were found living there. They ordinarily gather in small colonies of 10 to 50 individuals. Many such colonies may in fact be very close to each other and form parts of really the same population.

TABLE OF DIURNAL BIOTOPES OF *Taphozous kachhensis*

Locality	Date of observation	Estimated number of individuals	Number of captures	Nature of Biotope
Vijayanagar	October	Several colonies of 50-100 individuals each. 500-1000 altogether	13	Old monuments, specially the temples of the demolished capital
Pattadkal	October	3 colonies 50-100 individuals	4	Old temples
Badami	October	3 colonies at least. 200-250 individuals	4	Old temples
Aurangabad	March August	Several colonies. 200 individuals estimated.	8	Buddhist caves
Ajanta	March	do.	7	do.
Ellora	March August	800-1000 individuals	30	Numerous colonies, practically present in each cave
Vedtial	December	50-100	4	At least 3 colonies in barns and inhabited houses
Bochasan	December	100-150	none	On the walls of a barn
Ahmedabad	November July	50-100	11	Several colonies in the mosques of the town
Khajurao	March	8-10	1	In an old temple
Sanchi	March	14	14	In an old temple
Fatehpur Sikri	April	Great number several hundreds	a dozen	Numerous colonies in undergrounds and crevices of the buildings
Agra	April	do.	2	do.
Tuglakabad	April	30-40	5	Several colonies in tombs and undergrounds

Nocturnal Biotope

These bats leave their diurnal haunts about 15 minutes after sunset (observations made in Aurangabad and Ahmedabad). They immediately flew away and it was unfortunately not possible to observe this bat in its hunting territory. It also appeared that *T. kachhensis* does not come back to its diurnal biotope during the night (The caves at Aurangabad were watched for 3 hours after sunset).

Field Characters

A large *Taphozous*, living in cracks of old caves and monuments, or simply hanging against a wall in dark corners. In villages of Gujarat, *T. kachhensis* inhabits barns and houses. Each colony does not usually contain many individuals, but several such colonies may be seen dispersed in the same group of temples and/or caves. The individuals keep themselves close to each other, but do not form clusters. (Plate III)

This species is not shy and it is easy to look at it from close quarters. At the approach of an intruder, the most usual reaction is to run in the direction of a crack, or a corner, where the bat tries to conceal itself. The capture of *Taphozous kachhensis* is not difficult. When caught, this species emits a loud cry and can bite seriously.

Nocturnal Flight

It is very strong, fast, and straight, quite similar to that of swifts. At sunset, if the light is sufficient, one can see, at certain seasons, the orange colour of the lower parts due to the fat infiltrations, which is peculiar to this species.

Reproduction

The gular sac and the pectoral gland are more distinct during spring.

The rut seems to be at the end of March. At this time of the year, pairs were observed in several places. At Sanchi, several couples were caught in a small temple, each couple being isolated from the other in one of the cracks in the temple. At the same period of the year, pairs were obtained from crevices in the Tuglakabad Fort, near Delhi. I have not seen newly-born young, but parturition certainly takes place in the first half of July. At Ahmedabad, at the end of June, the females were heavily pregnant, and several hundreds of half-grown young were seen in Aurangabad and Ellora on 28th and 29th August. A single young was always observed with the females.

For an insectivorous bat, the growth of the young is slow. About 6 months appear necessary for the young to reach full size. Young seen at Badami in October and probably 4 months old were still with their mothers, though they were able to fly well.

The young of this species shows an extraordinary behaviour never before observed in bats. It keeps itself on the back of the mother and not on her lower surface under the forearm, as in the other *Taphozous.* (For more details, see Brosset—Sexualité et reproduction des chiroptères de l'ouest et du centre de l'Inde. *Mammalia,* in press.)

Hibernation

Never observed in this species. The state of activity is probably continuous. Cooling experiments were without effect.

Nevertheless, the existence of the enormous fat accumulations that the species shows at the base of the tail during certain times of the year appear to be in connection with prolonged periods of rest. This animal probably stays in its diurnal haunt for long periods without flying or feeding itself, as hibernating species do. In fact, in November and December, I noticed in Gujarat colonies of extraordinarily fat *Taphozous kachhensis*, which seemed to be in an abnormal state. Although wide-awake and easily moving along the walls, these bats refused to fly, even if caught in the hand or thrown on the ground. Shortridge had noticed the same behaviour in northern Mysore.

Association with Man

Taphozous kachhensis is a characteristic anthrophic species, probably adapted since several centuries to hypogean temples.

Although certainly useful, as other insectivorous bats, *T. kachhensis* is an undoubted nuisance to monuments of archaeological interest. Sculptures, walls, and ground in caves and temples are damaged by their urine and guano, and the strong smell spoils the pleasure of tourists and visitors in many places. The Archaeological Department has made war on this species in many places, but without success. If disturbed, the bat takes shelter in cracks and crevices of the edifice, where it is completely out of danger and can return after it is past. Only at Khajurao was this species nearly eliminated by placing wire lattices, closely affixed to the walls, at all the openings.

(*To be continued*)

Notes on Indian Commelinaceae—I

BY

SESHAGIRI RAO ROLLA
Botanical Survey of India, Poona

AND

R. V. KAMMATHY
Junior Research Fellow, C.S.I.R., Poona

(*With three plates*)

In the course of our study on the 'Cyto-taxonomic Revision of Indian Commelinaceae' a few interesting points have been observed while studying the specimens of the family from the following Herbaria: Blatter Herbarium, Bombay (BLAT); Botanical Survey of India, Western Circle, Poona (BSI); Botanical Survey of India, Southern Circle, Coimbatore, formerly known as Madras Herbarium (MH); the Osmania University (HY); and the Calcutta University (CU).[1]

In order to clarify these points for better identification of some of the species and for widening their distribution particularly for western India, the following notes are given under the respective species. Only specimens which indicate new localities and which were misidentified and published before are cited in this paper, though quite a large number of specimens have been critically studied under each species. The mis-identifications are marked with asterisks. The localities of some of the species cited in this paper are marked as far as possible on the maps in Plate III, indicating in general the distributional range of each species and suggesting the possible extent of such distribution.

I. *COMMELINA* Linn.

1. **Commelina subulata** Roth.

Cooke's FLORA includes this species, but he states: 'This has been included on the authority of Woodrow [*Jour. Bomb. Nat. Hist. Soc.* v. 12 (1899)] but, as he gives no locality, it would seem as if he had himself never found the plant. There are in all only 3 sheets in Herb. Kew, one a wretched fragment from Wight's and the other two from Rottler's

[1] The symbols used for each of the herbaria noted above, except for Calcutta University, are according to the International Association for Plant Taxonomy. Such symbols are given in brackets at the end of each set of specimens examined from the particular herbarium.

Herbarium. There is nothing to show that the plant is indigenous to Bombay. The habitat (Peninsular India) embraces a very wide area.' Fischer in Gamble's FLORA OF THE PRESIDENCY OF MADRAS also indicates its occurrence in Hills of Deccan, 3000-4000 ft. (910-1220 m.). Such notes on distribution are very vague as the data on the species available with Fischer were quite meagre and based on specimens collected from Ramandrug (Bellary Dist.) only. Santapau's record of its occurrence at the foot of Purandhar Fort, on the basis of one specimen which was examined, is quite interesting though, as noted below, this species is not so rare as recorded earlier. In fact, there are 2 good specimens in Poona Herbarium collected by Talbot from Dharwar as early as 1872 but misidentified as *C. attenuata* Koen.

Though the colour of the flower is noted as orange-purple drying violet in different floras, it is distinctly observed from plants of different populations growing in varied habitats as chrome-yellow.

Gargatwadi (Khed Taluka, north of Poona), *Rolla* 66273 ; in front of Topegaon School 9 miles north of Belgaum, *Rolla* 73043 ; opposite P. W. D. quarry, 9 miles south of Belgaum, *Rolla* 73048 ; Dharwar (North Kanara), *Talbot* 2052 ; Stigaon, near Police Check Post at 223rd mile on Poona-Bangalore Road, *Rolla* 73075 ; near Namadechilume Forest Rest House, Tumkur, *Rolla* 73994 ; Devarayadurga, Tumkur, *Rolla* 73392; Lalbagh Botanical Garden, Bangalore, *Rolla* 73488; Osmania University Campus, Hyderabad, *Kammathy* 73965. (BSI)

Bhor Hill, *Vartak* 1473 ; Kudale (near Poona), *Vartak* 1683 ; Ambavada (near Poona), *Vartak* 1886, 1887 ; Belgaum, *Chikkanaiah* in 1958 ; Dastitop (Dharwar Dist.), *Sedgwick* 1937. (BLAT)

Ramandrug (Bellary Dist.), *Madras Herb.* No. 52262. (MH)

Marshy areas of Lalbagh Gardens, Bangalore, *Krishnaswamy*. (CU)

Pakhal, near Warangal (old Hyderabad State). (HY)

Distribution. Now, on proper scrutiny and with recent collections, the species is considered to be distributed in different areas from northern parts of Poona to as far as Bangalore but mostly on the Deccan plateau region where it grows profusely in small patches at several places. Strangely enough the species, though growing commonly in Hyderabad and surroundings, has not been collected in the area between Bangalore and Hyderabad and from Hyderabad to Poona, a point which needs further study. Pl. III (1).

SPECIES OF MONOON SECTION

The species under the Monoon Section of Clarke are commonly confused as revealed by the study of many herbarium specimens. Practically all of them were misidentified as *Commelina obliqua* Ham.

Haines (1924), however, in his FLORA distinguishes the three species—*C. kurzii* Cl., *C. obliqua* Ham., and *C. suffruticosa* Bl.—but confuses with the 3-celled and 2-celled character of the capsules. The 2-celled capsule of *C. kurzii* and *C. obliqua* is formed from the second or third flower of the inflorescence, the first flower producing the normal characteristic three-celled capsule. The two-celled capsule of *C. suffruticosa* is distinct by itself. Besides, there are a few distinct vegetative characters distinguishing these species. A comparative account of the characters of 5 species under the Section, noted after careful observation of the species both in the field and under cultivation at Poona, is presented in Table I.

2. **Commelina paludosa** Bl.

Enum. Pl. Java 1 : 2, 1827. *C. obliqua* Buch.-Ham. ex Don, Prodr. Fl. Nep. 45, 1825, *nec* Vahl.

Commelina obliqua Ham. ex Don is a later homonym to *C. obliqua* Vahl [Enum. 2 : 172, 1806] which is a Mexican species, and hence Don's species is a *nomen illegit.* The next available name is *C. paludosa* Bl. whose type was examined by the senior author at Rijksherbarium Leiden.

Lonavla, *Bhide* in Oct. 1919 ; Khandala, *Gammie** 15461 (in part ; the other bit of specimen is *C. kurzii*) ; Matheran, *Wadhwa* 67404 ; Bombay Point Road, Mahableshwar, *Mahajan* 24641 ; Arthur Seat, Mahableshwar, *Ansari* 67603 ; Castle Rock (North Kanara), *Gammie* 15523 ; Teppakulum, Shencottai (Kerala), *K. N. Subramanian* 71210 ; Gangadhareswargudi, Billigirirangan Hills, *Rolla* 73709. (BSI)

Borivli (near Bombay), *Herbert* 2833 ; different areas of Mahableshwar, *Santapau* 13072 and other numbers, *Sedgwick* 4677, *Bole* 299 ; Katlekan evergreen forest, *J. Fernandez* on 28-11-1950 ; Devimane Ghat (North Kanara), *Hallb. & McCann* 35023 ; Kondapalli (Krishna Dist., Andhra), *Wagh* 3214 ; Gudem (Vizag. Dist., Andhra), *Wagh* 2117, 2119. (BLAT)

Jolpad (South Kanara), *Barber* 2367 ; Charmadi (South Kanara), *Raju & Naganatham* 18202 ; foot of Shiruvani (Coimbatore Dist.), *K. Subramanyam* 1261, 1531. (MH)

Distribution. The species, due to misidentification, is reported to be common in different parts of western and peninsular India ; but it is now observed that this species grows in a restricted manner, mostly in hilly areas of the western coast, and is comparatively less common ; it is well distributed in different parts of eastern India even beyond Assam region. A recent careful study of this species from the Deccan plateau area, particularly between Poona and Hyderabad on the northern part and Bangalore on the southern part, further reveals that this species is rather rare in this region when compared with *C. kurzii* which grows quite commonly.

3. **Commelina paleata** Hassk.

Kanheri Caves, Bombay, *Rolla* 32737 ; Aarey Milk Colony, Bombay, *Rolla* 32762 ; Khandala, *Rolla* 32772, *Wadhwa* 64075 ; Neral to Matheran, *Wadhwa* 64108 ; Kirkee (near Poona), *Garade* 557 ; Karwar (North Kanara), *Talbot* 1292. (BSI)

Sion Hill, Bombay, *Santapau* 219.3H, 219.6H ; National Park, Borivli, Bombay, *Fernandes* 21 and other numbers ; Aarey Milk Colony and surroundings, Bombay, *Tavakari* 1382 and other numbers ; Malad, Bombay, *Shah* 99 and other numbers ; Mumbra (near Bombay), *Shenoy* 98 and other numbers ; different parts from Neral to Jummapatti (Western Ghats), *Irani* 4209 and other numbers ; Khandala, *Santapau* * 822, * 4656 ; *Blatter Herb.* No. * 27396 (noted under *C. obliqua*) ; Parsik, *Acland* 1236 ; *Santapau* 219.9H. (BLAT)

Distribution. Though the species was reported by Fischer from Coimbatore Dist., Courtallum etc. of south India, the specimens from Madras Herbarium turned out on scrutiny to be *C. ensifolia* Br. On putting aside such misidentifications, this species, as at present understood, seems to be common in the Konkan area, but extending further towards Poona area through Matheran and Khandala. Its further extension to different parts of Deccan plateau as far as Hyderabad on one side and Bangalore on the other side from Poona area has been very carefully verified by recent field studies and it is, therefore, a point of interest to record here that this species does not occur in general in different areas of Deccan plateau. Pl. III(2). The citation of Hooker for Malabar needs further verification.

4. **Commelina kurzii** Cl.

Bhopal Hills, *Puri* 4160a ; Amkut (M.P.) *Puri* 23585 ; on way to Devalia tank, Mt. Abu, *Rolla* 66661 ; Dhinodhar, Kutch, *Jain* 46919 ; Sasangir (Gujarat) *Rolla* 63835 ; Bassein Fort, Thana Dist., *Chhibber* 141 ; Jogeshwari, Bombay, *Rolla* 32769 ; B.S.I. compound, Poona, *Cherian* 65947 ; Ukkad, Belgaum, *Puri* 19965D ; Yellapur (North Kanara), *Talbot* in 1882 ; Eradimatti, Jogimatti State Forest, near Chittaldrug, *Rolla* 73090 ; Jogi Hill, Chittaldrug, *Rolla* 73143 ; Devarayadurga, Tumkur, *Rolla* 73355 ; Kitherdevargudi, between 18-20 miles from Chamarayanagar to Billigirirangan Hills, *Rolla* 73606 and 73636 ; Kallar, Coimbatore Dist., *Kammathy* 73928 ; 10 miles north of Attakatty Rest House, Annamalais, *Kammathy* 73938 and 73941 ; Osmania University Campus, Hyderabad, *Kammathy* 73969 ; Narsapur, Medak Dist., *Kammathy* 73985 ; Tenmalai (Kerala), *K. N. Subramanian* 71541 ; Hastinapur, near Meerut, *Murthy & Singh* 785. (BSI)

TABLE I

Comparative account of the various characters of 5 species of *Commelina* under the Monoon Section of Clarke

	C. paludosa	*C. paleata*	*C. kurzii*	*C. suffruticosa*	*C. ensifolia*
1. Habit	Stout, erect or slender, semi-erect herb, sometimes rooting at nodes on scandent branches, perennial. One or two nodal roots become tuberous in var. *viscida* and var. *mathewii*	Stout, scandent herb, rooting at almost all nodes, internodes slightly arching, branched, perennial	Slender, erect or semi-erect herb, profusely branched, perennial	Slender, erect herb, mostly tufted and branched, perennial	Slender, spreading herb, rooting at nodes, profusely branched, branches developing like a rosette, perennial
2. Roots	Slender fibres	Thick fibres	Thick fibres, unusually long sometimes more than 30 cm.	Thick long fibres	Slender long fibres
3. Leaves	10-15 cm. long and 3-4 cm. broad, glabrous, leaf-base oblique with rusty brown hairs along the margin of leaf sheaths 3-8 cm. long and 1-2 cm. broad, hairy, in var. *viscida* and var. *mathewii*	10-12 cm. long and 2.5-4 cm. broad, hairy	5-12 cm. long and 2-3 cm. broad, hairy or glabrous	8-12 cm. long and 3-5 cm. broad, glabrous	6-12 cm. long, 1.5-2.5 cm. broad, glabrous or slightly hairy
4. Spathes	3-8 spathes crowded at the tip of branches without any smaller leaves in addition to the two mature leaves subtending the spathes. Spathes mostly sessile, triangular, funnel-shaped and glabrous, (Pl. I. B, i.)	Spathes axillary, solitary, peduncle 1-5 cm. long projected out, closed at one end and pointed at the other end, hairy, (Pl. I. C, i.)	3-5 spathes confined to the tips of branches accompanied by 2-4 smaller leaves in addition to the 2 mature leaves subtending the spathe, (Pl. I A). Peduncle 0.5 cm. covered by leaf sheaths, spathes triangular, closed at one end and beaked at the other end, hairy or glabrous, (Pl. I. D, i).	Spathes 3-8, normally one in young plants, peduncle 1.5-2.5 cm. long projected out, spathe open and glabrous, (Pl. I.E, i)	Spathe solitary, axillary, on a small peduncle of 0.5-1 cm. long slightly projected out. Spathe hairy, triangular, closed at one end and pointed at the other end, hairy, (Pl. I. F, i.)

5. Racemes	5-8 flowers on a single outer raceme	Racemes bifid, inner with a single flower or represented by a sterile stump (Pl. I. C, i.), outer raceme with 6-8 flowers	Racemes usually bifid, inner sterile represented by a small or long stump, outer raceme 3-6 flowered	6-10 small flowers on a single outer raceme	4-6 flowers on a single outer raceme
6. Flower colour	Blue	Deep blue	Violet or violet-purple	White	Light blue
7. Capsule	2-4 capsules per spathe, with first flower developing into complete capsule. 3-equal celled (Pl. I. B, ii.) and 3-valved; cells with one free seed in each	2-3 capsules per spathe, with first flower developing into complete capsule. 3-equal celled (Pl. I. C, ii.) and 3-valved; cells with one free seed in each	2-3 capsules per spathe, with first flower developing into complete capsule. 3-celled but 2-valved, upper valve bearing an indehiscent[1] (Pl. I. D, ii), warty cell with one seed; the lower two cells with one free seed in each	6-8 capsules per spathe, with first few flowers developing into complete capsules. 2-equal celled (Pl. I. E, ii) and 2-valved; cells with one free seed in each	1-2 capsules per spathe, with the first flower developing into complete capsule. 2-celled (Pl. I. F, ii) and 2-valved; cells with one free seed in each
8. Seeds	Oblong or oval (Pl. I. B, iii.) with or without creamy white powdery covering	Oblong or oval, black in colour with brown patches (Pl. I. C, iii)	Seeds oval with a membranous margin (Pl. I. D, ii)	Seeds hemispherical, usually pale yellow in colour and lightly pitted (Pl. I. E, iii)	Seeds nearly spherical smooth (Pl. I. F, iii) with a white band around

[1] A few specimens as noted under the last para of specimens cited under *Commelina kurzii*, however, show 3-equal valved capsules, all properly dehiscing without any warty, indehiscent, posterior cell, but exhibit all the other characters clearly similar to those of *C. kurzii*. Even the chromosome numbers of these two types of specimens are so identical that in two populations from Jogeshwari and Tenmalai of the first type (with warty, indehiscent, posterior cell), the haploid number is 60 and 45 respectively whereas in two different populations from Agumbe and Katraj ghat of the second type (with 3-equal valved capsule), the number is 60 and 45 respectively. This indicates that the indehiscent nature of the posterior cell does not seem to form an important character of the species as understood at present. It is also very likely that this type of species may be a hybrid between *C. kurzii* and possibly *C. paludosa* which grow together in several populations. However, as this type cannot be distinguished from *C. kurzii* proper without the capsule, it is at present treated under *C. kurzii* only.

TABLE I

Comparative account of the various characters of 5 species of *Commelina* under the Monoon Section of Clarke

	C. paludosa	*C. paleata*	*C. kurzii*	*C. suffruticosa*	*C. ensifolia*
1. Habit	Stout, erect or slender, semi-erect herb, sometimes rooting at nodes on scandent branches, perennial. One or two nodal roots become tuberous in var. *viscida* and var. *mathewii*	Stout, scandent herb, rooting at almost all nodes, internodes slightly arching, branched, perennial	Slender, erect or semi-erect herb, profusely branched, perennial	Slender, erect herb, mostly tufted and branched, perennial	Slender, spreading herb, rooting at nodes, profusely branched, branches developing like a rosette, perennial
2. Roots	Slender fibres	Thick fibres	Thick fibres, unusually long sometimes more than 30 cm.	Thick long fibres	Slender long fibres
3. Leaves	10-15 cm. long and 3-4 cm. broad, glabrous, leaf-base oblique with rusty brown hairs along the margin of leaf sheatbs 3-8 cm. long and 1-2 cm. broad, hairy, in var. *viscida* and var. *mathewii*	10-12 cm. long and 2.5-4 cm. broad, hairy	5-12 cm. long and 2-3 cm. broad, hairy or glabrous	8-12 cm. long and 3-5 cm. broad, glabrous	6-12 cm. long, 1.5-2.5 cm. broad, glabrous or slightly hairy
4. Spathes	3-8 spathes crowded at the tip of branches without any smaller leaves in addition to the two mature leaves suhtending the spathes. Spathes mostly sessile, triangular, funnel-shaped and glabrous, (Pl. I. B, i.)	Spathes axillary, solitary, peduncle 1-5 cm. long projected out, closed at one end and pointed at the other end, hairy, (Pl. I. C, i.)	3-5 spathes confined to the tips of branches accompanied by 2-4 smaller leaves in addition to the 2 mature leaves subtending the spathe, (Pl. I A). Peduncle 0.5 cm. covered by leaf sheaths, spathes triangular, closed at one end and heaked at the other end, hairy or glabrous, (Pl. I. D, i).	Spathes 3-8, normally one in young plants, peduncle 1.5-2.5 cm. long projected out, spathe open and glabrous, (Pl. I.E, i)	Spathe solitary, axillary, on a small peduncle of 0.5-1 cm. long slightly projected out. Spathe hairy, triangular, closed at one end and pointed at the other end, hairy, (Pl. I. F, i.)
5. Racemes	5-8 flowers on a single outer raceme	Racemes bifid, inner witb a single flower or represented by a sterile stump (Pl. I. C, i.), outer raceme with 6-8 flowers	Racemes usually bifid, inner sterile represented by a small or long stump, outer raceme 3-6 flowered	6-10 small flowers on a single outer raceme	4-6 flowers on a single outer raceme
6. Flower colour	Blue	Deep blue	Violet or violet-purple	White	Light blue
7. Capsule	2-4 capsules per spathe, with first flower developing into complete capsule. 3-equal celled (Pl. I. B, ii.) and 3-valved; cells with one free seed in each	2-3 capsules per spathe, with first flower developing into complete capsule. 3-equal celled (Pl. I. C, ii.) and 3-valved; cells with one free seed in each	2-3 capsules per spathe, with first flower developing into complete capsule. 3-celled hut 2-valved, upper valve bearing an indehiscent[1] (Pl. I. D, ii), warty cell with one seed; the lower two cells with one free seed in each	6-8 capsules per spathe, with first few flowers developing into complete capsules. 2-equal celled (Pl. I. E, ii) and 2-valved; cells with one free seed in each	1-2 capsules per spathe, with the first flower developing into complete capsule. 2-celled (Pl. I. F, ii) and 2-valved; cells with one free seed in each
8. Seeds	Oblong or oval (Pl. I. B, iii.) with or without creamy white powdery covering	Oblong or oval, black in colour with brown patches (Pl. I. C, iii)	Seeds oval with a membranous margin (Pl. I. D, ii)	Seeds hemispherical, usually pale yellow in colour and lightly pitted (Pl. I. E, iii)	Seeds nearly spherical smooth (Pl. I. F, iii) with a white band around

[1] A few specimens as noted under the last para of specimens cited under *Commelina kurzii*, however, show 3-equal valved capsules, all properly dehiscing without any warty, indehiscent, posterior cell, but exhibit all the other characters clearly similar to those of *C. kurzii*. Even the chromosome numbers of these two types of specimens are so identical that in two populations from Jogeshwari and Tenmalai of the first type (with warty, indehiscent, posterior cell), the haploid numher is 60 and 45 respectively whereas in two different populations from Agumbe and Katraj ghat of the second type (with 3-equal valved capsule), the number is 60 and 45 respectively. This indicates that the indehiscent nature of the posterior cell does not seem to form an important character of the species as understood at present. It is also very likely that this type of species may be a hyhrid between *C. kurzii* and possihly *C. paludosa* which grow together in several populations. However, as this type cannot be distinguished from *C. kurzii* proper without the capsule, it is at present treated under *C. kurzii* only.

Iran River upstream, Sasan (Saurashtra), *Santapau* 16416 ; Waghai, Dangs, *Santapau* 19273 ; Junagadh, foot of Girnar, *Santapau* 14906, *Bole* 724 ; Sion, Bombay, *Acland* 1222, *Santapau* 219.4H, 219.5H ; Bandra, Bombay, *Acland* 1223 and other numbers; Vinayalaya, Andheri, *Santapau* 14023, 14024 ; Aarey Milk Colony, Bombay, *Shah* 1829, *Tavakari* 1420, 1421 ; Malad and surroundings, *Shah* 9172 and other numbers; Khandala, *Gammie* * 15461 (in part as the other bit of specimen is C. *obliqua*) ; Belgaum, *Sedgwick* 2980 ; Tavargatti, *Sedgwick* 2637; Karwar (North Kanara), *Hallb.* & *McCann* 34966 ; Ratnagiri (Vizag. Dist.) *Santapau* 20597, 20647 ; Vansalmamdi (Vizag. Dist.), *Santapau* 20714 ; Lamasingi (Vizag. Dist.) *Santapau* 20758 ; Sinhachalam (Vizag. Dist.), *Wagh* 2014, 2015 ; Valley garden (Vizag. Dist.), *Wagh* 4633 ; Papikonda (West Godavari Dist.), *Wagh* 1900 ; Kondapalli (Krishna Dist.), *Wagh* 3212, 3214. (BLAT)

Tigorda, Hirapur Reserved Forest (Saugor Dist.), *Balakrishnan* 11450 ; Mahendragiri (Ganjam Dist.), *Narayanaswami*, 5669 ; forest near Araku (Vizag. Dist.) *Balakrishnan* 10798 ; Dharakonda (Vizag. Dist.), *Madras Herb.* No. 5221 etc. ; east of Narsapur (Vizag. Dist.), *Sebastine* 6711 ; Karakakonda (Vizag. Dist.) *Barber* * 1711 ; Kondapudi River, Godavari Agency, *Barber* * 5226 ; Godavari gorge, *Bourne* * 3517 (noted under *C. obliqua* in FL. MADRAS) ; Ginjee (South Arcot), *Raju* & *Naganathan* 17968 ; Chengattu Patti (Tiruchirapally Dist.), *Sebastine* 6247 ; Thekkumalai (Coimbatore Dist.), *Sebastine* 1376 ; Kodaikanal Ghat, *Bourne* * 2255 (noted under *C. obliqua* in FL. MADRAS) ; on way to Naterikal, (Tinnevelly Dist.), *Madras Herb.* No. 52204 ; Walayar Railway Station, Malabar, *Raju* & *Ratnavdu* 18634. (MH)

Specimens having 3-valved capsule without an indehiscent cell :

Bhogaon, near Paud (Poona), *K. N. Subramanian* 64939 ; Katraj Ghat, near Poona, *Kammathy* 71251 ; Agumbe (North Kanara), *R. S. Raghavan* 74035 ; Jogi Hill, Chittaldrug, *Rolla* 73151 ; Minicoy Islands (Laccadive), *Wadhwa* 69835. (BSI)

Near Unai Rest House, Dangs *Santapau* * 16989 (noted under *C. obliqua*) ; Katraj Ghat, *Sedgwick* 7535. (BLAT)

Barnakonda Reserved Forest (Vizag. Dist.), *Madras Herb.* No. 52211 etc. ; Nallamalai (Kurnool Dist.), 52217 etc. (MH).

Distribution. The species, which was always mixed up with *C. paludosa* (= *C. obliqua*) by different workers on western India flora, has not been reported at all from western parts of India. The species, as understood at present, is well distributed in different parts from Rajasthan to Kerala, Deccan plateau, including Billigirirangan and Annamalai Hills, south Indian hills, and Eastern Ghats. In fact this is more commonly represented in peninsular India than *C. paludosa*. This is now newly recorded from northern area at Hastinapur near Meerut. The distribution of this species in different parts of the country will be examined further on the basis of various collections from other herbaria including the Central National Herbarium, Calcutta. Pl. III(3).

5. **Commelina suffruticosa** Bl.

Jogeshwari, Bombay, *Rolla* 32770 ; Borivli (Bombay), *Rolla* 32738 ; Aarey Milk Colony, Bombay, *Rolla* 32761 ; Karjat, *Puri* 22879 ; Agumbe (North Kanara), *R. S. Raghavan* 74035A ; Yellapur (North Kanara), *Talbot* 698 ; Mothronwala, Dehra Dun, *M. A. Rao* 16392. (BSI)

Subir, Dangs, *Santapau* 19508 ; Waghai, Dangs, *Santapau* 19190 ; Salsette, *Acland* 1239, *Blatter Herb.* No. 26263, 26267 ; Aarey Milk Colony, Bombay, *Tavakari* 1339 and other numbers ; Mumbra, near Bombay, *Shenoy* 58 and other numbers ; Malad, Bombay, *Shah* 9628 ; Jummapatti, *Irani* 4127 ; Khandala, *Santapau* * 718, *2585 (noted under *C. obliqua*) ; Thakurwadi, *Irani* 4173 ; Tungar (Thana Dist.), *Santapau* 219. 8H. (BLAT)

Dhain-Bori Road (Hoshangabad Dist.), *Joseph* 11226. (MH)

Distribution. Though this species is recorded from Bengal, Behar, and central India, and recently from Bombay area, it is interesting to note that the authors have collected this species from Assam plains and Khasia Hills (specimens at Shillong Herbarium) ; the species is now recorded from several new localities in Gujarat, lower and upper ghat region from Bombay to Poona, and further south-east to North Kanara in Mysore State. It is interesting to note here that the species has recently been collected from Dehra Dun area which forms a very useful record to extend the distribution further north. Such distribution from Assam to Bombay area of the west coast through Bengal, Behar and central India, Uttar Pradesh and Gujarat, and further extending towards northernmost points through Dehra Dun and North Kanara through Western Ghats region needs further study in the light of fresh collections to be made from other parts of the Uttar Pradesh and Punjab and from Deccan Plateau and east coast. Pl. III(4). However, recent field studies along different points on Deccan plateau from Poona to Hyderabad and also to Bangalore indicate clearly that this species is conspicuously absent in such areas of the plateau.

6. **Commelina ensifolia** Br.

Devarayadurga, near Tumkur, *Rolla* 73302 ; Lalbagh Botanical Garden, Bangalore, *Rolla* 73480 ; Maruthumalai, Coimbatore, *Kammathy* 73924 ; about 10 miles north of Attakatty Rest House, Annamalais, *Kammathy* 73937 ; Tenmalai and surroundings (Kerala), *K. N. Subramanian* 70891 and other numbers. (BSI)

Bollapalle Reserved Forest (Guntur Dist.), *Madras Herb.* No. 52240, 52242 ; Cuddapah Dist., *Gamble* 15114 ; Bangalore, *Madras Herb.*

No. 85046 ; Chingleput (Madras), *Gamble* 17621 ; Nagari (North Arcot Dist.), *Madras Herb.* No. 52258-52260 ; Hosur Cattle Farm (Salem Dist.), *Narayanaswami* 2908, 2962 ; Arepalayam, Kollegal (Coimbatore Dist.), *Narayanaswami* 3469, 3477 ; Maruthamalai (Coimbatore Dist.), *Sebastine* 1296 ; slopes of Kuridimalai (Coimbatore Dist.), *K. Subramanyam* 706 ; on way to the top of Pachamalai (Tiruchirapalli Dist.), *Sebastine* 6160 ; Kodaikanal Ghat, *Bourne* 2267 ; Sirumalai (Madura Dist.), *Madras Herb.* No. * 72918 (noted under *C. undulata* var *setosa* in FL. MADRAS) 52227 ; on way to Naterikal (Tinnevelly Dist.), *Madras Herb.* No. 52236, 52237 ; Mahendragiri (Tinnevelly Dist.), *Madras Herb.* No. 52252 and other numbers ; on way to Mancholai (Tinnevelly Dist.), *Sebastine* 4518 ; above lower Dam Papanasam (Tinnevelly Dist.), *Sebastine* 8366 ; Courtallum (Tinnevelly Dist.), *Madras Herb.* No. 52230 and other numbers. (MH)

Distribution. Though the distribution of this species is recorded in Peninsular India from Bellary to Tinnevelly, specific localities within this zone are recorded here for the use of different workers as this species is mostly confused with *C. paleata* and *C. undulata* in the herbarium. By the new record here from Tenmalai, Kerala State, where this species grows profusely, the distribution is extended further west. Pl. III(4).

II. *MURDANNIA* Royle

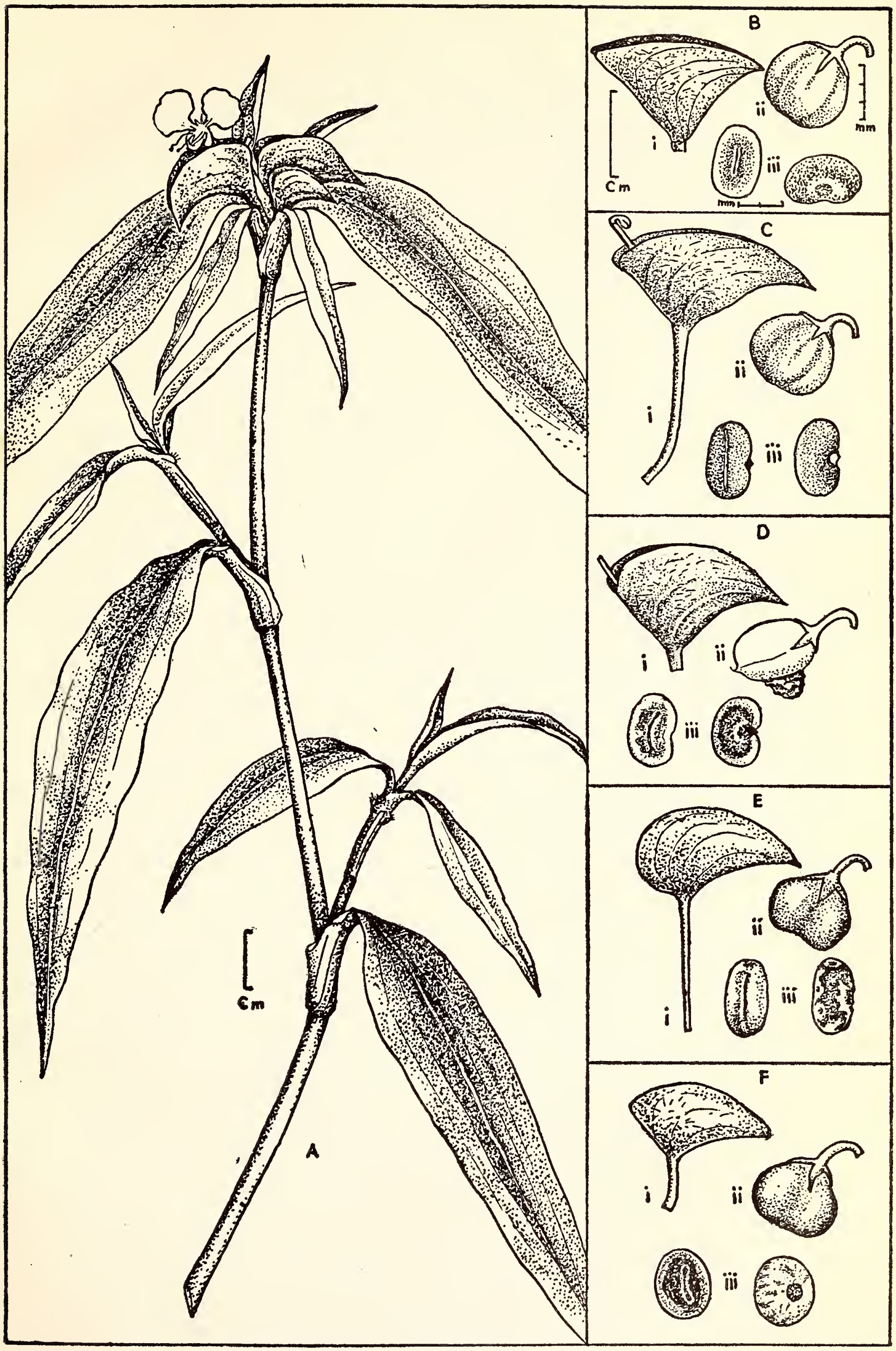
Royle in *Illust. Bot. Himal.* 403, t. 95, fig. 3, 1839, described the genus *Murdannia*, which he named after Murdan Aly. Its gender is feminine as Royle published as *M. scapiflora.* Brenan in *Kew Bull.* 1952, 179, made this point clear enough, though the neuter gender was adopted by Brückner [*Nat. Pflanzenfam.*, ed. 2, 1930], Santapau [*J. Bombay nat. Hist. Soc.* 52 ; 658, 1954] and Raizada [*Ind. For.* 83 : 498-499, 1958] which is wrong. All the specific names under *Murdannia* ending in '*um*' as noted by previous workers should therefore end in '*a*'.

Two species, namely *Murdannia simplex* and *Murdannia gigantea*, are often mistaken for each other, due to their partial similarity in external morphology. Their distinguishing characters as observed from plants under cultivation are presented in Table II.

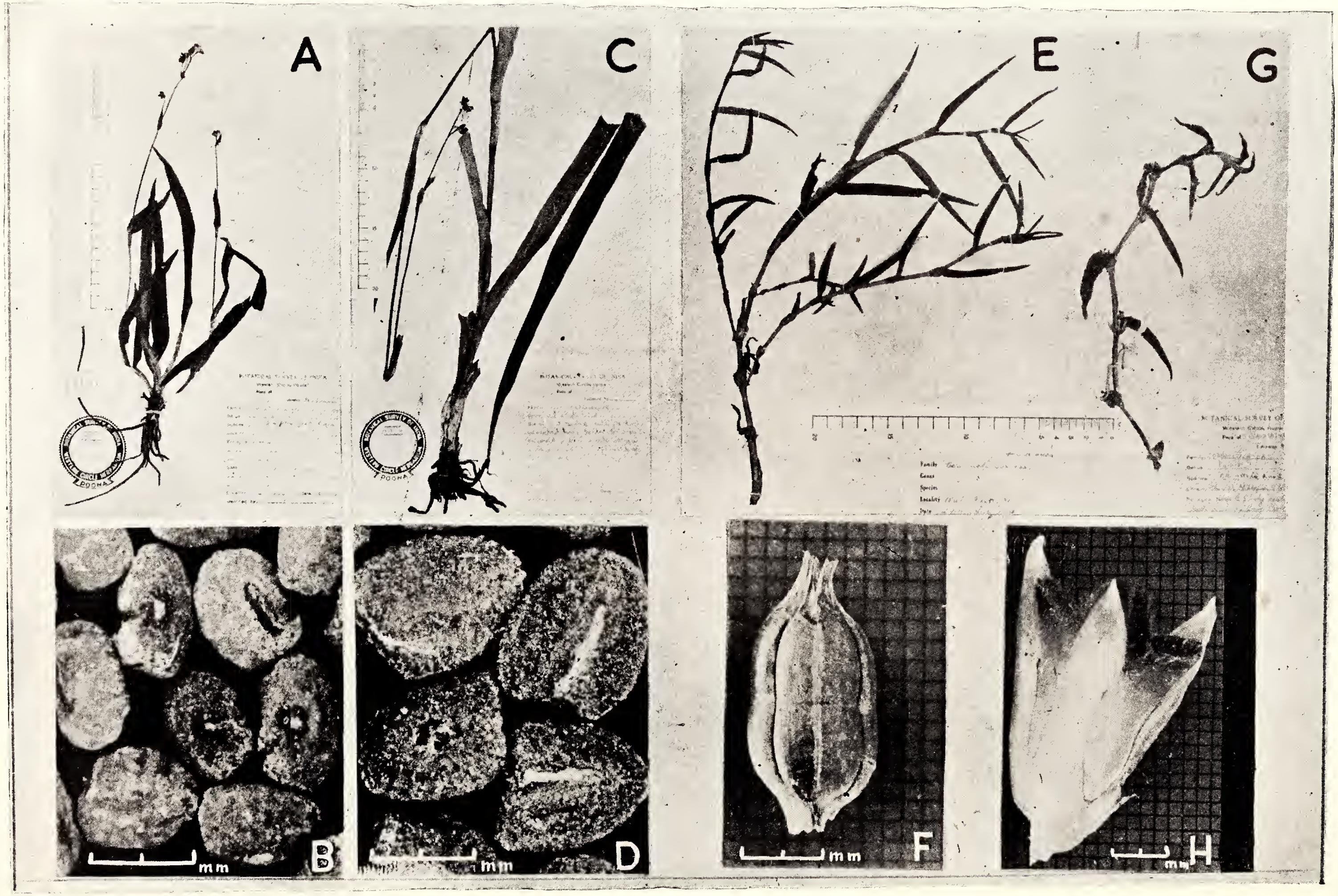
1. **Murdannia simplex** (Vahl) Brenan

(*Aneilema sinicum* Ker-Gawl. as amended by Brenan in *Kew Bull.* 1952: 186.)

Mahableshwar, *Cooke* (noted under *A. secundum* in Fl. of Bombay) ; Khanapur, Belgaum, *Ahuja* 43653; Agumbe (North Kanara) *R. S. Raghavan* 74284 and other numbers; Siddulgundi (North Kanara), *Talbot* on 10.10.1884 ; Karwar (North Kanara), *Talbot* 1510 ; Madapur, Coorg



A. Flowering branch of *Commelina kurzii* Cl. (note the smaller leaves accompanying the spathes). B,C,D,E, & F : (*i*) Spathe, (*ii*) Capsule, and (*iii*) Seeds (in dorsal & ventral view). B. *Commelina paludosa* Bl. ; C. *Commelina paleata* Hassk. ; D. *Commelina kurzii* Cl. ; E. *Commelina suffruticosa* Bl. ; F. *Commelina ensifolia* Br. (Scale same for all)



A & B. Habit of *Murdannia simplex* (Vahl) Brenan (note the lateral origin of the flowering branches) and the seeds respectively; C & D. Habit of *Murdannia gigantea* (Vahl) Brückn. (note the terminal flowering scape) and seeds respectively; E & F. Habit of *Cyanotis axillaris* (L.) Schult. f. and capsule respectively; G & H. Habit of *Cyanotis cucullata* Kunth and capsule respectively.

Dist., *Rao A.S.* 74965 ; about 5 miles north of Attakatty Rest House, Annamalais, *Kammathy* 73944. (BSI)

Yellapur (North Kanara), *Santapau* 18734 ; Dandeli (North Kanara), *Santapau* 18771, 18772; North Kanara, *T.R.D. Bell* 2702; Gersoppa Falls (North Kanara), *Sedgwick* 7155; Tavargatti *Sedgwick* 2642. (BLAT)

Poonachi, Annamalais, *Barber* 3705; between Alliar and Thora Kadaviar, Annamalais, *Barber* 3680 ; Benne Forest (Nilgiri Dist.), *K. Subramanyam* 10472; Karadisonai Betta top, Kollegal (Coimbatore Dist.), *Narayanaswami* 3629. (MH)

TABLE II

Comparison of characters of *Murdannia simplex* and *Murdannia gigantea*

	M. simplex	*M. gigantea*
1. Habit	A perennial spreading herb with stout fibrous roots ; leaves radical, 15-30 cm. long and 1-1.5 cm. broad ; flowering branches a few, axillary, bearing very small leaves, spreading laterally and rooting at nodes (Pl. II, A), leaf sheath hairy	A perennial erect herb with stout fibrous roots ; first few leaves radical, 20-40 cm. long and 1-2 cm. broad; peduncle solitary, terminal, bearing smaller leaves and developing erect from the centre of the radical leaves (Pl. II,C), leaf sheath mostly glabrous
2. Seeds	Seeds somewhat oval, brown in colour, faintly rugose (Pl. II,B)	Seeds flat, somewhat triangular, brown in colour, obscurely pitted (Pl. II, D)

Distribution. This species has so far been recorded from the Western Ghats only from Konkan southwards. On the basis of the new localities cited above, the distribution can be extended towards the Deccan plateau immediately east of Western Ghats up to North Kanara in the east and up to the Annamalais, Nilgiris, and in the south through the Western Ghats of Coorg district. Pl. III(5).

2. **Murdannia gigantea** (Vahl) Brückn.

(*Aneilema giganteum* Br.)

Balmora track, Tenmalai (Kerala), *K. N. Subramanian* 70890; Kazhuthurity, Arienkav (Kerala), *K. N. Subramanian* 70951. (BSI)

Wight's Herbarium, *Madras Herb.* No. 52365. (MH)

Distribution. The distribution of this species is quite interesting and discontinuous as it is recorded so far from the Khasia Hills of Assam and the mountainous districts of Madras State, the latter, however, being quite vague. Though this species is now recorded from the

Tenmalai region of Kerala hills, it is quite possible that it has a restricted distribution in the south Indian hills as it is mostly confused with *M. simplex*. Further, this species does not seem to occur in Konkan-Mahableshwar of western India as no specimen of this has so far been collected from that area and as Cooke's collection from Mahableshwar and others' collections from Dandeli, North Kanara, turn out to be *M. simplex* on scrutiny. Pl. III(5).

III. *ANEILEMA* R. Br.

1. **Aneilema scaberrimum** Kunth

Nilkund (North Kanara), *Talbot* on 5.12.1883; Devala, Nilgiris, *Gamble* 15702; Balmora track, Tenmalai (Kerala), *K. N. Subramanian* 70895 and other numbers; near main falls, Annamalais, *Kammathy* 73948. (BSI)

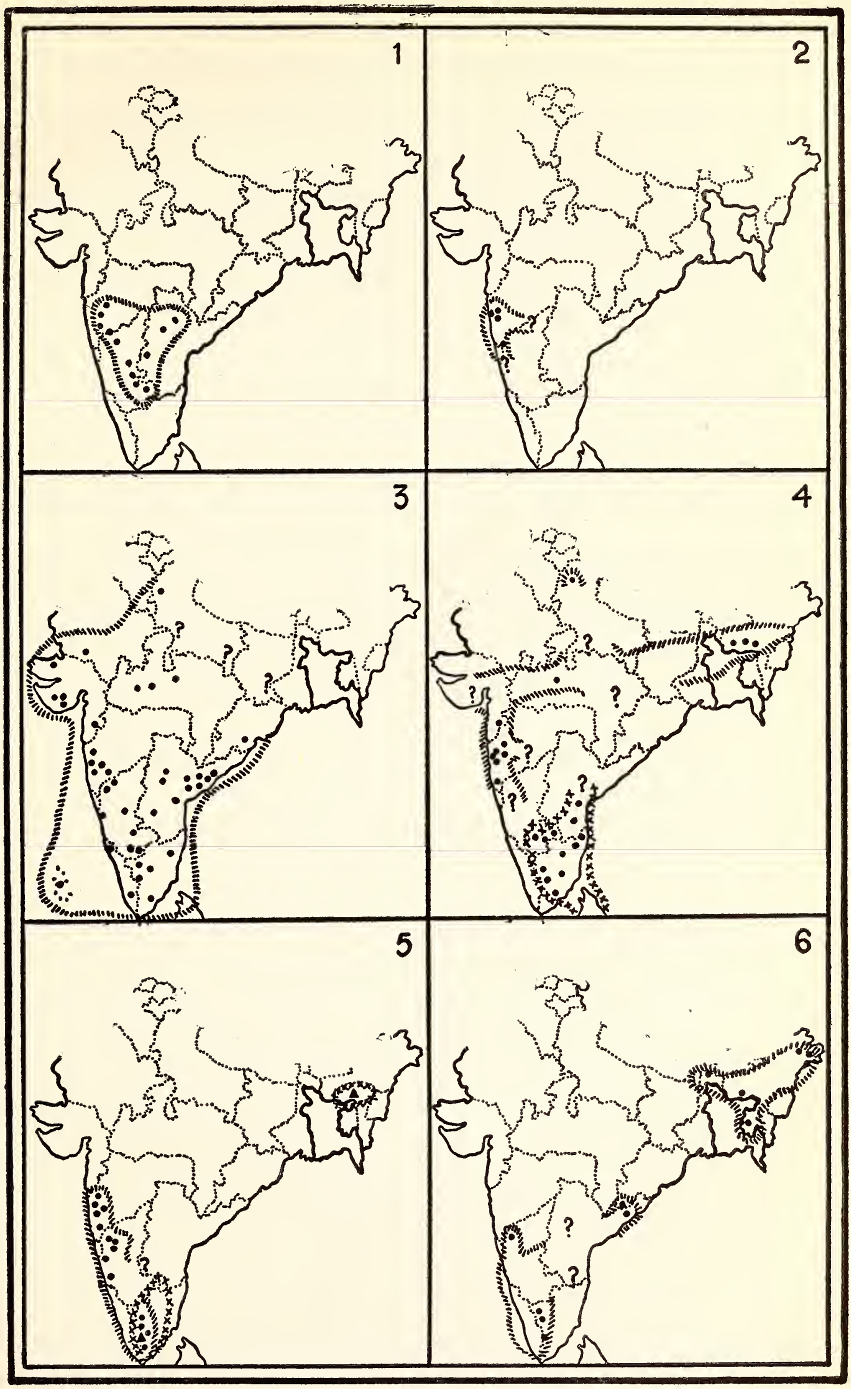
Jeypore (Orissa), *Santapau* 21374, 21375. (BLAT)

Forest near Sunkarimetta (Vizag. Dist.), *Balakrishnan* 10925; Vanathirtum (Tinnevelly Dist.), *Sebastine* 9669. (MH)

Distribution. This species which has been recorded from the Western Ghats region from Coorg to Travancore of peninsular India in FLORA OF MADRAS, is now reported from North Kanara, Nilgiris, Annamalais, and Vizag. Districts of east coast and thus the distribution of the species is extended further north and east of peninsular India. Similarly this species was collected as a common weed by the senior author from Siang Frontier, Lohit Frontier, Tirap Frontier divisions of North-East Frontier Agency Himalayas, thus extending its distribution further east from Sikkim Himalayas proper, and also collected from Tripura State, thus extending its distribution further south from the Khasia Hills. Pl. III(6).

IV. *CYANOTIS* Don

Cyanotis axillaris (Linn.) Schult. f. and *Cyanotis cucullata* Kunth are two closely allied species and have puzzled many taxonomists. By the correct identity of *C. cucullata*, several new localities not recorded before are given here, thereby widening its distribution. The vegetative characters, as noted from living plants both from field and under cultivation, are presented in Table III.



. Maps of India showing the distribution of some species of Indian Commelinaceae.

1. *Commelina subulata* Roth. ; 2. *Commelina paleata* Hassk. ; 3. *Commelina kurzii* Cl. ; 4. *Commelina suffruticosa* Bl. (area indicated by hatching) ; *Commelina ensifolia* Br. (area indicated by crosses) ; 5. *Murdannia simplex* (Vahl) Brenan (area indicated by hatching) ; *Murdannia gigantea* (Vahl) Brückn. (area indicated by crosses ; 6. Aneilema *scaberrimum* Kunth.

TABLE III

Comparison of characters of *Cyanotis axillaris* and *Cyanotis cucullata*

	C. axillaris	*C. cucullata*
1. Habit	A branched herb, leaves long, narrow, 5-10 cm. long and 0.4-1 cm. broad, internodes comparatively longer even in the upper portion, leaf sheath though slightly bulged during flowering and fruiting never cucullate (Pl. II, G)	A branched herb, leaves small succulent, 3-6 cm. long occasionally up to 10 cm. long and 0.8-1.2 cm. broad, closely developed in the upper portion covering the internodes, leaf sheath much swollen and cucullate at each node (Pl. II, E)
2. Capsule	Capsule with a pointed end at the tip without any depression (Pl. II, H)	Capsule with three red projections at the tip and depression at the centre (Pl. II, F)

1. **Cyanotis cucullata** Kunth

Umarai, Central India, *Puri* 26509 ; Mendikare, central India, *Puri* 26451 ; Abaidullahganj, East Bhopal, *Wadhwa* 59597 ; between Dhari and Visavadan, Saurashtra, *Rolla* 63788 ; between Veraval and Dholka, Saurashtra, *Rolla* 63912 ; Olpad near Surat, *Rolla* 63603 ; Mukundpur *Rolla* 68530; Ghavar, Mukundpur, *Rolla* 68547; Dahej, Bombay coast, *Toor* on 20.10.1957; Bibi village, Khed Taluka, *Rolla* 66163; Law College, Poona, *K. N. Subramanian* 64606; Chathursinghi, Poona, *R. S. Raghavan* 64260 ; Pandharpur, *Bhide* in Sept. 1913 ; Karlimatti Woodrow on 28.8.1892 ; Erandol, East Khandesh, *Mahajan* 6456 ; near Veruba hill 3 miles from Alit, Satara Dist., *Rolla* 73036 ; Stigaon, near Police check-post at 223rd mile on Poona-Bangalore Road, *Rolla* 73076 ; Ranganalligudi, Chittaldrug, *Rolla* 73162, 73175 ; four miles from Hiriyur, near Chittaldrug, *Rolla* 73209; on the northern side of Gayathri reservoir canal, *Rolla* 73238; Budhawar Peth, Kurnool, *Kammathy* 73959 ; Osmania University Campus, Hyderabad, *Kammathy* 73974 ; Narasapur, Medak Dist., *Kammathy* 73986 ; Dhangarwadi, near Wadi Railway Station, *Kammathy* 73987 ; Coimbatore, *Joseph.* (BSI)

Near irrigation lake, Gondal, *Santapau* 14647 ; Gondal-Rajkot, *Bole* 556 ; beyond Rajkot Station, *Santapaü* 16852, 16853, and other numbers ; Sindhwai Temple Road, Broach, *Shah* 877 ; Diva Ghat, Poona, *Blatter Herb.* No. 26616 ; near Purandhar bus stand, *Santapau* 11464 ; Jbudge, *Patel* on 19.9.1886. (BLAT)

Round about Hoshangabad (Hoshangabad Dist.), *Joseph* 11082 ; Nagarjunsagar (Nalconda Dist.), *Sebastine* 9731 ; in cultivated field, on way to Vaniampadi (North Arcot Dist.), *K. Subramanyam* 7491 ; northern slopes of Kuridimalai (Coimbatore Dist.), *K. Subramanyam* 1465 ; Perianaickenpalayam (Coimbatore Dist.), *K. Subramanyam* 1314 ; Sathyamangalam (Coimbatore Dist.), *Raju* 6195. (MH)

Distribution. Generally on the basis of the available collections, including the recent ones, it appears that *C. axillaris* is rather common along the coastal areas on the west and east, though collected from other parts of India along moist and marshy areas; whereas *C. cucullata* is more common on the Deccan plateau, growing in several areas in between Poona, Hyderabad, and Mysore, mostly along the cultivated fields where possibly there is less competition of weeds. The more common among the two in Poona and surroundings is *C. cucullata* rather than *C. axillaris.*

Acknowledgements

The authors express their grateful thanks to the Council of Scientific and Industrial Research, New Delhi, for their grant for the scheme under which this work is being carried out, and to Rev. Father Dr. H. Santapau, Chief Botanist, Botanical Survey of India, Calcutta, for kind encouragement and co-operation, and for his keen interest in the progress of the work. The authors' thanks are also due to the various friends and colleagues who have been constantly co-operating in sending the various specimens of the family from different parts of the country.

References

Brenan, J.P.M. (1952): Notes on African Commelinaceae. *Kew Bull.*: 179-208.

Brückner, G. (1930): Commelinaceae. In Engl. & Prantl, Pflanzenfam., ed. 2, **15A**: 159-181.

Clarke, C.B. (1881): Commelinaceae. In DC. Mon. Phan. **3**: 148-245.

Cooke, Th. (1901-1908): The Flora of the Presidency of Bombay. (Commelinaceae in **4** : 625 - 816, 1907).

Fernandes, R., Randeria, R., & Santapau, H. (1954): New Plant Records for Bombay. *J. Bombay nat. Hist. Soc.* **52** : 662 - 663.

Fischer, C.E C. (1931) : Flora of the Presidency of Madras. (Commelinaceae in **9** : 1538 - 1550).

Haines, H.H. (1924): The Botany of Bihar and Orissa. (Commelinaceae in 1077-1078).

Hooker, J.D. (1872-1897) : Flora of British India. (Commelinaceae in **6** : 366-390, 1892).

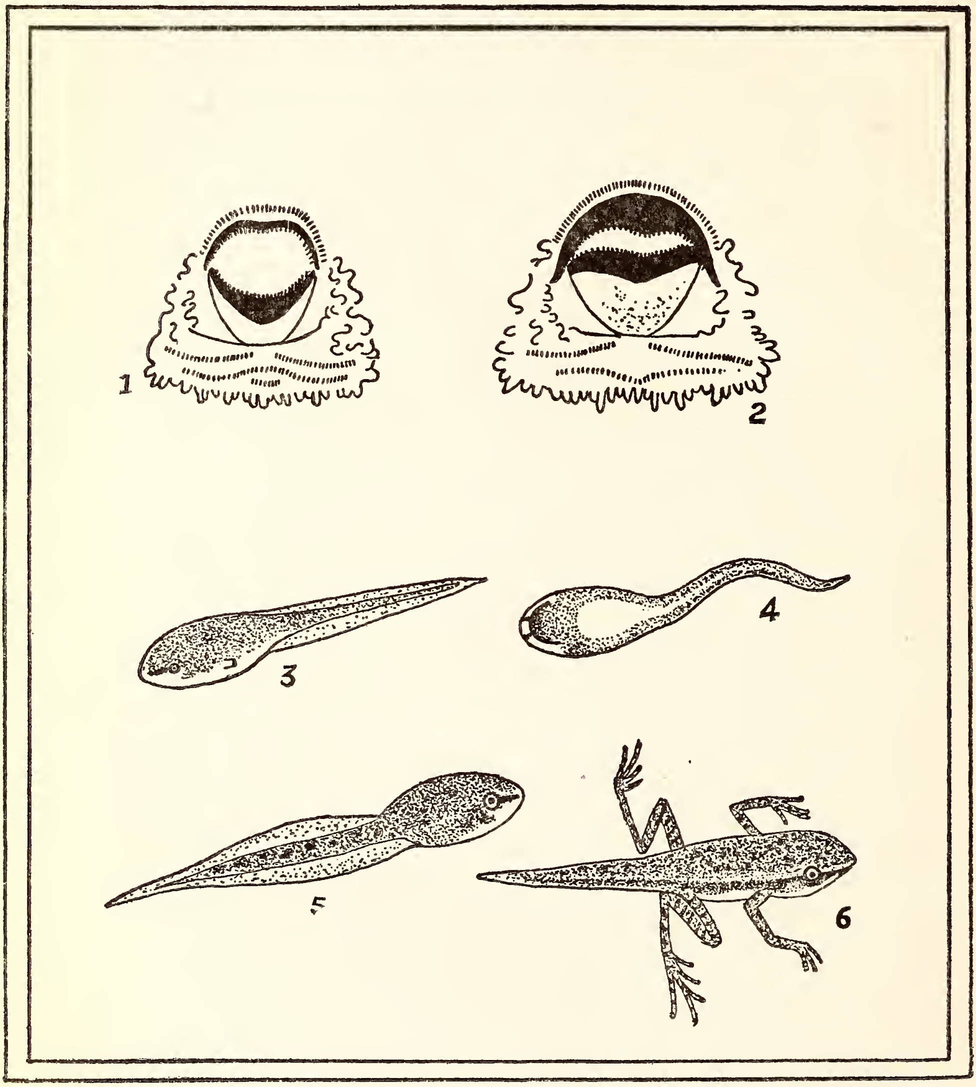
Raizada, M. B. (1958) : Name changes in common Indian Plants. *Ind. For.* **83** : 498-499.

Santapau, H. (1953): Flora of Khandala on the Western Ghats of India in *Rec. Bot. Surv. India* **16** (1) : 323-327.

——— (1954): The Genus *Murdannia* in Bombay State. *J. Bombay nat. Hist. Soc.* **52** : 658.

——— (1955) : Contributions to the Botany of the Dangs Forest, Bombay State. *J. Gujarat Res. Soc.*: 54-55.

———(1958): The Flora of Purandhar: 133-135.



The Fungoid Frog, *Rana malabarica* Bibron

1. Mouth-disc showing additional row of teeth in lower lip ; 2. Normal mouth-disc ; 3. Tadpole with spiracle visible ; 4. Ventral view of tadpole, showing mouth-disc ; 5. Tadpole, showing streak between nostril and eye ; 6. 4-limbed stage, showing dark streak on side and bands on hind limbs.

A Description of the hitherto undescribed Tadpole of, and some Field Notes on the Fungoid Frog, *Rana malabarica* Bibron

BY

V. K. CHARI
Prince of Wales Museum of Western India, Bombay

(*With one plate*)

During the 1957 monsoon, while collecting zoological material from rain-water pools in the Krishnagiri National Park, Borivli, Salsette Island, Bombay, I obtained a tadpole in its 4-limbed stage which looked quite different from those already known from this locality. It was taken in a dip-net from a pool on the west of Gandhi Smarak Mandir Hill, close to a culvert on the road to the Kanheri caves. At the same time I also took tadpoles of *Rana cyanophlyctis* Schneider, the fishes *Rasbora daniconius* (Hamilton), *Puntius ticto* Hamilton, and *Channa gachua* (Bloch), and a few dragon-fly larvae.

The flat flesh-coloured dorsum, the dark brown flanks, the conspicuous dark band extending from snout to hind-limb, the alternately arranged prominent light and dark transverse bands on the limbs, and the characteristic digits were all strongly suggestive of the specimen being an early stage of the Fungoid Frog, *Rana malabarica* Bibron.

Efforts to obtain some more specimens of this tadpole on the same day were in vain. Three subsequent collections, made on 1, 6, and 8 September 1957, were productive of fifty specimens including some in the 4-limbed stage. The only other pool which yielded this tadpole was one also adjoining the road to the Kanheri Caves and situated on the southern side of the Gandhi Smarak Mandir Hill about half-a-mile away from the first pool.

Eight of the tadpoles collected on 1 September were reared at the Natural History Section, Prince of Wales Museum of Western

India, Bombay, three of which developed into the juvenile frogs of *Rana malabarica* Bibron now in the collections of the Bombay Natural History Society. The rest died at different stages of metamorphosis.

The description of the tadpole of *Rana malabarica* Bibron recorded by Boulenger (1920) in 'A Monograph of the South Asian, Papuan, Melanesian and Australian Frogs of the Genus *Rana*' (*Rec. Ind. Mus.* **20** : 100), based on the tadpoles collected by Mr. Kemp from Talewadi, near Castle Rock, North Kanara, and identified as of this species by Dr. Annandale (ibid.) differs greatly from the specimens collected in Borivli, whose identity is not in doubt.

The Talewadi tadpoles (*vide* Boulenger's description) differ from the Borivli tadpoles as under:

Talewadi Tadpoles	*Borivli Tadpoles*
1. Large, overall length 70 mm.	Medium-sized, the largest being 48 mm.
2. Tail $1\frac{1}{2}$ to $1\frac{2}{3}$ times the length of head and body; the crest on tail not extending on to the back.	Tail nearly twice the length of head and body; the crest extending slightly on to the back.
3. Horny teeth in eight upper series, the two outer continuous, the others gradually decreasing in length; six or seven lower series, the innermost narrowly interrupted, the others continuous.	Horny teeth in one upper series; commonly two lower series, of which the inner row is interrupted in the middle, rarely a short 3rd outermost row.

Four of the Talewadi tadpoles (Z.S.I. No. 18270) were examined by courtesy of the Director, Zoological Survey of India, Calcutta. They were found close to Rao's (1919) description of the tadpoles of *Rana curtipes* Jerdon. They also compare well with the four tadpoles of this species in the collections of the Bombay Natural History Society, Bombay, obtained by Mr. Humayun Abdulali from the Kali-Nadi, Dandeli, North Kanara District, Bombay (now Mysore), during Christmas 1951, B.N.H.S. Amphibian Collection No. 256.

Apart from these important structural differences, the respective colours of these two tadpoles in life are quite different. The Talewadi tadpoles were said to have been of 'black colour above and beneath', whereas those from Borivli are straw-yellow. There can, I think, be no doubt that the Talewadi specimens and Boulenger's description refer to *Rana curtipes* Jerdon and not to *Rana malabarica* Bibron leaving the latter tadpoles undescribed. I am, therefore, giving a description of the tadpole of *Rana malabarica* Bibron;

Description of tadpole of **Rana malabarica** Bibron

Head and Body: Oval, the broader end being towards anus; snout bluntly pointed and declivous; eyes dorsal, prominent; nostrils, black and inconspicuous, nearer the tip of the snout than the eye; dorsum flat.

Mouth-disc: Fairly big and sucker-like, ventral in position; roughly spherical in shape, with a pointed emargination on either side: the margin of the upper lip fringed with horny teeth and devoid of papillae; the lower lip with two rows of horny teeth, the first row interrupted and the second complete: rarely an additional ill-developed third row, in which case the second row has a small concavity just in the middle of its course into which the small third row fits (6 of 50 examined had this character); papillae lining the margin of the lower lip of the mouth-disc extend laterally up to the upper lip on either side of the mouth-disc, and are continuous with the row of teeth fringing its margin; dental formula 1/1+1:1 rarely 1/1+1:2; the upper beak crescentic; lower broadly V-shaped; margins of both finely serrated.

Tail: Nearly twice the length of head and body, tapering gradually and sharply pointed; the fin-membranes well developed both dorsally and ventrally and relatively broad, the upper commencing dorsally from the posterior part of the body slightly above the origin of the tail.

Spiracle: Tubular in shape, located laterally roughly at mid-body on the left.

Anus: Prominently tubular; extending to nearly $\frac{1}{8}$ of the tail, directed to the right.

Colour: General colour straw-yellow. Head and body blotched with brownish black, and the ventral surface whitish; nostril black; pupil black; iris golden yellow; spiracle whitish; tail straw-yellow with light speckling of black; upper beak black; lower generally white, rarely pearly-white with grey blotches, and margin black; a dark line commences at the nostril and continues backwards through the eye and along the side of the body on either side to the base of the tail in the four-limbed stage; hind limbs prominently barred transversely and alternately in black and white; fore limbs also similarly barred but less strikingly.

Field Notes: Both the pools from which the tadpoles were obtained were open and not shaded by trees or shrubbery. The water was ankle- to knee-deep, with a muddy bottom, and there was a profuse growth of weeds, grass, and other monsoon-vegetation in and around the pools.

TABLE

Measurements of 11 specimens of *Rana malabarica* Bibron in various stages of development

	1	2	3	4	5	6	7	8	9	10	11
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Total length ..	26	35	38	41	44	48	46	36	32	23	19
Length of head and body ..	9	13	14	15	16	16	15	20	20	17	16
Breadth of head and body ..	5	7	8	8	9	9	9	10	8	7	6.5
Depth of body ..	5	5	6	6	8	7	8	8	8	6	4
Greatest depth of tail ..	6	7	8	7	9	7	10	6	4	3	No tail

Note: No. 6 with well-developed hind limbs; Nos. 7, 8, 9, and 10 in the 4-limbed stage ; and No. 11 a juvenile frog.

It was interesting to note that the tadpoles in both the pools were always found in company with those of *Rana cyanophlyctis* Schneider, as every scoop of the net invariably brought out a small mixture of both the species. *Rana malabarica* Bibron is ordinarily solitary. It may be worthwhile drawing attention to the fact that, though the frog is most often seen in rocky cisterns (but outside water) in the caves, forts, etc. in the hills around Bombay, the tadpoles were taken in an open pool with a muddy bottom at sea-level.

Laboratory Notes: It took two months and eighteen days for the tadpoles to grow into juvenile frogs, of which the last one died on 18 November 1957, probably for want of suitable live insect-food, while the others died at various stages of development. Under natural and more congenial conditions the period of development will perhaps differ.

Every attempt was made to afford the tadpoles as much natural environment as possible, including mud and weeds from the original pools. They were fed on minced meat.

These studies were carried out together with Dr. E. G. Silas, then Registrar of the Bombay Natural History Society, and I would like to record my gratitude for his assistance and co-operation.

In view of the paucity of field notes regarding this species, I am gratefully accepting Mr. Humayun Abdulali's offer to append his personal notes (unpublished), which he has supplemented with those of Mr. Charles McCann (*J. Bombay nat. Hist. Soc.* **36** : 168-169). Mr. Humayun Abdulali writes:

'Some specimens which I obtained on the Kasara Ghat near Igatpuri, Nasik District, and others in the Society's collection from Cannanore and Nelambur, in Malabar District, appear to represent the northern and southern limits of this species. McCann recorded it as fairly common in Bombay and Salsette Islands, generally in forested areas but occasionally in open country. He continued: "It is terrestrial and semi-arboreal in habit, and is frequently found perched high up on the bark of trees and on the leaves of bushes. In all probability it is a diurnal species as I have often come across it during the day, but have so far not found it about at night."

'In the dry weather (January, March, and April) they may be found in the stone cisterns at the Kanheri and other caves near Bombay, usually on the hills between 1000 and 2000 feet. They were noted on the wet soil or on the rocks and in crevices in the walls of the cistern but never inside the water. I have not seen it on trees but it does occur occasionally in the low country. The animal is not gregarious and is usually seen singly—though on 30 March 1956 more than 20 were seen together in one cistern. It is not at all shy and can be easily captured. One handled at Tansa Lake in September 1943 produced a smell like that of burnt rubber but this experience was never repeated.

'Jerdon in the *Journal of the Asiatic Society of Bengal*, 1853, p. 531, wrote: "Found only on the West Coast and chiefly during the monsoons when it enters houses and makes a gobbling so much like a turkey that some people call it the Turkey Frog." McCann says: "when handled it utters a call not unlike the mew of a cat as also a sort of high-pitched *kut, kut,* repeated several times". A very distinctive *wuck, wuck, wuck* in changing tones and notes heard at night have been traced to this frog sitting at the edge of a small rain-pool and shaded by mango trees. The pool held many skipper frogs (*Rana cyanophlyctis*). On another occasion the call was traced to an individual seated on the edge of a rock quarry and I have subsequently often heard this call by the side of pools in the low country, always at night.

'On the night of 24 June 1954 a female loaded with eggs, each half white and half black, was taken in one of the cisterns at Kanheri, but in spite of periodic examinations no spawn or tadpoles were found in the rock cisterns, where several other species are known to breed. It would appear that the rock cisterns are frequented only for moisture and that the breeding takes place in pools in open country.

'Two large and four small individuals were taken from the congregation seen on 30 March—the two large ones were females while the others were of both sexes. In all the organs were dormant, the large female contained reddish fat bodies on the stomach.

'The stomachs of small specimens examined held remains of dragonflies (?), while a large one taken at Kanheri contained the remains of *Rana leithii*. The female loaded with eggs referred to earlier contained four large centipedes.'

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 3

BY

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

(*With ten text-figures*)

[*Continued from Vol.* **58** (3): 748]

HYMENOPTERA

Hymenoptera, with 36 species so far known, constitute about 8% of the total nival insects (Table I, Fig. 3), with species endemism of nearly 47%, and Palaearctic elements amounting to almost 90%, (Tables VI and X, Fig. 22). Of the ten families found (Table V, Fig. 21) so far, Formicidae and Bombidae are the most abundant families.

TABLE V

Analysis of abundance of species in different families of the nival Hymenoptera

Serial No.	Family	No. of species	Percentage in total Hymenoptera
1.	Tenthredinidae	1	3.12
2.	Anthophoridae	1	3.12
3.	Andrenidae	1	3.12
4.	Megachilidae	1	3.12
5.	Pompilidae	2	6.24
6.	Sphegidae	2	6.24
7.	Vespidae	1	3.12
8.	Bombidae	8	25.00
9.	Formicidae	13	40.63
10.	Ichneumonidae	2	6.24
	Total	32	

NOTE.—Four species belonging to Bombidae, the exact localities of their collection not being known, are not taken into consideration for the above calculation. Including these species the total Hymenoptera is 36.

The Mediterranean element is represented by one species. Three species are also known to extend to the Nearctic Realm. Most of the

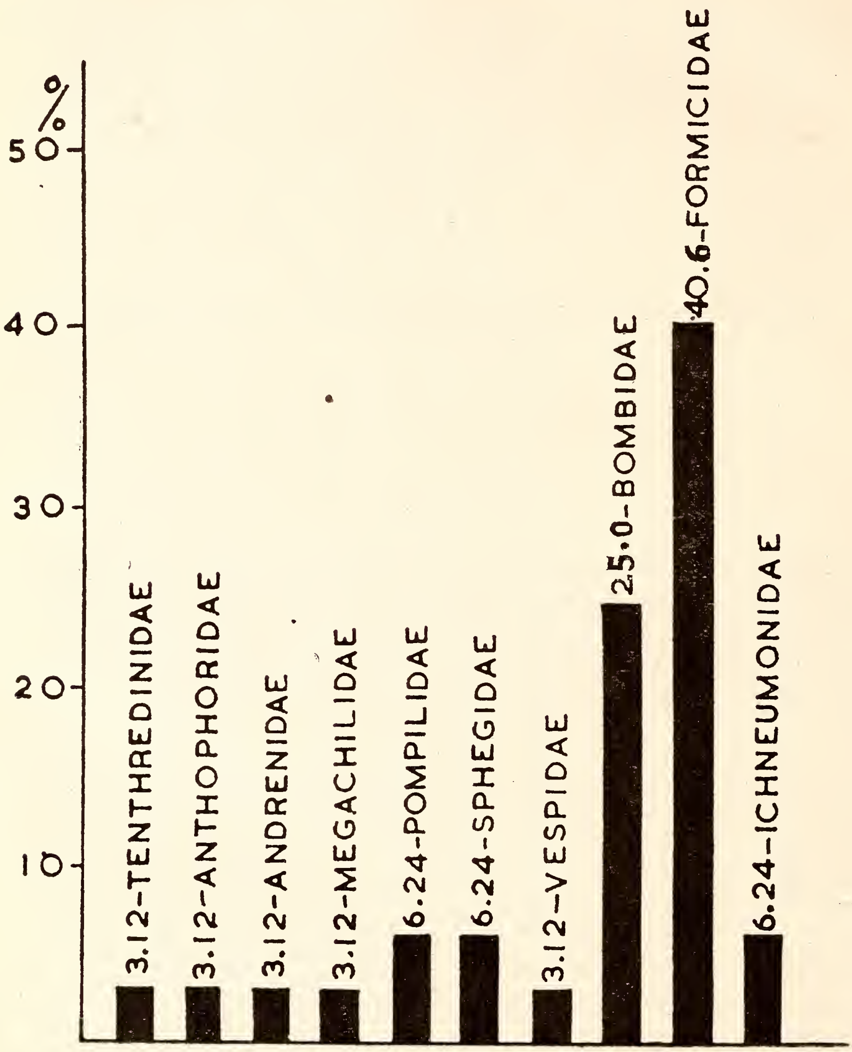


Fig. 21. The nival Hymenoptera from the north-west Himalaya.

species occur in the neighbourhood of an elevation of 3500 m., but about 9 species are known above 4000 m. The maximum altitude 4800 m. is reached by *Formica* (*Serviformica*) *picea* Nyl., in the Mustag Glacier area. Of the 12 species of Bombidae so far known (all Palaearctic) from above the timber line in the NW. Himalaya, *Subterraneobombus melanurus subdistinctus* (Richard) and *Bombus longiceps* Smith

TABLE VI

Faunal elements of nival Hymenoptera

Serial No.	Family	Total species	Endemites	Palaearctic Total	Palaearctic Medit.	Indo-Malayan
1.	Tenthredinidae	1	—	1	—	—
2.	Anthophoridae	1	—	—	—	1
3.	Andrenidae	1	1	1	—	—
4.	Megachilidae	1	—	—	—	1
5.	Pompilidae	2	2	2	—	—
6.	Sphegidae	2	—	1	1	1
7.	Vespidae	1	—	1	—	—
8.	Bombidae	12	2	12	—	—
9.	Formicidae	13	9	13	—	—
10.	Ichneumonidae	2	1	2	—	—
	Total	36	15	33	1	3
	Percentage out of 36, except in the case of Mediterranean, where it is out of the total Palaearctic		41.8	91.6	3.0	8.3

are endemic. These two species and *Bombus alticus* Evers., *Bombus valestris* Smith, *Mendacibombus margreiteri* O. Vogt, *Lapidariobombus*

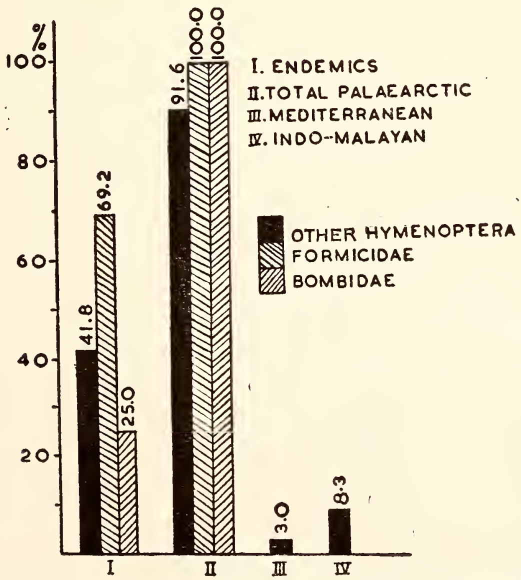


Fig. 22. Faunal elements of the nival Hymenoptera from the North-West Himalaya.

separandus (O. Vogt), *Lapidariobombus alagesianus pamirus* Skorikov, and *Subterraneobombus melanurus* (Lepel) among the non-endemics, are mostly localized in the Indus drainage area N. of the main crest

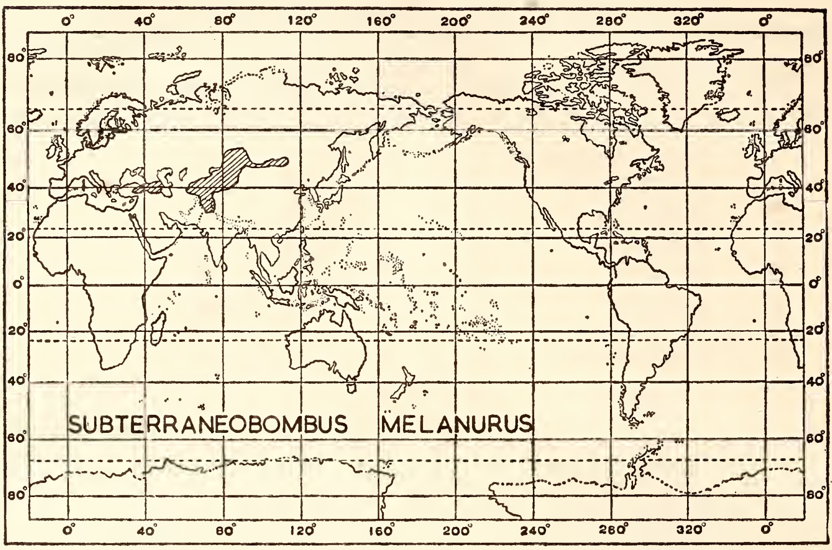


Fig. 23. The area (striped) of the world distribution of *Subterraneobombus melanurus* (Lepel).

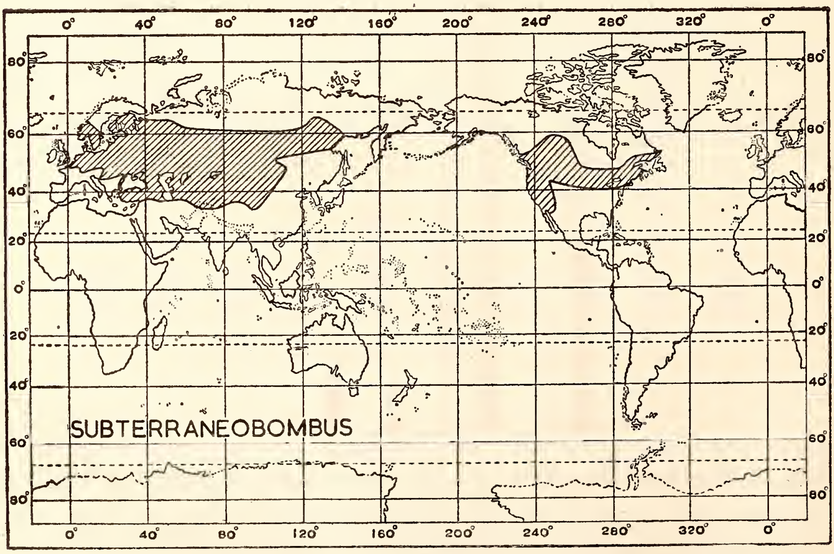


Fig. 24. The area (striped) of the distribution of the genus *Subterraneobombus* (*After Skorikov*, 142).

line of the Great Himalaya. The last mentioned species is also found in Tibet, Pamir, Altai, Gyangtse, and Transcaspia. The distribution of these forms is shown in Figs. 23 and 24. Four species occur at elevations above 4000 m. and *Bombus atrocinctus terminalis* Smith often occurs below the timber line up to as low an elevation as 1676 m. The remaining species are found between 3000 m. and 3700 m.

The distribution of Bombidae (Fig. 25) from the NW. Himalaya and the Pamir region has been discussed in some detail by Skorikov (142). He analysed the mountainity of Palaearctic species and listed the genera which are exclusively found on mountains of Eurasia. He recorded about 32 endemic species from the entire Himalaya and among the non-endemites about 34% are central Asian forms and 13% are South Palaearctic elements. Furthermore, he observed the endemism on the south slopes of the Himalaya to be 63% and on the north slopes 43%. The southern elements on the north slope constitute about 21% and on the south slopes about 44%.

Species endemism in Formicidae is about 70%. The absence of both Mediterranean and Manchurian elements should be noted. Of the endemites, *Plagiolepis balestrierri* Menozzi is alone localized in the Indus drainage area, *Formica* (*Serviformica*) *picea* Nyl. is widely distributed in the drainage areas of Indus and Jhelum. Two species extend across the crest line of the Great Himalaya from Chenab-Beas drainage area to the Indus drainage area. Most of the endemic species occur immediately above the timber line, but a few species, especially the boreal *Formica* (*Serviformica*) *picea* Nyl., may be found nearly from 2500 m. to 4800 m. above m.s.l. *Formica* (*Formica*) *gagates* Latr., *Formica* (*Formica*) *rufibarbis* Fabr., and *Formica* (*Formica*) *sanguinea* Latr., found in the drainage area of Chenab-Beas, are also known from N. Asia, N. Europe, and N. America. The range of the non-endemic species of *Formica* from the NW. Himalaya is shown in Fig. 26.

The distribution and zoogeographical characters of the nival ants from the NW. Himalaya, Tibet, and Central Asia have been discussed in some detail by Menozzi (104), Mayer (102 & 103), Eidmann (33 & 34), with special reference to Nanga Parbat.

Tenthredinidae

1. **Allantus himalayensis** Radozk

   Localities : Khilanmarg 3352 m.

   Other Distribution : Simla Hills, Kufri 2743 m., Phagu, Dehra Dun, Chakrata.

Anthophoridae

2. **Anthophora confusa** Smith

   Localities : Ladakh 3450 m.

   Other Distribution : Barrakpore, Sikkim, Burma, Bombay.

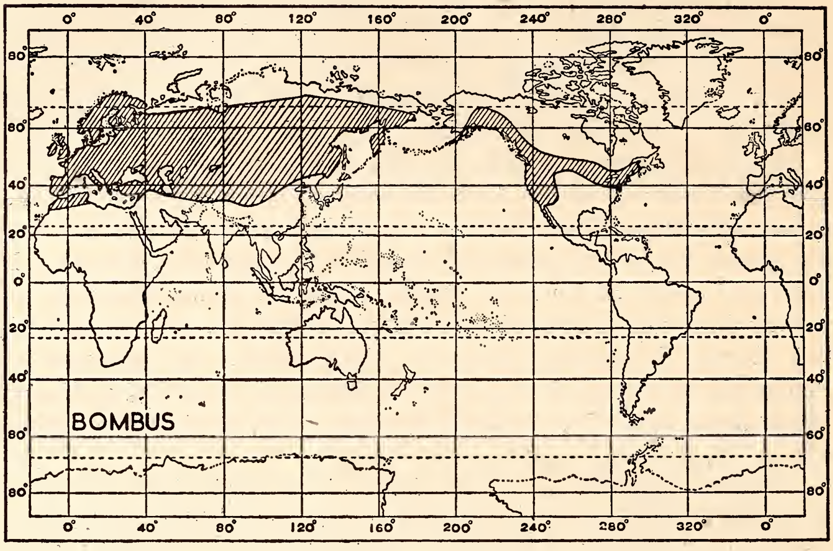


Fig. 25. The area (striped) of the genus *Bombus* (*After Skorikov*, 142).

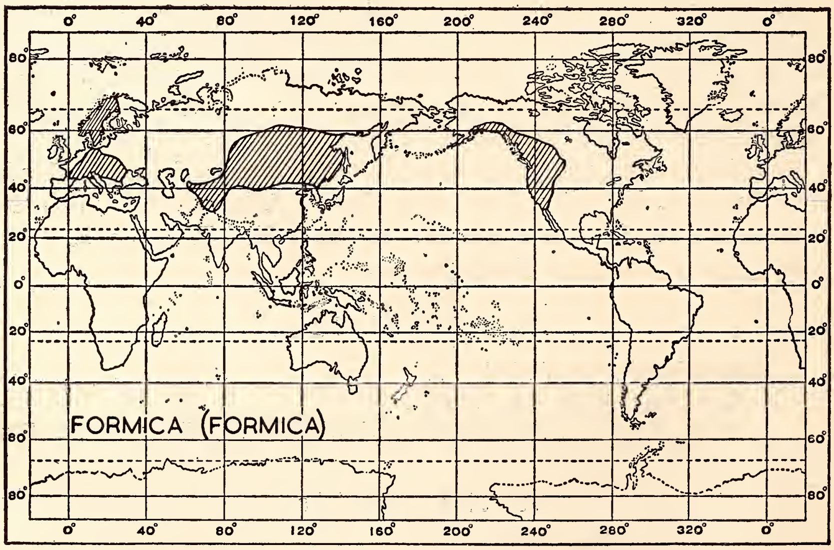


Fig. 26. The area of the world distribution of the non-endemic species of *Formica* (*Formica*) from the north-west Himalaya.

Andrenidae

*3. **Andrena floridula** Smith
Localities : Dras 3100 m., Kargil 2740 m., and Leh 3450 m.

Megachilidae

4. **Megachile vigilans** Smith
Localities : Ladakh 3450 m.
Other Distribution : Sikkim, Ceylon, Tenasserim.

Pompilidae

*5. **Pompilus moestus** Bingham
Localities : Dras 3100 m., Kargil 2740 m., Leh 3450 m.

*6. **Priocnemis rufofemoratus** Smith
Localities : Dras 3100 m., Kargil 2740 m., Leh 3450 m.

Sphegidae

7. **Ammophila laeta** Bingham
Localities : Gramphu 3675 m., Dhorni 3675 m., Hamta Gorge 3675 m., Manali 1828 m.
Other Distribution : Afghanistan, Chaman.

8. **Ammophila vagabunda** Smith
Localities : Dras 3130 m., Kargil 2740 m., Leh 3450 m.
Other Distribution : North China, Sumatra.

Vespidae

9. **Vespa velutina** Lepel
Localities : Marhi 3657 m., Dhorni 3657 m., Hamta Gorge 3657 m.
Other Distribution : Kumaon, Sikkim, Burma, Tenasserim, Java, China.

Bombidae

10. **Bombus atrocinctus terminalis** Smith
Localities : Dharmsala 1676 m., Shahpur, NW. Himalaya about 3000 m.
Other Distribution : Sikkim 3050 m., Garhwal, Kumaon, Almora, Tibet 4267 m., throughout China.

11. **Bombus alticus** Eversm.
Localities : Tanktze, Pangong Valley 4267 m.
Other Distribution : Asiatic Russia.

12. **Bombus haemorrhoidalis** Smith
Localities : Dras 3100 m., Kargil 2740 m., Leh 3450 m., Kangra Valley, Shahpur, Chamba, Kashmir : Srinagar.
Other Distribution : Simla Hills, Garhwal, Kumaon, Almora, West Himalaya.

*13. **Bombus longiceps** Smith
Localities : Dras 3100 m., Kargil 2740 m., Leh 3450 m.

14. **Bombus rufofasciatus** Smith
Localities : Chhatru 3657 m., Namu 3050 m.
Other Distribution : Sikkim 3657 m.

15. **Bombus vallestris** Smith
Localities : Dras 3100 m., Kargil 2740 m., Leh 3450 m.
Other Distribution : Sikkim above 2133 m.

16. **Lapidariobombus separandus** (Vogt)
Localities : North-west Himalaya.
Other Distribution : Turkestan and Altai.

17. **Lapidariobombus alagesianeus pamirus** Sk.
Localities : North-west Himalaya.
Other Distribution : Turkestan, Pamir and Tibet.

18. **Mendacibombus margreiteri** O. Vogt
Localities : North-west Himalaya.
Other Distribution : Pamir, Altai, Alexander Mts. in Russia, Turkestan.

19. **Subterraneobombus difficillimus** Sk.
Localities : North-west Himalaya.
Other Distribution : Pamir and Tibet.

20. **Subterraneobombus melanurus** (Lepel)
Localities : Pangong Valley 4267 m.
Other Distribution : Tibet, Altai, Pamir, Turkestan, Transcaspia, Syria, Siberia.

*21. **Subterraneobombus melanurus subdistinctus** (Richard)
Localities : Pangong Valley 4267 m., Leh 3450 m.

Formicidae

*22. **Aphaenogaster (Aphaenogaster) sagei** (Forel)
Localities : Lahaul to frontier of Tibet 3200 m. to 4000 m.

*23. **Camponotus (Camponotus) budhae** Forel
Localities : Lahaul to frontier of Tibet 3200-4000 m.

*24. **Camponotus (Sylvaticus) paradichrora** Em.
Localities : Jhelum Valley 1200 m., Suru 2700 m., Braldo Valley, Askole 3100-3200 m.

*25. **Cataglyphis (Monocombus) cugiai** Menozzi
Localities : Dras 3100 m., Kargil 2740 m., Partapgarh near Nanga Parbat 2800 m., Skardu 2400 m., Braldo Valley : Dusu 2400 m., Askole 3250 m., Punmah Valley : Skiniltalmosa 3200 m.

26. **Formica (Formica) gagates** Latr.
Localities : Lahaul to Tibet frontier 3200-4000 m.
Other Distribution : Northern and Central Europe, North Asia and N. America.

27. **Formica (Formica) rufibarbis** Fabr.
 Localities : Lahaul 3200 m., Dharmsala, Himalaya over 3050 m.
 Other Distribution : Sikkim, Europe and N. America.

28. **Formica (Formica) sanguinea** Latr.
 Localities : Lahaul to Tibet frontier 3200-4000 m.
 Other Distribution : Widespread in north Europe, Asia and N. America.

29. **Formica (Formica) trunicola** Nyl.
 Localities : Lahaul to Tibet frontier 3200-4000 m.
 Other Distribution : Widespread in northern and central Europe and northern Asia.

*30. **Formica fusca glabaria rubescens** Forel
 Localities : Srinagar, Baltal 2900 m., Lalpani, Deosi 4000 m., Dras 3100 m., Chamur near Nanga Parbat 3200 m., Kangra 1900 m., Shirting 2500 m., Hot sulphur spring Chongo 3000 m., Shigar 2200 m.

*31. **Formica (Serviformica) picea** Nyl.
 Localities: Sind Valley, Kishanganga Valley, Chhota Deosi 3850 m., Lalpani 4000 m., Kamri 2400 m., Burzil Chauki 3400 m., Braldo Valley : Hot sulphur spring Chongo 3000 m., Askole 3200 m., Thla Brok 4000 m., Punmah Valley: Tsok 2800 m., Dumiltar 3900 m., Skinmag 4300 m., Baltoro : Confluence of Baltore Dunge 3900 m., Liligo 3800 m., Robutz 3700 m., Urdukas 400 m., Mundu 4300 m., Jermanendu 4300 m., Mustag 4800 m., Moni Bransa 4600 m., Durbin Jungle 4000 m., Valley of K_2 4200 m., Indus Valley : Karal Mafro 4300 m., Boorgi Nullah 3600 m.

*32. **Myrmica aimonis sabaudiae** Menozzi
 Localities : Gond 1939 m., Doyan near Nanga Parbat 2700 m., Askole 3100 m., Tolti 2400m., Skardu 2400 m., Kutty, Kushumul 2300 m., Dusu 2200 m.

*33. **Myrmica smythiesi cachmirensis** For.
 Localities : Chokpiong 2600 m., Askole 3100 m., Shimtsa 3200 m., Tsok 3500 m. (Punmah Valley). Kashmir.

*34. **Plagiolepis balestrierri** Menozzi
 Localities : Kargil 2740 m., Skardu 2200 m., Shigar 2300 m., Hot sulphur spring Chongo 3000 m., Askole 3100 m., Kro Brok 3700 m.

Ichneumonidae

35. **Triptognathus subalpinus** Heinr.
 Localities : Dhorni 3657 m.
 Other Distribution : Bavarian Alps.

*36. **Ichneumon americanocolor** Heinr. & Gupta
 Localities : Dhorni, Chandra Valley 3657 m.

NEUROPTERA

The order Neuroptera is represented by *Myrmecaelurus punctulatus* Stev., collected at an altitude of about 3450 m. from Leh in the Indus drainage area. The occurrence of this species in the NW. Himalaya is interesting ; it is known from S. Russia and Hungary.

TRICHOPTERA

This order represents 2.5% of the total nival insects (Table I) and is characterized by total endemism (Table X). All the species are Palaearctic. The genus *Stenophylina* is endemic. There are besides several endemic genera below the timber line and are not included in our account of the nival fauna. Three of the species seem to be more or less localized in the Jhelum drainage area, and three others are localized in the Indus drainage area. The majority of the species are found at elevations in the neighbourhood of 3000 m. The maximum altitude record is 4640 m., at which height *Pseudohalesus kaschmirus* Mart. is reported to have been taken. The distribution of 11 species so far known from the nival zones of the NW. Himalaya is shown in Fig. 27.

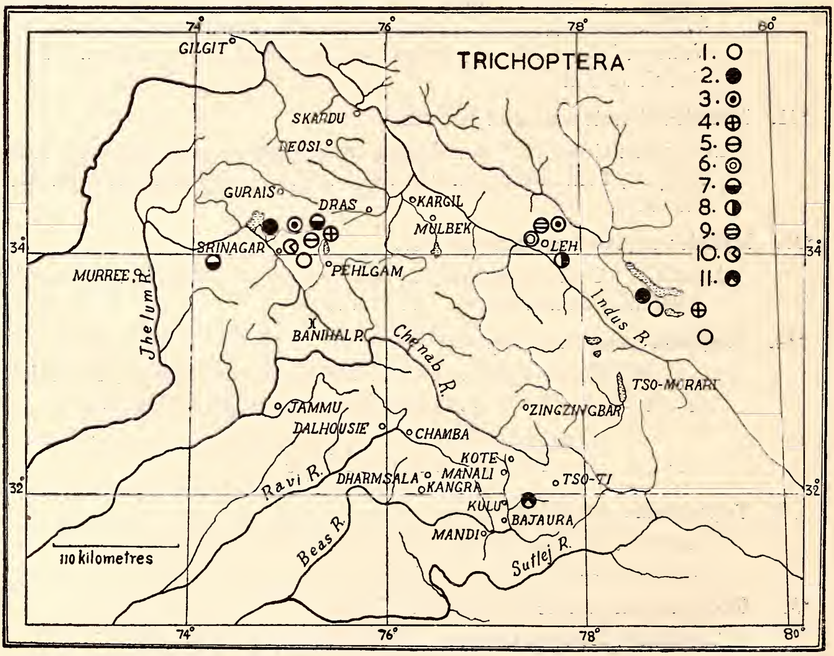


Fig. 27. The distribution of the endemic nival Trichoptera in the north-west Himalaya. 1. *Brachycentrus kozlovi* Mart. ; 2. *Pseudohalesus kaschmirus* Mart. ; 3. *Dolidophilodea tibetana* Kimmins ; 4. *Dinarthrum sonamax* Mosely ; 5. *Eothremma laga* Mosely ; 6. *Dinarthrum inerme* McLach. ; 7. *Apatidea brevis* Mosely; 8. *Platyphylax* sp. ; 9. *Stenophylax micraulax* Mosely ; 10. *Stenophylina mitchelli* Mosely ; 11. *Stenophylina schelpei* Kimmins.

Sericostomatidae

*1. **Brachycentrus kozlovi** Martynov
Localities : Lake Vishanshar 3657 m., Basgo, Chushul 4340 m.

*2. **Dinarthrum inerme** MacLach.
Localities : Leh 3450 m.

*3. **Dinarthrum sonomax** Mosely
Localities : Sonemarg 3000 m., Ladakh-Tibet border 4000 m.

*4. **Eothremma laga** Mosely
Localities: Gagarbal 3657 m.

Limnophilidae

*5. **Apatidea brevis** Mosely
Localities : Gagarbal 1590 m., Khilanmarg 3200 m.

*6. **Platyphylax** sp.
Localities : Leh 3450 m.

*7. **Pseudohalesus kaschmirus** Martynov
Localities : Kashmir 3000 m., Chagra 4640 m.

*8. **Stenophylax micraulax** Mosely
Localities: Leh 3450 m.

*9. **Stenophylina mitchelli** Mosely
Localities : Lake Vishanshar 3657 m.

*10. **Stenophylina schelpei** Kimmins
Localities : Dibikokri Nal, Runi Tach 3900 m. (Kangra Dt.).

Philopotamidae

*11. **Doliphilodea tibetana** Kimmins
Localities : Prang, Digar Polu 4420 m.

LEPIDOPTERA

About 23.0% of the nival insects belong to Lepidoptera (Table I, Fig. 3). Species endemism in Lepidoptera amounts to about 45.0% (Table X, Fig. 29). All the species are Palaearctic, of which the Mediterranean element is about 0.4% and is confined to the family Pieridae (Table VIII). About 90 species, distributed over 28 genera and 13 families, are so far known from the nival regions of the North-west Himalaya (Table VII, Fig. 28).

TABLE VII

Analysis of the abundance of species in different families of nival Lepidoptera

Serial No.	Family	No. of nival species	Percentage in total nival Lepidoptera
1	Alucitidae ..	1	1.12
2	Zygaenidae ..	1	1.12
3	Sphingidae ..	1	1.12
4	Brahmaeidae ..	1	1.12
5	Saturniidae ..	1	1.12
6	Lymantriidae ..	2	2.24
7	Noctuidae ..	4	4.48
8	Arctiidae ..	2	2.24
9	Phalonidae ..	1	1.12
10	Papilionidae ..	31	34.00
11	Pieridae ..	20	22.00
12	Nymphalidae ..	21	23.52
13	Lycaenidae ..	5	5.60
	Total ..	91	

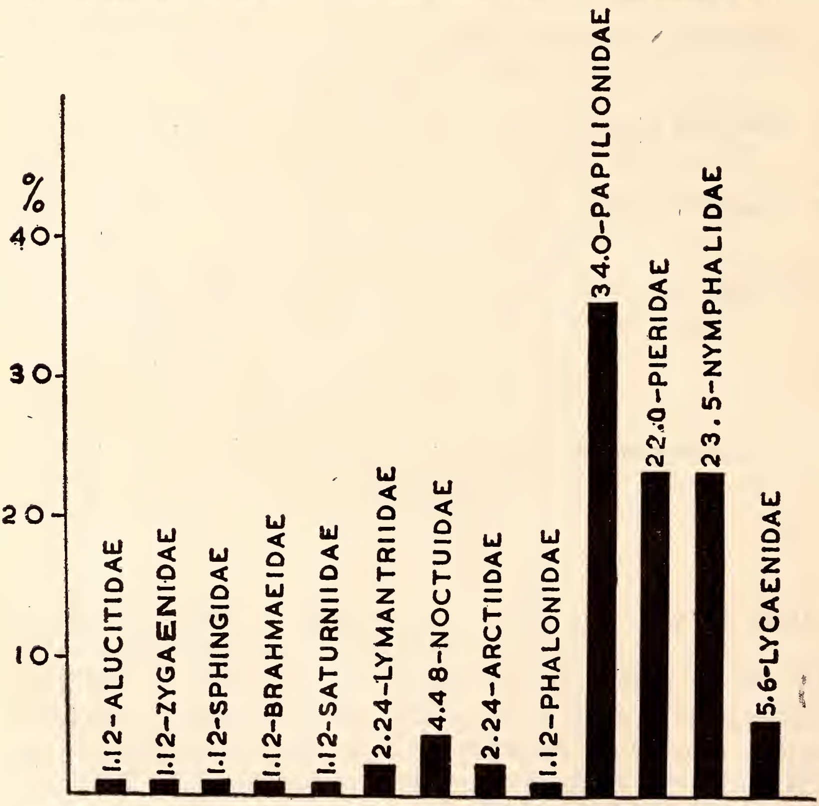


Fig. 28. The nival Lepidoptera from North-West Himalaya.

TABLE VIII

Faunal elements of nival Lepidoptera

Serial No.	Family	Total species	Endemites	Palaearctic		Indo-Malayan
				Total	Medit.	
1.	Alucitidae ..	1	1	1	—	—
2.	Zygaenidae ..	1	—	1	—	—
3.	Sphingidae ..	1	1	1	—	—
4.	Brahmaeidae ..	1	—	1	—	—
5.	Saturniidae ..	1	—	1	—	—
6.	Lymantriidae ..	2	2	2	—	—
7.	Noctuidae ..	4	3	4	—	—
8.	Arctiidae ..	2	2	2	—	—
9.	Phalonidae ..	1	1	1	—	—
10.	Papilionidae ..	31	19	31	—	—
11.	Pieridae ..	20	3	20	4	—
12.	Nymphalidae ..	21	5	21	—	—
13.	Lycaenidae ..	5	3	5	—	—
	Total ..	91	40	91	4	0
	Percentages out of 91, except in the case of Mediterranean, where it is out of total Palaearctic.		43.9	100	4.4	0

TABLE IX

Percentage faunal elements in the three dominant families of nival Lepidoptera

Serial No.	Family	Total species	Endemites	Palaearctic	
				Total	Medit.
1.	Papilionidae ..	31	61.2	100	—
2.	Pieridae ..	20	15.0	100	19.4
3.	Nymphalidae ..	21	23.8	100	—

Of the 40 endemites, 19 belong to Papilionidae, 3 to Pieridae, 5 to Nymphalidae, 3 to Lycaenidae, and the remaining 10 species are found in six other families (Table VIII). Over 25 species are commonly found at elevations above 4000 m. and about a dozen species occur above

5000 m. and often also as high as 5600 m. The highest elevation at which nival Lepidoptera have been collected so far from the NW. Himalaya is 5790 m. The endemites, which are more or less localized in the Indus drainage area, represent about 28.0 % of the total nival Lepidoptera of the area.

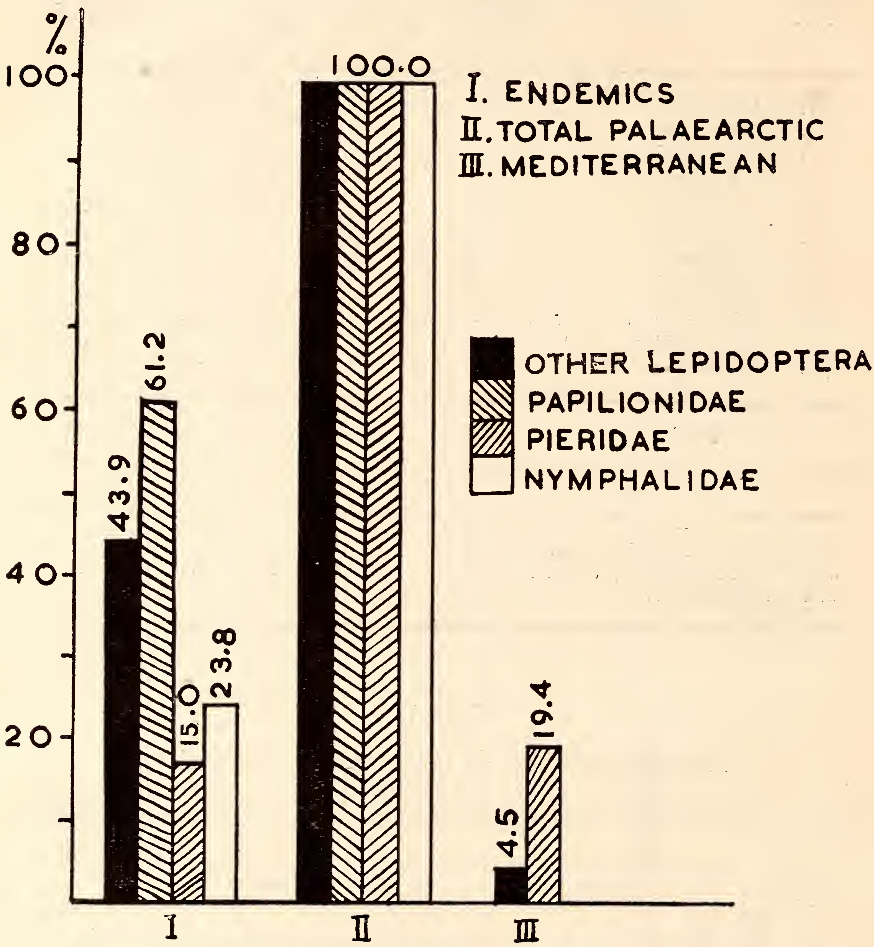


Fig. 29. Faunal elements of the nival Lepidoptera from the North-West Himalaya.

Nearly one-third of the nival Lepidoptera (Table IX, Fig. 28) are Papilionidae, in which the species endemism is nearly 61%. There are several local subspecies[1] in most of the genera. The Holarctic *Papilio machaon* Linn. group is represented by two subspecies, one of which is also known from Tibet and the other from Pamir. The distribution of

[1] Lepidopterists use the term 'race', and in other orders of insects the term 'variety' is also used (46).

both these subspecies above the timber line in the NW. Himalaya is localized in the Indus drainage area. The Holarctic genus *Parnassius* is represented by 8 species and 25 local subspecies ; 18 of these under 6 species are endemites. While *Parnassius acco* (Gray) is widely distributed in the Himalaya up to Darjeeling in the east, the subspecies *Parnassius acco pundjabensis* Bang-Haas is localized in the Spiti area and the subspecies *Parnassius acco tagalangi* Bang-Haas is localized in the Indus drainage area. The *charltonius* group of the Pamir element is represented by 4 subspecies, two of which are endemites. The *delphius* group of the Altai-central-Asian element has, in addition to the typical form, five endemic subspecies in the Indus drainage area and one endemic subspecies in the Jhelum drainage area. Five of the *delphius* group inhabit elevations above 5000 m. This group is represented in the Pamir and Altai mountains by the related subspecies *interjecta* Verity, at an elevation of 3000 m. Localized in the Sutlej area are two subspecies of the *epaphus* group. There are five subspecies of *simo* group, of which *Parnassius simo simo* Gray also occurs in Nepal Himalaya and Tibet, and the rest of the group are endemic. Peculiar to the NW. Himalaya are three subspecies of *Parnassius stoliczkanus* Feld., the typical form of which extends east in Himalaya up to Kumaon. The geography of *Parnassius* of the NW. Himalaya, Tibet, Pamir, and central Asia has been discussed in some detail by Staudinger & Bang-Haas (139), Avinoff (56), Menzbir (105), and Filipjev (38).

Pieridae amount to 22% of the total nival Lepidoptera (Table IX, Fig. 28). Endemism in the family Pieridae is relatively low, viz. only 16 %, and is restricted to *Colias*. The wide occurrence of *Baltia schawii* (Bates) in the NW. Himalaya, in Karakorum, and on many glaciers (e.g. the subspecies *baitalensis* Moore on Feldschenko Glacier 4500 m.) in Pamir is extremely interesting. Of the 9 species of *Colias* so far found in the nival zones of the NW. Himalaya, about half have geographical subspecies. *Colias electofieldi* Men. is widely distributed in the Himalaya and also extends to Baluchistan, Assam Hills, Upper Burma, and China. Common to Pamir and Turkestan mountains are *Colias eogene eogene* Feld., *Colias stoliczkanus* Feld., and *Colias leechi* Gr.-Gr. Among the species common to the NW. Himalaya and Tibet are *Colias cocandica* Ersch. and *Colias ladakensis* Feld. A few of the species inhabiting the region above timber line are occasionally found at comparatively low elevations within the taiga zone. Four species occur above elevations of 5000 m. Though we did not collect, there are good reasons to believe in the occurrence of *Colias erate pallida* Stgr. and *Pieris napae* in the NW. Himalaya. The distribution of the 6 other species of *Pieris* is interesting from several points of view. The Mediterranean element is represented by four species in the family.

Endemism (Table IX) in Nymphalidae is slightly higher than in Pieridae, with two species in *Argynnis*, one each in *Karanasa*, *Maniola*, and *Melitaea*. The Holarctic *Argynnis* is represented by five species, of which two are also known from Pamir. *Karanasa hübneri* Feld. has many subspecies in different parts of its range, shown in Fig. 30. It is also rather remarkable that *Vanessa urticae* Linn., common in Europe, seems to be more or less localized in the Chenab-Beas drainage area and has been collected somewhat above an elevation of 4200 m. *Vanessa ladakensis* Moore, found at nearly 4900 m., seems to be a Tibetan form, which extends west up to Chitral and in the east to Sikkim. There are three endemic Lycaenidae and the two non-endemics are found in Chitral and Baluchistan mountains. *Lycaenia icarus* (Roth.) is represented by the subspecies *icadius* (Gr.-Gr.) in Pamir.

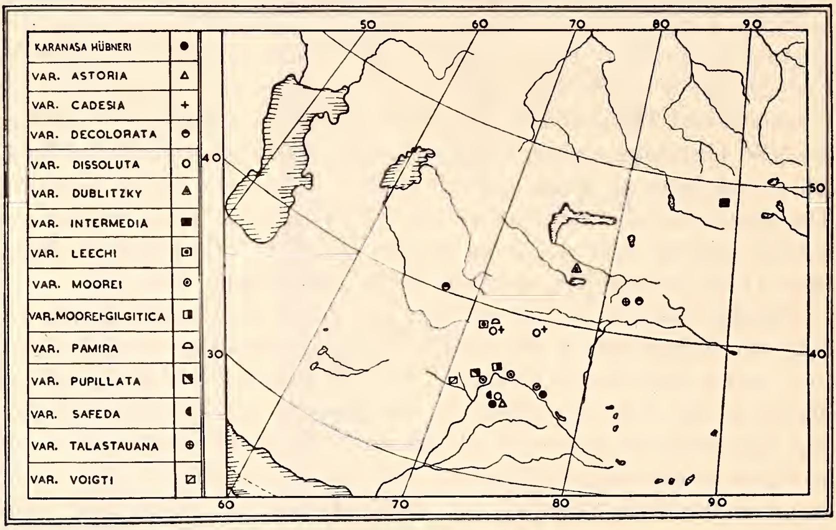


Fig. 30. The distribution of the local subspecies of *Karanasa hübneri* Feld.

Among the remaining families, reference may be made to the endemic *Celerio euphorbiae nervosa* Roth. The genus *Celerio* is represented at an elevation of 4500 m. on the Feldschenko Glacier in Pamir.

Alucitidae

*1. **Platyptilia superscandens** Fletcher

Localities : Khilanmarg 3350 m.

Zygaenidae

2. **Compylotes histrionicus** Westwood

Localities : Kashmir about 3000 m.

Other Distribution : Throughout Himalaya, Afghanistan, NW. India, Jeolikot; Mussoorie, Sikkim: Lebong, Raitdong 3050 m., Khasi Shillong, Cherrapunji, and West China.

Sphingidae

*3. **Celerio euphorbiae nervosa** Roth.
Localities: Ladakh 3450 m., foot of Zojila Pass 3050 m., Changla Gali (Sabathu).

Brahmaeidae

4. **Brahmaea wallichii** Gray
Localities: Manali, Solang Valley 3050 m.
Other Distribution: Nepal, Sikkim, Khasi Hills, Assam, Upper Burma.

Saturniidae

5. **Saturnia stoliczkana** Feld.
Localities: Ladakh 3450 m.
Other Distribution: Yarkand.

Lymantriidae

*6. **Lachana ladacensis** Moore
Localities : Kashmir, Ladakh 3450 m.

*7. **Laelia heterogyna** Hampson
Localities : Kashmir, Dras 3100 m.

Noctuidae

*8. **Agrotis accipiter** Feld.
Localities : Ladakh 3450 m., Pangi 3050 m.
Other Distribution : Sikkim.

*9. **Agrotis tenuis** Butl.
Localities : Laka 4267 m., (Kangra).

*10. **Agrotis monticola** Hampson
Localities : Lahaul 3657 m.

*11. **Trichanarata ladakensis** Feld.
Localities : Ladakh 3450 m.

Arctiidae

*12. **Arctia tibitica** Feld.
Localities : Ladakh 3450 m, Kulu, Kashmir, Dharmsala.

*13. **Carcinophyga lichenigera** (Feld.)
Localities : Ladakh 3450 m.

Phalonidae

*14. **Euxanthis innotatana** (Warren)
Localities : Kalapani 4000 m., Dras 3100 m., Ladakh 3450 m.

Papilionidae

15. **Papilio machaon asiatica** (Men.)
   Localities: Kashmir north of Indus around 4000 m.
   Other Distribution: Up to Tibet in the east and Chitral in the west.

16. **Papilio machaon ladakensis** (Moore)
   Localities: Ladakh 3450-3960 m.
   Other Distribution: Pamir.

17. **Parnassius acco** (Gray)
   Localities: Ladakh 5181-5486 m.
   Other Distributions: Up to Nepal and Sikkim.

18. **Parnassius acco acco** Gray
   Localities: E. Ladakh about 4000 m.
   Other Distribution: Tibet and Nepal.

*19. **Parnassius acco pundjabensis** Bang-Haas
   Localities: East Spiti, Tum-Tum-Thang Mts. 4870 m.

*20. **Parnassius acco tagalangi** Bang-Haas
   Localities: South Ladakh, Tagalang La 5335 m.

*21. **Parnassius actius yelyangi** Bang-Haas
   Localities: South Kashmir, Zaskar, Yelyangi Pass 4115 m.

*22. **Parnassius charltonius** ssp. ?
   Localities: NW. Himalaya 4267-5691 m.
   Other Distribution: Pamir.

*23. **Parnassius charltonius bryki** Haude.
   Localities: Spiti: Nilang Pass to Shipki Pass, Tum-Tum-Thang Mts. 4667 m.

*24. **Parnassius charltonius charltonius** Gray
   Localities: Ladakh, Kharbu 3450 m.
   Other Distribution: To Kumaon.

*25. **Parnassius charltonius deckerti** Verity
   Localities: Kashmir 3657-4387 m.

26. **Parnassius delphius** Eversm.
   Localities: Ladakh, Rupshu, Karakorum 5580 m.
   Other Distribution: Turkestan, Pamir, SW. China, Sikkim, Bhutan.

*27. **Parnassius delphius atkinsoni** Moore
   Localities: Pir Panjal Range, north of Kashmir (Srinagar) about 3900 m.

*28. **Parnassius delphius ladakensis** Avinoff
   Localities: Shera La 5480 m.

*29. **Parnassius delphius mamaievi** Bang-Haas
   Localities: South and western Ladakh 3500 m.

*30. **Parnassius delphius rupshuana** Avinoff
Localities : South and western Ladakh, Rupshu 5334 m.

*31. **Parnassius delphius shigarensis** Bang-Haas
Localities : Baltoro Glacier 5472 m.

*32. **Parnassius delphius workmani** Avinoff
Localities : Saltoro Glacier 5790 m.

33. **Parnassius epaphus cachmirensis** Oberth.
Localities : Sutlej Valley, Parbati Valley, Hamta on Pir Panjal 4257 m.
Other Distribution : Chitral to Kumaon.

34. **Parnassius epaphus hillensis** Bang-Haas
Localities : Spiti above 3500 m.
Other Distribution : Bashar.

35. **Parnassius jacquemontii jacquemontii** Boisd.
Localities : Keylang, Kulu, Kashmir about 3500 m.
Other Distribution : Turkestan, Chitral to Kumaon in the east, Pamir.

*36. **Parnassius simo saserensis** Bang-Haas
Localities : Saser Pass 5335 m.

37. **Parnassius simo simo** Gray
Localities : Sutlej Valley, Parbati Valley, Hamta 4257 m.
Other Distribution : Tibet, Nepal.

*38. **Parnassius simo simonides** Austant
Localities : North Ladakh above 4000 m.

*39. **Parnassius simo simoides** (Bang-Haas)
Localities : Ladakh, Zaskar, South-west of Leh 4000 m.

*40. **Parnassius simo zarraensis** (Bang-Haas)
Localities : Tagalang La 5335 m., Zarra 4700 m.

41. **Parnassius stoliczkanus** ssp. ?
Localities : Kashmir, Ladakh, Kulu, North Kashmir to Ladakh 4000 m.
Other Distribution : Kumaon.

*42. **Parnassius stoliczkanus spitiensis** Bang-Haas
Localities : Spiti, Tum-Tum-Thang Mts. 4572 m.

*43. **Parnassius stoliczkanus stoliczkanus** Feld.
Localities : Ladakh to Kulu, Kutie Pass 5180 m., Baralacha Pass 5480 m., Runung and Hungrung Pass 4572 m.

*44. **Parnassius stoliczkanus zojilaica** Tydler
Localities : Zoji la Pass 3534 m.

*45. **Polydorus philoxenus punchi** : (Bang-Haas)
Localities : West Kashmir, Jhelum Valley 3352 m.

Pieridae

46. **Aporia leucodice balucha** Marshall
Localities : Ladakh 3450 m.
Other Distribution : Baluchistan to Chitral and Ladakh.

47. **Baltia schawii** (Bates)
Localities : Ladakh, Akatagh west of Karakoram Pass 4750 m.
Other Distribution : Chitral.

48. **Baltia butleri butleri** (Moore)
Localities : Ladakh 3450 m.
Other Distribution : Kumaon.

49. **Colias cocandica** Erschoff
Localities : Ladakh, about 3640 m.
Other Distribution : Turkestan to west China, Hindukush, Tibet.

50. **Colias cocandica thrasibulus** Frush.
Localities : Chonging Valley, Kardong Pass 4570-5625 m.

51. **Colias electofieldi** Men.
Localities : NW. Himalaya 761-4267 m.
Other Distribution : Chitral to Sikkim, Bhutan, up to 4267 m., Assam, Baluchistan, Upper Burma, China.

52. **Colias eogene eogene** Feld.
Localities : Ladakh, E. Karakoram.
Other Distribution : To Kumaon.

*53. **Colias eogene francesca** Watkin.
Localities : Baltistan Skoro La over 5000 m.

54. **Colias ladakensis** Feld.
Localities : Ladakh.
Other Distribution : Tibet, Kumaon, Chinese Tartary.

55. **Colias leechi** Gr.-Gr.
Localities : Chonging Valley, Kardong Pass 5625 m.
Other Distribution : Pamir.

56. **Colias stoliczkana** ssp. ?
Localities : Kashmir, Ladakh. Chang La 5630 m.
Other Distribution : Sikkim, Turkestan.

*57. **Colias stoliczkana stoliczkana** Moore
Localities : Kashmir, Ladakh, Amdo 3960 m.

58. **Pieris callidice** (Esper)
Localities : NW. Himalaya above 3657 m.
Other Distribution : Chitral to Mussourie, from Altai Mts. to Himalaya, China, Europe.

59. **Pieris callidice kalora** Moore
Localities : Manali, Parbati Valley, Sutlej Valley, Hamta 4250 m.
Other Distribution : Chitral to Kumaon.

60. **Pieris daplidice** (Linn.)
Localities : Ladakh, Kashmir.
Other Distribution : Chitral, Baluchistan, Pamir.

61. **Pieris deota** (Nicev.)
Localities : Kashmir to Ladakh.
Other Distribution : Pamir.

62. **Pieris krueperi devta** (Nicev.)
Localities : Ladakh, Kashmir.
Other Distribution : To Baluchistan.

63. **Pieris rapae iranica** Le Cerf.
Localities : Ladakh, Kashmir.
Distribution : Chitral, Baluchistan, N. Persia, Mesopotamia.

64. **Pontia chloridice alpina** (Verity)
Localities : Ladakh.
Other Distribution : To Chitral and Baluchistan.

65. **Pontia daplidice moorei** (Röber)
Localities : Parbat Valley, Sutlej Valley, Hamta 4250 m.
Other Localities : Tibet, Yunan, Chitral, Baluchistan.

Nymphalidae

66. **Argynnis aglaia vitatha** Moore.
Localities : North Kashmir, Goorais, Skoro La above 5000 m.
Other Distribution : Chitral, Tzhiptyk (Pamir).

*67. **Argynnis altissima mackinnoni** Nicev.
Localities : Sutlej Valley, Parbati Valley, Hamta 4250 m., Gonas Pass 4570 m.

*68. **Argynnis hagemone** Staud.
Localities : Ladakh, Hunza Valley above 3000 m.

69. **Argynnis jainadeva** Moore.
Localities : Sutlej Valley, Parbati Valley, Hamta 4250 m.
Other Distribution : Chitral to Kumaon.

70. **Argynnis pales generator** Staud.
Localities : North Ladakh, Hunza Valley above 3000 m.
Other Distribution : Afghanistan, Chitral, Turkestan, Pamir.

71. **Erebia mani** Nicev.
Localities : Ladakh.
Other Distribution : Chitral, Pamir.

72. **Erebia shallada** Lang.
Localities : Western Himalaya, Kashmir 3657.
Other Distribution : Chitral, Mussoorie.

73. **Karanasa hübneri** Feld.
Localities : Ladakh, Kashmir, NW. Himalaya.

74. **Karanasa pimpla** Feld.
Localities : Ladakh, NW. Himalaya.
Other Distribution : Afghanistan.

75. **Lethe confusa** Auriv.
Localities : Sutlej Valley, Parbati Valley, Hamta 4250 m.
Other Distribution : Simla to Sikkim, Assam, Burma, Tenasserim, Java.

76. **Maniola pulchella** (Felder)
Localities : Sutlej Valley, Parbati Valley, Manali, Hamta 4250 m., Ladakh, Kashmir.
Other Distribution : Chitral.

77. **Maniola pulchella pulchra** Feld.
Localities : Kashmir, Ladakh, Dalhousie.
Other Distribution : Chitral, Ganges Valley.

*78. **Maniola coenonympha** Feld.
Localities : Ladakh, Kashmir.

79. **Maniola devendra** Moore
Localities : Spiti, Ladakh.
Other Distribution : Chitral, Afghanistan.

80. **Melitaea sindura** Moore
Localities : Sutlej Valley, Parbati Valley, Hamta 4250 m.
Other Distribution : Tibet, Kunawar to Sikkim.

*81. **Melitaea sindura balbita** Moore
Localities : Confined to high elevations in Kashmir.

82. **Nytha baldiva** (Moore)
Localities : Lahaul, Hunza above 3000 m.
Other Distribution : Chitral.

83. **Nytha baldiva lehana** Moore
Localities : Ladakh, Hunza 3000 m.
Other Distribution : Chitral.

84. **Vanessa ladakensis** Moore
Localities : Chang Chenmo 4870 m., Karatagh Tso, Nilang Pass.
Other Distribution : Western Tibet, Chitral, Sikkim (Eastern Himalaya).

85. **Vanessa rizana** Moore
Localities : Kashmir above 3050 m.
Other Distribution : Widely distributed in Sikkim (Eastern Himalaya).

86. **Vanessa urticae** Linn.
Localities : Sutlej Valley, Parbati Valley, Hamta 4250 m.
Other Distribution : Widely distributed in Europe.

Lycaenidae

*87. **Lycaena devanica** Moore
Localities : Ladakh, Kashmir.

88. **Lycaena icarus** (Roth.)
Localities : Ladakh
Other Distribution : Chitral, Baluchistan.

89. **Lycaena omphisa** Moore
Localities : Ladakh, Lahaul 3300 m.
Other Distribution : Chitral.

*90 **Lycaena orbitulum jaloka** Moore
Localities : Kashmir, Ladakh, 3450 m., Pangi 3050 m.

*91. **Lycaena pheretes lehana** Moore
Localities : Ladakh 3450 m., Kashmir.

(To be continued)

The Bombay Natural History Society/ World Health Organization Bird Migration Study Project

BY

SÁLIM ALI
Chief Investigator, BNHS/WHO Bird Migration Study Project

(*With four plates*)

INTRODUCTION

In March 1959 I attended, as a representative of the Bombay Natural History Society, the meeting of a Scientific Group of ornithologists and virologists convened at Geneva by the World Health Organization to consider the question of research on birds as disseminators of arthropod-borne viruses, and put forward a scheme for the establishment of a bird-ringing centre in the Rann of Kutch. This area seemed appropriate for the purpose in hand because a considerable portion of the birds migrating into India from the north-west, i.e. from eastern Europe, Siberia, and central and northern Asia, come down the Indus Valley and across the Great Rann into Kutch, Gujarat, and the Saurashtra peninsula. There is also evidence that Kutch lies on the eastern fringe of a broad stream of migration from central and northern Asia in a south-westerly direction in autumn (and vice versa in spring) across Afghanistan, Baluchistan, Sind, and the Arabian Sea into British Somaliland, Abyssinia, and further south. The outbreak of a form of encephalitis in the Kayasanur Forest area in Mysore, the virus of which was reported in 1957 to be related to a group of viruses occurring in Omsk in the U.S.S.R., suggested the possibility of its having been carried by migrating birds. The Scientific Group was impressed by the possibilities of the scheme and recommended it for the consideration of the General Body of the World Health Organization.

Pending the decision of the General Body I conducted a preliminary survey of the area in April 1959 to select possible sites for the field stations, to investigate local conditions, and to estimate the requirements and plan the necessary details. The expenditure for the preliminary survey was met out of funds placed at the Society's disposal by the Rockefeller Foundation.

Preliminary Field Survey: Kutch, 6 to 13 April 1959

I visited Kutch between 6th and 13th April 1959. A jeep was hired from the Government Garage through the good offices and co-operation of the Ministry of Local Self Government & Public Health, Bombay, and of the Collector of Kutch. In all some 700 miles were covered during the week, and all the likely areas bordering the Great Rann, along the northern boundary of Kutch district, were visited in two separate trips. The first started from Bhuj north through the Banni to Khavda and Nir, travelling westward thence through Kuār Bēt, Dordha (2 miles south of Banri *jhil*), Hajipir, Lakhpat, and back to Bhuj; the second from Bhuj eastwards through Anjar, Bhachau, Gandhidam, Chitrod to Rapar, and thence through Fatehgadh, Mouana, Bela, Bālāsar, and Desalpur, back to Rapar, and to Bhuj. Unfortunately Khadir Island could not be visited as the shortest route across the Rann from Chobari was still impassable owing to its being wet. The places I particularly wished to see on Khadir Island were Amrapur in the east and Dholovira in the west, which from the map appear to be well situated for intercepting migratory birds.

Fresh water is extremely scarce after the winter season, and with the onset of the hot weather it is unobtainable except in a few spots where there are scanty natural springs, or *viris* (deep-shafted wells). The Banni area north of Bhuj though deficient in water is good grazing country for cattle after a normal monsoon. Homesteads of *maldharis* (property owners) possessing large numbers of excellent milch cattle are dotted about the area, concentrated in small groups where water is available. As the season advances and the water dries up, these herdsmen move on to other spots. The bird life for miles around concentrates about the wells and water-holes to drink, and at the time of my visit in April the early morning up to forenoon and then from about 4 o'clock onwards was the best time for watching birds at these watering places. To water the cattle the herdsmen draw from the deep wells and fill up shallow troughs prepared near by, and it is at these troughs that all the birds gather.

In selecting possible sites for camps, water was the foremost consideration since it would be impossible to keep a camp supplied from any distance. Population is sparse and daily labourers difficult to hire, and no facilities for the transport of water are available. In the neighbourhood of the wells and natural springs there is usually fairly luxuriant vegetation, chiefly bushes and shrubs of *Salvadora persica* and *oleoides, Prosopis spicigera, Capparis aphylla,* and such other semi-desert species. The growth was of a nature that would permit the effective use of mist nets.

The shade temperatures during the week I was in Kutch ranged from 82° F. minimum after midnight to 108° F. maximum in the day. Out in the sun it was far from pleasant, and the scorching wind which blew in a gale over the sandy wastes all through the day, particularly in the Banni, did not improve matters.

Although the greater part of the spring migration in Kutch was over by the time of my visit (first half of April), the following migrants were still present and were noted in varying numbers:

Circus aeruginosus, Tringa nebularia, T. totanus, T. ochropus, T. hypoleucos, T. glareola, Charadrius dubius, Numenius arquata, Anas clypeata, A. querquedula, Gelochelidon nilotica, Sylvia curruca, Hippolais caligata, Acrocephalus agricola, Motacilla f. melanogrisea, Upupa epops, Anthus campestris (?), *Hirundo rustica, Emberiza melanocephala, E. buchanani, Sturnus roseus.*

The last two species were in the greatest numbers. Rosy Pastors in perfect summer plumage were feeding everywhere on *Salvadora* berries now ripening profusely. A succession of flocks was observed at Rapar on 10th and 11th April, flying purposefully due north at sunset, obviously on migration.

Several places appeared suitable for netting camps : Wâd Wāli Wâi (Well of the Banyan), Nâd Vīri, Gândi, Nera Wāli Sāran (ill-drained ground ; spring?, bog?), Nīr, Kuār Bēt, Luna, Lakhpat, Fatehgadh, Bela Island, Bela, Jatawala, Bālāsar, and Desalpur. Of all these Kuār Bēt on the border of the Rann, besides being a delightful place to camp in, appeared to have great possibilities for trapping birds in both the spring and the autumn migrations. Possibly northern Saurashtra, along the Gulf of Kutch and the Little Rann, would be an equally suitable area and well worth investigation when the Kutch project was being expanded. It certainly seemed to be more accessible at all seasons than the Great Rann, and to present fewer problems of transport.

Another place that would need proper investigation was Suigam, north Gujarat, at the NE. corner of the Little Rann, which also seemed

View across Rann to Pachham "Island" from near Kuar Bet.

Mist net set along margin of field of bajri

(*Photos : Harold Trapido*)

Removing bird from mist net

(*Photos : Harold Trapido*)

very advantageously situated in relation to the general trend of migration over western India.

Pilot Field Session: Kutch, 15 September to 1 October 1959

In order to test the practical potentialities of the project and to train our personnel in the use of Japanese mist nets and the various techniques involved, a pilot scheme was launched in September 1959 while the autumn (inward) migration was in progress.

This was financed out of the grant received by the Society from the Rockefeller Foundation, supplemented by a sum of $1000 from W.H.O. as a token of their active interest.

The basic field party of the Bombay Natural History Society comprised myself and three assistants P. W. Soman, P. B. Shekar, and Fernando. In addition there were usually 2 to 4 volunteers in camp, who underwent training and participated in the activities from 5 days to a week each. The participation of these volunteers in the training programme was taken as an implicit undertaking on their part to offer their services again in March the next year. The Society bore their living expenses and, in some cases, also the cost of their travel to Kutch and back by air or rail.

Thanks to the grant from W.H.O., we were able to defray the cost of a return air passage from Switzerland for Dr. Alfred Schifferli, who kindly accepted our invitation to visit Kutch for a few weeks to train our workers in the use of mist nets and other relevant techniques employed elsewhere, particularly at the Swiss migration study centre in Sempach (near Lucerne) of which he is the Director. Dr. Schifferli arrived on 12th September and was in the field with us till 2nd October. His help was invaluable, and the training our staff received from him has stood them in good stead for carrying out the work in March 1960 and later competently and with confidence.

Unfortunately, the monsoon that year was phenomenally heavy and long-drawn. The average annual rainfall in Kutch is 13-15 inches, and for a succession of years it was not unusual to have much less, giving rise to drought conditions. In 1959 the monsoon was quite unprecedented. By the beginning of September, Kutch had already received over 50 inches of rain, including one cloudburst in which 15 inches (*c.* 375 mm.) fell in 24 hours! It caused considerable damage to houses, livestock, and agriculture. Many areas of sandy semi-desert were converted into vast lakes. Road embankments and bridges were washed away in places. The flooded country and the ill-drained loamy soil rendered traffic impossible, and parts of the district became completely isolated for weeks on end.

One of the worst to suffer in this way was Kuār Bēt. The rains continued ceaselessly, and it soon became clear that there was no hope of our being able to reach the place while the autumn migration lasted. We were thus driven to look for a more accessible alternative spot where the training of the men at least could be put through with whatever birds were available.

There is a preserve of stunted thorn forest abutting on cultivation (*Sorghum* and *Pennisetum*), about three miles south of Bhuj, which seemed to answer the requirements. It contained a good population of resident birds and looked as if it would prove attractive to in-coming migrants as well. It was decided to concentrate our attention on this area. The results justified our choice; between 15th September and 1st October over 1750 birds were caught in the mist nets and ringed. They belonged to 56 forms, of which 27 were migrants and the rest endemic. The birds were banded with aluminium rings of three sizes A, B, and C bearing the legend 'INFORM BOMBAY NAT. HIST. SOCIETY' and 'No. . . . .' They were identified, measured, weighed, ringed, registered, and examined for ectoparasites before being released.

The Virus Research Centre, Poona, who were authorised by the Indian Council of Medical Research to co-operate with the Bombay Natural History Society in the project, sent two technicians. Dr. Harold Trapido, Asst. Director of the V.R.C., visited the camp for 2 or 3 days and laid down the procedure for his men. They remained with the field party throughout the work in order to collect ticks from the captured birds. Over 1700 birds were examined by them.

Positive as well as negative results were recorded. Ticks were found on 6 individuals of the following: *Pycnonotus cafer, Passer domesticus, Streptopelia senegalensis, Hirundo daurica, Emberiza melanocephala, Emberiza buchanani.* Of these species the last two are migratory and the other four are endemic in Kutch.

It became obvious that the most important bottleneck in any field activities that we undertook in Kutch would be motor transport. No vehicles are available in Bhuj for reasonable hire and, owing to the remote and rugged nature of the place where the spring migration work was planned (Kuār Bēt), it was essential to have adequate transport arrangements which would guarantee free movement and independence from the vagaries of rapacious hirers and dilapidated vehicles. The Government jeeps and trucks upon which we had counted had all to be diverted to flood relief work, and the transport problem would have been crippling but for the helpful co-operation of the Maharajkumars Shri Fatehsinhji and Shri Himmatsinhji who very kindly placed their jeeps at the disposal of the party.

A list of the birds handled during our September field work is given in Table I. Migrant species are marked (M) and those from which ticks were obtained with an asterisk.

TABLE I

List of Birds Netted and Ringed: Kutch, 15 Sept. to 1 Oct. 1959.

Parus nuchalis	2	*Carpodacus erythrinus* (M)	13
Turdoides caudatus	55	*Passer domesticus**	185
Aegithina nigrolutea	8	*Petronia xanthocollis*	207
*Pycnonotus cafer**	231	*Emberiza melanocephala* (M)*	249
——— *leucogenys leucotis*	56	——— *buchanani* (M)*	12
Saxicola caprata (M)	2	*Hirundo daurica**	14
Oenanthe picata (M)	3	*Motacilla flava* (M)	1
Phoenicurus ochruros (M)	1	——— *alba* (M)	1
Erithacus svecicus (M)	2	*Anthus trivialis* (M)	1
Hippolais caligata (M)	30	*Mirafra erythroptera*	1
Saxicoloides fulicata	19	*Eremopteryx grisea*	13
Muscicapa striata (M)	10	*Nectarinia asiatica*	21
Lanius vittatus	1	*Dendrocopos mahrattensis*	1
——*collurio phoenicuroides* (M)	8	*Jynx torquilla* (M)	16
Tephrodornis pondicerianus	4	*Clamator jacobinus* (M)	8
Acrocephalus stentoreus (M)	7	*Eudynamys scolopacea*	1
——— *dumetorum* (M)	77	*Psittacula krameri*	2
——— *agricola* (M)	1	*Coracias garrulus* (M)	1
Orthotomus sutorius	3	*Merops orientalis*	6
Phragamaticola aëdon (M)	1	*Upupa epops* (M)	22
Sylvia communis (M)	41	*Streptopelia senegalensis**	63
—— *hortensis* (M)	2	——— *tranquebarica*	19
—— *curruca* (M)	6	——— *decaocto*	6
Prinia sylvatica	8	*Coturnix coturnix* (M)	3
——— *subflava inornata*	5	——— *coromandelica*	2
Sturnus roseus (M)	14	*Francolinus pondicerianus*	1
Acridotheres tristis	1	*Tringa ochropus* (M)	1
Ploceus philippinus	207		
Lonchura malabarica	75		

Total number of birds netted and ringed (excluding the 297 recaptured during the 17 days of field work) 1751

Incidentally the netting added three species to the Kutch list: the Grasshopper Warbler (*Locustella naevia*), the Blackthroated Weaver (*Ploceus benghalensis*), and the Thickbilled Warbler (*Phragamaticola aëdon*), the last being new for Saurashtra and Gujarat as well[1]. This bird was a surprise, since it is known only as an eastern species breeding in Siberia, Burma, Thailand, and south China, wintering chiefly in Assam and East Bengal, Bhutan, etc. It has been recorded also from Mysore and Kerala in winter. The Grasshopper Warbler and the Blackthroated Weaver Bird do not figure in the list because only one bird of each species was caught and it was kept as a specimen for the Society's collection. Two Thickbilled Warblers were caught of which one was kept as a specimen.

Spring Field Session: Kutch, 10 to 28 March 1960

The venue selected was Kuār Bēt which had stood first in my order of preference (see above). Several of the other likely places, e.g. Nâd Vīri and Nīr, were inaccessible for wheeled transport due to the Rann still being wet or flooded after the previous year's exceptionally heavy and prolonged monsoon.

Kuār Bēt is a flat, rocky and sandy, grass- and scrub-covered islet (directly opposite Kotda Police Outpost to the north). It is separated from the Pachham mainland by an arm of the Great Rann about a mile wide, and forms one of the most northerly points of Kutch district. There is a shallow depression in the middle of the islet which becomes a *jheel* during the monsoon and holds water till about January. The only 'fresh' water on the islet, such as it is, is provided by a well in the bed of this *jheel*. This well harboured a dense population of frogs (*Rana cyanophlyctis*) and was the only source of 'fresh' water on Kuār Bēt. Its water, analysed by the Public Health Laboratory, Bhuj, gave a pH value of 7.5 with a Permanent Hardness (as $CaCo_3$) of 100.4 and Temporary Hardness of 24.4. It was not potable, and drinking water for the camp had to be transported in drums by motor truck daily from the mainland, from a well called Wâd Wali Wâi some 6 miles distant. Adjoining the Kuār Bēt well is a mud-built trough for watering cattle and camels, to which all the birds for miles around repair to drink. The *jheel* bed is thickly covered with rank grass (Cyperaceae). This was still fresh and green in March and held numbers of Streaked Fantail Warblers (*Cisticola juncidis*) and a few Grasshopper Warblers

---

[1] See Sálim Ali (1960): *J. Bombay nat. Hist. Soc.* 56 : 635.

A Whitethroat in the mist net

Placing the ring

(Photos : Harold Trapido)

Weighing bird in plastic bag and recording data

Ringing equipment

(Photos : Harold Trapido)

(*Locustella naevia*). The surroundings are well wooded with shrubs and moderate-sized trees of Babul (*Acacia arabica*), Kandi (*Prosopis spicigera*), *Acacia senegal, Capparis aphylla, Salvadora persica* and *S. oleoides, Zizyphus jujuba,* and other species. *Capparis* and *Salvadora* are the commonest bushes on the rest of the island, and patches of ground here and there are covered with jhil (*Chenopodium album* ?) a foot to 3 ft. high. Among the less pleasant features of Kuār Bēt was the extraordinary abundance of the Phoorsa or Saw-scaled Viper (*Echis carinata*) and scorpions on the island. In retrospect, it seems little short of a miracle that, in spite of narrow escapes almost every day and night, such a large party should have escaped without casualty.

In the advance party I was accompanied by Mr. D. J. Panday, Mr. Loke Wan Tho, and Mr. Charles Ho. We arrived in Bhuj by air from Bombay on 1 March in order to make arrangements for establishing camp on Kuār Bēt. Tents, camp furniture, and other requisites were hired locally from the Public Works Department of Gujarat, and efficient arrangements for transport of the equipment and extra personnel were made by the Department of Public Health of Gujarat. The main party consisting of 14 persons arrived by rail and air on 8 March. It included 4 technicians of the Virus Research Centre, 4 field assistants from the Bombay Natural History Society and 6 amateur ornithologists as voluntary helpers.

The question of local mobility for the field party was satisfactorily solved, thanks to our Vice-Patron Mr. Loke Wan Tho, who generously placed a station wagon at the disposal of the Society, and the Tata Locomotive & Engineering Co. Ltd. who loaned to us one of their Mercedes-Benz multi-purpose vehicles ('Unimog'). These two vehicles, together with a third 4-wheel-drive station wagon from the Virus Research Centre, proved invaluable for the unhampered movement of personnel, and of necessities such as food supplies and drinking water.

The field work started on 10 March with an average of some 20 nets, several of them consisting of more than one unit (one of 10), deployed over an area of about 1 square mile surrounding the *jheel* bed.

During the first week of our activities, 10-18 March, *Capparis aphylla* was in profuse blossom all over the island. The attractive salmon-pink flowers of this shrub contain a copious supply of sugary nectar which seems to serve as both food and drink to birds of many species and is eagerly sought by them. All the visitors get their fore-head feathers thickly coated with pollen, and they doubtless play an important part in cross-pollinating the flowers. The birds invariably in attendance on these flowers were babblers (*Turdoides caudatus*) and bulbuls (*Pycnonotus leucogenys leucotis*) among the resident birds, and Rosy Pastors (*Sturnus roseus*), Orphean Warblers (*Sylvia hortensis jerdoni*), Lesser Whitethroats (*Sylvia curruca blythi*), and Tree Warblers (*Hippolais caligata*) among the migrants. Nets placed near flowering *Capparis* bushes took all these species.

Immediately encircling the dry lake bed, on the edge of which our camp was pitched, was a fairly dense green belt of moderate-sized trees and shrubs frequented by warblers and other small birds, both migratory and resident. This wooded belt and the flowering *Capparis* bushes beyond formed the principal features which dictated the placement of the nets, and on the whole yielded fairly satisfactory results. During the period of operation, 10-28 March, the total number of birds ringed was 1001. In addition to these there were 188 recaptures, particularly of the resident babblers and bulbuls, while a great many others (particularly babblers) captured in the nets and found positive for ticks were handed over to the virus technicians directly, without registering or ringing, as they were required to be killed for detailed examination.

In all 39 species of birds were captured and ringed, of which 21 species (or 54%) were migratory. Of the total number of individuals, 322 (or 32.2%) were migratory and the rest resident. The migratory species ringed are listed in the table at the end of this paper.

Unfortunately weather conditions after 18 March became freakish and abnormal, and produced a marked set-back in the flow of migration. While our two best days were 17 and 18 March with 109 and 106 birds respectively (excluding recaptures), they were abruptly followed by one of the worst. On the 19th only 21 birds were ringed. A heavy gale had sprung up during the night of the 18th which continued with unabated intensity all the next day. The windy season in the Rann of Kutch area normally commences only in the first or second week of April. The abnormality of weather was further emphasized by the unseasonable rain which fell on Kuār Bēt on 10 and 11 March. In some portions of Kutch, notably in the Banni a little north of Bhuj, the downpour was so heavy and continuous that the countryside was turned into a quagmire, disrupting motor traffic for over a week. This was followed by occasional dust storms and an unprecedented drop in the temperature, which touched 40° F. during the night of 21 March and 48° F. at 7 p.m. on the 22nd, and kept in that neighbourhood for two more days. Completely unprepared for near-freezing temperatures so late on the season, the party spent some memorably uncomfortable nights.

Reports from bird watchers in other parts of Kutch and in Saurashtra confirmed that, presumably due to the exceptionally heavy and prolonged SW. monsoon of 1959 and the continuance of abnormally cool weather into March 1960, the spring migration was greatly retarded, the species and quantities of migratory birds commonly seen at this time of year not yet having appeared by the end of that month. Whether they would come along at some later date, in April, remained to be seen though, as far as Kuār Bēt was concerned, there was little hope of ascertaining this on account of the remoteness of the locality and difficulty of access to it.

We found the best conditions for success with mist nets to be when the sky is cloudy and overcast, and cool at midday with the air still or a light breeze blowing, as on our two best days. Mist nets proved completely useless under windy conditions. In addition to the fact that high wind directly inhibits local bird activity, mist nets have a tendency to bunch in folds at one end in a cross-wind, rendering the net so taut over the rest of its length that even when a bird flies into it, it bounces back and is usually able to escape. When the wind is head-on to the net, the net billows out so much to the lee that it becomes equally ineffective in 'bagging' the bird.

Altogether the field work on Kuār Bēt in March proved less successful than was anticipated. To what extent abnormal weather was accountable for this disappointment it is difficult to assess. It might be worthwhile to try here once again during the autumn migration if the approach through the Rann at that season permits. It struck me, however, that perhaps a more rewarding course in future work would be not to be encumbered with a large central camp in any one place, but to split up into small independent units each consisting of a couple of ornithologists with local helpers and a couple of virus technicians with the necessary equipment for camping and working at a number of selected points over a wider area in northern Kutch and Saurashtra. In this way it may be easier to hit upon the most suitable places for intercepting migrants.

The netting on Kuār Bēt in March added two more species to the Kutch bird list, namely the Blackcrowned Finch-Lark [*Eremopterix nigriceps affinis* (Blyth)] previously recorded within Indian limits only from Rajasthan and eastern Punjab, and the Grey Hypocolius

(*Hypocolius ampelinus*) a Persian and Iraqi bird of which only two specimens have so far been taken in India as rare vagrants.[1]

In addition to the above, the Eastern Rosy Pelican (*Pelecanus onocrotalus roseus*) was discovered, for the first time, to nest in India. The nests were found among worn-down old flamingo nests on the periphery of the occupied Flamingo City in the Great Rann. These pelicans were heretofore only known as winter visitors, and the large colony of an estimated 3000-4000 adults in early summer and hundreds of nests with eggs or young are of particular interest. It is reported by the flamingo warden that he observed these birds nesting here for the first time only in 1959, so they would now appear to be establishing themselves as a breeding species. A more detailed note has appeared in the *Journal*.[2]

A further point of interest, and a somewhat intriguing one, was the netting, on 10 March of one more example of the Thickbilled Warbler, *Phragamaticola aëdon*. The unprecedented and unexpected meeting with this species in Kutch the previous September (recorded above) had raised speculation as to whether the examples then captured were merely vagrants, or whether the species is possibly a regular winter visitor (or autumn passage migrant) but overlooked in the past. The capture of a third specimen in March poses the question whether the bird had spent the winter in Kutch, or was now on northward passage to its breeding grounds from its known winter quarters in SW. or eastern India—whether indeed the hitherto recorded status of this warbler needs amending.[3]

Autumn Field Session: Saurashtra, 8 to 30 September 1960

Owing to the difficulties of getting the transport vehicles across the Little Rann from Saurashtra into Kutch and also of reaching the outlying areas bordering the Great Rann so soon after the monsoon, field work for the autumn migration was confined to the Saurashtra peninsula in Gujarat. This lies between 21° N. lat. and the Tropic of Cancer, and 69° and 72° 30′ E. long., therefore well athwart the NW. route of bird migration into India.

Two field camps were established, one on Jalandar (or Jhillander) Bēt, an islet separated from the border village of Jhinjhuvada by a mile-wide arm of the Little Rann, the other at Hingolgadh the private estate of the Raja Saheb of Jasdan, about 12 miles from the capital of that quondam Indian State.

[1] P. B. Shekar (1960): *J. Bombay nat. Hist. Soc.* 57: 224-5.
[2] Sálim Ali (1960): *J. Bombay nat. Hist. Soc.* 57: 412-5.
[3] Since then it has also been taken in Rajasthan (see p. 123).

Jalandar Bēt is a flat, sandy islet, covered with semi-desert scrub which in some places is quite dense. This is particularly so in and along the dry, often steeply eroded, water-courses with which the islet is scoured. The vegetation is of a xerophytic character and the over-all ecology of the place is reminiscent of Kuār Bēt in Kutch *Prosopis spicigera, Capparis aphylla, Salvadora persica,* and *S. oleoides,* stunted trees and bushes, are common and abundant, and when in flower and fruit in spring must constitute a great attraction for many species of passerine birds — warblers, Rosy Pastors, and others.

In recent years *Prosopis juliflora* has been widely planted by the Forest Department in the barren salt-lands bordering the Rann as part of their desert reclamation programme. It has taken well, and now forms flourishing and extensive thickets here and there. Curiously enough, in spite of the shade it provides in a land where any shade is welcome and, *contra* its congener *P. spicigera,* this species is studiously avoided by birds of all kinds.

Hingolgadh is situated more inland, in central Saurashtra. It is an undulating area of rocky and stony thorn scrub, which has been closed to grazing, hacking, and felling for many years and, under strict protection, has now become an island, or oasis, of fairly dense thorny vegetation set in the midst of the extensive champaign under cereal and groundnut cultivation. The activities at the Hingolgadh camp were under the efficient and enthusiastic direction of Yuvraj Shri Shivrajkumar of Jasdan.

Each of the two camps was manned by a more or less equal basic complement of workers: two members of the field staff of the Bombay Natural History Society, and three technicians of the Virus Research Centre, Poona. These teams were assisted at either camp by two post-graduate Avian Biology students of the Baroda University. Dr. R. M. Naik of the Department of Zoology, Baroda University, who received his training at our Kuār Bēt camp earlier in the year, was in charge of the Jalandar Bēt camp. It was refreshing to find such flexibility and useful co-operation from a university department which, in India, are normally so rigidly conventional and hide-bound. It is to be hoped that more universities and science-teaching institutions will realize the value of the facilities these field camps afford and will second their biology teachers as well as senior students to participate in the activities of the Bombay Natural History Society. Participation in such outdoor scientific activities can prove of very great mutual advantage. The Society's ringing work with migratory birds in India will begin to pay dividends only when it can be expanded to cover all parts of the country. This cannot be achieved without voluntary effort and the co-operation of universities in encouraging their post-graduate biology students to take part in our field work while keeping their academic terms.

The combined teams of the Bombay Natural History Society and the Virus Research Centre, Poona, arrived at their respective posts on 7 September, and field operations commenced on the morning of the 8th. The Jalandar camp remained in operation till 25 September (18 days), and Hingolgadh up to 28 September (21 days).

The failure of the monsoon in the Jalandar area caused abnormally high day temperatures in September, the daily maximum ranging mostly between 95° and 105° F. in the shade, with a relative humidity of between 64% and 79%. The sun temperatures at midday were so high that many birds died in the nets if left exposed even for a few minutes. During the last few days this necessitated our putting the nets out of action after 11 a.m. and opening them again only when it became relatively cooler in the afternoon—a circumstance which naturally reflected adversely on our daily catches. The position at Hingolgadh was somewhat better, but there also a certain amount of mortality among the netted birds dictated similar precautions latterly.

The destruction of our nets by the large and ever increasing numbers of cattle, driven in for pasture to Jalandar from the surrounding drought-ridden villages, swelled to such an extent that we were compelled to abandon the work on 25 September, 4 days before schedule. The results of the field work, in so far as the total number of ringed birds is concerned, are comparable in both camps but, as will be seen from Table II below, the composition of the catches in the two areas was strikingly different. During the 18 days of rather fitful operation on Jalandar Bēt 1008 birds were ringed. They represented 46 forms, of which migrants accounted for 22. The most abundant migratory species here proved to be *Sylvia hortensis jerdoni* (94), followed by *Sylvia curruca blythi* (58), *Hippolais caligata rama* (47), *Sylvia communis icterops* (41), *Jynx torquilla* ssp. (16), and *Erythropygia galactotes familiaris* (13). During the 20 working days at Hingolgadh camp (3 more than at Jalandar) in all 1232 birds representing 72 forms were ringed. Of these over 50% were migratory. The most plentiful migrant species in the Hingolgadh area during this period was *Sylvia communis icterops* (256 examples), which ranked 4th in order at Jalandar. *Sylvia hortensis jerdoni*, which was No. 1 at Jalandar, came next. At Hingolgadh, Rosy Pastors (*Sturnus roseus*) were present in enormous swarms (as they were also at Jhinjhuvada, but not so many at Jalandar) although only 58 were taken in the nets. These birds, which had already arrived in large numbers by early August, continued in abundance in the 2 localities, and more or less throughout Saurashtra, during September. They were now feeding chiefly on the ground on grasshopper nymphs, and on the ripening jowar and bajra (cereal) standing crops. They roosted in enormous swarms in the dense grove of trees surrounding the Rest House at Jhinjhuvada, where large flocks converged from all directions at sunset. There was a large roost also on the edge of the netting area at Hingolgadh.

Hingolgadh had 10 Kashmir Rollers (*Coracias garrula semenowi*) while Jalandar had none, only 2 examples being noted during the entire period and that within the last week; whereas against the 13 Greybacked Warblers (*Erythropygia galactotes familiaris*) ringed at Jalandar none was caught at Hingolgadh and only one observed in the area during the entire period. The difference in the composition of the resident bird population is even more striking, but this may be accounted for largely by the difference in ecological conditions. For the migrants, most of which would be merely passing through at both places, the composition of the catches respectively provides the first positive datum suggestive of the pattern on which bird migration takes place in this part of the country, and pinpoints the need for further analysis and investigation. The captures at the two field stations, operating simultaneously and no more than about 50 miles apart as the crow flies, afford interesting comparison of the differential movements of various species during migration, but many more data will be needed before the position can be understood. Additional interest is lent to this problem by the results of 4 days' subsequent netting (on 10-11 and 20-21 October) by Yuvraj Shivrajkumar in the Hingolgadh neighbourhood, about 3 miles distant from the September area. With 4 helpers, using on an average 10 nets, his catches amounted to 45, 96, 54, and 149 birds, or a total of 344. They included 263 migrants of 18 species, of which the most prominent were: *Calandrella cinerea* (120), *Emberiza buchanani* (79), *Upupa epops* (12), *Sylvia curruca* (11), *Hippolais caligata* (11).

From the point of view of arthropod-borne viruses, a very striking contrast in tick infestation is presented in the two areas.

While the percentage of positive birds at Jalandar Bēt (semi-desert country) was comparatively insignificant, at Hingolgadh (fairly thick thorn scrub forest) it was over 16%. The significance and implications of this differential tick infestation will be better understood when the material has been identified and ecologically studied. This, as well as the results of the bleeding of several species of birds undertaken by their technicians, will be reported on separately by the Virus Research Centre.

Of the 980 migrants examined at the 2 camps 86 individuals (8.7%) bore ticks, while 155 (14.5%) of the 1062 residents were so infected. In the latter, infestation among the ground-dwelling partridges and quails was as high as 85% (22 examined) and 61% in the Indian robins (108 examined).

Our greatest handicap today is the lack of competent field ornithologists and trained field personnel. These camps, which are in the nature of continuing seminars, provide admirable opportunities not only for learning bird identification and migration study techniques, but also for co-operative living and team work by persons of kindred scientific interests, and for stimulating informal discussions on a variety of ornithological and technical problems. The Bombay Natural History Society invites university biology teachers and students, and others seriously interested in the problems of Indian migration and in the role of birds as disseminators of arthropod-borne viruses, to take advantage of the opportunities afforded by its spring and autumn field camps, so that they may qualify themselves to conduct similar work in other parts of the country independently, and contribute towards making up some of the leeway from which scientific ornithology suffers in India.

Visitors: Drs. Harold Trapido and Jorge Boshell, of the Virus Research Centre, Poona, spent several days at each camp sharing in, and directing, the activities of their entomologists and the technicians. In addition, the camps were visited for varying periods by a number of persons, either to assist in the work or for training and experience. Among these were Messrs Zafar Futehally, Dinshaw and Jamshed Panday (Bombay), R. S. Dharmakumarsinhji (Bhavnagar), K. S. Lavkumar (Rajkot), Prof. J. P. Joshua and Mr. Gift Siromoney (Madras).

During the field work on Kuār Bēt (Kutch) in March 1960, blood smears from about 60 netted birds were taken at the request of Dr. Marshall Laird of McGill University, Canada, who is interested in studying the zoogeographical status of avian haematozoa from our region, particularly the species of *Plasmodium*. A detailed report has still to come, but he writes that a preliminary glance through the material has shown several of them with Haemoproteus infections (i.e. mosquito-transmitted bird malaria), and a number of *Turdoides c. caudatus* to be harbouring *Atoxoplasma*. A further collection of 62 smears was made for Dr. Laird from birds netted on Jalandar Bēt during September.

Spring Field Session: Kutch, 9 to 26 March 1961

Following the deficient SW. monsoon of 1960, the greater part of Kutch was officially declared a scarcity area. Many of the smaller bunded irrigation reservoirs dried up by January, and it was only the unexpected 3 inches or so of unseasonable rain that fell in late February that ameliorated the situation somewhat, and averted drought conditions.

The northernmost areas, along the edge of the Great Rann, were amongst the most seriously affected. The only source of water on Kuār Bēt, where the spring migration field camp had been operated in 1960, was almost dry by early March, and in contrast to the lush conditions of vegetation in 1960, the island presented a desiccated and forbidding appearance. The few places in the northern areas where any water was available were overrun by village cattle driven in from scarcity areas far around, and past experience had amply demonstrated that cattle and mist nets cannot co-exist!

It was a problem to find a place with the required conditions for netting, yet free from cattle. Two promising sites were finally selected, (1) at Chaduva about 14 miles WSW. of Bhuj, and (2) in Wanothi Rakhal (or forest preserve) near Assambia village, *c.* 9 miles N. of Mandvi.

1. *Chaduva* (*c.* 23° 15′ N. × 69° 40′ E.): This is the private estate of H. H. the Maharao of Kutch. It contains a well-watered, well-wooded orchard of mango, guava, mulberry, and other fruit trees. This garden is situated immediately below the dam which impounds the extensive Prāgsar tank (or reservoir). A seepage nala (or stream) trickles through the garden, the bed of which for about 200 yards or more is densely overgrown with coarse reeds (*Saccharum* ?) 10 to 12 ft. high. Bordering this garden on one side is a stretch of cotton fields, lying fallow at this season. The surrounding hummocky country which forms the catchment area of the two large bunded

(dammed) tanks Prāgsar and Phārsar is stony and sparsely scrubbed with the normal semi-desert type of vegetation characteristic of Kutch.

The Chaduva garden is the nightly roost of enormous hordes of House Crows (*Corvus splendens*), estimated as *c.* 10,000, which gather from before sunset and into dusk from long distances around to sleep in the large leafy trees, whereas the smaller mango grafts and guava trees together with the adjoining reed-bed are patronized by Common Mynas (*Acridotheres tristis*), estimated as 5000+, and Rosy Pastors (*Sturnus roseus*), estimated as 2000+, together with hundreds of bulbuls, both *Pycnonotus cafer* and *P. leucogenys leucotis*, Bank Mynas (*A. ginginianus*), and countless weaver birds (*Ploceus philippinus*).

Besides myself, the personnel here consisted of 1 member of the Society's field staff, a personal attendant trained for the work, Mr. P. V. Rajamannar of the Delhi University Zoology Department, and Rev. Axel Krebs, a Danish Missionary from Madras State. A second member of the Society's staff, D. Mathew, and V. C. Ambedkar, a post-graduate Field Ornithology student of the Bombay University, joined the party a few days before the operations were wound up. Two technicians of the Virus Research Centre looked after tick collection from the birds.

2. *Wanothi Rakhal* (*c.* 22° 50′ N. × 69° 30′ E.): This is an area of thorn forest preserved by the Forest Department principally for cattle fodder and fuel (firewood). The vegetation is composed largely of species such as *Acacia arabica, A. senegal, Prosopis spicigera,* and the others usual to a semi-desert biotope. The Mandvi District of southern Kutch, within which the reserve is located, is rather fertile, well-watered and well cultivated, and dotted about with green and flourishing *wādis* (market gardens), and lush lucerne fields irrigated from ring wells and dammed reservoirs. There are several rivers in this section with sandy beds which still ran trickles of water by the end of March, with puddles and squelchy patches here and there covered with dense reedbeds, large and small, which afforded community roosts to wagtails, swallows, and weaver birds.

The camp itself was located just below, and adjacent to, the dam of the Assambia tank, at the head of an effluent feeder canal. The seepage from the dam formed several stagnant marshy pools, overgrown along their edges by bulrushes (*Typha*), and these marshes and their surroundings provided attraction for wagtails, warblers, swallows, and other species, both resident and migratory. The Wanothi camp was under the direction of Yuvraj Shivrajkumar of Jasdan assisted by P. W. Soman, M. Pereira and P. Swami of the Society's staff, and A. R. K. Das, post-graduate Avian Biology student of Baroda University. Unfortunately, being pre-occupied with other commitments elsewhere, no entomologists or technicians could be spared by the Virus Research Centre for this camp, hence some valuable opportunities for tick collection from migrant birds such as swallows and wagtails were missed.

On the whole it seemed that bird movement was tardy during the period of operation of the camps, and that possibly migration was delayed. This impression was partly confirmed by reports coming in from Saurashtra as well. However, up to a point it may also be that the netting sites themselves were less favourable as compared with the more forward areas in northern Kutch along the borders of the Great Rann. When motoring back through eastern Kutch and Saurashtra at the end of March, Blackheaded Buntings (*Emberiza melanocephala*) were observed in large numbers which looked as if they were working their way westward and northward. Rosy Pastors were also far more abundant and widespread in Saurashtra and Gujarat at that period than they were in Kutch.

During this spring session one more species was added to the Kutch list, namely the Moustached Sedge Warbler (*Lusciniola melanopogon*)[1], of which six examples were taken in the nets at Wanothi. This warbler is not uncommon in winter in West Pakistan, but has only been recorded exceptionally in India as far south as Madhya Pradesh, and also in Saurashtra. The number caught suggests that it may perhaps be less rare than supposed.

An interesting experience, worth recording, was the re-capture of two ringed bulbuls (1 *Pycnonotus cafer*, 1 *P. leucogenys leucotis*) during a morning's snap netting at Changalra (Bhuj neighbourhood) in the identical half-mile square that was worked during the first session of this series 18 months earlier—in September 1959. Both the birds were registered as adult at that time.

During this latest session our attention was increasingly shifted to the overriding advantage of netting migratory birds like the Rosy Pastor and wagtails and swallows at their communal roosts. The possibility of bulk capture of these species—of significance from the tick infestation and virus dissemination point of view—was limelighted by the experience at Wanothi where, within an hour's netting at a wagtail roost at sunset, over 170 birds were caught, and at a swallow roost near-by over 50. It appeared that our most fruitful

---

[1] *J. Bombay nat. Hist. Soc.* 58 : 513.

course for future activities would be to search out suitable roosts in marshy reedbeds etc. and concentrate all effort on these. However, our experience with Rosy Pastors, roosting in their close-packed tantalising thousands amongst similar reedbeds and shrubbery, proved thoroughly futile and disappointing! These birds are far too cunning for ordinary mist netting, and seem to possess an uncanny instinct for avoiding the nets. Perhaps our most rewarding course with them would be to employ professional bird catchers with their special techniques. The Rosy Pastor seems a particularly desirable subject for attention, both from the migration study and from the virus dissemination points of view. (A significant proportion of those examined previously were found positive for ticks.) This is a fairly large, conspicuous, and widely distributed species in its Indian winter quarters. It comes in enormous swarms, and lives, feeds, moves about, and roosts in vast congregations. It is destructive to cereal crops, and is itself relished as an article of food and, therefore, largely shot and netted everywhere as well as all along its migration routes, thus increasing the chances of ring recoveries.

A total of 2192 birds representing 69 species were captured and ringed at the two camps. They included 641 migrants (*c.* 30% of the total) of which 578 (*c.* 90%) were taken at Wanothi including 276 Yellow Wagtails (*Motacilla flava melanogrisea* and other races), 159 White Wagtails (*M. alba* mostly *dukhunensis*), and 32 Yellow-headed Wagtails (*M. citreola*), and 73 Common Swallows (*Hirundo rustica*).

Among the common resident birds in the present series, most frequently and consistently found with ticks attached were the Common Babbler (*Turdoides c. caudatus*), the Indian Robin (*Saxicoloides fulicata cambaiensis*), and the Weaver Bird (*Ploceus p. philippinus*), in that order. Among the migrant species, although the samples examined were inadequate, a high frequency of tick infestation was indicated by the Bluethroat (*Erithacus svecicus* ssp. ?) and the Redstart [*Phoenicurus ochruros phoenicuroïdes* (?)].

In several instances it was noted that a bird, found negative for ticks when first ringed and released, had ticks attached to it when re-captured two, three, or more days later. This could be due either to the ticks having escaped detection on the first occasion, or to their being picked up during the interval.

The identification of the ticks in the present series awaits study in the Virus Research Centre laboratory at Poona. The majority of those taken during the spring of 1960 (on Kuār Bēt) have been reported as

Haemaphysalis (*intermedia* ?) with a small percentage of *Hyalomma* sp. As against this, the ticks collected from birds in Saurashtra during autumn 1960 (Jalandar Bēt and Hingolgadh) included, in addition to *Haemaphysalis* (*intermedia* ?) (the majority), a few larvae and nymphs provisionally identified as *Hyalomma* sp., *Amblyomma* sp., and 1 or 2 examples of *Rhipicephalus* sp.

The Hyalommas are described as ticks of relatively dry areas. This genus as well as the species *Haemaphysalis intermedia* are not known to occur in the epizootic region of the Kayasanur Forest Disease in Mysore etc., though another species of the latter genus, namely *Haemaphysalis spinigera*, is abundant there and the principal carrier of the Kayasanur Forest Disease virus.

Autumn Field Session: 11 to 30 September 1961

Heavy monsoon rendered work in Kutch impracticable for the purpose of transport and communication, and a search had to be made for alternate venues for the autumn camps.

A restricted area in the neighbourhood of Bhavnagar town was selected for one of the camps. A second camp was established at Bharatpur in eastern Rajasthan (about 160 km. south-west of Delhi), which some pilot mist netting in late spring had indicated as a promising venue for migratory wagtails, swallows, warblers, and other passerines.

1. Bhavnagar (*c.* 21° 45′ N. × 72° 15′ E.), 12 to 30 September 1961

The netting here was principally done in a fenced-in area of reserved thorn jungle and scrub of about 500 acres under the Forest Department, known as Victoria Park. The area is protected against lopping of trees and grazing and browsing by domestic animals. It used to be a model wild life sanctuary in miniature in former years, and still holds some nilgai and wild pig. The vegetation consists of moderate-sized trees and shrubs of *Acacia arabica*, *A. senegal*, *A. catechu*, *Prosopis spicigera*, with an intermingling of *Salvadora persica* and *S. oleoides*, and the recently introduced all-too-flourishing *Prosopis juliflora*. At the end of the monsoon, which was again much above the average here, the Park presented a luxuriant appearance, and being in the nature of an island of greenery on the edge of the town, surrounded by cultivation and open country, it seemed to offer attractive conditions for migratory passerines on arrival. It had, in fact, been reported as a favourite halting place. The Park contains a low-lying basin of several acres, which becomes a lake during and after the monsoon and retains some water all the year round. Around its margins are beds of reeds and sedges suitable for reed warblers, and as night roosts for swallows and wagtails. In spite of these apparent advantages, the results of our 18 days' netting in the Park proved disappointing. Whether the second half of September is too early in the season for strong incoming migration (as we now suspect), or whether the vagaries of the monsoon were responsible for retarding it that year, or whether the choice of the venue itself was basically wrong, it is difficult to assess, but this much is certain that migration had apparently just commenced to trickle in by the end of September when the camp was being wound up. A total of 466 birds (58 species) was ringed in Bhavnagar, of which 90 (17 species) were migrant, i.e. about 19%.

In regard to tick collection, it is unfortunate that the Virus Research Centre were unable to render the necessary co-operation to our field teams this autumn as they had done on previous occasions. In the absence of special technicians to examine the birds, valuable opportunities were lost. The ornithological personnel in both camps, despite the voluntary help it periodically received from visiting bird students, was short-handed and otherwise pre-occupied, and often also grossly overworked. Some more satisfactory arrangement will need to be worked out for the future to ensure the fullest advantage being taken of the valuable opportunities afforded by these field sessions for studies of the role of birds in the dissemination of arthropod-borne viruses.

2. Bharatpur (27° 13′ N. × 77° 32′ E.), 11 to 30 September 1961

Mist netting here was done chiefly in and around the Forest Nursery situated within the Keoladeo Ghana Wild Life Sanctuary, and in the swampy fallow fields adjoining Jatoli village immediately outside. The higher ground in the village precincts was under maize, jowar, and bajra cultivation, most of which had suffered badly from the exceptionally heavy and late-continuing rains—already more than double the annual average—which had caused widespread floods and devastation in many parts of central and northern India. The Keoladeo Ghana, a natural depression some 7000 acres in extent densely covered with thorn jungle, is under the protection of the Forest Department. The vegetation consists largely of trees and shrubs of *Acacia arabica, Prosopis spicigera, Capparis horrida, Salvadora* *persica* and *S. oleoides*, and *Zizyphus jujuba*, with a sprinkling of large and ancient trees of *Stephegyne parviflora*. Dense shrubbery of *Clerodendrum* (*phlomoides* ?) occurs outside the forested area. In a year of good monsoon (such as the present) a large portion of the Ghana forest becomes inundated and teems with fish brought down by the various rivers that contribute to its water supply. This remarkable abundance of food is the basis of the phenomenal concentrations of nesting storks, egrets, herons, cormorants, and other water birds, for which the Keoladeo Breeding-Waterbird Sanctuary has acquired fame within the country and abroad. The lake also affords winter refuge to countless migratory ducks and geese, and is reckoned as one of the finest duck-shooting *jheel*s in India.

By April the greater part of the Ghana dries up, furnishing rich grazing to thousands of cattle from the town and surrounding villages. Little 'islands' of sedges and bulrushes then stand out here and there amidst swampy patches on its bed to serve as night roosts for wagtails, swallows, and reed warblers. It was the chance stumbling upon one such roost in May 1961, which yielded 370 birds (including 184 migrants) on five consecutive evenings' mist netting, that first gave a clue to the inherent potentialities of the Ghana for ringing passerine migrants and prompted its selection for the present field camp.

During the period between 10 and 30 September there was a great surfeit of flood waters everywhere and most of the reedbeds were submerged. No roosts of swallows or wagtails were discovered among them. Bird migration was on the whole distinctly tardy and, as in Saurashtra, it appeared that here also we were as yet too early for most species. But for a fortunate and fortuitous rush of Yellow Wagtail (*Motacilla flava*) migration, our results would have been no less disappointing than in Bhavnagar. Only small numbers of wagtails were observed on 10th September, yet three days later the marshy fallow fields were literally swarming with them—mostly the three subspecies *thunbergi*, *beema*, and *melanogrisea*. Their flocks in the air were reminiscent of major locust swarms. I cannot recall ever seeing such masses of wagtails together! Of the total number of 1122 birds caught and ringed in Bharatpur during the twenty days (see Table II) 681 were Yellow Wagtails. Since other migrant species were as yet in insignificant quantities only, it was decided to focus all our efforts on the wagtails alone. Owing to a continuous wind in the exposed fields, at least thrice as many birds bounced back and escaped from the nets before they could be removed, but even otherwise these would have represented merely a very small fraction of the wagtails present in that area of a few hundred acres! Over and over again experience has proved mist nets to be almost completely ineffective on windy days, especially in the case of such light-weight birds as wagtails and warblers. As yet no remedy for this has been found.

Working under pressure, it was early realized that there was little point in ringing common resident birds such as bulbuls, babblers, and mynas. Whenever it was practicable to examine the captives for ticks this was done; but otherwise, in most cases, such birds were promptly set free. In this way possibly some 300 or more birds were released unringed. Therefore in Table II any comparison by proportion of the percentages of resident and migrant species would be irrelevant.

A proposed innovation referred to at p. 118 above was tried out during the present field session, namely the employing of professional netters in order to supplement our own catches by sizeable quantities of migratory birds such as ducks, Grey Quails, Rosy Pastors, and waders (in-coming Ruff & Reeve pass through Bharatpur in autumn in enormous numbers). Two sets of 2 men each were imported from Bareilly (a centre of the wild bird trade) claiming to be experts in the art. One set was assigned to Bhavnagar, the other to Bharatpur. In both cases the experience proved a dismal failure and the claims of the men to be exaggerated out of all recognition! It is true that September may have been too early, considering the abnormal weather conditions, for Grey Quail and Ruff & Reeve, but the trappers even failed to catch any Rosy Pastors at a populous roost in Bhavnagar, and only a very negligible quantity of some of the common resident birds! Moreover, most of their catching was done with bird lime, a method quite unsuited for birds intended for ringing and prompt release. Though the experiment proved disappointing and disproportionately costly, it is felt that it may be worth repeating under more favourable auspices.

Besides the birds caught in mist nets, 111 nestling water birds[1] were ringed in the Keoladeo Breeding-Waterbird Sanctuary. This was in continuation of previous ringing work in this heronry, in an attempt to study the post-breeding dispersal of its seasonal occupants, which obviously converge here from over a very extensive range. One of the nestling Openbill Storks (*Anastomus oscitans*) ringed in the sanctuary on an earlier occasion was recovered at a

---

[1] Chiefly Purple Heron (*Ardea purpurea manilensis*), and the White Egrets (*Egretta intermedia* and *E. g. garzetta*).

distance of over 500 miles a few months later—an unsuspected wandering. The vast concentrations of nestling waterbirds and their young at this unique heronry (chiefly the families Phalacrocoracidae, Ardeidae, Ciconiidae, and Threskiornithidae) would seem to offer unparalleled opportunities for serological studies connected with the problem of virus transmission through bird-biting mosquitoes and other arthropods.

An interesting addition to the Rajasthan bird list, and a significant extension of its known winter range in India, was provided by a single specimen of the Thickbilled Warbler (*Phragamaticola aëdon*) taken in the nets at Bharatpur on 15 September. This large warbler, which could easily be mistaken in the field (and no doubt often is) for the Great Reed Warbler (*Acrocephalus stentoreus*), breeds in the USSR from eastern Altai and Kemerovo to Manchuria, and in central Japan. It winters at low elevations in the eastern Himalayas and Assam, and mainly on the eastern side of the Indian peninsula; also in Kerala, Mysore, and southern Maharashtra. It will be recalled that in autumn 1959 it was obtained for the first time (see pp. 105, 106) as far north on the western side as Kutch.

Table II

Summarized statement of the 3366 Migratory Birds ringed in five ringing sessions, 1959-61

Species	Pilot Camp	Spring 1960	Autumn 1960	Spring 1961	Autumn 1961	Total
1. Sparrow-Hawk, *Accipiter nisus* ..	..	..	..	..	1	1
2. Pale Harrier, *Circus macrourus* ..	..	2	..	..	..	2
3. Kestrel, *Falco tinnunculus* ..	..	..	..	1	..	1
4. Common Quail, *Coturnix coturnix*	3	2	..	..	..	5
5. Green Sandpiper, *Tringa ochropus*	1	..	..	..	..	1
6. Wood Sandpiper, *Tringa glareola* ..	..	..	..	6	..	6
7. Fantail Snipe, *Capella gallinago* ..	..	..	..	1	..	1
8. Pied Crested Cuckoo, *Clamator jacobinus* ..	8	..	4	..	5	17
9. European Nightjar, *Caprimulgus europaeus unwini* ..	..	..	1	..	1	2
10. Bluecheeked Bee-eater, *Merops superciliosus* ..	..	..	..	..	2	2

Summarized statement of the 3366 Migratory Birds ringed in five ringing sessions, 1959-61 (*contd.*)

Species	Pilot Camp	Spring 1960	Autumn 1960	Spring 1961	Autumn 1961	Total
11. European Roller, *Coracias garrulus* ..	1	..	13	..	..	14
12. Hoopoe, *Upupa epops* ..	22	12	10	1	15	60
13. Wryneck, *Jynx torquilla* ..	16	14	33	3	30	96
14. Short-toed Lark, *Calandrella cinerea* ..	..	..	..	6	..	6
15. Swallow, *Hirundo rustica* ..	..	..	..	73	2	75
16. Redbacked Shrike, *Lanius collurio*	8	2	37	..	..	47
17. Golden Oriole, *Oriolus o. kundoo*	..	..	1	..	9	10
18. Grey or Ashy Drongo, *Dicrurus leucophaeus* ..	..	..	..	1	1	2
19. Rosy Pastor, *Sturnus roseus* ..	14	60	70	9	..	153
20. Spotted Flycatcher, *Muscicapa striata* ..	10	..	32	..	1	43
21. Redbreasted Flycatcher, *Muscicapa p. parva* ..	..	15	..	3	..	18
22. Paradise Flycatcher, *Terpsiphone paradisi* ..	..	..	2	..	4	6
23. Moustached Sedge Warbler, *Lusciniola melanopogon* ..	..	..	..	6	..	6
24. Grasshopper Warbler, *Locustella naevia straminea* ..	..	..	1	..	..	1
25. Thickbilled Warbler, *Phragamaticola aëdon* ..	1	1	..	..	1	3
26. Indian Great Reed Warbler, *Acrocephalus stentoreus* ..	7	18	..	2	..	27
27. Blyth's Reed Warbler, *Acrocephalus dumetorum* ..	77	23	48	4	38	190
28. Paddyfield Warbler, *Acrocephalus agricola* ..	1	..	..	8	..	9
29. Booted Warbler, *Hippolais caligata* ..	30	22	56	..	9	117
30. Whitethroat, *Sylvia communis* ..	41	..	305	..	4	350
31. Orphean Warbler, *Sylvia hortensis* ..	2	61	149	..	11	223
32. Lesser Whitethroat, *Sylvia curruca* ..	6	64	132	16	7	225

Summarized Statement of the 3366 Migratory Birds ringed in five ringing sessions, 1959-61 (*contd.*)

Species	Pilot Camp	Spring 1960	Autumn 1960	Spring 1961	Autumn 1961	Total
33. Hume's Lesser Whitethroat, *Sylvia althaea* ..	..	..	6	..	..	6
34. Brown Leaf Warbler, or Chiffchaff, *Phylloscopus collybita tristis* ..	..	3	..	14	..	17
35. Bright Green Leaf Warbler, *Phylloscopus nitidus* ..	..	..	1	..	1	2
36. Greybacked Warbler, *Erythropygia galactotes familiaris* ..	..	..	13	..	..	13
37. Bluethroat, *Erithacus svecicus* ..	2	4	..	8	8	22
38. Black Redstart, *Phoenicurus ochruros* ..	1	6	15	8	4	34
39. Stone Chat, *Saxicola torquata* ..	..	..	..	..	4	4
40. Pied Bush Chat, *Saxicola caprata*	2	..	2	..	2	6
41. Pied Chat, *Oenanthe picata* ..	3	..	1	..	..	4
42. Blue Rock Thrush, *Monticola solitarius pandoo* ..	..	..	..	..	1	1
43. Tree Pipit, *Anthus trivialis* ..	1	..	10	..	12	23
44. Tawny Pipit, *Anthus campestris* ..	..	3	2	..	1	6
45. Blyth's Pipit, *Anthus godlewskii* ..	..	..	..	..	1	1
46. Brown Rock Pipit, *Anthus similis*	..	..	..	1	..	1
47. Yellow Wagtail, *Motacilla flava* ssp.	1	..	..	123	680	804
48. Pied, or White, Wagtail, *Motacilla alba* ..	1	..	..	159	1	161
49. Blackheaded Yellow Wagtail, *Motacilla f. melanogrisea* ..	..	..	..	153	..	153
50. Yellowheaded Wagtail, *Motacilla citreola* ..	..	..	..	32	..	32
51. Common Rosefinch, *Carpodacus erythrinus* ..	13	1	1	..	27	42
52. Blackheaded Bunting, *Emberiza melanocephala* ..	249	6	4	1	..	260
53. Redheaded Bunting, *Emberiza bruniceps* ..	..	..	..	..	14	14
54. Striolated Bunting, *Emberiza striolata* ..	..	..	15	..	..	15
55. Greynecked Bunting, *Emberiza buchanani* ..	12	3	20	1	..	36

Field Survey: Assam, 11 to 29 November 1961

As indicated earlier our knowledge of bird migration has been very meagre. Unlike NW. India which, on account of its strategic importance, has enjoyed the benefit of many knowledgeable ornithologists, chiefly British army and political officers, posted there for long periods in the last hundred years, the NE. frontier areas have suffered comparative neglect due to the absence of resident ornithologists. Such information as is available thence is the result of haphazard observations, mostly of botanical and zoological collectors who chanced to be working in various parts of the country at the appropriate seasons. But, meagre as they are, the data suffice to indicate that a considerable amount of movement occurs through the valleys of the Brahmaputra and its network of tributaries, and across some of the high mountain passes through the Himalayan barrier between Tibet and Indian territory.

Recent efforts for extending our field work elicited certain suggestive clues that seemed worth following up. Two of the areas, one in NEFA, the other in the North Cachar hills, seemed particularly promising. Accompanied by Mr. E. P. Gee of Shillong, a member of the Society's Advisory Committee, I visited the areas from 11-29 November 1961 for a personal investigation of their possibilities.

1. *Tuting*, roughly 29° N. × 95° E., the headquarters of the Assistant Political Officer of the Siang Frontier Division, lies at an altitude of about 2000 ft. in an elongated crater-like valley, *c.* 2-3 miles long and 1.5 miles at its widest, running N. and S. through a titanic jumble of steep-sided heavily-forested Himalayas rising 9-12,000 ft. all round. The lower slopes of the mountains around the settlement are dotted sparsely here and there with clearings for the shifting cultivation of the local Abors. Within the valley is situated the P.S.S.-covered airstrip on which Dakotas of the Kalinga Airlines periodically land with supplies for the outpost. Before the airstrip was made a few years ago, the journey to Tuting meant 14 days' marching on foot from Pasighat; now the plane from Mohanbari airfield (Dibrugarh) took us there in 40 minutes. Our fellow travellers in this severely austere craft were mostly bags of atta and dal, tins of kerosene, drums of petrol and oil, and such other supplies. Flying with the doors wide open was a novel experience in air travel and added to the thrill of the endless succession of peaks, ridges, and perilous gorges below. The gigantic snow-covered mountains flanking the route did sometimes seem a bit too

close to the wing-tips for peace of mind! All around was evidence in the shape of gigantic scars high up on the mountains of land-slides, especially those caused by the historic earthquake of 1950.

The settlement of Tuting is about 10 miles south of the frontier post of Geling, as the crow flies. On a clear day the lofty snow-capped ranges on the Tibetan frontier loom on the horizon with the giant Namchebarwa, over 25,000 ft., standing out prominently. The settlement is largely official, consisting of quarters for the political staff, a school, a hospital, the agriculture, the animal husbandry, and the public health centres, a public works office, and various community development agencies. Where it is not cleared for the construction of buildings or experimental cultivation, the valley is under dense secondary scrub in which a species of sugarcane-like Saccharum grass, tall, coarse, and saw-edged, with plumes of silky pinkish magenta flower-heads, and the ubiquitous *Eupatorum* weed predominate.

Tuting is situated on one of the two main tributaries of the Brahmaputra, namely the Tsangpo or Siang, almost where it enters India (the other being the more easterly Lohit). Further south the Siang is known as the Dihang until it merges with the Brahmaputra. A former A.P.O. of Tuting, Shri Nalni Jayal who was a competent bird watcher, had strongly recommended Tuting as a suitable locality for observing migration. During his 2½ years at Tuting he had noticed intense bird activity during the spring and autumn migrations, whereas at other seasons not much bird life was visible there. This latter I also found to be true at the time of my visit, 14-20 November, particularly in regard to migrant species. The scarcity and extreme shyness of all birds, large and small—here as in most other parts of the Assam hills—is no doubt due to their relentless persecution, with bows and blunt arrows and every other means, by the local tribals for food. According to the present A.P.O., Shri S. S. Yadav, large numbers of geese (?) were observed in the second half of October flying more or less directly N. to S. over the valley of the Siang River, in successions of wedges or echelons. From other local testimony, and from the general physiography of the area, it seems certain that at the appropriate periods in spring and autumn Tuting must be an exceptional venue for observing migration in progress, but possibly less satisfactory for mist netting of the smaller passerine birds. Apart from this uncertainty, there is the question of precise timing. Since migration appears to rush through rather hurriedly within short periods, it would be extremely difficult to plan the field work in advance. Owing to its remoteness and the difficulty and cost of transporting a field party and equipment all the way from Bombay, Tuting therefore seems an impracticable proposition for our present project. This is an activity that seems only feasible—and certainly very worthwhile—for ornithologists resident at the spot, who can go into operation at short notice immediately the opportunity presents itself. The A.P.O., Shri Yadav, is a very keen and energetic young man and, though not an experienced bird watcher, is sufficiently interested in the proposed study to keep a special look-out at the appropriate seasons in future and keep us posted with bird movements in his area.

2. *Jatinga* (*c.* 2000 ft.). This is a small settlement or village in the North Cachar hills, about 4 miles distant from the sub-divisional headquarters Haflong (*c.* 25° N.×93° E.), at the head of Jatinga Valley running roughly N. and S. The place has acquired a wide 'reputation' for the large numbers of 'migratory' birds killed by the inhabitants at bright lights exposed outside their houses during certain seasons of the year. On this account Jatinga was recommended to us as worth investigation for the proposed extension of the migration field project to Assam. Thanks to the kindness and good offices of Mr. Gee, I was enabled to visit the place in his company between 23 and 29 November. We motored down the 250 odd miles from Shillong through Garampani in his jeep, mostly over narrow winding and spectacular contour roads, largely through magnificent lofty evergreen hill forest. Unfortunately, here also, the timing was wrong. The most favourable period for the bird-catching activity at Jatinga is said to be between the middle of August and the end of October (i.e. during the monsoon), the best month being September. Nevertheless, we visited the actual spots where the operations had been carried out as lately as a few weeks before, and in an attempt to identify some of the victims of these holocausts, picked up a quantity of feathers strewn about the place. From Mr. E. W. Suchiang, an intelligent young Khasi resident of Jatinga, who has himself participated in the 'sport' for many years, the following particulars were obtained:

A suitable night is one that is dark and moonless, cloudy and overcast, preferably with a light drizzle, and with heavy mist or fog near the ground, with wind blowing S. to N., i.e. against the flow of migration. If the wind direction is not right no birds will come to the petromaxes, bonfires, or flares. The light is screened on the southern side for the hunter to remain invisible to the birds as they fly in from north. Under the requisite conditions the birds are attracted to the lights in large numbers. All the inmates of Jatinga village sally forth with their petromaxes or flares and sticks to kill the birds with, and also those of the outlying hamlets and homesteads, in order to gather in this harvest of bird meat. The movement is confined to the immediate vicinity of Jatinga only, and even 2 miles further away, in apparently identical situations, no birds come to the lights. During a season several thousand birds may be taken. As many as 5-600 birds are often killed in a single night at 50 to 60 lights. The best time is from 7 to 10 p.m., and then again from 2 to 4 a.m. During the rest of the night there are only a few individual stragglers. About 10 years ago, our informant, then a boy, claims to have killed over 200 birds in a night single-handed. The birds are plucked of their feathers, and either eaten fresh or smoke-dried and preserved for future consumption.

As regards the species of these birds there seemed to be much uncertainty. Our informant described them as 'geese, small ducks, waterbirds with long legs like storks, and others sparrow size and even smaller'. Unfortunately no diagnostic parts of the birds were available for examination since, before drying, the head, bill, and legs are discarded. The collection of feathers picked up on the sites of slaughter and brought to Bombay for study with the Society's reference collection of birds gave no evidence of any geese or ducks, but some species whose identity is unmistakable were as follows:

Malay Bittern (*Gorsachius melanolophus*).
Little Egret (*Egretta garzetta*).
Hill Partridge (*Arborophila rufogularis* ?).
Kalij Pheasant (*Lophura* ?).
Green Pigeon (*Treron* sp. ?).
Emerald Dove (*Chalcophaps indica*).
Whitebreasted Kingfisher (*Halcyon smyrnensis*).
Ruddy Kingfisher (*Halcyon coromanda*).
Necklaced Laughing Thrush (*Garrulax moniligerus*).

Many other feathers could not be properly identified. The curious thing, however, is that all the species in the above list are what is known as 'resident' birds, though our informant asserted that they are not met with in that part of the country at any other time, excepting only 'green pigeons' of which considerable numbers appear to be attracted to the lights at this period. The identification of Emerald Dove feathers was confirmed by two live examples kept in a cage, taken at a light a few weeks previously.

This seasonal nocturnal mass movement of 'non-migratory' birds, all of which are diurnal except the bittern and should normally be roosting peacefully, is difficult to understand and worthy of closer investigation by some knowledgeable bird student resident in that neighbourhood. It is hoped that this note will help to focus attention on the 'mystery'. I understand that this cruel practice of wholesale destruction of birds at lights is prohibited by law; that it continues, nevertheless, and without anybody apparently being much concerned about the ban is all too evident. Here again, there is a fruitful venue for ringing birds on the appropriate occasions by persons resident on or within easy reach of the spot. Owing to distance and the uncertainty of the occurrence of the requisite weather conditions, it would obviously be impracticable for the Bombay Natural History Society to undertake the work departmentally.

Studies on the Freshwater Oligochaeta of South India

I. Aeolosomatidae and Naididae

PART 2

BY

K. VANAMALA NAIDU

Government Arts and Science College, Chittoor (A.P.)

(*With five text-figures*)

[*Continued from Vol.* **58** (3) : 652]

Family NAIDIDAE

KEY TO ALL THE SUBFAMILIES OF NAIDIDAE

A-1 Nephridia absent .. [1] Paranaidinae

A-2 Nephridia present

B-1 Segment III strongly elongated ; no pharyngeal diverticulum ; none to one pair of commissural vessels .. Chaetogastrinae

B-2 No specially elongated segments ; pharynx with dorsal diverticulum ; 4 or more pairs of commissural vessels, simple, branched or forming plexus

C-1 Dorsal setae begin in IV, V, or VI .. Naidinae

C-2 Dorsal setae usually begin in II (in *Pristina macrochaeta* in III or IV)

D-1 Four segments budded at anterior end by budding zone ; testes in IV and ovaries in V .. [2]Stephensonianinae *nov.*

D-2 Seven segments formed at anterior end by budding zone ; testes in VII and ovaries in VIII .. Pristininae

---

[1] Members of this subfamily are not recorded from the Indian sub-continent.
[2] Represented by one genus only.

a. Subfamily CHAETOGASTRINAE Sperber, 1948

KEY TO ALL THE GENERA OF CHAETOGASTRINAE

Dorsal setae absent ; ventral setae of III-V absent ..	*Chaetogaster*
Dorsal setae present ; ventral setae present throughout ..	[1]*Amphichaeta*

2. Genus **Chaetogaster** von Baer, 1827

Generic characters : Worms whitish and transparent. No eyes. Body surface with fine outgrowths. External segmentation absent. No dorsal setae, ventral setae absent in III-V. Pharynx in II-III, oesophagus in IV, pharyngeal and oesophageal glands absent, stomach conspicuous and barrel-shaped; intestinal anti-peristalsis and ascending ciliary action absent. Septa present, no septal glands. Coelomocytes absent. Dorsal vessel contractile and mid-dorsal ; ventral vessel non-contractile and mid-ventral ; contractile lateral vessels ('hearts') 1 pair in IV. Brain with or without statocyst. Nephridia exonephric, start from VI or VII. Budding zones 1-7.

KEY TO ALL THE KNOWN AND VALID SPECIES OF CHAETOGASTER

A-1 Setae simple-pointed ..	* *setosus*
A-2 Setae double-pointed	
B-1 Setae with strongly curved teeth (at right angles to the shaft) ..	*limnaei*
B-2 Setae with normally curved teeth (at obtuse angles to the shaft)	
C-1 Prostomium conspicuous	
D-1 Sensory hairs long on prostomium ; body size medium (1-5 mm. long); setae 4-8 per bundle in II, 3-5 in others ..	*diastrophus*
D-2 Sensory hairs extremely long on prostomium and later segments ; body size small (0.6-1.7 mm. long) ; setae 4-6 per bundle in II, 3-5 in others ..	* *palustris*
C-2 Prostomium inconspicuous	
E-1 Distal tooth reduced ..	* *krasnopolskiae*
E-2 Distal tooth of setae longer than proximal	
F-1 Prostomium with median incision	*cristallinus*
F-2 Prostomium without median incision	
G-1 Setae large (145-350 μ long, 4.5 μ thick in II) ..	*diaphanus*

[1] Members of this genus are not recorded from the Indian sub-continent.

G-2 Setae small (60-100 μ long, less than 2 μ thick in II)

H-1 Pulsatile 'heart' on ventral vessel in IV ; body size (0.5-1.2 mm.) ; setae 4-6 per bundle and 59-73 μ long in II .. **parvus*

H-2 Pulsatile 'heart' absent ; body size 0.8-2.0 mm. ; setae 3-9 per bundle and 63-100 μ long in II .. *langi*

4. **Chaetogaster diastrophus** (Gruithuisen, 1828)

Fig. 4

Chaetogaster diastrophus (Gruithuisen). Pointner, 1911, p. 629. Lastočkin, 1918, p. 58 ; 1927, p. 65. Svetlov, 1925, p. 472. Cordero, 1931a, p. 349 ; 1931b, p. 333. Hrabě, 1939, p. 209. Chen, 1944, p. 2. Sperber, 1948, pp. 59-62, fig. 3C, 6, 7A B, G, pl. I, fig. 1 ; 1950, p. 52, pl. fig. 1.

Material examined : Many worms collected from the Bugga stream, Cuddapah, in March and December 1955 ; from the Kandakam tank, Bellary, in April 1956.

Worms minute, imperceptible to unaided eye. Prostomium well developed, bluntly pointed with long stiff sensory hair.

Ventral setae bifid with strong proximal noduli, shaft straight above and bent below nodulus. Distal prong longer and thinner than the proximal. Setae of II, 6-7 per bundle, 98 μ long ; in others 4-5 per bundle, 70 μ long.

Mouth ovoid and ventral, always open, gape increasing and decreasing. Oesophagus $\frac{1}{2}$-$\frac{2}{3}$ as long as pharynx. Stomach in V-VI, with transverse vascular loops giving a striped appearance. Intestine yellowish, wide in VII and VIII, narrow behind it. Chloragogues from V onwards with bluish globules. Septa delicate.

Brain incised in front and behind, conspicuous with semi-circular, mid-dorsal, greenish-blue statocyst in living worms. Ventral nerve cord well developed with irregular outline.

Dorsal vessel contractile, contractions starting behind and surging forwards ; ventral vessel non-contractile. Two lateral contractile vessels in IV.

Nephridia from VII on, two per segment, without nephrostomes, compact, consisting of glandular tissue enclosing a long coiled nephridial duct ; ectal duct thick, nephridiopores opening ventro-laterally.

Worms without fission zones rare ; chains composed of 2-5 zooids common. First budding zone always appears between IX and X,

* Species not recorded from the Indian sub-continent.

second zone a segment anterior to it. A chain of 8 zooids had the following composition :

Zooid No.	No. of Segments in the Zooid	Type of Segments
I Zooid	8	all of parent
	VI fission zone	
II Zooid	3	1 old + 2 new
	II fission zone	
III Zooid	4	1 old + 3 new
	IV fission zone	
IV Zooid	3	all new
	I fission zone	
V Zooid	8	3 old + 5 new
	VII fission zone	
VI Zooid	1	old
	III fission zone	
VII Zooid	4	all new
	V fission zone	
VIII Zooid	2 + undiff. region	2 old + rest new

l(p*) = 1.0-1.2 mm. (chain of 2) ; d(p*) = 0.1 mm. ; s = 14 ; n = 9.

Distribution in Indian sub-continent : Lake Inle of S. Shan State (Burma) ; Lahore (Pakistan). Now recorded from Cuddapah, Bellary (S. India).

Habits : The worms live in *Spirogyra* and other algae and feed on them.

Remarks : *Chaetogaster punjabensis* Stephenson and *Ch. annandalei* Stephenson, as Chen (1940) and Sperber (1948) pointed out, are undoubtedly *Ch. diastrophus*. *Ch. gulosus* Leidy (1850), with 'a digitiform upper lip', is *Ch. diastrophus* ; length of setae 1/133 inch (= 184 μ) ought to be 1/233 inch (= 108 μ), which evidently as Sperber (1948) suggests is a misprint. The setae cannot be so large for a worm of 2 mm. length.

5. **Chaetogaster langi** Bretscher, 1896

Fig. 5 A—C

Chaetogaster langi Bretscher. Pointner, 1911, p. 629. Lastočkin, 1924, p. 4 ; 1927, p. 65. Pasquali, 1938a, p. 20 ; 1938b, p. 28, fig. 3, 4. Hrabě 1941, p. 3 ; 1952, p. 2. Chen, 1944, p. 2. Svetlov, 1946, p. 103. Berg, 1948, pp. 40, 46, fig. 30c.

* Preserved

Sperber, 1948, pp. 63-65, fig. 7c, H, pl. I, fig. 2 ; 1950, p. 52, pl. I, fig. 2 ; 1958, p. 46.

Chaetogaster pellucidus Walton. Causey, 1953a, p. 55.

Material examined : Many worms collected from the Bugga stream, Cuddapah, in April 1955 ; from the Kandakam tank, Bellary, in May 1954.

Worms (Fig. 5A) minute. Prostomium inconspicuous with rounded margin, fringed with sensory hairs.

Setae (Fig. 5B, C) 4 per bundle, 63-77 μ long in II, 42-52 μ long in others, have conspicuous proximal nodulus, shaft below it is bent. Prongs equally thick, distal longer and more curved than the proximal.

Mouth subterminal, ovoid, always open, gape increasing and decreasing. Oesophagus half as long as the pharynx and narrow. Stomach in V-VI, yellowish, barrel-shaped with transverse vascular loops. Pharynx and stomach push septa 3/4 and 4/5 into IV. Intestine begins in VII, yellowish. Septa present.

Brain slightly opaque, without statocyst.

Dorsal contractile and ventral non-contractile vessels are median, above and below the gut ; two contractile lateral vessels in IV.

Nephridia 2 per segment, exonephric, from VI or VII onwards, consisting of a glandular mass and a coiled nephridial duct.

The worms have 1-3 fission zones. In a chain of 3 zooids, the earliest formed zone is between IX and X, the next formed zone a segment in front of it. Sexual worms not encountered.

1 (p) = 1 mm. (chain of 2) ; d (p) = 0.1 mm. ; s = 10-15 ; n = 9.

Distribution in Indian sub-continent : Calcutta (N. India) ; Khandala (W. India). Now recorded from Cuddapah, Bellary (S. India).

Habits : When pebbles with encrustations of plant and animal material were left in beakers for two days, these worms appeared on the wall of the containers. They were never found in the algae and other aquatic plants.

Remarks : *Chaetogaster spongillae* Annandale (1906) is a synonym of *Ch. langi* as pointed out by Chen (1940) and Sperber (1948), for the length of the oesophagus is a variable character in the same species as pointed out by Pointner (1914) and Sperber (1948, pp. 58 and 64).

Ch. pellucidus Walton (1906) from N. America with a length of 1.5 mm. and 12 or more stomachal ducts is a synonym of the species.

6. **Chaetogaster cristallinus** Vejdovsky, 1883

Fig. 6 A—H

Chaetogaster crystallinus Vejdŏvsky. Pointner, 1911, p. 629. Lastočkin, 1918, p. 58 ; 1924, p. 4 ; 1927, p. 66. Svetlov, 1925, p. 472. Hrabĕ, 1939, p. 209. Chen, 1944, p. 2. Sperber, 1948, pp. 68-71, fig. 7E, K, pl. I, fig. 3, pl. II, fig. 1-3 ; 1950, p. 53, pl. I, fig. 3.

Material examined: Many worms collected from the Bugga stream, Cuddapah, in January 1954, December 1955 ; from Langford Town tank, Bangalore, in May 1958.

Worms (Fig. 6A) very much larger than *Ch. langi* and *Ch. diastrophus*. Prostomium (Fig. 6B, C) inconspicuous with a median incision and with sensory hairs of 2 lengths, longer alternating with shorter.

Ventral setae (Fig. 6 D) in II, 6-7 per bundle, 180 μ long ; in others 2-6 per bundle, 119-140 μ long and have strong proximal nodulus (D : P : : 32 : 16 in II, 22 : 16 in others), with shaft straight above and bent below nodulus ; prongs curved, distal longer than the proximal in all. Length and position of nodulus vary from seta to seta in each bundle.

Mouth circular and subterminal. Pharynx thick-walled, spinose externally. Oesophagus thin and S-shaped with longitudinal wrinkles and lumen closed when empty, distending during food passage. Stomach in V—½VII, barrel-shaped with 26-30 transverse vascular loops giving striped appearance, narrow anteriorly, widening abruptly behind, its wall contracting near septa forming 3 temporary compartments in deflation, disappearing in inflation. Intestine yellowish, wide in ½VII—VIII and narrow behind.

Brain (Fig. 6E, F) with a median statocyst, bluish, with gray granules in and around it in the young worms, without granules in the older worms. Nerve ring (Fig. 6G) thick, ventral nerve cord with well developed ganglia, free from the bodywall.

Dorsal vessel mid-dorsal, contractile ; ventral vessel mid-ventral and non-contractile ; one pair of contractile transverse vessels in IV.

Nephridia exonephric, start in VII, attached to body-wall near setal bundles, (Fig. 6H) composed of irregular glandular mass, enclosing highly coiled nephridial duct, opening by nephridiopore near the setal bundles. No ciliary vibrations in nephridial duct.

Worms with 2-5 zooids common. In a chain of 5 zooids I, II, III, IV formed budding zones are between X and XI, VIII and IX, XV and XVI, and XIX and XX respectively. I to V zooids are each composed of 8, 2, 5, 4, and 6 segments respectively.

l (living) = 5 – 6 mm. (chains) ; d (living) = 0.3 – 0.6 mm. ; s = 12 – 16 ; n = 10.

Lengths of longest ventral setae in μ and position of nodulus in the ratio D : P : :

	II	VI	VII	VIII	IX	X	XI	XII
Crotchet	168	136.5	133	133	133	133	122.5	126
	32 : 16	23 : 16	22:16	22:16	23 : 15	21 : 14	21 : 16	20 : 16

Distribution in Indian sub-continent : Calcutta (N. India). Now recorded from Cuddapah, Bangalore (S. India).

Habits : The worms live among filamentous algae, *Spirogyra* etc., and contain bits of algal filaments, protozoans, rotifers, crustaceans, and oligochaetes in their gut. Those in captivity contained in the gut, pieces of the body and setae of their kin.

Commensals : Vorticellids are attached to the body of many worms.

Parasites : Several unidentified spherical ciliate parasites with blue-green inclusions are found in the gut.

Remarks : *Chaetogaster* sp. Annandale (Stephenson, 1923), with a length of 2-3 mm.; n = 8 or 9 ; anterior end 'somewhat truncated', cerebral ganglion containing a densely pigmented mass (statocyst), is no doubt *Ch. cristallinus*, as suggested by Sperber (1948, p. 64), not *Ch. langi*. The statocyst, hitherto not noticed by earlier workers, has been noticed in the present worms.

Chaetogaster sp. Svetlov (1924) also agrees with *cristallinus* except in the presence of a well-developed pharyngeal plexus. The presence or absence of pharyngeal plexus is not a constant and dependable character (Pointner, 1914, and Sperber, 1948).

In the present worms the transverse stomachal ducts are 26-30 (as against 20-22) ; setae of II, 168 μ and of others 136 μ long (as against 165 μ and 130 μ respectively) found in literature for this species.

b Subfamily NAIDINAE Lastockin, 1924

KEY TO ALL GENERA AND SUBGENERA OF NAIDINAE

A-1 Dorsal bundles with crotchet-like or stout, straight needles only
- B-1 Needles crotchet-like ; several in a bundle
  - C-1 Dorsal setae from II .. * *Homochaeta*
  - C-2 Dorsal setae from VI .. * *Uncinais*
- B-2 Needles stout, straight, 1 per bundle .. * *Ophidonais*

A-2 Dorsal bundles with hairs and needles
- D-1 Prostomium with proboscis
  - E-1 Ventral setae present in all segments from II, hairs not specially elongated
    - F-1 Dorsal bundles with 8-18 hairs, 9-12 needles ; spermathecal ampulla spherical .. * *Arcteonais*
    - F-2 Dorsal bundles with 1-3 hairs, 1-3 needles ; spermathecal ampulla elongated .. *Stylaria*
  - E-2 Ventral setae absent in IV-V ; hairs especially elongated in VI-VIII .. * *Ripistes*

D-2 Prostomium without proboscis

G-1 Branchial processes present

H-1 Gills finger-like dorso-lateral processes ; 2 per segment anteriorly .. *Branchiodrilus*

H-2 Gills around anus in funnel-shaped organ at hind end

I-1 Ventral setae all of one type only .. * *Allodero*

I-2 Ventral setae of II-V sharply distinct from the rest

J-1 Branchial organ with palps .. *Aulophorus*

J-2 Branchial organ without palps .. *Dero*

G-2 Branchial processes absent

K-1 Dorsal bundles start from XVIII, XIX, or XX in adults .. *Haemonais*

K-2 Dorsal bundles start from IV, V, or VI

L-1 Asexual reproduction by fragmentation ; dorsal setae starting in VI .. *Allonais*

L-2 Asexual reproduction by budding

M-1 Dorsal bundles with strongly serrated hairs ; (simple pointed needles) .. * *Vejdovskyella*

M-2 Dorsal bundles with smooth hairs

N-1 Hair setae of VI very long ; body with rows of sensory papillae covered by foreign matter .. *Slavina*

N-2 No elongated hair setae

O-1 Ventral setae of II-V mostly sharply differentiated from the rest .. *Nais*

O-2 Ventral setae all of one type only

P-1 Eyes absent ; penial setae present .. * *Specaria*

P-2 Eyes present ; penial setae absent .. * *Piguetella*

* Genera not known from the Indian sub-continent.

3. Genus **Nais** Müller, 1773

Generic characters : Dorsal setae from VI ; ventral setae of II—V differentiated from others. Pharynx in II—III ; pharyngeal and oesophageal glands present, chloragogues begin in VI, entire gut ciliated ; intestinal anti-peristalsis and ascending ciliary vibration occur. Septa developed ; no septal glands. Coelomocytes present. Dorsal vessel contractile, placed ventrally to the left for the most part and mid-dorsal in anterior 6 segments. Ventral vessel non-contractile and mid ventral. Nephridium composed of pre-septal ciliated nephrostome, followed by a neck connecting the post-septal, consisting of a fusiform ampulla followed by a long ciliated coiled duct, partly enclosed in gland tissue, its ectal part opening by nephridiopore ventrally in front of the ventral bundles. Budding occurs ; budding zones provide prostomium and 5 head segments to the posterior zooid, some hind segments to the anterior zooid before fission. Sperm-sac and ovi-sac are back-pouchings of septa 5/6 and 6/7 respectively, extending backwards, the former inside the latter.

Key to all the known and valid Species of NAIS

- A-1 Needles spatulate .. **schubarti*
- A-2 Needles single pointed
  - B-1 Ventral setae of II - V with distal tooth enormously elongated and hooked, proximal tooth reduced or vestigial .. **behningi*
  - B-2 Ventral setae of II-V, 2-5 per bundle and of normal shape
    - C-1 Needle seta more or less hair-like with long sharp tip
      - D-1 Nodulus slightly distal in needles ; ventral setae from VI on much shorter, stouter and more curved than anterior ones, with prongs equally long ; hairs and needles each up to 5 per bundle .. **barbata*
      - D-2 Nodulus 1/3 from tip in needles ; ventral setae behind V thin, not strongly curved with distal tooth about 1.5 times as long as proximal; hairs and needles 1-3 per bundle .. **pseudobtusa*
    - C-2 Needle seta with short fairly obtuse tip
      - E-1 Needles with nodulus 1/5–1/4 from tip ; distal prong of ventral setae of II—V, twice as long and equally thick as proximal .. ** alpina*
      - E-2 Needles with nodulus 1/3 from distal end ; ventral setae of II-V with distal prong thinner and longer than proximal
        - F-1 All ventral setae of about equal length .. ** andina*
        - F-2 Ventral setae of II-V longer than in following segments .. ** simplex*
- A-3 Needles double-pointed
  - G-1 Ventral setae of some segments behind V very thick with distal prong several times as long as proximal

H-1 Thick ventral setae begin in VII; some segments (VIII—XIII) often have giant setae without proximal prong; stomach dilates slowly .. *bretscheri*

H-2 Thick ventral setae begin in VI; no giant setae; stomach dilates abruptly; enlarged cells project into lumen round the opening of oesophagus .. *pardalis*

G-2 No enlarged ventral setae at all

I-1 Needle teeth long, almost parallel; all ventral setae with distal prong twice as long as proximal .. *elinguis*

I-2 Needle teeth short diverging; prongs of ventral setae of approximately the same length

J-1 Ventral setae of II—V twice as long as those of following segments .. *raviensis*

J-2 Ventral setae of II—V slightly longer than those of following segments .. *variabilis*

J-3 Ventral setae all of about equal length

K-1 Needle teeth minute and equal; no swimming .. *communis*

K-2 Needle teeth distinct, proximal thicker than distal; swims by spiral movement .. *menoni* sp. nov.

7. **Nais communis** Piguet, 1906

Fig. 7A-F

Nais communis Piguet. Pointner, 1911, p. 631. Lastočkin, 1918, p. 58; 1924, p. 4; 1927, p. 66. Stephenson, 1922b, p. 280; 1931a, pp. 34-38. Hrabě 1937, p. 6; 1952, p. 4. Chen, 1944, p. 5. Berg, 1948, p. 40, fig. 31. Sperber, 1948, pp. 102-107, Pl. VII, fig. 1; 1950, p. 60, pl. I, fig. 7; 1958, p. 46. Causey, 1953a, p. 55. Yamaguchi, 1953, pp. 286-288, fig. 6.

Nais communis var. *punjabensis* (Stephenson). Mehra, 1920, p. 457.

Material examined: Many worms collected from the Bugga stream, Cuddapah, in January 1956; from the Langford Town tank, Bangalore, in May 1958.

Worms delicate, pale white, with bright yellow pigment in I—VI. Prostomium bluntly triangular, containing coelomic fluid and corpuscles, and fringed with sensory hairs. Eyes at the base of the prostomium, black with violet tinge. Segmentation clear.

Dorsal setae from VI, 1 hair and 1 needle (rarely 2 of each) per bundle. Hair simple, nearly straight, smooth, 168-186 μ long. Needle

---

* Species not known from the Indian sub-continent.

(Fig. 7C) bifid, 56-65 μ long, with indistinct nodulus, about a third from distal end, shaft nearly straight below and gently curved above the nodulus. Teeth distinct, short, equal, and diverging. Ventral setae (Fig. 7A, B) begin in II, bifid, 3-5 per bundle, 70-90 μ long, with distal prong thinner and longer than the proximal ; nodulus proximal (D : P : : 14 : 10) in II—V, median (D : P : : 10 : 10) in VI, distal (D : P : : 10 : 12) in rest. Setae in II—V are less curved than in others.

Mouth ventral with prostomium overhanging. Pharynx in II—III, wide. Oesophagus in IV—VI, thin and wavy. Stomach in VII—VIII, broad anteriorly. Intestine thin in IX and wide from X. Anus postero-dorsal. Chloragocytes brownish. Coelomocytes spherical, 10 μ diameter, with greenish globules. Septa well developed.

Brain (Fig. 7E) incised deeply behind and less deeply in front.

Blood yellowish. Dorsal vessel divides anteriorly into 2, branches unite below the pharynx with ventral vessel. Lateral contractile vessels 3 pairs in III—V, first 2 pairs arise about the middle of III and IV, each branching into 2 ; third pair arises near the posterior septum of V and unbranched ; all vessels meet the ventral vessel.

First nephridium (Fig. 7F) in VII with its nephrostome in VI, succeeding segments have 2 nephridia each.

One fission zone common, 2 or 3 zones rare. In a chain of 4, first formed fission zone between XVI and XVII, second formed a segment in front, third formed some segments behind the first zone. Fission zones are in different stages of development.

Clitellum from ½V—VII (2½ segments). Testes not observed. Ovaries a pair of light brown irregular bodies on the posterior face of septum 5/6. Sperm-sac and ovi-sac, back-pouchings of septa 5/6 and 6/7, former within the latter, extend to IX and X respectively. In sexual worms alimentary canal degenerates. Spermathecae ovoid in V with their openings in front of ventral bundle of V. Atrial ampullae roundish in VI, with their openings near the ventral setae of VI. Penial setae (Fig. 7D) 2 per bundle, 63 μ long in VI.

1 (living) = 4-5 mm. ; d (living) = 0.2 mm. ; s = 27-28 ; n = 15-19, 16 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	—	—	—	—	140	143.5	145	145	145
Needle :	—	—	—	—	45.5	49	49	49	52.5
					3:10	3:11	3:11	3:11	3:12
Crotchet:	84	80.5	77	77	70	80.5	77	77	73.5
	14 : 10	14 : 9	13 : 9	12 : 10	10 : 10	11 : 12	10 : 12	10 : 12	10 : 11

Distribution in Indian sub-continent: Kasauli, Agra (N. India); Khandala (W. India); Bheemanagar, Travancore (S. India) ; Lahore (Pakistan). Now recorded from Cuddapah (S. India).

Habits : Worms live in aquatic vegetation feeding on it and on protozoans, rotifers, etc. Occasionally they inhabit delicate tubes. They entangle themselves into knotty masses ; on removal to a slide with some water, they disentangle and move away in all directions. Swimming absent.

Commensals : Sessile vorticellids are found attached to setae at either end of worms.

Parasites : Three sporozoans parasitise these worms. Numerous cysts of two actinomyxid sporozoan parasites, *Triactinomyxon naidanum* Naidu (1956) and *Triactinomyxon* sp. (Naidu, 1959b) were found in the intestinal wall of a few worms. Sporocysts of a microsporid sporozoan, *Mrazekia caudata* Leger & Hesse (Naidu, 1959a), were found in the coelom of two worms. These parasites cause the death of their host.

Remarks : Lengths of setae are slightly greater than those tabled out by Sperber (1948), p. 106, but fall within the extremes observed by her and those found in literature.

As suggested by Sperber (1948), the two Indian varieties *Nais communis punjabensis* and *N. c. caeca* of Stephenson (1923) have no taxonomic status, as they agree with the main form in all characters and differ from it only on trivial characters, the absence of pigmentation, shorter prostomium, finer teeth of needles ; and the latter variety differs further in the absence of eyes. Absence of eyes cannot be taken as a character to create a new species, as it is found that forms without eyes have been met with in *Stylaria fossularis* also in the family.

Nais heterochaeta Benham (1893) and *N. parvula* Walton (1906) undoubtedly belong here as pointed out by Sperber (1948).

Nais communis and *N. communis* f. *magenta* reported by Marcus from Brazil, as suggested by Sperber (1948), belong to a new species distinct form *N. communis* already recorded from Peru, S. America (Piguet, 1928).

8. **Nais menoni**[1] sp. nov.

Fig. 8 A-F

Material examined : Numerous worms collected from the Bugga stream, Cuddapah, in January 1956; from Langford Town tank, Bangalore, in May 1958.

---

[1] Named after my teacher Sri P. Kotchukutta Menon, Professor of Zoology, Presidency College, Madras 5.

Worms small, slender, and brownish, without any pigmentation in I - V. Prostomium bluntly triangular with sensory hairs. Eyes absent.

Dorsal setae start in VI, 1 hair and 1 needle per bundle, hairs slightly bayonet-shaped, 140 - 175 μ long ; needles (Fig. 8B) bifid, sickle-shaped, 40 - 45 μ long, with distal conspicuous nodulus (D : P : : 2 : 10) and teeth equally thick, distal straighter and longer than the proximal.

Ventral setae (Fig. 8C) in II - V, 2-4 per bundle, less curved, 40-48 μ long, with proximal to median nodulus (D : P : : 7:6 or 6:6), distal prong 1.5 times longer than the proximal; the rest (Fig. 8D) 2-6 per bundle, 43-50 μ long, with distal nodulus (D : P : : 6 : 8) and prongs equally thick and long.

Pharynx in II - III, wide with a longitudinal slit in its roof and a protrusible diverticulum. Oesophagus in IV - VIII. Stomach IX - X, weak and gradual. Intestine sacculated; antiperistalsis and ascending ciliary action occur. Anus (Fig. 8A) postero-dorsal. Entire gut ciliated. Chloragocytes brownish, occur from VI onwards. Coelomocytes numerous, colourless, granular, and spherical (morula-like). No septal glands.

Brain (Fig. 8E) incised deeply in front and less deeply behind.

Blood yellowish. Dorsal vessel laterally attached to left of the gut up to VI and mid-dorsal in head segments. Pharyngeal vascular plexus formed by the loops of the dorsal vessel. No lateral contractile vessels.

First nephridium (Fig. 8F) in VIII with its pre-septal funnel containing nephrostome in VII on the left side; post-septal with fusiform brown ampulla followed by a long ciliated duct, partly free and partly enclosed in gland tissue, opening by nephridiopore ventrally.

Worms develop one budding zone at a time, buds off hinder part of anterior zooid and prostomium and head segments to the posterior zooid before fission.

Sexual worms not encountered.

l (p*) = 2.5 – 3.0 mm. ; d(p*) = 0.2 mm.; s = 20–35 ; n = 22 in one.

For lengths of setae and position of nodulus see Table III.

Type : The type specimen is being deposited with the Zoological Survey of India, Calcutta.

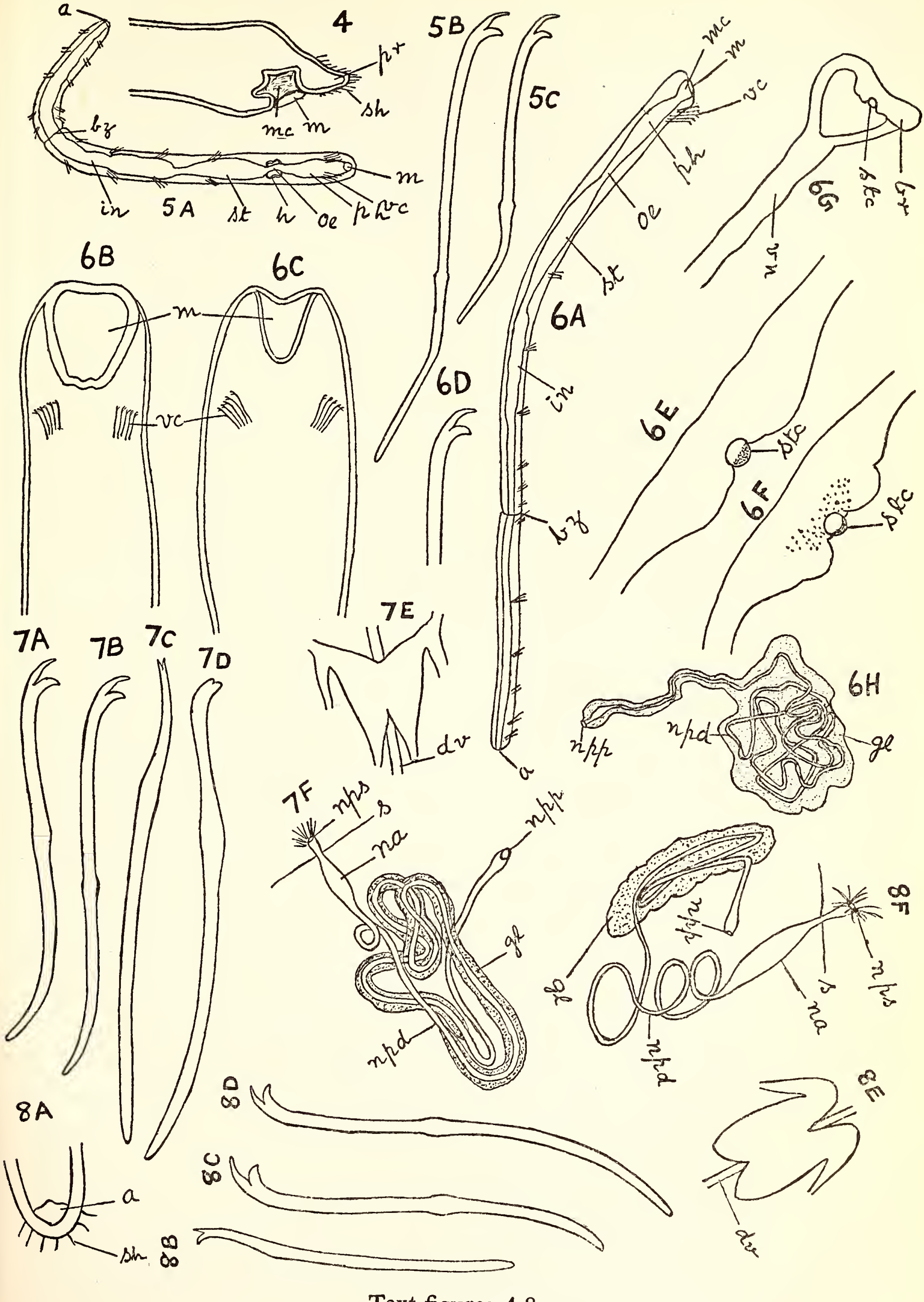
---

* Preserved

TABLE III

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
Hair	—	—	—	—	140	143.5	161	175	161	157.5	161	150.5
Needle	— —	— —	— —	— —	42 2:10	42 2:10	42 2:10	43.7 2.5:10	43.7 2.5:10	43.7 2.5:10	43.7 2.5:10	43.7 2.5:10
Crochet	47.2 7.5:6	45.5 7:6	42.0 6:6	43.7 6.5:6	47.2 6:7.5	49.0 6:8	49.0 6:8	49.0 6:8	49.0 6:8	45.5 5:8	45.5 5:8	45:5 5.8
do.	45.5 7:6	43.7 7:5.5	42.0 6:6	42.0 6:6	49.0 6:8	49.0 6:8	49.0 6:8	49.0 6:8	45.5 6:7	45:5 6:7	45.5 6:7	45.5 6:7
do.	43.7 7:5.5	42.0 7:5	40.2 6:5.5	— —	47.2 6:7.5	47.2 5.5:8	49.0 6.8	45.5 6:7	45.5 6:7	45.5 6:7	45.5 6:7	45.5 6:7
do.	— —	— —	— —	— —	47.2 6:7.5	43.7 5:7.5	— —	45.5 6:7	— —	43.7 5.5:7	— —	— —



Text-figures 4-8.

For explanations see p. 145.

Habits : Swim with brisk spiral movement.

Remarks : Of the 13 known species of *Nais*, this form very closely resembles *Nais communis* but, however, differs from it in the shape of the needle setae. The needles of this form have distinct teeth; the distal tooth is thinner, longer, and straighter than the proximal as against the minute, equal, and straight teeth of *N. communis*. Further, the nodulus is $\frac{1}{5}$ the distance from the distal end in the former and $\frac{1}{4}$ from the distal end in the latter. Other differences are : stomach in IX—X (VII—VIII in *N. communis*); lateral contractile vessels absent (present in *N. communis*) ; swimming present (absent in *N. c.*) ; worms of small size, 2.5—3.0 mm. long (medium sized, 4—5 mm. in *N. communis*).

(*To be continued*)

Explanations to Text-figures

Fig. 4. *Chaetogaster diastrophus* (Gruithuisen) : Lateral view of anterior part of the body. Fig. 5. *Chaetogaster langi* Bretscher : A. Entire worm (ventral view) ; B. Ventral seta of II × 850 ; C. Ventral seta of VI × 850. Fig. 6. *Chaetogaster cristallinus* Vejdovsky : A. Entire worm (lateral view) ; B. Anterior part of the worm (ventral view) in relaxation ; C. Anterior part of the worm (ventral view) in contraction ; D. Distal part of seta of II × 525 ; E. Brain of old worm ; F. Brain of young worm ; G. Nerve ring and ventral nerve cord ; H. Nephridium. Fig. 7. *Nais communis* Piguet : A. Ventral seta of XII × 625 ; B. Ventral seta of II × 625 ; C. Needle seta × 1050 ; D. Penial seta × 1050 ; E. Brain ; F. Nephridium. Fig. 8. *Nais menoni* sp. nov. : A. Posterior end of the worm ; B. Needle seta × 1100 ; C. Ventral seta of II × 1150 ; D. Ventral seta of VIII × 1275 ; E. Brain ; F. Nephridium.

a : anus ; *br* : brain ; *bz* : budding zone ; *dv* : dorsal vessel ; *gl* : gland; *h* : heart ; *in* : intestine ; *m* : mouth ; *mc* : mouth cavity ; *na* : nephridial ampulla; *npd* : nephridian duct ; *npp* : nephrostome ; *oe* : oesophagus ; *ph* : pharynx ; *pr* : prostomium ; *s* : septum ; *sh* : sensory hair ; *st* : stomach ; *stc* : statocyst ; *vc* : ventral seta ; *vn* : ventral nerve cord.

The Swiftlets (*Collocalia*) of Java and their Relationships

BY

LORD MEDWAY

University of Malaya

INTRODUCTION

In 1960/61 I spent six months in Indonesia engaged on a study of the swiftlets (Aves, Apodidae, genus *Collocalia* Gray) of Java. The genus is widespread in south-east Asia, and all species characteristically nest in caves or cave-like situations. I was able to travel freely in the provinces of West Java, Central Java, and Jogjakarta, where I investigated most regions of limestone outcrop and many known *Collocalia* nesting sites. Breeding colonies of five species were located, one of which (*C. maxima*) had not previously been recorded from Java. In the following pages, the specimens collected are listed by locality, and are described briefly; heights A.S.L. are given in metres. All measurements are given in millimetres; the furcation of the tail is given as the difference in length between the longest (outer) and shortest (inner) pairs of retrices, expressed as a percentage of the length of the longest pair.

In this difficult genus the form and materials of the nest are of taxonomic importance (Sims 1961). Accordingly, as many specimens as possible were collected on or in close association with nests, and these are described in some detail. On the basis of nest-type as well as external morphology, the interrelations between Javanese forms and other *Collocalia* in adjacent regions (including India) are discussed, with particular reference to grouping and correct nomenclature at the specific level.

All prepared skins have been deposited at the British Museum (Natural History), with duplicates at the Museum Zoologicum, Bogor, Indonesia.

ACKNOWLEDGEMENTS

This work was supported in Indonesia by a fellowship from the Siswa Lokantara Foundation. I am also grateful for facilities offered by the directors and staff of the following institutes: Museum Zoologicum, Bogor; British Museum (Natural History); Rijksmuseum van Natuurlijke Historie, Leiden; National Museum, Singapore; and Zoologische Museum, Berlin.

Annotated Specimen List

Collocalia esculenta linchi Horsfield & Moore

Local name : *Kapinis* (Sundanese) ; *seriti*, *kelintji* (Javanese)

Specimens : Mt. Lawu, central Java, 1500 m.[1] 2 unsexed: wing 99, 100, tail 43, 44 (furcation 9%, 11%)

Tepus, Jogjakarta, 40 m. ♀ : wing 99, tail 44 (furcation 5%)

This swiftlet is adequately described elsewhere (Kuroda 1936, Delacour 1947); its small size and white belly are diagnostic. It is abundant throughout the island, at all altitudes. It was seen in numbers in the active crater of Mt. Gedeh (2960 m.) where it appeared to be resident, although no nesting colony was found.

This swiftlet cannot utter the so-called rattle call, which has been shown to be indispensable for echolocation among *Collocalia* (Novick 1959, Medway 1959a, and in press).

Nests: Nests of this swiftlet from Java have been described by Spennemann (1928) and Hoogerwerf (1949); from Lombok by Hartert (1896). They are bracket-shaped (Lack 1956), always made chiefly of strands of vegetable material bound together by a sparse application of the characteristic salivary nest-cement, which is copious only at the base of the nest, at the juncture between nest and supporting wall.

The chief vegetable constituents evidently depend partly on the availability of suitable material, and partly on individual preferences. Thus, in the colony on Mt. Lawu, among cultivated *Pinus* forest at high altitude, all nests were made of the lichen epiphytic on the trees; in a small colony at Klapanunggal, West Java, among agricultural land from which all natural forest cover has been felled, all nests were made of threshed rice ears; nests at Tepus, a barren and deforested area where the chief crop is cassava, were made of blades of grass and broad leaves. But where a variety of acceptable material is available, neighbouring nests may include entirely different kinds of material. For example, three adjacent and partially adjoined nests taken from a house in Bogor (near the Botanical Gardens)

---

[1] Collected on nests by M. Pierre Jauffret, to whom I am grateful for information concerning the habitat.

consisted of the following principal materials, in approximate proportions: (1) lichen 80%, pine needles 10%, grass; (2) *Arenga* palm fibres 95%, lichen and pine needles; (3) pine needles 70%, casuarina foliage 20%. It is clear from these examples that the precise identity of the vegetable material used in the nest is not taxonomically important; the form and manner of construction of the nest, however, remain constant despite the use of different materials, and it is these that are significant.

Collocalia gigas Hartert & Butler

Specimens : None.

This swiftlet was not seen and I include it only for the sake of completeness.

Nest: Described by Hoogerwerf (1949) as a vegetable nest, with thick walls, mainly consisting of aerial roots and fibrous material.

Collocalia maxima maxima[1] Hume $\gtrless$ **lowi** Sharpe

Local name : *Dekok* (Sundanese)

Specimens: Tjiampea, West Java, 200 m. 3♂, ♀, 1 unsexed: wing 128-136, tail 52-58 (furcation 2-10%)

Dorsum dark blackish-brown; rump slightly paler than back and tail, with dark shaft-lines on paler feathers. Concealed white in the plumage of back and venter (Mayr 1937, Medway 1959b, Sims 1961) is reduced. Tarsi bear a conspicuous row of feathers on the outer-side, and are also feathered, but less conspicuously so, on the innerside.

This swiftlet utters the rattle call (see above).

The species has not hitherto been recorded from Java.

Nests: Typical bracket-shaped 'black nests' (Medway 1959b, Sims 1961), consisting of the swiftlet's own feathers bound together by copious nest-cement. This species was found in only one cave in the Tjiampea district. It was well known to the local birds' nests contractor, but its nests were regarded as worthless and were not collected. I neither found nor heard indications of another colony of this swiftlet elsewhere in any region of Java that I was able to visit.

Discussion: Black nests are known to be built by *C. maxima maxima* in Malaya and peninsular Thailand (Chasen 1939, under the name *C. lowi robinsoni*), by *C. maxima lowi* Sharpe from Sarawak

---

[1] Formerly *Collocalia lowi robinsoni* Stresemann. The name *maxima* is based on somewhat disputable grounds (Deignan 1955 a), but since it has already been used by Smythies (1960) and Medway (1959 a, b, and in press), I prefer to retain it.

and North Borneo (Smythies 1960), and by *C. maxima tichelmani* Stresemann from south-east Borneo (Stresemann 1926a). With the addition of the present specimens, these black-nest builders form a natural morphological group of large swiftlets, distinguished by size, by a relatively square, slightly furcated tail, and by a thickly feathered tarsus.

The two races *lowi* and *maxima* are separated by rump coloration. In the former, the rump is entirely concolorous with back and tail; in *maxima* the rump is distinctly paler. The colour of the rump of the present specimens is intermediate and they cannot be assigned definitely to either race, as indicated above. Indistinguishable from these Javanese birds are two skins from Tapanuli, Sumatra, in the Museum Zoologicum, Bogor, (nos. 18165-6), formerly ascribed to the race *lowi* (Peters 1940).

Black nests, indicating the presence of this species, have also been recorded from the mountains of Assam (Stuart Baker 1927, under the name *C. brevirostris*). Among the swiftlet skins from east Bhutan and southern Tibet [Ludlow/Sheriff collection in the British Museum (Natural History)], two forms can be distinguished, attributable to *C. brevirostris* and *C. maxima* respectively; the latter has not previously been recognised from the area. Skins of *C. maxima* are distinguishable by a longer wing, a less deeply forked tail, and a thickly, as opposed to a sparingly, feathered tarsus. Respective measurements, taken from the skins, are: *C. brevirostris* (5 specimens): wing 124-126, tail 51-55 (furcation 15-22%); *C. maxima* (7 specimens): wing 128-135, tail 50-58 (furcation 11-15%). The specimens of *C. maxima* are not distinguishable from the nominate race. Both species occur up to the highest altitude recorded, 12,750 feet (*c.* 3890 m.).

Collocalia brevirostris vulcanorum Stresemann

Specimens : Crater of Tangkuban Perahu, West Java, 2076 m. ♂, 2 ♀ : wing 124-125, tail 54-57 (furcation 11-13%)

Dorsum dark blackish-brown; rump paler than back and tail, a uniform band of greyish-fawn with dark shaft lines. Concealed white in the contour plumage of back and venter is imperceptible. The tarsi of the male are entirely naked; the tarsi of the females bear 2 to 7 small and inconspicuous feathers on the outersides, and are naked on the innersides.

These specimens have been compared with a paratype of *vulcanorum* from the crater of Mt. Gedeh (♀ : wing 122, tail 55, furcation 22%) from the Bartels collection in the Rijksmuseum van

Natuurlijke Historie, and with the type of *brevirostris* in the British Museum (Natural History).

This swiftlet utters the rattle call.

Nests: These birds were netted (1/iv/61) at the mouth of a deep fissure in the wall of the first crater (Kawah Ratu) on Mt. Tangkuban Perahu, into which descent was not possible. Cries of young birds were heard, but nests were not seen.

A nesting colony of this swiftlet was found on Mt. Gedeh, West Java, by Bartels (Kuroda 1936), and was known to Hoogerwerf (1949). But there is no record that the nests were collected, and no published description of them exists. The fissure in the crater wall of Gedeh that used to be occupied by these birds was shown to me. Nowadays it directly overhangs the newest crater opened by the violent eruptions of 1947-8, and is uninhabited. The only swiftlet I saw around the summit of Gedeh was *C. esculenta linchi*, and the colony of *C. brevirostris* is evidently extinct. The only description of their nests available is a volunteered statement by Sdr. Kudit, an employee of Tjibodas Botanical Gardens, who told me that he had entered the cave before the last eruption, and had collected what would purport to be bracket-shaped vegetable nests. Vegetable nests were also found in the crater of Mt. Tjeremai by Junghuhn (see Stresemann, 1926b), but cannot be attributed with certainty to this swiftlet.

Discussion: The taxonomy of this species is particularly confused. Stresemann originally considered all the larger grey-brown swiftlets to be conspecific, uniting them under the prior name of *brevirostris* McClelland. He therefore described the newly discovered form *vulcanorum* as a subspecies of *C. brevirostris* (Stresemann 1926b). Later (1932) Stresemann separated the forms building black nests from *C. brevirostris*, on morphological grounds including *vulcanorum* with the former for which he used the specific name *C. lowi* Sharpe. In the same paper (Stresemann 1932) he tentatively united the controversial *innominata* Hume with the equally controversial '*fuciphaga*' Thunberg (correctly known as *C. salangana* Streubel, see below). No other specimens of *vulcanorum* were collected, and Kuroda (1936), Peters (1940), and Hoogerwerf (1949) all followed Stresemann, assigning this swiftlet to the species *C. lowi* (=*C. maxima*, see above).

C. innominata was distinguished from the black-nest builders (i.e. *C. maxima*) by both Robinson (1928) and Chasen (1939), and has since been shown by Deignan (1955b) to be conspecific with *C.*

brevirostris. Sims (1961) has suggested that *C. brevirostris* replaces *C. 'fuciphaga'* (=*C. salangana*) on the Asiatic mainland; however, the present specimens of *vulcanorum* were found together in the same cave with *C. salangana* (see below) and the two are clearly specifically distinct. The race *vulcanorum* is adequately distinguished from the nominate race *C. b. brevirostris* by the reduced feathering of the tarsus.

Specimens attributable to *C. brevirostris* (wing 125) have also been collected in north Sumatra (Robinson & Kloss 1924: 243, under the the name *C. innominata*). Here they were taken on nests 'made of moss and other vegetable matter fixed to the wall with the well-known slimy secretion from the buccal glands'. The specimens discussed (Robinson & Kloss, loc. cit.) have been lost as a result of the war, and I have been unable to compare them with skins from Java.

The species *C. brevirostris* has a wide distribution eastwards from the Himalayas, where it is sympatric with *C. maxima* (see above), through Burma and Thailand. This swiftlet has also been collected in Malaya; but here all specimens were winter-caught and were considered by both Chasen (1939, under *C. innominata*) and Deignan (1955b) to include representatives of a more northerly breeding population which is migratory. This population was named *rogersi* by Deignan (1955b). Measurements of winter-caught Malayan *C. brevirostris* show a wide variation, suggesting a mixed population: (12 specimens) wing 121-132, tail 51-58 (furcation 14-23%). Since the species is now shown to be resident in Sumatra and Java, it is possible that some Malayan specimens also represent a resident population, nesting in the as yet poorly known hinterland. In the circumstances, the position of *rogersi* is obscure. The minimum wing measurement given by Deignan (1955b) is well below the least wing measurement of any other race of *C. brevirostris*, and it is possible that *rogersi* (as defined) includes more than one species.

Collocalia francica fuciphaga (Thunberg)

Local names : *Walet* (Sundanese) ; *lawet* (Javanese)

Specimens: Tjiampea and Klapanunggal, West Java. ♂, 2 ♀, 2 unsexed : wing 111-115, tail 48-53 (furcation 12-16%).

Karangduwur, Central Java, 0 m. 2♂, 3♀: wing 113-118, tail 48-51 (furcation 13-15%)

Dorsum dark blackish-brown; rump very little paler than back and tail; in the midline the exposed parts of the vanes of the rump feathers are in fact quite as dark as the back plumage, and only the lateral feathers are paler, with dark shaft-lines. One female has tarsi naked, the remainder have tarsi sparsely feathered. Concealed white in the back is pronounced in nestlings and recent fledglings, but on aged birds may be very inconspicuous, reduced to the distal tips of only a few of the fluffy basal barbs. Deignan (1955b) noted a greater amount of concealed white in the contour feathers of juveniles as opposed to aged adults among *C. brevirostris* too, and Sims (1961) noted variation in the extent of the white areas in *C. maxima.* Sims (1961) has suggested that the distribution of concealed white on the basal barbs of the contour feathers of the back might be used to distinguish between those species which possess the character; but it is clear that some caution is required.

This swiftlet utters the rattle call.

Nests: Bracket-shaped 'white nests', in general composed exclusively of nest-cement. Among a large collection of nests from a sea cave at Karangbolang on the south coast, there were a few examples in which filaments of algae were incorporated; these were later identified as 'chiefly *Cladophora*, but also some *Lyngbya* and one fragment of *Sphacelaria*' (Dr. J. Th. Koster, *in litt.* 1962). Similar algae, I was informed by the nest collectors, grew on the spray-splashed rocks around these nests. At the time I had no hesitation in crediting the nest collectors' belief that the inclusion of these algae in the nest was accidental (see Smythies 1960).

This species is responsible for building all white nests throughout the island. The problem of its nomenclature has been discussed elsewhere (Medway 1961).

Collocalia salangana salangana Streubel

Local name : *Lukut* (Sundanese)

Specimens : Tjiampea, West Java, 250 m. 5♂, 6♀, 2 unsexed: wing 115-123, tail 49-54 (furcation 6-17%).

Tangkuban Perahu volcano, West Java. 2076 m. ♀ : wing 123, tail 52 (furcation 10%)

Dorsum uniform dark blackish brown; rump entirely concolorous with back and tail. There is no concealed white in the plumage of back and venter. The tarsi of all specimens from Tjiampea are naked; the left tarsus of the female from the cave in the crater wall of Tangkuban Perahu bears one small feather on the outerside.

This swiftlet utters the rattle call.

Nests: Rounded vegetable nests (see Bartels in Stresemann 1926b). Nests collected from Tjiampea with the present specimens were made principally of *Arenga* fibres, aerial rootlets, threshed rice ears, fine dead twigs, dead grass, and other leaves; tufted moss formed only a small proportion of the vegetable constituents, and to apply the term 'mossy nest' (Sims 1961) would be misleading. These materials were agglutinated with a sparse amount of soft, moist nest-cement, which was no more copiously applied at the back of the nest than elsewhere. Each nest rested on an irregularity in the cave wall.

Discussion: The presence of this swiftlet in Java was discovered by Stresemann (1914) who restricted the use of the name *fuciphaga* to this species. It was under the name *C. fuciphaga* that it was included by subsequent authors (Stresemann 1925, 1932, Chasen 1935, Kuroda 1936, Peters 1940, Sims 1961). However, as shown elsewhere (Medway 1961) the name *fuciphaga* must be applied to the previous species (above), and the builder of rounded vegetable nests is correctly known as *C. salangana.* The nominate race *salangana* can be distinguished from the race *natunae* Stresemann of the Natunas and Borneo (Medway 1959b, under *C. fuciphaga natunae*) by the very reduced (or totally absent) feathering of the tarsus.

References

Chasen, F. N. (1935) : Handlist of Malaysian Birds. *Bull. Raffles Mus.* **11** : 1-389.

———— (1939): Birds of the Malay Peninsula. Vol. IV. Witherby & Co., London.

Deignan. H. G. (1955a) : The identity of *Collocalia maxima* Hume. *Bull. Brit. Orn. Cl.* **75** : 82.

———— (1955b) : The races of the swiftlet *Collocalia brevirostris* (McClelland). *Bull. Brit. Orn. Cl.* **75** : 116-118.

Delacour, J. (1947): Birds of Malaysia. MacMillan, New York.

Hartert, E. (1896) : A collection of birds made in Lombok. *Nov. Zool.* **3** : 591-599.

Hoogerwerf, A. (1949):De Avifauna van Tjibodas en omgeving. Bogor.

Kuroda, N. (1936) : Birds of Java. Vol. II. Tokyo.

Lack, D. (1956) : Genera and nesting habits of swifts. *Auk* **73** : 1-32.

Mayr, E. (1937) : *Collocalia. Am. Mus. Novit.* **915** : 1-19.

Medway, Lord (1959a) : Echolocation among *Collocalia. Nature* **184** : 1352-1353.

———— (1959b) : Thunberg's Swiftlet, *Collocalia fuciphaga. Sarawak Mus. J.* **8** : 683-689.

———— (1961) : The identity of *Collocalia fuciphaga* (Thunberg). *Ibis* **103** a : 625-626.

Novick, A. (1959) : Acoustic orientation in the cave swiftlet. *Biol. Bull.* **117** : 497-503.

Peters, J. L. (1940) : Check-list of Birds of the World. Vol. IV. Harvard University Press, U. S. A.

Robinson, H. C. (1928): Birds of the Malay Peninsula. Vol. II. Witherby & Co., London.

———— & Kloss, C.B. (1924) : Birds from west Sumatra. *J. Fed. Malay States Mus.* **11** : 189-347.

Sims, R. W. (1961) : The identification of Malaysian species of swiftlets. *Ibis* **103**a : 205-209.

Smythies, B. E. (1960): Birds of Borneo. Oliver and Boyd, Edinburgh.

Spennemann, A. (1928) : *Collocalia esculenta linchi. Beitr. Fortpfl. biol. Vog.* **4** : 53-58, 98-103.

Stresemann, E. (1914) : Was ist *Collocalia fuciphaga*? *Ornith. Ges. Bayern* **12** : 1-12.

———— (1925) : Bruchstucke einer Revision der Salanganen. *Mitt. Zool. Mus. Berlin* **12**:179-190.

———— (1926a) : Kenntnis der Salanganen S. O. Borneos. *Ornith. Mbr.* **34** : 104-108.

———— (1926b) : Bruchstucke einer Revision der Salanganen, II. *Mitt. Zool. Mus. Berlin* **12** : 349-353.

———— (1932) : Swiftlets of Malaysia. *Bull. Raffles Mus.* **6** : 83-94.

Stuart Baker, E. C. (1927) : Fauna of British India, Birds. Vol. IV. Taylor and Francis, London.

Critical Notes on the Orchidaceae of Bombay State

VIII. SOME OF THE SMALLER GENERA

BY

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

(*With six plates*)

[*Continued from Vol.* **58** (3) : 607]

1. *SPIRANTHES* L. C. Rich.

SPIRANTHES L.C. Rich. in Mem. Mus. Paris 4 : 50, 1818, nom. cons. ; Endl. Gen. Pl. 212, 1837; Benth. & Hook. f. Gen. Pl. 3 : 396, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 113, 1888; Hook. f. Fl. Brit. Ind. 6 : 102, 1890; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 276, 1898 ; Duthie, ibid. 9 (2) : 163, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 81, 1905 ; Schltr. Orchid. 109, 1927 ; Correl, Nat. Orch. N. America 184, 1950 ; Holttum, Rev. Fl. Malaya 1 : 139, 1953. *Gyrostachis* Pers. Syn. 2 : 511, 1807. *Ibidium* Salisb. in Trans. Hort. Soc. 1 : 291, 1812, nom. nud.

The name *Spiranthes* is derived from the Greek words *speira* = a spiral or a coil, and *anthes* = a flower, in allusion to the spiral arrangement of the flowers in many of the species.

A polymorphic genus of about 300 species, widely distributed throughout the temperate zones of both hemispheres. One of the few orchid genera with round-the-world distribution.

According to Correll, these plants flourish under a variety of habitats. This ability to adapt themselves to various habitats may be the reason for the world-wide distribution of the genus.

Spiranthes lancea (Thunb. ex Sw.) Backer, B. v. d. Brink Jr. & v. Steenis in Blumea 6 : 361, 1951 ; Holttum, 734, add. *Ophrys lancea* Thunb. ex Sw. in Vet. Acad. Handl. Stockh. 21 : 233, 1800. *Aristotelia spiralis* Lour. Fl. Coch. 522, 1790, (non *Spiranthes spiralis* Koch. 1849). *Epidendrum aristotelia* Raeusch. Nomencl. ed. 3, 265, 1797. *Neottia sinensis* Pers. Syn. 2 : 511, 1807. *Spiranthes australis* Lindl. in Bot. Reg. 10 : sub t. 823, 1824 ; Lindl. in Journ. Linn. Soc. 1 : 178, 1857 ; Wight, Icon. 5 (1) : 15, t. 1724, 1851 (media fig. et dextra tantum) ; Dalz. & Gibs. Bomb. Fl. 270, 1861 ; Hook. f. N. Zeal. Fl. 272, 1867 ; Hook. f. 102 ; King & Pantl. 278, t. 369 ; Prain, Beng. Pl. 1038, 1903 ;

J. J. Smith, 81, f. 55 ; Cooke, Fl. Pres. Bomb. 2 : 707, 1907 ; Fyson, Fl. Nilg. Puln. Hill-tops, 397, t. 251, 1915 ; Haines, Bot. Bih. Or. 1161, 1924 ; Brühl, Guide Orch. Sikk. 162, 1926 ; *Spiranthes longispicata* A. Rich. in Ann. Sc. Nat. ser. 2, 15 : 78, 1841. *Spiranthes sinensis* (Pers.) O. Ames, Orchid. 2 : 53, 1908 ; Fischer, Fl. Pres. Madr. 1454, 1928 ; Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 730, 1931 ; F. T. Hubbard in Bot. Mus. Leafl. Harv. Univ. 4 : 85, 1937 ; Holttum, 139. *Spiranthes aristotelia* (Raeusch.) Merrill in Philipp. Jour. Sci. 15 : 230, 1919, et in Trans. Amer. Phil. Soc. n. s. 24 : 122, 1935.

Herbs 6-52 cm. or more high, slender. *Roots* clustered, tuberous, up to 6 cm. or more in length. *Leaves* present or absent at the time of flowering, subclustered at the base of stem or not, broadly sheathing below, subpetiolate, passing above into bracts, 1.5-6 × 0.3-1 cm., narrowly linear-lanceolate, or oblong-lanceolate or narrowly elliptic, acute or subobtuse, entire. *Peduncle* 4-22 cm., spirally twisted, somewhat terete, with a few oblong-lanceolate, acute or subobtuse, entire, subamplexicaul bracts, ± glandular pubescent. *Spikes* 3-22 cm. long, secund or subsecund. *Flowers* sessile, bracteate. *Bracts* 5-7 × 1-1.5 mm., narrowly oblong-lanceolate, acute, glabrous or pubescent, 1-nerved. *Sepals* 3-5.5 × 0.75-1.5 mm., whitish, 1-nerved, connivent and slightly spreading at apex, glabrous or glandular-pubescent on the outside, narrowly linear-oblong, obtuse or subacute, entire. *Petals* 2-4.5 × 1 mm., ± cohering with the dorsal sepal but slightly shorter, 1-nerved, narrowly oblong-spathulate, obtuse, glabrous. *Lip* 5.5 mm. long, with 2 spherical calli at the subconcave base, obscurely 3-lobed ; lateral lobes 1.5-3 mm. long, very narrow, acute, slightly widening about middle, pale green, connivent above to enclose column ; midlobe 1-2 × 1-2.25 mm., white, deflexed, somewhat cuneately ovate, the apical part irregularly crenulate, retuse or obtuse, the margins somewhat erect. *Column* pale greenish-white, about 2-2.5 mm. long, narrow below, widening about middle and again tapered to the retuse, shallowly 2-toothed rostellum. *Anther* about 1.5 × 1.5 mm., cuneately-ovate ; pollinia obpyriform-ovate, lamellate with a small, opaque, suborbicular, exposed gland. *Ovary* sessile or shortly stalked, 2-4 mm. long, glabrous or glandular-pubescent.

Flowering : March to September.

Occurrence in Bombay State : KONKAN : *Stocks.* W. GHATS : Panchgani, *Kapadia* 1916 (coll. *Rukminibai*) ; Chorla Ghat, *Dalzell & Gibson.*

Distribution : India : Throughout India from Punjab to Upper Assam and southwards to Chittagong and the Nilgiris and Palniys. *World :* Ceylon, India, W. Tibet, Afghanistan, N. Asia, Siberia, China, Java, Philippines, Australia and N. Zealand.

Notes : The plant described here was discovered by accident on St. Xavier's College terrace garden. Mrs. Rukminibai collected a group of lily bulbs from Panchgani, just below the 1st Tableland and planted them in pots for their flowers. The next year in March, this orchid was found in flower among the lilies.

Our plant from Panchgani is glandular-pubescent all over including the flowers, whereas the Kotagiri specimens of Saldanha are more or less glabrous.

2. *DIDYMOPLEXIS* Griff.

Didymoplexis Griff. in Calcutta Journ. Nat. Hist. 4 : 383, 1844; Hook. f. Fl. Brit. Ind. 6 : 121, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 260, 1898 ; J. J. Smith, Fl. Buitenz. 6 : 76, 1905 ; Schltr. Orchid. 102, 1927 ; Holttum, Rev. Fl. Malaya 1 : 107, 1953.

The generic name *Didymoplexis* is derived from the Greek *Didymos* = double, and *plexis* = a plaiting or weaving, probably in allusion to the connate sepals and petals.

A genus of a few species (about 10), distributed from India through Malaysia to New Caledonia and Fiji.

D. pallens Griff. was the only species described when the genus was first erected ; it must be considered the type species of the genus *Didymoplexis* Griff.

The genus *Didymoplexis* Griff. has not been mentioned by Cooke nor by Blatter & McCann for Bombay State.

Type species : *D. pallens* Griff.

Didymoplexis pallens Griff. in Calcutta Journ. Nat. Hist. 4 : 383, t. 17, 1844 ; Hook. f. 122 ; King & Pantl. 260, t. 346 ; Prain, Beng. Pl. 1025, 1903 ; J. J. Smith 77, f. 51 ; Holttum 108. *Apetalon minutum* Wight, Icon. 5 (1) : 22, t. 1758, 1851. *Cheirostylis kanarensis* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 732, f. 4, 1932.

We have collected only fruiting specimens of this species. The details of the flowers are taken from Blatter & McCann's description.

Rhizome 20 × 8 mm., usually horizontal about 2-7 cm. below surface level ; one to several per plant, ellipsoid. *Scape* 3-7 cm. long, leafless, pinkish-brown, erect, bracteate, terete. *Bracts* minute, cupular, persistent, brown. *Flowers* usually 3, at right angles to scape, 10 × 6 mm., pure white, light brownish in bud. *Dorsal sepal* linear-oblong, 9 × 2.5 mm. ; petals 5 × 2 mm. similar to dorsal sepal, subfalcate, entire. *Lateral sepals* 5 mm. long, nearly semi-circular ; sepals and petals 3-nerved, the veins very prominent on the back. *Lip* 5 × 4 mm., with 2 large, rounded, ± incurved lateral lobes, the midlobe shorter, shortly rounded ; attached to the short foot of the column, with a central yellow, broad, furry ridge which is transversely very irregularly and deeply impressed, not pinnately divided, leaving the central axis entire. *Column* white, with 2 large, square expansions parallel to each other, occupying the upper one-third or more, one on each side of the round stigmatic surface ; pollinia greyish, powdery, long-ovoid. *Ovary* slightly twisted at the base, 7 mm. long.

Flowering and Fruiting : June.

Occurrence in Bombay State : N. KANARA : T a t w a l, about 10 miles from Yellapur, *Bell* ; *Kapadia* 2002-2009.

Distribution : India : Distributed over the whole of Bengal and Assam from the base of Sikkim Himalayas to the Bay of Bengal ; also in N. Kanara, and South India. *World :* India, Malaya, Java.

Notes : We have found this species in black soil, locally abundant in dense undergrowth, usually around bamboo clumps.

Our specimens have been collected from the exact locality mentioned by Blatter & McCann for *Cheirostylis kanarensis.* The leafless saprophytic habit, the structure of the flowers and the considerable elongation of the fruiting pedicel are typical and preclude this species from *Cheirostylis* Bl.; the plant clearly belongs to the genus *Didymoplexis* Griff.

3. *SIRHOOKERA* O. Kuntze

SIRHOOKERA O. Kuntze, Rev. Gen. Pl. 681, 1891. *Josephia* Wight, Icon. 5 (1) : 19, 1851 (non Salisb. et Kn. 1809); Benth. & Hook. f. Gen. Pl. 3 : 516, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 126, 1888 ; Hook. f. Fl. Brit. Ind. 6 : 823, 1890 ; Schltr. Orchid. 129, 1927.

The generic name *Sirhookera* commemorates the distinguished botanist Sir J. D. Hooker.

There are only 2 species in the world, endemic to S. India and Ceylon.

Josephia Wt. (1851) is a later homonym of *Josephia* Salisb. & Kn. (1809), *Josephia* Vell. (1825), and *Josephia* Steud. (1840). *Josephia* Salisb. & Kn. commemorates Sir Joseph Banks ; Wight named his plant in honour of Sir Joseph D. Hooker.

The name *Sirhookera* has not been accepted in any of the major provincial floras of India published after 1891. The conservation of *Josephia* Wt., which is the only name used in our floras, deserves careful attention.

Sirhookera lanceolata (Wt.) O. Kuntze, Rev. Gen. Pl. 681, 1891. *Josephia lanceolata* Wight, Icon. 5 (1) : 19, t. 1742, 1851 ; Hook. f.

823 ; Cooke, Fl. Pres. Bomb. 2: 681, 1907 ; Gammie in Journ. Bombay nat. Hist. Soc. 17 : 942, 1907 ; Blatt. & McC. ibid. 35 : 268, 1931 ; Fischer, Fl. Pres. Madr. 1428, 1928. (See Plate XXXVII).

Perennial *epiphytes. Roots* stout, with a thick velamen. *Leaves* sheathing at the base, somewhat coriaceous ; petioles 2-5 cm. long, sulcate ; lamina 6-8 × 1.5-2.5 cm., oblanceolate, oblong or oblong-elliptic, acute, entire ; in dried leaves, the nerves are fairly prominent beneath, giving the lamina a tessellated appearance ; there is a marginal nerve running near the margin. *Inflorescence* 5-14 cm. long, axillary ; peduncles 0.5 mm. thick, sheathed with scaly bracts at the nodes, and bearing panicles towards the apex ; branches racemose. *Buds* minute, about 2 mm. in diam.

We have had no means of examining fresh flowers in detail. According to Wight the flowers are whitish tinged with purple and with a reddish-lilac lip. Blatter & McCann on the authority of Hallberg add : ' Sepals white tinged with yellow. Petals and lip white. Anthers opercular, yellow with a brown spot on the connective. Stigmatic lobes just in front of tip of anther.'

Flowering : August to September.

Occurrence in Bombay State : N. Kanara : *Stocks.* This species has never been gathered in the State after Stocks.

Distribution : N. Kanara, W. Ghats of Madras State, High Wavy Mtns., Ceylon.

Notes : Our description has been made from Stocks's specimen, kindly loaned by the National Herbarium, Calcutta.

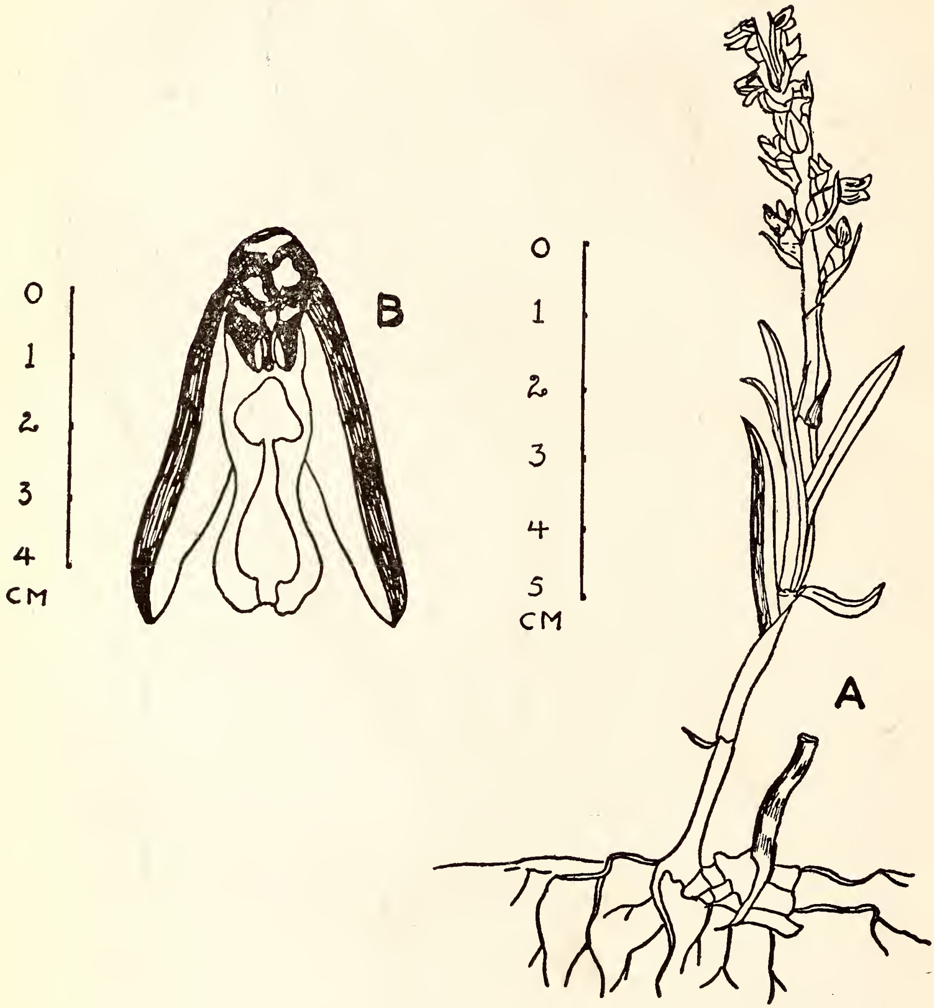
Cooke and later Blatter & McCann state that there has been an error in Wight's *Icones* 1742 and 1743, in that the inflorescence and flowers have been interchanged ; in our opinion there has been no such interchange.

Wight on Jerdon's authority mentions that the same spike of *Sirhookera latifolia* O. Kuntze comes into flower repeatedly.

4. *TROPIDIA* Lindl.

Tropidia Lindl. [in Wall. Cat. 7386, 1831, nom. nud. ; et] in Bot. Reg. sub t. 1618, 1833 ; Endl. Gen. Pl. 214, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 592, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 121, 1888 ; Hook. f. Fl. Brit. Ind. 6 : 92, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 274, 1898 ; J. J. Smith, Fl. Buitenz. 6 : 131, 1905 ; Schltr. Orchid. 124, 1927 ; Correll, Nat. Orch. N. America 247, 1950 ; Holttum, Rev. Fl. Malaya 1 : 140, 1953. *Govindooia* Wight, Icon. 6 : 35, t. 2090, 1853.

Sirhookera lanceolata O. Kuntze.



Zeuxine strateumatica Schltr.

A. Whole plant. B. Top view of column, lip and lateral sepals.

The generic name *Tropidia* is derived from a Greek word meaning ' keel ', in allusion to the boat-shaped lip.

This is a small genus of about 20-30 species, mainly of the East Indies, Malaya, China and Japan, with only one or two found in the Americas.

Type species : *T. curculisioides* Lindl.

Tropidia angulosa Bl. Orch. Arch. Ind. 122, 1858 ; Hook. f. 92 ; King & Pantl. 275, t. 355 ; Fischer 1452 ; Mooney, Suppl. Bot. Bih. Or. 208, 1950. *Govindooia nervosa* Wight, Icon. 6 : 35, t. 2090, 1853. *Tropidia bellii* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 736, 1932.

We have not seen any flowering specimens of this species. In absence of the original description of the species, we give King & Pantling's description : ' Stem 8 to 12 in. high, slender, erect, clothed with obtuse sheaths an inch or more in length, and bearing at the apex two broadly elliptic plicate many-nerved leaves with acute apices and widely sheathing bases, 4 or 5 in. long and 2 to 3 in. broad. *Spike* solitary, terminal, conical, shorter than the leaves, its peduncle bearing numerous linear spreading bracts nearly as long as the flowers. *Flowers* resupinate, crowded, .65 in. long; *floral bract* lanceolate, caudate-acuminate, curving upwards, longer than the sessile ovary. *Sepals* subequal, oblong-lanceolate, the lateral pair connate nearly to the apex. *Petals* somewhat smaller and less acute. *Lip* about as long as the petals, oblanceolate-oblong, obtuse, entire, concave towards the base; adnate to the column, the base with a cylindric, blunt spur half as long as and parallel to the column. *Column* short ; the rostellum and anther very long, lanceolate, acuminate ; *pollinia* clavate-cylindric, elongate, deeply grooved, united below ; the caudicle long and slender ; gland linear, half as long as the caudicle. *Capsule* clavate-cylindric, boldly ridged, .75 in. long. . . . The flowers are white flushed with pale ochre-colour.'

Occurrence in Bombay State : N. KANARA : Siddhapur, *Blatter & Hallberg* 34634 ; Guddehalli, *Bell.*

Distribution : India : Sikkim Himalaya at about 1000 m., N. Kanara, Bababudan Hills, Malabar, Travancore. *World :* India, Burma, Malaya, Java.

Notes : Although we have not seen the type of *T. bellii* Blatt. & McC. (*T. R. Bell* 2992), we cannot find any significant character in Blatter & McCann's description to differentiate the above species from *T. angulosa* Bl. We, therefore, unite *T. bellii* Blatt. & McC. with the earlier *T. angulosa* Bl.

ZEUXINE Lindl.

Zeuxine (' Zeuxina ') Lindl. Coll. Bot. App. n. 18, 1826 ; Orch. Scel. 9, 1826, et Bot. Reg. 19 : sub. t. 1618, 1833, nom. cons. ; Endl. Gen. Pl. 216, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 599, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 116, 1888 ; Hook. f. Fl. Brit. Ind. 6 : 106, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 285, 1898 ; Duthie, ibid. 9 (2) : 168, 1906 ; J. J. Smith, Fl. Buitenz. 6 :107, 1905 ; Schltr. Orchid. 120, 1927 ; Correll, Nat. Orch. N. America 244, 1950 ; Holttum, Rev. Fl. Malaya 1 : 130, 1953. *Adenostylis* Blume, Bijdr. 414, 1825 (non *Adenostyles* Cass. 1816).

The name *Zeuxine* is a Greek word meaning ' joining ', in allusion to the partial union of the lip and column.

Perennial, terrestrial, rhizomatous *herbs*. *Rhizome* creeping, fleshy, ascending or erect. *Leaves* membranous on drying, somewhat fleshy when fresh, sessile or petiolate, ovate to lanceolate or linear. *Inflorescence* of few to many small flowers. *Flowers* scarcely opening. *Sepals* subequal ; dorsal one erect, concave connivent with the petals to form a hood ; laterals free, enclosing the base of the lip. *Petals* somewhat narrower. *Lip* with a saccate base, which usually contains two glands, edges usually inflexed ; limb (blade) transversely widened, entire or 2-lobed, small, connected to the saccate base by a short neck or more or less elongated claw. *Column* short with or without appendages in the front. *Anther* erect or antrorsely inclined, membranous, dehiscent, oblong, shortly apiculate, somewhat stipitate ; pollinia 2, entire or 2-partite lamellate, with a caudicle, and a small gland from the base in between the narrow divided, rostellar arms. *Stigmatic surface* at the base of the rostellum, convex, broad, depressed or in the form of viscous calli. Capsule small, erect, ovoid to subglobose.

About 30 species, extending from tropical Africa, through India and Malaysia to Samoa ; Correll writes that *Z. strateumatica* Schltr. has been recently and accidentally introduced in Florida in the U. S.

This genus is closely related to *Hetaeria* Bl. but is distinguished, according to Holttum, by the flowers, which have the lip in the usual inferior position and usually with a distinct, transversely widened blade at the end of the lip.

Type species : *Z. sulcata* Lindl. = *Z. strateumatica* (L.) Schltr.

Key to the species of *ZEUXINE* of Bombay

1. Leaves sessile, linear or linear-lanceolate, grass-like ; peduncles, ovary and sepals glabrous ; lip equalling the sepals or slightly shorter, narrowly panduriform, apical lobe suborbicular or transversely elliptic .. *strateumatica*

1. Leaves petiolate, broad, ovate or ovate-oblong; peduncle, ovary and sepals glandular-pubescent outside with long, retrorse, lax or dense hairs ; lip equalling the sepals or longer, the apical portion (or blade) 2-lobulate :
   2. Dorsal sepal and petals about 7 mm. long ; lip about 12 mm. long, white, thin, with a small globular sac at the base ; claw connecting the sac and the blade 3-4 mm. long ; blade 2-lobulate, lobules about 8 × 2-3 mm. narrowly and obliquely oblong, irregularly toothed on the outer margin .. *longilabris*
   2. Dorsal sepal and petals about 3-4 mm. long ; lip 4-4.5 mm. long, very fleshy ; sac orange-red with 2 curved papillae within ; claw very short, hardly 1 mm. long ; blade 2-lobulate, lobules white, 1.5-2 × 1.5-2 mm., oblong-orbicular, entire .. .. .. *gracilis*

ENUMERATION OF THE SPECIES OF *Zeuxine* OF BOMBAY STATE

1. **Zeuxine strateumatica** (L.) Schltr. in Fedde. Repert. Beih. 1 : 77, 1911 ; Fischer, Fl. Pres. Madr. 1456, 1928 ; Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 731, 1932 ; Correll 244 ; Holttum 131. *Orchis strateumatica* Linn. Sp. Pl. 2 : 943, 1753. *Zeuxine sulcata* Lindl. Gen. Sp. Orch. 485, 1840, et in Journ. Linn. Soc. 1 : 186, 1857 ; Hook. f. 106 ; King & Pantl. 286, t. 381 ; Prain, Beng. Pl. 1029, 1903 ; J. J. Smith, 108, f. 76 ; Duthie 168, et Fl. Upp. Gang. Pl. 3 : 219, 1920 ; Cooke, Fl. Pres. Bomb. 2 : 708, 1907 ; Haines, Bot. Bih. Or. 1161, 1924 ; Brühl, Guide Orch. Sikk. 170, 1926. *Pterygodium sulcatum* Roxb. Fl. Ind. 3 : 452, 1832. *Zeuxine bracteata* Wight, Icon. 5 (1) : 16, t. 1724 bis, 1851. *Z. brevifolia* Wight, Icon. t. 1725. *Z. robusta* Wight, Icon. t. 1726. *Adenostylis strateumatica* (L.) Ames in Orchid. 2 : 57, 1908 ; Mooney, Suppl. Bot. Bih. Or. 209, 1950. (See Plate XXXVIII).

Herbs 7-40 cm. tall from an underground rhizome which is covered over by a fine network of thin hair-like roots. *Stems* leafy upwards, terete, fleshy, the underground portion reddish-brown, aerial parts greenish or creamy-white. *Leaves* several, alternate, pentastichously arranged all along the stem, pale olive-green to yellowish, 1.8-9 × 0.3-0.6 cm., linear or linear-lanceolate, acute, the margins entire, slightly turned outwards. *Inflorescence* erect or slightly decurved, 1.5-18 cm. long. *Flowers* sessile, bracteate, in dense spirally arranged secund or subsecund spikes. *Bracts* 5-18 × 2-5 mm., longer than ovary, ovate-lanceolate, acute or subacuminate, entire, glabrous, 5-nerved, greenish-white tinged with pale pink. *Sepals* unequal, white, obtuse, entire, glabrous; lateral ones 5 × 2 mm., subobliquely linear-oblong, cymbiform, 1-nerved; the dorsal one 7 × 3 mm., ovate-oblong, concave, faintly 3-nerved. *Petals* 6 × 3 mm., white, obliquely oblong-elliptic, obtuse, entire, glabrous. *Lip* 4.5 × 2 mm., minutely glandular-papillate, slightly saccate at base, narrowly panduriform, obtuse or sub-emarginate with 2 subconcave depressions in continuation with each other, in the 2 lobes; colour of lip pale purple at base, yellow from a little above middle. *Column* very short, produced into 2 white, iridescent wings folded on top of column. *Anther* 1.7 × 1 mm., brown, broadly comma-shaped, apiculate and opening longitudinally, depressed in the folds of the columnar wings; pollinia 2, 1 × 0.5 mm. lamellate, yellow, obpyriform; caudicle 1 mm. long, narrowly oblong tapering at base with a small oblong-orbicular gland. *Stigmas* 2, subobliquely cuneate, parallel, dull-brown, situated just below the columnar wings. *Ovary* 7-8 × 3-4 mm., ovoid, tumid, greenish-white, sessile, ribbed. *Capsule* broadly ovoid, beakless, strongly ribbed. *Seeds* minute, powdery, deep brown in colour.

Flowering : January to March.

Occurrence in Bombay State : Baroda, *Shah* 7061. DANGS: Banks of Ambika Nalla, Waghai, *Bell.* W. GHATS: Deolali, *Acland* 1180. DECCAN: Paschan, near Poona, *Gammie; Kapadia* 1823-1827, 1049-1052; Gokak Falls, *Sedgwick.* N. KANARA: *Law*; Dharwar, *Law.*

Distribution : India : Hooker f. mentions this as the commonest orchid in India. It is found abundantly in grassy places throughout India, ascending to about 1600 m. on the outer Himalayan ranges, Bengal, Bihar, Orissa, Upper Gangetic Plain, Gujarat, Dangs, W. Ghats, N. Kanara, Ganjam, Mysore. *World :* Afghanistan, Pakistan, India, Ceylon, Malaya, China, Japan, Philippines; recently reported from the United States.

Notes : According to Correll the specific name *strateumatica* is a Latin adjective meaning 'military', doubtless in allusion to the erect, soldier-like aspect of the plant or to the ascending rigid sword-shaped or bayonet-like leaves. This species is commonly found in moist, swampy ground, often in running water, among short grasses.

The type locality of this species is Ceylon. Correll has pointed out that this is the only Asiatic terrestrial orchid which has been introduced into the eastern parts of the U. S. According to him, Ames in 1938 rightly conjectured that this orchid was brought from

China into Florida with the seeds of *Eremochloa ophiuroides*, which was first introduced in 1917 and is now a common lawn-grass in Florida and other parts of the Southern states.

Correll credits the combination *Z. strateumatica* to Schltr. in Bot. Jahrb. 45 : 394, 1911; Mooney credits *Adenostylis strateumatica* (Linn.) to Ames, in Fedde, Repert. Beih. 1 : 77, 1911 ; *Index Kewensis* gives the references as mentioned in our synonymy.

Haines considers *Z. membranacea* Lindl. distinct from *Z. strateumatica* Schltr. (= *Z. sulcata* Lindl.). The 2 species are distinguished by him on the following characters :

Median sepal 0.2-0.25″, lip with terminal lobes, anther broad-ovate, cuspidate .. .. *Z. sulcata*
Median sepal 0.1″, lip with 2 lateral wings, anther narrow saggitate .. .. .. *Z. membranacea*

Blatter & McCann follow Haines in keeping the 2 species separate.

2. **Zeuxine longilabris** Benth. ex Hook. f. Fl. Brit. Ind. 6 : 107, 1890 ; Prain 1029 ; Cooke 709 : Fischer 1456 ; Blatt. & McC. 731. *Monochilus longilabre* Lindl. Gen. Sp. Orch. 487, 1840, et in Journ. Linn. Soc. 1 : 186, 1857 ; Dalz. & Gibs. Bomb. Fl. 271, 1861. *Monochilus affine* Wight, Icon. 5(1) : 16, t. 1728, 1851, (non Lindl. 1840). (See Plate XXXIX).

Herbs 23-48 cm. tall. *Rhizome* fleshy, greenish-brown, up to 6 mm. thick, swollen at the nodes. *Leaves* clustered at the base, pale olive-green, subcoriaceous, membranous on drying, 1-7 × 0.8-3 cm., somewhat loosely sheathing, ovate-oblong to ovate-lanceolate, acute, entire ; midnerve prominent with 3-5 faint, lateral ones ; petioles up to 2 cm. long. *Peduncle* 8-22 cm. long, terete, bracteate, densely and retrorsely villous-tomentose ; bracts 0.7-2 cm. long, ovate-lanceolate, acute, entire, villous-tomentose, the lower ones sheathing the peduncle. *Racemes* 2-17 cm. long, lax, secund or subsecund. *Flowers* greenish-white, bracteate, very shortly pedicellate. *Sepals* unequal, brownish-green, villous-tomentose outside, glabrous inside, acute, entire, 1-nerved ; dorsal sepal 7 × 5 mm., ovate-triangular ; lateral ones 5 × 2.5 mm. ovate, subfalcate. *Petals* 7 × 2.5 mm. slightly shorter than the dorsal sepal. *Lip* white, 1.2 cm. long ; claw 3-5 mm. long with a small globose pouch-like sac at the base, pubescent outside, conduplicate, spreading into a broad, white limb, which is about 8 × 4-6 mm. and 2-lobed ; lobules obliquely oblong, irregularly toothed on the outer margins, about 8 × 2-3 mm. *Column* small. *Anther* about 3 × 1.5 mm. the apiculus about 1¼-2 times as long as the cells covering the caudicle only the gland being exposed ; the dorsal surface with 2 broad parallel, red bands meeting about the centre and then again diverging ; pollinia 2, oblong, lamellate, with an oblong tapering caudicle and a small, ovate-orbicular gland. *Stigmatic surfaces* 2, pale brown. *Ovary* brownish-green, 1 × 0.2 cm. oblong, with long woolly interwoven hairs.

Flowering : February to March.

Occurrence in Bombay State : KONKAN : *Law* ; *Stocks*. N. KANARA : Kumbelli Mines, about 17 miles from Supa, *Kapadia* 2697-2698, 2708-2713 ; Anshi, *J. Fernandez* ; *Kapadia* 2860 ; Anmod, *Talbot* ; *Sedgwick* ; *J. Fernandez* 8671.

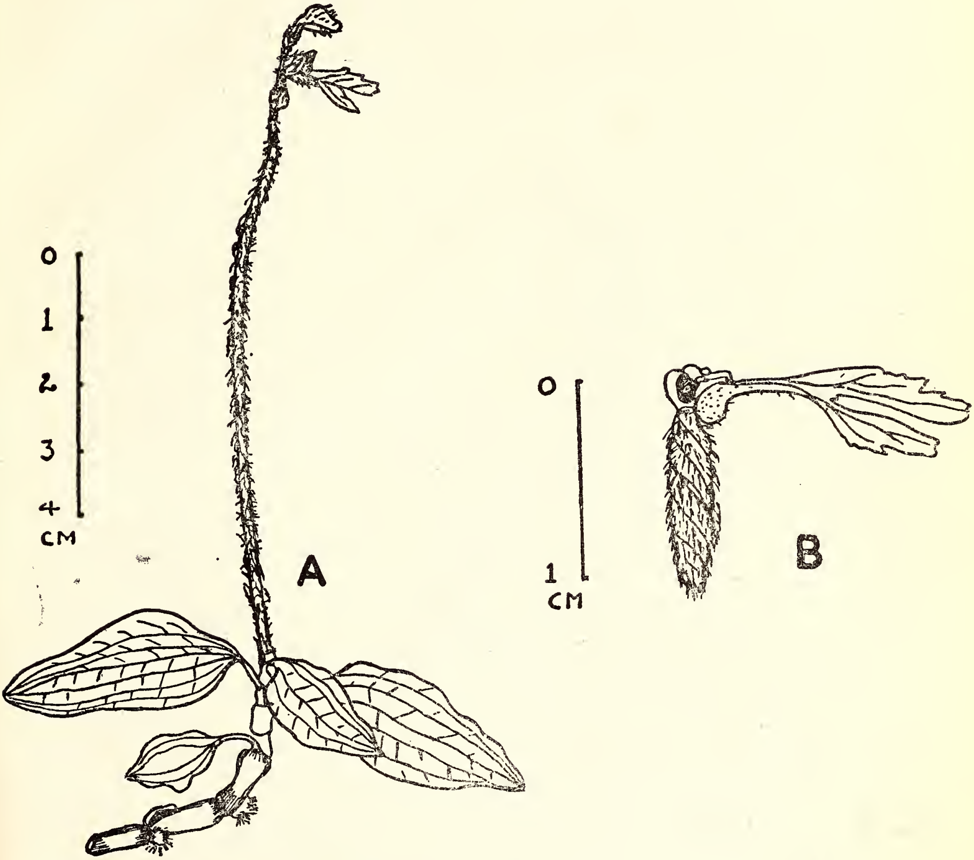
Distribution : *India* : Bengal, Assam, N. Kanara, W. Ghats of S. India from the low country to 1300 m., High Wavy Mountains. *World* : India, Ceylon.

Notes : This species is generally found at the edges of high sloping ground, with the rhizome creeping under a covering of dry, decaying leaves.

In the literature the binomial *Z. longilabris* is attributed to Bentham (in Benth. & Hook. f. *Gen. Pl.* 3 : 600, 1893). But Bentham, did not actually make the combination (see Art. 32 of the *Int. Code Bot. Nomencl.*, 1956). He merely reduces the genus *Monochilus* Lindl. to a section of *Zeuxine*, stating that all the *Monochilus* species should pass to the genus *Zeuxine*. It was Hooker f. who actually published *Z. longilabris* and the combination should be credited either to Benth. ex Hook. f. or simply to Hook f.

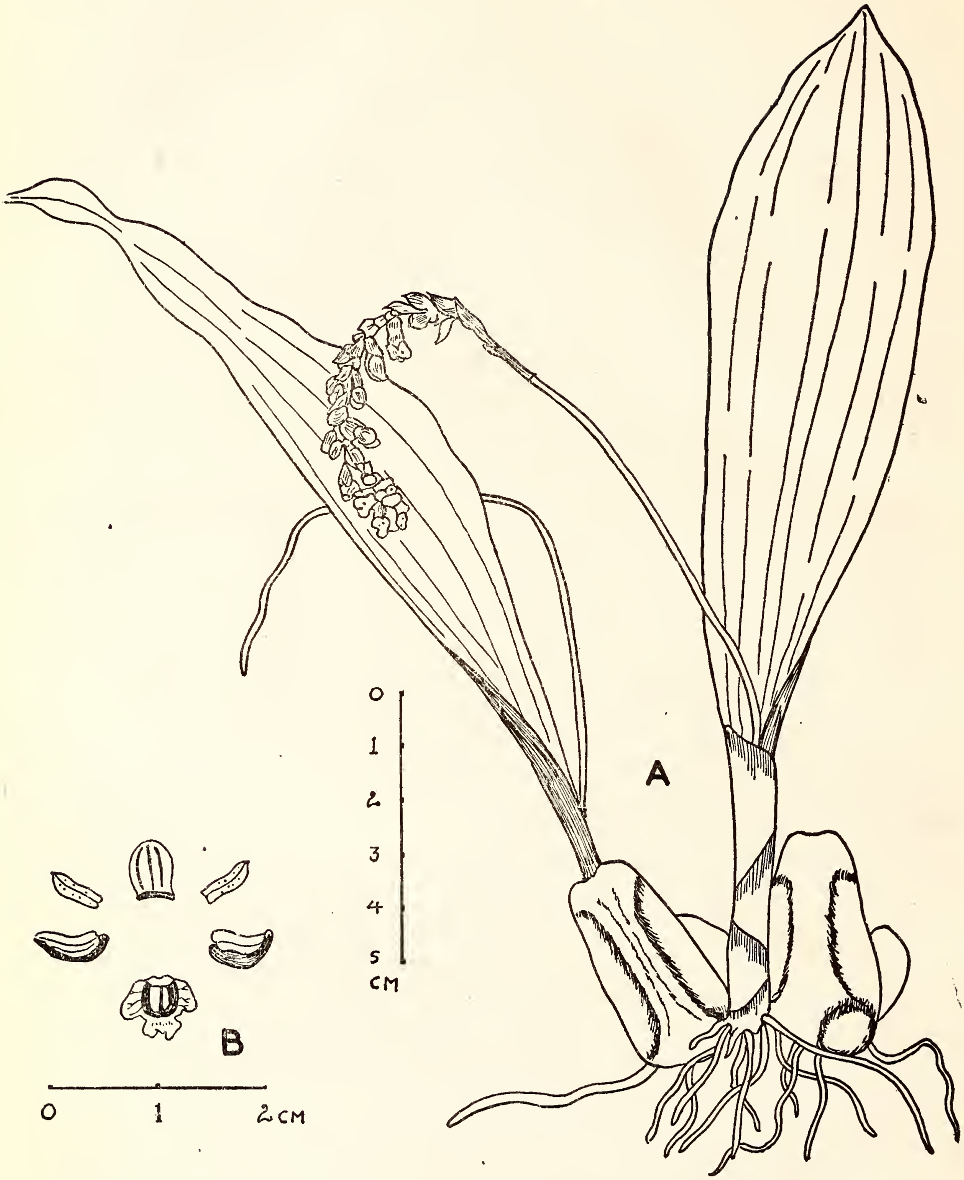
3. **Zeuxine gracilis** (Breda) Bl. Fl. Jav. N. S. 56, t. 18, f. 2. t. 23 D, 1858 ; J. J. Smith 110, f. 78 ; Holttum 134, f. 22. *Psychechilos gracile* Breda, Gen. Sp. Orch. t. 9, 1827. *Monochilus affine* Lindl. Gen. Sp. Orch. 487, 1840. *Zeuxine affinis* Benth. ex Hook. f. Fl. Brit. Ind. 6 : 108, 1890 ; King & Pantl. 290, t. 387 ; *Zeuxine blatteri* Fischer in Kew Bull. 1928 : 76, et Fl. Pres. Madr. 1456, 1928.

Herbs 15-50 cm. tall. *Rhizome* creeping but becoming erect, sheathed at the nodes, fleshy, smooth, dark green. *Leaves* 4-6, fading at the time of flowering, olive-green to greyish-green, or often somewhat reddish-brown, sheathing at the base, very shortly petiolate ; sheaths about 1 cm. long, laxly embracing the stem, tubular, nerved, glabrous ; petioles about 5 mm. long ; lamina 3-6 × 0.7-2.5 cm., oblong or oblong-lanceolate or ovate or ovate-lanceolate, acute, rounded at the base, glabrous. *Peduncles* with spike 15-35 cm. glandular-pubescent with long, lax, retrorse hairs, and with 2-3 bracts which are sheathing, oblong-lanceolate, about 7-12 mm. long, glandular-pubescent. *Flowers* 4-6 mm. long, sessile, bracteate, scarcely opening. *Bracts* 4-7 mm. long, equalling the ovary or shorter, pale green, lanceolate, acute or acuminate, entire, glandular-pubescent, the hairs retrorse. *Sepals* subequal, ovate or ovate-oblong or ovate-lanceolate, obtuse, entire, 1-nerved, somewhat



Zeuxine longilabris Benth.

A. Whole plant. B. Lateral view of ovary, column and lip.



Pholidota imbricata Lindl.

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

gland-dotted, glandular-pubescent, the hairs long, lax, retrorse, pale green with paler tips ; dorsal one 4 × 2-2.5 mm. concave at the base ; laterals slightly shorter and narrower. *Petals* 3.25-4 × 1.5 mm., oblong-lanceolate, obtuse, entire, 1-nerved, somewhat gland-dotted, pale green with white tips or pale pink, cohering with the dorsal sepal. *Lip* 4 mm. long, fleshy, strongly saccate at base, with 2 curved papillae within the sac, the margin of the very short neck cohering ; limb of 2 lobes, which are oblong or oblong-orbicular to even subcuneate, glabrous 1.5-2 × 1.5-2 mm., about 4 mm. across. Sac orange-red with the blade white. *Column* 1.5 × 1.5 mm. *Anther* ovoid, pale pink, shortly stipitate, dehiscent; pollinia narrowly oblong with short caudicle and a small gland. *Stigmatic* surfaces 2, brownish at base of rostellum ; rostellum of 2 subulate processes, containing the gland of the pollinia in between at the base. *Ovary* about 9 mm. long, green with long, retrorse, lax glandular-pubescent hairs, sessile. *Capsule* about 10 mm. long, narrowly ellipsoid, glabrescent.

Flowering and *Fruiting :* March.

Occurrence in Bombay State : N. KANARA : Kumbelli Mines, about 17 miles from Supa, *Kapadia* 2665-2672, 2704-2707.

This species has been recorded for the first time for Bombay State.

Distribution : India : Khasia Hills, Sikkim, N. Kanara, High Wavy Mtns. *World :* India, Burma, Malaya, Java, Sumatra, Borneo.

Notes : After a very careful examination of the descriptions, it seems to us that all the above names belong to one and the same species. All the descriptions seem to fit our specimens from N. Kanara. Fischer distinguishes *Z. blatteri* from *Z. affinis* Hook. f. by the broader leaves, narrow petiole, glabrous sheaths and the lip which is saccate, fleshy, ecalcarate within the lobes of the lip, orbicular, glabrous, distant. The leaf-sheaths in *Z. affinis* are not pubescent, and the lip is not calcarate within; in our specimens the lobes of the limb vary from oblong, oblong-orbicular to subcuneate, and are glabrous.

In the literature the combination *Z. affinis* is attributed to Bentham (in Benth. & Hook. f. *Gen. Pl.* 3 : 600, 1883). But it was Hooker f. who actually published the combination and therefore it should be attributed to him, or to Benth. ex Hook. f.

J. J. Smith remarks that *Z. gracilis* Bl. is similar to the Indian *Z. affinis* Hook. f. Holttum writes : ‘ Whether the Malayan plants are quite identical with *Z. gracilis* from Java, or with *Z. affinis* from India, is not certain. There is much variation in this group of Zeuxines and the exact limitation of species is not certain without more careful observation of living plants.’

In our opinion the 3 species, *Z. gracilis* Bl., *Z. affinis* Hook. f. and *Z. blatteri* Fisch. are identical. The earliest valid specific epithet is *gracilis*, and the correct name for the plant *Z. gracilis* (Breda) Bl.

There are variations in the colour of the lip. J. J. Smith describes it as pale flesh-coloured at the base, becoming paler and whitish or yellowish upwards. Holttum gives it as yellowish at the base with a white blade. King & Pantling describe the lip as yellow; the blade is also coloured yellow in their plate. Fischer gives the sac of the lip as orange, and the limb white. We have noted the following colour details : sepals greenish with paler or white tips ; petals greenish, paler or white at the tips, rarely pale pink; sac of the lip orange-red to orange, with the limb white or pale-yellowish. In formaline preserved flowers the sac changes to a pale yellow colour. The anther is pink.

It may be further pointed out that this species has not been recorded for Bombay State until now. It constitutes a new record.

6. *PHOLIDOTA* Lindl.

Pholidota Lindl. in Hook. Exot. Fl. sub t. 138, 1825 ; Endl. Gen. Pl. 190, 1837 ; Benth. & Hook. f. Gen Pl. 3 : 520, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 127, 1888 ; Hook. f. Fl. Brit. Ind. 5 : 844, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 144, 1898 ; Duthie, ibid. 9 (2) : 115, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 150, 1905 ; Pfitz. & Kranzl. in Pflanzenr. 32 : 142, 1907 ; Schltr. Orchid. 152, 1927 ; Holttum, Rev. Fl. Malaya 1 : 233, 1953.

The generic name *Pholidota* is derived from the Greek words *Pholidos* = scale, *ous* or *otis* = ear or ear-like, in allusion to the scaly bracts of the flowers which are ear-like.

There are about 40 species distributed from India and southern China to Australia.

Along with the generic diagnosis, *Pholidota imbricata* Lindl. was the only species described ; this must, then, be considered the type species of the genus *Pholidota* Lindl.

Type species : *P. imbricata* Lindl.

Pholidota imbricata (Roxb.) Lindl. loc. cit. 1825 ; Wight, Icon. 3 : 9, t. 907, 1844-1845 ; Dalz. & Gibs. Bomb. Fl. 262, 1861 ; Hook. f. 845; Grant, Orch. Burma 161, 1895 ; King & Pantl. 144, t. 201 ; Duthie 115, et Fl. Upp. Gang. Pl. 3 : 190, 1920 ; Prain, Beng. Pl. 1012, 1903 ; J. J. Smith 151, f. 112 ; Pfitz. & Kranzl. 154 ; Gammie in Journ. Bombay nat. Hist. Soc. 17 : 942, 1907 ; Blatt. & McC. ibid. 35 : 267, f. 3, 1931 ; Cooke, Fl. Pres. Bomb. 2 : 688, 1907 ; Haines, Bot. Bih. Or. 1167, 1924 ; Brühl, Guide Orch. Sikk. 96, 1926; Fischer, Fl. Pres. Madr. 1431, 1928 ; Holttum 234. *Cymbidium imbricatum* Roxb. Hort. Beng. 63, 1814, nom. nud. et Fl. Ind. 3 : 460, 1832. (See Plate XL).

Pseudobulbs 2-6 × 1.5-3 cm. broadly ovoid-conical, dull grey-green or dull brown to mauve-brown, with broad grooves on the sides making them somewhat 4-angled. *Leaf* solitary, from the top of pseudobulb, coriaceous, subplicate, pseudopetiole 2-5 cm. long; lamina 12-30 × 3-6 cm., elliptic to broadly oblanceolate or oblong, entire, acute, many-nerved. *Rachis* from the base of pseudopetiole and from the top of pseudobulb, raceme up to 45 cm. long, smooth, terete, pendulous. *Raceme* synanthous, drooping. *Flowers* dirty-pink arising in a closely distichous manner, pedicellate, bracteate, not wide opening. *Bracts* 7.5 × 2.5-3 mm. convolute, round the shorter ovary, dirty pinkish-brown, broadly elliptic on spreading, obtuse, entire, the apical portion minutely irregularly serrulate. *Pedicel* with ovary about 5 mm. long. *Sepals* subequal, pale pinkish-brown, concave, 3-nerved, entire; the dorsal one 5×4 mm. broadly oblong-suborbicular, obtuse; the lateral ones 6×2.5-3 mm., broadly sickle-shaped, subacute, strongly carinate. *Petals* 5-6×1-2 mm. narrowly linear-oblong, subfalcate, acute, entire, glabrous, somewhat gland-dotted, 1-nerved. *Lip* pale pink, 5-7 mm. long, deeply saccate, almost globose; hypochil (or base of lip) up to the lateral lobes with a circular callus in the middle, the lateral lobes 4×3 mm., erect, broadly oblong, entire, obtuse, the lip about 7.5-8 mm. broad; epichile (or blade of lip) consisting of the midlobe 2×3-4 mm. deflexed, somewhat incurved, 2-lobulate with a broad sub-truncate sinus, the lobules subobliquely truncate, subacute. *Column* 3-3.5× 2-3 mm., broadly winged, the margins irregularly serrulate. *Anther* 1.5×1 mm. golden-brown; pollinia 4, in pairs, each pair consisting of a large ovoid pollinium and a small one on the inner side. *Stigmatic surface* broadly funnel-shaped, brownish. *Capsules* 20×12 mm. tumid, pale-brown, shiny, ovoid.

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

Occurrence in Bombay State : KONKAN : *Stocks* ; *Dalzell* ; Vengurla, *Dalzell and Gibson*. N. KANARA ; Sampkhand, *Sedgwick and Bell* ; Sirsi, *Santapau* 18506 ; Siddhapur, *Kapadia* 2360-2361 ; Shintheri Rocks, between Dandeli and Gundh, *Kapadia* 1751-1753 ; Jog-Mavingundi, *Santapau* 18614.

Distribution : *India* : Chota Nagpur, Konkan, N. Kanara, W. and E. Ghats of S. India, 600-1000 m. *World* : Ceylon, India, Nepal, Burma, Malaysia, Southern China, Philippines, Pacific Islands, Australia.

Notes : The life-history of this plant deserves attention. Towards the end of the dry season, leaves are given off from the rhizome in the axils of large bracts near the base of old pseudobulbs. In the early part of the monsoon the inflorescence comes out from near the base of a leaf; gradually with the advance of the season, the base of the leaf begins to swell and thus eventually pseudobulbs are produced; the rachis of the fruiting inflorescence is attached to the top of the pseudobulb.

Holttum distinguishes his *Pholidota longibulba* from *P. imbricata* Lindl. in the following way :

Pseudobulbs not angled ; lip deeply bilobed .. *P. imbricata*
Pseudobulbs angled ; blade of lip entire *P. longibulba*

Pfitzer and Kranzlin describe the pseudobulbs of *P. imbricata* Lindl. as tetragonal ; King and Pantling speak of them as furrowed ; Lindley in his original description gives them as sulcate. We have noted that very young pseudobulbs are ovoid and completely smooth without any furrows ; with advance in age and size, the longitudinal grooves make their appearance, so that the mature pseudobulbs become conspicuously angled. The colour of pseudobulbs and leaves in *P. imbricata* Lindl. varies from green to brown or mauve-brown, the shape of the pseudobulbs varying from ovoid-conical to almost suborbicular.

Hooker f. and J. J. Smith have united *P. pallida* Lindl. with *P. imbricata* Lindl. Smith is unable to differentiate *P. imbricata* Lindl. from *P. loricata* Reichb. f., as *P. imbricata* Lindl. varies greatly in the shape of the pseudobulbs, the colour and size of the flowers ; in consequence he has fused the two species into one.

Pfitzer and Kranzlin distinguish 3 species, *P. loricata* Reichb. f., *P. pallida* Lindl., and *P. imbricata* Lindl. thus :

Bracts ovate, acute, clearly longer than broad, about equalling the flowers .. *P. loricata*
Bracts broadly ovate or almost orbicular :
Midlobe of lip trilobulate, midlobule round.. *P. pallida*
Midlobe of lip emarginate, lobules round .. *P. imbricata*

In view of their acceptance of these 3 species, it is difficult to see how these authors can give *Coelogyne pallida* Reichb. f. as a synonym of both *P. imbricata* Lindl. and *P. pallida* Lindl. Further they list *P. imbricata* Bot. Reg. t. 1213, 1825 (non Lindl.) as a synonym of *P. pallida* Lindl. (1835) ; in the same book they give the reference to Bot. Reg. t. 1213 under *P. imbricata* Lindl. (1825). All this is very confusing to say the least. In the key they accept the separate identity of the three plants, but this is denied in subsequent pages.

We consider the three species *P. pallida* Lindl., *P. loricata* Reichb. f., and *P. imbricata* Lindl. as identical.

7. *LIPARIS* L. C. Rich.

Liparis L. C. Rich. in Mem. Mus. Hist. Nat. Paris 4 : 43, 1818, nom. cons. ; Endl. Gen. Pl. 189, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 495, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2(6) : 130, 1887 ; Ridley in Journ. Linn. Soc. 22 : 252, 1887; Hook. f. Fl. Brit. Ind. 5 : 691, 1890; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 22, 1898; Duthie, ibid. 9(2) : 89, 1906; J. J. Smith, Fl. Buitenz. 6 : 258, 1905; Schltr. Orchid. 157, 1927; Correll, Nat. Orch. N. America, 271, 1950; Holttum, Rev. Fl. Malaya 1 : 197, 1953. *Leptorkis* Thou. in Nouv. Bull. Soc. Philom. Paris 1 : 319, 1809. *Leptorchis* Thou. O. Kuntze, Rev. Gen. Pl. 2 : 669, 1891.

The generic name is derived from the Greek word meaning 'fat' or 'smooth' or 'oily', in allusion to the typically fleshy-thickened shiny leaves.

Perennial, epiphytic or terrestrial herbs. *Stems* ± creeping, branches somewhat pseudobulbous and short and thick, or long and narrow, sheathed. *Leaves* one or more, from the top of pseudobulb or stem, sheathing, ± plicate. *Scape* terminal, terete or angled and winged. *Racemes* dense or lax. *Sepals* and *petals* erect or reflexed; sepals mostly oblong-lanceolate, free, spreading; petals narrowly linear to filiform, very rarely broader. *Lip* clawed, ± parallel to column, narrow; limb broad, entire or bifid; calli absent, or if present 1 or 2, conic, at base of lip. *Column* footless, rather long, curved, with narrow lateral wings above, rarely short. *Anther* ovate, 2-celled, terminal, incumbent, opercular; pollinia 4, waxy, ovoid, united in pairs at their apices. *Capsules* ellipsoid or pyriform, erect or subpendulous.

This is a large and complex genus of about 260 species, one of the most widely-spread genera of the family. It is found in most parts of the world except in polar regions; the greatest concentration of species being found in tropical Asia.

Liparis Rich. is closely allied to *Malaxis* Sw. in its habit (particularly the terrestrial species), but can easily be distinguished by the lip being inferior, without auricles and nearly always sharply bent at or below the middle; also by the rather long curved column with 2 small membranous wings on the sides of the stigmatic surface.

Type species : *L. loeselii* (L.) L. C. Rich.

Key to the species of *LIPARIS* of Bombay

Leaves flat on ground, almost sessile and opposite; flowers green, often faintly tinged with yellow; bracts deflexed; lip minutely clawed, green with 2 fleshy, shiny, conical calli at base, lamina orbicular or transversely oblong-orbicular, minutely denticulate with a central oblong shiny patch .. *prazeri*

Leaves erect, alternate on stem, ± shortly stalked; flowers pale yellow, often tinged with purple ; bracts erect ; lip sessile, pale yellow with a purple tinge ; calli 2, meeting at the base, often with a minute third one in between ; the lip obcordate in outline on spreading .. *nervosa*

1. **Liparis prazeri** King & Pantl. in Journ. As. Soc. Bengal II, 66: 582, 1897. *L. flavo-viridis* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 260, f. 6, 1931. *L. paradoxa* Reichb. f.? Gammie in Journ. Bombay nat. Hist. Soc. 16 : 565, 1905. (See Plate XLI).

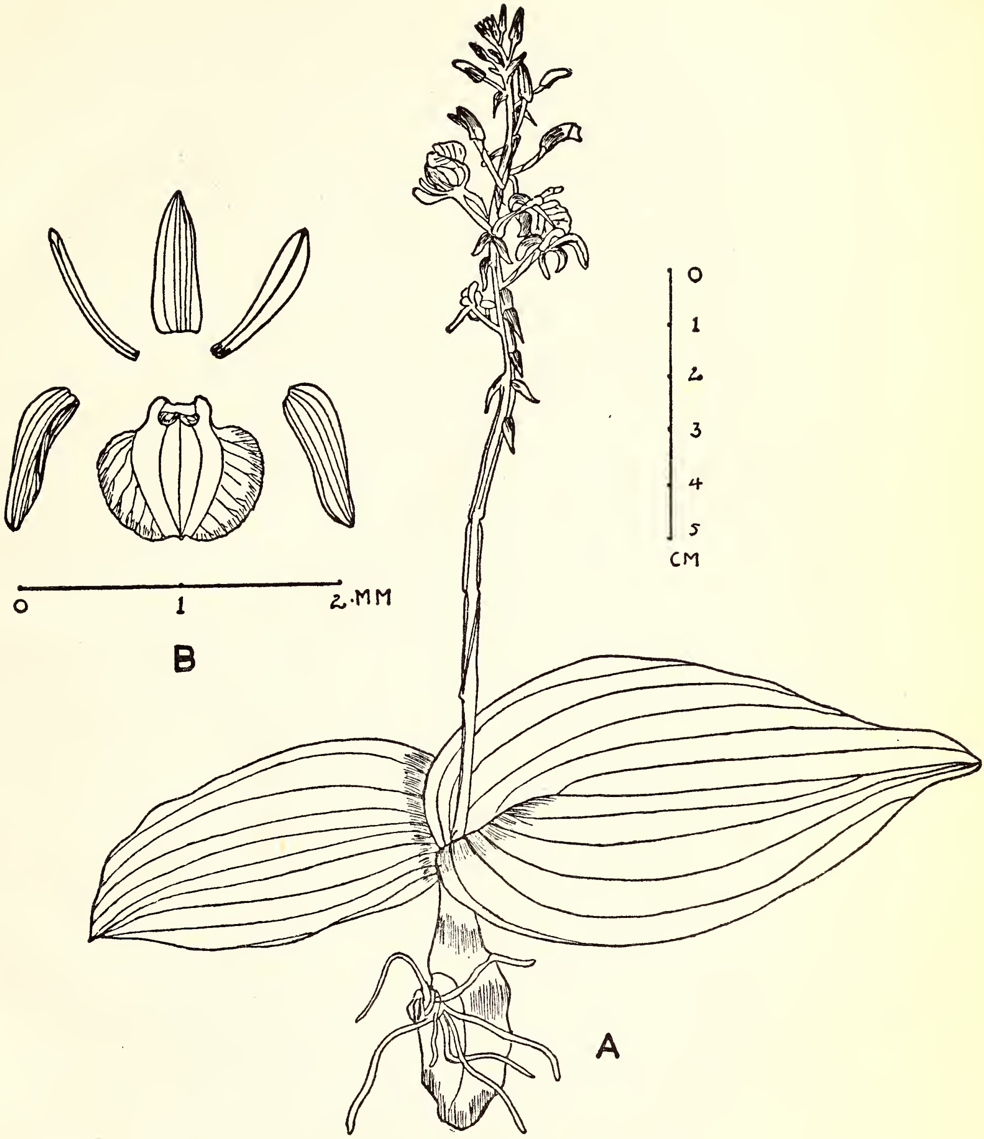
Terrestrial *herbs.* Corm tuberous, about 7-11 mm. in diam. *Stem* underground, not more than 2 cm. high, sheathed. *Leaves* usually 2, often up to 5, flat and spreading on ground, sessile, sheathing at base, 6-16 × 2-9 cm., broadly ovate, elliptic, or ovate-lanceolate, acute or abruptly tapered to an acuminate apex, fleshy, plicate, green, about 7-nerved. *Scape* 7.5-32 cm. long, 0.75-2 mm. thick, green, angled, winged. *Flowers* in lax racemes, long-pedicelled, bracteate, green, often somewhat yellow. *Bracts* 4-6 × 1-2 mm., deflexed, lanceolate, sub-acuminate, entire, pale green. *Pedicel* with *ovary* about 10 mm. long, green, erect. *Sepals* 9 × 3 mm., pale green, acute, 5-nerved, lanceolate; the dorsal one bent backwards almost along the ovary, with involute margin ; lateral ones straight, slightly incurved at base and apex, lying behind the lip. *Petals* 9 × 1 mm., pale green, lying behind the lip, along with lateral sepals, margins involute narrowly linear, on spreading about 2 mm. broad, linear-obspathulate, acute 1-nerved. *Lip* dark green, clawed; claw about 2 mm. long, erect, ± parallel to the column, with inflexed edges, the base with 2 conical, shiny, dark green calli nearly touching the column ; limb about 7 × 7 mm., bent at right angles to the claw ; transversely oblong-orbicular or obcordate-orbicular or orbicular-reniform, emarginate at apex with or without a minute apiculum, minutely denticulate on the margin with a narrowly-oblong, shiny, subconcave, nectar-secreting patch extending up to the middle or a little beyond. *Column* 4 mm. long, pale green, strongly curved forwards at the top, linear-oblong, base much dilated ; lateral wings small. *Anther* 0.75 × 0.75 mm., ovate-oblong, pale green. *Stigmatic surface* deep seated. *Capsules* 15 × 7 mm. long, obovoid, strongly ribbed ; pedicels 7-9 mm. long.

Flowering and *Fruiting :* August.

Occurrence in Bombay State : N. KANARA : Londa, *Spooner ;* Dandeli, *Bell* ; Yellapur, *Bell* ; *Kapadia* 2243-2250.

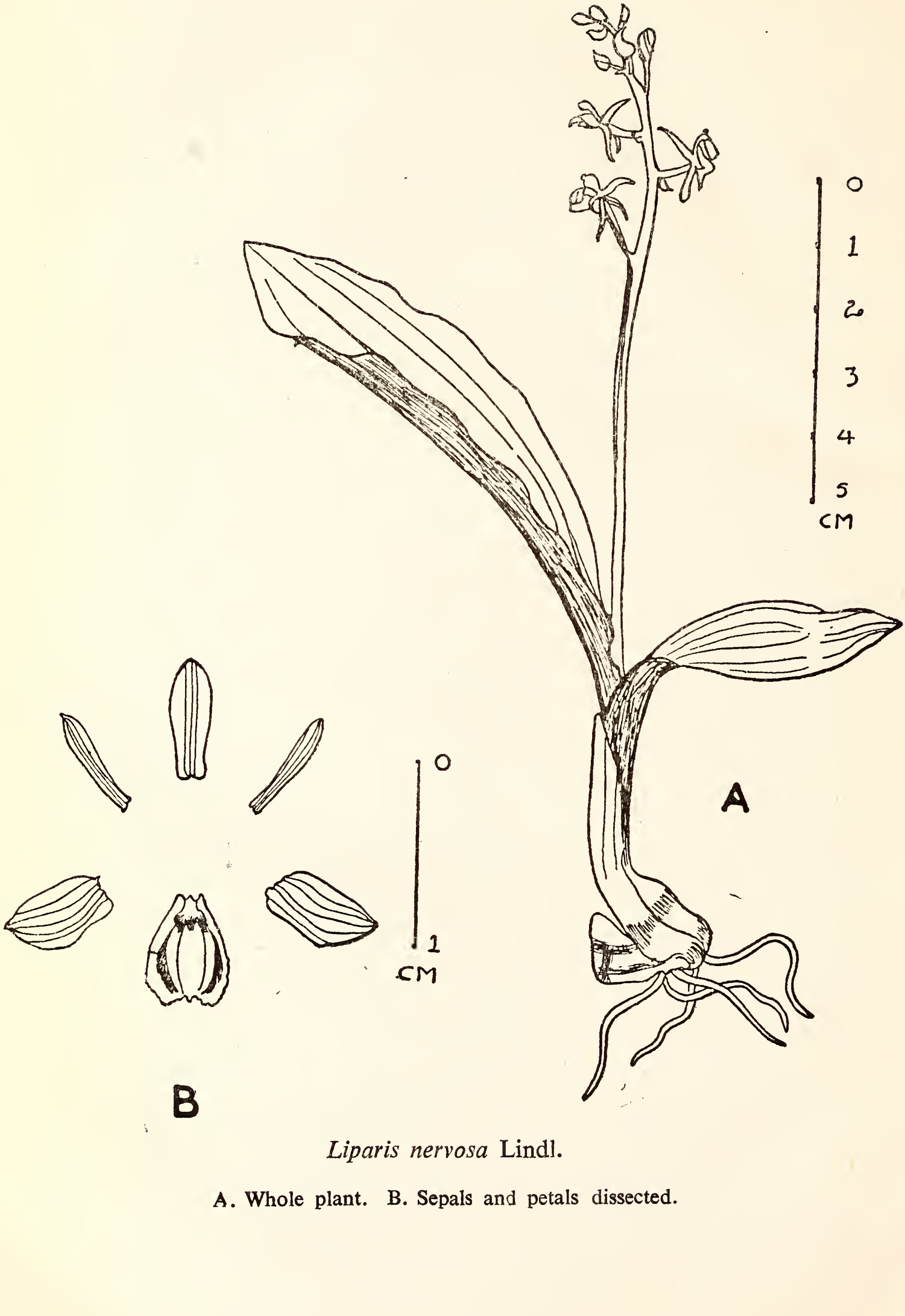
Distribution : India : N. Kanara, *World :* India, Burma.

Notes : Our specimens have been collected from one of the original localities given for *L. flavo-viridis* by Blatter & McCann. They may,



Liparis prazeri King & Pantl.

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



Liparis nervosa Lindl.

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

therefore, be considered authentic for the purpose of clarification of the identity of the species.

We have examined the type specimen of *L. prazeri*. Our specimens exactly match it. On the type specimen there is a note in Rolfe's hand 'Not identified, but not in condition for comparison. The few flowers are badly dried and tightly glued to the sheet.' This sheet is labelled *Liparis prazeri* King & Pantling. King & Pantling in their original description point out that the species resembles *L. deflexa* Hook. f. but differs in having nearly sessile broader leaves and an entire lip. Actual examination of flowers of the type specimen, shows that the lip is not entire but minutely denticulate, just as in our specimens from N. Kanara.

There seem to be very slender differences between *L. prazeri* King & Pantling and *L. deflexa* Hook. f. King & Pantling describe the stem of *L. deflexa* Hook. f. as 5-7 cm. long; in our specimens of *L. prazeri* King & Pantl., the stem is never more than 2 cm. high. This seems to be the only difference, which does not seem to be enough for specific differentiation. They also mention that the lip is deflexed from the very base, and give this as another distinguishing character for *L. prazeri*. This again does not seem to be quite correct; from our specimens examined in the fresh condition it is clear that the lip has a very small claw, which is inflexed parallel to the column; this can scarcely be seen in pressed specimens, especially in the badly preserved material at the disposal of the authors. The 2 species certainly seem to be identical.

Hooker f., Duthie, Cooke, and Blatter & McCann cite *Liparis diphyllos* Nimmo (in Graham, *Cat. Bomb. Pl.* 252, 1839) as synonymous with *Habenaria diphylla* Dalz. We quote Nimmo's description, which although short seems adequate: 'Leaves pressing on the ground, ovate, acute, plaited; flowers greenish, lip large and round'. In *Habenaria diphylla* Dalz. the leaves are pressing on the ground and fleshy, but are certainly not *plaited;* the lip is 3-*partite* with long, somewhat filiform, slender spreading segments, and definitely not large and round. Nimmo's description clearly fits one of the *Liparis* discussed above and cannot be referred to *Habenaria diphylla* Dalz. The locality given by Nimmo is Konkan, and most probably refers to *L. prazeri* King & Pantling, but the description is too short for a satisfactory identification of the plant.

2. **Liparis nervosa** (Sw.) Lindl. Gen. Sp. Orchid. 26, 1830; Cooke, Fl. Pres. Bomb. 2: 678, 1907; Haines, Bot. Bih. Or. 1166, 1924; Fischer, Fl. Pres. Madr. 1410, 1928; Blatt. & McC. 259, f. 5. *Melaxis nervosa* Sw. in Vet. Akad. Nya Handl. Stockh. 21: 235, 1800. *Liparis paradoxa* (Lindl.) Reichb. f. in Walp. Ann. 6: 218, 1861; Ridley 261; Hook. f. 697; Grant, Orch. Burma 24, 1895; King & Pantl. 27, t. 34; Prain,

Beng. Pl. 1005, 1903 ; Brühl, Guide Orch. Sikk. 49, 1926. *L. dalzellii* Hook. f. Fl. Brit. Ind. 5 : 698, 1890 ; Gammie 565. *L. nervosa* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 671, 1891. (See Plate XLII).

Terrestrial *herbs. Corm* 5-10 mm. in diam., whitish. *Stem* erect, 3-13 cm. tall, slender to 8 mm. thick, 1-2-sheathed. *Leaves* generally 2, rarely 3, $\pm$ erect, shortly stalked, plicate, alternate, 4-15 × 1-5 cm., elliptic or oblong-elliptic or oblong-lanceolate, acute, entire, 5-7-nerved. *Inflorescence* about 10-20 cm. long, erect, lax ; peduncle ebracteate, greenish, subterete. *Flowers* long-pedicelled, pale yellow or yellow tinged with pale purple on the lip, bracteate. *Bracts* about 3 mm. long, erect or suberect, narrowly linear, acute. *Pedicel* with *ovary* about 9 mm. long, the apical portion straight or curved upwards, yellowish-green. *Sepals* unequal, subacute, entire, 3-5-nerved, pale yellow ; the dorsal one 6 mm. long, curved, at first erect, later reflexed with the margins much involute giving the sepal a narrow linear appearance, linear-oblong, about 2 mm. broad on spreading ; lateral sepals 5 - 6 mm. long, spreading. *Petals* 5-6 mm. long, pale yellow, narrowly linear-oblong, slightly broader in upper half, margins involute, acute, 3-nerved. *Lip* 6 mm. long, 4.5 mm. broad on spreading, obcordate in outline ; the basal half erect, parallel to the column, the calli meeting at the base, often with another minute one in between ; the colour of the lip is pale yellow, often tinged with pale, brown or purplish on the sides of the deflexed apical half. *Column* 4-4.5 × 1-1.5 mm., erect, at about right angles to the ovary, curved forwards at the apex. *Anther* 2 × 1.5 mm. ovate, acute.

Flowering and *Fruiting :* August.

Occurrence in Bombay State : N. KANARA : *Law ;* Londa, *Spooner ;* Yellapur, *Kapadia* 2251-2258 ; Castle Rock, *Sedgwick :* Gud-dehalli, near Karwar, *Kapadia* 2126 ; Karwar, *Hallberg & Mc-Cann* 34263.

Distribution : India : Punjab, Kumaon, Khasia Hills, 1200 – 1900 m., Bengal, Konkan, N. Kanara, Nilgiris, Annamalais at 1000 m. *World :* India, Nepal, Burma, Japan.

The Great Indian Bustard [*Choriotis nigriceps* (Vigors)] at the Nest

BY

R. S. DHARMAKUMARSINHJI

(*With two plates*)

On 13 August 1961 I arrived in the typical Great Indian Bustard, *Choriotis nigriceps* (Vigors), habitat of south Saurashtra. The rains had been early this year with spells of hot sunshine; the country looked green and clear water flowed in the numerous streams. The habitat consists of low undulating hilly country studded with bushes and covered with various grasses and monsoon plants. With a foundation of trap and basalt and quartz, this strip of grassland extends for about three miles. It is intersected by cart tracks and is hemmed in by fields of groundnut. On the outskirts lie scattered villages, bordered by extensive cultivation, the fields being divided by grass hedges. A river flows close to a main metalled road leading to a town.

It was a bright sunny day with cumulus clouds—a break in the weather that was ideal for me. This grassland where bustard is known to remain throughout the year was protected from grazing as it was administered by the Gujarat State Forest Department and was reserved for the planting of forest trees.

With the help of the Forest staff a nest was soon discovered. At 13.00 hours, alighting from a jeep station wagon at the margin of the grassland where a cart road skirted cultivation, we proceeded on foot for half a mile. Fifty yards away a pile of outcropping stones, resembling the inverted keel of a boat, stood out prominently in a slight depression—I shall refer to this as the boat-pile. The terrain formed a raised grassland, from which emanated shallow gullies containing innumerable *Zizyphus* bushes, some *Balanites* saplings, and young *Acacia* amidst a sea of short grasses with patches of tall thin grasses mixed with many species of small plants with variously coloured flowers.

From the boat-pile, which pointed north and south, the ground sloped easily eastward through shallow gullies and eroded clefts to end in a bowl of grassland full of tall grass and a stand of stunted trees. To the west it rose for about 100 yards and then dropped in undulations to reach a road and a river about 600 yards away. On the south a belt of stony country stretched past knolls and gullies for about 400 yards and veering eastward merged in a chain of low hills, intersected by cartroads and bordered here and there by cultivation, through which narrow ravines trickled with water. To the north, close behind the boat-pile, was a conspicuous rise which sloped gently down to groundnut fields, and a separate tongue of bare stony hills reached across a ravine into grazing land. Near the base of the rise a small *khakra* bush (*Butea monosperma*) and an *Acacia arabica* sapling provided cover for the bustard. Scarring the entire grassland reserve were artificial scrapes for seeds of forest trees, many of which had germinated. On the south-west at a distance a village could be seen against a background of higher ranges of forested hills. This then is the nesting habitat of the Great Indian Bustard.

Falling into single file the Forest Guard and I proceeded silently till, following his signal with my eyes, I saw about twenty yards away the slow retraction of a bustard's snake-like head and neck as it watched our approach. Passing on without stopping, I could with difficulty make out the hen bustard sitting tight on the nest. Her brown upper parts blended well with two outcropping rocks and a near-by boulder, making detection very difficult. The nest was on the eastern side of the boat-pile, near its top, and could only be seen from this side. Circling twice around the nest in a spiral approach we got to within 25 feet, but I did not try to take a photograph for fear of flushing a bird sitting on its egg. Leaving an observer, 'A', I returned to camp.

At 17.30 hours I was back with observer 'B'. The hen bustard having left five minutes before our arrival, all three of us walked to the nest—a typical bustard-scrape, oval in shape and about a foot in length, pointing north-south, in short and long thin grass with *Zizyphus* bushes and a dry leafless plant close by. It contained one egg, greenish-brown, splashed with reddish brown lying lengthwise of the scrape. The slight depth of the scrape, the slope of the boat-pile, and the surrounding vegetation prevented the egg being seen from more than fifteen feet away. So some cutting of the grass would be necessary for the bird and the egg to be photographed together. The egg had been seen ten days prior to my arrival, so incubation must have been well advanced. A used cart track passed about 20 yards east of the boat-pile, and was used morning and evening by the cultivators working in their fields. Also, we were informed that earlier in the season, when the forest guards and labourers were planting seed, at least half a dozen bustards including the cock had been seen feeding and the cock had displayed close to them. So it appeared possible that the bustard would tolerate our 'gardening'. Selecting a site for the hide about 60 yards east of the boat-pile and across the cart track, I turned back to watch the bird, which in the meantime had returned to its nest unknown to us. At 17.45 hours the bustard left the nest and moved north over the rise after feeding steadily and calmly. Seizing the opportunity, we quietly erected the hide and camouflaged it with cut grass. Then we retreated south along the cart track to a small rise 200 yards away, which I chose as my observation post. From here we could see the movements of the bird as it left the nest and as it wandered to feed in the central depression of the sloping ground. It also controlled the cart track, so that one could from here request persons using the cart track to circle round and avoid disturbing the bird. Outside the depression it was not possible to watch the bird without posting a large number of observers, which would be undesirable with a suspicious bird like the bustard. A thick *ber* bush at the top of the observation post offered cover to an observer lying down or sitting crouched, and gave him an opportunity to retire undiscovered if necessary.

Making a scrape like that of a bustard close to the *ber* bush, I lay down and silently watched through the binoculars. At 18.04 hours the hen bustard walked briskly from the rise behind the boat-pile; it moved down the slope, turning its head left and right in true bustard fashion, the neck outstretched and held high, the bill pointing slightly upwards. I could see the unbroken dark pectoral band as the bird walked quite fast straight towards the nest. Half way down the slope, when almost in the shallow pocket in which the boat-pile lay, it stopped and faced sideways, standing with neck held high and slightly behind the vertical neck line. This pose is a sign of alarm and, without hearing the usual short *hook* call, I knew I had been seen. My head must have been cutting the sky-line and been fairly conspicuous. Embarrassed but patient, I waited to see the reaction. Remaining motionless for a minute or more, the bird crept at right angles to me, the head held low and just in line with the back, the neck in a wide loop or U, the whole body crouching, to the solitary *khakra* bush. Taking cover behind it, with only the head and a small portion of the neck visible, and the head facing sideways, the bird remained for well over 10 minutes, and then withdrew its head. A quarter of an hour later it suddenly appeared behind a long tuft of thin grass and gazed steadily for some time; then it skulked back to the *khakra* bush, and watched me suspiciously with only the head visible. For nearly 45 minutes it made no attempt to approach the nest. As the bird was watching me intently and with suspicion, I ducked and withdrew. 15 minutes later I crept back and, seeing no bird, thought it had moved to the nest. Suddenly I saw a movement, and training my glasses in that direction I saw the bustard, which again began to slink away, turning its head sideways and looking at me. This action appeared deliberate and it surprised me that the bird should act in this manner at such great distance, when one could hardly see it with the naked eye. Failing in its ruse to draw me out, the bird hid behind the *khakra* bush and again began to watch me. I made no movement but watched the antics of the bird with a thrill, suspecting at the same time that there might be two birds, one with young and the other on the nest. Soon after sunset, when there remained a bright glow, I turned back to camp.

On 14 August observers 'A' and 'B' watched from the observation post from before sunrise while I was engaged with other observations in the vicinity.

At 8.30 hours the hen bustard left the nest and walked slowly over the rise to the north, picking up food here and there. Flocks of house crows and cattle egrets were seen flying over the fields and grassland. At 10.15 hours the bustard approached the nest and, seeing 'A', crouched low and repeated its behaviour of the previous evening. 'A' kept out of view, and when he looked three-quarters of an hour later found that it had settled on the nest. At 14.35 hours the bird left the nest and walking westwards began feeding, mainly on grasshoppers. Half an hour later it walked back to the boat-pile and was seen to remain there. At first it was presumed to have settled on the nest, but watching revealed the bird on the ridge of the boat-pile. When I took over at 4 p.m. the bird was on the nest. I watched attentively until 17.10 hours when I saw it circling the boat-pile and realised that it had crept off the nest when I was not looking. Slinking behind bushes and grass tufts in zigzag manner it returned to the boat-pile, where it waited for a considerable time, apparently watching the hide. Then without ceremony it slowly walked

The Great Indian Bustard, *Choriotis nigriceps* (Vigors)

......walked into the nest without hesitation

......straddled the egg

(Photos : R. S. Dharmakumarsinhji)

The Great Indian Bustard, *Choriotis nigriceps* (Vigors)

Straddles the eggs sitting on its tarsi

......slowly raised its neck and head in stages

(Photos : R. S. Dharmakumarsinhji)

to the nest-site, and yet I did not see it settle, having I imagine crouched low when entering the nest. The next thing I saw was the head and neck appear like a snake above the nest-site. Observer 'A' continued the watch from this stage till after dark, and at 20 hours the hide was moved as silently as possible to a pre-selected site across the cart track to within 90 feet of the nest.

On 15 August again observers 'A' and 'B' took over while I went to investigate another portion of the grassland. As before, flights of house crows and cattle egrets flew over in the early morning, farmers went past to their fields with their bullocks, and labourers worked in the adjoining fields. One house crow, noticing observer 'A', circled over his head cawing. Then another house crow came and both searched for food. At 9.05 hours when the crows departed the bustard left the nest and walked to the feeding ground across 'north rise'. As soon as the bird had disappeared, 'A' placed 'B' on duty and, walking across, discovered that the egg was not visible from the hide and that the hide would have to be moved closer to the nest.

At 10.20 hours observer 'B' saw the bird walk briskly towards the boat-pile from 'north rise'. After crouching and steadily staring at the hide it began false feeding and preening itself, and then slunk slowly closer to the boat-pile. Realising that the bird had become very suspicious 'B' kept out of view. The weather was warm and clouds were blanketing the sky. At 11.35 hours some travellers passed by. In the meantime the bird settled on the nest. At 15.00 hours it left the nest and, after feeding some 150 yards away to the west and north, returned to the boat-pile at 16.20 hours in the usual slow approach and then moved secretly to the nest and settled down without betraying itself. Only when the neck was raised could the observer tell that it had settled. In the evening the bustard remained on the nest until almost sunset. At 19.05 hours, having seen the bird depart over 'north rise', 'A' and 'B' went forward and moved the hide to about 40 feet from the nest. Then they returned to the observation post, whence 'A' watched the bird enter the boat-pile and then as it grew dark he left his post.

On the following morning we arrived at the observation post at dawn. At 8.45 hours the bustard left the nest to feed. When it was out of sight I approached and discovered that I could not see the egg from inside the hide. The hide was therefore moved to a distance of 33½ feet from the nest. While I was arranging the camera and settling myself comfortably the bustard returned and passed from bush to bush watching us closely but I continued the necessary work.

In spite of intervening cover it kept about 80 yards from us. At 10.45 hours I was ready but the curiosity of a wandering house crow had been aroused; it had spied the egg and was cawing over our heads. We tried hard to scare it away but failed. Then an idea struck me. I entered the hide and told the men to wait a little and then leave me as if they were by themselves and to move away talking, watching at the same time to see whether the crow would follow. The crow, which had settled some distance away, followed the two men as I had hoped. At 11.25 hours I heard some chirping above the hide and discovered that a pair of Whitethroated Munias was perched on top of the hide, the grass on which had dried and made it a conspicuous patch of brown. The munias apparently were searching for a nesting site. They troubled me for some time, entering the opening where my telephoto-lens was placed, peeping into the lens, and twice alighting inside the lens hood.

At 11.35 hours I saw the bustard about 60 yards away looking fixedly at the hide. Then it moved slowly to the side, stopping and walking slowly with head and neck erect. Looking at the observation post, where 'A' and 'B' were on duty, I was disgusted to see the outline of a human head on the sky-line, so conspicuous that no bustard could miss noticing it. As time passed and the bustard did not come to the nest the sight of the man's head became an eyesore. It was 12.15 hours when I heard a caw and saw a house crow alight six feet from the nest. I felt like leaping out of the hide and was about to shout when, to my surprise and relief, the hen bustard rushed out from the side and attacked. With feathers puffed out, the mantle, crown, and neck feathers raised, wings spread sideways in shield-like manner, and the tail fully cocked, it lunged forward with bill and neck outstretched and drove away the crow. Then it turned to the nest and stood defiantly over the egg, with evident anger in its eyes, seemingly too irritated to settle down on the egg. The crow, realising that its game was up, flew away, while the bustard quietly retreated eyeing the hide with suspicion. The sky had become overcast with the light fluctuating between cloudy-bright to dull. At 12.45 hours the bustard walked into view from the right hand side, approached hesitatingly, stopped, and scanning the countryside with head and neck held erect stood for a couple of minutes a few yards from the nest. I turned my head for a moment to peer at the observation post; no head protruded. The bird came closer and walked into the nest without hesitation. Promptly, I took photographs. The bird walked up to the egg, turned round to face right, then straddled the egg, paused for a moment, and settled down. Four rapid photographs were taken in succession on 35 mm. Kodak Tri-X film at 1/250 of a second with a tele-lens of 300 mm. focal length. It is not difficult to photograph a bustard incubating, but I had at last achieved my ambition of taking it in the act of entering its nest with the egg visible in the picture, a feat which I believe no one else has yet achieved.

After settling down the bird kept its head and neck pressed down on its mantle and maintained a frozen attitude. Slowly, the head moved slightly from side to side; I even saw the eyeballs move with a look in the eyes of a frightened rather than an angry bird. Rain-laden clouds began to gather and to darken the sky. The wind was blowing towards me in gusts. At 13.30 hours the bird slowly raised its neck and head in stages until it was almost fully stretched up like a cobra with hood open and erect body. When the bird faced me with bill pointing slightly upwards, it was reminiscent of an Ostrich and also reminded me of the pose of a Little Bittern when attempting to conceal itself in front of danger. I took two more photographs, and that was all, as by some fate the camera shutter jammed. Nevertheless, I continued my observations. But for the constant turning of the head and slight neck movement by which it kept a ceaseless watch over its surroundings, the bird did not move. At 14.45 hours, sunlight shot through the clouds after a brief shower of rain and a piercing beam of light lit the landscape. The wind dropped, and it became quite hot. The bird opened its bill slightly and then rapidly moved its throat breathing. Presently, the clouds covered the sky and it became suddenly cool. The bird closed its bill. At 15.04 hours, the bird raised itself, turned the egg with the ventral part of the lower mandible, and with a slight backward movement and then a deliberate forward action combined in one, settled down on the egg in straddled squatting pose. Quite unlike a Sarus Crane which first stands over the nest and egg and then squats down to it vertically, the bustard straddles the egg sitting on its tarsi before settling on the egg. I have also noticed this with the hen Lesser Florican. I noticed that, when the bustard settles on its egg, the egg lies slightly rear of the breast, or it seems so on account of the long overlapping neck plumes.

A spell of sunlight fell through the clouds at 15.17 hours and I noticed that the mantle of the bird was raised, the bill slightly open, and the gular region moving rapidly. I saw another movement. The bird turned its neck and head round facing the tail and pecked at the feathers of the scapula, picking some louse-like animal and swallowing it. After this, it commenced to preen the mantle, inner shafts of secondaries and primaries, and then the lesser wing-coverts and the bastard-wing all while sitting. The bird appeared quite at ease raising the neck, looking round, and listening.

At 18.16 hours, the bustard left the nest for feeding. It walked slowly and, when it flushed a locust or grasshopper, it would follow it, look down, and with a sudden lowering of the head catch it and swallow it. It would sometimes run to catch an insect which had flown up. Yet the bird was not as active as I have seen other non-nesting bustards when feeding. I also noticed that food was scarce. The bird fed in a circular manner on the west side of the boat-pile only to disappear over 'north rise'.

'A' and 'B' continued the watch from the observation post. The bird, returning from 'north rise' at 19.00 hours, settled on the nest by 19.20 hours. Soon after, farmers were seen returning homewards. At 22.00 hours, rain fell intermittently with heavy downpours during the night.

17 August was a cloudy morning with a slight drizzle which ceased at 6.45 hours. The absence of predatory animals such as Jackals, Wolves, and Foxes in the vicinity of the nest was surprising. So far we had seen none, although signs of their droppings were noticed in gullies and in the forest stand. Chinkaras were regularly seen in the nest area and a single female Blackbuck. It was observed that the bustard did not leave the nest while the feeding flights of crows were in swing or when the sound of a crow cawing in the distance was heard. At 8.16 hours, the bird left the nest and gradually walked away to the north. Ten minutes later a crow cawed in the distance. Immediately the hen bird came back over the 'north rise' and walked towards the boat-pile. The crow soon appeared, flying straight towards the nest. The bustard moved into the boat-pile—I again realised how amazingly quickly a bustard can walk when it wants to. Breaking speed, the crow circled over the boat-pile. The bustard puffed its feathers and in the characteristic aggressive manner stabbed at the flying crow. The crow settled close by and after a time flew towards us. It circled over our heads and then departed. At 9.10 a strong breeze commenced and low rain clouds began to pass by. At 9.42 hours, when the weather had changed to cloudy-bright, we approached the nest talking, following the cart road. I was hoping the bird was not on the nest, but we found it present. With head pressed in and down it huddled low.

When we reached the hide there was a shuffling movement, the two wing shoulders pressed tight by the side moved alternately once and then twice, and suddenly the bird flew off the nest with the legs dangling for a time; and then in a slight zigzag flight it shot away low—a distraction display which I recognized as an attempt to draw us away from the nest. The bird alighted 150 yards or more behind some bushes. I entered the hide at 10.12 hours, and sent the men away to the east. Soon after the bustard approached, moving fairly quickly, and stopped in the boat-pile where I could not see it. Suddenly, the head appeared over a bush. Then it went down and reappeared, reminiscent of a crocodile's head surfacing in water. The head went down again and came up behind a tuft of grass. For a minute the bird, almost invisible except for a slight movement of the head, stared at the hide. Then it walked slowly and erect on top of the boat-pile and down to the right side to enter the nest gracefully. Inside the hide, I tapped the wooden side and whistled. This made no difference. Before entering the hide I had turned the egg cross-wise of the oval scrape-nest. On straddling the egg the bird immediately turned the egg with its bill so that it again lay lengthwise of the oval, and then settled down. This was at 11.05 hours. At 12.35 hours light rain commenced, and later came a downpour with gusty winds. At 13.45 hours, when the rain had stopped, the bird rose from its nest, walked away a few feet, and raising its neck and crown feathers and also the mantle and scapulars gave itself a good shaking. It then stood for a while with slightly open wings and walked slowly away. It had no appetite, for when a small grasshopper got up in front of it, it made no attempt to pursue but walked listlessly, now and then trying half-heartedly to catch an insect. 18 minutes later it returned, passing within 10 feet of the hide and giving me a very close view. Entering the nest at 14.12 hours it incubated steadily till 15.23 without a movement except of the head. Soon after I vacated the hide, leaving my observers on duty.

After a shower of rain in the evening the bird was again seen to leave the nest, shake itself, and preen its feathers, and after feeding leisurely close by it returned to the nest at 19.06 hours. An after-sunset glow brightened the sky. A pair of Great Horned Owls was seen perched on boulders. Hares came out on the cart road, and Sykes's Crested Larks, Lesser Floricans, and Painted Francolins called incessantly until darkness fell.

On 18 August at dawn the watch was resumed. I took over at

8.15 hours. At 8.34 hours the bustard left the nest, and I walked over and again changed the position of the egg. I re-entered the hide at 9.00 hours. At 9.15 hours, a crow approached from the west. Immediately I heard the alarm *hook* of the bustard, and the bustard came flying low over the rise towards the boat-pile and the crow disappeared. The bustard walked up to the boat-pile and stood on the ridge. Rain-clouds darkened the sky. At 10.24 I heard the hoot of a Great Horned Owl and this call was repeated till 10.50 at intervals of 5, 8, 6, and 7 minutes. Rain Quail were calling too. At 10.54 hours the hen bird walked into the nest and, immediately turning the egg lengthwise of the scrape, sat in a semi-squatting pose. Bending its neck, it placed its ear close to the egg as if listening to the chick inside. Turning its face the other side it again 'listened' and after moving the egg slightly backwards settled down.

At 11.22 hours, I heard close by the double booming sound of a cock bustard. The hen bustard reacted by raising its head and listening. Again the double boom was heard. The hen bird stretched her neck high and turning the head looked round in almost a circle. She kept on listening and turning her head, and at 11.40 hours walked off in the direction from where the cock had boomed. At 12.11 I was relieved from the hide. However, I had seen the cock bustard displaying, and the hen approaching within 50 yards of the cock though they did not meet.

At 13.30 hours the bird returned to the nest cautiously. Some vultures were flying high and I saw the bustard turn its head slantingly upwards. Quite suddenly it withdrew its head, pressing it down, and froze, the eyes looking slightly upwards. A White-eyed Buzzard-Eagle was soaring, but lower down a Short-toed Eagle was gliding. As soon as the latter passed the nest area up went the head and neck of the bustard. At 14.23 hours the bird without giving any warning crept off the nest and hid behind the boat-pile and returned after a short interval. I failed to discover what had disturbed it. After some time the bird placed a small dry stick the size of a match on its scapulars and picking up what seemed like a dead bee placed it next to the stick. I also noticed it pecking at a twig of a dry Saddler's Plant and at some dry grass at the side of the nest restlessly. Was it bored, I wondered, and trying to amuse itself? Dark clouds gathered and threatened heavy rain. A cool strong wind commenced to blow and it became dark and gloomy. As my men approached to relieve me the bird crouched with head pressed down; then the ruffling of the shoulders as seen previously; as they reached the hide the bird flew off and I noticed the downward curvature of the wings as seen from the rear. It started to rain and we quickly left and watched from a distance. The time was 16.15 hours.

At 18.38 hours, the sky cleared and the rain stopped. Looking through the binoculars after sunset, I saw the bird brooding.

The final day was the 19th August. In the early morning we were at the observation post. Observer 'A', watching in the early hours, had not seen a sign of the bustard or any other animal life. After 10.15 hours we walked to the nest and found it empty except for small bits of egg shell. About 30 feet downwind I found half an egg shell, clean and bloodless. The edges of the shell had minute serrations as if a chick had pecked at it. A search was made in the area but no sign of the bustard was found. Observer 'B' was placed on watch in the grassland. He saw a hen bustard flying and settling on the west side of the grassland. At 18.05 hours a hen bustard flew high overhead but did not settle in the nesting ground. A hen bustard with a newly hatched chick is known to leave the young and fly to water for drinking and return later. Such behaviour was not observed.

Synopsis

This is a study of the Great Indian Bustard, *Choriotis nigriceps* (Vigors), at the nest from 13 to 19 August 1961 when, it is presumed, the single egg hatched out. With this species the hen bird, which alone incubates, sits close as incubation advances and permits close approach by the observer, but is very wary off the nest. The conclusions drawn from the study are that the bird leaves the nest when all is quiet and feeds regularly in the morning, afternoon, and evening. As the time for hatching approaches, it feeds closer to the nest and maintains a careful watch. Though feeding is routine, the sitting bird has a small appetite and eats little. Walking activity seems vital, presumably to stretch and exercise its legs, and also for feeding. It was observed to dangle its legs and fly in a zigzag manner when danger threatened its nest, a distraction display that I have observed before. This particular nesting bird was not seen to fly to water or to its feeding ground or to make a sound or alarm call other than when its egg was threatened by a House Crow. The House Crow appears to be a constant menace and its call caused great agitation to the nesting bird. Ground predators were not a serious threat, though I have known

Wolves to be a menace to the species. An occasional eagle flying overhead caused the bird to 'freeze' on the nest. During the period of observation insect food seemed scarce, though in certain patches of grass away from the nesting place hoppers and locusts were found in moderate number, while snakes, scorpions, and lizards were scanty. Some large and small mammals were seen. A few photographs were taken of the bird while entering the nest and settling on the egg, the first ever taken of this species showing the egg and parent bird together. Photographs were also obtained during incubation.

Acknowledgements

In conclusion I wish to thank the Conservator of Forests, Junagadh, for the co-operation rendered to me by his subordinate staff in my studies. I also wish to thank Shri Ramjibhai Kamani for his kind hospitality at Ram-Bagh.

Vegetation of Kodaikanal in South India

II. A Supplementary list of Trees, Shrubs, and Herbs

BY

RAJ KUMAR GUPTA

French Institute, Pondicherry

(*Continued from Vol.* **57** (1) : 65)

INTRODUCTION

The present paper is the result of a tour undertaken by the author during the month of June 1960 and embodies observations made by him on the vegetation of the area in and near Kodaikanal.

LIST OF THE PLANTS COLLECTED

I. Angiosperms

Magnoliaceae

Michelia nilagirica Zenk. (Fyson 1 : 14)

Trees with elliptic flat and drooping leaves. Flowers white. Common in the sholas above 1500 m.; in Tiger and Bear sholas.

Violaceae

Viola serpens Wall. (Fyson 1 : 27)

Perennial with ovate leaves, deeply cordate; petiole not winged. Common in sholas above 2000 m.; in Tiger shola.

Pittosporaceae

Pittosporum tetraspermum W. & A. (Fyson 1 : 31)

A small tree with grey bark, twigs with yellow pustules in bunches of 3 or 4 together. Leaves whorled at the end of twigs. At the edges of the sholas; in Tiger shola below Kodaikanal.

Pittosporum floribundum W. & A. (Fyson 1 : 31)

A small tree; twigs with yellow pustules. Flowers in contracted racemes. Below Shembaganur in Tiger shola 2000 m.

Polygalaceae

Polygala arillata Hamilton (Fyson 1 : 33)

A large shrub. Flowers in drooping racemes, yellow. Above 1200 m. in Bear shola, Tiger shola and Bombay shola, quite common.

Polygala rosmarinifolia W. & A. (Fyson 1 : 34)

Branched annual, stem pubescent. Flowers greenish. On the western slopes of Perumalmalai in the grassy areas.

Ternstroemiaceae

Gordonia obtusa Wall. (Fyson 1 : 55)

An evergreen tree of moderate size. Leaves acute at both ends. From a distance the tree is often confused with *Acacia melanoxylon*. Common near water in Tiger and Bear sholas.

***Schima wallichii** Choisy

Large evergreen tree. Flowers resembling very much those of *Gordonia obtusa*. Not mentioned by Fyson. Planted along the lakesides.

Malvaceae

Urena lobata Linn. (Fyson 1 : 59)

Stellately hairy undershrub. Leaves deeply lobed. Flowers in leaf axils. On the way to Perumalmalai on grassy slopes.

Sterculiaceae

***Eriolaena hookeriana** W. & A.

A small tree, common in the Tiger shola below Kodaikanal at 1800 m. Not mentioned by Fyson.

Tiliaceae

Triumfetta pilosa Roth. (Fyson 1: 62)

Perennial undershrub, uniformly hirsute. Flowers yellow. On way to Perumalmalai on roadsides in the grassy slopes.

Elaeocarpaceae

* **Elaeocarpus serratus** Linn.

A small tree with greyish wood. Not recorded by Fyson. Gamble records it in Western Ghats up to 1800 m. The tree can be collected from Tiger shola at 1800 m.

Geraniaceae

Biophytum intermedium Wight. (Fyson 1 : 76)

Small annual with branching stem. Leaves pinnate at the end of branches. Flowers yellow. Common on the roadsides in shady places in and near Kodaikanal.

Impatiens viscida Beddome. (Fyson 1 : 93)

Small herb, stem decumbent. Flowers purple-pink. On wet rocks near Kodaikanal; quite common.

Rutaceae

Evodia lunu-ankenda Merr. (Fyson 1 : 98 under *E. roxburghiana* Benth.)

Small tree. Leaves 3-foliate. Flowers in cymes. Reported from Western Ghats by Gamble; from plains it could be collected up to 1800 m. only.

Acronychia laurifolia Blume. (Fyson 1 : 103)

Small evergreen tree with 1-foliate leaves. Flowers in axillary or terminal cymes. Common in the sholas near Ghat road below Kodaikanal.

Burseraceae

***Garuga gamblei** King.

A large tree. Leaves imparipinnate. Inflorescence long. Fruit small. Large trees can be seen along the roadsides and in the low level sholas mixed with *Toona ciliata*. The tree can be easily confused with *Toona ciliata* but distinguished by its fruits, leaves and the blaze of the bark. Fruits resemble that of *Lannea coromandelica*.

Meliaceae

Cipadessa baccifera Miq. (Fyson 1 : 103)

Shrub with imparipinnate leaves. Flowers small in axillary peduncled panicles. Gamble reports up to 1800 m. from Western Ghats. It can be collected from Tiger shola below Shembaganur.

* **Heynea trijuga** Roxb.

Small tree with pinnate leaves; long petiolulate. Flowers small in corymbose panicles, pale creamy in colour, with bright orange-yellow stamens, massed in centre. Not mentioned by Fyson; common in Tiger shola below Kodaikanal.

Nothapodytes foetida (Wight) Sleumer. Syn. *Mappia foetida* Miers. (Fyson 1 : 106)

Tree with alternate simple leaves. Flowers foetid in terminal corymbose cymes. Gamble records the plant from the Nilgiris. Fyson mentions it from the downs of the Palnis. Can be collected from Tiger shola.

Aquifoliaceae

Ilex denticulata Wall. (Fyson 1 : 108)

Large tree with spreading branches. Leaves denticulate. Fyson records it as quite common on Nilgiri downs but not in Palnis. The plant can be collected from Tiger shola below Kodaikanal.

Celastraceae

Celastrus paniculata Willd. (Fyson 1 : 114)

Large woody, unarmed climber with nearly circular leaves. Common in the sholas near Kodaikanal; Tiger shola, Bear shola, etc.

*** Elaeodendron glaucum** Pers.

A tree with simple glaucous leaves. Not mentioned by Fyson. Gamble records it in the deciduous forests of western coast. Can be collected from Tiger shola below Kodaikanal.

Rhamnaceae

Rhamnus wightii W. & A. (Fyson 1 : 120)

A large shrub, sometimes a tree. Flowers in fascicles in the axils of leaf. In Tiger shola near Silver Cascade.

Vitaceae

Tetrastigma muricatum Gamble. (Fyson 1 : 123)

Climber with simple or forked tendrils. Leaves mostly 5-foliate. Abundant in the Bombay shola and Bear shola. Fyson mentions it below 2000 m. Recently reported by Pallithanam.

Staphyleaceae

Turpinia cochinchinensis (Lour.) Merr. Syn. *T. nepalensis* W. & A. (Fyson 1 : 126)

Tree with drooping foliage. Flowers pale yellow in axillary panicles. Common in sholas everywhere, in and near Kodaikanal.

Sapindaceae

Allophylus serratus Radlk. (Fyson 1 : 128)

Tree with leaves having 3 leaflets. Flowers small in unbranched spikes with cyme-like fascicles, small globular. Fyson does not mention it from Kodaikanal. It can be collected below Kodaikanal from Tiger shola.

Leguminosae

Crotalaria leschenaultii DC. (Fyson 1 : 147)

Small shrub with long, narrow and wedge-shaped leaves. Flowers yellow in spikes. On open downs and paths near Kodaikanal and on Perumalmalai slopes.

Crotalaria notonii W. & A. (Fyson 1 : 152)

Thickly pubescent shrub. Flowers yellow in axillary racemes. Fyson does not mention it from Kodaikanal. It can be collected near Kodaikanal and from the Perumalmalai slopes in grassy areas.

Indigofera pedicellata W. & A. (Fyson 1 : 155)

Perennial with slender, wiry and trailing branches. Flowers red, crowded 6-12 in small corymbs. Common on the slopes of Perumalmalai in grassy areas, gravel paths and exposed slopes.

Indigofera pulchella Roxb. (Fyson 1 : 156)

Shrub with slender branches, leaflets 11-15. Flowers pinkish, mostly before the leaves. Common in open downs above Kodaikanal.

Desmodium rufescens DC. (Fyson 1 : 161)

Shrub with slender branches. Leafstalk, veins of the underside of leaves and stipules covered with dense reddish brown hairs. Flowers purple to deep blue. Common in thickets near Kodaikanal.

Moghania grahamiana (W. & A.) O. Kze. Syn. *Flemingia grahamiana* W. & A. (Fyson 1 : 173)

Spreading shrub, branches and leaflets clothed with hairs and dark glands. Flowers yellow. On western slopes of Perumalmalai and on rocks near Kodaikanal.

Cassia mimosoides Linn. (Fyson 1 : 183)

A low diffused perennial. Leaves with hairy leafstalks; leaflets 30-50 with one gland below the lowest pair of leaflets. Flowers yellow. On grassy slopes of Perumalmalai.

* **Acacia mollisima** Willd.

Native of Tasmania, Victoria, Queensland and South Australia. Planted near the lake. Not mentioned by Fyson.

***Acacia elata** A. Cunn.

Native of New South Wales in shady ravines. Planted near the lake for ornamentation. Not mentioned by Fyson.

Rosaceae

* **Prunus cerasioides** D. Don. Syn. *P. padus* Roxb. ex Wall.

Unarmed glabrous tree. Leaves minutely toothed, long pointed. Flowers white in drooping racemes. Planted along the roadsides near the lake. Not mentioned by Fyson.

Photonia notoniana W. & A. (Fyson 1 : 201)

Large tree with spreading branches. Flowers white tinged with pink. On the outskirts of the sholas and upto 1500 m. mixed with the evergreen species. Quite common.

Pyrus communis Linn. (Fyson 1 : 204)

Tree with broadly ovate, crenate leaves. Flowers white in short racemes. Planted for the fruits in the gardens.

* **Pygeum wightianum** Bl.

A large handsome tree. Bark mottled and streaked. Leaves and fruits smell of Prussic acid. Flowers white. Not mentioned by Fyson; can be collected from Tiger shola.

Crassulaceae

Kalanchoe grandiflora W. & A. (Fyson 1 : 208)

Thick stemmed shrub with thick succulent leaves. Flowers bright yellow. On poor soil and rocky ground near Kodaikanal.

Droseraceae

Drosera peltata Smith. var. **lunata** Ham. Syn. *D. lunata* Ham. (Fyson 1 : 211)

Small herb with crescent-shaped leaves, fringed with long stalked glands. Flowers white. On open downs in grassy areas.

Hammameliadaceae

* **Symingtonia populnea** (R. Br.) van Steenis. Syn. *Bucklandia populnea* R. Br.
A large tree with long petioled leaves, densely silky when young. Native of temperate Himalayas, planted on the lakesides. Not mentioned by Fyson, recently reported by Pallithanam.

Myrtaceae

Syzygium arnottianum Walp. (Fyson 1 : 219)
Large spreading tree. Leaves lumpy, drooping. Flower buds red in bunches. On the downs by the wayside or in sholas over-topping most other trees ; in Tiger shola and slopes of Perumalmalai.

Syzygium montanum Gamble. (Fyson 1 : 220)
Large tree with wings on the four edges of youngest branches. Leaves large, veins not closely set. Fyson does not mention it from Kodaikanal, but refers as common near Ootacamund. Recently Pallithanam collected it from Bombay shola ; I could also collect the trees from sholas above golf course and Bombay shola.

Syzygium calophyllifolium Walp. (Fyson 1 : 221)
Large tree, branches with brown bark arising 3-4 together. Leaves almost round set closely. Fyson mentions the plant from Nilgiris. Gamble also records it from Nilgiris above 2000 m. The tree can be collected from Tiger shola and the slopes of Perumalmalai.

Lythraceae

Rotala rotundifolia Koehne. (Fyson 1 : 234)
Creeping herb forming large patches; conspicuous by its terminal spike of rose coloured flowers. Common on the margin of the lake and in damp places.

Passifloraceae

Passiflora calcarata Mast. (Fyson 1 : 240)
Climber, leaves 3-lobed with large stipules. Flowers with purple corona having blue tips. Native of Madagascar, a garden escape near Kodaikanal lake sides. Fyson records it for Nilgiris only.

Begoniaceae

Begonia malabarica Lamk. (Fyson 1 : 245)
Large succulent shrub. Leaves unequal-sided, cordate. Flowers rose coloured. Common in sholas in moist places.

Umbelliferae

Heracleum ringens Wall. (Fyson 1 : 255)
Tall erect perennial. Leaves with slightly lobed leaflets. Flowers creamy yellow. On open downs and grasslands of Perumalmalai.

Sanicula europaea Linn. (Fyson 1 : 249)
Erect perennial. Radical leaves 3-foliate on long stalk. Flowers white in groups of about 3. In shady places near Kodaikanal and downs to 1700 m.

Caprifoliaceae

Viburnum acuminatum DC. (Fyson 1 : 263)

Small tree with elliptic acuminate leaves, margins recurved. Underside of the leaves covered with small rusty scales. Fyson mentions it from lower levels of Palnis but not from Kodaikanal. Collected from the sides of the lake ; planted.

Viburnum punctatum Ham.

Small evergreen tree with white flowers. In the lower sholas at 1800 m. Included by Fyson with *Viburnum acuminatum*.

Lonicera leschenaultii Wall. (Fyson 1 : 266)

Climbing shrub with reddish brown papery bark. Leaves broadly ovate dull green above, white below. Flowers creamy white. Straggling over small trees below Kodaikanal.

Rubiaceae

Wendlandia notoniana Wall. (Fyson 1 : 270)

A small tree, leaves 3 at a node. Flowers white or pink in panicles. On the lower downs below Shembaganur in Tiger shola.

Ophiorhiza brunonis W. & A. (Fyson 1 : 278)

Small herb, leaves ovate elliptic. Flowers white-pink arranged in terminal cymes. In sholas below Kodaikanal.

Knoxia mollis W. & A. (Fyson 1 : 281)

Herb with ovate many-veined leaves, densely pubescent on the undersurface. Flowers blue in terminal corymbs. Common on the grasslands of Perumalmalai slopes.

Ixora notoniana Wall. (Fyson 1 : 284)

Small tree. Flowers in hemispherical clusters, massed in broadly rounded panicles; pink. In sholas below Kodaikanal, Tiger shola and shola on Old Ghat Road.

***Canthium rheedii** DC. Syn. *Plectronia rheedii* Bedd.

Scandent thorny shrub. Flowers greenish-white. Below Kodaikanal in Tiger shola.

Canthium dicoccum (Gaertn.) Merr. Syn. *Plectronia didyma* Kurz. (Fyson 1 : 283)

Fair-sized tree with coriaceous leaves. Flowers in dense shortly peduncled cymose umbels. Below Kodaikanal, Old Ghat Road sholas.

***Canthium ficiforme** Hook. F. Syn. *Plectronia ficiformis* Gamble.

An evergreen tree with elliptic leaves. Flowers in compound umbels. Not mentioned by Fyson ; collected from sholas below Kodaikanal.

***Psychotria subintegra** Hook. f.

A large shrub. Flowers in cyme. Below Kodaikanal from Tiger shola, not mentioned by Fyson.

Psychotria bisulcata W. & A. (Fyson 1 : 288)

A dark-leafed shrub. Flowers starry, corolla white, tipped with green. Below Kodaikanal. Gamble mentions it from Nilgiris; also not mentioned by Fyson.

Lasianthus coffeoides Fyson. (Fyson 1 : 291)

A shrub with upright undivided stem. Leaves much in the habit of cultivated coffee. Flowers white. In Bombay and Bear sholas; quite common.

Lasianthus venulosus Wight. (Fyson 1 : 290)

Well-branched shrub. Flowers yellowish-white in sessile cyme. Common under the shade of trees above Kodaikanal in the sholas above golf course.

Valerianaceae

Valeriana hookeriana W. & A. (Fyson 1 : 296)

A pubescent herb, bearded at the nodes. Leaves pinnate, leaflets 7 or more. Flowers white. Common on the downs under the shade of shola trees in and near Kodaikanal.

Compositae

Vernonia pulneyensis Gamble. (Fyson 1 : 310)

Much-branched shrub with cottony hairs. Pappus dirty white. Fyson mentions from Shembhaganur hillside; it can be collected above Kodaikanal and near the Lake also.

Anaphalis oblonga DC. var. **elliptica** Hk. f. Syn. *A. elliptica* DC. (Fyson 1 : 330)

A soft woolly herb. Stems, many ascending from the root. Leaves 3-5 nerved. Involucral bracts white. On the west slopes of Perumalmalai. Only dried specimens were collected.

Anaphalis lawii Gamble. (Fyson 1 : 330)

A cottony herb with leaves in compact terminal masses. Involucral bracts white-pink. Common everywhere on poor soil.

Anaphalis wightiana DC. (Fyson 1 : 332)

Herb with stem woody below. Leaves white underneath. Flower heads large with several rows of cottony bracts. In damp and cool places, on the slopes of Perumalmalai.

***Helichrysum bracteatum** Anders.

Branched minutely scabrous herb. Flowers yellow. Native of Australia. A garden escape on roadsides.

***Helichrysum luteo-album** Reichb.

Herb with yellow-white flowers. Native of Australia. Garden escape on the roadsides.

Dichrocephala chrysanthemifolia DC. (Fyson 1 : 317)

Herb with chrysanthemum-like leaves. Flowers purplish in spherical heads. On open downs and slopes of Perumalmalai.

Picris hieracioides Linn. (Fyson 1 : 352)

Stiffly hairy annual, stem juicy. Flowers yellow in numerous heads; involucral bracts black, hairy. On open downs and slopes of Perumalmalai in grassy areas.

Primulaceae

Lysimachia deltoides Wight. (Fyson 1 : 370)

A trailing herb. Leaves opposite. Flowers yellow. In cool and shady places and on damp hillsides in and near Kodaikanal.

Myrsinaceae

Rapanea wightiana Wall. (Fyson 1 : 374)

A tree with ascending branches. Leaves streaked with glands at the end of branchlets. In and near Kodaikanal.

Sapotaceae

Xantolis tomentosa (Roxb.) Rafin. Syn. *Sideroxylon tomentosum* Roxb. (Fyson 1 : 377)

Small tree with long axillary spines. Closed flowers pointing downwards like cones with protruding curved style. Common in the sholas above Kodaikanal ; above golf course, Bear shola and Bombay shola.

Oleaceae

Jasminum humile Linn. var. **bignoniaceum**. Syn. *J. bignoniaceum* Wall. ex Don. (Fyson 1 : 387)

Erect shrub with angular branches. Flowers yellow at the end of twigs. In the sholas all over the downs near Kodaikanal.

Ligustrum perottetti DC. (Fyson 1 : 390)

Small shrub in dense tufts. Flowers profusely in panicles with white fragrant flowers. On roadsides and margin of sholas upto 1000 m.

Apocynaceae

***Alstonia veneanta** R. Br.

Shrub with long closely nerved leaves. Flowers white. Below Kodaikanal in Tiger shola at 2000 m., not mentioned by Fyson.

Rauvolfia densiflora Benth. (Fyson 1 : 393)

Shrub with leaves in whorls of 3 or 4, Flowers white in bifurcating cymose cymes. Common in sholas below Kodaikanal and in sholas near golf course. Not mentioned by Fyson from Kodaikanal.

Asclepediaceae

Tylophora tenuis Bl. (Fyson 1 : 398)

Glabrous twiner. Leaves lanceolate with rounded base. Flowers dark purple in racemes. On grassy slopes near Kodaikanal.

Gentianaceae

Gentiana pedicellata Wall. var. **wightii** Kurz. (Fyson 1 : 409)

Small herb. Flowers with bright blue corolla. Common on grassy slopes. Fyson does not mention it from Kodaikanal; recently reported by Pallithanam

Solanaceae

Solanum giganteum Jacq. (Fyson 1 : 422)

Large shrub. Branches and undersurface of leaf white. Flower lilac in dense corymbs. Not mentioned by Fyson from Kodaikanal. Near the sholas.

Scrophulariaceae

***Linaria (supina ?)**

Small herb with white flowers. Not mentioned by Gamble, Fyson and Hooker (FBI). Quite common on the grassy slopes of Perumalmalai.

Striga lutea Lour. (Fyson 1 : 431)

An erect branching parasitic herb. Flowers in slender spike. Common on open downs and dry grassy slopes of Perumalmalai.

Gesneraceae

Didymocarpus tomentosa Wt. (Fyson 1 : 440)

Herb with broadly elliptic leaves, wrinkled with shallow crenations. Flowers mauve pink. Below Kodaikanal.

Verbenaceae

Verbena venosa Gill & Hooker. (Fyson 1 : 460)

Pubescent herb with serrated leaves, stem clasping. Flowers pink in spike. Native of Brazil, escape at Kodaikanal.

Labiatae

Coleus forskohlii (Poir) Briq. Syn. *Coleus barbatus* Benth. (Fyson 1 : 468)

Softly hairy perennial. Flowers pale blue. Not mentioned by Fyson from Kodaikanal.

Prunella vulgaris Linn. Syn. *Brunella vulgaris* Linn. (Fyson 1 : 477)

Small perennial with hairy leaves. Flowers purple having a broad bract often with purple margins. Common in grassy area on open downs in and near Kodaikanal.

Leucas vestita Benth. (Fyson 1 : 482)

Perennial with leaves acute at both ends. Flowers with brown upper lip of the corolla. On open hillsides above Silver Cascade and slopes of Perumalmalai.

Calamintha umbrosa Benth. (Fyson 1 : 475)

Herb with a weak pubescent stem. Leaves ovate. Flowers purple in the whorls arising in axil of leaves and at the end of short branches. Common in the woods and on the downs above Kodaikanal.

Lauraceae

Cinnamomum macrocarpum Hook. f. (Fyson 1: 504)

A large tree with long leaves, strongly 3-nerved. Flowers in short panicles.

Not mentioned by Fyson from Kodaikanal. Can be collected from sholas near the golf course.

Machilus macrantha Nees. (Fyson 1 : 504)

Large tree with brown branches when dry. Leaves elliptic, acute at both ends. Panicles terminal in open corymbs. A tree in sholas upto 2330 m.

Litsaea deccanensis Gamble. (Fyson 1 : 506)

Tree with alternate leaves, underside yellowish, glossy above. Clusters solitary. Sholas below Kodaikanal, Tiger shola.

Litsaea ligustrina Nees. (Fyson 1 : 506)

A small tree, leaves elliptic with fine reticulations. Umbels solitary axillary or lateral. Sholas above Kodaikanal; Bombay shola.

Phoebe lanceolata Nees. (Fyson 1 : 509)

Trees with alternate penni-nerved leaves. Inflorescence and leaf beneath minutely grey puberous. Branchlets nearly black. Fyson mentions on the authority of Gamble at an elevation of 1600 m. The plant can be collected from Tiger shola near Silver Cascade.

Neolitsaea zeylanica Merrill . (Fyson 1 : 508)

A small glabrous tree. Leaves elliptic lanceolate, acute at both ends. Flower clusters in dense masses at the leaf axils. Fyson does not mention it from Kodaikanal; recently reported by Pallithanam. The tree has been collected from Bombay shola.

Loranthaceae

Taxillus tomentosus (Roth.) van Tieghem. Syn. *Loranthus tomentosus* Heyne. (Fyson 1 : 514)

A parasitic shrub with brown tomentose branches. Flowers brown in bunches at the axils of the leaves; bract conspicuous. Not mentioned by Fyson from Kodaikanal. Collected from sholas on the Old Ghat Road.

Erytranthe loniceroides Engler. (Fyson 1 : 518)

Parasitic shrub with large flowers having red deflexed petals. Common on the trees of *Acacia melanoxylon* that are invariably infected with this parasite. Fyson mentions it from the lower levels of Palnis but it can be collected from the trees planted along the sides of the lake.

Buxaceae

Sarcococca trinervia Wt. (Fyson 1 : 524)

Glabrous shrub with smooth green branchlets. Leaves dark green, 3-nerved glossy. Sholas below Kodaikanal; Tiger shola.

Euphorbiaceae

Glochidion velutinum Wight. (Fyson 1 : 531)

Small tree with crooked stem and branches. Young parts pubescent and light coloured. In shola forests below Kodaikanal; Tiger shola and sholas on the Old Ghat Road.

Glochidion neilgherense Wight. (Fyson 1 : 531)

Small tree with flattish rounded outline and angular trunk. Fyson mentions it below Kodaikanal. Recently Pallithanam reported it from Bombay shola above Kodaikanal. I could collect the specimens from Tiger shola and sholas on the Old Ghat Road.

***Glochidion hohenackeri** Bedd. Syn. *G. ellipticum* Wt.

Small tree with slender branches. In Tiger shola. Not mentioned by Fyson.

Daphniphyllum glaucescens Blume. (Fyson 1 : 533)

Trees with erect leaves having curved margins. Common on the sholas and downs above and below Kodaikanal.

Antidesma menasu Miq. (Fyson 1 : 534)

A small tree. Leaves elliptic oblong with long spikes (10-15 cm.). Common on the sholas below Kodaikanal, Tiger shola and shola on the Old Ghat Road.

Mallotus phillipensis Muell.- Arg. (Fyson 1 : 535)

Shrub with leaves 3-nerved at the base. Young parts covered with reddish hairs. Ovary covered with crimson glands. Common as undergrowth in the shola below Kodaikanal.

Macaranga indica Wt. (Fyson 1 : 536)

A large tree. Leaves rounded but pointed and peltate. Panicles lateral. Often confused with *Mallotus albus*, but distinguished by its leaves. Fyson mentions from Niligiris ; can be collected from Tiger shola.

Ulmaceae

Celtis australis Linn. (included with *C. tetrandra* Roxb. in part by Fyson 1 : 538)

A middle-sized deciduous tree with whitish specks on the bark ; branchlets drooping. Leaves tough, serrated from near the base. Distinguished from *C. tetrandra* by its globose orange-red drupes. Below Kodaikanal.

Celtis tetrandra Roxb. (Fyson 1 : 538 including *C. australis* Linn.)

A large medium-sized tree with pubescent leaves, serrated from above the middle. Fruit a purplish black ellipsoidal drupe. Fyson does not record it from Kodaikanal ; recently recorded by Pallithanam from Bombay sholas. I have collected the plants from Tiger shola.

Celtis wightii Planch. (Fyson 1 : 538)

Large tree with smooth bark ; branchlets brown pubescent. Flowers in small pubescent panicles. Not recorded by Fyson from Kodaikanal ; recently reported by Pallithanam. Can be collected from Tiger shola.

Moraceae

***Ficus hirta** Vahl.

Small tree. Leaves ovate elliptic rounded. Not recorded by Fyson, collected from Tiger shola.

Urticaceae

Girardinia zeylanica Dcne. Syn. *G. heterophylla* Dcne. (Fyson 1 : 544)

Shrub with long stinging hairs. Leaves deeply divided palmately. In sholas and downs in and near Kodaikanal.

***Debregeasia velutina** Gaud.

A small tree, with rough branches having warty excrescences and scars of fallen leaves. It grows well below Kodaikanal in the sholas. Not recorded by Fyson; recently reported by Pallithanam. Common in Tiger shola.

Pouzolzia wightii Benth. (Fyson 1 : 551)

A tall robust herb with broadly ovate leaves. Common near Kodaikanal.

Cupuliferae

***Quercus robur** Linn. Syn. *Q. pedunculata* Linn.

A large deciduous tree widely distributed throughout Europe, mainly confined to the lowlands. Planted in the garden ; Bryants Park. Not mentioned by Fyson.

***Alnus nepalensis** D. Don.

Large deciduous tree, distributed in the Himalayas in moist shady ravines near the water courses. Planted along the lake sides. Not mentioned by Fyson.

Casuarinaceae

***Casuarina suberosa** Ott. & Dietr. Syn. *C. leptoclada* Miq.

Small sized tree. Native of all states of Australia except western Australia. Planted near the lake. Not mentioned by Fyson.

Amaryllidaceae

Hypoxis aurea Lour. (Fyson 1 : 601)

Small herb with linear leaves. Flowers yellow, solitary on slender stalks. In damp places on the downs and grassy slopes in and near Kodaikanal.

Commelinaceae

Cyanotis fasciculata Schultes. (Fyson 1 : 619)

A small annual, cottony all over. Flowers in terminal cymes. Below Kodaikanal, on the slopes of Perumalmalai.

Juncaceae

Juncus prismatocarpus Gr. (Fyson 1 : 620)

Tufted herbs. Leaves in two ranks. Flowers at the ends and the forkings of branched inflorescence, pale yellow, 6-10 in a bunch. On the downs and in Kodaikanal lake.

Eriocaulaceae

Eriocaulon brownianum Rubl. (Fyson 1 : 627)

Herb with a thick rhizome having 2-3 flowering stalks. On Kodaikanal downs and near the lake.

Cyperaceae

Mariscus cyperinus Vahl. (Fyson 1 : 637)

Lower sheath of leaves red. Spikes at the top of stem. At the top of Perumalmalai.

Fimbristylis uliginosa Steud. (Fyson 1 : 640)

Tufted plants clothed at base with dead sheaths. Leaves hair-like, spikelets many, tufted at the top. At the top of Perumalmalai.

Gramineae

Andropogon foulkesii Hk. f. (Fyson 1 : 665)

Perennial with slender stem. Leaves finely acuminate with spreading hairs. Axils of the spike bearded with long soft hairs; spikelets purple. At the top of Perumalmalai.

Pollinia phaeothrix Hack. (Fyson 1 : 663)

Annual clothed at the base with rusty coloured tomentose sheaths. Leaf blades slender, hairy on the back. Spikes golden brown in colour. Near Kodaikanal and at the top of Perumalmalai.

II. Gymnosperms

***Cupressus torulosa** Don.

Large evergreen tree, wood fragrant. Wild in west Himalayas mostly on limestone and in hot dry aspects. Planted near the lake. Not mentioned by Fyson.

***Cupressus funebris** Endl.

Tree with pendulous branches. Grown for ornamentation near the lake. Not mentioned by Fyson.

***Cedrus deodara** Loud.

Large evergreen tree. Indigenous in western Himalayas from Afghanistan to Garhwal. Planted for ornamentation. Not mentioned by Fyson.

***Cryptomeria japonica** Don.

Large straight, fast-growing tree. Native of Japan. Planted in the gardens for ornamentation. Not mentioned by Fyson.

***Araucaria cunninghamii** Ait.

Tall cylindrical tree. Native of coastal scrub (rain forest) areas from the Hastings River, New South Wales to North Queensland, also in mountain regions of New Guinea. Planted in the gardens. Not mentioned by Fyson.

***Araucaria bidwilii** Hook. f.

Large cylindrical-stemmed tree. Native of south-east Queensland. Planted in the gardens. Not mentioned by Fyson.

* **Callitris rhomboidea** R. Br.

Small tree of fastigiate form. Restricted distribution in eastern coastal districts of Australia, occurring in certain parts of New South Wales; in the neighbourhood of Sydney. Planted near the lake. Not mentioned by Fyson.

* **Pinus radiata** Don. Syn. *Pinus insignis* Dougl.

A large tree. Native of Monterey, California along the sea coast on slopes and ridges. Planted in the gardens. Not mentioned by Fyson.

Acknowledgements

The author is deeply indebted to Rev. Fr. G. Foreau and Rev. Fr. Matthew, of the Sacred Heart College, Shembaganur, for their kind help in the identification of some of the plant specimens; and to Mr. M. Viart, Assistant Director, French Institute, Pondicherry for his constructive suggestions and help in the field.

References

Fyson, P. F. (1932): Flora of the South Indian Hill Stations. Madras. 2 Vols.

Pallithanam, J. (1957): Observations on the Flora of Kodaikanal. *J. Bombay nat. Hist. Soc.* 54 : 836-844.

Matthew, K. M. (1959): The Vegetation of Kodaikanal Grassy slopes. *J. Bombay nat. Hist. Soc.* **56** : 387-422.

Troup, R. S. (1932): Exotic Forest Trees in the British Empire. Oxford.

The Birds of Nepal

PART 6

BY

BISWAMOY BISWAS
Zoological Survey of India, Indian Museum, Calcutta

[*Continued from Vol.* **58** (3) : 677]

Subfamily TIMALIINAE

474. **Pellorneum ruficeps mandellii** Blanford. Mandelli's Spotted Babbler.

BHABAR : Amlekhganj : 1 ♂, 3 ♀♀ (March 6-9). DUN : Hitaura, Bhimphedi : 11 ♂♂, 4 ♀♀, 1 juv. ♀ (May 5-31, June 12). NEPAL VALLEY : Thankot : 1 ♂, 1 ♀ (April 7).

The Spotted Babbler is very common in central Nepal occurring in bushes, scrub, bushy undergrowths of forests, sometimes even on grasslands. It did not, however, appear so common in the Nepal Valley as it was in the bhabar and the dun.

Scully (1879) did not report it from Nepal. Ripley (1950b, p. 390) found it at *c.* 305-1370 m. from western to eastern Nepal. Smythies (1950, p. 514) noted it on Nagar Jong, Nepal Valley, at *c.* 1525 m. Polunin (1955, p. 889) recorded it from Nawakot in the Trisul Valley (*c.* 915 m.) in summer. Proud (1955, p. 58) found it scarce in the Nepal Valley but common in the tarai. Rand & Fleming (1957, p. 121) reported it from west-central to eastern Nepal at *c.* 290-1675 m.

I am unable to agree with Ripley's (loc. cit.) observation that it is found in the tarai and duns in winter but higher up in spring. I do not think it moves much seasonally. We found it very common and breeding in the dun in May-June.

Some of my April and May birds are worn and some moulting.

Birds were in fully breeding condition in April and May. A female had an exhausted ovary on June 12.

Colours of soft parts : Iris crimson to deep crimson (reddish brown in juvenile); upper mandible dark horny, sometimes paler on tip or horny black on basal half; lower mandible light yellow on the posterior half, bluish white on the anterior half, with dusky tip, the dusky portion is variable and may extend up to nearly the middle ; legs, feet, claws and pads fleshy, sometimes the claws may be light horny.

Measurements :

	13 ♂♂	8 ♀♀
Wing :	68, 70, 71+,—(2), 72 (2), 73, 73+, 74, 75 (3)	66, 66+, 67 (2), 68 (3), 69+
Tail :	70 (2),—(6), 72, 74+, 75, 76, 77	65, 66, 66.5, 67, 68+, 70,—(2)
Bill :	18 (2), 18.5 (2), 19 (7), 20.5, 21	17.5, 18, 18.5 (3), 19 (2), 19.5

*475. **Trichastoma abbotti abbotti** (Blyth). Abbott's Babbler.

Abbott's Babbler was not present in Hodgson's first lot of specimens presented to the British Museum (Gray & Gray, 1846). It was, however, included in his later presentation from Nepal (Gray, 1863, p. 40). The only other report of this species from Nepal that I can trace, is Ripley's (1950b, p. 390) from Chatra, eastern Nepal tarai, in winter.

476. **Pomatorhinus montanus schisticeps** Hodgson. Slatyheaded Scimitar Babbler.

DUN : Hitaura : 4 ♂♂, 1 juv. ♂, 4 ♀♀, 1 juv. ♀ (May 14-29, June 1, 19).

The Slatyheaded Scimitar Babbler does not appear to be uncommon in the central Nepal dun. During May-June, it was found in pairs.

Ripley (1950b, p. 390) reported it from western Nepal at *c*. 1525 m. in winter; Smythies (1950, p. 514 noted it on Sheopuri Range, Nepal Valley; and Rand & Fleming (1957, p. 122) recorded it from western and west-central Nepal at *c*. 455-1065 m., also in winter.

The wing and tail are more or less worn in all my specimens.

The juvenile male (May 21) is reddish olive on the upper side, rufous on the forehead, and its supercilia and eye-stripes are developing. Its underside is downy with the breast and flanks rusty. The juvenile female specimen (May 18) appears a little older than the juvenile male specimen.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	100 (2), 101, 102	104+, 111, 113, 115	31 (3), 31.5
4 ♀♀ :	—, 97+, 97.5, 100	106, 107, 109, 110	31, 31.5, 32,—

477. **Pomatorhinus ruficollis ruficollis** (Hodgson). Nepal Rufousnecked Scimitar Babbler.

MARKHU VALLEY : Deorali : 1 ♀ (April 28). NEPAL VALLEY : Thankot : 4 ♂♂, 1 subad. ♂, 6 ♀♀, 1 subad. ♀ (March 22-26, April 6, 14).

This scimitar babbler is not uncommon in thick forests on the hills round the Nepal Valley during March-April. A few were also observed by us in similar biotope on the Mahabharat Range, Markhu Valley.

Ripley (1950b, p. 390) found it also in western Nepal; Polunin (1955, p. 889) from the Langtang Valley, northern central Nepal; and Rand & Fleming (1957, p. 122) in west-central and eastern Nepal.

The subadult birds are more rusty above than the adults.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	74, 78, 80 (3)	84, 84+, 85 (2), 86	23. 5, 24 (3), 25
7 ♀♀ :	76 (2), 78, 78. 5, 79 (2), 84	80, 82, 83, 83+, 84, 85, 91	23. 5, 24 (4), 24. 5 (2)

*478. **Pomatorhinus ruficollis godwini** Kinnear. Godwin's Rufousnecked Scimitar Babbler.

The only record of Godwin's Rufousnecked Scimitar Babbler for Nepal was furnished by Ripley (1950b, p. 391) on the basis of a single specimen taken at Mangalbaré (*c.* 2745 m.) on Tinjure Danda, Tamur Valley, eastern Nepal.

479. **Pomatorhinus erythrogenys erythrogenys** Vigors ⪋ **haringtoni** Baker. Nepal Rustycheeked Scimitar Babbler.

DUN : Hitaura, Bhimphedi : 2 ♂♂, 5 juv. ♂♂, 1 ♂ chick in down, 3 ♀♀ (March 12, 13, May 3-18, June 4). NEPAL VALLEY : Thankot : 2 ♂♂, 7 ♀♀ (March 21-29, April 7-14).

The Rustycheeked Scimitar Babbler is common in hill forests from the central duns to the Nepal Valley. It usually occurs in small parties of about half a dozen individuals in dense forest as well as along the edges of forests bordering cultivation.

Ripley (1950b, p. 391) reported it also from western Nepal, Polunin (1955, p. 889) from northern central Nepal, and Rand & Fleming (1957, pp. 122-123) from western to eastern Nepal.

Many of my March-April specimens have a very worn tail.

Very young birds, including the chick in down, were taken in May and June. A young bird of May 3 has the forehead and sides of the crown rufous, underside downy with budding feathers on the chin and throat, undeveloped malar stripe, rufous breast and flanks, and white centre of abdomen. Two other young specimens taken on May 7 and 10, appear a little older than the May 3 specimen. They both have the throat feathered, without malar stripes, with dusky stripes on the upper breast, and downy lower abdomen and vent. Another young bird collected on May 13 appears still older.

The chick in down taken on May 18, has rufous feathers on the head, but reddish down on the back, an almost naked chin and throat, whitish down on the centre of abdomen, and rufous down on the breast, flanks and vent.

Measurements :

	5 ♂♂	10 ♀♀
Wing :	96 (3), 98 (2)	92, 92 + (2), 93, 93.5 +, 94, 95 (3), 96
Tail :	100, 101, —(3)	96 +, 97 +, 98 +, 99 (2),—(5)
Bill :	36 (2), 37, 38, 39	34.5, 35 (3), 36 (3), —, 37, 38.5

My central Nepal examples represent a variable intermediate population, specimens ranging in characters from typical *erythrogenys* of western Himalaya to typical *haringtoni* of Sikkim. Scully (1879, p. 289) noted characters of *haringtoni* in his Nepal Valley specimens. Polunin's specimens from central Nepal are close to *haringtoni*. Rand & Fleming noted the variable and intermediate nature of their series from western, west-central, central and eastern Nepal. It would appear, therefore, that *Pomatorhinus ferrugilatus* Hodgson, 1836 (type locality sub-Himalayan Nepal) refers to this intermediate group, and this name has been used by both Ripley and Rand & Fleming for their Nepal birds. It seems unnecessary to use a separate name for such a variable intermediate population.

*480. **Pomatorhinus erythrogenys haringtoni** Baker. Baker's Rusty-cheeked Scimitar Babbler.

The only record of this scimitar babbler for Nepal is based on Stevens's (1923b, p. 731) report from the Mai Valley, eastern Nepal, at *c.* 1065-2135 m.

*481. **Pomatorhinus ferruginosus ferruginosus** Blyth. Coralbilled Scimitar Babbler.

After Hodgson's later collection (Gray, 1863, p. 45) the only report of the Coralbilled Scimitar Babbler from Nepal consists of a doubtful sight record by Scully (1879, p. 288) near Nawakot, central Nepal.

*482. **Xiphirhynchus superciliaris superciliaris** Blyth. Slenderbilled Scimitar Babbler.

This scimitar babbler was not present in Hodgson's earlier collection (Gray & Gray, 1846), but it was included without locality in his later collection (Gray, 1863, p. 45), and one cannot be sure as to whether it was taken in Nepal or the Darjeeling district. However, Stevens (1923b, pp. 731-732) provided the only authentic report of its occurrence within Nepal. He found it on the Nepal side of the Singalila Range near Kalipokhari at *c.* 2440-3050 m. in April-May.

*483. **Pnoepyga albiventer pallidior** (Kinnear). Western Scalybreasted Wren-Babbler.

The Western Scalybreasted Wren-Babbler was first reported from Nepal by Ripley (1950b, pp. 391-392) from the Karnali Valley, western Nepal, at *c.* 275 m. in winter. It was later found by Rand & Fleming (1957, pp. 123-124) in western and west-central Nepal at *c.* 1065-1980 m. in winter.

Rand & Fleming's specimens from central and eastern Nepal should belong to the eastern subspecies (see next item, below).

484. **Pnoepyga albiventer albiventer** (Hodgson). Eastern Scalybreasted Wren-Babbler.

Tesia albiventer Hodgson, 1837, *J. Asiat. Soc. Beng.* **6** : 102. (Nepal, hereby restricted to the slopes of Chandragiri above Thankot, Nepal Valley.)

BHABAR : Amlekhganj : 1 juv. ♀ (March 6). CHITLANG VALLEY : Chitlang : 2 ♀♀ (March 14, April 22). NEPAL VALLEY : Thankot : 4 ♂♂, 5 ♀♀ (March 26-April 12).

The eastern form of the Scalybreasted Wren-Babbler is not uncommon in the Nepal Valley among boulders and in dense undergrowths of forests, particularly near hill-streams. We found it also on the southern side of the Chandragiri at its foot above Chitlang in small numbers, and once only in central bhabar in dense forest near Amlekhganj.

Neither Scully (1879) nor Ripley (1950b) reported it from Nepal. Proud (1955, pp. 58-59) found it only on higher elevations in the Nepal Valley. Polunin (1955, p. 890) noted it occasionally in the Langtang Valley, central Nepal, at *c.* 3960 m. in summer. Rand & Fleming (1957, p. 123) found it in the Nepal Valley at *c.* 2745 m. in April, and at *c.* 2285 m. in eastern Nepal in December.

All my adult specimens are moulting in one part of the body or the other, except a female (April 22) which has just completed the moult.

The immature bird has no fulvous spots on the upper side [*cf.* Ripley's (1950b, pp. 391-392) only example (♂) of *P. a. pallidior* from western Nepal, also lacks those spots].

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	58, 60, 61, 62	17 (2),—,18	—,14, 14.5 (2)
7 ♀♀ :	57 (3), 59(2), 60 (2)	17 (2),—(2), 18 (3)	—,14 (5), 14.5

I am unable to agree with Rand & Fleming (1957, pp. 123-124) in placing birds from western, central and eastern Nepal all together under the western race *pallidior* Kinnear. While I have not had the opportunity of examining any example from the west of the Nepal

Valley, I am convinced from a study of the material in the British Museum, the American Museum of Natural History, and the Koelz Collection, that the central Nepal birds are *albiventer*. Ripley (1950b, p. 392) came to the same conclusion. It is, however, theoretically possible that *pallidior* and *albiventer* intergrade somewhere in west-central Nepal, if western birds are true *pallidior*. Recently, however, Ripley (1961, p. 357) followed Rand & Fleming in giving the ranges of these forms.

Although restriction of the type locality of Hodgson's *albiventer* to eastern Nepal, as suggested by Rand & Fleming, may help their thesis, we cannot disregard the following facts: (*a*) that Hodgson was stationed in Kathmandu in 1837 when the form was described, and when it certainly was much easier for him to get virtually local material than from far-off eastern Nepal, and (*b*) that Hodgson's earlier collection contained very few, if any, eastern specimens. I am, therefore, unable to agree with Rand & Fleming's suggestion, nor with Ripley's (loc. cit.) restriction of the type locality to Ilam district, eastern Nepal. I am of the opinion that if restriction of the type locality is at all desired, it should be in the Nepal Valley, as I have done above, which will conform to facts.

485. **Pnoepyga pusilla pusilla** Hodgson. Brown Wren-Babbler.

CHITLANG VALLEY : Chitlang : 1 ♂, 1♀ (April 22, 25). NEPAL VALLEY : Thankot : 1 ♂ (April 14).

We did not find this wren-babbler at all common in central Nepal. Only a few specimens were observed by us in the dense undergrowths of the forests on the Chandragiri on both the Thankot and Chitlang sides.

It was not reported from Nepal by either Scully (1879) or Ripley (1950b). Proud (1955, p. 58), however, found it common in the Nepal Valley from *c.* 1525 to 2435 m. Rand & Fleming (1957, p. 124) recorded it from the western tarai and the Nepal Valley.

All my three specimens are worn, the Thankot specimen very much so. There is no sign of moult in the male specimens, but it has just started on the crown of the female specimen.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	50 (2)	13,—	—(2)
1 ♀ :	50	15	13.5

*486. **Spelaeornis caudatus** David & Oustalet. Tailed Wren-Babbler.

The Tailed Wren-Babbler was first obtained in Nepal by Hodgson (Gray, 1863, p. 28) when he was living in Darjeeling. It has not been reported from that country since then.

*487. **Stachyris ruficeps ruficeps** Blyth. Redheaded Babbler.

The first record of the occurrence of the Redheaded Babbler in Nepal is based on Hodgson's later collection (Gray, 1863, p. 45). Subsequently, it was obtained in Nepal only by Stevens (1923b, p. 733) from the Mai Valley, eastern Nepal, and observed by Smythies (1950, p. 514) on Sheopuri Range, Nepal Valley on October 27.

488. **Stachyris pyrrhops** Blyth. Redbilled Babbler.

Stachyris pyrrhops Blyth, 1844, *J. Asiat. Soc. Beng.* **13** : 379. (Nepal.)

Stachyris pyrrhops ochrops Koelz, 1954, *Contrib. Inst. Reg. Explor.* (1) : 6. (Kotla, Kangra district, Punjab.)

DUN : Hitaura, Bhimphedi : 5 ♂♂, 3 ♀♀ (March 11-13, May 7-23). MARKHU VALLEY : Deorali : 1 ♀ (April 30). CHITLANG VALLEY : Chitlang : 1 ♀ (April 17). NEPAL VALLEY : Thankot : 2 ♂♂, 1 ♀ (March 21—April 7).

The Redbilled Babbler is fairly common in central Nepal from the dun up to the Nepal Valley in light forests, scrub jungles, etc.

Scully (1879) did not obtain this species in Nepal. It was reported from western and west-central Nepal (*c.* 305-2435 m.) by Ripley (1950b, p. 392) and Rand & Fleming (1957, p. 124).

All my specimens taken in mid-April and afterwards, and two males of March 11 and 21 are worn, those dated May 18 (1 ♂) and 23 (1 ♀) are very much so, but only one specimen (♀, April 30) was moulting on the crown.

Worn birds have much redder crown, sides of the head and underside than birds in fresh plumage.

Measurements :

	Wing	Tail	Bill
7 ♂♂ :	52, 53, 53+, 53.5, 54 (2), 55	48.5, 49 (2), 50 (2), —, 51	14.5, 15 (2), 15.5 (2), 16, —
6 ♀♀ :	51, 52 (2), 52.5, 53, —	49 (2), — (3), 51	14.5, 15 (2), 15.5, — (2)

As has already been said above, birds in fresh plumage from Nepal and elsewhere are less red (= *ochrops* Koelz). However, in seasonably comparable material, Kangra and Rampur-Bushahr birds seem to be slightly paler than Nepal birds, to which those from Simla to Kumaon are quite close.

*489. **Stachyris chrysaea chrysaea** Blyth. Nepal Goldenheaded Babbler.

The sole post-Hodgsonian record of this babbler in Nepal is Proud's (1955, p. 58) observation in Pokhara area at *c.* 2435 m. in west-central Nepal.

490. **Stachyris nigriceps nigriceps** Blyth. Blackthroated Babbler.

DUN : Bhimphedi : 5 ♂♂, 1 imm. ♂, 2 ♀♀ (March 12, 13, May 4-8). MARKHU VALLEY : Deorali : 2 ♂♂ (April 29, May 2). CHITLANG VALLEY : Chitlang

2 ♂♂ (April 17, 22). NEPAL VALLEY: Thankot: 7 ♂♂, 2 ♀♀ (March 21-29, April 8).

The Blackthroated Babbler is quite common in flocks of about six to ten (early and mid-March) or in pairs (late March-May) in dense or light forests of central Nepal from the dun up to the Valley. On a few occasions we observed it in mixed feeding parties with other birds in March.

It was not included in Scully's (1879) list. Rand & Fleming (1957, p. 124) found it also in west-central Nepal at *c.* 760 m. in January-February.

It was breeding as early as March 12 at Bhimphedi.

Measurements :

	16 ♂♂	4 ♀♀
Wing :	57, 58, 59 (4), 59+, 59.5 (2), 60 (2), 60+, 61 (4)	56.5,58 (3)
Tail :	52, 52+, 52.5+, 53 (3), 53+, 53.5, 54 (2),—, 55 (3), 56 (2)	50 (2), 51 (2)
Bill :	17.5, 18 (6), 18.5 (4), 19 (4),—	17.5, 18 (2),—

*491. **Dumetia hyperythra hyperythra** (Franklin). Northern Rufous-bellied Babbler.

The first record of the Rufousbellied Babbler from Nepal was made by Ripley (1950b, p. 392) from the western tarai where it was subsequently taken by Rand & Fleming (1957, p. 125).

492. **Macronus gularis rubricapilla** (Tickell)$\gtrless$**mayri** Koelz. Yellow-breasted Babbler.

BHABAR: Amlekhganj: 6 ♂♂, 1 ♀ (March 6-8). DUN: Hitaura: 5 ♂♂, 2 imm. ♂♂, 2 ♀♀, 1 imm. ♀ (May 14-30, July 9).

The Yellowbreasted Babbler is common in the bhabar and dun of central Nepal. It occurs in flocks of a dozen or more birds, in scrub forests, bamboo jungles, etc.

Scully (1879) did not find it in Nepal. Ripley (1950b, p. 392) obtained it only in the eastern tarai and dun, and Rand & Fleming (1957, p. 125) from similar areas of western to eastern Nepal.

Ripley (loc. cit.) remarked that this species 'has not previously been reported from Nepal', following which Rand & Fleming (loc. cit.) stated: 'it has not been recorded before from central or west Nepal'. However, it may be noted that Hodgson (1845, p. 23) not only collected specimens of this species in Nepal, but described it also as a new species, *Mixornis ruficeps.* It was included in his earliest list (Hodgson, 1844, p. 83) as 'Mixornis ruficeps, v. Timalia gularis *Horsf.* 699' and in Gray & Gray's (1846, p. 85) catalogue of Hodgson's earlier collection under the '*Streaked-throated Timalia*'

Furthermore, Baker (1922d, p. 273) included Nepal within the range of this species. As to whether Hodgson obtained his specimens from the western, central or eastern region, nothing is known for certain. But I should imagine it more likely that his collection of this species came from the bhabar and/or dun of central Nepal, because it is so common along the main trail to Kathmandu through that region.

Measurements :

	11 ♂♂	3 ♀♀
Wing :	58.5 (2), 59 (5), 59.5, 60 (2), 61	56 (2), 56 +
Tail :	51,—(2), 52 (4), 52.5 (2), 53, 53.5	48,—,49
Bill :	15.5 (2), 16 (6), 16.5,—(2)	15, 15.5 (2)

I am unable to agree with Ripley (1961, p. 366) in synonymizing *mayri* Koelz (1951, p. 27) from Darjeeling district and *assamicus* Koelz (op. cit., pp. 27-28) from the Garo Hills with *rubricapilla* Tickell from Purulia district, West Bengal. Comparison of fresh material leaves one without any doubt as to the validity of *mayri*. I am, however, not so sure about *assamicus*, not having seen enough good material. But the few I have examined from the Garo Hills, Assam, are different from both *rubricapilla* and *mayri*. It would appear that the species is in need of revision.

493. **Timalia pileata bengalensis** Godwin-Austen. Bengal Redcapped Babbler.

Dun : Hitaura : 3 ♂♂ (May 18-27).

The Redcapped Babbler was observed by us only a few times in the scrub forests of the central dun during May-June.

Scully (1879) did not find it in Nepal, while Ripley (1950b, p. 392) and Rand & Fleming (1957, p. 125) reported it only from western Nepal.

All my specimens are in worn plumage, those of May 18 and 26 more so.

Measurements : 3 ♂♂ : Wing 58, 61, 62 ; tail 65,—, 67 +; bill 18 (3).

494. **Chrysomma sinense sinense** (Gmelin). Indian Yellow-eyed Babbler.

Dun : Hitaura : 5 ♂♂, 2 ♀♀ (May 14-27, June 21).

The Yellow-eyed Babbler is found in small numbers in scrub, tall grass and in bushes of the central dun. It usually occurs in pairs during May-June.

Scully (1879) did not record it from Nepal. Ripley (1950b, p. 393) and Rand & Fleming (1957, pp. 125-126) found it only in western Nepal.

All my specimens are in very worn plumage, and only one (♂, May 23) has the forehead in moult.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	66 + (2), — (3)	80 +, —(4)	14.5 (2), 15 (3)
2 ♀♀ :	65, —	78 +, —	14, 15

*495. **Turdoides nipalensis** (Hodgson). Spiny Babbler.

The Spiny Babbler is probably endemic in Nepal, having been known from that country alone, except for a single example said to have been taken by Pinwill at Lohoo Ghat across the Nepal border in Kumaon. However, Pinwill's collection is well known for inaccurate locality records on the labels. I shall not be surprised if Pinwill in fact purchased a skin while at Lohoo Ghat from Nepali people who seasonally go across the border to Kumaon for trade.

The first post-Hodgsonian report of the species from Nepal is to be credited to Proud (1949, p. 699) who noted it occasionally in Kathmandu. Later, in reporting on his specimen (the first one taken in Nepal after Hodgson) from *c.* 1525 m. in western Nepal, Ripley (1950b, pp. 393-394) gave an account of its rarity. Upon this, Proud (1952b, p. 667) thought she made a mistake in the identity of the bird. Subsequently, however, it was found to be 'in fact quite common in suitable localities' (Proud, *in litt.*) of the Nepal Valley (see also Fleming, 1952, p. 661; 1957, pp. 766-767). Rand & Fleming (1953, p. 941; 1957, p. 126) found it in western and west-central Nepal at *c.* 915-1430 m. in winter.

*496. **Turdoides earlei earlei** (Blyth). Eastern Striated Babbler.

After Hodgson's collection, the Striated Babbler has been recorded from Nepal by Ripley (1950b, p. 393), and by Rand & Fleming (1957, p. 126) in the western tarai.

*497. **Turdoides longirostris** (Horsfield & Moore). Slenderbilled Babbler.

The occurrence of the Slenderbilled Babbler in Nepal is known only from Hodgson's later collection (Horsfield & Moore, 1854, p. 408; Gray, 1863, p. 44).

498. **Turdoides striatus striatus** (Dumont). Bengal Jungle Babbler.

DUN : Hitaura : 4 ♂♂, 4 ♀♀ (May 12-23, June 10-23).

The Jungle Babbler is common in central Nepal from the plains up to the duns, about cultivation, in grassland and scrub.

It was also reported from the western tarai by Ripley (1950b, p. 393) and from the tarai to duns of western, west-central and eastern Nepal by Rand & Fleming (1957, pp. 127-128).

All my specimens are in very worn plumage and moulting in one part or the other. Thus, a male taken May 23 is just beginning to moult; two males and four females (May 12, 19, 22, June 12, 13, 23) have their head and neck moult almost finished; and one male (June 10) has new body and wing feathers but still moulting tail.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	103 +, 104, 107, 107 +	103 +, 104+(2), 106	24 (3), 24.5
4 ♀♀ :	101 + (2), 103, 103 +	102 +, — (2), 104 +	24 (3), 24.5

Ripley (1958, pp. 5-10) has shown that the correct specific name of the Jungle Babbler is *Turdoides striatus* (Dumont) and not *T. somervillei* (Sykes) as currently used.

499. **Garrulax albogularis albogularis** (Gould). Whitethroated Laughing Thrush.

CHITLANG VALLEY : Chitlang, Chandragiri above Chitlang : 1 ♂, 3 ♀♀, (April 16-20). NEPAL VALLEY : Thankot, Chandragiri above Thankot : 7 ♂♂, 6 ♀♀, 1 unsexed (March 21—April 13).

The Whitethroated Laughing Thrush is quite common in forests on hills round the Nepal Valley southward to about the upper limits of the central dun. It occurs in flocks of about six to fifteen individuals.

It was also reported from western Nepal by Ripley (1950b, p. 394); western and west-central Nepal by Rand & Fleming (1957, p. 128); northern regions of central Nepal by Proud (1952a, p. 362) in the Gandak-Kosi watershed and Polunin (1955, p. 888) in the Langtang Valley; eastern Nepal by Stevens (1923b, p. 729) in the Mai Valley, and Biswas (1960a) in the Likhu Valley in February.

Specimens taken during the last days of March and in April are in different stages of wear. A male and a female collected at Chitlang on April 19 and 16 respectively, are very much worn.

It was breeding in April.

Colours of soft parts : Iris dull white to bluish white ; bill horny black ; legs and feet plumbeous ; claws grey (once plumbeous) ; pads yellowish white.

Measurements :

	8 ♂♂	9 ♀♀	1 unsexed
Wing :	126 +, 130 (2), 131, 132, 133, 134,—	127, 128 (2), 129 (2), 130 (2), 135, —	135
Tail :	128 +, 129 +, 133, 135 (2), 139 (2),—	125 +, 132 +, — (2), 133, 134, 134 +, 135, 136	142
Bill :	25 (2), 26 (3), 27 (2),—	24.5, 25 (3), — , 26 (2), 26.5, 27	25.5

I agree with Rand & Fleming (1957, p. 128) that *G. a. whistleri*

Baker from western Himalaya is a valid subspecies, *contra* Berlioz, 1930, p. 135 (see also Vaurie, 1954b, p. 5).

*500. **Garrulax moniliger moniliger** (Hodgson). Indian Necklaced Laughing Thrush.

The first post-Hodgsonian record of the Necklaced Laughing Thrush from Nepal consists of Proud's (1949, p. 699) observation in the Valley on Phulchauki Danda at *c.* 1675 m. in June. It has subsequently been found only by Rand & Fleming (1957, p 129) in west-central Nepal at *c.* 915 m., central dun and eastern bhabar.

501. **Garrulax pectoralis pectoralis** (Gould). Indian Blackgorgetted Laughing Thrush.

BHABAR: Amlekhganj: 1 subad. ♀ (March 6). DUN: Hitaura: 3 ♂♂, 4 subad. ♂♂, 1 juv. ♂, 1 ♀, 2 subad. ♀♀, 1 juv. ♀, 1 nestling unsexed (March 29, May 19, 29 — June 1, 19-23, July 19,20).

This laughing thrush is common in the central dun, particularly in forests with dense undergrowths. It occurs in flocks of 10-20 individuals.

Scully (1879) and Ripley (1950b) both failed to find it in Nepal, and Rand & Fleming (1957, p. 129) reported it only from eastern Nepal.

All my subadult and adult birds are much worn. The subadult examples have rufous anterior to the pectoral band, and have thinner bills.

The two juvenile birds (♂, ♀, July 19, 20) are similar to adult birds in coloration of the upper side, but have down feathers on the abdomen.

The nestling (unsexed, June 11) has the chin and throat almost naked, and the pectoral band downy.

502. **Garrulax striatus vibex** Ripley. Nepal Striated Laughing Thrush.

DUN: Bhimphedi: 1 ♂ (May 5). MARKHU VALLEY: Deorali: 1 ♀ (May 1). CHITLANG VALLEY: Chitlang: 2 ♂♂, 2 ♀♀ (March 14, 15, April 19, 20). NEPAL VALLEY: Godavari, Thankot: 6 ♂♂, 3 subad. ♂♂, 5 ♀♀ (March 21—April 5, 14, May 13).

The Striated Laughing Thrush is common on hills round the Nepal Valley. We observed it particularly on the Chandragiri above Chitlang and Thankot, and the Mahabharat Range on both Deorali and Bhimphedi sides, in dense forests, undergrowths, as well as on the lower branches of trees. During March-May it was found in pairs.

It has been reported also from western Nepal by Ripley (1950b, p. 394), west-central Nepal by Proud (1955, p. 58) and Rand & Fleming

(1957, p. 129), and from the Trisul Valley, central Nepal, by Polunin (1955, p. 889).

It was breeding in April-May. A female taken on March 31 had fairly well developed but not fully breeding ovary, while a male specimen had fully breeding testes on May 13.

Colours of soft parts: Iris brownish pink to dull brick-red with a thin yellow inner ring; bill dark horny, paler on the base of lower mandible; legs and feet pale slate; claws horny to pale horny; pads yellowish grey.

Measurements:

	9 ♂♂	8 ♀♀
Wing:	138+, 139, 140, 141.5, 142,—, 147 (2), 148	133, 133+, 136, 136+, 138, 139, 141, 142
Tail:	128, 129 (2), 130,—, 132 (2), 133, 134	126 (3), 128+, 129, 130, 132, 139
Bill:	29 (3), 29.5 (2), 30 (2),—(2)	28 (2), 28.5, 29, 29.5, 30 (2),—

Rand & Fleming (op. cit., p. 130) have fully discussed the status of this subspecies.

*503. **Garrulax striatus sikkimensis** (Ticehurst). Sikkim Striated Laughing Thrush.

The only report of the occurrence of this laughing thrush in Nepal is based on Ripley's (1950b, p. 394) record from Mangalbaré on Tinjure Danda, eastern Nepal.

504. **Garrulax leucolophus leucolophus** (Hardwicke). Himalayan White-crested Laughing Thrush.

Bhabar: Amlekhganj: 5 ♂♂ (March 7-9). Dun: Hitaura, Bhimphedi: 4 ♂♂, 5 ♀♀ (March 11, May 4, 17, 27, June 6). Nepal Valley: Thankot: 1 ♂ (March 25).

The Whitecrested Laughing Thrush is very common on hills round the Nepal Valley down to the bhabar in flocks of about half-a-dozen to a dozen individuals.

Ripley (1950b, p. 395) reported it from *c.* 305 and 1525 m. in western Nepal and *c.* 305 m. in eastern Nepal in winter; Rand & Fleming (1957, p. 130) from west-central Nepal at *c.* 455-1370 m. in winter; and Biswas (1960a) in eastern Nepal at *c.* 1525 m. in June.

March specimens are somewhat worn, but those of May-June are still more so.

A female taken on May 31 had already laid: it had an exhausted ovary; while another female taken June 6 had an oviducal egg without shell but with layers of albumen, and an enlarged ovary, the largest ovarian ovum measuring 15 mm.

Colours of soft parts: Iris reddish brown; orbital skin pale bluish slate; bill black; legs and feet dull black; claws dark horny; pads yellowish grey.

Measurements :

	10 ♂♂	5 ♀♀
Wing :	130+, 132, 132+, 133, 133+(3), 135, 135+, 136	134, 134+, —, 135, 135+
Tail :	125+(2), 126,—(3), 128, 130 (2), 131	125+, 128, 128+, 131,—
Bill :	27.5, 28 (2), 29 (3), 29.5, 30 (3)	28.5, 29 (3), 29.5

The name *G. l. hardwickii* Ticehurst, 1926, currently used for the eastern subspecies (Ripley, op. cit., p. 395; Rand & Fleming, loc. cit.) is a synonym of *G. l. patkaicus* Reichenow, 1913 [type locality: Patkai Hills, North East Frontier Agency (formerly part of Assam), India], as has been shown by Mayr (1942, p. 526).

*505. **Garrulax variegatus variegatus** (Vigors). Eastern Variegated Laughing Thrush.

Cinclosoma variegatum Vigors, 1831, *Proc. zool. Soc. Lond.* (1) : 56. (Himalayas=Simla-Almora, according to Ticehurst & Whistler, 1924, p. 471. The earlier restriction of the type locality by Baker, 1920b, p. 243, to eastern Nepal does not seem to be based on any authenticity.)

The first post-Hodgsonian report of this laughing thrush from Nepal is based on Proud's (1952a, p. 362) observation from the Gandak-Kosi watershed, central Nepal, at *c.* 3350 m. in spring. It has subsequently been found in the northern regions of central Nepal by Polunin (1955, p. 888) in the Langtang Valley at *c.* 3050-4115 m. in summer, and Lowndes (1955, p. 30) in Manangbhot at *c.* 2745-3960 m. in summer; and in the Kali Gandak Valley, west-central Nepal, at *c.* 2590-2745 m. in winter by Rand & Fleming (1957, p. 130).

506. **Garrulax rufogularis rufogularis** (Gould). Eastern Rufouschinned Laughing Thrush.

DUN : Bhimphedi : 1 ♂, 1 juv. ♀ (May 4, 5). MARKHU VALLEY : Deorali : 1 ♂ (May 2). NEPAL VALLEY : Thankot : 4 ♀♀ (March 21, April 5, 14).

The Rufouschinned Laughing Thrush did not appear to be common in central Nepal. We occasionally saw pairs or small parties of three to six individuals in dense undergrowths of forests or in scrub on their edges.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	93, 98	103, 110	23, 24
4 ♀♀ :	92, 94 (3)	98, 100 (2), 103	23.5, 24 (2), 25

I am unable to accept Ripley's (1950a, p. 104) *grosvenori* from western Nepal, to which Rand & Fleming's (1957, p. 131) examples from west-central Nepal have been relegated. Although I have not had the opportunity to examine any west-central or western Nepal skin, a comparison between fresh birds from Garhwal, Kumaon, central Nepal and Darjeeling district has revealed that the central Nepal specimens (=*rufimenta* Hodgson) themselves show a tendency towards *occidentalis* Hartert from Dehra Dun. Ripley's *grosvenori* appears, to all intents and purposes, to represent nothing but an intermediate population between *occidentalis* and *rufogularis*, where the intermediate characters must be a little more accentuated than in central Nepal birds.

*507. **Garrulax ocellatus ocellatus** (Vigors). Eastern Whitespotted Laughing Thrush.

The first record of this species from Nepal after Hodgson's collection was made by Polunin (1955, p. 888) from the Langtang Valley, central Nepal, at *c.* 2745 m. in summer. It was later reported only by Rand & Fleming (1957, p. 131) from Okhaldhunga district, eastern Nepal, at *c.* 3050 m. in winter.

508. **Garrulax caerulatus caerulatus** (Hodgson). Greysided Laughing Thrush.

MARKHU VALLEY : Deorali : 1 ♀ (April 30).

This laughing thrush appeared rather uncommon in central Nepal. It was observed by us only on a few occasions in small parties of three or four birds on Chandragiri above Thankot in early April, on Phulchauki Danda above Godavari in May, and on the Mahabharat Range about Deorali towards the end of April.

Scully (1879) did not find it in Nepal. All other reports of this species from Nepal referred to the central region (Proud, 1949, pp. 698-699, 1955, p. 58; Ripley, 1950b, p. 395; Rand & Fleming, 1957, pp. 131-132).

Measurements : 1 ♀ : Wing 104 ; tail—; bill 26.

*509. **Garrulax ruficollis** (Jardine & Selby). Rufousnecked Laughing Thrush.

Hodgson's collection (Gray & Gray, 1846, p. 82) represents the sole record of the Rufousnecked Laughing Thrush from Nepal.

510. **Garrulax lineatus setafer** (Hodgson). Nepal Streaked Laughing Thrush.

MARKHU VALLEY : Deorali : 1 ♂ (April 29). CHITLANG VALLEY : Chitlang : 1♀ (April 22). NEPAL VALLEY : Thankot : 6 ♂♂ (March 28, 29, April 13, 14).

The Streaked Laughing Thrush is not particularly common in central Nepal. We encountered it only occasionally in small parties of two to six specimens on both sides of the Chandragiri, on

Phulchauki Danda and on the Mahabharat Range, in undergrowths, scrub, open parts of forests, and even near cultivation.

Smythies (1948, p. 440) found it in the Gandak-Kosi watershed, central Nepal, at *c.* 2435 m. in autumn, and later (1950, p. 514) on the Mahabharat Range at *c.* 1890 m. 'but never in the Nepal Valley'; Ripley (1950b, p. 395) reported it from the Chandragiri Pass, central Nepal. Polunin (1955, pp. 888-889) recorded it from the Langtang Valley, central Nepal, up to *c.* 3350 m. in summer. Lowndes (1955, p. 30) noted it in the Marsiyandi Valley on the way to Manangbhot, central Nepal, at *c.* 1980 m. Rand & Fleming (1957, p. 132) found it in winter in western Nepal at *c.* 1065 m., in west-central Nepal at *c.* 2745 m., and in eastern Nepal at *c.* 2435 and 2745 m. Biswas (1960a) reported it from Sangasoti Danda, Chautara district, central Nepal, at *c.* 2130 m. in January, and Khumbu, eastern Nepal, at *c.* 3050-3960 m. in April-May.

Measurements :

	Wing	Tail	Bill
6 ♂♂ :	77, 78 (3), 80.5, 81	90, 90+, 93, 96, 97 (2)	18, 19 (2), 19+, —(2)
1 ♀ :	76	90+	19

It may be noted that the Nepali birds (*setafer*) have the black subterminal band on lateral tail feathers much wider than those of western Himalayan birds (*lineatus* Vigors)—a character not mentioned by Baker (1922d, pp. 180-181). The Nepali race also appears to be a little smaller than the western.

Regarding the use of the different names for the races of the species, see Ripley (1961, pp. 391-392).

511. **Garrulax squamatus** (Gould). Bluewinged Laughing Thrush.

Nepal Valley: Thankot : 1 ♀ (March 21).

This laughing thrush appeared rare indeed in central Nepal, having been met with by us only once in dense bush on the bank of a stream in the forest of Thankot. The only other post-Hodgsonian record of the species from Nepal is Stevens's (1923b, p. 730) from *c.* 1370-2130 m. in eastern Nepal.

Measurements : 1 ♀ : Wing 103 ; tail 103 ; bill 23.

*512. **Garrulax subunicolor subunicolor** (Blyth). Plaincolored Laughing Thrush.

The post-Hodgsonian reports of this laughing thrush from Nepal consist of Stevens's (1923b, 729) from the Mai Valley, eastern Nepal, at *c.* 1825-2130 m., and Biswas's (1960a) probable sight record from Sangasoti Danda, Chautara district, central Nepal, at *c.* 2130 m.

*513. **Garrulax affinis affinis** Blyth. Western Blackfaced Laughing Thrush.

Since Hodgson's days this laughing thrush has been reported from Nepal by Smythies (1948, p. 440) in the Gandak-Kosi watershed, central Nepal, at *c*. 3350-3960 m. in autumn; Proud (1952a, p. 362) in the same area at *c*. 3505 m. in spring; Polunin (1955, p. 888) in the Langtang Valley, central Nepal, at *c*. 3050-4115 m. in summer; Lowndes (1955, p. 30) in Manangbhot, central Nepal, at *c*. 2745 and 3655 m. in summer; and Rand & Fleming (1957, p. 132) in the Kali Gandak Valley, west-central Nepal, in winter.

*514. **Garrulax affinis bethelae** Rand & Fleming. Eastern Blackfaced Laughing Thrush.

The Blackfaced Laughing Thrush from eastern Nepal belongs to this subspecies. It has so far been recorded there by Ripley (1950b, p. 395) at *c*. 2745 m. in winter; Rand & Fleming (1956, p. 2; 1957, p. 133) in Okhaldhunga district at *c*. 3050 m. in winter; and by Biswas (1960a) in Khumbu from *c*. 3050 to 4570 m. in February-May.

515. **Garrulax erythrocephalus kali** Vaurie. Nepal Redheaded Laughing Thrush.

CHITLANG VALLEY: Chitlang: 4 ♂♂, 1 ♀ (April 16-22). NEPAL VALLEY: Thankot: 4 ♂♂, 1 juv. ♂, 5 ♀♀, 1 (♀) (March 22—April 18, June 29, July 22).

The Redheaded Laughing Thrush is not uncommon on hills round the Nepal Valley in pairs or small parties of four to six birds in undergrowths of forests.

Rand & Fleming (1957, p. 133) reported it also from west-central Nepal.

A male specimen has its tail moulting on April 20.

The juvenile male bird taken July 22 is similar to adult, but has the mantle and sides of the neck olive rufous, a few feathers having black subtips; the feathers on the breast have black subtips but not those of the neck.

Measurements :

	8 ♂♂	7 ♀♀
Wing:	100, 101, 102 (4), 103, 104	94, 95, 96[a], 96+, —, 97, 99
Tail:	114 (4), —, 115 (2), 117	—, 106, 106[a], 106+, 107+, 108, 108+
Bill:	24.5 (2), 25 (4), 25.5, 26	24, 24.5 (2), 25[a], 25, —(2)

[a] Marked ♂ on label, but very probably wrongly sexed.

Rand & Fleming (op. cit., pp. 134-135) have given an excellent summary of the geographical variation in the populations of this species from Mussoorie to Sikkim. I would only add that the specimens listed above have the ear coverts margined generally with pink and in a few cases with pink and white. Only five specimens have traces of dusky on the crown.

*516. **Garrulax erythrocephalus nigrimentus** (Oates). Sikkim Redheaded Laughing Thrush.

This form was first reported from Nepal by Gray (1863, pp. 42-43) based on Hodgson's later collection and was entered under the name *Pterocyclus chrysopterus*. It was subsequently obtained in eastern Nepal by Rand & Fleming (1957, pp. 133-134) from Okhaldhunga district, and by Biswas (1960a) from the Dudh Kosi Valley.

Vaurie (1953a, pp. 78-79) questioned the occurrence of this subspecies in Nepal because the manuscript name of Hodgson's figure on which Oates named this form was based on a specimen which, according to Kinnear (quoted by Vaurie), almost certainly came from Sikkim. However, Gray (op. cit., p. 43) gave Nepal as the locality, and there is no doubt that a good deal of eastern Nepal elements were present in Hodgson's later collection.

Rand & Fleming's specimen mentioned above is perhaps not true *nigrimentus*, nor are perhaps Biswas's (1960a) (see also Ripley, 1961, p. 395).

*517. **Liocichla phoenicea phoenicea** (Gould). Nepal Crimsonwinged Laughing Thrush.

The Crimsonwinged Laughing Thrush is known from Nepal only through Hodgson's and Gould's specimens.

518. **Leiothrix argentauris argentauris** (Hodgson). Silver-eared Mesia.

DUN : Hitaura, Bhimphedi : 9 ♂♂, 6 ♀♀ (March 14, May 11—June 5).

The Silver-eared Mesia is not an uncommon bird of the central dun, especially in the Hitaura region. It occurs in small flocks of six to ten birds on bushes in the forests.

It was also reported from western and west-central Nepal by Ripley (1950b, p. 395) and Rand & Fleming (1957, p. 135).

Some of my May-June birds are fairly worn.

Measurements :

	9 ♂♂	6 ♀♀
Wing :	75, 76 (2), —(2), 78 (3), 81	73.5+, 75 (3), 77.5, 78
Tail :	66, 67, 68 (2), 69 (3), 71 (2)	63+, 67 (2), 69 (2), 70
Bill :	17, 18, 18.5 (4), 19 (3)	17.5 (2), 18 (3), —

519. **Leiothrix lutea calipyga** (Hodgson). Eastern Redbilled Leiothrix or ' Pekin Robin '.

CHITLANG VALLEY : Chitlang : 7 ♂♂, 6 ♀♀ (April 16-26).

The Redbilled Leiothrix is a common bird of central Nepal. In April-May it was found by us in the Nepal and Chitlang Valleys occurring in pairs or small parties of four to six individuals in scrub or bushes in forests.

Smythies (1950, p. 514) found only a solitary example in the Nepal Valley on Sheopuri at *c.* 2135 m. on September 1, 1942, but none in June, July or August. Proud (1952a, p. 363) reported it also from the northern region of central Nepal in the Gandak-Kosi watershed at *c.* 2435 m. in spring; and Rand & Fleming (1957, p. 135) from west-central Nepal at *c.* 915 and 1400 m. in winter. It was not found by Scully (1879).

Some of my specimens are somewhat worn.

Measurements :

	7 ♂♂	6 ♀♀
Wing:	66+, 67 (2), 69, 70 (3)	65 (2), 67, 67.5, 68, 69
Tail:	55+, 56 (2), 57 (3), 59	53, 55 (2), 56, 57 (2)
Bill:	15, 15.5, 16 (3), 16.5, —	15, 15.5 (2), —(3)

*520. **Myzornis pyrrhoura** Blyth. Firetailed Myzornis.

The post-Hodgsonian records of the Firetailed Myzornis from Nepal consist of Stevens's (1923b, p. 739) from the Singalila Range, eastern Nepal, at *c.* 2285-3050 m. in March-April, and Ripley's (1950b, p. 396) from eastern Nepal at *c.* 2745 m. in winter.

521. **Cutia nipalensis nipalensis** Hodgson. Nepal Cutia.

MARKHU VALLEY : Deorali : 4 ♂♂, 2 ♀♀ (April 28—May 2). CHITLANG VALLEY : Chitlang : 2 ♂♂ (April 18).

The Nepal Cutia does not appear to be a common bird of central Nepal. We observed it in small parties on Phulchauki Danda above Godavari, Chandragiri above Chitlang, and on the Mahabharat Range at Deorali, in deep forests.

Neither Scully (1879) nor Ripley (1950b) reported it from Nepal.

Measurements :

	Wing	Tail	Bill
6 ♂♂:	90, 91 (2), 93 (2), 96	58, 59 (2), 60 (2), 60.5	22.5 (2), 23 (3), 23.5
2 ♀♀:	85, 88	56.5, 58	21 (2)

*522. **Pteruthius rufiventer** Blyth. Rufousbellied Shrike-Babbler.

The specimens of the Rufousbellied Shrike-Babbler from Hodgson's later collection received by the Museum of the East India Company, were entered as coming from Nepal (Horsfield & Moore, 1854, p. 173), but those received by the British Museum were stated to be coming from Darjeeling (Gray, 1863, p. 50). I am unable to trace any other record of the species from Nepal.

523. **Pteruthius validirostris ripleyi** Biswas. Himalayan Redwinged Shrike-Babbler.

MARKHU VALLEY: Deorali: 3 ♀♀ (May 2-3). CHITLANG VALLEY: Chitlang, Chandragiri above Chitlang: 3 ♂♂, 4 ♀♀ (March 15, April 18-21). NEPAL VALLEY: Thankot, crest of Chandragiri: 6 ♂♂, 5 ♀♀ (March 28—April 15, 23).

The Redwinged Shrike-Babbler is a common bird of central Nepal occurring in pairs in the forests on hills round the Nepal Valley, as well as on the Mahabharat Range. During March-May it was not seen much below 1830 m.

Rand & Fleming (1957, p. 135) reported it also from western and west-central Nepal.

It was breeding from mid-April, laying in early May. A male taken April 18 had the testes measuring R: 7×5.5, L: 9.25×5 mm.; and another male shot on April 21 had them R: 7×4.5, L: 8.25×5.75 mm.; while two female specimens of April 15 and 20 had 9×7 (largest ovum 2.5) mm., and 10×5.25 (largest ovum 2) mm. ovaries, respectively.

Colours of soft parts: Iris greenish grey; upper mandible black with bluish slate on edges and sides of the basal third, lower mandible bluish slate paler, on tip; legs and feet fleshy; claws horny; pads fleshy white.

Measurements:

	9 ♂♂	12 ♀♀
Wing:	80(2), 81.5, 82, 84, 85 (4)	78, 79, 79+, 81 (3), 82, 83, 84, 84.5, 85, 87
Tail:	59 (2), 60 (2), 61 (3), 62, 64	57, 58+, 59 (2), 60 (2), 61 (2), 62 (2), 63, 64
Bill:	18, 18.5 (2), 19 (5), 19.5	18.5 (3), 19 (6), 19.5 (2), 20

*524. **Pteruthius xanthochloris xanthochloris** J.E. & G.R. Gray. Green Shrike-Babbler.

The post-Hodgsonian Nepali records of the Green Shrike-Babbler have been provided by Proud (1955, p. 60) and Rand & Fleming (1957, p. 136) from the Nepal Valley at *c.* 2130-2435 m. The latter authors found it also in the Maulung Valley (Okhaldhunga district), eastern Nepal, at *c.* 3050 m.

525. **Pteruthius melanotis melanotis** Blyth. Chestnut-throated Shrike-Babbler.

MARKHU VALLEY: Deorali: 1 ♂, 1 ♀ (April 29, May 1).

We came across this shrike-babbler in central Nepal only on a few occasions in April-May, when it occurred in pairs.

Neither Scully (1879) nor Ripley (1950b) reported it from Nepal, but Proud (1955, p. 59) and Rand & Fleming (1957, p. 136) noted it in the Nepal Valley.

Measurements :

	Wing	Tail	Bill
1 ♂ :	61.5	42	—
1 ♀ :	56	39+	13

526. **Actinodura egertoni egertoni** Gould. Nepal Barwing.

Chitlang Valley : Chitlang : 1 ♀ (April 16).

The Nepal Barwing was found by us to be rare indeed in central Nepal. It was observed only once in a small party of four or five birds in dense forest at the foot of Chandragiri above Chitlang. It would appear that the present specimen is the only example of the species collected from Nepal since Hodgson's days.

The specimen is in worn plumage.

Measurements : 1 ♀ : Wing 85 + ; tail 113+ ; bill 19.

527. **Actinodura nipalensis nipalensis** (Hodgson). Nepal Hoary Barwing.

Chitlang Valley : Chandragiri above Chitlang : 6 ♂♂, 5 ♀♀ (April 16-25).

This barwing was commonly found by us on hills round the Nepal Valley, including the southern face of Chandragiri above Chitlang. It was seen to occur in small parties of three to six individuals in oak forests, usually above 1830 m.

Smythies (1948, p. 440) and Proud (1952a, p. 362) found it in the Gandak-Kosi watershed, central Nepal, between *c.* 2130 and 2745 m. (once at *c.* 3350 m.); Smythies (1950, p. 514) reported it as resident above *c.* 2440 m. on Phulchauki Danda and Sheopuri Lekh, both in the Nepal Valley; and Rand & Fleming (1957, p. 136) found it also in west-central Nepal at *c.* 2130 m.

All the specimens listed above are worn, a few being very much so.

Measurements :

	Wing	Tail	Bill
6 ♂♂ :	91, 91 + (2), — (2), 93	82+, 83, 84, — (3)	21.5, 22 (5)
5 ♀♀ :	87+, — (2), 89 + (2)	77, — (2), 79, 80	20.5, 21 (3), 21.5

*528. **Actinodura nipalensis vinctura** Ripley. Eastern Hoary Barwing.

The Hoary Barwing from eastern Nepal to Bhutan was separated by Ripley (1950a, p. 104) as distinct from the western populations. This form was recorded only twice from Nepal, by Ripley (loc. cit., and 1950b, p. 396) from the type locality, and by Rand & Fleming (1957, p. 137) from Okhaldhunga district, eastern Nepal.

*529. **Minla ignotincta ignotincta** Hodgson. Redtailed Minla.

Neither Ripley (1950b) nor we came across the Redtailed Minla in Nepal. In central Nepal it was reported from the Nepal Valley by Scully (1879, pp. 319-320), Proud (1949, p. 701; 1955, p. 59), and Rand & Fleming (1957, p. 137), and from Sangasoti Danda, Chautara district at *c.* 2285 m. in January by Biswas (1960a). Rand & Fleming found it also in Okhaldhunga district, eastern Nepal.

530. **Minla strigula strigula** (Hodgson). Stripethroated Siva.

CHITLANG VALLEY: Chitlang: 1 ♂, 2 ♀♀ (April 20-24). NEPAL VALLEY: Thankot: 1 ♂ (April 12).

The Stripethroated Siva did not appear to be particularly common in central Nepal. It was seen by us only on a few occasions on Phulchauki Danda above Godavari, and on Chandragiri both on Thankot and Chitlang sides. Our observation in this regard agrees with Ripley's (1950b, p. 396) rather than with Scully's (1879, p. 319).

In west-central Nepal, Rand & Fleming (1957, p. 137) found it in the Kali Gandak Valley at *c.* 2130-2745 m. in November. In the northern regions of central Nepal, it was reported from the Gandak-Kosi watershed by Smythies (1948, p. 440) at *c.* 2130-3350 m. in autumn, and Proud (1952a, p. 363) at *c.* 2435-2745 m. in spring; from the Langtang Valley by Polunin (1955, p. 889) at *c.* 2745-3050 m. in summer; and from Manangbhot by Lowndes (1955, p. 31) at *c.* 2435-3050 m. in summer. In eastern Nepal, it was recorded from Okhaldhunga district at *c.* 1825-2285 m. by Rand & Fleming (op. cit., p. 138), and in Dhankuta district by Ripley (loc. cit.) at *c.* 1980-2745 m. in winter.

Measurements:

	Wing	Tail	Bill
2 ♂♂:	70(2)	69, 72	14·5, 15
2 ♀♀:	66, 69	67, 68	15(2)

The length of tail 'about 70 to 72 mm.' as given by Baker (1922d, p. 313) for this bird (ssp. *strigula+simlaensis*) does not appear to be quite correct. Thirty specimens, males and females, from Nepal, Sikkim, Darjeeling and Bhutan measure: 65(1), 66(3), 67(4), 68(4), 68.5(2), 69(5), 69.5(3), 70(3), 71(3), 72(2).

531. **Minla cyanouroptera cyanouroptera** (Hodgson). Bluewinged Siva.

DUN: Bhimphedi: 1 ♀ (May 4). MARKHU VALLEY: Deorali: 3♂♂, 1 ♀, 1 juv. ♀ (April 29—May 2). NEPAL VALLEY: Thankot: 1 ♂, 1 ♀ (March 22, April 8).

The Bluewinged Siva was found infrequently in central Nepal by us. In the Nepal Valley it was seen at Godavari and Thankot, but appeared commoner on the Mahabharat Range around Deorali.

Scully (1879, p. 319) noted it as scarce in the Nepal Valley where Smythies (1950, p. 514) recorded it as a resident species above *c*. 2440 m. on the Phulchauki and Sheopuri Ranges. Rand & Fleming (1957, p. 138) reported it as one of the commonest species of central Nepal. They found it also in western and west-central Nepal.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	63, 65, 65.5, 65	66.5, 68, 69, 70	17(2), —(2)
3 ♀♀ :	65 (2), 67	67, 68 (2)	16 (2), 17

*532. **Yuhina bakeri** Rothschild. Chestnut-headed Ixulus.

The first post-Hodgsonian record of the Chestnut-headed Ixulus from Nepal has been provided by Ripley (1950b, p. 397) who found it in Dhankuta district, eastern Nepal. It has subsequently been reported by Rand & Fleming (1957, p. 139) from west-central and central Nepal, at *c*. 1825 and 2285 m. in winter, and by Biswas (1960a) from Khumbu, eastern Nepal, at *c*. 3960 m. in early April.

*533. **Yuhina flavicollis albicollis** (Ticehurst & Whistler). Western Yellownaped Ixulus.

The Yellownaped Ixulus was first reported from Nepal by Ripley (1950b, p. 396) in the western region. Later, it was again recorded from western and west-central Nepal by Rand & Fleming (1957, p. 138). They, however, list all their birds from western to central Nepal under the nominate *flavicollis*. I have followed Ripley (1961, p. 408) in assigning the western and west-central birds under *albicollis*.

534. **Yuhina flavicollis flavicollis** Hodgson. Yellowheaded Ixulus.

DUN : Bhimphedi : 1 ♀ (March 13). MARKHU VALLEY : Deorali : 1 ♀ (April 28). CHITLANG VALLEY : Chitlang : 2 ♂♂, 3 ♀♀ (April 17-22). NEPAL VALLEY : Thankot : 7 ♂♂, 4 ♀♀ (March 24—April 7).

The Yellowheaded Ixulus is common in central Nepal on hills round the Nepal Valley and on the Mahabharat Range. It occurs in small flocks on bushes or on lower branches of trees in the forests.

It was reported from the northern regions of central Nepal by Proud (1952a, p. 363) in the Gandak-Kosi watershed at *c*. 2435-3050 m. in spring, Polunin (1955, p. 889) in the Langtang Valley at *c*. 2745 m. in summer, Lowndes (1955, p. 31) in the Marsiyandi Valley at *c*. 1980 m. in summer. In eastern Nepal, it was reported by Stevens (1923b, p. 737) on Singalila Range in May, and Ripley (1950b, p. 397) from Dhankuta district in winter.

Measurements :

	9 ♂♂	9 ♀♀
Wing :	63 (3), 64 (2), 65 (3), 65.5	61 (2), 61.5, 62 (2), 63 (2), 64, 64+
Tail :	50 (6), 51 (2), 52	48, 49, 49+, —, 50(3), 51 (2)
Bill :	14 (5), 14.5 (2), 15 (2)	14 (5), 14.5, 15, —(2)

535. **Yuhina gularis gularis** Hodgson. Eastern Stripethroated Yuhina.

MARKHU VALLEY : Deorali : 2 ♂♂, 2 ♀♀ (April 28—May 1). CHITLANG VALLEY : Chitlang : 6 ♂♂, 5 ♀♀ (April 21-26). NEPAL VALLEY : Thankot : 1 ♂, 2 ♀♀ (April 2).

The Stripethroated Yuhina is common in central Nepal in bushes and lower branches of trees. It occurs in flocks and at an altitude of about 1825 m. upwards.

In west-central Nepal, it was found by Rand & Fleming (1957, p. 139) at *c.* 2130 m. in November. In the northern regions of central Nepal, it was reported by Proud (1952a, p. 362) in the Gandak-Kosi watershed up to *c.* 3350 m. in spring, Polunin (1955, p. 889) in the Langtang Valley at *c.* 2745 and 3340 m. in summer, and Lowndes (1955, p. 31) in the Marsiyandi Valley at *c.* 2435 m. in summer. In eastern Nepal, it was recorded from Dhankuta district at *c.* 1980-2745 m. in winter by Ripley (1950b, p. 397), and Okhaldhunga district at *c.* 3050 m. in December by Rand & Fleming (loc. cit.).

Most of my specimens are in different stages of moult. A few however, have not started moulting yet, while a few others have just completed moult.

Measurements :

	9 ♂♂	9 ♀♀
Wing :	70+, 72, 73 (2), 74 (4), 77	68+, 69, 71, 71+, 73 (3), 73+, 74
Tail :	56 (4), —, 57 (2), 58 (2)	53 (2), 54, 55 (3), —, 57, 58
Bill :	17·5, 18 (8)	17·5, 18 (6), —(2)

*536. **Yuhina occipitalis occipitalis** Hodgson. Rufousvented Yuhina.

This yuhina was not obtained by us, or by Ripley (1950b) or Rand & Fleming (1957). However, Scully (1879, pp. 321-322) found it to be resident in the Nepal Valley, and Proud (1949, p. 700) noted it common there on higher hills. She further (1952a, pp. 362-363) reported it from the Gandak-Kosi watershed, central Nepal, at *c.* 3350 m. in spring. Polunin (1955, p. 889) recorded it in the Langtang Valley, central Nepal, at *c.* 3050 m. in summer. Lowndes (1955, p. 31) found it in the Marsiyandi Valley, central Nepal, at *c.* 2435 m. in summer.

537. **Yuhina nigrimentum nigrimentum** Blyth. Blackchinned Yuhina.

DUN : Bhimphedi : 2 ♂♂, 2 ♀♀ (March 12, May 3, 4).

The Blackchinned Yuhina appeared rather uncommon in central Nepal. We saw it on a few occasions in small flocks on the upper branches of trees in the forests of Bhimphedi region in the dun.

Ours appears to be the only post-Hodgsonian record of the species from Nepal.

A female taken March 12 has the moult on the forecrown nearly finished. Incidentally, this specimen was breeding, somewhat early for the species.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	55.5, 57	38, 39	—, 13
2 ♀♀ :	55 (2)	38, 39	14 (2)

538. **Yuhina zantholeuca zantholeuca** Blyth. Whitebellied Erpornis.

DUN : Hitaura : 5 ♂♂, 2 ♀♀ (May 11-22).

The Whitebellied Erpornis is not a common bird of central Nepal. We observed it in pairs on bushes and trees in the forests of the Hitaura dun.

Scully (1879) did not find it in Nepal, but Proud (1949, p. 700), Ripley (1950b, p. 397) and Rand & Fleming (1957, pp. 140-141) noted it on hills round the Nepal Valley. The last-named authors also reported it from west-central and eastern Nepal.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	64, 65, 66, 68 (2)	44, 45, 46, 47, 48	14.5, 15 (3), 15.5
2 ♀♀ :	62, 63	42, 45	14.5, 15

*539. **Alcippe chrysotis chrysotis** (Blyth). Goldenbreasted Fulvetta.

The only record of the Goldenbreasted Fulvetta from Nepal since Hodgson's days is Stevens's (1923b, p. 734) from the Mai Valley, eastern Nepal, at *c.* 2435-3050 m. in March-May.

*540. **Alcippe cinerea** (Blyth). Dusky Green Tit-Babbler.

The only post-Hodgsonian record of this species from Nepal consists of Proud's (1949, p. 700) observational report above Godavari at *c.* 2130 m. on Phulchauki Danda, Nepal Valley, in April.

541. **Alcippe castaneceps castaneceps** (Hodgson). Chestnut-headed Tit-Babbler.

MARKHU VALLEY : Deorali : 2 ♂♂ (April 28, May 1). CHITLANG VALLEY : Chitlang : 5 ♂♂, 4 ♀♀, 1 unsexed (April 18-26). NEPAL VALLEY : Thankot, Chandragiri Pass : 5 ♂♂, 6 ♀♀, 1 unsexed (March 22—April 18).

The Chestnut-headed Tit-Babbler is a common bird on hills round the Nepal Valley and on the Mahabharat Range. It occurs in small flocks, usually above 1825 m., in undergrowths, dense bushes, sometimes even on trees.

Measurements :

	12 ♂♂	10 ♀♀	2 unsexed
Wing :	56, 56.5(2), 56.5+, 57(5), 58 (2), 59	53, 53.5(2), 54(4), 55 (3)	55, 58
Tail :	42, 43(3), 44(4), 44.5, 45(2), 45.5	41(2), 41.5, 42(3), 42.5(2), 43,—	42, 45
Bill :	12.5(2), 13(7), —(3)	11.5, 12(7), 12.5,—	12, 13

Ripley (1950b, pp. 397-398) has discussed the geographical variation in this species on the material available to him, and concluded: 'From the speciation point of view there are probably several different populations, but I hesitate to recognise them. From the point of view of convenience in arranging these specimens in drawers in a museum (a necessary if arbitrary process) I would be inclined to recognize *castaneceps* as the race of Nepal, Sikkim, Assam, Burma, Yunnan and Siam, . . .' And recently, he (1961, p. 411) followed this arrangement, synonymizing *brunneicauda* Sharpe and *garoensis* Koelz with nominate *castaneceps*. However, an examination of fresh skins from the Himalayas and southern Assam shows that the populations from the Garo and Khasi Hills are indeed paler than that of central Nepal, the chestnut of the head being palest in Garo Hills birds, so that both *brunneicauda* Sharpe (1883, p. 609) and *garoensis* Koelz (1951, p. 29) should be admitted for the Khasi and Garo Hills birds, respectively.

542. **Alcippe vinipectus vinipectus** (Hodgson). Hodgson's Fulvetta.

CHITLANG VALLEY: Chitlang: 3 ♂♂, 3 ♀♀ (April 20-25). NEPAL VALLEY Thankot: 1 ♀ (April 6).

We did not find Hodgson's Fulvetta to be common in central Nepal. It was seen in small flocks on both sides of the Chandragiri in undergrowths and bushes on the edges of forests during April.

Scully (1879) did not observe it in Nepal. In the northern regions of central Nepal, it was found by Smythies (1948, p. 440) in autumn at *c.* 3350-3655 m. in the Gandak-Kosi watershed where Proud (1952a, p. 362) also came across it at *c.* 2895-3350 m. in spring; Lowndes (1955, p. 31) in the Marsiyandi Valley at *c.* 2435 m. in summer. Smythies (1950, p. 514) reported it as a probable resident species on Phulchauki and Chandragiri Ranges, central Nepal, above *c.* 2440 m. Rand & Fleming (1957, p. 141) noted it in the Kali Gandak Valley, west-central Nepal, at *c.* 1525-2745 m. in winter.

Measurements :

	Wing	Tail	Bill
3 ♂♂ :	54+(2), 55	48, 49(2)	10.5, 11, 12
4 ♀♀ :	51, 51+, 53, 54	46, 47, —, 52	10.5, 11 (2), 11.5

*543. **Alcippe vinipectus chumbiensis** (Kinnear). Eastern Fulvetta.

The Eastern Fulvetta ranges from eastern Nepal eastward. It has been recorded for the first time from Nepal by Ripley (1950b, p. 398) from Dhankuta district, at *c.* 2745 m. in winter. It has subsequently been reported by Rand & Fleming (1957, pp. 141-142) from Okhaldhunga district at *c.* 2130-3050 m. in winter, and Biswas (1960a) from Khumbu at *c.* 3655-3960 m. in the Dudh Kosi and Imja valleys during the latter half of February and early March, and in the Imja Valley at *c.* 4265 m. early in May.

544. **Alcippe nipalensis nipalensis** (Hodgson). Nepal Babbler.

DUN : Bhimphedi : 3 ♂♂, 2 ♀♀, 1 unsexed (March 12, May 4-7). MARKHU VALLEY : Deorali : 2 ♂♂, 1 ♀ (April 28—May 2). CHITLANG VALLEY : Chitlang : 5 ♂♂, 1 ♀ (April 17-26). NEPAL VALLEY : Phulchauki Danda above Godavari, Thankot : 14 ♂♂, 5 ♀♀, 1 juv. ♀ (March 16—April 9, May 13).

The Nepal Babbler is a very common bird of central Nepal. We found it in pairs or small parties on hills round the Nepal Valley near their bases, and on the Mahabharat Range, on bushes as well as on trees usually above *c.* 1525 m. (*cf.* Baker, 1922d, p. 276).

Rand & Fleming (1957, p. 142) reported it also from west-central Nepal at *c.* 760-1675 m. in winter.

The juvenile female specimen has a rufous tinge on the back and tail.

Measurements :

	24 ♂♂	9 ♀♀	1 unsexed
Wing :	57+, 59, 60 (7), 60+, 60.5, 61 (8), 61.5, 62(3), 62.5	58, 59.5, 60(3), 60.5(2), 62, 63	60
Tail :	57, 58, 59(6), 59.5, 60(4), —, 61 (3), 61.5(3), 62 (2), 62.5, 63	58, 59, 59.5, 60(3), 61.5, 62, 64	59
Bill :	13.5 (2), 14 (13), 14.5 (8), —	—, 14 (5), 14.5, 15 (2)	14

545. **Heterophasia capistrata nigriceps** (Hodgson). Nepal Blackheaded Sibia.

DUN : Bhimphedi: 1 ♂, 1 ♀ (March 11, May 6). MARKHU VALLEY : Deorali: 2♂♂ (April 30). CHITLANG VALLEY : Chitlang : 3 ♂♂, 2 ♀♀ (March 15). NEPAL VALLEY : Thankot, Chandragiri above Thankot, Crest of Chandragiri: 8 ♂♂, 2 ♀♀, 1 unsexed (March 23-31, April 14-18).

The Blackheaded Sibia is quite a common bird of central Nepal in forests above 1525 m.

In the northern regions of central Nepal, it was recorded by Proud (1952a, p. 363) in the Gandak-Kosi watershed at *c.* 2435-2745 m. in spring, Polunin (1955, p. 889) in the Langtang Valley at *c.* 2590-

2895 m. in summer, and Lowndes (1955, p. 31) in the Marsiyandi Valley and Manangbhot at *c.* 1980-3200 m. in summer. Rand & Fleming (1957, p. 142) found it in western and west-central Nepal at *c.* 1065-2130 m. in winter.

Measurements :

	14 ♂♂	5 ♀♀	1 unsexed
Wing :	96(3), 97(2), 98(3), 99(2), 100(2), 101, 102	90, 90+, 91, 92, 93	96
Tail :	99+, 100(2), 101(2), 102(2), 103(3), 105(3), 106	94, 95(2), 97, 99	106
Bill :	22, 22.5(2), 23(2), 23+, 23.5(2), 24(5), —	22, 22.5, 23, 23.5,—	23.5

***546. Heterophasia capistrata capistrata** (Vigors). Eastern Black-headed Sibia.

Cinclosoma capistratum Vigors, 1831, *Proc. zool. Soc. Lond.* (1) : 56. (Himalayas = Darjiling, according to Baker, 1922d, p. 296.)

Leioptila capistrata bayleyi Kinnear, 1939, *Ibis* (14) **3** : 752. (Taktoo, near Sakdan, Bhutan.)

This eastern form has been recorded from eastern Nepal by Ripley (1950b, p. 399) in Dhankuta district at *c.* 2130 m. upwards, Rand & Fleming (1957, p. 142) in Okhaldhunga district at *c.* 2285 and 2745 m. in December, and Biswas (1960a) on Sangasoti Danda and in Likhu Valley, Ramechhāp district, at *c.* 1740-1980 m. during late January and early February, in the Hongu and Tamur valleys and on the Nepal side of the Singalila Range between 1830 and 2745 m. in June.

Ripley (loc. cit.) has discussed the question of the nomenclature of the Himalayan races of this species. As additional evidence for synonymizing *bayleyi* Kinnear with *capistrata* Vigors, I may mention here that although Kinnear (op. cit., pp. 751-752) thought that Vigors's description of *capistrata* 'dorso medio pallidè brunnescenti-griseo' applied only to the western Himalayan bird, he described *bayleyi* as having 'darker colour of the back, which is sooty brown tinged with grey'. Kinnear's description of *bayleyi* would appear to fit in admirably with Vigors's of *capistrata.*

Recently, however, Ripley (1961, pp. 416-417) has gone back to Ticehurst-Whistler-Kinnear arrangement in re-restricting the type locality of *capistrata* Vigors to Simla, in spite of earlier restrictions by Baker, Ticehurst and Whistler.

***547. Heterophasia picaoides picaoides** (Hodgson). Longtailed Sibia.

The sole post-Hodgsonian Nepali record of the Longtailed Sibia is Scully's (1879, p. 293) who reported it to be 'tolerably common about Nimboatar [in the central dun] in winter, but was not observed elsewhere in Nepal'.

(*To be continued*)

An Account of a trip to the Barapede Cave, Talewadi, Belgaum District, Mysore State, with some Notes on Reptiles and Amphibians

BY

HUMAYUN ABDULALI

(*With one text-figure*)

In May 1961, I accompanied Mon. A. Brosset on a short trip to the Barapede Cave at Talewadi (Belgaum District, Mysore State). The main objective was Wroughton's Free-tailed Bat, *Otomops wroughtoni* (Thomas), discovered here by the late Mr. S. H. Prater in 1912 and not recorded since then from anywhere. We took with us two members of the Society's staff, P. W. Soman and M. J. Pereira. The 'long-lost' bats were present in numbers in cracks in the roof of the cave, and specimens were caught in a net thoughtfully brought by M. Brosset all the way from Bombay—a net with a long handle made up of poles which fitted into each other. In the course of the trip, Soman visited a large and extensive group of caves at Krishnapur, some six miles down the valley to the west of Talewadi and close to the Goa border, and collected some bats, including 5 males of *Taphozous theobaldi* Dobson. This species has a wide distribution over Burma, Malaya, and Java, but there is only one previous record of it from India—3 males obtained at Asirgarh, Nimar, Central India, during the Mammal Survey in 1911. M. Brosset is reporting on the bats in the course of a paper dealing with the species met by him during his sojourn of two years in India. I am giving a short account of the other aspects of the trip as readers may find it of interest.

Leaving Bombay by car on the morning of the 19th May, we arrived the same night at the Forest Bungalow at Khanapur (on the road to Karwar) which was to be our headquarters. On the 20th, we drove to Shiroli twenty miles away and proceeded thence by car to Hemadga (4 miles) and then on foot to Talewadi and the Cave on the top of the Ghat, a distance of another five miles. On the way, at Hemadga, we were joined by Mr. P. L. Menezes, a retired miner, who took a share in our bat-catching and other natural history activities.

Our trip was discussed when M. Brosset first arrived in Bombay, but was finally arranged at short notice. Only a day before we left Bombay, we discovered that Talewadi and the Barapede Cave lay in a Security Area and that special permission was required to visit it. In response to telephonic and telegraphic requests, the Commissioner of the Division very kindly arranged to send a message to Talewadi and left a copy of it with the Forest Department at Belgaum, which we picked up on our way through. On our way to the Cave, we happened to by-pass the hamlet and the police outpost at Talewadi. Coming back from the Cave and nearing Talewadi, we found ourselves being rapidly approached by three armed persons, one of them carrying a Sten gun ready for action, and evidently a police patrol guarding the Goa border. We were a party of seven, carrying two guns and including a European. Conscious how suspicious our appearance and movements must seem and how short a time there had been for the local authorities to be informed about our presence in the area, we tried to look unconcerned and waited for them to come up to us. There were a few tense moments. Fortunately, we were able to satisfy them as to our bona fides and they took us to their camp and entertained us to a very welcome cup of tea.

After the successful catch at the Barapede Cave, Mr. Menezes offered to show us the way to the Krishnapur Caves, about which we had been told at Talewadi. As we had effected our main object, we thought it would be more interesting to visit the Dandeli Game Sanctuary. So the party broke up and Soman stayed over at Hemadga to visit Krishnapur, while the others returned to Khanapur. On the 21st, we drove over hilly and forested country to Dandeli. It was raining most of the time and we arrived to find that the causeway over the river bordering the Sanctuary had been flooded since the morning and would be unusable for the duration of the monsoon! On the way back, we had to make a detour of several miles to go round another impassable causeway. Hurrying to Shiroli in the evening to pick up Soman, we found the road beyond it impassable and returned to Khanapur, leaving him to spend another night at Hemadga. On the 22nd morning, we were back at Shiroli and met Soman, who had had a strenuous but interesting and successful walk to Krishnapur. We then turned back and, spending a night at Satara, reached Bombay on the 23rd, after making a short stop at Mahableshwar.

On the open plateau at Talewadi, we saw marks of bison which are said to visit this place in some numbers during certain seasons of the year. Beyond these hoof prints, we saw no trace of any game (in which term I am including hare) in all our travelling, some of which was at night. On the Nagargali Ghat, a forest contractor drove past and stopped to chat. A shot-gun rested against his seat, ready for action. There can be little doubt that here, as in Bombay and almost all over the country, most of the larger animals have been killed off by indiscriminate shooting from cars, and by the large number of crop-protection guns.

Of birds, we did not see many. No partridge, junglefowl, or peafowl was seen. A few miles before Belgaum was a raptor's nest high up in a tree, visible from the road. On the return journey, we stopped for a while and the single full-fledged young of the Booted Eagle (*Hieraaëtus pennatus*) flapped away from the nest. At the same place, we saw White-eyes (*Zosterops palpebrosa*) and Bay-backed Shrikes (*Lanius vittatus*) building, while Brahminy Mynas (*Sturnus pagodarum*) were seen entering a hole up in a tree. At Khanapur, Red-rumped and Wire-tailed Swallows (*Hirundo daurica erythropygia* and *H. smithii filifera*) were both present. A pair of the former was attending to a nest still unlined and empty under a culvert. A party of 4 adult and 5 young Wire-tailed Swallows were settled on a half-built bridge across the river. The adults perched on steel rods projecting horizontally from the structure, while the young, which flew about, appeared to cling to vertical surfaces only. I did not have the opportunity of watching them long enough to be sure, but it would indeed be interesting if such a difference in perching habits at different ages could be confirmed. Four young of the Pied Bush Chat (*Saxicola caprata*) in the spotted stage were noted. Only the male parent was seen and the small amount of white on the lower surface, restricted to the vent, separated him from the migrant form *bicolor*, but it was not possible to decide whether it was *burmanica* of Baker which breeds at Khandala, or *nilgiriensis* of Whistler described from Ootacamund, Nilgiris.

A pair of Crow-Pheasants (*Centropus sinensis*) attracted attention —one chased the other, hopping along the ground and in short flights, over several hundred yards. One or both, usually the pursuer, had the tail spread out to one-and-half times or twice the normal width.

It was also often held at an absurdly tilted angle. Is this some form of courtship?

During the trip, with Soman's assistance, we secured several frogs and reptiles. In view of the scarcity of information regarding these creatures in India, I am listing them together with such fragmentary notes as we were able to record, and take this opportunity of including notes previously made by me from other places.

Lizards

1. **Hemidactylus brooki** Gray :

Under stones in burnt clearings in the forest at Talewadi. A juvenile was seen near two round eggs side by side under a stone. The young are of the same colour as the adult.

As already noted by McCann (*J. Bombay nat. Hist. Soc.* **41**: 756-7), this gecko is common near Bombay but is found more often in trees and under stones, its place in the house being taken by *H. flaviviridis* Rüppell, though at Nasik I have seen them in a house under conditions identical with those of the latter.

2. **Hemidactylus prashadi** Smith :

Several were seen on the walls of a forest bungalow at Shiroli in the evening. One young, black and strongly marked with white, was also obtained. Two recently hatched eggs close together on the top of a wooden box inside the bungalow were also noted. This appears to be a small extension of the known distribution of this species, which is recorded so far only from Jog (Gersoppa), the type locality.

3. **Hemidactylus frenatus** Dum. & Bib. :

Specimens were obtained on a lamp post in a garden in Belgaum at about 8 p.m., capturing insects attracted by the light. Though recorded from Bengal and eastern Nepal, this appears to be the northernmost known limit of this species in peninsular India[1].

4. **Hemidactylus leschenaulti** Dum. & Bib. :

One taken at Satara Dak Bungalow.

5. **Mabuya carinata** (Schneider) : The Common Skink :

Was seen but not collected.

6. **Riopa guentheri** (Gray) :

Two juveniles and two adults were found under stones in open

[1] I have subsequently obtained this species on a tree at Kihim, Kolaba District, Maharashtra, and found three specimens from Salsette Island, Bombay, in the Society's collections.

country adjoining the forest at Talewadi. This southern species extends northwards to Matheran, Kolaba District (Smith), and we have obtained it at Mahableshwar earlier.

7. **Calotes rouxi** Dum. & Bib. :

On the western slopes towards Krishnapur.

Snakes

Dryophis nasutus (Lacépède) :

A single specimen of the Green Whip Snake was captured near Talewadi. One taken at Mahableshwar on 2 November 1954 had an entire anal, while another brought in later from the same place by Fr. Norman Fuller had it normal, i.e. divided.

Amphibians

1. **Rana cyanophlyctis** Schneider :

Common in small pools on open plateau at Talewadi. They call both by day and night and also almost all through the year, though there is no evidence that they breed all the time. Many, including Babar in his MEMOIRS, have referred to its habit of skipping over the surface of the water. It does not however appear to have been noted that the last hop never stops on the surface, but is continued under water, with the frog emerging a short distance away to rest at the surface.

2. **Rana tigerina** Daud. :

Noted at Khanapur and other places. Tadpoles were obtained on the Talewadi plateau in pools as much as a hundred yards from the forest. This species also calls by day and night, but only during the breeding seasons and when seated in the water or on mud or land.

McCann in the course of his excellent Notes on Indian Batracians (*J. Bombay nat. Hist. Soc.* **36** : 158-166) refers to the pale lemon yellow of the adults being apparently due to aestivation. It is, however, strange that this colour should have been noted in males only, implying that females do not react to aestivation in the same manner. On 20 June 1955, I drove into the Krishnagiri Park, near Bombay. The monsoon was late, but it had rained a little. On the way in at about 8 a.m., I noted 2 large yellow frogs seated on the damp bottom of a pond along the road below Gandhi Mandir. There was yet no water on the surface. When we returned after about $1\frac{1}{2}$ hour, it had been raining all the time and there was quite a lot of water collected in the tank. A large number of yellow *tigerinas* had appeared from somewhere, and were all waiting to jump on to anything that moved. From a distance of about 10 yards, one could hear a low 'gurr' uttered by them.

3. **Rana limnocharis** Wiegm. :

Noted between Shiroli and Talewadi. This frog has a loud and distinctive call which is only uttered at night. Tadpoles may be found in shallow monsoon streams and even in rain water flowing over a road. They were also seen in deeper monsoon pools with stagnant water, and in rock-bound cisterns. The breeding season appears to be prolonged, for I have seen large numbers of tiny frogs in a swampy marsh along the edge of a lake not far from Nasik on 26 December 1954. The adult is reluctant to swim.

4. **Rana rufescens** (Jerdon) :

One obtained at Talewadi. This species described from Malabar also extends as far north as Khandala, and at the Kanheri Caves near Bombay on 17 June 1956 a pair was seen in copula in the water of a cistern with vertical walls. Both had orange patches at the back of their fore-arms and on the sides of the neck. On land, its habits are toad-like. The eggs and tadpoles of this frog are yet unknown.

5. **Rana breviceps** Schneider :

A specimen obtained at Satara had only one tubercle on its feet (cf. Bhaduri & Kirpalani, *J. Bombay nat. Hist. Soc.* **52** : 620-623).

6. **Rana beddomii** Gunth. :

Talewadi.

7. **Rana malabarica** Bib. :

Talewadi.

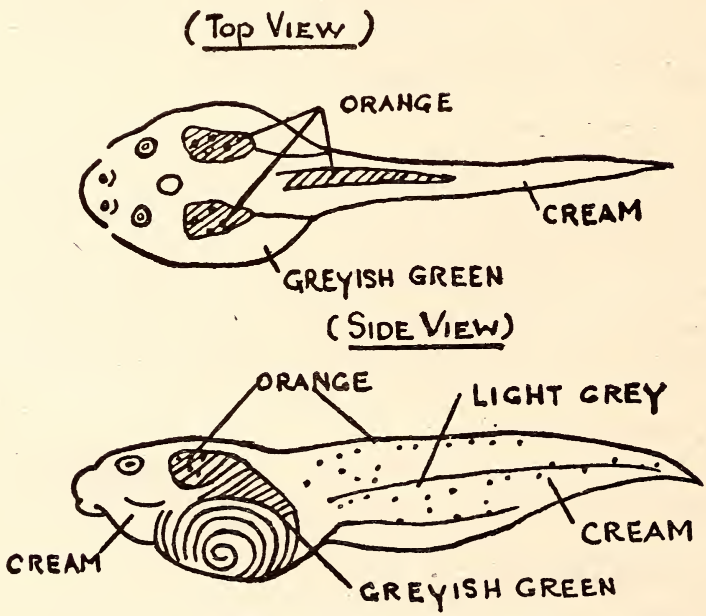
8. **Rana curtipes** Jerdon :

On the way to Talewadi, adults were obtained on the road near a stream and in a dry river bed. The adults are sluggish in their movements. In May 1953, they were found to be numerous under dry leaves on damp soil along a stream at Anmode near Castle Rock.

They are uncomfortable in water and, if driven or thrown in, immediately swim ashore.

Soman obtained tadpoles with fore and hind legs in a stream of running water on the western slopes of the Ghats beyond Talewadi. They did not keep together in a shoal. The dentition agrees with the descripion of the tadpoles of this species by Rao (*Rec. Indian Mus.* **10** : 265-266) but in colour the present series is all black and not 'uniformly dark with a few darker spots above, and dirty white below'.

During Xmas 1951, I obtained some tadpoles (see text-figure) at Dandeli which swam in compact shoals. As the dentition agreed with Rao's description, I have considered them as of this species. They however had a prominent orange-red paratoid gland on the back.



Sketch of Tadpole collected at Dandeli

Rao specifically stated that the tadpoles described by him had no paratoid glands which in Soman's specimens are visible, though smaller than and not brightly-coloured as those referred to above.

Mr. V. K. Chari in his description of the tadpoles of *Rana malabarica* (*J. Bombay nat. Hist. Soc.* **59** : 71-76) refers to tadpoles, also from Talewadi, in the collections of the Zoological Survey of India (ZSI No. 18270) which were originally said to be of *Rana malabarica.* The dentition in these tadpoles agrees with that for *curtipes*, and the colour is also said to be dark, though no reference is made to the presence or absence of the paratoid glands.

The colour of the tadpoles, the size and colour of their paratoid glands, as well as their habit of swimming together or apart, may change with age or development, but it is possible that the tadpoles referred to above are of more than one species.

9. **Rana temporalis** (Gunth.) :

Were observed at Mahableshwar on the way back (23 May). Further to my observations in the *Journal* (**52** : 636-637), I noted them as very common during the day at the Dhobi's Waterfall at Mahableshwar on 21-25 October 1955. Few attempts were made at calling and they were also very tame and could be easily caught. One was timed sitting under water for 12 minutes. A large, almost black female was 82 mm. long. Her stomach contained 2 small frogs and a pebble 12 mm. $\times$ 9 mm. (11 a.m.). Another male had eaten a *R. limnocharis*. An earlier note states that when calling, a yellowish patch shows at the throat.

10. **Nyctibatrachus humayuni** Bhaduri & Kirpalani :

Seen at Mahableshwar. A male obtained on Fitzgerald Ghat (21-25 October 1955) had orange patches under the thighs (cf. yellow in female, *J. Bombay nat. Hist. Soc.* **52** : 859) but the testes were not enlarged. Its stomach as well as that of another individual (both taken at about 9 p.m.) was packed with Neuropterous insects.

11. **Philautus leucorhinus** (Lichten. & Martens) :

This species was very common in the forest near Shiroli. Attention was first drawn to them at sunset when they started calling, all perched on trees between 4 and 5 ft. from the ground, and facing downwards at an angle of 45° from the vertical. On 2 June 1953, I took one specimen among the stones on the bank of a stream near Castle Rock. The call has been recorded and may be syllabilised thus : a loud *trēēk* uttered every four seconds, some of the calls being slightly prolonged, *trēē-ek*, and almost disyllabic; at irregular intervals the same individuals (?) produced a drumming noise, *kuk* being rapidly repeated four to five times.

12. **Ixalus** sp. :

One taken at Talewadi does not agree with any of the specimens available for comparison.

13. **Kaloula pulchra taprobanica** Parker :

As we drove out of Dandeli at about 2-30 p.m., it was drizzling slightly and attention was drawn to two loud calls emanating from roadside pits which now contained water. One was traced to this species which was larger and more numerous than *Ramanella montana* (Jerdon) which was responsible for the other. The call was uttered invariably from near the shore, but seated in water with usually only the head and chin showing above water. The species was sluggish in its movements. Several were seen in copula in the water, the grip being axillary.

14. **Ramanella montana** (Jerdon):

Though smaller, its call was deeper than that of *Kaloula pulchra*, and always uttered from the shore or seated on a floating stick, outside water.

15. **Uperodon globulosum** (Gunth.) :

On the night of the 20 May, it was raining heavily at Khanapur, and a loud call immediately outside the house was traced to this species. A further examination revealed it calling all over the neighbourhood. The rain-water gutter along the railway station held several individuals, calling while floating at an angle of 45° with their snouts touching the vertical side. They were also seen in shallow standing water where individuals floated on their bellies when they could have settled at the bottom. The shape and bulk of the species perhaps makes it easier for them to float than to sit.

They appeared to be common and also widely scattered over the area—quite unlike the earlier records of this species which have been extremely localised and restricted. The present record forms an extension of the recorded distribution, the nearest locality so far having been Bombay (*J. Bombay nat. Hist. Soc.* **52** : 637-639).

It will be recalled that they were first discovered at the same time in 1954 at the Kanheri Caves and at Thana. In subsequent years, it was seen again at Kanheri but not at Thana.

On 16 June 1957, a cistern at the Caves was dry and contained no water, but one corner held an unrecognisable lump and the other what appeared to be a large *Rana tigerina*. Pebbles thrown at the first failed to move it, but as it appeared to be some organic matter, I descended into the 5 ft. rock-bound tank and found it to be a female *Uperodon*. The large 'bull frog' was found to be a mass of 1 bull frog, 11 *Rana breviceps* (7 females and 4 males), and 4 male *Uperodons*. A pair of each species was taken and the female *Uperodon* was found to contain large masses of eggs which showed as a white mass with many black specks therein. Under the microscope the eggs were seen to be round, half-white and half-black. The place was re-visited on the night of 22 June; the cistern contained 2 feet of water but, except for the 2 very large *tigerinas* and 1 water-snake (*Natrix piscator*), there was no trace of the 9 *breviceps* and 3 male *Uperodons*.

A loud grunt-like 'oink' led me to a near-by cave outside which a male was calling seated on the wet stone floor. Another was calling similarly about 15 yards away. When uttering the call, the black chin was inflated and a much larger grey bag appeared below. In the torchlight, a larger female was seen approaching him with long strides, not hops. Unfortunately, the first male which had been picked up was dropped near the second and, though the latter called again, something appeared to have gone wrong and there was no activity for 10 minutes, all three remaining in the same position a few inches apart.

No regular notes and/or observations were retained at Kanheri over subsequent years, but it does appear fairly certain, as is also supported by the evidence from Thana, that this species does not breed successfully every year and this, together with its strictly nocturnal habits, may account for the fact that so few persons have seen and/or recorded it.

Acknowledgements

Young Imran Tyabji, on holiday from Shri Shivaji Preparatory Military School at Poona, accompanied us and took a lively part in our activities. It is hoped that the interest he showed in Natural History will continue and develop. As mentioned above, P. W. Soman was actively associated with the collection of specimens, and M. J. Pereira was helpful in many ways. Mr. J. C. Daniel, Curator, Bombay Natural History Society, has assisted in the identification of the specimens. I also record my indebtedness to Mon. A Brosset for having given me the opportunity of making the trip, and to the Forest Department, Government of Mysore, particularly to Shri G. B. Narvekar, Range Forest Officer at Khanapur, without whose active collaboration in several ways we would have been unable to reach Talewadi.

A Preliminary Account of the Bionomics and Taxonomy of Aphids from Assam

BY

A. K. GHOSH, M.SC. AND D. N. RAY CHAUDHURI, D.SC.[1]
Zoology Laboratory, Charuchandra College, Calcutta

(*With a text-figure*)

INTRODUCTION

Assam is bounded on the north by Bhutan and Sikkim, on the south by Burma, on the west by West Bengal and East Pakistan, and on the east by Manipur and Burma. The average temperature varies from 15.6° C. to 21.1° C. throughout the year, while the average monthly rainfall ranges from three inches in January to sixteen inches in July. From the available literature, it is observed that only two species of aphids have so far been recorded from this region, by Buckton[2] (1896) and van der Goot[3] (1916).

The present survey was done in January 1960 and collections were made from Pandu (alt. 200 m.), Gauhati (*c.* 200 m.), Titabar (*c.* 200 m.), Tocklai (*c.* 200 m.), and Shillong (*c.* 1500 m.). At the time of collection, the temperature of the different places as well as the biology of the various species were also noted. Collections have been made from 43 types of plants.

Altogether 17 species belonging to twelve genera are recorded here, with notes on their biology and catalogue of food plants. Definite identification of five species is not possible at the present moment.

---

[1] Present address of the authors: Entomology Laboratory, Dept. of Zoology, University of Calcutta, 35, Ballygunge Circular Road, Calcutta 19.

[2] Buckton, G. B. (1896): Notes on two new species of gall forming aphids from north-western Himalayan region. *Ind. Mus. Notes* **4**: 50-51.

[3] Goot, P. van der (1916): Notes on two undescribed aphids from collection of Indian Museum. *Rec. Ind. Mus.* **12**(1): 1-4.

Synopsis of the Species

I. Genus *APHIS* L. 1758. Syst. Nat., ed. 10, p. 451.

(1) A. gossypii Glov. 1876. Rept. com. Agr. U.S.A. (1877), p. 36.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hair on III segment of antenna $\frac{1}{2}$ to $\frac{2}{3}$ basal diameter of the segment. Antennae imbricated, $\frac{1}{2}$ to $\frac{2}{3}$ length of body. Processus terminalis about $2\frac{1}{2}$ times as long as base of segment VI. Rostrum reaches little beyond hind coxae. Hairs on dorsum of abdomen mostly acute. Siphunculi imbricated. Cauda with 6 to 7 hairs. Hairs on 1st tarsal segments 2, 2, 3.

Measurements of one specimen in mm. :

Length of body 2.13
Antennal segments—III : IV : V : VI—0.28 : 0.13 : 0.13 : 0.11 + 0.28
Siphunculus : length 0.36
,, breadth at base, at apex 0.07, 0.06
Breadth at middle of hind tibia 0.04

Alate viviparous female. Longest hair on III segment of antenna $\frac{3}{5}$th basal diameter of the segment. Antennae imbricated· Processus terminalis $2\frac{1}{8}$ times as long as base of VI. Hairs on dorsum of abdomen like those of apterous form. Siphunculi imbricated. Cauda with 3 to 4 hairs. Hairs on 1st tarsal segments 2, 2, 3.

Measurements of one specimen in mm. :

Length of body 2.1
Antennal segments—III : IV : V : VI—0.28 : 0.12 : 0.12 : 0.11 + 0.24
Siphunculus : length 0.14
,, breadth at base, at apex 0.07, 0.05
Breadth at middle of hind tibia 0.3

LOCALITY AND HOST PLANTS

Pandu (6-i-60): from *Clitoria ternatea*; Shillong (7-i-60, 8-i-60): from *Duranta plumieri, Spirea cantonensis, Hibiscus rosa-sinensis, Helianthus annuus, Vitex negundo*; Titabar (16-i-60, 17-i-60); from *Capsicum frutescens, Dahlia* sp., *Bougainvillaea* sp., *Hibiscus sabdariffa,* and *Solanum tuberosum.*

Total number of specimens: 47 apterous, 15 alate, and 57 nymphs.

BIOLOGY

The insects were mostly collected from the undersurface of leaves of different physiological ages, except in the case of *Duranta plumieri* where infection was found on the growing region of the stem. In life, the colour of the insects varies from light green to brown. In association with specimens collected from *D. plumieri,* adult coccinellids were noticed.

II. Genus *AULACORTHUM* Mordvilko 1914. Faune de Russie, in Hem. **1**, p. 68.

(2) **A. (Neomyzus) circumflexus** (Buck.) 1876. Hille Ris Lambers, D. (1949), Temminckia **8**, p. 198.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hairs on III segment of antenna $\frac{1}{4}$ basal diameter of the segment. Antennae imbricated, $1\frac{1}{6}$ times as long as body. Processus terminalis $2\frac{5}{7}$ times as long as base of segment VI. Rostrum reaches 2nd coxae. Hairs on dorsum of abdomen with acuminate and blunt apices. Siphunculi long, slender and imbricated. Cauda with 3 to 4 hairs. Hairs on 1st tarsal segments 3, 3, 2.

Measurements of one specimen in mm.:

Length of body 2.37
Antennal segments—III : IV : V : VI—0.61 : 0.47 : 0.40 : 0.30 + 0.82
Siphunculus : length 0.50
,, breadth at base, at apex 0.08, 0.04
Breadth at middle of hind tibia 0.03

LOCALITY AND HOST PLANTS

Shillong (7-i-60): from *Hydrangea hortensis*, *Cestrum* sp., and *Ipomea* sp.

Total number of specimens: 6 apterous and 16 nymphs.

BIOLOGY

The specimens were found to infest the flowers of *Hydrangea hortensis*. Heavy infection was noticed on the young leaves of *Cestrum* and on the undersurface of the matured leaves only of *Ipomea* sp. In living condition the colour of the specimens is green.

III. Genus *CINARA* Curtis 1835. Bri. Entom. 12 (144), no. 576.

(3) **C. (Cinarella) pineus** Mordv. 1895. Hille Ris Lambers, D., 1948, Trans. R. ent. Soc. London **99**, p. 275.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hair on III segment of antenna $2\frac{1}{2}$ times as long as basal diameter of the segment. Antennae $\frac{1}{2}$ length of body. Processus terminalis $\frac{3}{8}$ length of base of VI. Rostrum reaches beyond 3rd coxae. Hairs on dorsum of abdomen long, with acute and acuminate apices. Siphunculi on hairy cones. Cauda helmet-shaped with many long acute hairs.

Measurements of one specimen in mm.:

Length of body 4.3
Antennal segments—III : IV : V : VI—0.71 : 0.32 : 0.40 : 0.22 + 0.08
Diameter of siphunculus 0.7
Breadth at middle of hind tibia 0.1

Alate viviparous female. Longest hair on III segment of antenna $3\frac{1}{2}$ times as long as basal diameter of the segment. Antennae imbricated, $\frac{1}{2}$ length of body. Rostrum reaches beyond 3rd coxae. Hairs on dorsum of abdomen mostly with acute apices. Siphunculi very small, pore-like. Cauda with many long acute hairs.

Measurements of one specimen in mm.:

Length of body (distorted)
Antennal segments—III : IV : V : VI—0.45 : 0 : 24 : 0.30 : 0.18 + 0.04
Diameter of siphunculus 0.6
Breadth at middle of hind tibia 0.05

LOCALITY AND HOST PLANTS

Shillong (10-i-60): from *Pinus insularis.*

Total number of specimens: 4 apterous, 1 alate, and 20 nymphs.

BIOLOGY

Heavy infestation was noticed on the host plants at the junction of the needles and growing part of the stem. At the time of collection the colour of the specimens was deep brown.

IV. Genus *CAPITOPHORUS* van der Goot 1913. Tijdschr, Ent. **56**, p. 84.

(4) **C. hippohaeus** (Walker) 1852, van der Goot, P., 1915. Beitr. Z. Kenntnis. Holl. Blattläuse, pp. 122-125.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hair on III segment of antenna $\frac{3}{10}$ basal diameter of the segment. Antennae imbricated, $1\frac{1}{4}$ times as long as the body. Processus terminalis $8\frac{1}{4}$ times as long as base of VI. Rostrum reaches middle coxae. Hairs on dorsum of abdomen capitate. Siphunculi long, slender, imbricated. Cauda with 7 to 10 hairs.

Measurements of one specimen in mm.:

Length of body 2.00
Antennal segments—III : IV : V : VI—0.50 : 0.35 : 0.38 : 0.05. + 1.04
Siphunculus: length 0.6
,, breadth at base, at apex 0.07, 0.03
Breadth at middle of hind tibia 0.03

LOCALITY AND HOST PLANTS

Shillong (8-i-60): from *Polygonum chinense.*

Total number of specimens: 7 apterous, 22 nymphs.

BIOLOGY

The insects were collected from the underside of the mature leaves of the host plant. The insects were light green in colour. This insect was found in association with *Macrosiphum* (*Sitobion*) *fragariae* (Wlk.) ?.

V. Genus *LIPAPHIS* Mordv. 1928. in Filip., Insect Key, Moscow, 200.

(5) **L. erysimi** (Kalt.) 1843. Doncaster, J.P., 1954, Proc. R. ent. Soc., London **23** (B), p. 83.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hair on III segment of antenna $\frac{3}{8}$ basal diameter of the segment. Antennae imbricated, $\frac{4}{9}$ length of body. Processus terminalis $2\frac{5}{7}$ times as long as base of VI. Rostrum reaches 2nd coxae. Hairs on the dorsum of abdomen mostly acute. Siphunculi slender, imbricated. Cauda with 4 to 5 hairs.

Measurements of one specimen in mm.:

Length of body 2.26
Antennal segments—III : IV : V : VI—0.35 : 0.18 : 0.15 : 0.10 + 0.27
Siphunculus : length 0.23
,, breadth at base, at apex 0.07, 0.03
Breadth at middle of hind tibia 0.04

Alate viviparous female. Longest hair on III segment of antenna $\frac{1}{3}$ basal diameter of the segment. Antennae imbricated. Processus terminalis $2\frac{1}{4}$ times as long as base of VI. Rostrum reaches 2nd coxae. Hairs on dorsum of abdomen with acute and acuminate apices. Siphunculi slightly constricted at apex, imbricated. Cauda with 4 to 5 hairs. Hairs on 1st tarsal segments 3, 3, 2.

Measurements of one specimen in mm.:

Length of body 2.64
Antennal segments—III : IV : V : VI—0.32 : 0.14 : 0.14 : 0.11 + 0.25
Siphunculus : length 0.11
,, breadth at base, at apex 0.03, 0.03
Breadth at middle of hind tibia 0.02

LOCALITY AND HOST PLANTS

Pandu (6-i-60): from *Rhaphanus sativus, Brassica oleracea* var. *botrytis;* Shillong (8-i-60): from *Lactusa sativa;* Gauhati (13-i-60):

from *Tropelium majus*; Titabar (17-i-60): from *Brassica rapa*, and *Brassica oleracea* var. *capitata;* Tocklai (18-i-60): from *Ficus heterophylla* and *Calendula*.

Total number of specimens: 9 apterous, 104 alate, and 7 nymphs.

BIOLOGY

The colour of the insects varied from dull green to green or blackish and in all cases only undersides of leaves were infested. The specimens collected from *Brassica rapa* were visited by ants, while in no other case were ants seen.

VI. Genus *LACHNUS* Burmeister 1835. Handbuch der Entom. 2, p. 91.

(6) **Lachnus** sp. A

LOCALITY AND HOST PLANT

Shillong (11-i-60): from *Pyrus khasiana*.

Total number of specimens: 28 apterous and 2 alate.

BIOLOGY

The colour of the insects in life was green. The insects were noticed to attack only the young growing portions of the stem.

(7) **Lachnus** sp. B

LOCALITY AND HOST PLANTS

Titabar (16-i-60): from *Heteropanax fragrans*.

Total number of specimens: 55 apterous.

BIOLOGY

The insects have the same colour as *Lachnus* sp. A, but could be collected only from the underside of the leaves of the tree.

N.B. *Lachnus* sp. A, and sp. B seem to be not only distinct from the rest of the known species of this genus but also specific difference exists between A and B. Due to the lack of material for comparison their specific identification is not possible at the present moment. However, this will be reported on later.

VII. *MACROSIPHUM* Passerini 1874. Glif. afidi, 27.

(8) **Macrosiphum ibarae** Mats. 1917. subsp. **rosaeformis** Das 1918. Matsumara, S., 1917, Jl. Coll. Agr. Sapporo 7, p. 397.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hair on III segment of antenna $\frac{1}{3}$ basal diameter of the segment. Antennae imbricated, $\frac{5}{8}$th length of body. Processus terminalis $4\frac{1}{2}$ times as long as base of VI. Rostrum reaches almost 2nd coxae. Hairs on dorsum of abdomen with acute, acuminate, and blunt apices. Siphunculi imbricated, except distal $\frac{1}{6}$-$\frac{1}{7}$ portion which is reticulated. Cauda with 9 to 10 hairs. Hairs on 1st tarsal segments 3, 3, 3.

Measurements of one specimen in mm.:

Length of body 3.16
Antennal segments—III : IV : V : VI—0.74 : 0.54 : 0.47 : 0.10 + 0.64
Siphunculus : length 0.84
,, breadth at base, at apex 0.14, 0.04
Breadth at middle of hind tibia 0.04

Alate viviparous female. Longest hair on III segment of antenna $\frac{1}{2}$ basal diameter of the segment. Antennae $1\frac{1}{8}$ times as long as body. Processus terminalis $4\frac{5}{8}$ times as long as base of VI. Rostrum reaches almost 2nd coxae. Hairs on dorsum of abdomen with acute and acuminate apices. Siphunculi twice as long as cauda. Cauda with 15 to 17 hairs.

Measurements of one specimen in mm.:

Length of body 3.1
Antennal segments—III : IV : V : VI—0.85 : 0.71 : 0.58 : 0.05 + 0.92
Siphunculus : length 0.71
,, breadth at base, at apex 0.14, 0.7
Breadth at middle of hind tibia 0.03

LOCALITY AND HOST PLANTS

Shillong (7-i-60 & 9-i-60): from *Hibiscus rosa-sinensis, Rosa* spp.
Total number of specimens: 16 apterous and 30 alate.

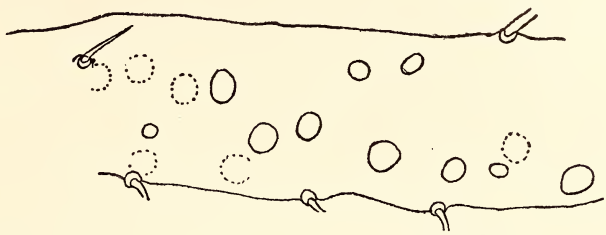
BIOLOGY

The yellowish-red insects were collected only from the leaves of various physiological stages and the flower buds.

(9) **Macrosiphum (Sitobion) fragariae** (Wlk.) ? 1848. Hille Ris Lambers, D., 1939, Temminckia **4**, p. 113.

MORPHOLOGICAL CHARACTERS

Apterous oviparous female. Body elongated. Abdominal tergite pale in bleached specimen; brownish small muscal platten arranged in longitudinal rows near stigmata. Antennae imbricated, longer than body, IV and V subequal, processus terminalis longest; rhinaria on III absent; longest hair on III with blunt apex, about $\frac{1}{2}$ as long as basal diameter of the segment. Rostrum with rather blunt apex reaching base of 2nd coxae. Hind tibiae much stouter than 1st and 2nd, with numerous small pseudosensoria on basal $\frac{3}{4}$ portion (text-figure). Abdominal hairs with acute and acuminate apices. Siphunculi faint brown, with distal $\frac{1}{8}$ portion reticulated, rest very slightly imbricated. Cauda with 11 hairs.



TEXT-FIGURE

Basal portion of hind tibia of *Macrosiphum* (*Sitobion*) *fragariae* (Wlk.), showing pseudosensoria

Measurements of one specimen in mm. :

Length of body 1.92
Antennal segments—III : IV : V : VI—0.47 : 0.34 : 0.32 : 0.12 + 0.57
Siphunculus : length 0.47
,, breadth at base, at apex 0.1, 0.04
Breadth at middle of hind tibia 0.03

LOCALITY AND HOST PLANTS

Shillong (8-i-60): from *Polygonum chinense.*
Total number of specimens: 1 apterous.

BIOLOGY

This specimen was green in colour in life and was collected from the underside of the leaves of the host plant along with *Lipaphis erysimi* (Kalt.) and *Myzus persicae* (Sulz.).

N.B. The find of one oviparous female suggests that the specimen visited the plant for the purpose of laying eggs. The host plant can therefore be regarded as a primary host.

(10) **Macrosiphum** sp.

LOCALITY AND HOST PLANTS

Shillong (8-i-60): from *Lactusa sativa.*
Total number of specimens: 1 alate.

BIOLOGY

This specimen is green in colour in life and was collected from the underside of one of the mature leaves of the host plants along with *Myzus persicae* (Sulz.) and *Lipaphis erysimi* (Kalt.).

N.B. Though *Lactusa sativa* has been mentioned as the host plant, we believe this is probably not the host of the species. It may be that only one alata in course of flight to some other host plant rested over there. Although this specimen seems to be a distinct species, it is premature to name it on only one specimen which is available to us.

VIII. Genus *MYZOCALLIS* Passerini 1860. Gli. afidi, 28.

(11) **M. bambusifoliae** (Tak.) Takahashi, R., 1931, Aph. Formosa, pt. 6, p. 84.

MORPHOLOGICAL CHARACTERS

Alate viviparous female. Longest hair on III segment of antenna $\frac{1}{4}$ basal diameter of the segment. Antennae imbricated. Hairs on dorsum of abdomen long and acute. Siphunculi small, imbricated. Cauda with many hairs. Hairs on 1st tarsal joints 5, 3, 3.

Measurements of one specimen in mm.:
Length of body 2.6
Antennal segments—III : IV : V : VI :—0.54 : 0.26 : 0.26 : 0.20 + ?
Siphunculus : length 0.09
,, breadth at base, at apex 0.08, 0.05
Breadth at middle of hind tibia 0.04

LOCALITY AND HOST PLANTS

Shillong (7-i-60): from *Phyllostacus manii.*

Total number of specimens: 4 alate and 40 nymphs.

BIOLOGY

The insects were red and were found to attack only the undersides of young leaves.

IX. *MYZUS* Passerini 1860. Gli. afidi, 27.

(12) **M. persicae** (Sulzer) 1776. Buckton, G. B., 1875, Mono. Brit. Aphids, pt. 1, p. 178.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hair on III segment of antenna $\frac{1}{2}$ basal diameter of the segment. Antennae imbricated, $\frac{4}{5}$th length of body. Processus terminalis about 4 times as long as basal part of VI. Rostrum reaches 2nd coxae. Hairs on dorsum of abdomen with acute and acuminate apices. Siphunculi long, slender, imbricated. Cauda with 5 to 6 hairs.

Measurements of one specimen in mm.:
Length of body 2.68
Antennal segments—III : IV : V : VI—0.40 : 0.36 : 0.27 : 0.12+0.50

Siphunculus : length 0.51
,, breadth at base, at apex 0.11, 0.05
Breadth at middle of hind tibia 0.03

Alate viviparous female. Longest hair on III segment of antenna $\frac{1}{3}$ basal diameter of the segment. Antennae nearly $\frac{5}{6}$ length of body. Processus terminalis twice as long as base of VI. Rostrum reaches 2nd coxae. Hairs on dorsum of abdomen, with acute or acuminate apices. Siphunculi swollen towards apex. Cauda with 5 to 6 hairs. Hairs on the 1st tarsal joints 3, 3, 3.

Measurements of one specimen in mm. :
Length of body 2.35
Antennal segments—III : IV : V : VI—0.51 : 0.48 : 0.28 : 0.14+0.30
Siphunculus : length .40
,, breadth at base, at apex, at middle 0.07, 0.05, 0.02
Breadth at middle of hind tibia 0.04

LOCALITY AND HOST PLANTS

Pandu (6-i-60): from *Beta vulgaris, Brassica oleracea* var. *capitata, B. rapa, Duranta plumieri, Rhaphanus sativus*; Shillong (8-i-60): from *Oxalis trifolia, Hibiscus rosa-sinensis, Lactusa sativa, Petunia* sp., *Pyrus communis, Solanum* sp.; Titabar (17-i-60): from *Brassica rapa.*

Total number of specimens: 19 apterous, 21 alate, and 35 nymphs.

BIOLOGY

All the insects collected from the different plants were green and attacked only the undersides of leaves. The infestation was comparatively heavy on *Rhaphanus sativa* and *Beta vulgaris.* The specimens collected from *Brassica rapa* were visited by ants.

X. Genus *RHOPALOSIPHUM* Koch 1856. Die Pflazenlaüse Aphiden **1**, p. 13.

(13) **Rhopalosiphum rufiabdominalis** (Sasaki) 1899. Doncaster, J. P., 1956, Bull. Ent. Res. **47**, p. 741.

MORPHOLOGICAL CHARACTERS

Alate viviparous female. Longest hair on III segment of antenna $1\frac{1}{3}$ times as long as basal diameter of the segment. Antennae long, imbricated. Processus terminalis $4\frac{1}{2}$ to 6 times as long as base of V. Rostrum reaches almost 2nd coxae. Hairs on dorsum of abdomen with acute and acuminate apices. Siphunculi imbricated. Cauda with many hairs.

Measurements of one specimen in mm. :
Length of body (distorted)
Antennal segments—III : IV : V—0.54 : 0.17 : 0.10+0.51

Siphunculus : length 0.21
,, breadth at base, at apex 0.07, 0.04
Breadth at middle of hind tibia 0.04

LOCALITY AND HOST PLANTS

Shillong (11-i-60): from *Pyrus communis.*

Total number of specimens: 1 alate.

BIOLOGY

The colour of the insect was green at the time of collection and the collection was a mixed one, consisting of *Myzus persicae* (Sulz.) and *Aphis gossypii* Glov. amongst others.

N.B. From the find of only one alate it is doubtful whether *Pyrus communis* can be regarded as one of the host plants. Generally the species attacks the graminaceous plants.

XI. Genus *TOXOPTERA* Koch 1856. Die Pflazenlaüse Aphiden, Heft. 8, p. 253.

(14) **Toxoptera aurantii** (Boyer) 1841. Koch C., 1856, Die Pflazenlaüse Aphiden, p. 254.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hair on III segment of antenna $\frac{2}{3}$ basal diameter of the segment. Antennae imbricated, $\frac{9}{10}$th length of body. Processus terminalis $4\frac{1}{2}$ times as long as base of VI. Rostrum reaches just beyond 2nd coxae. Hairs on dorsum of abdomen with acuminate apices. Siphunculi tapering towards apex. Cauda with 15 to 17 hairs. Hind tibiae with stridulatory organs (spines) in row.

Measurements of one specimen in mm. :
Length of body 1.85
Antennal segments—III : IV : V : VI—0.32 : 0.28 : 0.25 : 0.13+0.58
Siphunculus : length 0.27
,, breadth at base, at apex 0.05, 0.02
Breadth at middle of hind tibia 0.02

LOCALITY AND HOST PLANTS

Shillong (7-i-60): from *Hibiscus rosa-sinensis*; Titabar (16-i-60): from *Ailanthus* sp., *Camellia sinensis, Litsea salicifolia*; Tocklai (18-i-60): from *Ficus heterophylla.*

Total number of specimens: 48 apterous, 3 alate, and 68 nymphs.

BIOLOGY

The insects were black in colour. This species was noticed to attack the buds and young leaves surrounding the buds. In so far as the leaves are concerned, the insects were noticed both on the upper as well as on the lower side. The insects were noticed to be myrmecophilous.

(15) **Toxoptera citricidus** (Kirk.) 1907. Eastop, V.F., 1952, Entom. **85**, pp. 57-61.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hair on III segment of antenna, almost equal to basal diameter of the segment. Antennae less than $\frac{1}{2}$ length of body. Processus terminalis $4\frac{1}{6}$ times as long as base of VI. Rostrum reaches just beyond 2nd coxae. Hairs on dorsum of abdomen mostly acute. Siphunculi imbricated. Cauda with 15 to 20 hairs. Hind tibiae with stridulatory organs.

Measurements of one specimen in mm.:

Length of body 2.42
Antennal segments—III : IV : V : VI—0.30 : 0.20 : 0.17 : 0.08 + 0.35
Siphunculus : length 0.24
,, breadth at base, at apex 0.08, 0.05
Breadth at middle of hind tibia 0.05

LOCALITY AND HOST PLANTS

Titabar (17-i-60): from *Citrus grandis.*

Total number of specimens: 21 apterous and 11 nymphs.

BIOLOGY

The insects were reddish-brown in colour at the time of collection and were found to infest the underside of the leaves of citrus.

(16) **Toxoptera odinae** (van der Goot) 1917. Eastop, V. F., 1952, Entom. **85**, pp. 57-61.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hair on III segment of antennae $2\frac{1}{2}$ times as long as basal diameter of the segment. Antennae $\frac{5}{9}$th the length of body. Processus terminalis $2\frac{1}{2}$ times as long as base of VI. Rostrum reaches just beyond 2nd coxae. Hairs on dorsum of abdomen with acute apices. Siphunculi short, cylindrical, imbricated. Cauda with 8 to 9 hairs. Hind tibiae with stridulatory organs.

Measurements of one specimen in mm.:

Length of body 3.28
Antennal segments—III : IV : V : VI—0.35 : 0.24 : 0.27 : 0.12+0.33
Siphunculus : length 0.10
,, breadth at base, at apex 0.08, 0.04
Breadth at middle of hind tibia 0.03

Alate viviparous female. Longest hair on III segment of antennae twice as long as basal diameter of the segment. Antennae long, imbricated. Processus terminalis $2\frac{1}{2}$ times as long as base of VI. Rostrum reaches 2nd coxae. Hairs on dorsum of abdomen with acute and acuminate apices. Siphunculi cylindrical, imbricated. Cauda with 7 hairs. Hind tibiae with stridulatory organs.

Measurements of one sp cimen in mm.:

Length of body (distorted)
Antennal segments—III : IV : V : VI—0.28 : 0.20 : 0.21 : 0.11+23
Siphunculus : length 0.10
,, breadth at base, at apex 0.10, 0.05
Breadth at middle of hind tibia 0.02

LOCALITY AND HOST PLANTS

Shillong (9-i-60): from *Viburnum fœtidum.*

Total number of specimens: 26 apterous, 1 alate, and 10 nymphs.

BIOLOGY

The colour of the insects was bottle green. The undersides of the apical leaves and the growth parts of the stem were attacked by the species.

XII. Genus *TUBEROLACHNUS* Mordvilko 1908. Ann. Mus. Zool. Acad., St. Petersburg **13**, p. 374.

(17) **Tuberolachnus saligna** (Gmelin) 1788. Takahashi, R., **1931**, Aph. Formosa, pt. 6, p. 21.

MORPHOLOGICAL CHARACTERS

Apterous viviparous female. Longest hair on III segment of antenna $\frac{4}{5}$th basal diameter of the segment. Antenna $\frac{3}{10}$th length of body. Processus terminalis $\frac{1}{2}$ base of VI. Rostrum reaches beyond 3rd coxae. Hairs on dorsum of abdomen with acute and acuminate apices. Siphunculi small, ring-like, on hairy cone. Cauda helmet-shaped with many fine hairs.

Measurements of one specimen in mm.:

Length of body 3.78
Antennal segments—III : IV : V : VI—0.40 : 0.17 : 0.18 : 0.14+0.07
Diameter of siphunculus 0.03
Breadth at middle of hind tibia 0.11

Alate viviparous female. Longest hair on III segment of antenna $\frac{2}{3}$ basal diameter of the segment. Antennae $\frac{2}{7}$th length of body. Processus terminalis $\frac{2}{5}$th base of VI. Rostrum reaches 3rd coxae. Hairs on dorsum of abdomen like those in apterae. Siphunculi ring-like. Cauda helmet-shaped.

Measurements of one specimen in mm.:

Length of body: 4.1
Antennal segments—III : IV : V : VI—0.51 : 0.18 : 0.18 : 0.14+0.05
Breadth of siphunculus (distorted)
Breadth at middle of hind tibia 0.07

LOCALITY AND HOST PLANTS

Shillong (9-i-60): from *Salix babylonica.*

Total number of specimens: 15 apterous, 1 alata, and 23 nymphs.

BIOLOGY

The insects were jet black in colour. The bare woody stem was noticed to be heavily infested with the insect.

Conclusion

The aphids, collected from a few places in Assam and so far identified, reveal seventeen species from forty-three host plants. These seventeen species are distributed over twelve genera, while the recorded species of the Indian plains are restricted to a much smaller number of genera. Mordvilko's[1] (1908) supposition about the origin of Aphids in temperate countries can perhaps be supported from the find of these different genera from Assam which can definitely be regarded as a temperate zone in India.

So far only two male and one oviparous female aphids have been recorded from high altitudes in India. In addition to them an oviparous female of *Macrosiphum* (*Sitobion*) *fragriae* (Wlk.)? is reported.

We believe that further survey of Assam will reveal many new interesting features about aphids.

Acknowledgements

We are grateful to the Bombay Natural History Society for the travelling grant out of funds made available by the Rockefeller Foundation which has made this survey possible. The Charu-chandra College authorities are thanked for laboratory facilities given us. In connection with collecting materials from different places in Assam thanks are due to Sri S. P. Bhattacharya, Pandu, Dr.

[1] Mordvilko, A. (1908): Tableaux pour servir a la determination des groupes et des genres des Aphides. *Ann. Mus. Zool. Acad. Sc. Petersburg* 13: 374.

S. Chaudhuri of the Sericultural Research Station, Titabar, and the Director of Tocklai Experimental Research Institute. The Botanical Survey of India, Eastern Zone, Shillong, and the late Professor Anutosh Dasgupta, Bangabasi College, Calcutta have helped by identifying a few host plants.

FOOD PLANT CATALOGUE

	Food Plant	Name of Aphid
1.	*Acronychia laurifolia*	*Macrosiphum* sp.
2.	*Ailanthus* sp.	*Toxoptera aurantii* (Boyer)
3.	*Oxalis trifolia*	*Myzus persicae* (Sulz.)
4.	*Beta vulgaris*	*Aphis gossypii* Glov. *Myzus persicae* (Sulz.)
5.	*Bougainvillaea* sp.	*Aphis gossypii* Glov.
6.	*Brassica oleracea* var. *capitata*	*Lipaphis erysimi* (Kalt.)
7.	*B. oleracea* var. *botrytis*	*Lipaphis erysimi* (Kalt.) *Myzus persicae* (Sulz.)
8.	*Brassica rapa*	*Lipaphis erysimi* (Kalt.) *Myzus persicae* (Sulz.)
9.	*Calendula* sp.	*Lipaphis erysimi* (Kalt.)
10.	*Camellia sinensis*	*Toxoptera aurantii* (Boyer)
11.	*Capsicum frutescens*	*Aphis gossypii* Glov.
12.	*Cestrum* sp.	*Aulacorthum* (*Neomyzus*) *circumflexu* (Buck.) *Myzus persicae* (Sulz.)
13.	*Citrus grandis*	*Toxoptera citricidus* (Kirk.)
14.	*Clitoria ternata*	*Aphis gossypii* Glov.
15.	Coranaceae N.O.	*Aulacorthum circumflexus* (Buck.)
16.	*Dahlia excelsa*	*Aphis gossypii* Glov.
17.	*Dryopteris* sp.	*Aphis gossypii* Glov.
18.	*Duranta plumieri*	*Myzus persicae* (Sulz.)
19.	*Eupatorium adenophorum*	*Lipaphis erysimi* (Kalt.)
20.	*Ficus heterophylla*	*Toxoptera aurantii* (Boyer)
21.	*Helianthus annuus*	*Aphis gossypii* Glov.
2.	*Heteropanax fragrans*	*Lachnus* sp.

FOOD PLANT	AME OF APHID
23. *Hibiscus rosa-sinensis*	*Aphis gossypii* Glov. *Macrosiphum* (*Sitobion*) *ibarae* Mats.
24. *Hibiscus sabdariffa*	*Aphis gossypii* Glov.
25. *Hydrangea hortensis*	*Aulacorthum* (*Neomyzus*) *circumflexus* (Buck.)
26. *Ipomea* sp.	*Aulacorthum* (*Neomyzus*) *circumflexus* (Buck.)
27. *Lactusa sativa*	*Lipaphis erysimi* (Kalt.) *Myzus persicae* (Sulz.)
28. Liliaceae N.O.	*Aphis gossypii* Glov.
29. *Litsea salicifolia*	*Toxoptera aurantii* (Boyer)
30. *Phyllostacus manii*	*Myzocallis bambusifoliae* Tak.
31. *Pinus insularis*	*Cinara* (*Cinarella*) *pineti* Mordv.
32. *Polygonum chinense*	*Capitophorus hippohaeus* (Koch) *Macrosiphum* (*Sitobion*) *fragariae* (Wlk.)?
33. *Pyrus communis*	*Myzus persicae* (Sulz.)
34. *Pyrus khasiana*	*Lachnus* sp.
35. *Rhaphanus sativus*	*Lipaphis erysimi* (Kalt.) *Myzus persicae* (Sulz.)
36. *Rosa* sp.	*Macrosiphum* (*Sitobion*) *ibarae* Mats.
37. *Salix babylonica*	*Tuberolachnus saligna* (Gmelin)
38. *Solanum tuberosum*	*Aphis gossypii* Glov.
39. *Solanum* sp.	*Myzus persicae* (Sulz.)
40. *Solanum melongena*	*Aphis gossypii* Glov.
41. *Tropelium majus*	*Myzus persicae* (Sulz.)
42. *Viburnum foetidum*	*Toxoptera odinae* (v.d.G.)
43. *Vitex negundo*	*Aphis gossypii* Glov.

A Revision of Indian Mugilidae[1]

PART I[2]

BY

SAROJINI R. PILLAY
Central Inland Fisheries Research Institute, Calcutta

(*With four text-figures*)

CONTENTS

INTRODUCTION

Workers on the grey mullets (Mugilidae) all over the world seem to have experienced considerable difficulty in distinguishing the different species of the family owing to the very close resemblance between them. This has led to a search for more reliable and distinctive characters for distinguishing the various species; and the generic revisions of the family by Schultz (1946) and Smith (1948) are notable contributions in this direction.

Little or no progress has been made in the study of the taxonomy of the Indian species of the family Mugilidae since Day's comprehensive account, FISHES OF INDIA (Day, 1876-1888) and FAUNA OF BRITISH INDIA, FISHES (Day, 1889), although local species in various

---

[1] Communicated by Dr. H. Srinivasa Rao, F.A.SC., F.N.I. Part of the thesis that formed the basis for the award of the degree of Doctor of Philosophy of the University of Madras.

[2] Genus *Mugil* Linnaeus, genus *Rhinomugil* Gill, and some 'doubtful species' will appear as Part II of this paper together with the complete list of references.

parts of the country have been studied by Whitehouse (1922) at Tuticorin, Pillay (1951) in Bengal, and Devasundaram (1951) in Chilka Lake. Some of the later workers have questioned the validity of certain species described in Day's publications. A detailed biometric comparison of samples of the Indian species, *Mugil dussumieri* Valenciennes and *M. parsia* Hamilton, made by me (Sarojini, 1953) has shown that the two are synonymous. Following this interesting finding, it was considered desirable to re-examine the systematics of all the known Indian species of the family.

The present study is based mainly on the collections of mullets in the Zoological Survey of India which contain many of Day's original specimens. But fresh collections of mullets made by me in West Bengal, and those obtained from Visakhapatnam, through the courtesy of Dr. N. K. Panikkar, and from Ennore, Krusadai Island, and Cochin, through the courtesy of Dr. T. V. R. Pillay, were also available for study.

Distinguishing Characters of Mugilidae

Previous studies have shown that many of the characters considered to be of taxonomic value undergo marked changes with growth. Jacot (1920), Sarojini (1953), and Pillay (1954) have observed the absence of adipose eyelids in young stages (of *M. cephalus, M. parsia,* and *M. tade* respectively) and their progressive development with the growth in size of the fish. Thompson (1954) also recognised this fact, though he has made use of this character to distinguish certain Australian genera and species of mullets.

Pillay (1954) has observed variation in the size of the eye of *M. tade* in relation to the size of the fish.

Jacot (1920) observed in *M. cephalus* that the cycloid scales of the young fish become ctenoid later. Pillay (1951) has corroborated the same in *M. cephalus, M. tade, M. parsia* and *M. corsula.*

While Day (1878, 1889), Günther (1861), and Whitehouse (1922) have attributed considerable taxonomic importance to the size and shape of the uncovered chin space of mullets, I have found these to vary markedly with the growth of the fish.

The number of rays in the anal fin has also been used as a diagnostic character by many workers. Jacot (1920) found the first soft ray in the anal fin of the young *M. cephalus* gradually ossifying to become the third anal spine. A similar change with growth has also been observed in *M. parsia* by me (Sarojini 1953, 1957) and in *M. tade* by Pillay (1954).

Day (1889), Whitehouse (1922), and others considered the mandibulary angle to be of taxonomic importance in mullets. Weber & de Beaufort (1922) and Thompson (1954), however, found this angle varying with age in some species. The acute angle in the young of *M. cephalus* becomes gradually obtuse as the fish grows.

The length of the 3rd anal spine has also been used as a diagnostic feature by Day. But, as pointed out elsewhere (Sarojini, 1953), this cannot be relied upon, as with the growth of the fish the base of the fin gets more and more densely covered with fine scales which makes measurement of the length of the spine subject to bias.

A comparative study of the young and the adults of the Indian species of mullets has shown convincingly that the characters mentioned are of no taxonomic importance owing to their variability with the growth of the fish. A sound taxonomic key should enable the identification of both the young and the adult stages of each species. So these characters have not been used in the diagnosis of the species considered in this study. But where the characters attain a certain constancy of form after a particular stage in the growth of the fish, as seen in the scale characteristics, the number of anal rays, the presence of adipose thickenings around the eye, etc., they have been included in the descriptions.

Though Schultz (1946, 1953) and subsequently Smith (1948) and Thompson (1954) laid great stress on the nature of the dentition for distinguishing the genera of mullets, in the present study this character has been used only in the diagnosis of species. In some species, however, the structure of the teeth changes with the growth of the fish, having simple tips in young and bifid or even trifid in large adults (Schultz, 1946).

The dorsal profile of the mullets which has been considered a diagnostic character by Day (1878, 1889) and Weber & de Beaufort (1922) is greatly altered by the degree of distension or contraction of the body muscles after death and is, therefore, not considered in this study as a reliable distinguishing character.

Examination of fresh material of the available species has shown the relative height of body to be of some use as a specific character. But many of the preserved specimens in the Zoological Survey of India, the abdomen of which had been slit open for the purpose of preservation, had the cut edges of abdominal wall curled in and could not be measured correctly for body height. So this could not be used as a diagnostic character in the present study.

Another diagnostic feature of somewhat limited application is the relative position of the anal and second dorsal fins. Its inter-specific variability consists of the proportion of the basal length of the anal in advance of the origin of the second dorsal, which usually ranges between $\frac{1}{4}$ and $\frac{2}{3}$. In actually measuring this, i.e. by dropping a vertical line from the point of origin of the second dorsal to meet the base of the anal and then measuring the distance from that point to the origin of the anal, there is a likelihood of much personal error occurring. Hence no stress has been laid on this character for diagnostic purpose.

Smith (1935) has suggested that the arrangement of the ventral fins and the inter-ventral flange may have some significance in specific or generic distinction. As many of the specimens in the Zoological Survey of India collections had been cut in this region for preservation it was not possible to examine its significance.

Measurements studied:

The measurements employed in this study for calculation of body proportions were taken with fine point dividers. Some of the measurements used, such as standard length, length of head, least height (depth) of caudal peduncle, and the distance from snout to anal were taken as defined by Pillay (1954) and some others, the forkal length, length of snout, height of body, distance from snout to 1st dorsal, snout to 2nd dorsal, and snout to the ventral, as taken by Thompson (1954). Hence these are not re-defined here. The various other measurements used here are defined below:

Total length—from the tip of the snout to the end of the longest ray of the ventral lobe of the caudal fin

Height of head—the maximum height between the dorsal and ventral aspects of the head taken just before the operculum bends upwards

Width of head—the maximum width of head, measured from cheek to cheek

Height of snout—measured just in front of the anterior rim of the orbit

Width of snout—measured just in front of the anterior rim of the orbit

Diameter of orbit—usually the distance between the anterior and posterior rims of the orbit. Where the orbit was not exactly circular, the diameter between the dorsal and ventral rims were also noted

Width of anterior adipose eyelid—from the anterior rim of orbit to the edge of the anterior eyelid

Width of posterior adipose eyelid—from the posterior rim of orbit to the edge of the posterior eyelid

Inter-orbital distance—measured across the head as the distance between the uppermost points on the dorsal rims of the orbits

Length of caudal peduncle—from the posterior edge of the base of anal fin to the end of hypurals

Height of 1*st* & 2*nd spines of the* 1*st dorsal*—from the base of the spines to their tip

Length of pectoral—from the point of origin of the pectoral fin to the tip of its longest ray

Morphological characters:

The following morphological characters were found to be of help in distinguishing the different genera and species of mullets:

1. The presence or absence of opercular spine
2. The presence or absence of folds and papillae on the upper lip
3. The position of the lips (terminal or ventral)
4. Nature of the serrations on the extremity of the pre-orbital
5. Nature of the symphysial knob
6. Exposed or concealed position of the end of maxilla when mouth is closed
7. Presence or absence of notch on the ventral aspect of the lower lip below the symphysial knob
8. The relative position of the pre-orbital
9. Presence or absence of pointed scale in axil of pectoral fin

Family Mugilidae

Since the erection of the genus *Mugil* by Linnaeus in 1758, several workers have attempted to subdivide it; and there have been several generic revisions of the family. Of the numerous genera thus created, the genus *Liza* of Jordan & Swain (1884) was considered valid by Indian workers and some Indian species were assigned to this genus (Chaudhuri, 1917; Whitehouse, 1922; Hora, 1923; Herre, 1941, and Devasundaram, 1951). Recent workers in other countries (Smith, 1948; Herre, 1953, and Thompson, 1954) have also recognised this genus. The distinguishing character of *Liza* Jordan & Swain is the absence of adipose eyelids; but many of the species assigned to this genus do possess adipose eyelids, though their degree of development may be less than those of *Mugil*. Moreover, as pointed out on page 255, the adipose eyelids are not evident in the young of most of the Mugilids, even though they may be well developed in the adults. Hence, as Roxas (1934) rightly pointed out, this genus cannot be considered valid, its revival by Oshima (1922) notwithstanding.

Schultz (1946) was the first to conduct a comprehensive study of the world genera of Mugilidae. He drew attention to the taxonomic importance of the mouth parts and other qualitative characters in the family, and defined 13 genera which he considered valid. Of these the genera under which certain Indian species have been placed, are *Rhinomugil* Gill, *Crenimugil* Schultz, *Mugil* Linnaeus, and *Chelon* Röse.

Rhinomugil Gill, has for its genotype *Mugil corsula* Hamilton, and the distinguishing characters of this genus are stable and distinct enough for it to be accepted as valid.

Crenimugil Schultz was erected to accommodate *Mugil crenilabis* Forskål. *Mugil labiosus* Valenciennes, which occurs in Indian waters also, has been assigned to this genus by Thompson (1954). But he had presumably not seen Schultz's recent contribution (Schultz, 1953) wherein he created a new genus, *Plicomugil*, to accommodate *Mugil labiosus* Valenciennes. The distinguishing characters of this new genus are stable and very distinct from those of *Crenimugil* Schultz, and are in complete agreement with the specimens of *Mugil labiosus* examined by me. *Plicomugil* Schultz, and not *Crenimugil* Schultz, is therefore accepted here as one of the valid Indian genera.

The characters of *Mugil* Linnaeus and *Chelon* Röse are, however, overlapping. The original descriptions of the genera, with *Mugil cephalus* Linnaeus and *Mugil chelo* Valenciennes respectively as genotypes, do not differ from each other in any significant details. Schultz (1946), who has elaborated on these genera, has also not laid down any clearly defined and stable differentiating characters for them. He has placed undue importance on certain characters, such as the presence or absence of adipose eyelids. There are also some vaguely defined characters in his descriptions, such as 'the pre-orbital is also bent posteriorly at a *more or less sharp angle*' in *Chelon*, while in *Mugil* 'the pre-orbital has the front edge *straight or nearly so*; maxillary *not notably exposed*'; 'upper lip *usually not so wide* as distance between nostrils'; 'teeth *probably present* on vomer . . . etc.': (the italics are mine). The differentiating characters of the two genera given by Schultz (1946, 1953) are tabulated below:

	Mugil Linnaeus	*Chelon* Röse
1.	Distance between nostrils wide, equal to or greater than width of upper lip (upper lip usually not so wide as distance between nostrils)	Upper lip wider than distance between nostrils
2.	Anterior and posterior nostrils widely separated, farther apart than anterior nostril is from groove that separates upper lip from rest of snout	Nostrils closer to each other than anterior is from groove behind upper lip
3.	Posterior edge of pre-orbital narrower than distance between nostrils, its posterior tip scarcely or not reaching past front of eye. Anterior edge straight or nearly so without a conspicuous concavity	Posterior edge of pre-orbital is wider than distance between nostrils. Anterior edge of pre-orbital concave or angular
4.	Maxillary and premaxillary not hooked downward, maxillary not notably exposed, both in line with front edge of pre-orbital	Maxillary with its posterior part notably exposed, sharply curved downward over posterior part of premaxillary and extending below pre-orbital a distance greater than width between nostrils. Premaxillary with its front margin sharply angular, non-dentate posterior portion hooked backward and downward almost at right angles to toothed portion
5.	Adipose eyelid well developed reaching to or nearly to pupil except in young	No adipose eyelid present
6.	No teeth on vomer or palatine	Villiform patches of teeth on vomer and palatines present or absent
7.	Teeth in certain species become bifid or trifid in very large sized adults	Teeth simple in young as well as large sized adults

A close study of these characters will show that most of them are not distinct enough for a clear differentiation between the two genera. The only characters which show clearly marked difference are the relative position of the two nostrils and the shape of the maxillary bone. From the present study it is seen that these characters can be assigned only specific significance. *Mugil seheli* Forskål, which Schultz (1953) has assigned to *Chelon* Röse, in fact shows affinity, in the relative position of its nostrils, to *Mugil* Linnaeus rather than to the former. *Mugil parsia* Hamilton and *Mugil tade* Forskål show what may be called intermediate characteristics in that the distance between the nostrils is equal to the distance of the posterior border of upper lip from the anterior nostril. At the same time the other characteristics of these species do not allow of inclusion in any other tenable genus of Mugilidae. Again, according to Schultz (1946, 1953) the maxillary in *Mugil* is not notably exposed, while in *Chelon* it is notably exposed. In *Mugil seheli* Forskål the maxillary is not exposed when the mouth is closed; yet Schultz (1953) has assigned it to the genus *Chelon*. In the shape of the maxillary bone, the different Indian species show varying degrees of intermediate characteristics between those laid down by Schultz (1946, 1953) for *Mugil* and *Chelon*. Besides, I am at variance with Schultz's (1946, 1953) statement that both *Mugil* and *Chelon* have cycloid scales. In fact, all the Indian species allotted to these genera by Schultz himself have cycloid scales in the young and ctenoid scales in the adult, the only exception being *Mugil seheli* Forskål (*Chelon seheli*, according to Schultz, 1953) which has cycloid scales when young as well as when grown to a large size. After a considered study of all the differentiating characters between *Mugil* Linnaeus and *Chelon* Röse as described by the original authors and by Schultz (1946, 1953) I am of opinion that the difference between the two, if any, cannot be given importance, at any rate as far as the Indian Mugilidae are concerned. *Chelon* Röse has, therefore, not been recognised here.[1]

Whitley (1930) created genus *Ellochelon* with *Mugil vaigiensis* Quoy & Gaimard as genotype, and subsequently Smith (1948) has recognised this genus. The distinguishing characters of the genus are 'the broad head, truncate caudal and dark fins'. These characters, as Schultz (1953) pointed out, are not sufficiently distinctive or stable to be bestowed generic importance. *Ellochelon* Whitley is, therefore, considered here as a synonym of *Mugil* Linnaeus.

Valamugil (Smith, 1948) has for its genotype *Mugil seheli* Forskål. The distinguishing characters given were: 'No adipose eyelids. Upper lip thin, no papillae, maxilla bent down over pre-maxilla, end concealed. Lower margin of pre-orbital concave. Anal starts about opposite 2nd dorsal.' Schultz (1953) contends that, since these characters are not in any way different or distinct from those attributed to *Chelon* Röse, genus *Valamugil* Smith should be considered a synonym of the former. I am in agreement with Schultz (1953)

[1] It has not been possible to examine the genotype of *Chelon* Röse, *Mugil chelo* Valenciennes of the Mediterranean. *Chelon* Röse has not, therefore, been brought here under the synonymy of *Mugil* Linnaeus.

that *Valamugil* Smith cannot be considered a tenable genus, and so have brought it under the synonymy of *Mugil* Linnaeus.

Liza Jordan & Swain and *Valamugil* Smith have been recognised by Thompson (1954) as valid genera; but, for the reasons already discussed, I am unable to agree with him in this respect.

Fowler (1939) erected the genus *Sicamugil* to accommodate *Mugil hamiltoni* Day. Schultz (1946, 1953) and Thompson (1954) did not consider this genus to be tenable and, therefore, assigned it to the synonymy of *Trachystoma* Ogilby. The present study showed *M. hamiltoni* Day and the closely allied species *M. cascasia* Hamilton to be different from all other known Mugilids in the possession of an opercular spine. So it becomes necessary to separate these two species under a distinct genus. *Sicamugil* Fowler is, therefore, removed from the synonymy of *Trachystoma* Ogilby and emended here to include this distinct character, namely the presence of an opercular spine. In Fowler's (1939) description of the genus he has laid emphasis on 'the strongly spinate pre-orbital, the head largely and completely covered with small scales, especially over its lower surfaces, absence of adipose eyelids and peculiar facies (*Sica*=dagger, with reference to the pre-orbital spine)'. He has not mentioned the presence of the opercular spine though it is seen in the figure given by him. I am of the opinion that this particular character, viz. the presence of an opercular spine, is of greater generic significance than the characters emphasised by Fowler. It may also be pointed out here that Fowler's (1939) figure appears to be somewhat exaggerated in regard to the pointed snout.

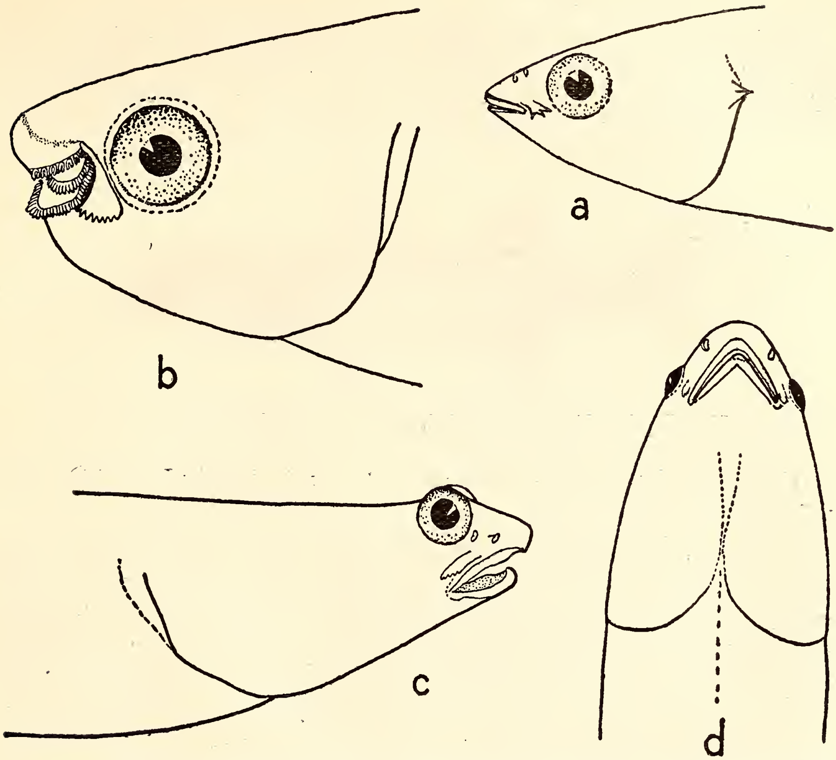
In view of the above discussion it is possible to recognise only four genera for the Indian species of grey mullets studied here.[1]

These genera may be distinguished by the following key:

KEY TO THE INDIAN GENERA OF MUGILIDAE

1.	Opercle with a spine	.. *Sicamugil* Fowler
	Opercle without spine	.. 2
2.	Upper lip with paired fleshy papillate lobes	.. *Plicomugil* Schultz
	Upper lip without paired fleshy papillate lobes	.. 3
3.	Upper lip terminal of snout	.. *Mugil* Linnaeus
	Upper lip ventral of snout	.. *Rhinomugil* Gill

[1] In her recent paper on the grey mullets of Kayamkulam Lake, John (1955) has recognised *Liza* and *Valamugil*. In view of the reasons laid down in the foregoing pages, I am unable to support her recognition of these genera.



Text-fig. 1.—(*a*) Lateral view of the head of *Sicamugil cascasia* showing the opercular spine and the tri-cuspid pre-orbital; (*b*) Lateral view of the head of *Plicomugil labiosus* showing the folded papillate lips; (*c*) Lateral view of the head of *Rhinomugil corsula* showing the overhanging snout and elevated eyes; (*d*) Ventral view of the head of *Rhinomugil corsula* showing the position of lips and mouth.

Genus **Sicamugil** Fowler

Sicamugil Fowler, *Notul. Nat. Acad. Philad.* **17**, p.9, 1939 (genotype *Mugil hamiltoni* Day) (Rangoon, Burma).

An opercular spine present (Text-fig. 1). Lips terminal and without lobes or papillae. Nostrils in level with upper rim of orbit. Symphysial knob present. No distinct teeth on jaws. Anterior edge of pre-orbital without conspicuous notch and its extremity with a few well-developed spines. Mouth protrusible.

Key to the Indian species of Genus *Sicamugil*

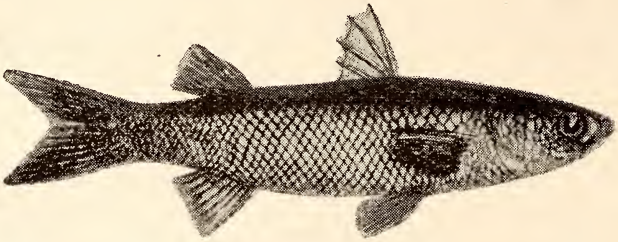
Extremity of pre-orbital distinctly tri-cuspid .. *S. cascasia* (Hamilton)
Extremity of pre-orbital distinctly tetra-cuspid .. *S. hamiltoni* (Day) [1]

---

[1] Though *S. hamiltoni* (Day) has not been recorded from Indian waters, a description of the species based on specimens in Day's collections in the Zoological Survey of India has been included in this paper.

Sicamugil cascasia (Hamilton)

Mugil cascasia Hamilton, *Fish. Ganges*, pp. 217-380, 1822 ; Cuvier & Valenciennes, *Hist. Nat. Poiss*, 11, p. 145, 1836 (N. Bengal) ; Day, *Fish. India*, p. 355, pl. LXXV, fig. 6, 1878-1888 (Delhi) ; Fauna Brit. India, Fishes 2, p. 351, 1889 (upper waters of Jamuna and Ganga ; also Indus and Brahmaputra).



Text-fig. 2. *Sicamugil cascasia* (Hamilton) (After Day, 1878)

D IV, 1 + 8 ; A. III + 8-9 ; V. I + 5 ; P. 14-15 ; L. 1. 36-39; L. tr. 16-18.

Length of head greater than height of body. Head higher than broad. Length of snout equal to or very slightly less than its own height, which is again less than its breadth. Diameter of orbit equal to or slightly greater than length of snout, and less than inter-orbital distance. Insertion of D_1 conspicuously nearer tip of snout than to base of caudal. Origin of pelvic fins nearer anal than to tip of snout. Length of caudal peduncle less than height of head and equal to or slightly less than width of head. The 1st spine of D_1 longer than the 2nd spine. Insertion of pectoral fin below middle of body. Caudal fork fairly deep.

Proportionate measurements: vide Appendix A.

Scales: 36-39 on the longitudinal series and 16-18 on the transverse. Pre-dorsal scales 16. No elongated scale in axil of pectoral. Bases of all fins except D_1 covered with minute scales. Scales of body strongly ctenoid.

Orientation of fins: Insertion of D_1 above 7th-8th, of D_2 above 22nd-24th, and of anal below 20th-22nd scales of the longitudinal series. Pelvic fin inserted below 4th-5th and reaches to the 11th-13th L.1. scales.

Teeth not present on jaws. Lips very thin. Upper lip forms tip of snout and part of dorsal profile. Pre-orbital bent and strongly serrated on the anterior and ventral aspects. The extremity is distinctly tri-cuspid. Nostrils of unequal size, the posterior larger than the anterior. The distance of the posterior nostril to the orbit is less than that of the anterior to the upper lip, which in turn is slightly greater than the distance between the nostrils. Symphysial knob double. Adipose eyelid absent. End of maxilla hardly visible when mouth is closed. Opercle with one strong spine.

Colour: Bright yellow on sides. Dorsal and dorso-lateral parts of body streaked with black bands on the bright yellow background. Ventral aspect white and silvery. A large yellow blotch on base of caudal fin and a smaller one on base of pectoral. Base of anal and pelvics tinged yellow.

Material: 3 specimens from Delhi, Z.S.I. Nos. 2044 to 2046; 2 specimens from Assam, Z.S.I. Nos. 1392, 2043 (Day's collections). 12 specimens collected from the Yamuna at Allahabad and Delhi.

Distribution: Type locality: River Ganges. This species has been recorded only from India, where its occurrence is restricted to the upper reaches of the larger river systems of north India, viz. the Ganga, the Yamuna, the Brahmaputra, and the Indus. This is a purely freshwater species. The lowermost point on the Ganga river system where this has been recorded is Patna.

The species does not grow beyond a size of 10 cm.

Sicamugil hamiltoni (Day)

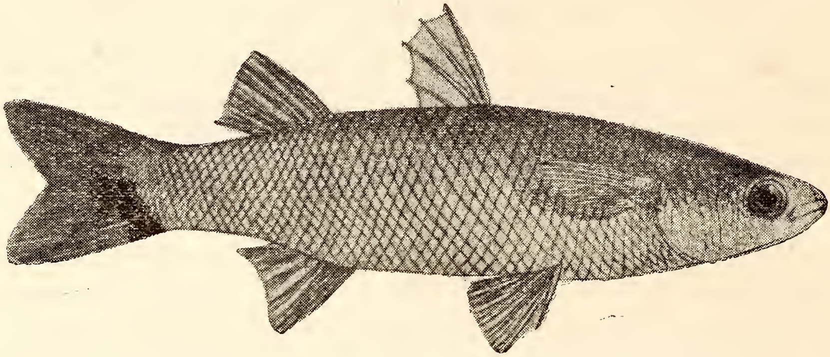
Mugil hamiltoni Day, *Proc. Zool. Soc. London.* p. 614, 1870 (Rivers of Burma) *Fish. India*, p. 354, pl. LXXV, fig. 5, 1878-1888 ; Fauna Brit. India, Fishes 2 p. 349, 1889 (Rivers of Burma).

D. IV, 1 + 8 ; A. III + 9 ; V. I + 5 ; P. 12–14 ; C. 15 ; L. l. 43-47 ; L. tr. 16-18.

Length of head greater than height of body. Head higher than broad. Length of snout equal to or slightly less than its own height, which is again equal to or slightly less than its width. Diameter of orbit equal to or slightly less than length of snout and distinctly less than the interorbital distance. Insertion of D_1 nearer to base of caudal than to tip of snout. Origin of pelvic fins nearer to origin of anal than to tip of snout. Length of caudal peduncle greater than width and height of head. Least height of caudal peduncle less than width of head. 1st spine of D_1 longer than the 2nd. Insertion of pectoral either in middle of body or very slightly above middle. Caudal fork is deep.

Proportionate measurements: vide Appendix A.

Scales: 43-47 rows on the longitudinal and 16-18 on the transverse series. Pre-dorsal scales 32-34. Elongated scale not present in axil of pectoral. Scales on body are strongly ctenoid.



Text-fig. 3. *Sicamugil hamiltoni* (Day) (After Day, 1878)

Orientation of fins: Insertion of D_1 above 15th-17th, of D_2 above the 27th-29th and of anal below the 23rd-25th L. 1. scales. Pelvic fin inserted below 6th-8th and reaches to the 16th-18th scales. The pectorals reach to the 9th-11th L. 1. scales.

No distinct teeth on lips. Upper lip very thin, forming tip of snout and part of the dorsal profile. Pre-orbital very conspicuous, has a very slight bend and is strongly serrated on the anterior and ventral margins. Extremity distinctly tetra-cuspid. Nostrils of unequal size, the posterior larger. The distance between them is equal to the distance of the anterior from the upper lip and less than that of the posterior from the orbit. Symphysial knob single. No adipose thickening over the eye. End of maxilla hardly visible when mouth is closed. Opercle with one strong spine.

Colour: Silvery, shot with gold, leaden along upper half of body.

Material: 3 specimens from Burma, Z.S.I. cat. Nos. 136 (Sittang), 355, 1401 (from Day's collections).

Remarks: It has not been possible to study fresh specimens of this species. Those in the collections of the Zoological Survey of India were not in a good state of preservation, most of the fins having been damaged. The proportionate measurements, where expressed in relation to total length, and the coloration given here are taken from Day's (1889) descriptions.

Distribution: Type locality: Rivers of Burma.

This species has so far been recorded only from the rivers of Burma where it is a purely freshwater form. The largest size of this species recorded is only 11.5 cm.

Genus Plicomugil (Schultz)

Plicomugil Schultz, *U. S. Nat. Mus. Bull.* **202**, pp. 315 and 320, 1953 (genotype, *Mugil labiosus* Cuvier & Valenciennes).

No spine on opercle; lips terminal, with lobes and papillae; nostrils in level with upper rim of orbit; symphysial knob present; no teeth on jaws. The characteristic feature of this genus is the distinctly lobed (folded) upper lip, which has 2 paired lobes ventral to edge and 4 more at corner of mouth on each side. The lobes are fleshy and fringed with papillae. Front edge of pre-orbital with a conspicuous deep notch into which the lobes of the lip at corner of mouth fit, when mouth is closed. Mouth is protrusible.

Monotypic, *Plicomugil labiosus* (Valenciennes).

Plicomugil labiosus (Valenciennes)

Mugil labiosus Valenciennes, (in Cuvier & Valenciennes), *Hist. Nat. Poiss.*, **11**, p. 125, 1836 (Red Sea); Day, Fish. India, p. 357, 1888 (Andamans); Fauna Brit. India, Fishes **2**, p. 352, 1889 (Andamans).

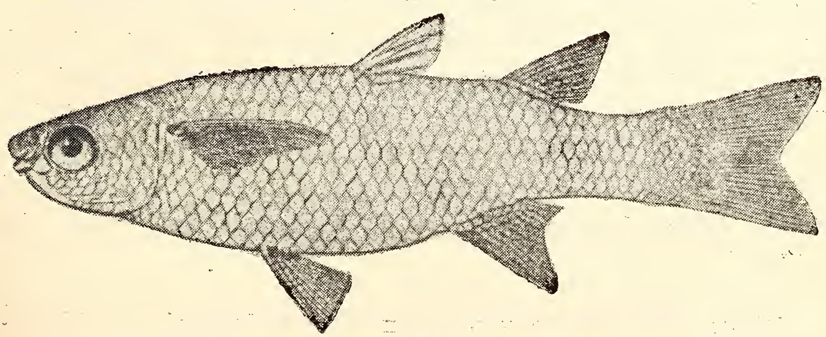
Mugil macrochilus Day, *Proc. Zool. Soc. Lond.*, p. 685, 1870 (Andamans).

Mugil crenilabris Day, Fish. India, p. 355, 1888 (Andamans); Fauna Brit. India, Fishes **2**, p. 350, 1889 (Andamans and Nicobar).

Liza labiosa Fowler, *Copeia*, 58, p. 62, 1918 (the Philippines).

Liza labiosus Herre, *Mem. Indian Mus.* **13**, p. 347, 1941 (Andamans).

Plicomugil labiosus Schultz, *U.S. Nat. Mus. Bull.*, 202, pp. 320-322, 1953 (Bikini, Rongelap, Kwajalein Atolls, Romuk and Reer islands, the Philippines, the Red Sea).



Text-fig. 4. *Plicomugil labiosus* (Valenciennes) (After Schultz, 1953)

D. IV, 1 + 8 ; A. III + 9 ; V.I + 5 ; P.14 – 15 ; C.14 – 15 ; L.l. 32-36 ; L. tr. 10 – 12.

Length of head less than height of body. Head higher than broad. Length of snout less than its height, which in turn is less than the width. Diameter of orbit equal to or slightly greater than length of snout. Diameter of orbit more than half of inter-orbital distance. Insertion of D_1 conspicuously 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 less than width of head. Length of 1st spine of D_1 exceeds that of the 2nd. Insertion of pectoral above middle of body. Caudal fork not very deep.

Proportionate measurements: vide Appendix A.

Scales: 32 to 36 on the longitudinal and 10 to 12 on the transverse series. 17 to 18 predorsal scales. No elongated scale in axil of pectoral. Bases of all fins except D_1 covered with minute scales. Scales on body ctenoid.

Orientation of fins: Insertion of D_1 above 10th-12th, of D_2 above 23rd-24th, and of anal fin below the 18th-21st scale of the longitudinal series. Pelvic fins inserted below 3rd-5th and reach to 12th-13th; pectorals reach to the 9th-11th L. l. scales.

Upper lip, forming tip of snout and part of dorsal profile, is broad and fleshy with two folds, the outer overhanging the snout. The outer fold is well folded on itself at the two corners of the mouth. All along the margin of this fold there is a row of short fleshy double papillae. The inner fold is fringed with a row of long fleshy single papillae. Lower lip thin, enlarged and reflected, with a wavy margin and without teeth or papillae. Pre-orbital with a large very conspicuous notch and serrated only on the ventral margin. Nostrils closer to each other than the posterior nostril is to the orbit, the distance of the latter being equal to that of the anterior nostril from the upper lip. The posterior nostril is larger than the anterior, the latter with a raised rim. Adipose eyelids absent. End of maxilla slightly visible when mouth is closed. Symphysial knob present but feeble.

Colour: Olivaceous grey or brown on back, dull white on sides and below. Pectoral with a dark axillary spot.

Remarks: While describing this species for the first time, Valenciennes (Cuvier & Valenciennes, 1836) pointed out its closeness to *M. crenilabis* Forskål. Day (1870) described *M. macrochilus* Bleeker from the sea off Andaman Islands but later, in his FISHES OF INDIA (1878-1888), considered it a synonym of M. *crenilabis* Forskål and recorded an allied form, *M. labiosus* Valenciennes, also from the Andamans. 2 specimens of *M. labiosus* and one labelled *M. macrochilus,* of Day's collections, were examined by me and it was found that these three specimens were identical in all essential details. Therefore, if, as Day considered, his *M. macrochilus* is synonymous with *M. crenilabis* Forskål, Day's *M. labiosus* will also have to be considered a synonym of *M. crenilabis* Forskål, the latter name getting priority. Most of the descriptions of *M. crenilabis* and *M. labiosus* available are overlapping, the distingushing points being in the number of L. l. scales and some vaguely described differences in the morphology of the lips. Schultz (1953), however, has given a clearly defined description of the differences between the two when he separated them under two different genera, *Crenimugil* and *Plicomugil.* The specimens examined by me (Day's *M. labiosus* and *M. macrochilus*) both come under Schultz's (1953) *Plicomugil* and not under his *Crenimugil.* The Indian species is, therefore, the same as *M. labiosus* of Valenciennes, *M. macrochilus* and *M. crenilabris* of Day being its synonyms.

Material: 2 specimens from Andamans—Z.S.I. Nos. 1409, 1410 (*M. labiosus* from Day's collection); 1 specimen Z.S.I. cat No. 353, from Andamans (labelled *M. macrochilus*).

Distribution: Type locality: Red Sea.

In India this species has been recorded only from the Andaman Islands. Its distribution outside India extends to Indonesia, Philippines, Australia, Marshall and Marianas Islands, and the Red Sea.

This species grows to over 40 cm. in length.

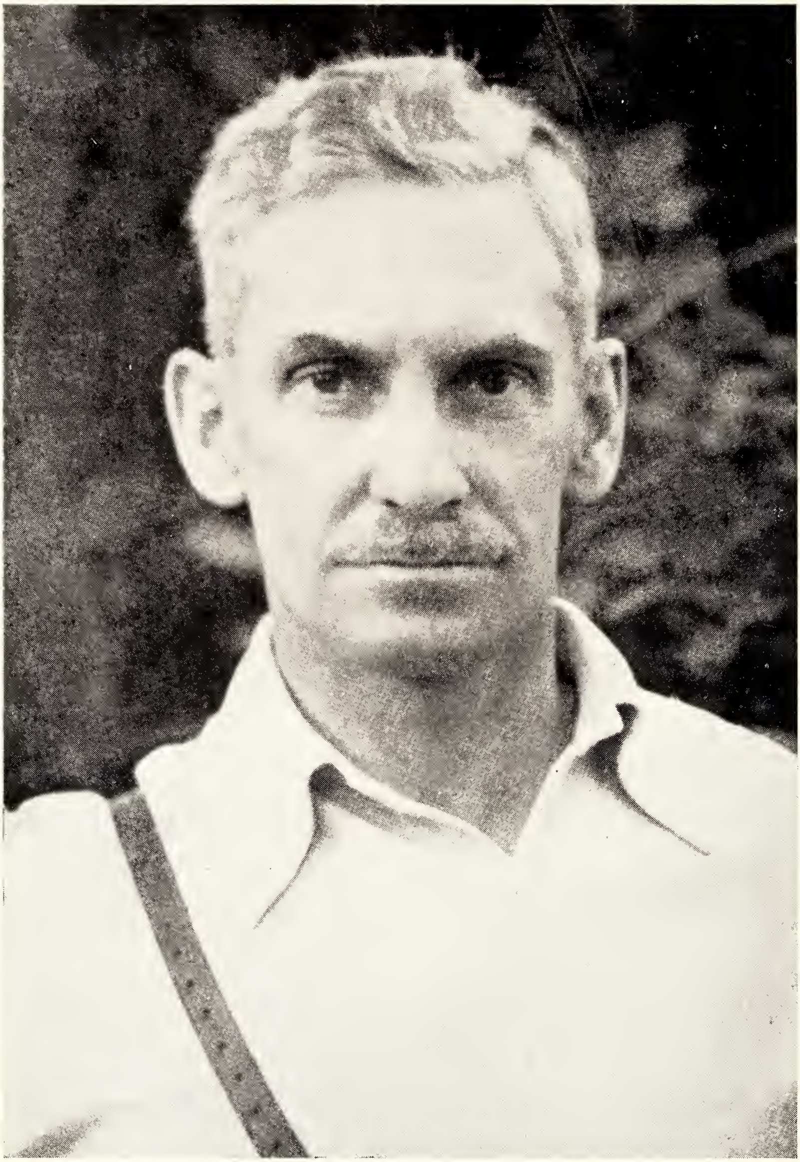
(*To be continued*)

Appendix A overleaf

APPENDIX A

Proportionate Body Measurements of Indian species of the Mugilid genera *Sicamugil* and *Plicomugil*

	Sicamugil cascasia	*Sicamugil hamiltoni*	*Plicomugil labiosus*
$\frac{\text{Total length}}{\text{Length of head}}$	4.40-5.00	4.25-5.50	4.50-5.40
$\frac{\text{Standard length}}{\text{Length of head}}$	3.53-3.63	3.50-3.64	3.47-5.00
$\frac{\text{Total length}}{\text{Height of body}}$	4.50-5.25	4.50-5.00	4.33-5.25
$\frac{\text{Standard length}}{\text{Height of body}}$	4.08-4.14	3.77-4.00	3.10-3.28
$\frac{\text{Length of head}}{\text{Diameter of orbit}}$	3.40-4.00	3.50-4.33	3.00-4.00
$\frac{\text{Inter-orbital distance}}{\text{Diameter of eye}}$	1.09-1.37	1.25-1.62	1.51-1.75
$\frac{\text{Length of head}}{\text{Height of head}}$	1.45-1.62	1.56-1.75	1.42-1.58
$\frac{\text{Length of head}}{\text{Width of head}}$	1.60-1.72	1.92-2.00	1.47-1.65
$\frac{\text{Length of head}}{\text{Inter-orbital distance}}$	2.61-3.16	2.66-2.80	1.95-2.11
$\frac{\text{Length of head}}{\text{Length of pectoral fin}}$	1.26-1.36	1.75	1.00-1.05
$\frac{\text{Length of head}}{\text{Length of caudal peduncle}}$	1.60-1.90	1.40-1.66	1.60-1.90
$\frac{\text{Length of head}}{\text{Least height of caudal peduncle}}$	2.50-2.53	2.15-2.40	2.05-2.11
$\frac{\text{Length of caudal peduncle}}{\text{Least height of caudal peduncle}}$	1.33-1.41	1.36-1.60	1.11-1.25
$\frac{\text{Total length}}{\text{Length of caudal fin}}$			5.25-5.50
$\frac{\text{Standard length}}{\text{Snout to } D_1}$	2.20-2.23	1.88-1.91	1.70-1.76
$\frac{\text{Standard length}}{\text{Snout to } D_2}$	1.28-1.32	1.31-1.38	1.23-1.42
$\frac{\text{Standard length}}{\text{Snout to pelvic fin}}$	2.40-2.55	2.37-2.45	2.27-2.47
$\frac{\text{Standard length}}{\text{Snout to anal fin}}$	1.35-1.38	1.32-1.44	1.34-1.41



R. S. P. Bates

Obituary

Lieut.-Col. R. S. P. BATES, I.A., (Retd.)

(*With a plate*)

It is sad to record the death of Lieut.-Col. R. S. P. ('Pat') Bates, I.A. (Retd.) on 3rd August 1961. He died suddenly of a ruptured aneuryson and aorta in hospital where he was rushed from his home in Thursley, Surrey. Col. Bates joined the Bombay Natural History Society in 1921 and became a Life Member in 1937. Throughout his service in India, and even after retirement and leaving the country in 1947, Col. Bates maintained the closest association with the Society, and was a model of what a really active member should be.

An ardent lover of birds and a knowledgeable and painstaking field ornithologist, he made significant contributions to Indian ornithology as his numerous notes and articles in the *Journal* testify. His love of the Indian countryside and, in particular, his passion for Kashmir and its birds were unquenchable. Many of his leave periods were spent in exploring the various valleys and their bird life, and his descriptions, apart from their fascination, are a useful and valuable guide for the nature-loving visitor to Kashmir.

But perhaps Bates's chief accomplishment and pioneering contribution lies in the field of bird photography in India. Up to the time he published his popular series on 'Bird Nesting with a Camera in India' in the *Journal* (1924), bird photography here was a neglected art. The articles opened up a wide field of interest and possibilities, which were soon taken advantage of and developed by other enthusiastic photographers. Many of his portraits of Indian birds must still rank amongst the finest ever made. And when it is remembered that in those early years cameras, telephoto lenses, and films were far less perfect than today, his achievement seems doubly creditable. That he could attain the perfection many of his photographs show with the apparatus and material his modest means could command was largely due to his ingenuity and skill in improvising and preparing with his own hands simple little gadgets to meet special requirements.

Bates was fortunate to have in India during the same period E. H. N. Lowther, an officer in the then East Indian Railway, also an accomplished field ornithologist and bird photographer. These kindred spirits soon discovered one another and became fast friends till the latter's death in 1954 (Obituary in Vol. **50** : 913). Many of their furloughs were purposely timed so that they could trek and camp together in Kashmir watching and photographing birds. The partnership proved rewarding and is immortalized by BREEDING BIRDS OF KASHMIR, a book of great charm and usefulness, every page of which testifies to the devotion, attention to detail, and scientific accuracy both men brought to bear on their study of birds.

Bates kept up his lively interest in birds and bird photography even after retirement in England, though his letters often complained about his circumscribed opportunities as compared with India, and lack of time from the mundane domestic chores that go with house-holding and life in general in the England of today. In spite of all this, however, he managed to keep his interest alive by taking active part in many local natural history societies, having latterly become an ardent convert to trapping and ringing birds. That he also missed no opportunity of indulging in his pet hobby of bird photography, and had lost none of his old cunning through want of practice was evident from the Xmas and New Year cards which his friends unfailingly received from him, portraying some English bird which had nested in or near his charming garden in Thursley. Gardening was another of Bates's minor passions. A few months before his death he wrote enthusiastically in a letter to me: 'My efforts at turning this garden into a wee bird sanctuary at last seem to be bearing some fruit. We have at last got both Green and Greater Spotted Woodpeckers in it regularly, and the Greater Spotted is at last digging a hole in a poplar stump I specially left standing for its delectation.'

Ever since his retirement, Bates had been dreaming and scheming for one more spell of birding in his beloved Kashmir, but alas it was fated otherwise. A man of gentle, loveable charm and modesty, and peaceful, cultured interests, he used to say that sometimes he was amused to see himself in soldier's uniform when he felt so little warlike within, and so much at peace with the world and all it contained! That he made a very good soldier nevertheless is proved by the high record of his military career. Bates's death is indeed a sad loss for Indian ornithology as it is for his numerous ornithological friends. He was one of the last links in the chain of distinguished British ornithologists working on Indian birds before the focus shifted lock, stock, and barrel to Africa. To Mrs. Bates, his constant helpmate and collaborator, who shared all his interests and hobbies, in India as in England, we offer our sincerest sympathy.

A list of Col. Bates's contributions to the *Journal* is placed below:

1923	(1)	Notes on Hugh Whistler's 'A Contribution to the Ornithology of Cashmere' in Vol. XXVIII, No. 4. ..	**29** : 798
1924	(2)	Birds' nesting with a camera in India ..	Part I, **29** : 947
		..	Part II, **30** : 97
		..	Part III, **30** : 306
		..	Part IV, **30** : 600
		..	Part V, **30** : 793
		..	Part VI, **31** : 277
1927	(3)	Impressions of Pachmarhi birds ..	**31** : 918
1929	(4)	A Reed-bed in the Dal Lake, Kashmir ..	**33** : 656
1931	(5)	A note on the nidification and habits of the Travancore Laughing Thrush *Trochalopterum jerdoni fairbanki* ..	**35** : 204
1932	(6)	Migration of Paradise Flycatcher (*Tchitrea paradisi*) ..	**35** : 896
1935	(7)	Notes on the habits of some Indian birds ..	**37** : 902
1935	(8)	Some birds of Chittagong ..	**38** : 158
1936	(9)	On the birds of Kishenganga Valley, Kashmir ..	**38** : 520
1937	(10)	Do birds employ ants to rid themselves of ectoparasites ? ..	**39** : 394
1938	(11)	On the parasitic habits of the Pied Crested Cuckoo (*Clamator jacobinus* Bodd.) ..	**40** : 125
1938	(12)	Rosefinches and other birds of the Wardwan Valley ..	**40** : 183
1939	(13)	Bird photography in India ..	**40** : 666
1942	(14)	A month in the Kazinag Range ..	**43** : 60
1942	(15)	Extension of the Range of the Atlas Beetle (*Chalcosoma atlas*) ..	**43** : 274
1943	(16)	A note on the Feeding Habits of the Little Bittern (*Ixobrychus minutus*) ..	**44** : 179
1948	(17)	Astanmarg ..	**48** : 38
1949	(18)	The Merbal Glen and some birds of the Pir Panjal ..	**48** : 399

1949	(19)	Peculiar Behaviour of the Darter (*Anhinga melanogaster* Pennant) ..	**48** : 810
1950	(20)	The lower Sind Valley, and some further observations on bird photography ..	**49** : 178
1952	(21)	(with E. H. N. Lowther) The History of Bird-Photography in India ..	**50** : 779
1952	(22)	Possible association between the Yellow-naped Woodpecker (*Picus flavinucha*) and the Large Racket-tailed Drongo (*Dissemurus paradiseus*) ..	**50** : 941
1955	(23)	Monkeys and Panther ..	**53** : 254
1956	(24)	Fighting among Birds ..	**54** : 191
1959	(25)	Communal nest feeding in Babblers ..	**56** : 630

Besides he was the author of a book BIRD LIFE IN INDIA published by the Bombay Natural History Society in 1931 (now out of print) and, jointly with E. H. N. Lowther of another entitled BREEDING BIRDS OF KASHMIR published by the Oxford University Press, 1952.

S. A.

Reviews

1. NATURE CONSERVATION IN WESTERN MALAYSIA, 1961. *Malayan Nature Journal* 21st Anniversary Special Issue. 45 papers by 41 authors. pp. 261 (25×16.5 cm.). 44 plates, 15 text-figures and maps, embellished with numerous line drawings. Price $5.00 (Malayan).

To celebrate their 21st anniversary the Malayan Nature Society have produced a special issue on Nature Conservation. The publication is timely. There is beginning to be a more general awareness of the need for conservation all over the world. In September 1961 an all-African conference was held in Arusha, Tanganyika. This has been followed up by an International Biological Programme, one of the aims of which is 'to promote a world-wide inquiry into natural biological communities menaced by human transformation or destruction'.

The contents of the volume under review range from the preservation of rare ferns and orchids, and wild life, to fossils. Malaya has a rich heritage of archaeological sites. There are many caves with deposits containing fossils. These have been depleted in many cases, the deposit being removed for use as fertiliser. In addition fossil-bearing rocks are exposed while quarrying or while digging foundations. Legislation is urgently needed for the temporary preservation of such sites, and for the permanent protection of a few typical localities which contain so much vital information about Malaya's pre-history.

It is often mistakenly thought that conservation is a sentimental concept. Sir Julian Huxley, at Arusha, emphasised that wild life, conserved and wisely cropped, would provide a better source of protein than cattle, which are expensive and susceptible to tse-tse-borne sleeping sickness. This type of good management of natural resources is exemplified by the management of the Birds' Nest Caves in north Borneo. The birds in question are two species of swiftlet (*Collocalia fuciphaga* and *C. brevirostris*) the nests of which are exported to form the basis of birds' nest soup, providing quite a valuable source of income to the Government. Only licensed contractors are allowed to collect the nests. *C. fuciphaga* builds three nests in a season. Of these two sets are collected before the eggs hatch but the third nesting is not disturbed. *C. brevirostris* builds two nests in a year. Both sets are collected, but the second harvesting is delayed until most of the fledglings have flown. Thus both species are preserved, although exploited.

The concept of mere *preservation* has given way to that of conservation of the habitat as a whole, since there is a complex interdependence of species. This is stressed in an article by J. L. Harrison on Small Mammals. He argues that the diversity of competing species in any environment prevents the undue increase of any one of them. Destruction of any one species could upset the balance and cause the emergence of another in sufficient numbers to constitute a pest.

There is a wealth of interesting information in this volume. G. E. Stubbs describes races of butterflies found on islands off the east coast of Malaya which differ strikingly from specimens of the same species found on the mainland. These have not been described by any other author and are not yet figured. Many of them are far nearer the Bornean races than the Malayan. This opens up fascinating speculations on the land connections of these islands in prehistoric times. One could quote indefinitely: up to six cubs may be born to the Malayan tigress, but more than two seldom survive to maturity; the Sumatran Rhinoceros, the Pangolin, the Orangutan, and many others are discussed.

Although the examples may be new, the concepts dealt with will be familiar to all readers of the Bombay Natural History Society's *Journal.* The aim of all Natural History Societies is to promote nature conservation, and the appearance of a book like this is to be welcomed.

R. R.

2. A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN. By Sidney Dillon Ripley II. pp. xxxvi+703 (23×15.5 cm.). Bombay, 1961 Bombay Natural History Society. Rs. 25.00.

The impact of zoological neo-systematics has been particularly marked in ornithology. Indian ornithology in its turn has tried to keep pace with the modern concepts. The large number of organized regional studies on birds conducted during the last three decades or so in India and the adjacent countries, and the numerous recent revisional studies of different groups of birds, have resulted in an accumulation of new data on the distribution, status, relationship, etc., of various Indian birds and a rearrangement of different taxonomic categories, so as to render Stuart Baker's FAUNA OF BRITISH INDIA, BIRDS (2nd ed.), vols. 1-8 (1922-1930), somewhat out-of-date. The want of a work incorporating the up-to-date information about Indian birds has been keenly felt for some time. The publication of Dr. Ripley's SYNOPSIS is, therefore, most opportune and will be warmly welcomed as an indispensable reference work by all bird students not only of India, Pakistan, Nepal, and Ceylon—the Countries it covers—but of other adjacent countries also.

The book opens with an introductory chapter, the highlights of which are clear but brief accounts of the history of the ornithology of the area since the publication of Stuart Baker's FAUNA, different forest types, zoogeography, and a very important list of endemic species. There are two maps here. One shows India and Pakistan before the reorganization of the Indian States, and the other shows the relief features of the subcontinent in colour. Furthermore, in a pocket inside the back cover there are two sets of maps printed on transparent plastic. One of them shows the reorganized States of India as from 1956, and the various climatic types are depicted in the other. This last set, when superimposed on the coloured relief-feature map, becomes a map of the forest types. All these maps are exceedingly useful.

The main text covers some 638 pages. Here the largest unit chosen is the family. The grouping of families into orders has been avoided (except in the 'Contents'), and the use of subfamilial names is resorted to only when absolutely necessary. The author has followed an arrangement of families 'which reflects' his 'own preferences'. Even the sequential arrangement for the Passerine families, as recommended by a Committee of the 11th International Ornithological Congress for the continuation of Peters's CHECK-LIST, has not been adopted.

The familial names are followed by generic names with original references and genotypes. Then each species is given with the author's name (but without original citation and reference), its common English name, and the range. Under each species the various subspecies are listed, each with the original citation and reference, synonyms, and range. Such information as is available about its breeding or wintering quarters, stray occurrences, the habitat it prefers, or the forest type it inhabits, is all included under the range

A species of which no subspecies is recognized is treated in the same way as a subspecies, i.e. all the above-mentioned information is given under the species. The subspecies (or species without subspecies) are serially numbered, and there are more than 2060 such entries. And this gigantic task has been carried out more or less singlehanded by Dr. Ripley! It has indeed been a courageous undertaking to attempt to cover such an extensive field. The results, while inevitably not commending themselves in all details, especially in the recognition or synonymization of many races, to everyone interested, must, however, command the maximum respect and admiration.

Detailed comments on the omissions or errors, which are probably inevitable in such an undertaking, are being published separately. However, three instances where the Direction or Ruling of the International Commission on Zoological Nomenclature have not been followed may be mentioned here. They are about the spelling of the familial name formed from the generic name *Podiceps* Latham (p. 1), the use of the name *Podiceps caspicus* (Hablizl) for the Blacknecked Grebe (p. 2), and the use of the generic name *Capella* Frenzel (pp. 122-125).

These and other omissions and errors noticed are matters of detail, however, well outweighed by the merits of the book.

The get-up of the book is good, and the printing surprisingly free from typographical blemishes (one casually noted is that page number 563 has been printed as 653). The publishers deserve warm commendation for fixing such an incredibly low price for the volume. And Dr. Ripley is to be congratulated for writing the SYNOPSIS which, I am sure, is going to remain as one of the most important and standard reference publications in Indian ornithological literature.

B. BISWAS

3. THE STUDY OF ANTS. By S. H. Skaife. pp. vii+178 (22×14 cm.). One plate and 61 text-figures. London, 1961. Longmans, Green & Co. Ltd. Price 25*s*. net.

The ant is everywhere very conspicuous, indoors and out, owing to its incessant activity. Many people, therefore, have worked on this interesting creature and have published their results. Even so, there are big gaps and naturalists working on this subject can throw light on a number of points which are still obscure. Dr. Skaife, with his vast experience gained from experiments in his laboratory in South Africa, has recorded some of his observations and his interpretations thereof in this little book. Though several points made by him are covered by previous workers, like Lubbock & Myers (1929, ANTS, BEES AND WASPS), D. W. Morley (1952, ANTS), W. Goetsch (1957, THE ANTS), &c., his observations on others are illuminating, e.g. the chapters on installing and feeding ants, mixed communities, parasites guests and predators, and remedial measures.

The book deals with 11 species of South African ants. The author has grouped them in five classes and has devoted one chapter to each class. A general account is given of each species, the races and the varieties if any, their habits, the composition of the colonies, &c. Well-drawn illustrations accompany and clarify the text. Unfortunately, in most cases the measurements of the insects are not given, which causes a confusion in the mind of the reader about the size of the insect. Also, it would have added to the usefulness of the book if the main distinguishing characters of each species had been given. However, very interesting points are explained in these chapters. The ant community differs vastly in its habits from species to species. Some species, like the Argentine Ant, live in colonies of thousands with a number of queens, 50 to 100, in the same nest, whereas some other species, like the Spotted Sugar Ants, have small colonies of 200 or less with one or even no queen at all. Some species marshal their forces in regular defined lines, as against others which, though they have their small colonies, wander about individually in an irregular way as if each ant is living independently. Some species have a marriage flight and mate in the air, whereas in others no mating is seen and even queen ants are absent. Some varieties live underground, some under stones, and some in the trees. There are a number of such features which make absorbing reading.

The next chapter deals with artificial nests for ant-rearing. For minute observations of the habits and breeding of any insect it is necessary to create natural conditions in a restricted area by erecting artificial barriers. The author has devised a number of such artificial nests and describes them with illustrations. His account will be useful to any worker studying non-flying insects or other non-flying small animals. The next two chapters deal with the collection of the ants from the natural sources, and their installing, feeding and rearing for observational purposes. A chapter is devoted to the study of the sense of smell in ants. Reference is made to previous study on this subject by other workers and the author's methods are described. From the point of view of economic entomology this information may be useful to evolve attractants and repellents. Next comes a chapter on intelligence tests. Lubbock, Wheeler, and others devised various experiments to see the intelligence of these animals. The author has devised his own and explains them in detail with explanatory drawings. In spite of his minute observation, however, he has not been able to draw definite conclusions. At times ants follow a method without any particular intelligence; at others their behaviour is inexplicable. There appears to be still a vast field for work in this direction.

In the chapters on mixed communities and reproduction very interesting facts of ant life are related. Two different species can never be induced to live amicably together in the same nest. This is in contrast to the findings of some of the previous workers. In the case of reproduction, in spite of keen observations, it could not be ascertained as to what makes the eggs hatch into queens or soldiers or workers from the same brood. In some species there were no queens, and the virgin workers and soldiers laid eggs which hatched and carried on the colony. There were still other species which did not give any clue as to the method of their multiplication. The chapter on parasites, guests, and predators reveals an amazing number and variety of creatures found in or near ant nests. Some insects, like the aphids, scales, and lycaenid larvae, are reared by the ants to suck the honey-dew produced by them; some beetles or other insects go there to feed on the ant larvae and eggs and are tolerated as the ants get a sweet juice from them; to some intruders the ants are indifferent, probably because they act as scavengers; and a large number go there to parasitise the eggs, the larvae, or the pupae. Apparently, except for this parasitisation, ants suffer from no disease. The final chapter, on remedial measures, after a brief discussion, concludes that DDT serves the purpose best. An index completes the book.

Nicely got up, well arranged, and well printed and illustrated, the book is recommended as a useful guide to students of ant life. The chapters about the establishment and maintenance of ant colonies in captivity will be especially helpful to workers in India, whether amateurs or professional scientists.

N. T. N.

1. Short-snouted pig from Great Andamans

2. Short-snouted pig from Little Andaman

(Photos : L. Cipriani)

3. Long–snouted pig from Little Andaman

(Photo : L. Cipriani)

Miscellaneous Notes

1. THE WILD PIGS IN THE ANDAMANS

(*With two plates*)

Some time back, Mr. A. K. Ghosh, I.C.S., Secretary, Ministry of Scientific Research and Cultural Affairs, Government of India, informed me that there were two kinds of wild pigs in the Andamans, where he was Commissioner from 1949 to 1953.

As the CHECKLIST OF PALAEARCTIC AND INDIAN MAMMALS by Ellerman & Morrison-Scott, 1951, refers to only one species *Sus scrofa andamanensis* Blyth 1858 from the Andamans, Mr. Ghosh suggested that I write to Dr. Lidio Cipriani, an Italian anthropologist who was examining kitchen-middens in the Andamans from 1951 to 1954 and who had more direct experience of these animals.

Dr. Cipriani very kindly sent me three photographs of pigs which he had shot in the area and these present an interesting problem which requires the collection of additional specimens for its solution. The photographs were sent to Mr. J. E. Hill of the British Museum and the following tentative identifications are endorsed by him.

Photograph 1:

This was shot in the Middle Andaman and represents the common wild pig of the Great Andamans; it appears to be the domestic animal run wild. Mr. Hill was in Car Nicobar in 1947 and his recollection of pigs there is that they were of this type and roamed the island in a semi-domestic state.

Photograph 2:

This represents a short-snouted pig which Dr. Cipriani shot in the Little Andaman, where it occurred along with the long-snouted form shown in photograph 3, the two separate forms being distinguished as such by the Onges (Andaman islanders). This is probably the form described by Blyth 1858 (*Journal Asiatic Society of Bengal* **27** : 267) as *Sus andamanensis*. His description was based on ochred skulls found in native huts at Port Blair. According to Blyth, these skulls seemed akin to *S. papuensis* of New Guinea and Hodgson's Pigmy Hog of the Nepal Sāl Forest, *Porcula salvania*. From the size of the adult skull he estimated that the animal would not exceed 15″ in height at the shoulder, but later (ibid **29** : 103) he referred to a complete skeleton from which the height at the shoulder was estimated at 19 or 20″. As far as one can judge, this would be near the height of the animal photographed by Dr. Cipriani. In the same journal (**28** : 271), Blyth had an additional note that the tail was reduced to a mere tubercle and that the animal was well clad with somewhat shaggy black hair. Blanford (FAUNA, p. 562) stated that the one skin examined showed no distinct crest on neck or back.

Photograph 3:

This represents a small pig about the same size as the short-snouted one (No. 2). It was found by Dr. Cipriani only in the Little Andaman. He says that the body was more slender and less heavy than that of No. 2. This was always attended by only one young.

Mr. Hill agrees that this represents a third variety occurring in the Andamans. His letter reads in part: 'The long snout, with the tushes set far back, suggests a relationship to *Sus barbatus* of Borneo, Malaya, and Sumatra, but the specimen portrayed is small for this species. However, *Sus barbatus* is distributed over many of the small islands of the Malay Archipelago, and the occurrence of a form of it on the Andaman Islands cannot be entirely discounted.'

Dr. Cipriani, to whom the above separation into three varieties was put, does not agree. In his opinion, the short-snouted pigs (Nos. 1 and 2) are of the same variety, the apparent difference in size between them being probably due to difference in age. He describes this short-snouted variety as attaining a maximum height of 55 cm., about the same as the long-snouted one, but says that it is stouter and heavier and may be as much as 80 kgm. in weight. He adds that, as in the long-snouted variety, the short-snouted females are followed by only one young, a fact which he would attribute in both cases to the inability of the mother pigs to protect more than one young one against the attacks of the Varanus Lizard (*V. salvator* ?). He states that the short-snouted variety reminded him strongly of a semi-domesticated form that he saw in south Asia and on the south-eastern slopes of the Himalayas. So also, he says, the Abors of the high Brahmaputra Valley have a pig which reminded him of the short-snouted Andamanese form. These observations suggest an explanation which may usefully be explored. In a paper, 'Excavation in Andamanese Kitchen-Middens', read by him at the 4th International Congress of Anthropological and

Ethnological Sciences at Vienna in 1952, Dr. Cipriani explained the derivation of '*Sus andamanensis*' thus: 'In the Nicobars, male pigs were invariably castrated in order to fatten them. Male and female pigs roam free in the jungle in daytime, but are called back to the house by special sounds in the evening. Females are fecundated by wild males. There can be little doubt that the wild pigs of the Nicobars are descendants from young animals which, before being castrated, did not obey to the evening calls of their owners and thus became feral. Similarly, *Sus andamanensis*, of late appearance in the kitchen-middens, would seem to be derived from a semi-domesticated breed.' Bearing these observations in mind, it seems possible that there is a gradation of intermediate forms between the local wild pig and the domestic pig, and this accounts for the difficulty which Dr. Cipriani feels in separating the short-snouted form into two varieties.

Material is required to clear up the doubts enumerated in this note and I would request sportsmen and other persons who are in a position to help to send to the Society's Offices specimens of different varieties of the wild pigs of the Andaman Islands, together with notes as to their appearance, size, weight, habits, etc.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, HUMAYUN ABDULALI
BOMBAY 6,
March 12, 1962.

2. TRANSMISSION OF RABIES WITHOUT BITING

In October 1961 Y. S. Shivrajkumar of Jasdan drew our attention to a report in an American journal about the transmission of rabies by bats without the victims being bitten. We thereupon made inquiries and, as the subject is important and of general interest, we publish the information so far obtained.

The new feature about the association of bats with the transmission of rabies is the probability that rabies may be transmitted without the victims being bitten. Regarding this, with the kind permission of Dr. Ernest S. Tierkel, Chief of the United States Public Health Service Rabies Programme, we reproduce below an extract from a report presented by him before the recently concluded

Interprofessional Seminar, University of Missouri Medical Centre, Columbia, Missouri:

'It had been noted previously that two individuals died of rabies after having been in Frio Cave, a large limestone bat cave in Southern Texas. Before their death, both men denied knowledge of being bitten by bats or other mammals, suggesting the possibility of a non-bite route of rabies transmission, at least under the environmental conditions existing in Frio Cave.

'In July 1961 a large group of animals were placed in a part of Frio Cave occupied by suckling and lactating female bats. They were held in the cave for approximately one month. The animals were placed in four different types of cages, each differing in the protection afforded against cave fauna. Cage type I was made of escape-proof 2.5 cm. metal mesh; type II had the same plus an additional cover of 6 mm. wire mesh to prevent contact with bats or other cave animals; type III was similarly enclosed and covered with 1.4 mm. plastic mesh in place of the 6 mm. wire mesh to prevent entrance of arthropods; Type IV was covered and sealed with transparent plastic, except at each end which was covered with 1 mm. dacron mesh plus the 1.4 mm. plastic mesh. The caged animals were separated from the meshed-in ends by a 'moat' of glycerine soaked spun-glass padding to insure against even the tiniest arthropods such as bat mites from entering the animal cages within the enclosure.

'A variety of carnivores including coyotes, foxes, dogs, cats, skunks, racoons, ringtails and opossums were used. Foxes and coyotes were distributed in each of the four types of cages. To date, all of the coyotes (10) in each of the four types of cages and all the foxes (10) in cage types I, II and IV died of rabies. Rabies virus was isolated from each animal and identified by serum-neutralization tests. The animals in the test had been caged in isolation for a quarantine period of 10 to 20 months before placing them in the cave. Exceptions were one coyote in cage type I and one fox in cage type IV, which were held four months previous to cave test. Two of the animals in the experiment (cage type II) were silver foxes and had been born in captivity three years previously. Negative results for the presence of serum-neutralizing antibody were obtained on all test animals previous to the study.'

According to the Virus Centre at Poona besides in vampire bats (*Desmodus* spp.), there is evidence of rabies in the following genera of bats:

Tadarida, Dasypterus, Lasiurus, Molossus, Myotis, Artibeus[1], *Uroderma*[1].

Of these only representatives of the genera *Tadarida* and *Myotis* occur in India.

The only case of rabies associated with a bat in India is reported in the Annual Scientific Report of the Pasteur Institute, South India, for the year 1955, as follows:

'Bat Rabies—(N. Veeraraghavan). It has been reported that the first case of Hydrophobia following bite by an insectivorous bat occurred in Srikakulam District of the Andhra State.

'With the co-operation of Major T. Joga Rao, Civil Assistant Surgeon, Tekkali, and Dr. Bh. Janakiramayya, Veterinary Assistant Surgeon, Tekkali, bats were shot in the area where the patient was bitten and examined for the occurrence of natural rabies infection among the bat population. So far, 12 bats have been examined. Negri bodies and the virus were not demonstrable in the brains of the bats.'

Unfortunately, the Director of the Pasteur Institute has no record of the species of the bat responsible for the bite or of the 12 bats examined.

Bombay Natural History Society,
91, Walkeshwar Road, EDITORS
Bombay 6,
March 12, 1962.

3. UNUSUAL PLUMAGE OF THE LITTLE CORMORANT [*PHALACROCORAX NIGER* (VIEILLOT)]

In the bird collection of the late Charles M. Inglis, the bulk of which is now housed in the Yale Peabody Museum, there is a male Little or Pygmy Cormorant, *Phalacrocorax niger* (Vieillot) which deserves mention. It was collected on 25 February 1935 on the Kamla River, Darbhanga District, Bihar. This appears to be an adult bird in winter plumage, with a white throat and lacking filamentous feathers about the head, but the whole plumage has a silvery-grey tone. Only the top of the head and round the neck are somewhat brownish. For the rest the bird is silvery-grey, paler below especially on the abdomen, many of the feathers, both of the back, primaries, and

---

[1] These are both frugivorous.

scapulars, and also the abdomen, edged with white. The effect is that of a partial albino, or bleached bird, nearly pearly in tone rather than white. I do not know of any other record of this type of plumage in one of the Indian Cormorants.

YALE UNIVERSITY,
NEW HAVEN, CONN., U.S.A., S. DILLON RIPLEY
February 26, 1962.

4. WIGEON, *ANAS PENELOPE* LINN., AND REDHEADED POCHARD, *AYTHYA FERINA* (LINN.), AT COIMBATORE, SOUTH INDIA

I am writing to report the occurrence of Wigeon, *Anas penelope* Linn., and Redheaded Pochard, *Aythya ferina* (Linn.), at Coimbatore, South India.

A pair of Wigeon, male and female, were sighted and the former was shot in the Big Tank at Coimbatore on 30 March 1960. E. C. Stuart Baker has written about this duck: 'Within our own limits, it is found everywhere, excepting the extreme South and Ceylon.' Phythian-Adams has recorded it from Mysore but says: 'not found further south'. In my long duck-shooting experience this is the first occasion I have sighted them in Coimbatore. To my knowledge, Wigeon has never before this been shot or sighted by anyone in these parts.

On 19 November 1961 six Redheaded Pochards were sighted in the Red Tank, about three miles from Coimbatore Town. Three of them, two male and one female, were shot by my son—weight of male 1 lb. 15 oz., weight of female 1 lb. 11 oz. Mounted specimens of both these species were examined by Mr. Humayun Abdulali during his visit to the meeting of the Indian Board for Wild Life at Ootacamund, and their identity was confirmed by him.

15, PERUMAL KOIL STREET,
FORT, COIMBATORE, B. SUBBIAH PILLAY
December 13, 1961.

[Mr. G. V. R. Frend shot one of several Wigeon at Haripur, Chitaldrug District, on 26 January 1960 and another at Kankuthia Tank about 50 miles further south on 25 February 1960. Phythian-Adams has noted that this species is erratic in its occurrence.

Approaching the nest

Suspicious of the 'hide'

Puffed up on seeing a crow near by

Turning the egg

The Great Indian Bustard, *Choriotis nigriceps* (Vigors)

(Photos : Y. S. Shivrajkumar)

Settling down

Almost settled down

... brooded for hours eyeing the surroundings carefully

... rose from the egg to pick up a grasshopper near by

The Great Indian Bustard, *Choriotis nigriceps* (Vigors) (*Photos : Y. S. Shivrajkumar*)

The Redheaded Pochard also is rare in southern India. The report on the Vernay Scientific Survey of the Eastern Ghats contained only two records of this species from Vizagapatam and Bellary. Subsequent to this on page 400 of Vol. 46 of the *Journal* H. G. Lumsden referred to seeing a few around Madras.—EDS.]

5. THE GREAT INDIAN BUSTARD [*CHORIOTIS NIGRICEPS* (VIGORS)] AT THE NEST

(*With* 2 *plates*)

The Great Indian Bustard, *Choriotis nigriceps* (Vigors), because of ceaseless persecution, is extremely wary at the nest. I therefore consider myself very fortunate to get the photographs of this bird at its nest, which I am sending you and which I think will interest you and your readers. In one of them the bird is seen with its feathers puffed out to drive off a crow which was flying low over the nest.

I take this opportunity to stress the need for protecting this magnificent bird. Once found in numbers in the Punjab, Rajasthan, and Sind, through central India, Kathiawar, and the Deccan to Mysore, it is now found in a few patches scattered here and there in its former range. In Saurashtra a nomadic race, the Dafers, are its worst enemies. Equipped with guns and camels they are perhaps responsible for wiping out more game birds and animals than any other single agency. Why they are allowed to keep guns is a mystery.

As the range of the bird is large it is perhaps not possible to adequately protect it throughout the range, but sanctuaries should be established at selected places in Rajasthan, Saurashtra, and the Deccan. Also, as they have a tendency to breed together and their breeding areas are well known, they should be strictly protected at the breeding season when they are most susceptible to attack.

My thanks are due to M. K. Dharmakumarsinhji without whose inspiration and guidance this note would not have been possible.

THE PALACE,
JASDAN, Y. S. SHIVRAJKUMAR
January 2, 1962.

6. DRUMMING BY, AND AN INSTANCE OF HOMO-SEXUAL BEHAVIOUR IN, THE LESSER GOLDEN-BACKED WOODPECKER (*DINOPIUM BENGHALENSE*)

On 20 April 1960, a friend and I were out watching birds. At 6.25 p.m. we heard a woodpecker drumming. A male Lesser Goldenbacked Woodpecker (*Dinopium benghalense*) was clinging to the trunk of a low palmyra palm which stood near two saplings of *Cassia fistula* on a field-bund. The bird was 12 ft. above the ground and just below the base of the lowest frond. Between 6.25 and 6.45 the bird drummed twelve times. Each session seemed to last about 3 seconds. During the 20 minutes the bird clung to the same place doing nothing in the intervals between drumming except once, after the 7th or 8th drumming, when it preened its breast. After the fourth drumming I noticed another woodpecker, a female of the same species, on a slender branch of a Cassia sapling. I do not know if the bird was there when the male started drumming. Anyway, the female did not seem to take any notice of the male. She was busy hopping up the branch and pecking at, or plucking, certain leaves which had been curled into well-sealed cylinders by some insect. She reached the top of the branch at 6.45, and at once flew off without uttering any call-note then or later. But the male flew after her immediately. He too did not utter any call.

I went up to the palmyra tree to examine the spot where the male had drummed. Most of the lower leaves of the tree had been cut off, and the remnants of the lowest fronds had become quite dry. The base of the frond under which the woodpecker had drummed was twisted, so that there was a hollow space just above the junction of the frond and the trunk. On the closely ridged outer-skin of the broad lower end was a pale buff patch. The bird's bill had appeared to be directed towards the centre of this. As I thought that the woodpecker's bill had made contact with the bark during the drumming, I expected to see an abraded area on the buff-coloured patch. But even the closest scrutiny revealed no such evidence of friction. It may be that the surface was so hard as to remain unscratched, or the bird's action so light as to leave no mark on it.

I had heard Goldenbacked Woodpeckers drumming on the dry stumps of thick mango branches often during the previous two weeks. The sound produced on this occasion appeared to be no louder than that produced by drumming on dry mango branches, though in this instance there was a natural resonance box in the shape of the hollow between the trunk and the base of the frond.

I had a curious hunch that the birds would be there next evening also, and so my friend and I went to the same place at 6.25 p.m. the next day. At 6.30 a woodpecker came and alighted on the trunk of the Cassia sapling. It hopped up and plucked off two or three leaf-whorls and ate the contents. Flying to the palmyra tree, it alighted 6 in. below the place where the 'drummer' had perched the previous evening, and hopped up to the exact spot. It flicked its tongue a number of times into the air like a snake, and preened its breast for a short while. Then it drummed twice within 90 seconds.

I had taken up a position from where I could see the bird in profile against the sky to note whether the bird's head moved up and down or from side to side in drumming. I found that on both occasions that evening the movements of the head and bill were from side to side and that the arc described by the tip of the bill was very small. In fact, it looked as though the bird's bill was just rapidly vibrating.

A few moments after the second drumming, another woodpecker (Bird No. 2), uttering the characteristic call note, came flying straight towards the drummer. The latter flew to a branch of the Cassia and the two birds appeared to be in danger of collision. But bird No. 2 turned off in the nick of time and flew off to a distant neem tree. A third woodpecker now flew to the Cassia and alighted on the branch where No. 1 (the drummer) was. No. 1 at once sidled up to No. 3 and mounted it. The copulatory action was brief and not very lively. No calls were uttered. No. 1 stepped off and sat touching No. 3 which was now 'squatting' across the branch with the body horizontal, wings slightly open and wing-tips arched down towards the ground and hanging down lower than the feet. A few seconds later No. 3, on which No. 1 had mounted, jumped on to the back of No. 1 and quite vigorously copulated. The tail was sharply bent down and thrust almost under the belly of No. 1.

After this, one of the two—I think it was No. 1—hopped up to the top of the Cassia and the other flew off to a tamarind tree 30 yds. away. A little later three woodpeckers called. The bird on the Cassia tree, which had remained silent, flew to a palmyra tree very near the tamarind to which No. 3 had gone. Here it was joined by No. 3 and the two flew to the base of a tall palmyra. A third woodpecker joined them here and all three ran round the trunk for a few moments. Then they dispersed.

Next evening the birds did not turn up at all.

The two woodpeckers which had mounted each other were of identical appearance. Both had black foreheads without any prominent white spots.

A very curious fact was that for a time before copulation, during copulation, and for a few moments thereafter, the woodpeckers were perched *across* the branch like any ordinary passerine bird.

A few furlongs away we had seen a fully-fledged young bird of the same species accompanied by an adult.

GOVERNMENT COLLEGE,
CHITTUR,
KERALA STATE,
August 14, 1960.

K. K. NEELAKANTAN

7. THE LESSER WHITETHROAT [*SYLVIA CURRUCA BLYTHI* TICEHURST & WHISTLER] IN NEPAL: A NEW RECORD

Among the warblers collected in Nepal by Dr. Raymond A. Paynter, Jr., on the Harvard-Yale Expedition of 1957 is one specimen which is a new record for that country. This is the Lesser Whitethroat, *Sylvia curruca blythi* Ticehurst & Whistler. A male was collected on 30 October 1957 at Phewa Tal, Pokhara (800 metres), Nepal. This species winters normally at low elevations, so that perhaps the October date and the altitude together signify a passage migrant.

YALE UNIVERSITY,
NEW HAVEN, CONN., U.S.A.,
February 26, 1962.

S. DILLON RIPLEY

8. ORANGEFLANKED BUSH ROBIN [*ERITHACUS CYANURUS* (PALLAS)] IN DEHRA DUN[1]

A male Orangeflanked Bush Robin, *Erithacus cyanurus* (Pallas), was seen in New Forest, Dehra Dun, (altitude 2100 feet) at the end of December 1961.

Ripley in A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN states

[1] Communicated by Mr. Zafar Futehally.

that the bird winters as low as 4000 feet in the western Himalayas, although in Assam it is seen as low as 1500 feet rarely.

The above record for Dehra Dun appears to be noteworthy.

NEW FOREST,
DEHRA DUN, JOSEPH GEORGE
January 18, 1962.

9. A NOTE ON THE SEXUALITY OF THE RIGHT OVARY IN BIRDS

During my studies on the sexual cycle of the Ashycrowned Finch-Lark, *Eremopterix grisea*, I came across six birds (out of nearly 150 birds dissected during a year) possessing paired ovaries but only the left oviduct; no trace of the right oviduct was present. In all the cases both the ovaries were equally well-developed in size and presented similar histological structure. The oocytes of the right ovary surrounded by their follicular layers were similar to those in the left ovary. The oocytes of the right ovary of two of these birds were in an advanced stage of maturity. Thus it seems obvious that both the ovaries are capable of functional maturation. Since the right oviduct is invariably absent, the ova from the right ovary must be passing out through the left oviduct.

A very thorough examination of slides was made by me to see whether any primordial germ cells could be seen in the right ovary using the criteria laid down by Firket (1914) and Swift (1914) for the identification of these cells. There is absolutely no evidence for the persistence of primordial germ cells in the right ovary of *Eremopterix grisea*.

Occasional presence of the right ovary has been reported in other birds by different investigators, viz. Biswas (1961), Chappellier (1914), Domm (1927), Gunn (1912), Kumerlowe (1930, 1931), Macklin (1923), McKenny (1931), Riddle (1925), Snyder (1931), Stanley (1937), Stieve (1924), Witschi (1935), etc. Diverse theories based on morphological and physiological considerations have been advanced by various authors, viz. Chappellier (1914), Disselhorst (1904), Firket (1914), Gadow (1912), Gunn (1912), Hoffmann (1892), Koch (1926), Stanley (1937), Stieve (1918), Swift (1915), Witschi (1923), in an attempt to explain the problem of asymmetry in the development of the right ovary in birds, a review of which has been given in Stanley's paper.

The most plausible answers to the normal absence of the right ovary in birds come from embryological studies. Dantschakoff & Guelin Schredina (1933) believe that in birds the germ cells originate in the preoral region and are carried to the gonad primordia by the blood stream. They maintain (1) that the arterial complex behind the mesenteric arteries acts as a filter to the germ cells as they are carried along in the blood stream, and (2) that the asymmetry in arterial system developed coincidentally with the turning of the embryo on its left side is responsible for the uneven distribution of germ cells to the two sides, and this results in the asymmetry in the reproductive system.

Witschi (1935), in his work on the Redwinged Blackbird, the English sparrow, and the chick, states that the germ cells are nearly evenly distributed up to the end of the third day of incubation, following which the endoderm withdraws from the dorsal body wall. Presently the mesentery is formed in the gonad region by the inward movement of the splanchnopleures so that the mesenchymatous plates containing the primordial germ cells become fused. Immediately after fusion, migration of the germ cells from the right to the left begins and by the end of the fourth day the 5:1 ratio of Firket or some similar left-right ratio is established. Witschi accounts for the unequal migration of the germ cells by assuming a deficiency in the inductor strength of the right cortex. According to him the primordial germ cells are attracted across the forming mesentery by the stronger left side. He concludes that the deficiency is fixed in the genetic make-up of the bird.

Much light has been thrown on the nature of the vestigial right gonad of birds by the experimental studies of Benoit (1923), Brode (1928), Domm (1927), Gray (1930), Finlay (1925), and Zowadowsky (1922). They have shown that ovariotomy of the left gonad will produce a compensatory growth of the rudiment of the right gonad and a testis may come to exist at the site of the previous gonad rudiment or, in some cases, even an ovary or ovotestis may develop. Domm (1927) has stated that if only medullary tissue remains in the right gonad, a testis or a testis-like organ will be produced. If a sufficient amount of cortical tissue is present it will give rise to an ovary, and if there are inadequate amounts of cortex and medulla an ovotestis will be produced. Thus the various possible developments on the site of the right ovary, both under normal and experimental conditions, seem to be determined by the embryonic composition of the rudiment in addition to other possible factors.

Brode (1928) has suggested that probably the left ovary inhibits the development of the cortex of the right ovary just as it inhibits the medullary components of the right gonad. Stanley (1937) has shown that the hereditary deficiency of the right embryonic gonad characteristic of the chick, the sparrow, and the Redwinged Blackbird as reported by Witschi (1935), is not present in the hawks, which invariably possess paired ovaries; here (in hawks), an even balance exists between the two gonad primordia and hence little if any migration occurs across the mesentery from the right to the left.

It is therefore obvious that in birds the cortex of the right female embryonic gonad has an inherent deficiency in its inductor strength, and this leads to the disappearance of the right ovary and the corresponding oviduct. The occasional presence of the right ovary in birds including *Eremopterix grisea* can perhaps only be explained by assuming that, due to an abnormality in their development, the inductor strength of the two gonad primordia is made even, resulting in an equal distribution of germ cells to the two sides.

ACKNOWLEDGEMENT

I am thankful to Dr. K. C. Bose, Professor and Head of the University Department of Zoology, Ranchi University, for guidance and for providing all facilities of work.

UNIVERSITY DEPARTMENT OF ZOOLOGY,
RANCHI UNIVERSITY,
RANCHI.
September 6, 1961.

P. N. MEHROTRA

References

Biswas, B. (1961): Some cases of ovarian abnormalities in Birds. *Science and Culture* **27** : 1

Brode, M. D. (1928): Significance of asymmetry of the ovaries of the fowl. *J. Morph. & Physiol.* **46** : 1

Chappellier, A. (1914) : Persistence et development des organes genitaux droits chez les femelles adultes des oiseaux. *Bull. Scient. de la France et de la Beleg.* **47**: 361

Dantschakoff, W. & Guelin Schedrina, A. (1933) : Keinzella und gonade, VI-Asymmetrie der gonaden beim Huhn Primare quantitative asymmetrie der gonadenlagen. *Z. Zellf. mikr. Anat.* **19** : 50

Domm, L. V. (1927) : New experiments on ovariotomy and the problem of sex inversion in the fowl. *J. exp. Biol.* **48** : 31

Firket, J. (1914): Recherches sur l'organogenese des glandes sexuelles chez les oiseaux. *Arch. de Biol.* **29** : 201

Gadow, H. (1912): The one sided reduction of the ovaries and oviducts in the Amniota with remarks on mammalian evolution. *Proc. Zool. Soc. London* **82** : 808

Gray, J. C. (1930) : The development, histology and endocrine function of the compensatory right gonad of the hen. *Amer. J. Anat.* **46** : 217

Gunn, T.E. (1912) : On the presence of two ovaries in certain British birds, more specially the Falconidae. *Proc. Zool. Soc. London* **82** : 63

Macklin, M. T. (1923): A description of material from a gynandromorph fowl. *J. exp. Zool.* **38** : 355

McKenny, F.D. (1931): A persistent right oviduct in the domestic fowl. *Anat. Rec.* **49** : 51

Riddle, O. (1925) : On the sexuality of the right ovary in the birds. *Anat. Rec.* **30** : 365

Snyder, L.L. (1931) : Paired ovaries in the hawks. *Auk* **48** : 117

Stanley, A.J. (1937): Sexual dimorphism in the North American hawks, I. Sex organs. *J. Morph.* **61** : 321

Stieve, H. (1924) : Beobachtungen uber den rechten eierstock und rechten Legdarm des Huhnerhabichts (*Falco palumbarinus*). *Morph. Jahrb. Leipzig.* **54** : 137

Swift. C.H. (1914): Origin and early history of primordial germ cells in the chick. *Amer. J. Anat.* **15** : 483

Witschi, E. (1935) : Origin of asymmetry in the reproductive system of birds. *Amer. J. Anat.* **56** : 119

10. MIGRATORY WAGTAILS IN KERALA

In December 1961, Mr. P. V. George of Kerala who had earlier attended two of our BNHS/WHO Bird Migration Study field camps, observed vast numbers of migratory wagtails, mostly the Yellow (*Motacilla flava*), feeding regularly during daytime in the extensive dyked paddylands in the Kuttanad area of Vembanad Lake, Kerala, (*c.* 9° 20′ N., 76° 38′ E.). Every evening, an hour or so before sunset he noticed that the birds formed themselves into disorderly flocks or rabbles 200 or 300 feet up in the air and commuted in a south-easterly direction. With commendable enterprise and perseverance George and a companion decided to trail these flocks cross-country, through intervening canals over tortuous *bands* through paddy fields, and other obstacles, a mile or two further each evening, till on the 17th day they finally succeeded in running down one of the roosts in a sugarcane field at Kuttoor, near Thiruvalla, some 15 to 25 miles away. Here, in an area of about one acre of standing sugarcane Mr. George estimated a roosting concentration of 10 to 12 thousand birds; the actual number may well be considerably higher. Presently they discovered several other such roosts in that area, all exclusively in standing sugarcane fields of the variety known as 'Java'. This variety is an upstanding cane with broad, robust, arching leaves for the birds to rest on, and comparatively free from prickly spines and saw-edging. Later, George and his companion discovered some more roosts in the Edanad area (near Chengannur) a few miles further south-east, where the concentrations of wagtails were even greater. Edanad is virtually an island of about 650 acres surrounded by the Pamba River. It has extensive sugarcane fields interspersed with patches under paddy and tapioca. The island is dotted about with the characteristic Kerala homesteads set amongst 'kampongs' of coconut and betelnut palms, jack fruit, kokam (*Garcinia*) and banana trees, and pepper vines. The arrival of the wagtails at dusk to roost in the sugarcane and their departure at dawn is a phenomenal spectacle. Around sunset, about 6.30 p.m. in February, the first scouts and small parties appear above the fields. The flocks swell as more and more birds arrive, till soon the sky overhead becomes a seething mass of undulating motes milling around in a disorderly rabble tier upon tier. They spread from horizon to horizon in numbers that defy estimation and can only be compared with locust swarms. Settling for the night commences just before dark and lasts for about 20 to 30 minutes from the first arrivals. Birds from the lower tiers drop directly into the cane from a height of 50 to 100 feet at a steep angle—first in 2s and 3s, then in dozens and scores—looking like a shower of falling leaves, and reminiscent also of wounded birds dropping to a 'browning' shot. Within 10 or 15 minutes of settling, complete silence prevails. The birds perch singly on the cane leaves and not huddled together. No noise or clamour emanates to betray the colossal hordes within; the acrid smell of their excreta is the only evidence. The departure of the birds in the morning is equally spectacular. At about 6.35 a.m. (when the light intensity is about the same as at roosting time) a solitary scout or small party flies out of, and 10-15 feet above, the standing sugarcane. This is the signal for the roosters. Presently other wisps, then flocks, then swarms, begin leaving the cane fields in quick succession. The noise of the rustling leaves as flock after flock takes off is like surf breaking on a sandy shore, or like an advancing rain storm over distant forest. The larger swarms at Edanad contained perhaps 5000, perhaps 20,000 birds, each. With several such swarms aloft in the sky, there was nothing but wagtails from horizon to horizon. The traffic rush lasted a full 25 minutes till the last party had left at about 7 a.m. Thereafter only belated ones and twos continued for another 5 minutes or so. The total number leaving this cane patch of perhaps less than 10 acres must be quite quarter to half a million birds. The thought that this is but one of the many such roosts in Kerala—itself but a minute dot in the birds' winter range—and that when they return to their breeding grounds the majority will pair, occupy individual territories and produce a family of 5 or 6 each, is staggering in its implications.

In 20 days' netting at Kuttoor and Edanad during January and February nearly 1900 Yellow Wagtails were ringed, mostly of the races *beema, thunbergi, melanogrisea,* and *simillima.* Among them were also a good number of *M. citreola* and a few (33) *Motacilla indica*—the Forest Wagtail. The last, of which 1 to 5 examples were taken each day, were sharing the roosts with the others. They probably came from the neighbouring homestead gardens where twos and threes were commonly to be met with feeding quietly on the ground in the shady 'kampongs'. Only a single recapture of a Yellow Wagtail was recorded. It was caught at the same roost where ringed exactly two weeks before. Owing to a shortage of trained hands the de-ticking could unfortunately only be done rather hurriedly and superficially. Even so, it is noteworthy that of over 1700 birds examined not a single one was found positive for ticks.

The occurrence of the Yellow Wagtails in such unsuspected abundance in Kerala is a new discovery. I certainly never came across anything like the scenes described above, during the ornithological survey of Travancore and Cochin in 1932-33.

33, Pali Hill,
Bandra,
Bombay 50,
March 6, 1962.

SÁLIM ALI

11. RECOVERY OF RINGED BIRDS

Ring No.	Species	Date of Ringing	Place of Ringing	Recovered on	Place of Recovery	Remarks
Bombay A-4886	*Motacilla alba* (*dukhunensis*)	17-3-1961*	Asambia near Mandvi, Kutch *c.* 22° 51′ N., 69° 32′ E.	June-July 1961	Kirov, USSR, *c.* 58° 35′ N., 49° 40′ E.	The recovery was reported by the Bird-Ringing Bureau, USSR Academy of Sciences, Commission for Nature Protection, 12 rue Kravtchenko, Moscow W-331
Bombay A-5458	*Motacilla flava* ssp.	14-5-1961*	Bharatpur, Rajasthan, *c.* 27° 13′ N., 77° 32′ E.	25-6-1961	Kirghizia, USSR, *c.* 41° 55′ N., 74° 30′ E.	do.
Bombay C-0518	*Anas querquedula* ♀	6-5-1961*	Ghana, Bharatpur, Rajasthan	29th August 1961	near Burla, Altai territory, *c.* 53° 20′ N., 78° 19′ E.	do.
Bombay C-381	*Anas querquedula* ♀	4-4-1962*	Ghana, Bharatpur, Rajasthan	30th April 1962	near Lokoti, Altai territory, *c.* 51° 10′ N., 81° 15′ E.	do.

* These were ringed in the course of BNHS/WHO Bird Migration Field Project.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
April 23, 1962

EDITORS

12. NOTES ON THE BIONOMICS OF THE FLYING LIZARD, *DRACO DUSSUMIERI* DUM. & BIB.

Draco dussumieri Dum. & Bib., an arboreal Agamid lizard, is common in many parts of Kerala, but the distribution appears to be local and erratic. In all 36 specimens (22 ♀♀, 14 ♂♂) were obtained, some from hilly regions, e.g. Kallar (200 m.) in Trivandrum District and Pathanapuram (60 m.) in Quilon District, and some from low country, e.g. Kulakulam (50 m.) in Kottayam District and Piravom (20 m.) in Ernakulam District. In the two places named last the lizards were found in the coconut and arecanut plantations on the banks of the Moovattupuzha River.

The agility and the swiftness which the lizards display on the trees is in marked contrast to their relative helplessness on the ground. On the tree the body is held close to the trunk with the head raised at an angle of about 45°. As noted by Günther (1864, REPTILES OF BRITISH INDIA: 122) the ordinary movements of the lizard climbing a vertical trunk are a series of jerky movements; but if pursued the patagia are slightly opened and the animal leaps a short distance dodging if necessary to avoid capture.

The patagium or 'wing' membrane is normally supported by six patagial ribs, but in two specimens, one ♀ and one ♂, seven patagial ribs were found; usually folded along the sides; when expanded convex above and concave below; margin frilled.

The erectile gular pouch below the throat and the wattles on the side of the head are believed to function as secondary sexual characters; it is possible that the sudden erection of the gular pouch and wattles is a protective device, as this reaction is generally observed when the animal is captured.

The animals are generally seen in pairs, one male and one female.

Coloration in life. Ashy grey dorsally with longitudinal series of black circles along median line. Head has two cross-bands touching orbits. Ventrally the body is greenish yellow. Throat and neck greenish with scattered black spots; black band across throat behind gular pouch. Gular pouch bright yellow. Dorsal side of patagium brown near body and purplish black with yellow patches near outer edge, this colouring being more pronounced anteriorly. Ventral side of patagium yellow with marginal series of black patches, this bright colour pattern being visible only when patagium is expanded.

The coloration is cryptic and harmonizes with the black and bright ash-grey patches on the trunks of coconut and arecanut palms, the bright colours showing up only in movement. It was noticed that specimens collected from hilly regions are darker. In this connection it may be relevant to mention that an animal kept in a small cage for a day was seen to be dark; on removal to a larger, well-lighted cage, however, it would resume its normal coloration within a few minutes.

In preserved specimens the body is greyish brown with dark markings, sometimes with a series of black circles on the back. It would appear from this that Malcolm A. Smith's remark: 'Colour in life not described'[1] (1935, THE FAUNA OF BRITISH INDIA, REPTILIA AND AMPHIBIA Vol. II. Sauria: 143) is not confined to the colour of the patagia.

Distinguishing characters between sexes. The males are usually smaller than the females. The gular appendage in the male is about three times as long as it is in the female, and when extended forward reaches beyond the snout. In addition, the male has a nuchal fold and a low but distinct caudal crest.

Egg-laying to hatching. A gravid female measuring 190 mm. in total length was collected on 18 July 1960 at Mulakulam and kept in a fairly large cage with wire-gauze netting at the laboratory. For the first two days it refused food, later it began to feed on small grasshoppers and other insects. To provide a natural environment as far as possible a heap of moist soil with decaying leaves was placed on the floor of the cage. It was also provided with water. On the morning of 25 July 1960, it made a small pit in the moist soil about one-and-a-half inches deep and two inches in diameter. In the afternoon of the same day at 2.15 p.m. the animal was seen moving near the pit and still working at it. Crouching on the soil, with hind-limbs stretched apart, the clawed fore-limbs were used alternately to remove the earth from the pit. It appeared very active and excited; but, disturbed by a slight movement of the observer, it stopped digging, covered up the pit with soil. and left the place. After some time it went round the heap of soil and examined various places and finally, selecting a new spot, made another pit. It lay crouched over the pit with the snout touching the soil, the tail slightly lifted up and, with the vent bent downwards into the pit, laid four white eggs. The eggs were then covered with soft soil completely and the pit was so well covered that it was difficult

---

[1] In *J. Bombay nat. Hist. Soc.* (1940) **42**: 46 McCann in 'A Reptile and Amphibian Miscellany' refers to a live specimen which he obtained in N. Kanara. He describes the colour pattern but prefaces his remarks with the statement that it is 'by no means constant as it keeps changing within certain limits.'—EDS.

to locate it afterwards. It remained near the pit for some time and then climbed on to the wire-gauze netting of the cage. The whole process took about half an hour.

The egg is oval, slightly pointed at one end rounded at the other. It has a hard, resilient, partly calcified shell. The freshly laid egg is pure white in colour. The surface of the egg is sculptured with longitudinal striations extending from one end to the other. An egg was 14 mm. in length and 8.1 mm. in breadth and weighed 0.54 gm.

The eggs were kept buried in soil which was frequently kept moist to prevent dessication. During the incubation period the egg changes in size and shape, becoming more rounded as development proceeds. The dimensions of the egg during this period are below:

Period of incubation	Length	Breadth
Freshly laid egg (25-7-1960)	14 mm.	8.1 mm.
2 weeks	13.5 mm.	10.05 mm.
3 weeks	12.5 mm.	10.5 mm.
4 days before hatching (9-9-1960) ..	16.5 mm.	13.5 mm.

The egg hatched out on 13 September 1960, fifty days after it was laid. The newly hatched young was quite active from the time of hatching. It was dark in colour, but after a few minutes of exposure to light it assumed the characteristic colour pattern of the adult. The gular pouch is small and yellow in colour. The patagium is not large enough to enable the lizard to glide. But it can run about actively on the ground, contrasting with the clumsiness of the adult when on the ground.

The dimensions of the newly hatched lizard are given below:

Head and body	32 mm.
Tail	52 mm.
Patagium on one side	15 mm.
Patagium extended fully on both sides	35 mm.
Gular pouch	3.5 mm.

ACKNOWLEDGEMENTS

I am grateful to Dr. A. P. Mathew for guidance and to the Council of Scientific and Industrial Research for the award of a Research Assistantship during which the work was undertaken.

MAR IVANIOS COLLEGE,
TRIVANDRUM, K. O. JOHN
KERALA,
January 23, 1961.

13. FURTHER STUDIES ON PADDY-CUM-FISH CULTURE AT HESSERAGHATTA FISH FARM IN MYSORE STATE

(*With one text-figure*)

INTRODUCTION

In India several attempts have been made to popularise fish culture in paddy fields. In earlier pilot studies carried out, the author (1953) reported a production of 100 lb. (45.36 kg.) of fish per acre (0.405 hectare) of paddy field, and an increase of 7% to 13% in paddy yield. Dr. S. L. Hora, commenting on these experiments, observed that the poor results were due to defective selection of fish, and that the high rate of escapement and consequent low production were accounted for by murrel being an air-breathing fish able to travel across paddy fields. He recognised the value of the experiments, however, as there was an indication of an appreciable increase in the yield of paddy, and recommended the culture of any of the carps in such experiments.

The Fisheries Research Committee of the Government of India in its report (1954), while reviewing these experiments conducted in Mysore State, observed:

> 'although the murrel is not the ideal fish for experiments of this kind, we are of the opinion that, on account of the preference for this fish in the State, the experiments should be continued.'

The members of the Committee also discussed the design of the experiments and advised the lines on which further experiments should be carried out. The experiments were continued accordingly.

MATERIAL AND METHODS

1. Paddy plots

The experiments were conducted in specially designed paddy plots situated between the nursery pond and the fry nurseries in the

Hesseraghatta Fish Farm (Text-fig.). The period of the experiment was from 28 August 1954 to 28 December 1954.

The paddy plots, twelve in number, were arranged in three terraces, and each terrace had four plots each measuring 242 sq. ft. each (2 *guntas*[1]). The terraces were designated A, B, and C and the plots A_1, A_2, etc. as shown in the text-figure. One plot (indicated by the subscript c) was kept as a control plot in each terrace.

A_1 300	A_2 400	A_c	A_3 200
B_1 300	B_c	B_2 200	B_3 400
C_c	C_1 400	C_2 200	C_3 300

Text-fig. showing the lay-out of paddy plots. The numbers indicate the number of murrel fish fingerlings stocked in each plot.

The control plots were selected at random. A trench 1 ft. (0.30 m.) deep and 1½ ft. wide was dug around each plot and the bunds were raised from 1 ft. to 1½ ft. The water outlet from each plot was kept 4 in. (10.16 cm.) above the soil level, to prevent the plots from going dry inadvertently. The water inlets and outlets were provided with velon netting to prevent the escape of fish fingerlings.

After all these arrangements were completed, the paddy plots were carefully prepared for the transplantation of paddy. Fifteen days before transplantation 600 lb. (272 kg.) of compost manure and, one day before transplantation, 224 lb. (102.50 kg.) of a 50:50 mixture of ammonium sulphate and super-phosphate were applied to each plot.

The paddy seedlings were transplanted on 31 July 1954. Twenty-four rows of seedlings were transplanted in each plot. The actual area under paddy was 64 ft.×24 ft. (19.51 m.×7.32 m.).

2. Fish fingerlings

2700 fish fingerlings of murrel (*Ophiocephalus striatus*) from different broods were collected, and without mixing were distributed

[1] 40 guntas = 1 acre

in the nine plots at the rate of 900 fish fingerlings per terrace. Three densities of 400, 300, and 200 fingerlings per plot were observed, the density per plot being fixed at random.

The fingerlings were released into the plots on 24 August 1954. The number released in each of the plots is shown in the text-figure. None were released in the control plots. Prior to the release of the fingerlings the total weight of the fingerlings released in each plot and the lengths of 30 selected at random from among them were recorded.

No observation was made of the growth of the fish at regular intervals, except at the time of harvest. On 28 December 1954, the day of harvesting, the water was drawn off so as to be maintained only in the trenches around the plots. The paddy yield in each plot and the growth and survival records of fish in the respective plots were carefully recorded. The readings are shown in the table on p. 305.

Discussion

(*a*) Gain in length

The average length of the fish in each plot at the time of introduction ranged from 32.00 mm. in plot No. C_3 to 90.17 mm. in plot No. A_1. The gain in length was 62.45 mm. and 80.01 mm. in the respective plots. The average length of the fish fingerlings at the time of introduction for all the plots was 50.65 mm., and that at the time of harvest was 107.15 mm., the average gain in length over a period of 123 days being 56.50 mm. The significant gain in length of 80.01 mm. in plot A_1 was perhaps due to the fact that fingerlings at an advanced stage were introduced into it.

(*b*) Weight of fish produced

The total weight of the fingerlings (2700) at the time of release was 4.9896 kg. and that of the 347 fish recaptured was 10.0291 kg. Thus, a produce of 5.0395 kg. in 18 *guntas* of paddy was recorded. This works out to a production of 11.1988 kg. of fish per acre.

(*c*) Fish recaptured

Out of the 2700 fish fingerlings introduced 347 were recaptured recording a recovery rate of 13%. Fish loss was mostly due to escapement and predation.

(*d*) Paddy yield

The paddy yield in control plots A_c, B_c, and C_c was 75 seers, 80 seers, and 64 seers respectively, averaging 73 seers. As against this the yield in the nine plots with fish ranged from 64 seers to 86 seers with an average yield of 79 seers. The increase in yield is six seers for 2 *guntas* or about 120 seers per acre.

The following analysis of the data brings out an interesting point:

Plots (1)	Total No. of fish introduced (2)	No. of fish captured (3)	Percentage recaptured (4)	Gain in length (5)	Average paddy yield in seers (6)
A_2, B_3, C_1 (400 each)	1200	107	8.90	52.92	76.7
A_1, B_1, C_3 (300 each)	900	110	12.22	61.81	77.7
A_3, B_2, C_2 (200 each)	600	130	21.70	55.96	81.7

It is significant to note that of the three densities in stocking, 200 fingerlings per plot seems to give the best general results in respect of recapture, gain in length, and yield of paddy.

Even though it is not possible at this juncture to draw any definite conclusions, this experiment adds weight to the finding that there is a slight increase in paddy yield and that the paddy plots could be used profitably for nursing the fry and fingerlings of economically important freshwater fishes.

Acknowledgements

The author is grateful to Dr. N. K. Panikkar, Fisheries Development Adviser, Government of India, and Dr. W. H. Rich, Stanford University, U.S.A., for their guidance.

Ministry of Community Development & Co-operaton,
(Dept. of Community Dev.),
Krishi Bhavan,
New Delhi 2,
April 20, 1961.

H. D. R. IYENGAR

References

Iyengar, H.D.R. (1953): Paddy-cum-fish culture. Pilot studies conducted at Hesseraghatta and Visweswaraya Canal Farms in Mysore State. *Ind. Jour. Vet. Sc. & A. H.* 23 (4): 289-297.

Government of India (1954): Report of the Fisheries Research Committee, Ministry of Food & Agriculture. p. 23, para. 43.

Statement showing readings on Paddy-cum-Fish Culture Studies conducted at Hesserghatta Fish Farm from 28 August 1954 to December 1954.

Paddy plots	No. of *Ophiocephalus striatus* fish fingerlings released	Average length in mm. of fish fingerlings		Gain in length in mm. (percentage of gain in length)	Kg. of fish released in each plot	Kg. of fish collected at the end of experiment	Increase in wt. in kg. (% increase)	No. of fish collected at end of experiment (percentage of recapture)	Seers of paddy yield per plot
		on 28-8-54	on 28-12-54						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A_1	300	90.17	170.18	80.01 (88.7%)	1.134	2.012	0.878 (77.4%)	33 (11.0%)	75
A_2	400	56.13	87.38	31.25 (55.7%)	0.680	1.021	0.341 (50.0%)	39 (9.7%)	86
A_c	—	—	—	—	—	—	—	—	75
A_3	200	55.37	109.73	54.36 (92.3%)	0.453	0.876	0.423 (93.1%)	50 (25.0%)	82
B_1	300	56.13	99.10	42.97 (76.6%)	0.680	1.194	0.514 (75.5%)	38 (12.6%)	83
B_c	—	—	—	—	—	—	—	—	80
B_2	200	51.31	104.65	53.34 (104.0%)	0.453	0.937	0.484 (106.6%)	40 (20.0%)	86
B_3	400	46.23	122.94	76.71 (165.9%)	0.680	1.503	0.823 (121%)	31 (7.7%)	80
C_c	—	—	—	—	—	—	—	—	64
C_1	400	36.32	87.12	50.80 (139.9%)	0.453	1.095	0.642 (141.4%)	37 (9.2%)	64
C_2	200	32.23	92.43	60.20 (186.8%)	0.226	0.656	0.430 (189.5%)	40 (20.0%)	77
C_3	300	32.00	94.45	62.45 (195.0%)	0.226	0.632	0.406 (179.06%)	39 (13.0%)	75
Total for 12 plots	2700	50.65 (Average)	107.55 (Average)	56.90 (112.55%) (Average)	4.985 (Total)	9.926 (Total)	4.941 (99.04%)	347 (12.89%) (Total)	

14. CRAB-FISHING AT BOMBAY[1]

(*With two plates*)

The crab fishery of Bombay, though of less commercial importance than the prawn and lobster fisheries, is widely dispersed all along the sea coast. Rai (1933), in his account of the shell-fisheries of Bombay, has dealt very briefly with the crabs. A more elaborate but preliminary note on the fishery, especially of fishing methods, was therefore considered necessary for future investigators.

Crabs of Economic Importance

Of the various species of crabs found in the seas around Bombay, the most important from the economic point of view is the common rock crab, *Scylla serrata* (Forskål), locally known as *khadapi chimbori*. It is available in quantities larger than all the other species put together. The average size of the crab sold in the market is about 4 – 5 in. across the carapace, although it can grow to a little more than 8 in.

Next in importance are the blue crabs, *Neptunus* (*Neptunus*) *pelagicus* (Linnaeus) locally known as *nili chimbori*, and the three-spotted crab, *Neptunus* (*Neptunus*) *sanguinolentus* (Herbst) locally known as *tin-doli chimbori*. These are smaller species, seldom exceeding 5 and 3 in. respectively in width across the carapace.

Charybdis (*Goniosoma*) *cruciata* (Herbst), as large as the crabs of the genus *Neptunus*, is seldom seen in the markets, being more abundant offshore and occurring in large numbers in trawler hauls taken at a depth of 25 fathoms.

Matuta lunaris (Forskål), locally known as *penkai*, a crab growing to 1½ in. across the carapace (excluding the lateral spines), takes the place of *Varuna litterata* (Fabricius) in Bengal in being used as the poor man's food in Bombay.

During the rainy season a freshwater crab, *Paratelphusa* (*Barytelphusa*) *jacquemontii* (Rathbun) locally known as *gorey panyachi chimbori*, which grows to as much as 5 in. and is caught in paddy fields and around lakes and streams, is also brought for sale to the markets.

Other varieties of crabs caught by the fishermen are retained by them for domestic consumption and are not brought to the markets for sale.

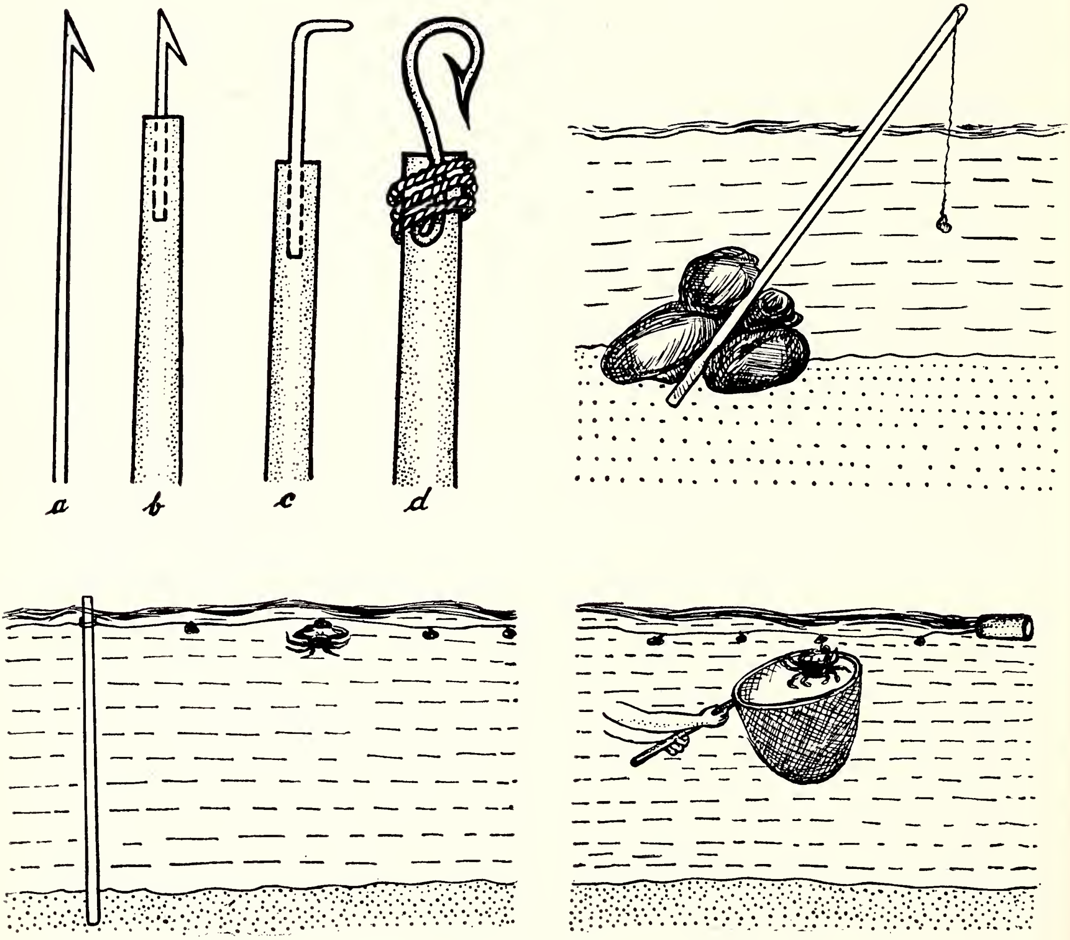
---

[1] Communicated by Dr. C. V. Kulkarni.

Crab-fishing at Bombay

a. A hoop net being let down. Note the bait in the centre of the ring.

b. An *ulendi* in use.



f

Crab-fishing at Bombay

a . & *b*. Two varieties of *dharkan* ; *c*. & *d*. Two varieties of *aankdi* ; *e*. A *kaabey* in position ; *f*. A *pagavli*

Methods of Fishing

Various types of gear, used mainly to catch fishes, also trap crabs, e.g. the *pera*, a type of seine net, often brings in large hauls of pelagic crabs.

There are also various contrivances used exclusively to catch crabs. Some are different from those described for other parts of India and are described here: (1) The *phuck* or hoop net (Plate I, a): known by other names in different localities, e.g. *fug* (at Uttan), *aankha* (at Arnala), *asu* (at Bassein), *gada* (at Manori, Madh), *garanda* (at Naigaum), *hili* (at Uran), *hila* (at Karanja).

It consists of a bamboo or iron hoop (known as *gada*) which may be as small as 1 ft. in diameter, but is usually 3 ft., or sometimes even 5 ft. (at Arnala). To this is fastened a basket-shaped net of cotton twine. When a wooden hoop is used, it is weighted with three to four stones of a total weight of about 6 lb. The net is made in the following manner. Thirty meshes are made to start the bottom portion of the net. At intervals along the height of the net, there is an increase of 30 meshes: this is called *vasang*. There are in all three *vasangs*, making the total number of meshes 120 at the hoop. Each mesh is $1\frac{1}{2}$ to 2 inches.

Two cross-pieces of thicker twine, tied tightly across the hoop, hold the bait which is locally known as *ghas*. This may be the flesh, fresh or dried, of *mushi* (shark), *pakat* (ray), *wagti* (ribbon fish), or *kaleti* (*Trypauchen vagina*). The intestines of goats or sheep are also used when fish bait is scarce. Though crabs are known to be scavengers, the fishermen believe that fresh bait attracts them more than dried or putrefying bait. They also say that crabs are attracted by sight rather than by smell, and therefore prefer *wagti* as bait since the skin of this fish shines brilliantly by reflected light. The flesh or the skin of shark come next in preference, as they are tough and take more time for the crab to consume.

The *phuck* is let down and hauled up by a long cord attached to the hoop by three bridles. A dried hollow *tumdi* or gourd at the other end of the cord acts as a float or buoy to indicate the location of the net.

About 10-15 *phucks* are used at a time by the fisherman. They are carried in *tonis* (dug-out canoes) to the fishing grounds, which are at three to four fathoms depth. The *phucks* are laid down, spaced at suitable intervals so that the hoops rest completely on the sea bottom. They are hauled up at intervals of 10-15 minutes to remove the crabs caught, and are set again.

Crab-fishing is often indulged in by young boys or poor fishermen who sometimes cannot afford even a *toni*, and a novel contrivance is used. Locally known as *ulendi* or *taranda* (Plate I, b), this is a flat log of the light *pangara* wood (*Erythrina indica* Lam.) 9 ft. long and 9 in. thick, tapering to a roughly rounded point at the front end, and weighing from one to 1½ maunds when dry. The fisherman lies on it, grips it between his thighs, and using his arms and legs as in the crawl stroke propels himself to the fishing grounds. Although frail and precarious in appearance, it serves well in the calm, relatively shallow waters where the *phucks* are used.

Although the *phuck* is mainly used for trapping crabs and lobsters, other animals, e.g. groupers (*Ephinephalus* spp.) and catfish (*Tachysurus* spp.), are sometimes caught in it. A similar contrivance, with minor adaptations, is used for catching crabs in California (Lahr, 1939) and lobsters in South Africa (Chopra, 1936).

(2) The *dharkan* (Plate II, a) is used for pulling out crabs from their burrows. It is a steel rod about 4½ ft. long and ¼ in. thick with a barb at one end. Instead of a complete rod, a short barbed piece 6 in. long is sometimes tied to a bamboo stick (Plate II, b).

A similar appliance is the *aankdi* (Plate II, c). This is simply a 1-foot-long steel rod with the last 2 inches bent at right angles, and fixed to a stick. Sometimes an ordinary fish-hook tied to the end of a stick serves the same purpose (Plate II, d).

(3) The *kaabey* (Plate II, e) is used at Gungwara. It appears like an angler's rod and line and consists of a 3-ft.-long stick at the end of which is tied a string of the same length. To the free end of the string is tied the bait (no hook being used). A number of these are fixed in crevices of rocks in waist-deep water and inspected from time to time, any crabs clinging to the bait being removed.

(4) The *pagavli* or *pagavni* (Plate II, f). This is the most commonly used method of catching crabs around Bombay. A string varying from 100 to 200 ft. in length is used. Bait is tied at intervals of 3 ft. along the line. One end of the line is fixed to a wooden stake driven into the mud. The line is paid out by the fisherman wading in chest-deep water. To the other end of the line is fixed a cork float. Crabs attracted to the bait cling to the line, which is inspected at intervals. The line is lifted by one hand, and a net known as *aankha* is slipped under, and the crab is jerked into it.

Marketing

Crabs are highly esteemed for their nutritive value. Medicinal properties are also attributed to them. Hence, they have a ready local market, and are caught and sold wherever they are available without a regular sales organization. They are brought to the markets in baskets, packed between layers of sea-weed soaked in sea-water to keep them cool and moist. They fetch a retail price ranging from 75 nP. a dozen (carapace breadth 2 in.) to one rupee a pair (carapace breadth 6 in.).

Taraporevala Marine Biological Station,
Bombay, B. F. CHHAPGAR
November 22, 1961.

References

Chacko, P. I. & Palani, E. (1955): An unusual crab fishery in the sea off Ennur, Madras. *J. Bombay nat. Hist. Soc.* **52**: 946, 947.

Chopra, B. (1936): The Cape crawfish industry of South Africa with some observations on the prawn and crab fisheries in India. *Curr. Sci.* (7)4: 529-533.

— — — — (1939): Some food prawns and crabs of India and their fisheries. *J. Bombay nat. Hist. Soc.* **41**: 221-234, pls. i-v.

Hora, S. L. (1935): Crab-fishing at Uttarbhag, Lower Bengal. *Curr. Sci.* (11)3: 543-546, 8 text-figs.

Jones, S. & Sujahsingani, K. H. (1952): Notes on the crab fishery of the Chilka Lake. *J. Bombay nat. Hist. Soc.* **51**: 128-134, 5 text-figs.

Lahr, L. E. (1939): The crab industry at Eureka, *California Fish & Game* (4) 25: 330-335, 5 text-figs.

Menon, M. Krishna (1952): A note on the bionomics and fishery of the swimming crab, *Neptunus sanguinolentus* (Herbst) on the Malabar coast. *J. Zool. Soc. India* **4** (2): 177-184, 3 text-figs.

Prasad, R. R. & Tampi, P. R. S. (1951): An account of the fishery and fishing methods for *Neptunus pelagicus* (Linnaeus) near Mandapam. *J. Zool. Soc. India* (2) 3,: 335-339.

Rai, H. S. (1933): The shell-fisheries of the Bombay Presidency. Part II. *J. Bombay nat. Hist. Soc.* **36**: 884-897, pls. i, ii, 2 blocks, 3 text figs.

Reddy, A R. (1936): Crab-fishing in the Ceded Districts. *Curr. Sci.* **5**: 178-179, 1 text-fig.

15. A NEW SPECIES OF *LEPIDIAPHANUS* FROM KASHMIR (ENTOMOBRYIDAE: COLLEMBOLA)

(*With a plate*)

The collembolan species described in this paper was collected by the authors at Srinagar during the Panjab University Entomological Expedition to Kashmir in August 1958. The identification has been based on keys and descriptions of species by Salmon (1949, '51).

Lepidiaphanus kashmirensis sp. nov.

Colour: In alcohol, the body pale yellow with irregular patches of dark brown granular pigment on all the segments except Abd. VI, where the pigmentation is weak; the antennae and furcula of a lighter shade than the body; Abd. V with two lateral irregular patches of granular pigment; Abd. I, II, III, IV each with a dorsal dark brown longitudinal band; and dark brown granular pigment on the top of the head (Fig. 1).

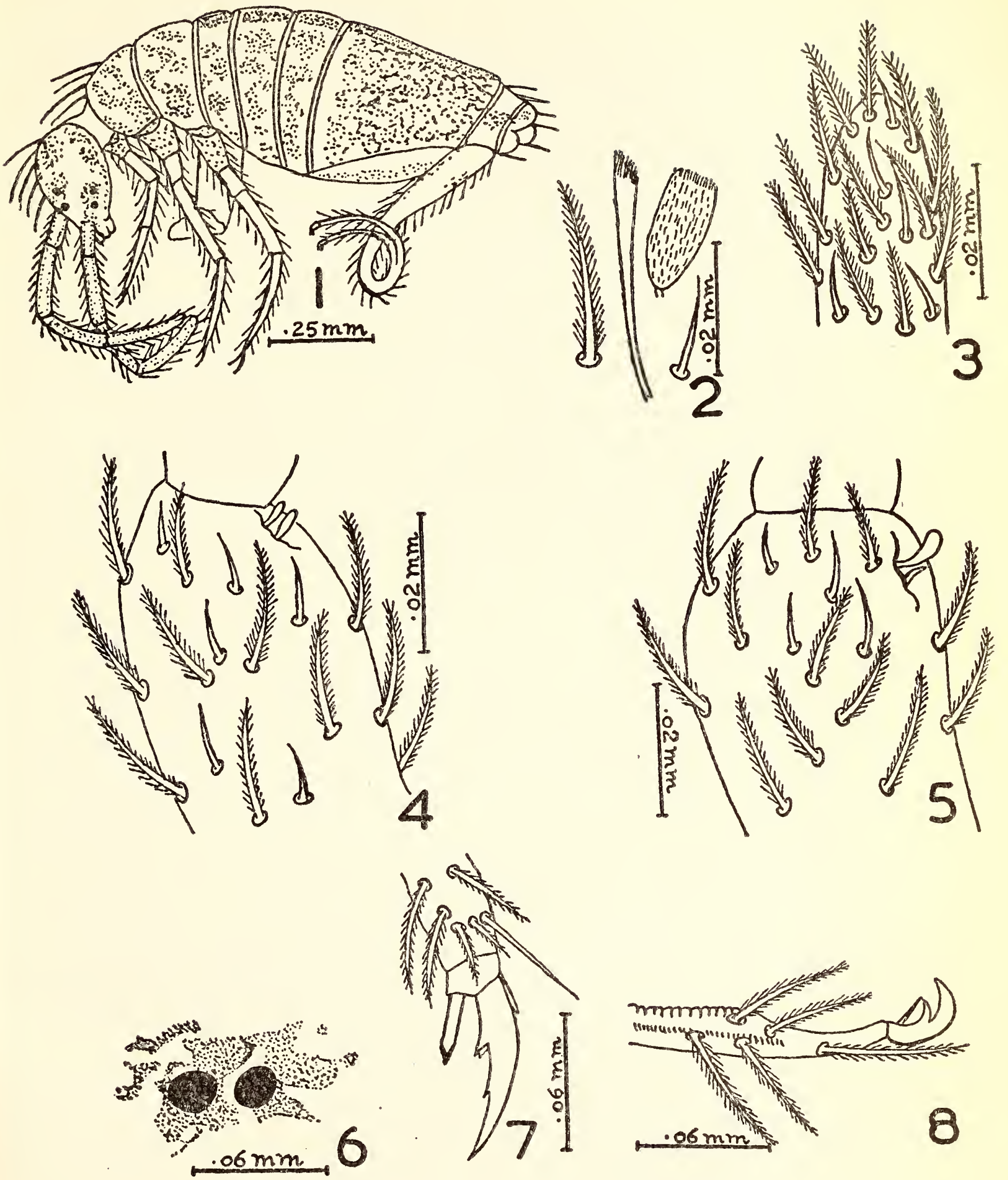
Clothing: Head, body, and appendages fringed with both ciliated and simple setae of various sizes and covered with lightly striated hyaline scales (Fig. 2). Lasiotrichia absent.

Body: Length from 1.45 to 1.50 mm.; head about half as long as antennae; the four antennal segments related as 6:10:6:14; Ant. IV without an apical exsertile knob and clothed with short ciliated setae, amongst which are scattered short, tapering straight simple sense rods (Fig. 3); Ant. III with setae similar to that of Ant. IV and its apical sense organ consisting of two short straight sense clubs on a weak cuticular ridge (Fig. 4); sub-apical sense organ of Ant. II consisting of a large stout apically rounded sense club and a short pointed sense rod, the two lying close together on the side of a strong cuticular ridge (Fig. 5); a pair of ocelli on each side of the head (Fig. 6), surrounded by a mass of dark brown pigment granules; Abd. IV approximately 3 times as long as Abd. III.

Legs: Unguis strong with 2 small outer lateral teeth, and with a pair of fine inner teeth about one-third from its proximal end; a simple inner fine tooth at two-thirds distance from the base; unguiculus simple, lanceolate, sharply pointed and about one half as long as unguis; a simple short, non-clavate tenent hair present on each foot (Fig. 7).

Furcula: Manubrium and dentes nearly equal in length; dens annulated and corrugated, its terminal uncorrugated portion about three times the length of the mucro; mucro small, falciform, narrow bidentate, with a basal spine reaching the tip of the curved pre-apical tooth; the apical tooth distinctly longer than the pre-apical and curved inwards; mucro slightly over-reached by long ciliated setae on the terminal part of the dens (Fig. 8).

Remarks: The genus *Lepidiaphanus* was instituted by Salmon in 1949 with *L. eudyptidus* Salmon as the type species. It was obtained by him from Campbell Island south of New Zealand during the New Zealand Cape Expedition. It was collected from leaf-mould under *Draco-phyllum* on the south coast below Mt. Dumas under stones in a colony



Lepidiaphanus kashmirensis sp. nov.

Text Figs. 1-8—(1) Lateral view of whole insect; (2) setae and scales from the body; (3) apex of Ant. IV; (4) sense organ of Ant. III.; (5) sense organ of Ant. II; (6) ocelli; (7) hind unguis; (8) mucro and apex of dens.

of penguins. No other species of this genus has been, so far, described from anywhere in the world. The present species *L. kashmirensis* is the first record of the genus from India and was collected (only two specimens) from a dung heap on the left bank of the river Jhelum at Srinagar (Kashmir) 5500 ft. above sea-level. It is possible that the species of *Lepidiaphanus* from Kashmir belongs to the colder regions of the north and future surveys of the Collemboles might throw more light on the distribution of the genus.

The new species *L. kashmirensis* differs from the described species *L. eudyptidus* in the following characters:

1. *L. kashmirensis* measures 1.5 mm. as against 1.4 mm. of *L. eudyptidus.*
2. The pigment granules are dark brown as against grey purple of *L. eudyptidus.*
3. There are no transverse pigment bands in the present species in Abd. I-IV (present in *L. eudyptidus*).
4. Abd. I-IV with dark brown dorsal longitudinal bands (absent in *L. eudyptidus*).
5. Antennal-segments-ratio is 6:10:6:14 as against 5:9:5:12 in *L. eudyptidus.*
6. There is a large, stout sense club of the sense organ of Ant. II as against the short pointed sense club of *L. eudyptidus.*
7. Abd. IV is about 3 times as long as Abd. III in the present species as against 5-6 times as long as Abd. III in *L. eudyptidus.*
8. Claw has an additional inner tooth at distal $\frac{1}{3}$ in *L. kashmirensis* (absent in *L. eudyptidus*).
9. The apical tooth of mucro is distinctly longer than the pre-apical (quite the reverse in *L. eudyptidus*).

Holotype: Marked specimen collem. 1 on slide deposited in the Entomological Collection of Panjab University, Zoology Department, Chandigarh. Paratype—one complete specimen in the authors' collection. The above description is based on the two complete specimens.

DEPARTMENT OF ZOOLOGY,
PANJAB UNIVERSITY,
CHANDIGARH,
July 27, 1961.

G. L. ARORA
MOHINDER SINGH

REFERENCES

Salmon, J.T. (1949): New sub-antarctic Collembola. *Cape Exped. ser. Bull. Dept. Sci. & Ind. Res.* **4** : 1-56.

Salmon, J. T. (1951) : Keys and Bibliography to the Collembola. *Zool. Pub. Vict. Univ. Coll.* **8** : 1-82.

16. *DANAUS CHRYSIPPUS* FORM *DORIPPUS* IN RAJASTHAN

For more than two years the writer has collected thousands of butterflies throughout India. Over a hundred *Danaus chrysippus* (Linnaeus) were collected in that period, and thousands more were seen. Not once in that period was a form *dorippus* Cramer encountered.

However, the capture of a male *dorippus* was finally effected at Sumerpur, Rajasthan (Pali District, 45 miles SSW. of Pali) on 5 October 1961, during a brief stay there.

The day was warm and sunny, and while collecting in a garden a very distinctive *dorippus* was seen flying in the company of normal specimens of *D. chrysippus*. Needless to say, the capture was made with all haste. The insect was not perfect, however. It was somewhat faded and had a few nicks in the margins of the hind wings.

Listed as rare, Wynter-Blyth (1957) states that *dorippus* mainly occurs in the drier regions of India. Marshall & de Nicéville (1882) record *dorippus* (which they list as a full species, *Danais dorippus* Klug) as occurring only in West Pakistan in the Indian Region, while the 'species' has a range that extends through eastern Europe to Africa, where it is common. They record it from West Pakistan in January, June, August, September, November, and December. Menesse (1950) also records *dorippus* from West Pakistan, and Harman (1950) records it from north Bihar.

Woodhouse & Henry (1942) state that form *dorippus* is rare in Ceylon, and is '. . . more likely to be captured in the low country dry zone, though it has been taken in Colombo'.

Best (1954) records *dorippus* from Calcutta, and an editorial addition to that paper further lists Campbellpur, Punjab; near Poona; near Trincomalee, north-east Ceylon; and the south and east Ceylon coasts as localities where this form has been collected.

116, SUNDAR NAGAR,
NEW DELHI,
November 28, 1961.

JULIAN P. DONAHUE

REFERENCES

Best, A. E. G. (1954): Occurrence of *Danaus chrysippus* var. *dorippus* at Dum Dum Air Port. *J. Bombay nat. Hist. Soc.* **52** (1): 218.

Harman, A. C. (1950): Champaran Butterflies—North Bihar. *J. Bombay nat. Hist. Soc.* **49** (1): 93-100.

Marshall, G. F. L. & Nicéville, Lionel de (1882): The Butterflies of India, Burma and Ceylon, Vol. I, Calcuttal.

Menesse, N. H. (1950): Butterflies of Sind. *J. Bombay nat. Hist. Soc.* **49** (1): 20-24.

Woodhouse, L. G. O. & Henry, G. M. R. (1942): The Butterfly Fauna of Ceylon. Colombo.

Wynter-Blyth, M. A. (1957): Butterflies of the Indian Region. Bombay.

17. TINGIDAE OF WESTERN U.P. (HEMIPTERA: HETEROPTERA)

(*With one photograph*)

The morphology, biology, and ecology of oriental Tingidae have been incompletely studied, due perhaps to the smallness of the insects and lack of knowledge of mass-rearing techniques. But the damage caused by these insects especially to garden plants is immense. In recent years attention has been directed to the biological aspect of the study of these insects. The biology of two indigenous species has been partially worked out: *Urentius echinus* Dist. by Patel & Kulkarny (1955) and (*Monanthia globulifera* Walk.) by Sharga (1953). The life-history of an imported lace bug *Teleonemia scrupulosa* Stal. (Lantana Bug) was completed by Khan (1945) and Roonwal (1952). The only available record on the regional survey of Tingidae is that made by Menon & Hakk (1959), which shows seven species of Tingids attacking garden plants in the Delhi area and they give a revision of the genus *Urentius*. The Oriental Region should be rich in tingifauna and an intensive regional survey is bound to be rewarding.

In western U.P. an up-to-date survey has revealed ten genera and fourteen species of tingids, mostly attacking plants of great economic value. The various species, their host plants, and their parasites and predators are summarised in the following tables. Detailed study on the incidence, population frequencies, structure of eggs, and the biological aspects of the various species and those of the predators will appear in series elsewhere.

TABLE I

TINGID SPECIES OF WESTERN U. P. AND THEIR HOST PLANTS

Tingid species	Host plants
1. *Galeatus scrophilus* Saunders, 1876	Compositae
	Helianthus annuus
	Gaillardia
	Marigold
	Launaea
	Vernonia
	Crysanthemums*
	Echinops echinatus
	Papaveraceae
	Argemone mexicana
2. *Corythauma ayyari* (Drake), 1933	Oleaceae
(The tingid that makes leaf curl gall, see photo.)	*Jasminum* spp.*

* Already recorded host plants.

3. *Cysteochila delineata* (Distant), 1903	Papilionaceae *Bauhinia* sp.
4. *Dasytingis rudis* (Drake & Poor), 1939	Verbenaceae *Vitex negundo*
5. *Dictyla cheriana* (Drake & Poor), 1936	Tree (unidentified)
6. *Dictyla sufflata* (Drake & Poor), 1939	Boraginaceae *Ehretia laevis*
7. *Monanthia globulifera* Walker, 1902	Labiatae *Salvia splendens* *Mentha** *Ocimum sanctum** *Ocimum basilicum** *Ocimum gratissimum*
8. *Monosteira minutula* Montandon, 1897 (a new record in the Orient)	Rhamnaceae *Zizyphus jujuba*
10. *Stephanitis typicus* (Distant), 1903	Musaceae *Musa paradisiaca**
11. *Tingis buddleiae* Drake, 1930	Verbenaceae *Vitex trifoliata*
12. *Tingis* sp. (new)	Compositae *Echinops echinatus*
12. *Urentius echinus* Distant, 1909	Solanaceae *Solanum melongena**
13. *Urentius euonymus* Distant, 1909	Malvaceae *Abutilon indicum* Hollyhock
14. *Urentius maculatus*	Malvaceae *Abutilon indicum* *Sida*

Table II

Parasites of Tingid Species

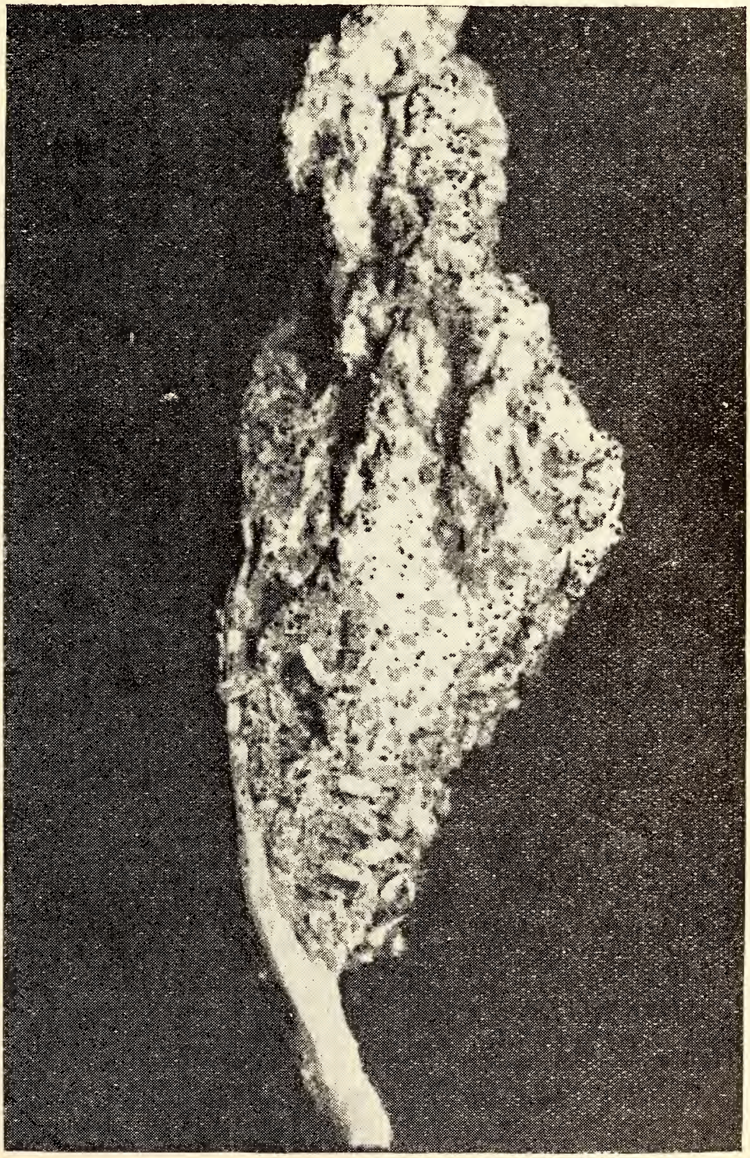
1. *Trichogramma* sp. (Chalcidae-Hym.). This is an egg parasite noted on *G. scrophilus* and *C. ayyari*. This is the first record of a *Trichogramma* sp. parasitising tingid eggs. Claridge (1959) recorded another species of *Trichogramma* (*Monorthochaeta pulchella*) in the eggs of Mirids (Heteroptera) and the first record of a tingid egg parasite belonging to the genus *Anaphes* (Mymaridae-Chalcidae) was made by Southwood & Scudder (1956).
2. *Leptus* sp. (Erythraeidae-Acarininae). The adults and immature stages of *G. scrophilus*, *C. ayyari*, and *U. euonymus* are being parasitised by this mite.

Table III

Predators of Tingid Species

1. *Apollodotus* sp. (Capsidae-Heter.). Nymphs and adults of this bug feed on *C. ayyari*, *D. sufflata*, and *S. typicus*.
2. Larvae of *Chrysopa* (Chrysopidae-Neuro.) are found feeding on *C. ayyari*, *D. sufflata*, and *T. buddleiae*.

3. An unidentified species of spider was observed predating on *D. cheriana*.
4. Ladybird beetles (Coccinellidae-Coleop.) Grubs of some species were found feeding on *D. sufflata*, and the following species have been noted by Sharga (1953) on *M. globulifera*: 1. Grubs of *Brumus suturalis* Fab. 2. Grubs of *Chilominus sexmaculata* Fab. and 3. Grubs and adults of *Coccinella septumpunctata* Linn.



Leaf-curl gall formed on *Jasminum* sp. by *Corythauma ayyari* (Drake), with adults and immature stages on it.

A fungus belonging to the genus *Cladosporium* grows on dead adults, nymphs, and faecal matters of *D. sufflata* and *C. ayyari.* It does not however cause the death of the insects.

SCHOOL OF ENTOMOLOGY,
ST. JOHN'S COLLEGE,
AGRA,
June 19, 1961.

DAVID LIVINGSTON,
Govt. of India Research Scholar

REFERENCES

Claridge, M.F.A. (1959): A new species of Trichogrammatid. (Hymenoptera, Chalcidoidea) Parasitic in *Mirid* eggs (Hemiptera : Heteroptera). *Proc. R. Ent. Soc. Lond.* (B) **28** (9-10) : 128-131.

Distant, W. L. (1903) : The Fauna of British India, including Ceylon and Burma. Rhynchota. **2** (1) (Heteroptera) : 120-145.

——— (1910): The Fauna of British India, including Ceylon and Burma. Rhynchota, **5** (Heteroptera : Appendix) : 100-126.

Drake, C. J. (1928): A new subgenus and species of Tingids from Burma. *Indian For. Rec.* **13** (3) : 283 : 284.

——— (1933) : On Some Tingidae from S. India including two new species. *J. Bombay nat. Hist. Soc.* **36** (4) : 1015-1016.

——— (1936) : An undescribed Tingid from S. India. *J. Bombay nat. Hist. Soc.* **39** (1) : 145.

——— (1937) : Some Tingidae from China, East Indies and India. *Lingnan Sci. J.* **16** (3) : 385-388.

——— (1954) : Miscellany of New Tingidae. *Proc. Biol. Soc. Wash.* **67** : 1-15.

——— & Davies, N. T. (1960) : Morphology, Phylogeny and higher classification of the Family Tingidae including the description of a new species of subfamily Vianaidinae (Hemiptera : Heteroptera). *Entomologica Americana* **39** (New Series) : 1-100.

——— & Lutz, J. C. (1953) : Two undescribed Tingidae from India (Hemiptera), *Bull. Brooklyn Ent. Soc.* 48 (4) : 104-106.

——— & Poor, M. E. (1936) : New Indian Tingidae, *Indian For. Rec. New Delhi* **2** : 141-149.

——— & Maa, T. (1953) : Chinese and Other Oriental Tingidae (Hemiptera). *J. Taiwan Mus.* **6** (2) : 88-110.

——— & Ruhoff, F. A. (1960) : Lace bug genera of the World (Hemiptera : Tingidae). *Proc. U.S. Nat. Mus.* **112** : 1-105.

Ghulamullah (1941) : Aphidae and some other Rhynchota from Afghanistan. *Indian J. Ent.*, **3** (2): 225-243.

Khan, A. H. (1945) : On the Lantana Bug (*Teleonemia scrupulosa* Stal). *Indian J. Ent.* **6** (1-2) : 149-161.

Kirkaldy, G. W. (1902): Memoirs on Oriental Rhynchota. *J. Bombay nat. Hist. Soc.* **14** : 297-299.

Menon, M.G.R. & Hakk; A. (1959 a) : Some Tingids of economic importance from Delhi State. *Proc. 46th Ind. Sci. Cong.*, Part 3, : 392.

——— (1959 b) : A revision of the genus *Urentius* Dist. with descriptions of five new species (Heteroptera : Tingidae) ibid. part 3, : 393.

Patel, R. C. & Kulkarny, H. L. (1955) : Bionomics of *Urentius echinus* Dist. (Hemiptera : Tingidae) an important pest of Brinjal (*Solanum melongena*) in North Gujarat. *J. Bombay nat. Hist. Soc.*, **53** (1) : 86-96

Roonwal, M. L. (1952) : The natural establishment and dispersal of an imported insect in India - - the Lantana bug *Teleonemia scrupulosa* Stal (Lantanae Dist. Hemiptera : Tingidae) with description of egg, nymphs and adult. *J. Zool. Soc. India*, **4** (1) : 1-16.

——— (1953) : Further remarks on the distribution of the Lantana bug *Teleonemia scrupulosa* Stal in India since its introduction in 1941 from Australia. *Indian Forester* **79** (11) : 628-629.

Sharga, U. S. (1953) : Bionomics of *Monanthia globulifera* Walk. (Hemiptera : Tingidae) *J. Bombay nat. Hist. Soc.* **51** (4) : 885-889.

Sinha, S. S. (1951) : Some observations on an attack of *Urentius echinus* Dist. on Brinjal at Sabar farm. *Indian J. Ent.* **13** (2) : 182.

Southwood, R.R.E. & Scudder, G.G.E. (1956) : The bionomics and immature stages of the Thistle Lace Bugs (*Tingis ampliata* H. S. & T. Cardui; Hemiptera : Tingidae). *Trans. Soc. British. Ent.* **12** (13) : 93-112.

18. THE GIANT LAND SNAIL, *ACHATINA FULICA* FÉRUSSAC, IN INDIA

The giant land snail, *Achatina fulica* Férussac, is a native of Africa. Today it is as common in some parts of India and the Indo-Pacific islands as in Africa, spreading as far west as the Hawaiian Islands.

In general shape and colour the Indian specimens appear more like those from the East African populations than those of Indonesian and Pacific populations (personal communication—Prof. A. R. Mead, 1959). In the following respects the Indian specimens differ from the nominate insular race in other countries.

The nepionic shell is of a very light horny colour. The streaks in some of the early post-nepionic whorls are brown and do not easily fade out. The 'criss-cross' texture in the early post-nepionic whorls is prominent. The columella is white with a bluish tinge towards the base, but the rest of it in the adult shell or the whole of it in the young shell is always pure white, without any trace of bluish tint.

The snail has a very limited range of distribution in India. It is found in considerable numbers in some districts of East Pakistan, in the northern and eastern parts of the State of West Bengal, and in Balasore District of Orissa. The species is rare in the western districts of West Bengal, and some parts of Bihar (Santhal Parganas) and Orissa (Cuttack). The distribution of this snail is totally unknown in other states of India and Pakistan. As far as my information goes, these snails are not found in the vicinity of Allahabad and Hyderabad and the Zoological laboratories of these areas obtain their snail supplies from Calcutta. A shell obtained from Nagpur is in the collections of the Zoological Survey of India, Calcutta; but this does not prove its distribution and presence there.

ZOOLOGICAL LABORATORIES,
CITY COLLEGE,
CALCUTTA,
October 25, 1961.

K. C. GHOSE

REFERENCES

Bequaert, J. C. (1950): Studies in the Achatininae, a group of African land snails. *Bull. Mus. Comp. Zool. Harv.* **105** (1): 1-217.

Rees, W.J. (1950): The Giant African Snail. *Proc. Zool. Soc. Lond.* **120** (3): 577-98.

19. A 'WEEPING' TREE

A tree (*Ormosia travancorica* Bedd.) growing in evergreen jungle near this Estate has recently been causing a good deal of wonder among those who have seen it.

Standing underneath the tree one experiences a light but continuous drizzle falling from the branches. The tree is about 80 feet tall and has small pale green leaves of a leguminous type. These appear to be just in the process of opening.

Local opinion credits the tree with a demon or god engaged in busily pumping up water from the soil into the branches!

Recently I took a small party from the Estate into the jungle to try and find a more logical explanation for the phenomenon. The first thing noticeable was the almost overpowering noise from cicadas coming from the tree—much louder than in the surrounding jungle which was fairly loud with insect life. The 'rain' appeared to be falling from almost all the branches and descending to the ground in the form of a fine spray. At first I wondered whether sap could be dripping from wounds in the branches caused by the cicadas and sent a man up the tree to cut a branch. As the man climbed, great clouds of cicadas flew out of the tree and both noise and drizzle subsided!

Was the drizzle in fact caused by excretions from the cicadas feeding on the rich sap flow from the tree?

THE BOMBAY BURMAH TRADING CORPORATION LTD.,
OOTHU ESTATE, R. D. B. HUGHES
SINGAMPATTI GROUP,
MANJOLAI POST, KULLADAKURICHI P.O.,
TIRUNELVELI DIST.,
April 18, 1961.

[The plant was very kindly identified by the Curator of the Central National Herbarium from the leaves sent by Mr. Hughes.

'Weeping' is a common phenomenon and is usually due to jassid infestation. A. P. Benthal in THE TREES OF CALCUTTA AND ITS NEIGHBOURHOOD (1946), p. 225 explains the name of the Rain Tree *Enterolobium saman* thus: 'The usual English name of this tree originated from the fact that in some places it is infested with cicadas which sometimes discharge moisture in the form of innumerable small drops, like rain, on passers-by beneath.'—EDS.]

20. *MOLLUGO NUDICAULIS* LAMK.: A NEW RECORD FROM BARODA[1]

Mollugo nudicaulis Lamk. Encycl. Meth. 4: 234, 1797; Ser. in DC. Prod. 1: 391, 1824; Wt. & Arn. Prod. 43, 1834; Clarke in Hook. f. Fl. Brit. Ind. 2 : 664, 1879; Gamble, Fl. Pres. Madr. 1 : 390, 1957 (reprinted edition). *Mollugo bellidifolia* Ser. in DC. Prod. 1: 391, 1824. *Pharnaceum spathulatum* Spr. Syst. Veg. 1: 948, 1825.

An erect or diffuse, annual herb, 10-30 cm. tall. Leaves 1-3×.5-1 cm., obovate-oblong or spathulate, numerous, crowded, all radical, glaucous-green, glabrous, obtuse or slightly acute at the apex, attenuated at the base; petiole 5-15 mm. long, slender, glabrous. Scape trichotomously panicled, leafless, glabrous, shallowly to deeply grooved. Flowers minute, white or very pale-creamy. Pedicels 5-8 mm. long, glabrous, filiform. Sepals five, persistent. Petals absent. Stamens three; filaments filiform, whitish, slightly flattened at the base. Capsule about 2 mm. long, glabrous, ellipsoid or sub-cylindric, three-valved, membranous. Seeds reniform, reddish-brown to almost black, shining, minutely tuberculated, with a microscopic scale-like appendage at the hilum. Embryo whitish, annular.

An occasional plant, collected from hedges along railway lines near Vishwamitri Station about 4.8 km. south of Baroda. It is a new record for the old Bombay State.

Flowers and fruits: August-November.

Specimens examined in Blatter Herbarium: Krishna, *SKW* 3423; Varadia (near Broach), *Shah* 302; Baroda, *Shah* 6493; Ahmedabad, *Saxton* 1873; Jodhpur 6847, 6849-51 (all without collectors' names).

World distribution: Tropical Africa, India (Punjab, Upper Gangetic Plain, Gujarat, Madras, Andhra) and Ceylon. According to Clarke, this plant is also found in New Caledonia and Cuba.

Critical notes: Mollugo nudicaulis Lamk. and *Mollugo pentaphylla* L. are very similar and likely to be confused; the two differ as follows:

Leaves all radical; seeds very minutely appendaged ... ... *nudicaulis*

Leaves both radical and cauline; the latter whorled at the nodes; seeds not appendaged ... ... *pentaphylla*

---

[1] Communicated by Prof. P. V. Bole.

This plant is not given by Saxton and Sedgwick in plants of Northern Gujarat (1918).

ST. XAVIER'S COLLEGE,
BOMBAY 1, G. L. SHAH
June 26, 1961. M.SC., Ph.D.

21. NOMENCLATURAL NOTES ON SOME BOMBAY PLANTS

(1) **Hibiscus lampas** Cav. Diss. 3 : 154, t. 56, f. 2, 1787 ; Blatter in Journ. Bom. Nat. Hist. Soc. 34 : 634, 1930; Bor, Man. Ind. For. Bot. 167, 1953; Gamble, Fl. Madr. 1 : 63, 1957 (reprinted edition). *Thespesia lampas* Dalz. & Gibs. Bom. Fl. 19, 1861 ; Santapau in Rec. Bot. Surv. Ind. 16 (1) : 23, 1953 ; Hu, Malv. Fl. China 69, 1955. *Thespesia macrophylla* Cooke, Fl. Pres. Bom. 1 : 114, 1901 (non Blume 1825).

This plant has been variously placed under *Hibiscus* and *Thespesia*. In his monograph on the genus *Hibiscus* in Ann. Cons. Jard. Bot. Genève 4 : 57, 1900, Hochreutiner writes for *Hibiscus lampas* : ' Following Engler & Prantl, Nat. Pflanzenfam., we join this species to *Hibiscus* because of its clearly lobed style, its noncaducous involucre, of its calyx which terminates into five distinct lobes and of the woody capsule, which is dehiscent and many seeded and of which the exocarp does not become separated as in *Thespesia populnea* . . . . . '

The two genera can be distinguished as follows :

Calyx five-lobed or five-fid, valvate, spathaceous or circumsciss ; fruit a five-valved capsule .. *Hibiscus*
Calyx truncate, entire ; fruit fleshy, indehiscent or very tardily dehiscent .. .. .. *Thespesia*

(2) **Triumfetta rhomboidea** Jacq. Enum. Pl. Carib. 22, 1760 ; Cooke, Fl. Pres. Bom. 1 : 117, 1901. *Bartramia indica* Linn. Sp. Pl. 389, 1753 (non *T. indica* Lamk. 1789). *Triumfetta bartramia* Linn. Syst. (ed. 10) 1044, 1759 (nom. illeg.) ; Merrill, Interp. Herb. Amb. 354, 1917 ; Blatter in Journ. Bom. Nat. Hist. Soc. 34 : 890, 1931 ; Santapau in Rec. Bot. Surv. Ind. 16 (1) : 30, 1953. *Triumfetta angulata* Lamk. ; Dalz. and Gibs. 25.

Merrill, Blatter, and Santapau consider *T. bartramia* L. as a valid name ; however, this name is illegitimate on two counts : (1) the binomial nomenclature is inconsistent with Art. 55 of the *International Code of Botanical Nomenclature* ed. 1956. Since *Bartramia indica* L. (1753) is the earliest name for the present plant, it should have been called *T. indica* ; this name, however, cannot be taken up now, as it is pre-occupied by *T. indica* Lamk. for a different plant ; (2) the next name is

T. bartramia L. (1759), which is *nomen ambiguum* it being a mixture of *Urena* L. and *Commersonia bartramia* (L.) Merrill. Merrill (1917) remarks : '*T. bartramia* L. has priority (1762) but Linnaeus might have included in it more than *T. rhomboidea* Jacq. as now understood.' Linne in Systema ed. 10 (1759) refers to Rumph. Herb. Amb. 3 : t. 119 and in Species Plantarum 1762, to *Lappago amboinica* Rumph. Herb. Amb. t. 25. f. 2. According to Merrill, in the later reference, the illustration and the description are certainly those of *Urena* L., while the drawing of the flowers are those of *Triumfetta*. Rumph. 3 : t. 119 is *Commersonia bartramia* (L.) Merrill, belonging to Sterculiaceae. The only valid and nonambiguous name for the present plant, then, is *Triumfetta rhomboidea* Jacq.

(3) **Sapindus laurifolius** Vahl, Sym. Bot. 3 : 54, 1794 ; Cooke, Fl. Pres. Bom. 1 : 266, 1902. *Sapindus trifoliatus* Linn. Sp. Pl. 367, 1753 ; Santapau in Rec. Bot. Surv. Ind. 16 (1) : 57, 1953. *Sapindus trifoliatus* Linn. forma *genuinus* Radkl. in Pfreich. 98 C : 657, 1932.

Linne lists *Sapindus trifoliatus* in Species Plantarum 367, 1753 and describes it simply as *Sapindus* with ' ternate leaves ' ; further he refers to Rheede, Hort. Malab. 4 : 43, t. 19. According to Rheede, this plant is a tree which has leaflets 7″ long and 3″ - 4″ broad, with acuminate apex. On the strength of the leaf character, it would seem that the Linnean plant corresponds to *S. laurifolius* Vahl. Trimen in Journ. Cey. Br. Roy. As. Soc. 9 : 20, 1885, and Handb. Fl. Cey. 1 : 306, 1893, states that the plant Linne called by the absurd name of *S. trifoliatus* is *Conghas* Herm. which seems to be *Schleichera oleosa* Oken. There, then, seems to be some doubt about the identity of the Linnean plant and in consequence the Linnean name, *S. trifoliatus* L., becomes at least a *nomen ambiguum*. This being the case, Vahl's name is the oldest, unambiguous one for this plant.

(4) **Thevetia peruviana** (Pers.) Merrill in Philip. Journ. Sci. Bot. 9 : 130, 1914. *Cerbera peruviana* Pers. Syn. 1 : 267, 1805. *Thevetia neriifolia* Juss. ex Steud. Nom. ed. 2, 2 : 680, 1841 ; Cooke, Fl. Pres. Bom. 2 : 144, 1904.

Several authors such as Bailey (Man. Cult. Pl. 809, 1949), Bor & Raizada (Some Beaut. Ind. Climb. & Shrubs 193, 1954), Santapau (Rec. Bot. Surv. Ind. 16(1), ed. 2 : 134, 1960), attribute the authority of this plant to K. Schumann in Pfam. 4(2) : 159, 1895. This, however, is not correct, since Schumann calls the present plant *T. neriifolia* Juss. even though he was of the opinion that it should be called *T. peruviana*. The later name is invalid according to Art. 33(3) of the *International Code of Botanical Nomenclature* ed. 1956, because it is merely an incidental mention by the author, who did not introduce the combination as a valid name.

(5) **Chloris barbata** Sw. Fl. Ind. Occ. 1 : 200, 1797 ; Cooke, Fl. Pres. Bom. 2 : 1035, 1908 ; Blatter & McCann, Bom. Grasses 256, 1935 : Bor, Grasses Pak. Ind. Burm. & Cey. 465, 1960. *Andropogon barbatus* Linn., Mant. Pl. Alt. 302, 1771 (non Linn. 1759). *Chloris inflata* Link. Enum. Pl. Hort. Berol. 1 : 105, 1821 ; Senaratna in Perad. Man. 8 : 88, 1956 ; Raizada in Ind. For. 85(8) : 479, 1759.

For the nomenclature of this plant Bor remarks : ' The epithet *barbatus* is illegitimate in the genus *Andropogon* since *A. barbatus* L. (1771) is a later homonym of *A. barbatus* L. (1759), both being based on different plants. The epithet *barbata*, however, is not illegitimate in the genus *Chloris* and Swartz was perfectly in order in calling his plant *Chloris barbata*, there being no other epithet available. *Ch. barbata* Sw. is regarded as a new name dating from 1797 '.

(6) **Themeda quadrivalvis** (L.) O.K. Rev. Gen. Pl. 2 : 794, 1891 ; Blatter & McCann, Bom. Grasses 118, 1935 ; Bor, Grasses 252, 1960. *Andropogon quadrivalvis* Linn. Syst. (ed. 13) 758, 1774. *Anthistiria ciliata* L. f. Suppl. 113, 1781 ; Fl. Brit. Ind. 7 : 213, 1897. *Themeda ciliata* (L. f.) Hack. in DC. Mon. Phan. 6 : 664, 1889 ; Cooke, Fl. Pres. Bom. 2 : 994, 1908.

Henrard in Blumea 4 : 522, 1941 considers *T. quadrivalvis* (L.) O.K. and *T. arguens* (L.) Hack. as synonyms and accepts the latter name for the present plant. Hackel named the Javanese grass *T. arguens*, based on *Stipa arguens* L. 1762. Henrard accepted Hackel's name on two grounds : (1) *Stipa arguens* L. (1762) has priority ; (2) Merrill (vide Henrard) examined the type specimen of the Linnean plant and proved that it did not occur in Java but it was the same as *Anthistiria ciliata* L. f. from British India, Bourbon, and Mauritius.

On the other hand, Bor considered *T. quadrivalvis* and *T. arguens* distinct. According to him, the two species differ as follows :

Spikelets arranged in large flabelliform clusters 4 - 5 cm. long, excluding awns ; 5 - 7 cm. long ; an annual or occasionally perennial	*T. arguens*
Spikelets arranged in much smaller clusters ; awns much shorter ; annuals or perennials	*T. quadrivalvis*

Our plant fits with *T. quadrivalvis* (L. f.) O.K. in the key given by Bor.

ST. XAVIER'S COLLEGE,
BOMBAY 1,
December 1, 1961.

G. L. SHAH, M.SC., Ph.D.

22. A NOTE ON *EURYALE FEROX* SALISB. IN ALWAR, RAJASTHAN

Euryale ferox Salisb. is an interesting member of the Nymphaeaceae, widely distributed in south-east Asia. The plant has been in cultivation for a long time in China where it is valued for its nutritious seeds. The seeds are popularly known as fox-nuts (*makhana* in Hindi and Bengali, *jewar* in Punjabi). They are sold in our bazaars and are eaten raw or roasted in hot sand. The seed flour is used as an invalid food and as a substitute for arrowroot.

The species has so far been recorded from Kashmir, Oudh of Uttar Pradesh, Bihar, Bengal, Assam, Manipur, Tripura, and its occurrence in other parts of the country is, therefore, of interest. Recently the authors found it growing luxuriantly over a large area in Bandadi of Salisgerh Lake in Alwar, Rajasthan. While it is possible that it may have been introduced there in the past, there is no evidence to confirm this from local sources; at present the plant thrives along with other aquatic species like *Typha angustata* Chaub., *Nymphaea* sp., *Polygonum glabrum* Willd., etc.

The Alwar specimens have leaves up to 1.5 m. in diameter with the dense prickly petioles as long as 2 to 3 m. The flowers have 20 to 24 petals in 5 to 6 whorls which are progressively smaller towards the interior and of which the innermost are white with violet spots. The spherical prickly berry has a crown of persistent sepals. The flowering period is May to June with the fruits ripening in September-October. The floating portions of the plant decay and die during the cold season and regeneration from the buried rhizome starts in April.

Since Rajasthan abounds in lakes this taxon could be introduced in them for its economic importance.

We are grateful to Dr. M. A. Rau for going through this note.

BOTANICAL SURVEY OF INDIA,
63, RAJPUR ROAD,
DEHRA DUN,
December 9, 1961.

N. C. NAIR
R. K. BHARTYA

23. *PHYSALIS LONGIFOLIA* NUTT., A NEW RECORD FOR KERALA STATE

Physalis longifolia Nutt. is an American weed recently reported to be naturalized in the coastal parts of Bombay and Andhra States (Santapau, Shah, & Kapadia, 1961). Earlier taxonomists confused this species as a form of *P. minima* but it can easily be distinguished from the latter by its perennial habit, the larger size of the plant, the hollow stem with purplish streaks, almost entire leaves, larger flowers, purplish spots on the inside of the corolla towards the base, greenish or greyish blue anthers, and reticulately purple-veined calyx in fruits.

The author has observed the species growing gregariously in bare waste land near the segregation ground Changanacherry in 1956 and, since then, has collected it from several localities. The sheets are deposited in the Herbarium of the Botanical Survey of India, Northern Circle, Dehra Dun, under the collection numbers of the author 1152, 1156, 1161-1164, 1254.

The author is grateful to Dr. G. L. Shah, St. Xavier's College, Bombay, for comparing his specimens and confirming the identity.

BOTANICAL SURVEY OF INDIA,
DEHRA DUN, N. C. NAIR
January 17, 1962.

REFERENCE

Santapau, H., Shah, G. L., & Kapadia, Z. (1961): New plant records for Bombay, *Physalis longifolia* Nutt. *J. Bombay nat. Hist. Soc.* **58**: 550-551.

24. ON THE IDENTITY OF *DALECHAMPIA INDICA* WT. FROM CUTCH AND KATHIAWAR

The genus *Dalechampia* is represented by only three species in India. *D. velutina* and *D. kurzii* have been recorded from high altitude regions of Nilgiri Hills and Assam respectively, while *D. indica* is restricted to the plains of the Deccan peninsula, Coromandel, and Ceylon, and to a few hillocks in Cutch and Kathiawar. Very recently the authors have added one more species, i.e. *D. scandens* L. var. *cordofano* (Hochst.) Muell.-Arg., from Vasad about 10 miles NW. of Baroda.

The plant was determined at Kew by Dr. G. Taylor, Director, Royal Botanic Gardens, who in his personal communication writes: 'You may be interested to know that a few fragments, which were not previously identified to species but match your specimen exactly, were sent by Dalzell in 1866 from eastern Kathiawar'. While writing about the identification of the same plant, Mr. M. B. Raizada, Head, Division of Forest Botany, Forest Research Institute, Dehra Dun, remarks: 'The plant comes very near *D. indica* Wt. but is not typical of the same'.

These very comments, coming as they do from such eminent systematists, created in our minds a doubt about the authenticity of *D. indica* Wt. reported by some of the previous workers from Kathiawar. In an attempt to solve this riddle, herbarium specimens of the said plant were obtained on loan from a few herbaria in Cutch and Kathiawar. A few specimens were also collected during this monsoon by one of our M. Sc. students from Palitana in Kathiawar (Saurashtra). After critical examination of all this plant material, we are inclined to conclude that *D. indica* Wt. does not at all occur in Cutch or Kathiawar, and that whatever has so far seen published under that name is nothing but *D. scandens* L. var. *cordofana.*

Taking into consideration the confusion that exists regarding the identity of *Dalechampia* of this part of the country, it would certainly not be out of place, if a key based on obvious external morphological characters, to differentiate the two species, namely *D. indica* Wt. and *D. scandens* L. var. *cordofana*, is presented:

Leaves 3-foliolate, leaflets shortly petiolate *D. indica*
Leaves simple, deeply 3-lobed, sometimes up to the middle only ... *D. scandens* L. var. *cordofana*

We are indeed grateful to Rev. Father H. Santapau, Chief Botanist, Botanical Survey of India, for critically going through the manuscript and making useful suggestions.

DEPARTMENT OF BOTANY,
M.S. UNIVERSITY OF BARODA,
BARODA,
January 25, 1962.

A. R. CHAVAN
S. D. SABNIS
S. J. BEDI

25. FOLIAR VARIATIONS IN *NARAVELIA ZEYLANICA* DC.[1]

(*With a photograph and a plate*)

Naravelia zeylanica DC. belonging to the family Ranunculaceae is a climbing shrub of the tropical plains. The leaves are trifoliate with the unpaired terminal leaflet modified into a tendril with three hooked branches (Gamble, 1915).

---

[1] Communicated by the Dean, Agricultural College, Coimbatore.

Foliar variation has been reported in several species like *Mirabilis jalapa* L., *Ficus religiosa* L., and *Eranthemum atropurpureum* Hort. by Singh (1930, 1931, 1935), *Anacardium occidentale* L. by Sabnis (1931), *Aralia* sp. by Saran (1934), *Ipomea pulchella* Roth. by Sinha (1933), *Azadirachta indica* A. Juss by Sundararaj *et al.* (1953), and *Arachis hypogea* L. by Srinivasalu *et al.* (1956). No record of any such variation seems to have been made in *Naravelia zeylanica*.

The following variations were observed in a plant growing wild near Walayar of Kerala State :

1. *Simple Leaf.* Occasionally the leaves were found to be simple (Fig. 1). It might have been due to the union of all the three leaflets of a typical leaf.

2. *Bifoliate leaf.* Another feature noted was the presence of bifoliate leaves. The unpaired third leaflet which is normally modified into the tendril might have united with a leaflet on one side resulting in this condition (Fig. 1).

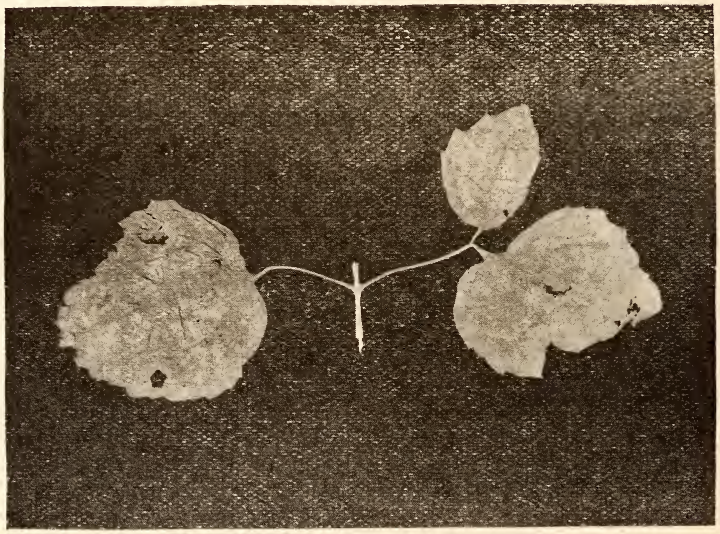


Fig. 1. Occurrence of simple and bifoliate leaves

3. *Trifoliate leaf.* Very often leaves with all the three leaflets were found (Fig. 2).

4. *Tendril ending in three leaflets.* This was another interesting variation observed. This suggests that the three hooks of the tendril of a typical leaf may be the modifications of three leaflets (Fig. 2).

5. *Pentafoliate leaf.* Leaves with five leaflets were also found (Fig. 3). This lends support to the suggestion that the typical leaf is pentafoliate with the portion of the rachis above the first pair of leaflets modified into the tendril and the three terminal leaflets into three hooks.

NARAVELIA ZEYLANICA DC.

Fig. 2. Trifoliate leaves and tendrils ending in three leaflets.

Fig. 3. Rachis-like stalk ending in three leaflets.

The author's thanks are due to Dr. D. Daniel Sundararaj, Mr. J. Sakharam Rao, and Mr. G. Thulasidas for their valuable help in the preparation of this note.

BOTANY SECTION,
AGRICULTURAL COLLEGE,
COIMBATORE-3,
December 14, 1961.

E. A. SIDDIQ

REFERENCES

Gamble, J.S. (1915): Flora of the Presidency of Madras. Adlard & Son Ltd., London.

Sabnis, T. S. (1931): Notes on Indian Plant Teratology. *J. Indian Bot. Soc.* **10**: 21-26.

Saran, A. B. (1934): Notes on the teratology of certain Indian plants. ibid **13**: 165-167.

Singh, T. C. N. (1930): Notes on the teratology of certain Indian plants. ibid. **9**: 249.

——— (1931): Notes on the teratology of certain Indian plants. ibid. **10**: 134-38.

Singh, T. C. N. (1935): Notes on the teratology of certain Indian plants. ibid. **14**:321.

Sinha, B. S. (1933): A note on the variations of leaf in railway creepers—*Ipomoea pulchella.* ibid. **12**: 48-49.

Srinivasalu, N. & Krishnaswamy, P. (1956): Variations in the leaflets of Groundnut, *Arachis hypogea* Linn. *Madras Agric. J.* **43**: 36-37.

Sundararaj, D. D., Girija Lakshmanan, & Ramakrishnan, V. (1953): The Phenomenon of Leaf forking in a few dicotyledonous plants. *Madras Agric. J.* **40**:41-42.

26. ECOLOGICAL OBSERVATIONS ON THE ORCHIDS OF NORTH KARNATAK

During the preliminary survey of the orchids growing in the three districts of Karwar, Belgaum, and Dharwar (formerly parts of the old Bombay State and now of the new Mysore State), it was observed that certain species grow abundantly in restricted localities while others show distinct preference for certain forest types. It therefore seemed possible that they could be taken as indicators of certain environmental conditions. On reviewing the literature relating to this group it was noticed that there is hardly any information in regard to their restriction to certain localities or to their being of any value as indicators. It was thus felt that my observations in this connection might be published.

Oberonia brunoniana Wight is only found on tops of branches in the evergreen or semi-evergreen forests.

Dendrobium macrostachyum Lindl., *D. aqueum* Lindl., *D. lawianum* Lindl., *D. macraei* Lindl., *Trias stocksii* Hook. f., *Pholidota imbricata* Lindl., *Cottonia macrostachya* Wight, *Sarcanthus peninsularis* Dalz., *Cymbidium aloifolium* Swartz., *Aërides ringens* Fischer, *Rhynchostylis retusa* Blume, *Luisia macrantha* Blatt. & McCann, *L. truncata* Blatt. &

McCann, *Habenaria crinifera* Lindl., etc. are epiphytes of the evergreen or semi-evergreen or moist deciduous forests.

The most characteristic orchids found in dry deciduous areas or on open borders in the moist deciduous tracts are *Dendrobium barbatulum* Lindl., *D. mabelae* Gammie, *D. ovatum* (Willd.) Kränzl., *D. microbulbon* A. Rich., *Oberonia brachyphylla* Blatt. & McCann, *Acampe praemorsa* Blatt. & McCann, *Vanda parviflora* Lindl., *Aërides crispum* Lindl., *A. maculosum* Lindl., etc. Of these, the *Dendrobiums* are most commonly found on low trees of *Randia dumetorum, R. uliginosa, Tectona grandis, Careya arborea, Terminalia paniculata, Emblica officinalis,* etc., growing isolated or in small clumps in open grasslands. *Acampe praemorsa* Blatt. & McCann is found to be very common on *Mangifera indica, Eugenia jambolana,* and other roadside trees. In some cases, it has been found to cover the entire surface of some branches. *Vanda parviflora* Lindl. is quite common on old roadside trees of *Ficus bengalensis* in Dharwar.

Many of the species of *Habenaria, Peristylus,* and *Platanthera* are terrestrial inhabitants of grassy patches and meadows. The occurrence of a large number of species of *Habenaria* is likely to indicate the predominance of grasslands in that tract. For instance, Razi (1952)[1] lists 17 species of *Habenaria* out of a total list of 28 species of orchids from Poona and neighbouring districts.

There are a few terrestrial orchids that prefer heavily shaded localities in semi-evergreen or moist deciduous forests or bamboo clumps. They are *Zeuxine longilabris* Benth., *Malaxis versicolor* (Lindl.) Sant. & Kapad., *Liparis flavo-viridis* Blatt. & McCann, *L. nervosa* Lindl., *Nervilia discolor* (Bl.) Schltr., *N. monantha* Blatt. & McCann, *Eulophia nuda* Lindl., and *E. macrostachya* Lindl. These are found thriving best in the shadow of trees in fairly moist soil.

Bulbophyllum neilgherrense Wight, *Trias stocksii* Hook. f., *Pholidota imbricata* Lindl., and *Dendrobium macraei* Lindl. are epiphytes of evergreen forests growing luxuriantly on branches and trunks of trees that hang over bodies of fresh water such as ponds, brooks, streams, rivers, etc., or in the vicinity of Areca and banana plantations. They are also found growing on outcrops of rocks on the banks of rivers flowing through evergreen tracts. Thus they seem to prefer localities with a warm and a constantly moist air.

There is an interesting observation as regards the concentration of the orchids on the roadsides. In a given locality, the Orchids (particularly epiphytic) characteristic of that area are found to be more

---

[1] Razi—Some aspects of the vegetation of Poona and Neighbouring Districts—*Jour. Poona University* **1**, No. 2, 1952.

concentrated on the roadside or the borders of open areas than elsewhere. In other words, the density of orchids is greater on the roadsides and borders of open areas than in the interior of forests. This is perhaps due to the free distribution of orchid seeds consequent upon the easy movement of wind in such localities. It may also be attributed partly to the availability of large masses of dust that settle on branches and trunks of trees growing on roadsides and borders of open areas consequent to vehicular traffic.

However, the above observations have to be taken with a certain amount of caution. The orchids of one or more of the above indicator groups may be found in a transitional tract. For instance, the orchids typical of moist deciduous forests may be found on or under some old trees in the dry deciduous area which is situated in a transitional belt or has undergone depletion due to biotic activity or interference. In such cases they are to be considered as relicts that indicate the type of vegetation that existed in the immediate past. However, the writer is of the opinion that many of these orchids still have good indicator value.

ACKNOWLEDGEMENT

The author expresses his grateful thanks to the Bombay Natural History Society for financial assistance to carry out a survey of orchids in this area.

KARNATAK SCIENCE COLLEGE,
DHARWAR, H. R. LADWA
August 26, 1961.

27. A PRELIMINARY REPORT OF THE FERN FLORA OF THE GREAT ANDAMANS

The Andaman Archipelago consists of over 200 small islets with a total land area of 649,572 hectares, situated between 10°30′—13°45′ N. latitude and 92°15′—93°15′ E. longitude in the Bay of Bengal, about 1200 km. east of Madras. The main part of this group, known as the Great Andamans, consists of five closely placed islands, North Andaman, Middle Andaman, South Andaman, Baratang Island, and Rutland Island, as well as many small islets lying close to the shores of the main group. The coast lines of the islands have deep tidal creeks, often bordered by dense mangrove swamps. There is a low mountain range, nearly 600 m. high, towards the middle line, lying closer to the eastern side of the islands than to the west. The general topography is rugged with many hills covered by dense, almost impenetrable forest, enclosing narrow valleys. Very few perennial freshwater streams occur.

The Andamans have an equable climate with the temperature varying on an average from 24° to 36°C. Due to the low altitudes and the position of the islands in low latitudes, the climate may be considered as more or less uniform throughout. There is little difference between the summer and the winter, and rains occur more or less throughout the year with the minimum fall during January-April and the maximum in June-July and October-November. The average annual rainfall varies from 280 to 430 cm., the northern islands receiving comparatively less rainfall than the southern. The atmospheric humidity is high throughout, reaching a maximum of *c.* 90% in May-June.

The present communication is a preliminary account of the fern flora of the Great Andaman Islands, compiled from collections recorded by a party of botanists from the National Botanic Gardens, Lucknow, who visited the Islands in April-May, 1961. In the accompanying list the genera are arranged according to Copeland's system of classification (Copeland, 1947). The species under each genus are alphabetically arranged. The numbers in brackets following the locality of collection refer to the collection number in the Herbarium of the National Botanic Gardens, Lucknow, where the specimens are deposited.

I. Schizaeaceae

(1) **Lygodium** Swartz.

(*a*) *L. circinnatum* (Burm.) Swartz. Common in forests of Long Island (78282), Parlobjig, Middle Andaman (79509), and Mt. Harriet (88490).

(*b*) *L. flexuosum* (L.) Swartz. Common in the littoral forests along the coast between Panighat and South Point, South Andaman (76820). Very common near Port Blair (88776).

(*c*) *L. scandens* (L.) Swartz. Common, large climber in the littoral forests near Jirkatang Camp at the foot of Mt. Choulanga, South Andaman (53165).

II. Gleicheniaceae

(2) **Dicranopteris** Bernh.

D. speciosa (Presl.) Holtt. Grows in patches on clay soil, forming vigorous clumps on slopes near footpaths in the T.L.D. Range, South Andaman (68136).

III. Hymenophyllaceae

(3) **Cephalomanes** Presl.

C. javanicum V. d. B. Grows on clay soil cuttings in shaded areas in the T.L.D. Range, South Andaman (68135, 68136).

IV. PTERIDACEAE

(4) **Microlepia** Presl.

M. speluncae (L.) Moore var. *villosissima* C. Chr. Grows in isolated clumps at the foot of Choulanga Hills, Jirkatang, South Andaman (53140).

(5) **Lindsaea** Dryander *apud* Smith.

L. ensifolia Sw. Stunted fern on clay soil in moist places near small gutters and waterways in the T. L. D. Range, South Andaman (68115).

(6) **Pteridum** Scopoli.

P. aquilinum (L.) Kuhn. Common towards the summit of Mt. Harriet, near Japani Morcha (76817).

(7) **Pteris** Linn.

(*a*) *P. biaurita* L. Common in the Elphinston Harbour area, North Passage Island (79583).

(*b*) *P. longipinnula* Wall. Common in forest clearings and fringes below the summit of Mt. Harriet (76847).

(*c*) *P. vittata* L. On clay soil in more or less exposed areas near Port Blair (88413).

(8) **Acrostichum** L.

A. aureum L. Very common, covering extensive areas in marshy localities. Specially abundant in coast land from Port Blair (88433) to Bambooflat (79506) as well as Baratang Island at Nilambur and adjacent areas (79614).

(9) **Pityrogramma** Link.

P. calomelanos (L.) Link. Common, especially on earth cuttings and forest clearings, forming isolated dense clumps in Baratang Island (79411), near water drains at Port Blair area (88775), fringes of dense forest belts at the foot of Choulanga Range, South Andaman, in Jirkatang (53153, 53168), and on the sides of the road cuttings in Parlobjig, Middle Andaman (79514).

V. PARKERIACEAE

(10) **Ceratopteris** Brongn.

C. siliquosa (L.) Copel. Very abundant in open, marshy areas near freshwater streams in T. L. D. Range, South Andaman (68119), and in freshwater ditches near the sea-coast in Port Blair area (88432).

VI. DAVALLIACEAE

(11) **Davallia** Smith.

D. solida (Forst.) Sw. Epiphytic on large trees, covering exposed areas of the substratum and forming elegant patches. Very common near Bambooflat and Wimberlygunj, South Andaman, growing mainly on the trunks of *Samanea saman*, on the basal half of the trunks, but usually not reaching the top (88318).

VII. Aspidiaceae

(12) **Polystichum** Roth.

P. lentum (Don.) Moore. Sparsely distributed towards the summit of Mt. Harriet (68537).

(13) **Egenolfia** Schott.

E. vivipara (Ham.) C. Chr. On rocky soil near Parlobjig, Middle Andaman (79581), and on boulders near creeks at Jirkatang.

(14) **Tectaria** Cav.

(*a*) *T. heterosora* (Bak.) Ching. Sparsely distributed in forest beds at Nilambur, Baratang Island (79490), and Parlobjig, Middle Andaman (79569).

(15) **Cyclosorus** Link.

(*a*) *C. contiguus* (Rosenst.) Copel. Near mangrove marshes on the margin of creeks of Baratang Island (79625). Not common.

(*b*) *C. latipinna* (Hk.) Tardieu Blot. Sparsely distributed on the margins of creeks on more or less dry land at Parlobjig, Middle Andaman (79535).

(*c*) *C. parasiticus* (Linn.) Farwell. Rather common, forming patches in open areas in lime soil at Panighat, South Andaman (78762).

(16) **Athyrium** Roth.

A. asperum (Bl.) Milde. Large ferns with stems about a foot high, growing close to freshwater streams in deep nallas at Parlobjig area, Middle Andaman (79562). More or less common.

VIII. Blechnaceae

(17) **Blechnum** L.

(*a*) *B. finlaysonianum* Hk. et Grev. Common on the fringes of mangrove clumps, forming dense clusters often 1.0 to 1.5 m. tall, at Parlobjig area, Middle Andaman (79513).

(*b*) *B. orientale* L. More or less common in the T.L.D. Range, South Andaman (68134).

(18) **Stenochlaena** J. Sm.

S. palustris (Burm.) Beddome. Very common climber in the littoral forest, covering stems and branches of small trees and other supports near Panighat and Wimberlygunj, South Andaman (68149). Common in the forest belts near creeks in Parlobjig, Middle Andaman (79515).

IX. Aspleniaceae

(19) **Asplenium** L.

A. musaefolium Mett. Grows in clumps on branches of trees, usually not towards the bases. Very frequent in Parlobjig area, Middle Andaman (79505).

X. Polypodiaceae

(20) **Pyrrosia** Mirbel.

P. longifolia (Burm.) Morton. Very common epiphyte, densely covering tree trunks in the Port Blair area (88772).

(21) **Drymoglossum** Presl.

D. piloselloides (L.) Presl. Very common epiphyte on tree trunks in exposed areas near Parlobjig, Middle Andaman (53103, 79535).

(22) **Microsorium** Link.

(*a*) *M. congregatum* (C. Chr.) Copel. Common epiphyte on trees in evergreen felling areas, opposite Baratang Island (79461).

(*b*) *M. punctatum* (L.) Copel. Common epiphyte on trees especially towards the foot of Mt. Harriet (88333).

(23) **Drynaria** (Bory) J. Sm.

D. quercifolia (L.) J. Sm. Common epiphyte on tree trunks and other supports, often forming extensive colonies at Wright Myo, South Andaman (68167). Very common all over the Port Blair area (88415).

XI. Vittariaceae

(24) **Vittaria** Smith

V. angustifolia Bl. Forms small clumps on the branches of trees and supports at Mt. Harriet area (68538).

Acknowledgements

The authors' grateful thanks are due to Prof. K. N. Kaul, Director, National Botanic Gardens, Lucknow, and to the Forest Department, Andaman and Nicobar Islands, for their help and for the facilities provided by them for the present study.

National Botanic Gardens,
Lucknow,
November 4, 1961.

B. K. NAYAR
G. S. SRIVASTAVA

References

Copeland, E. B. (1947) : *Genera Filicum*. Waltham, Mass., U.S.A.

Notes and News

Reprint of M. A. Smith's FAUNA OF BRITISH INDIA, Snakes

In the Annual Report for 1960-61 we mentioned that the Ministry of Scientific Research and Cultural Affairs, Government of India, had authorized us to reprint this badly-needed book. It subsequently transpired that there was some misunderstanding and that Government had already made other arrangements for its publication in India, and that the book was almost ready. It is now available with the Manager of Publication, Government of India, Civil Lines, Delhi, for Rs. 40 or 60*s*.

*　　*　　*　　*

2nd edition of S. H. Prater's THE BOOK OF INDIAN ANIMALS

This book was held up due to financial reasons. The Natural History Section of the Prince of Wales Museum of Western India has agreed to take up half the edition for Rs. 25,000 and thus enable us to place orders for its printing. It is hoped to have this available next year.

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
10 CHURCH ROAD, VEPERY, MADRAS—17-7-1962. C7300
EDITORS: H. SANTAPAU & HUMAYUN ABDULALI

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. With many coloured and monochrome plates. 2nd (revised) edition. (*In preparation*)

Birds

Game Birds of India, by E. C. Stuart Baker. Vol. III. Pheasants, 1st Edition. **Rs. 20**
(*Price to Members Rs.* 15)

The Book of Indian Birds, by Sálim Ali. With 64 coloured and many monochrome plates, 6th edition, revised and enlarged. **Rs. 25**
(*Price to Members Rs.* 20)

A Synopsis of the Birds of India and Pakistan, by S. Dillon Ripley II. An up-to-date checklist of all the birds resident and migrant, including those of Nepal, Sikkim, Bhutan, and Ceylon. **Rs. 25**
(*Price to Members Rs.* 20)

Snakes

Identification of Poisonous Snakes. Wall chart in English, Gujarati, and Marathi. **Rs. 10**
(*Price to Members Rs.* 8)

Miscellaneous

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 2nd edition. Revised by W. T. Stearn. **Rs. 20**
(*Price to Members Rs.* 16)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. **Rs. 22**
(*Price to Members Rs.* 17.50)

Butterflies of the Indian Region, by M. A. Wynter-Blyth. With 27 coloured and 45 monochrome plates. **Rs. 28**
(*Price to Members Rs.* 22.50)

Indian Molluscs, by James Hornell. With 2 coloured and many monochrome plates, and text-figures. **Rs. 6**
(*Price to Members Rs.* 4.50)

Glimpses of Nature Series Booklets :

1. OUR BIRDS I (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.80**
   Kannada **Rs. 0.62**
2. OUR BIRDS II (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.62**
3. OUR BEAUTIFUL TREES (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.62**
4. OUR MONSOON PLANTS (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.80**
5. OUR ANIMALS (with 8 coloured plates) in English. **Rs. 1.25**

Back numbers of the Society's Journal. Rates on application.

Obtainable from :

The Honorary Secretary,
Bombay Natural History Society,
91, Walkeshwar Road, Bombay 6-WB.

Agents in England :

Messrs. Wheldon & Wesley Ltd.,
Lytton Lodge, Codicote, Nr. Hitchin,
Herts., England.

The Society will gratefully accept back numbers of the *Journal*, particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 and a life membership fee of Rs. 500.

Ordinary Members pay an entrance fee of Rs. 5 and an annual subscription of Rs. 30.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postal registration (Rs. 2.50), if required—in all Rs. 32.50—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-10-0 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 26 Bishopsgate Street, London, E.C. 2.

CONTENTS

Journal of the Bombay Natural History Society

Vol. 59, No. 2

Editors

H. SANTAPAU, S.J., & HUMAYUN ABDULALI

AUGUST 1962

Rs. 15

NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and subspecific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri*.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8.20×5.60 cm. (No. 2 Brownie) and on glossy glazed paper.

6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name with the abridged titles of journals or periodicals underlined (italics), and titles of books *not* underlined (roman type), thus:

Banerji, M. L. (1958): Botanical Exploration in East Nepal. *J. Bombay nat. Hist. Soc.* **55** (2) : 243-268.

Prater, S. H. (1948): The Book of Indian Animals. Bombay.

Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Banerji, 1958).

9. *Synopsis:* Each scientific paper should be accompanied by a concise, clearly written synopsis, normally not exceeding 200 words.

10. *Reprints:* Authors are supplied 25 reprints of their articles free of charge. In the case of joint authorship, 50 copies will be given gratis to be distributed among the two or more authors. Orders for additional reprints should be in multiples of 25 and should be received within two weeks after the author is informed of the acceptance of the manuscript. They will be charged for at cost plus postage and packing.

EDITORS,
Journal of the Bombay Natural History Society.

91, Walkeshwar Road,
Bombay 6-WB.

CONTENTS OF VOLUME 59, NO. 2

JOURNAL
OF THE
BOMBAY NATURAL
HISTORY SOCIETY

1962 AUGUST Vol. 59 No. 2

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 $7\frac{1}{2}$ 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.

(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

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).

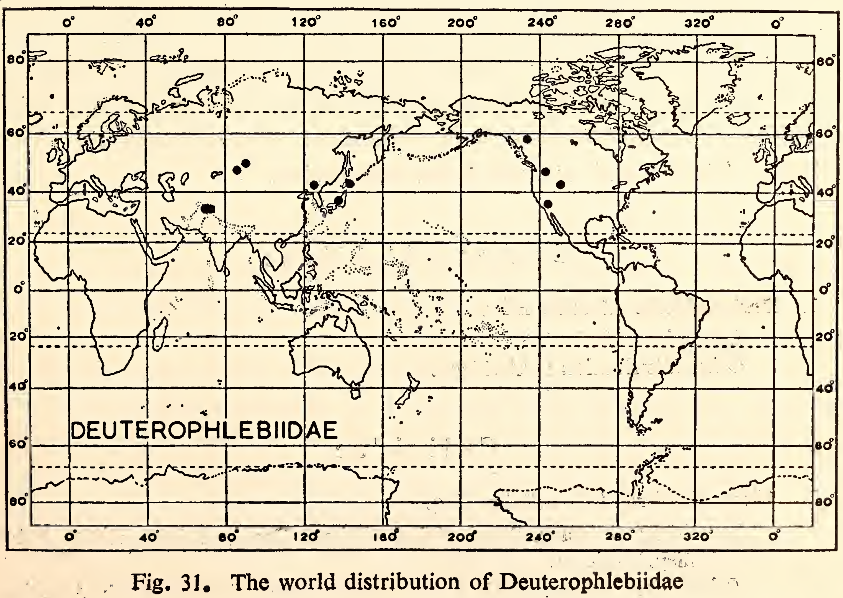


Fig. 31. The world distribution of Deuterophlebiidae

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

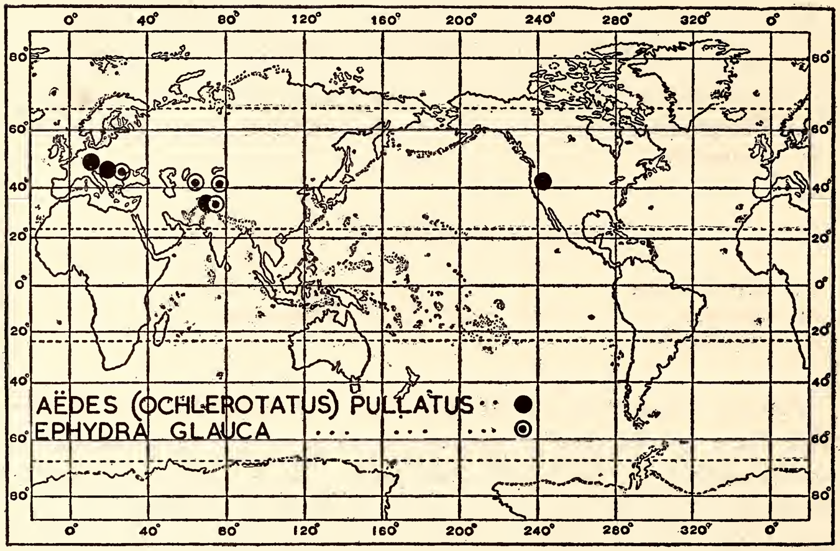


Fig. 32. The world distribution of the two non-endemic nival Diptera from the NW. Himalaya.

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.

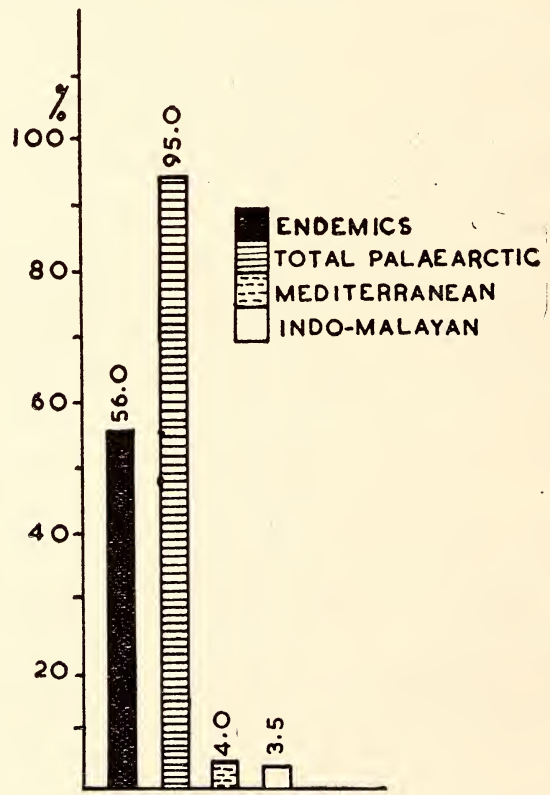


Fig. 33. Faunal elements of total nival insects from NW. Himalaya

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.

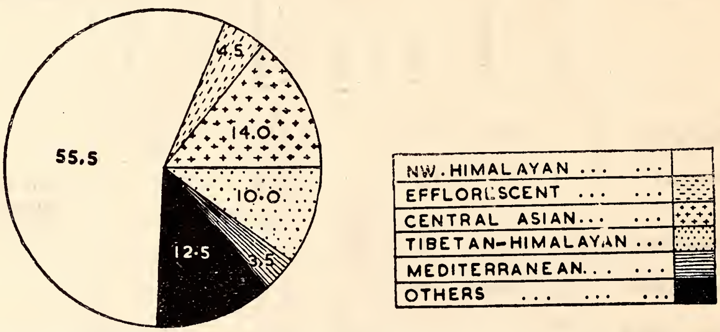


Fig. 34. Analysis of the Palaearctic components of the nival insect fauna from the NW. Himalaya

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

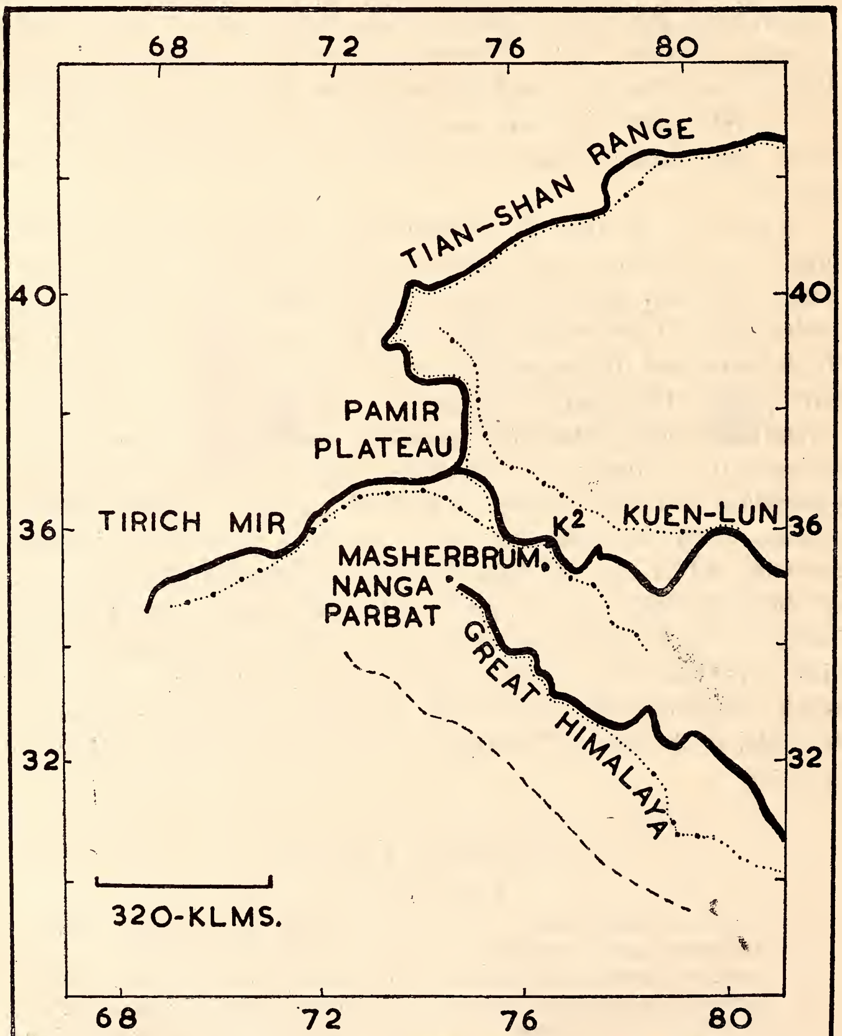


Fig. 35. The crest lines (broken lines) and the water partings (thick continuous lines) of the mountain ranges in the region of the NW. Himalaya meeting together in the so-called Pamir Knot. (*After Burrard & Hayden*, 18).

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,

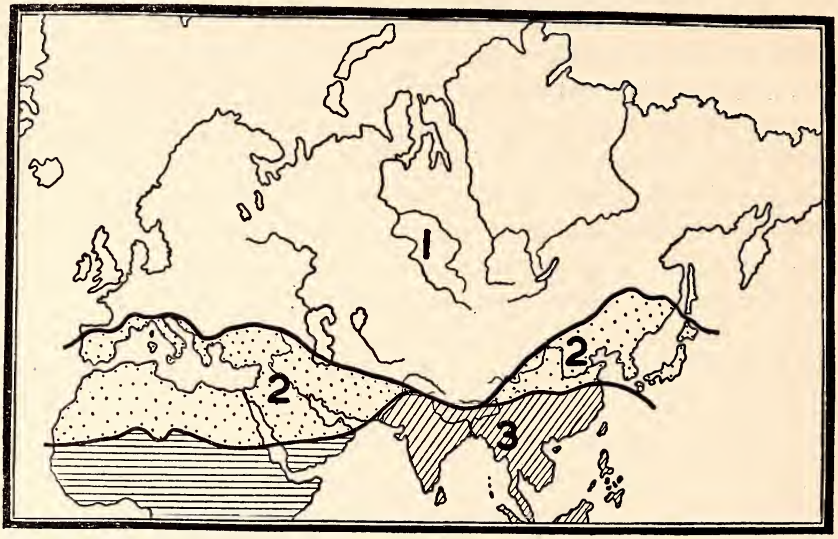


Fig. 36. The areas of the northern Palaearctic (1), the southern Palaearctic (2), and the Oriental Realms (3). Note the southward extension of the northern Palaearctic owing to the influence of the high altitudes in the region of the Himalaya. (*After Eidmann*, 34)

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

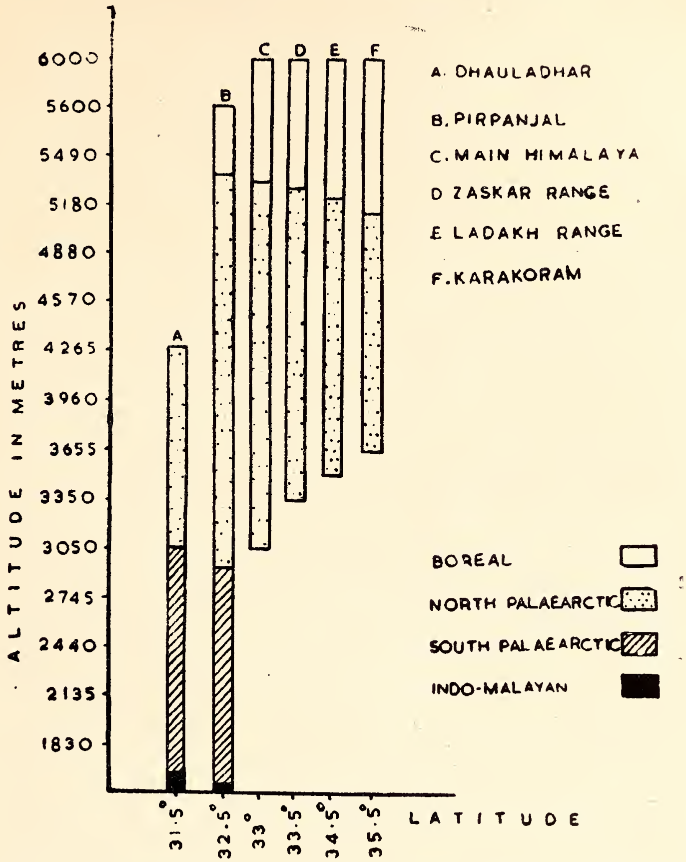


Fig. 37. The boundary altitudes of the faunal Realms on the different ranges of the NW. Himalaya, at a line drawn approximately north through Kangra, somewhat east of 76° E.lat.

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

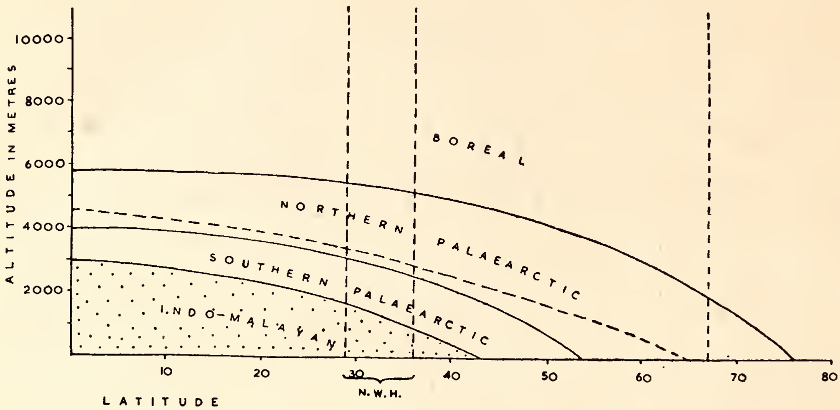


Fig. 38. The Altitude-Latitude relation of the faunal Realms in the region of the NW. Himalaya, about 76° E.lat. (*Modified from Eidmann*, 34)

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* (Ståll.)

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).

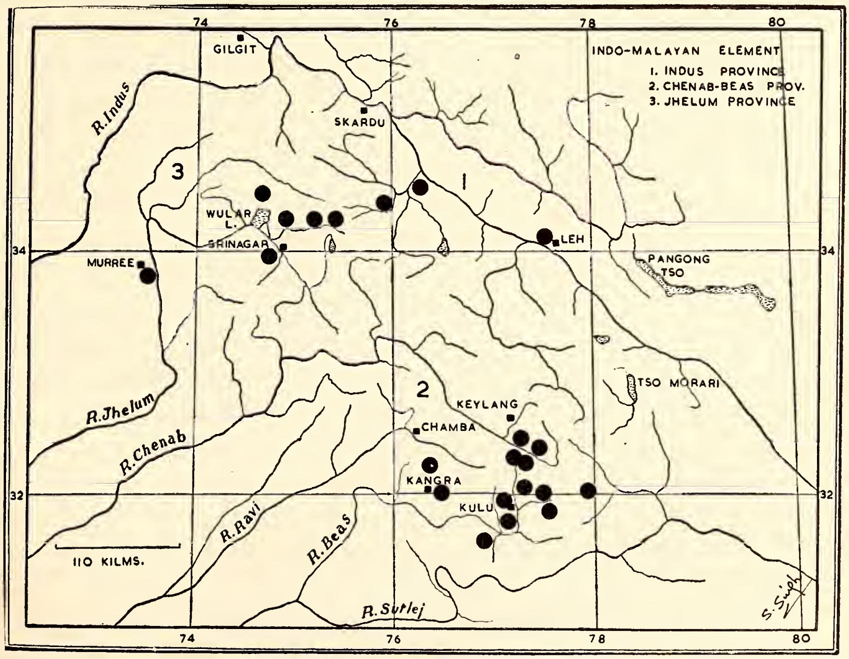


Fig. 39. The distribution of the Indo-Malayan elements in the nival insect fauna from the NW. Himalaya

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

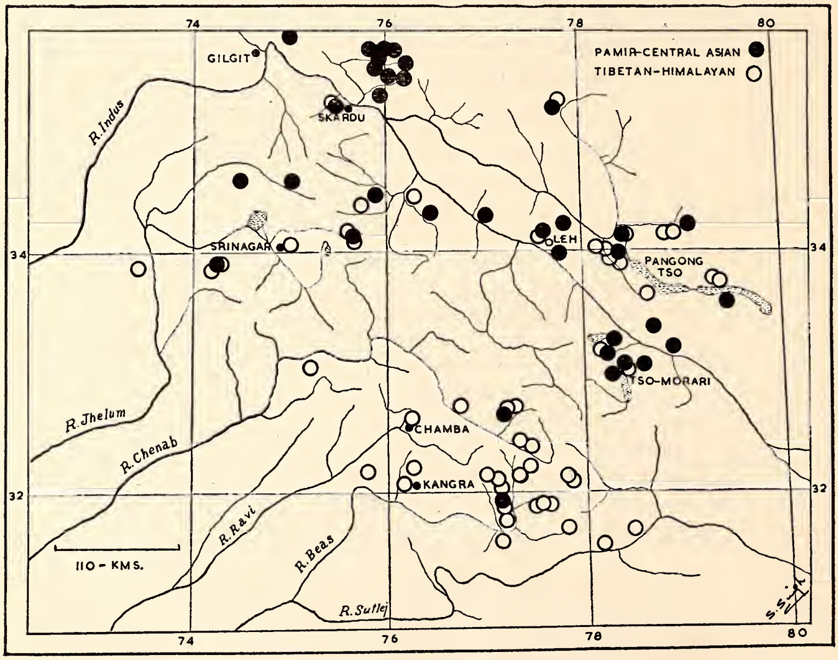


Fig. 40. The distribution of the Pamir-Central-Asian and of the Tibetan-Himalayan (i.e. Himalaya east of the R. Sutlej) in the nival insect fauna in the NW. Himalaya

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.

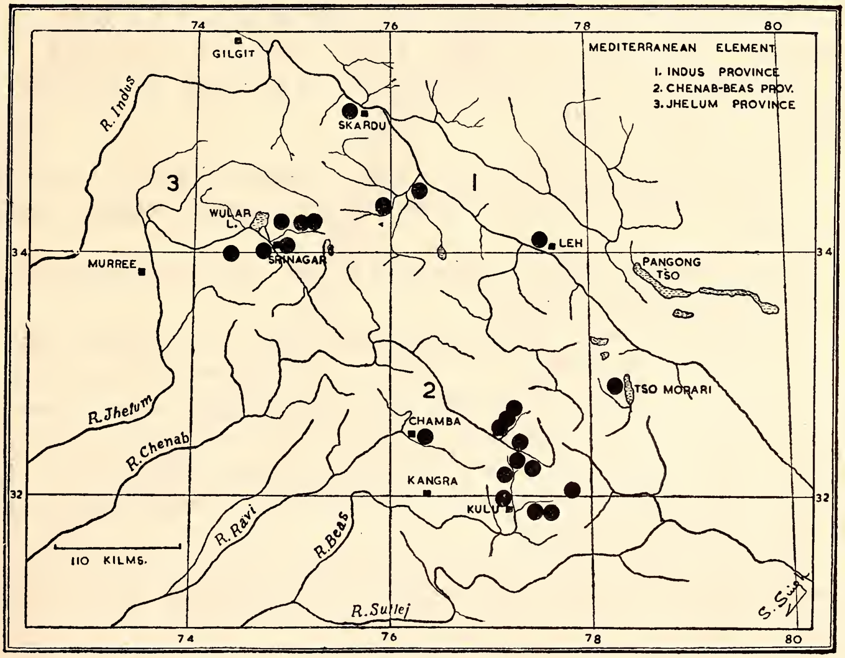


Fig. 41. The distribution of the Mediterranean elements in the nival insect fauna of the NW. Himalaya

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.

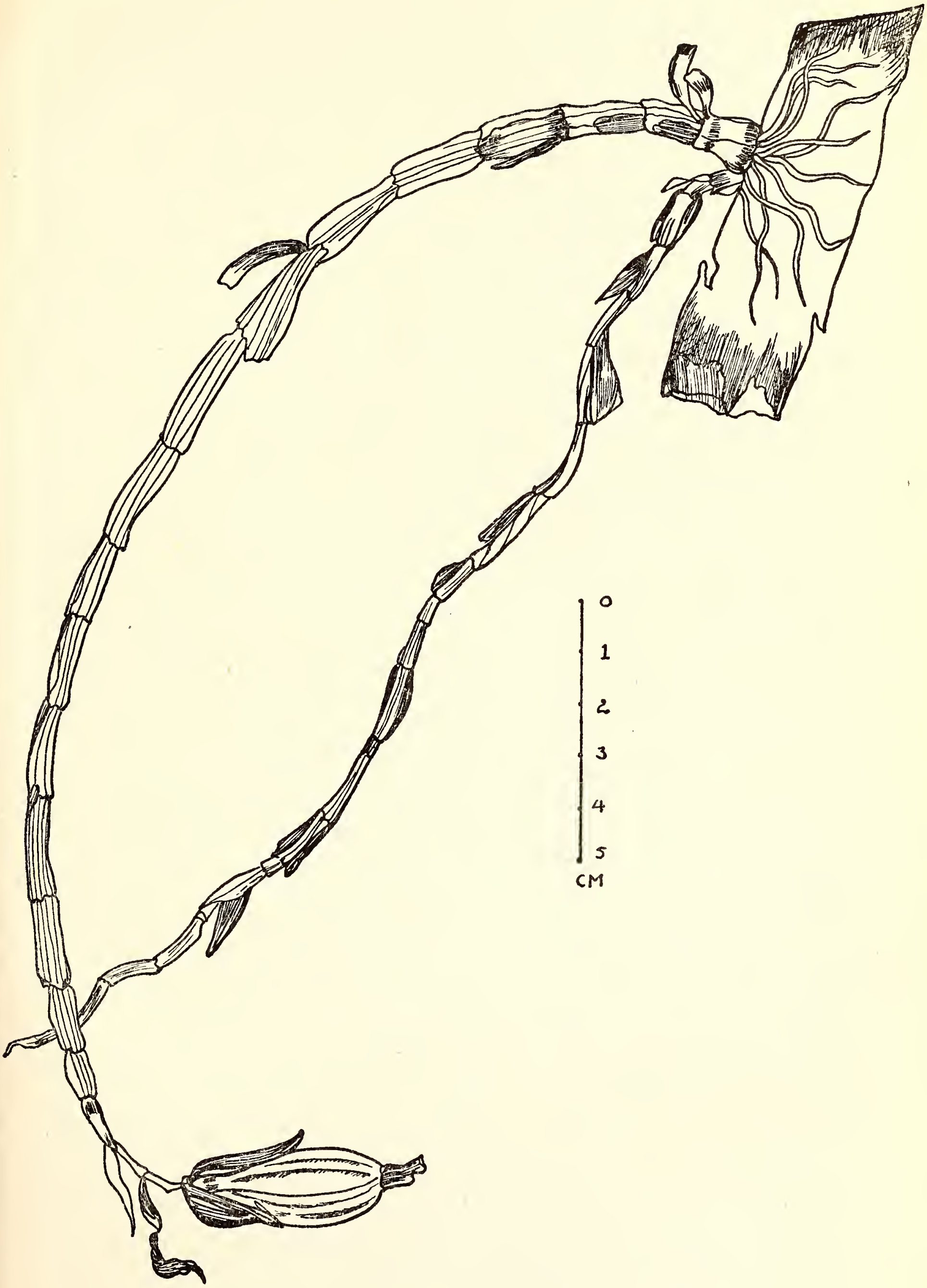
Species about 4, found in India and Burma, extending southwards to the extreme north of Malaya.

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.

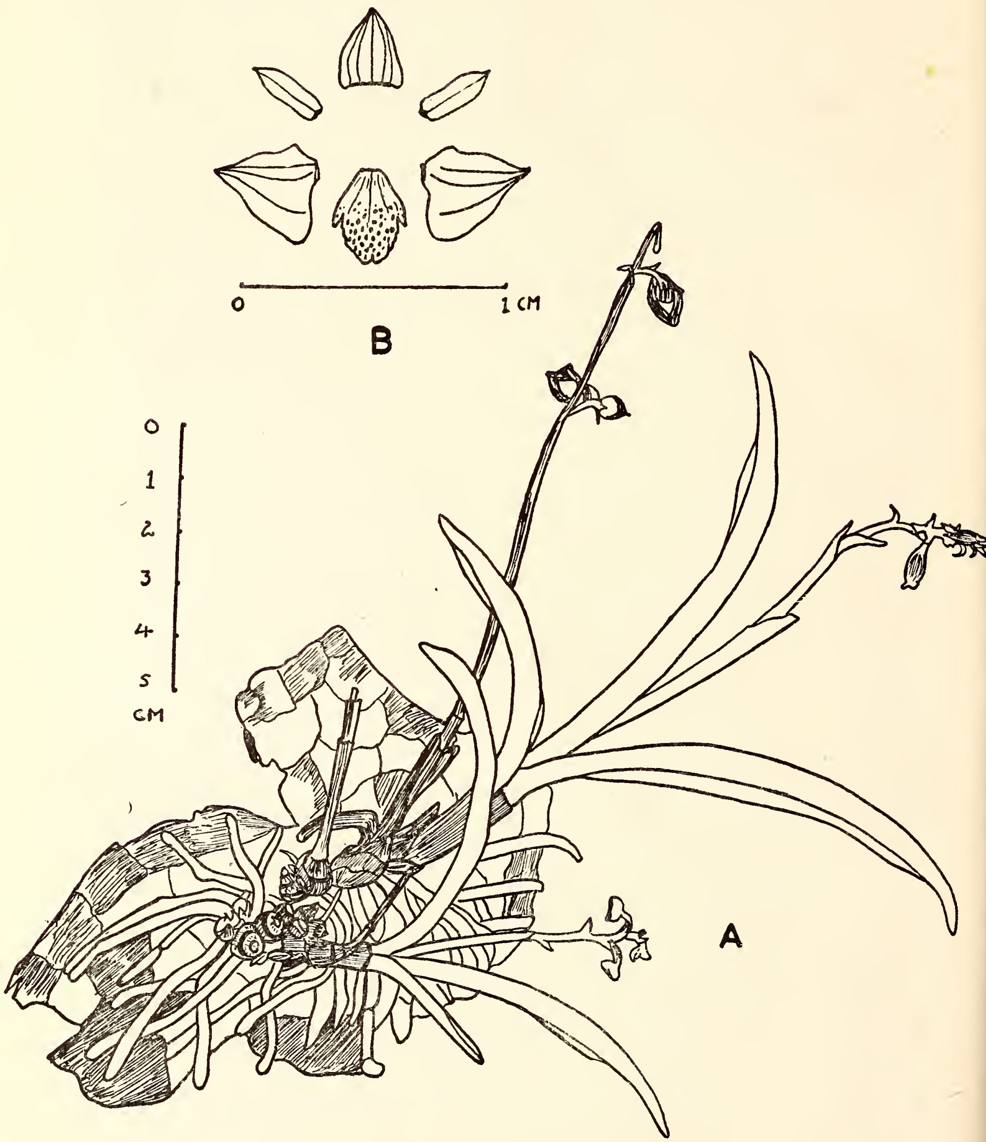
The only species described when the genus *Thunia* was erected is *T. alba* Reichb. f., which must, therefore, be considered as the type species.

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*

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*

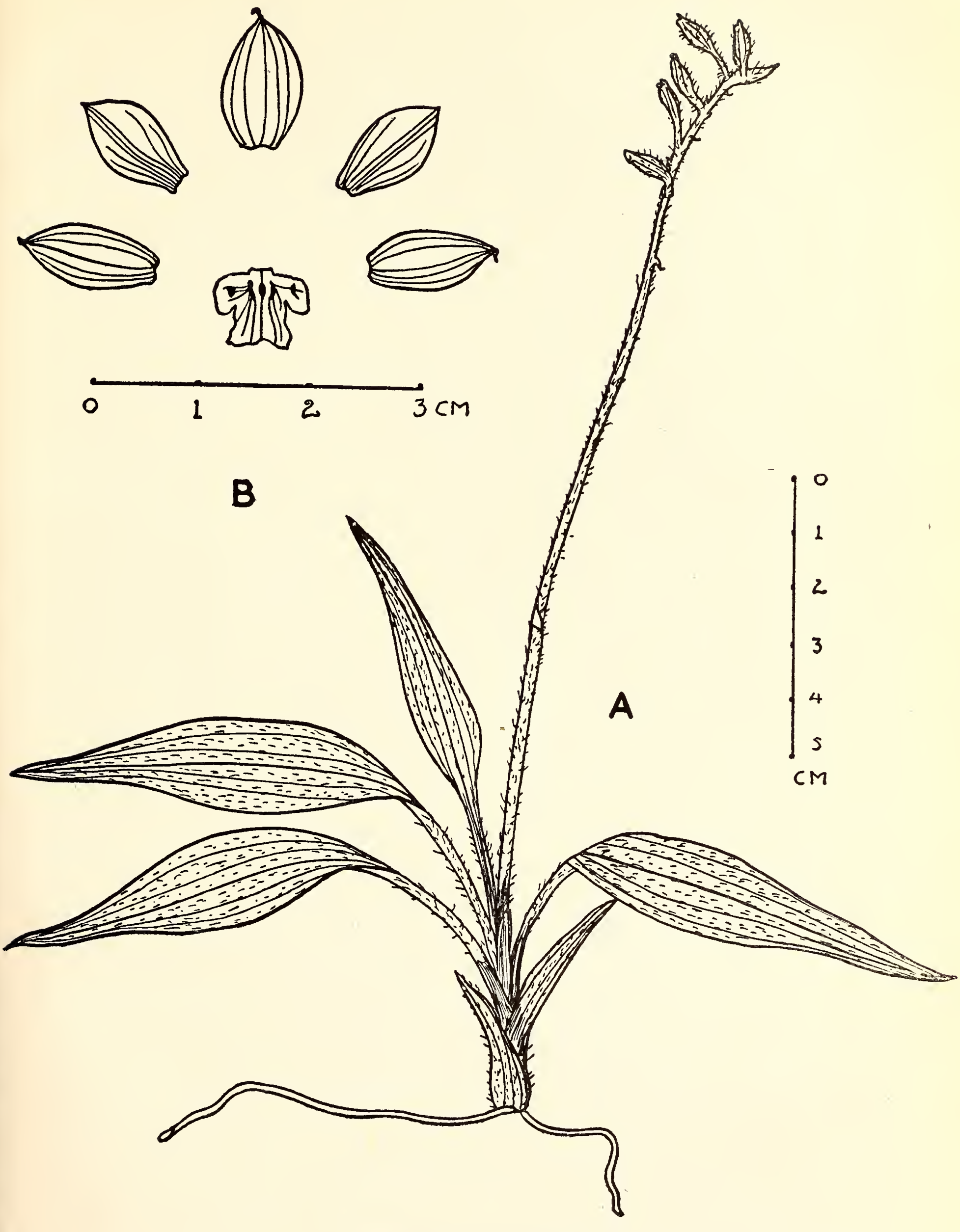
1. **Calanthe masuca** (D. Don) Lindl. [in Wall. Cat. 7337, 1832, nom. nud. et] Gen. Sp. Orch. 249, 1833, et in Bot. Reg. misc. 51, 1842, t. 37, 1844; Reichb. f. in Walp. Ann. 6: 915, 1861; Hook. f. 850; King & Pantl. 173, t. 234; Brühl, Guide Orch. Sikk. 108, 1926; Fischer, Fl. Pres. Madr. 1432, 1928; 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 ...'

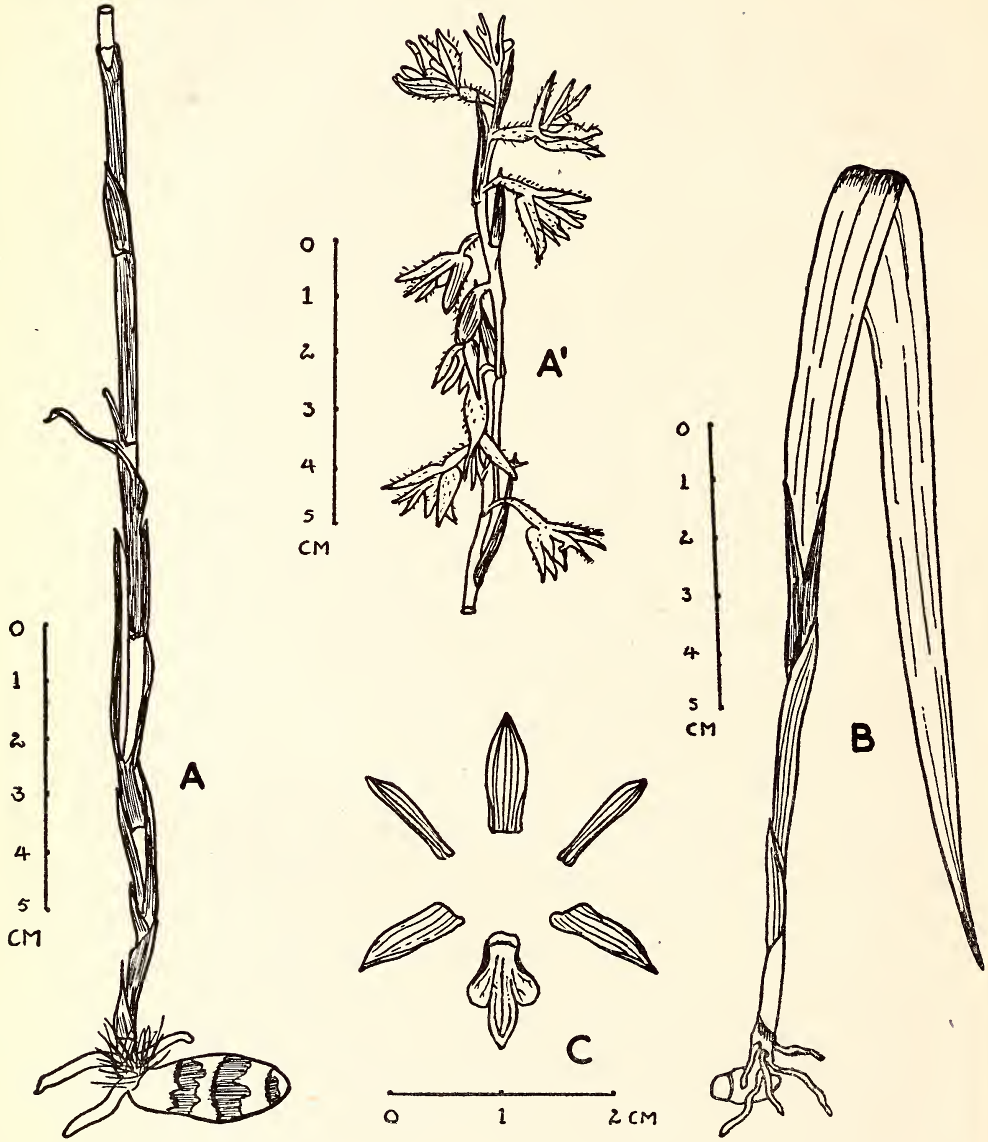
Occurrence in Bombay State: N. KANARA: Malemani Ghat, *Sedgwick*.

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).

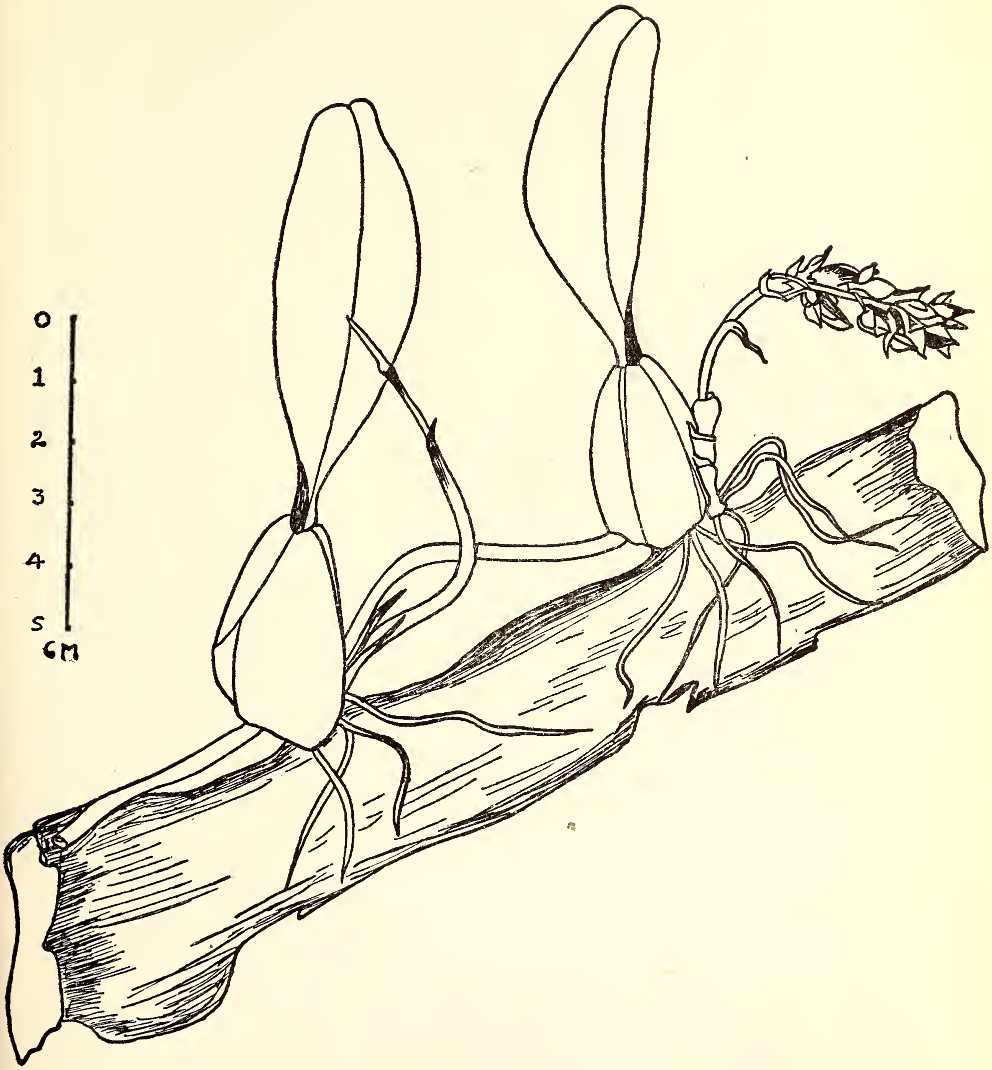
One of the largest of all orchid genera. In a wide sense there are probably 1000 species, distributed through tropical Africa and Asia, extending into S. Africa, Australia, New Zealand, Japan, and Korea, and also into Brazil and S. America.

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.

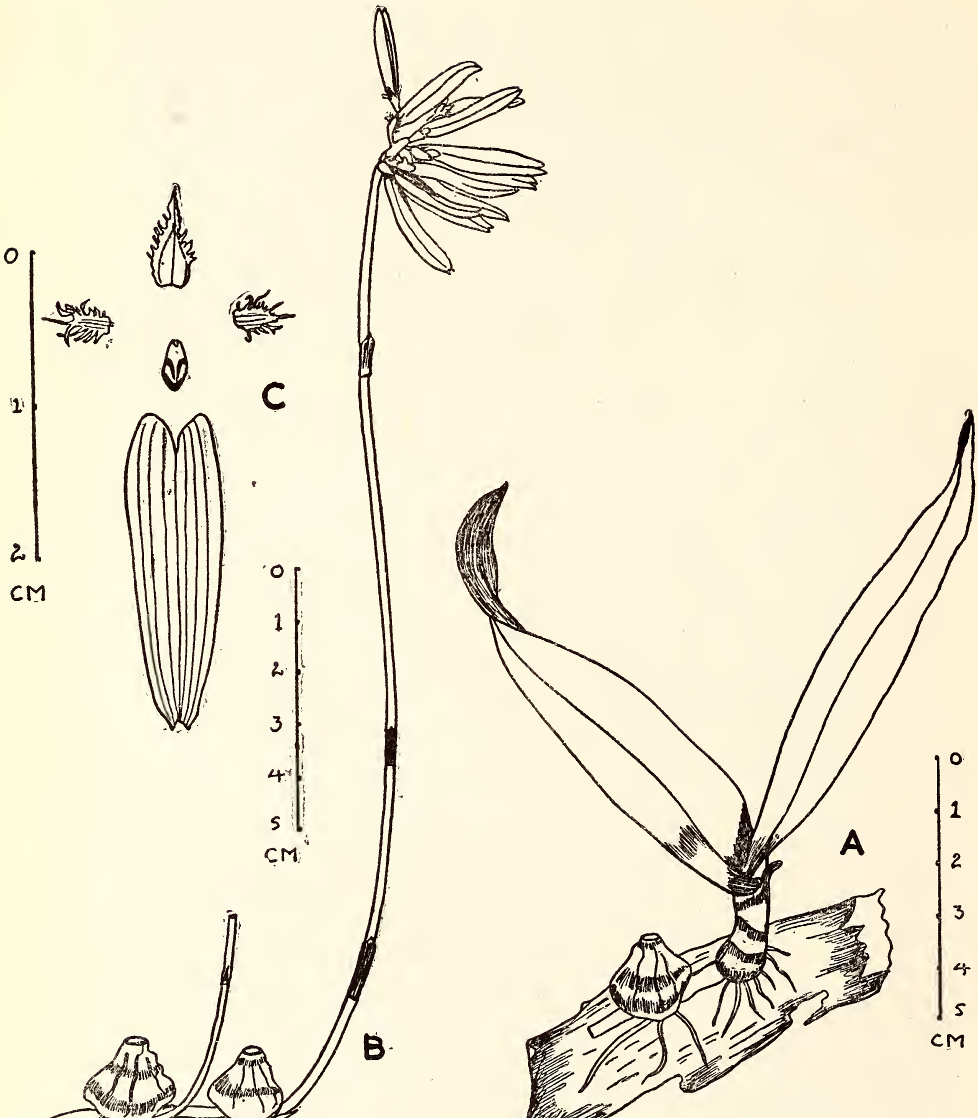
Type species : *B. nutans* Thou.

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 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, sub-entire, 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.

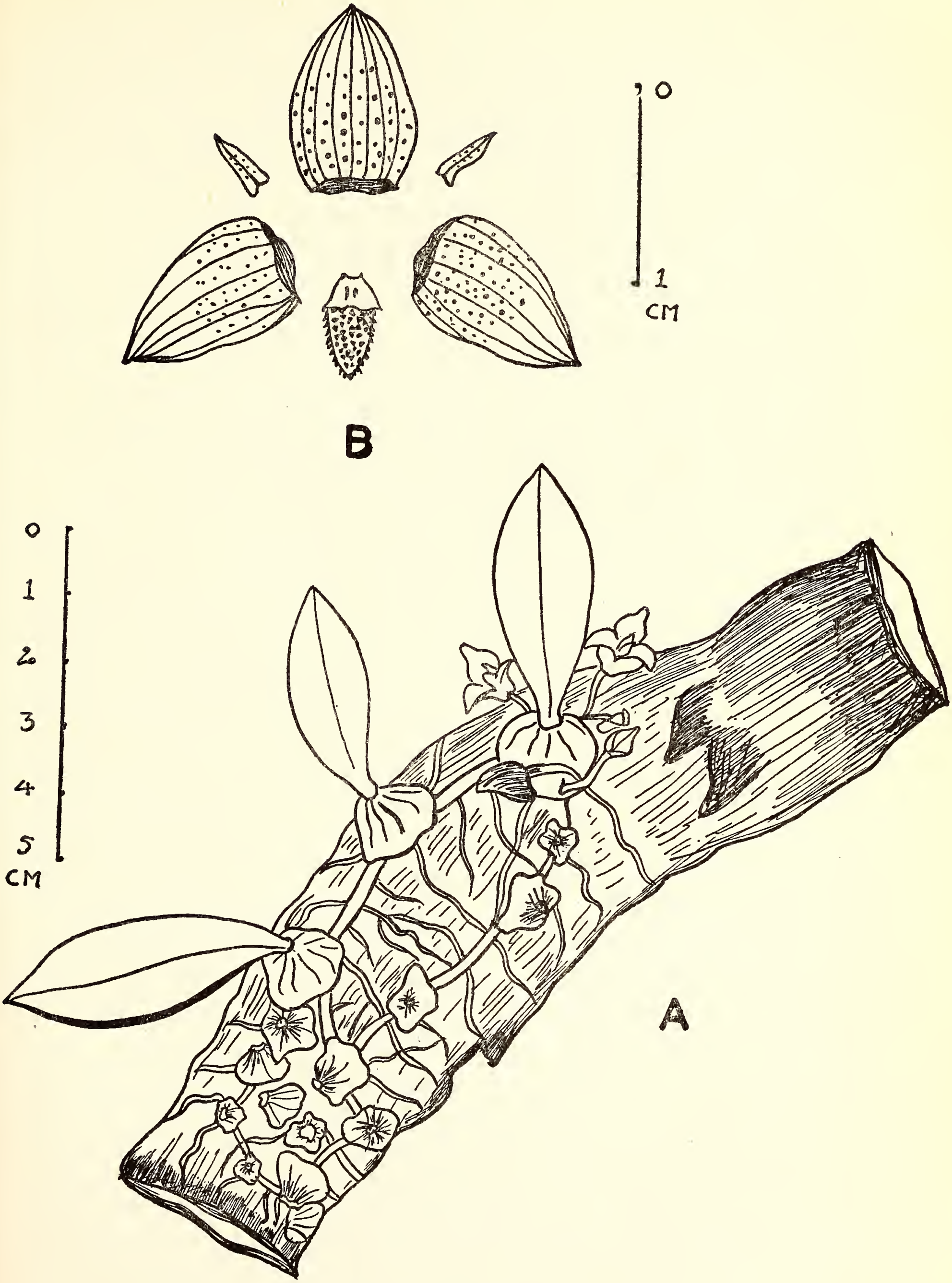
Occurrence in Bombay State : N. KANARA : Castle Rock, *Kapadia* 2819-2820 ; Siddhapur, *Kapadia* 2358-2359 ; Anmod, *Kapadia* 1864 ; Jog, *Kapadia* 1844-1845.

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.

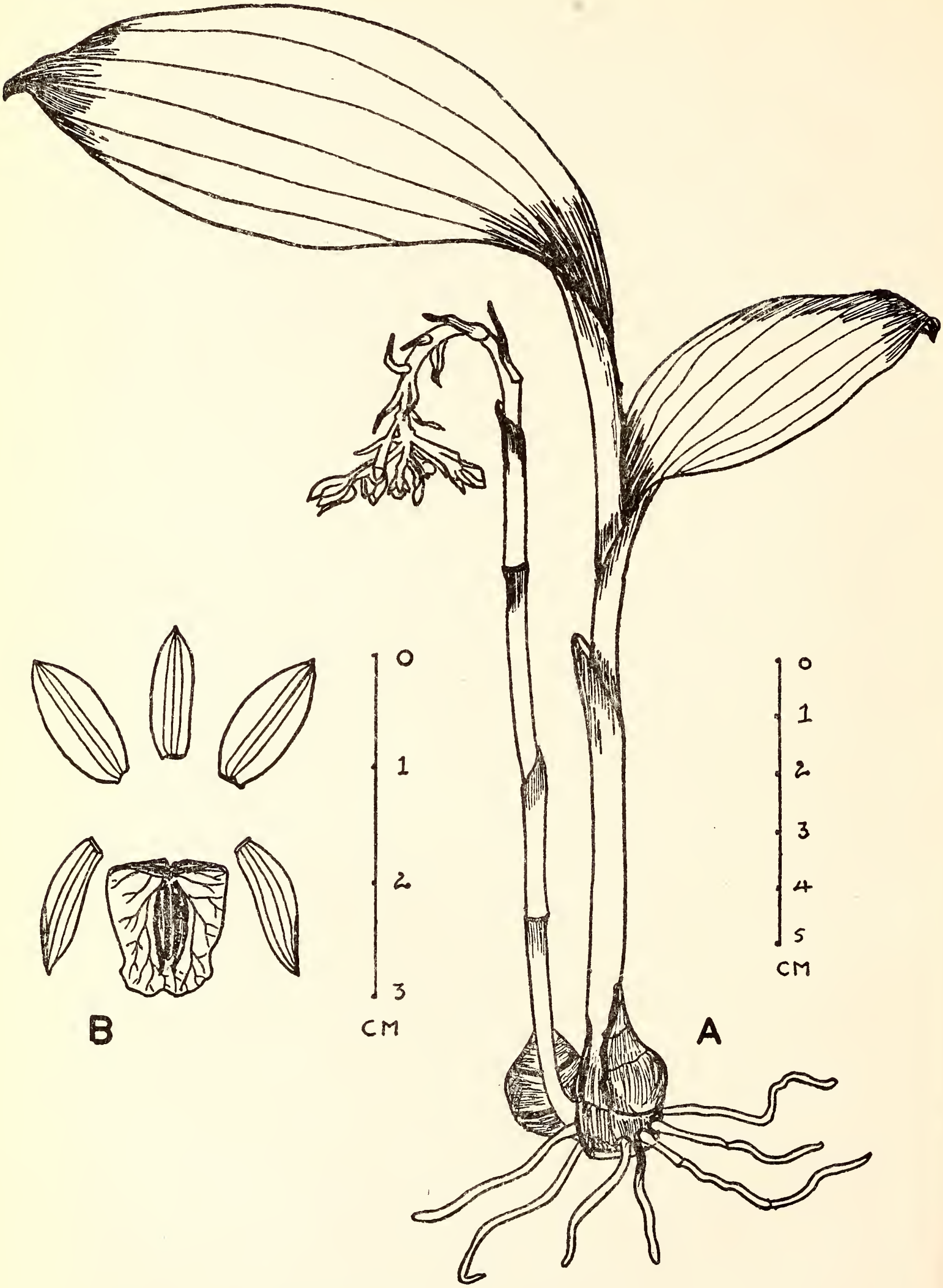
15. *GEODORUM* Jacks.

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: T a m b o l i, near Sawantwadi, *F. X. Miranda*; S i r s i, *Woodrow*; *Santapau* 18662-18664; *Hallberg & McCann* 35196; C h a n d w a r, *Ritchie*; K a l a n a d i, *Ritchie*; G u n d h, *J. Fernandez* 1522; *Kapadia* 1722-1724; S i d d h a p u r, *Kapadia* 2372-2374; D a n d e l i, *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

5

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 specimens 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/Tl: 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 '. Furthermore, 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 $\gtrless$ **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 collection 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*)

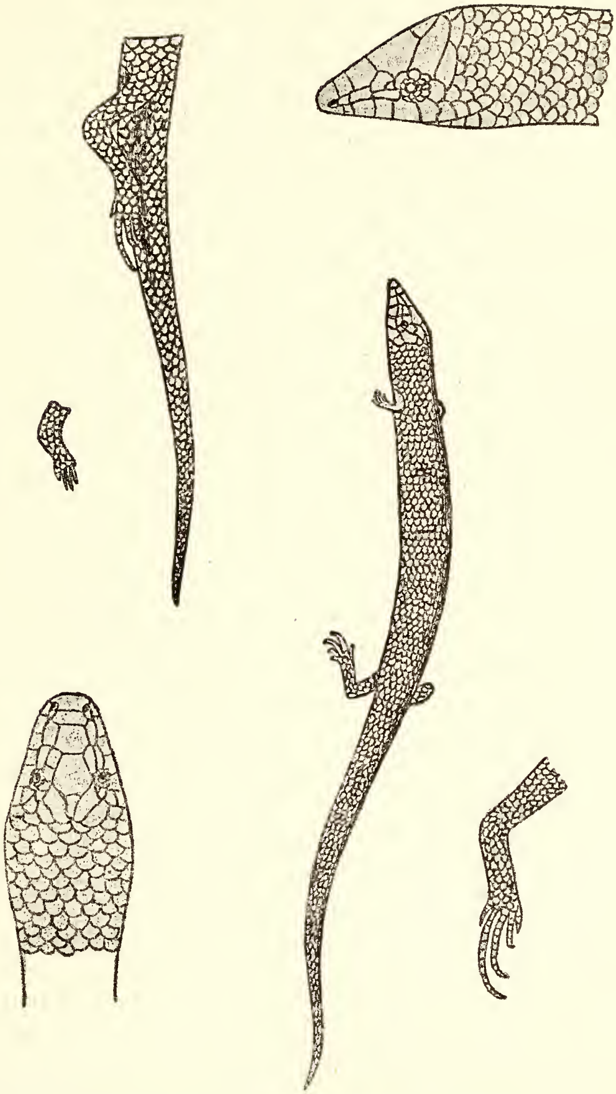
[In the *Madras Monthly Journal of Medical Science*, 1870-1, Major R. H. Beddome published a series of three papers describing 17 new species of reptiles from south India. In 1935 Dr. Baini Prashad, then Director, Zoological Survey of India, sent the Society a typed copy of the three papers with the 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.]

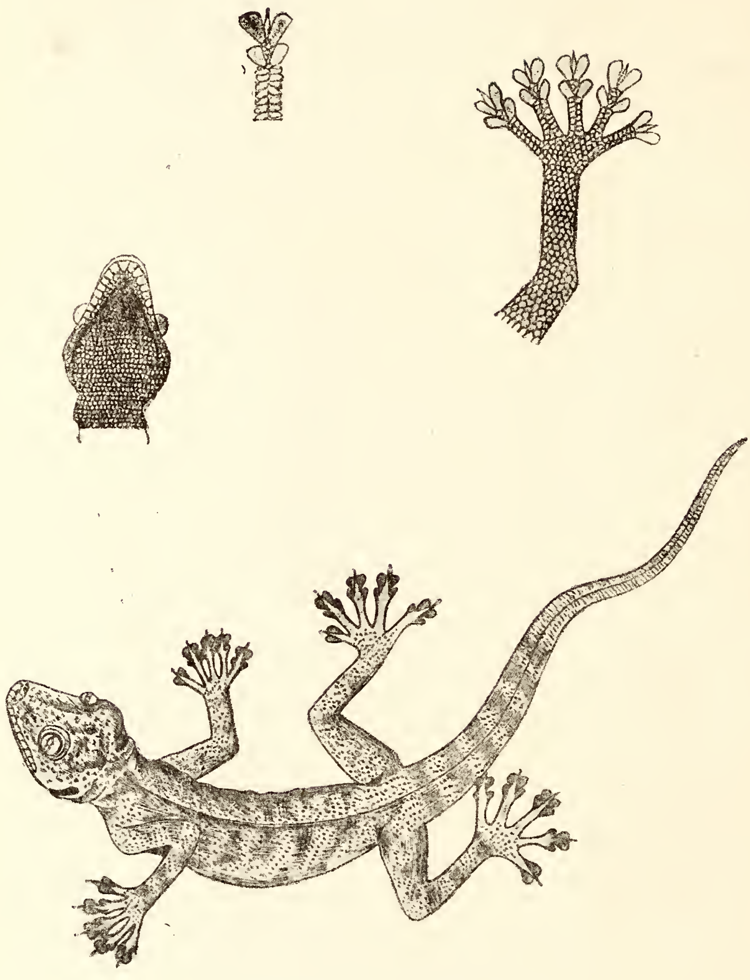
Sphenocephalus ? pentadactylus (Bedd.). [*Chalcides pentadactylus*, **2**: 350].

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.).

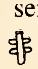
(Reproduced from *Madras Monthly Journal of Medical Science*, Vol. **1**, 1870) third, the fifth very small; form slender, four and quarter inches long, as thick as a goose quill, two-thirds cylindrical, flat and laterally angled beneath as far as the vent; the body and tail covered with small smooth 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 $6\frac{1}{2}$ to 7 inches, of which the tail is $3\frac{1}{4}$ to $3\frac{1}{2}$; length of fore limbs $1\frac{1}{2}$ inches, hind limbs $1\frac{7}{8}$ 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 $3\frac{1}{2}$ 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 $2\frac{3}{4}$ 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 $3\text{-}3\frac{1}{2}$ 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 $2\frac{3}{4}$ inches, of which the tail is $1\frac{1}{2}$.

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 $2\frac{1}{2}$ inches, of which the body is $1\frac{1}{2}$, 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 $3\frac{1}{2}$ inches, of which the body is $1\frac{5}{8}$; 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 1½ 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 $1\frac{3}{4}$; circumference $\frac{7}{8}$ths 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 $3\frac{1}{4}$ 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: 518].

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.

* * * *

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 $2\frac{3}{4}$ 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.

---

[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).

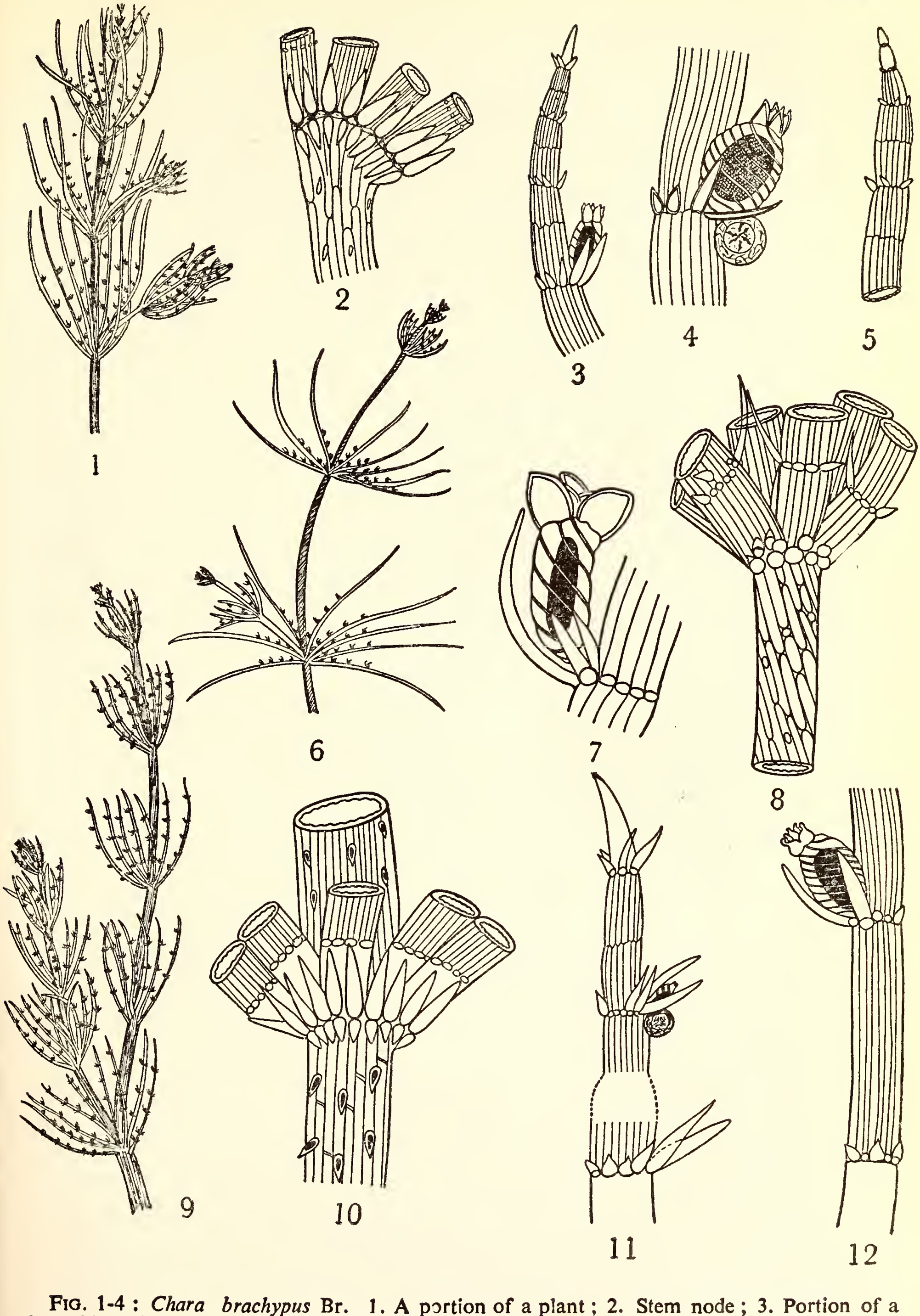


FIG. 1-4 : *Chara brachypus* Br. 1. A portion of a plant ; 2. Stem node ; 3. Portion of a branchlet ; 4. Branchlet node with oogonium and antheridium. FIG. 5-8 : *Chara fragilis* Desv. 5. Upper portion of the branchlet enlarged ; 6. A portion of a plant ; 7. Branchlet node with oogonium enlarged ; 8. 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.

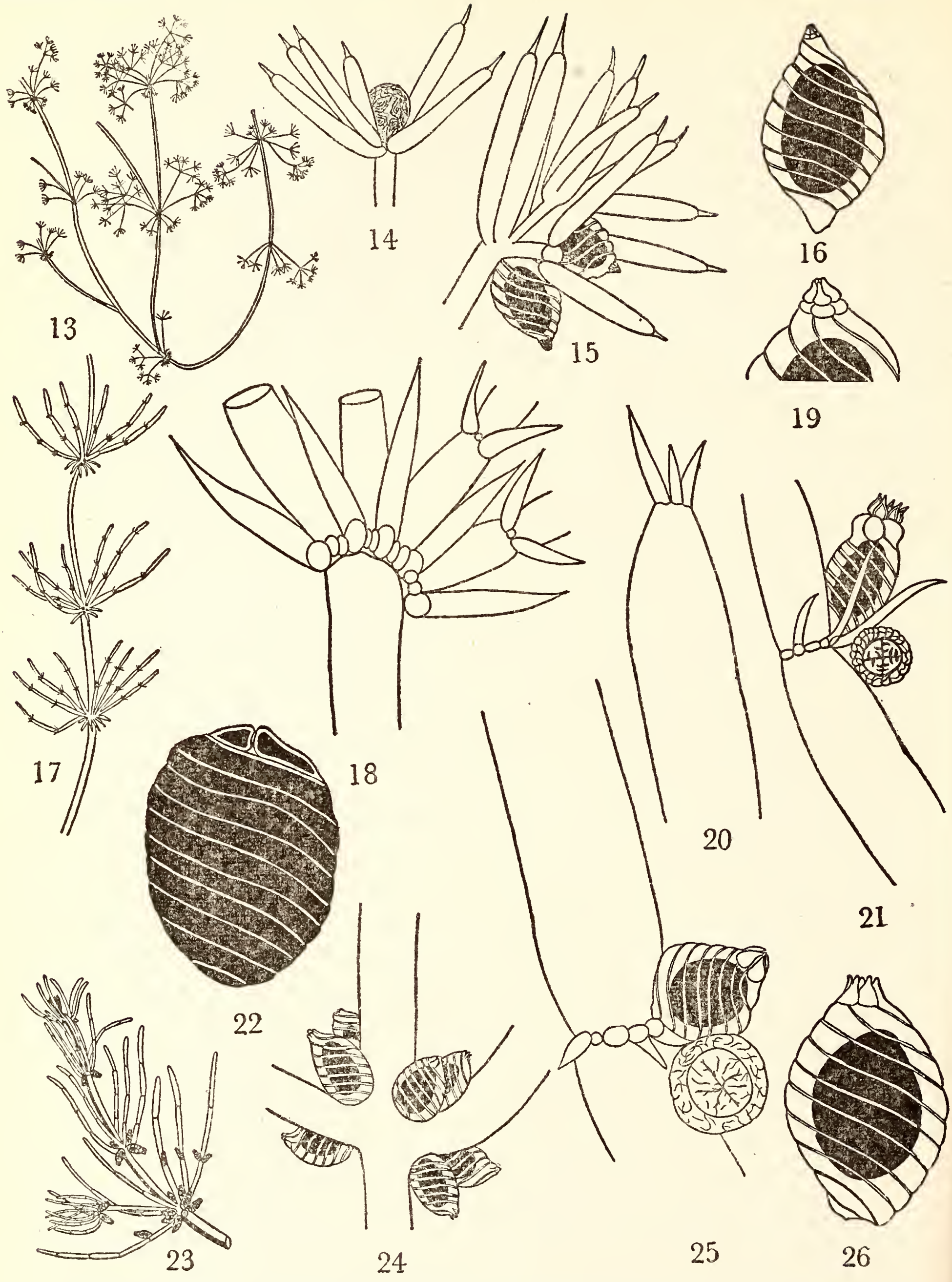


FIG. 13-16 and 19: *Nitella hyalina* Ag. 13. A portion of a plant; 14. Branchlet node showing antheridia; 15. Branchlet showing oogonia; 16. Oogonium; 19. Upper portion of oogonium showing crown cells. FIG. 17-18 and 20-22: *Chara braunii* Gm. 17. A portion of a plant; 18. Stem node; 20. Apex of a branchlet; 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, ocspore 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 $\frac{3}{5}$ 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).

ACKNOWLEDGEMENTS

The author is grateful to Shri M. M. Bhandari, Department of Botany, Jaswant College, Jodhpur, Rajasthan for his guidance, and to Dr. G. S. Venkataraman of the Indian Agricultural Research Institute, New Delhi, for his advice.

REFERENCES

Agardh, C. A. (1924): *Systema Algarum*: 123-130. Lund.

Agharkar, S P., & Kundu, B. C. (1937): Charophytes of Bengal. *J. Dep. Sci. Calcutta Univ.* N. S. **1**: 1-23.

Bhandari, M. M. (1952): A preliminary note on a collection of Algae from Jodhpur and its environs. *Univ. Raj. Studies* **1**: 103-120.

—— (1955): Occurrence of *Characiosiphon rivularis* Iyengar. *Curr. Sci.* **24**: 16-17.

Blatter, E., & Hallberg, F. (1918-20): Flora of the Indian Desert. pt. VI. *J. Bombay nat. Hist. Soc.* **27**: 278.

Braun, A. (1835): Uebersicht der genauer bekannten Chara-arten. *Flora* **18**: 49-73.

—— (1849): Characeae Indiae Orientalis et insularum maris pacifici. *Hooker's Jour. Bot. & Kew Garden Misc.* **1**: 292-301.

—— & Nordstedt, O. (1882): Fragmente einer Monographie der Characeen (Nach den hinterlassen Manuscripten A. Braun's herausgegben von Dr. Otto Nordstedt). *Abh. Kon. Akad. Wiss. Berlin*: 1-211.

Ghose, S. L. (1934): Some halophyllous and halotolerant algae from the Sambar lake of Rajputana. 21st *Proc. Indian Sc. Congr.*: 295.

Gmelin, C. C. (1826): *Flora Badensis Alsatica* IV: 643-47. Karlsrug.

Godbole, N. N. (1951): Does Sambar lake owe its salt to the Rann of Cutch. *Proc. Raj. Acad. Sci.* (Special Issue) No 1.

Goyal, S. K. (1960): Chlorophyceae of Jodhpur. M.Sc. thesis. Univ. Rajasthan, 1960

Groves, J. (1931): On the antheridium of *Chara zeylanica* Willd. *J. Bot.* **69**: 97-98.

—— & Bullock-Webster, G. R. (1920-24): British Charophyta. Part I, 1920; Part II, 1924. *Roy. Soc London*.

Ruprecht, F.J. (1845): *Symbolae ad Historiam et Geographiam Plantarum Rossicarum*: 75-80. Petrograd.

Singh, R.N. (1949): Ecological studies on the sub-aerial algae of Mt. Abu (Rajputana). *Annual Report Nat. Inst. Sci. India*: 51.

Sundaralingam, V.S. (1959): A systematic account of the South Indian Characeae. *Proc. Indian Acad. Sci.* **49B**: 7-61.

—————— & Francis, K.J. (1958): On the antheridium in Characeae. *Curr. Sci.* **27**: 138.

Willdenow, C.L. (1805): Du Genre nommé Chara. *Mem. Acad. Roy. Berlin,* 1803: 79-90.

Zaneveld, J.S. (1940): The Charophyta of Malaysia and adjacent countries. *Blumea* **4**: 1-224.

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]

CONTENTS

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.

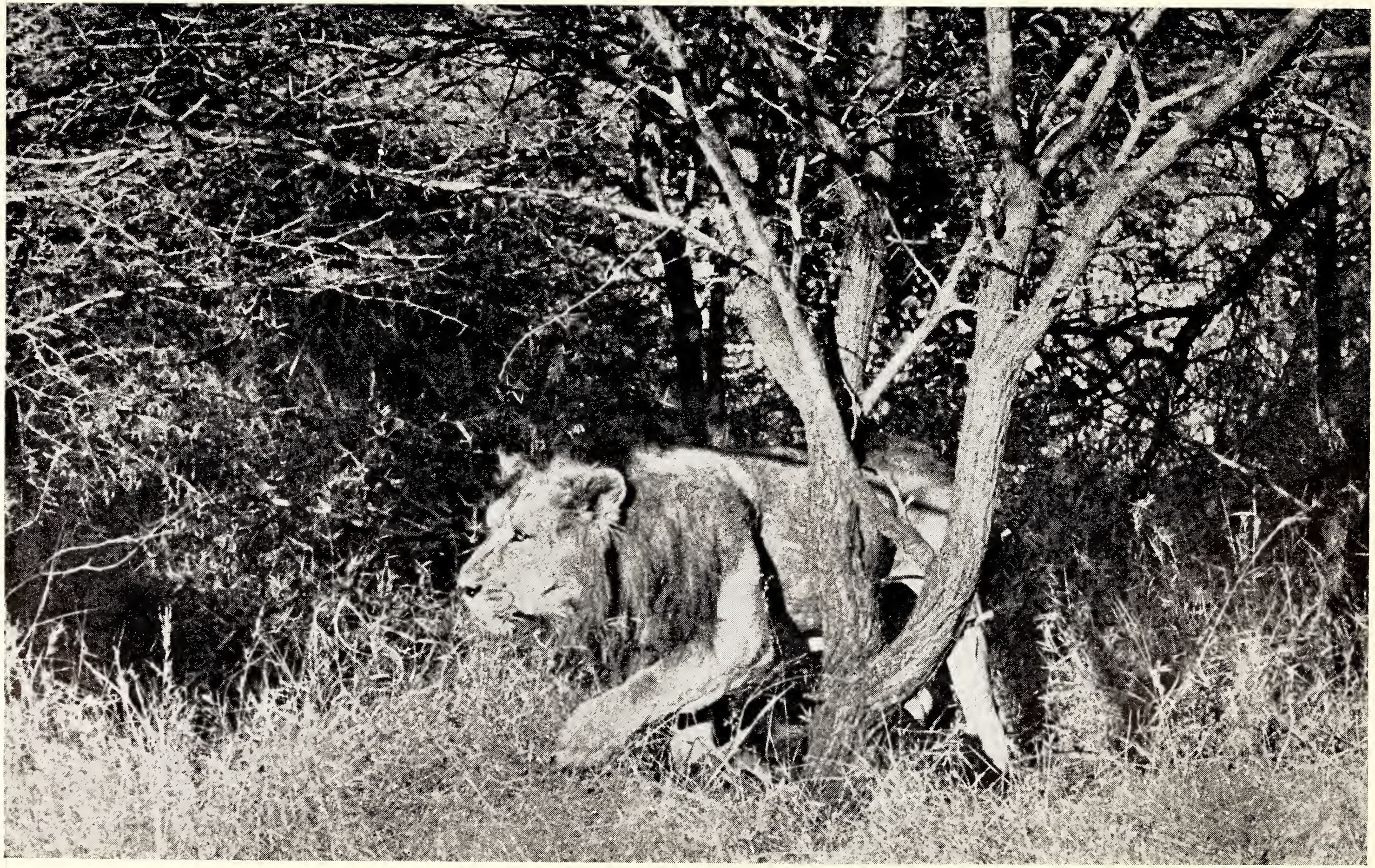
Moving Rare Species to Alternative Localities

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.

---

[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 conditions. 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.

References

Butcher, D. (1954): Exploring Our National Parks and Monuments. Boston, U.S.A.: 266-271.

Cahalane, V. H. (1951): Management of Large Nature Reserves. I.U.P.N. Technical Meeting. The Hague.

Gee, E. P. (1952-56): The Management of India's Wild Life Sanctuaries and National Parks. *J. Bombay nat. Hist. Soc.* **51** (1): 1-18; **52** (4): 717-734; **54** (1): 1-21.

Indian Board for Wild Life: Proceedings (1952): 53-64; (1953): 1-29; (1955, March): 55-60; (1955, July): 46-55; (1956): 95-109; (1957): 153-162; (1958): 180-193; (1959): 72-77; (1961)

Munro, D. A. (1949): Notes on Game Biology (Wildlife Management in Canada).

National Park Service (1957): Information Handbook.

Zoologica (1956): Introduced Mammals and their Influence on Native Biota. Scientific Contributions of the New York Zoological Society, **41** (4).

(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 mulluha 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)

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 plectranthoides 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* 494, 499, 518, 567, 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)

Acknowledgements

The author is deeply indebted to Dr. J. C. Sen Gupta, Chief Botanist, Botanical Survey of India, Calcutta, for his kind help in the identification of some of the plant specimens, and to Rev. Fr. H. Santapau, Director, Biological Section, St. Xavier's College, Bombay, for his constructive suggestions and going through the manuscript.

References

Champion, H.G. (1936) : A Preliminary survey of the forest types of India and Burma. *Indian For. Records* (N.S.), *Silvic.*, **1**.

Collett, H. (1921) : Flora Simlensis. Thacker Spink & Co., Calcutta and Simla.

Dudgeon, W. & Kenoyer, L.A. (1925) : The ecology of Tehri Garhwal. A contribution to the ecology of Western Himalaya. *J. Indian bot. Soc.* **4** : 233-285.

Gupta, R. K. (1956-57) : Botanical explorations in the Bhillangna valley of the erstwhile Tehri Garhwal State. *J. Bombay nat. Hist. Soc.* **53** : 581-594 (1956) & **54** 878-886 (1957).

——— (1959) : Vegetation of Tehri Garhwal (North-West Himalayas). *Proc. Indian Sc. Cong. Association.* (Abst.) pt. 3 : 309-310.

Heske, Fr. (1929) : Beitrag zur Kenntnis der Waldzonen des West-Himalaya. *Acta Forest Fennica* **34** : 1-30.

Mohan, N. P. & Puri, G. S. (1957) : The Himalayan conifers. Pt. III—The succession of forest communities in oak-conifer forests of Bashahr Himalayas. *Indian For. Records* (N.S.), *Silvic.*, **10**(2) : 19-66.

Osmaston, A. E. (1922) : Notes on the forest communities of the Garhwal Himalayas. *J. Ecol.* **10** : 129-167.

Puri, G. S. (1950) : The distribution of conifers in the Kulu Himalayas with special relation to geology. *Indian For.* **76** : 144-153.

Troup, R. S. (1921) : The silviculture of Indian trees. Oxford. 3 vols.

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.

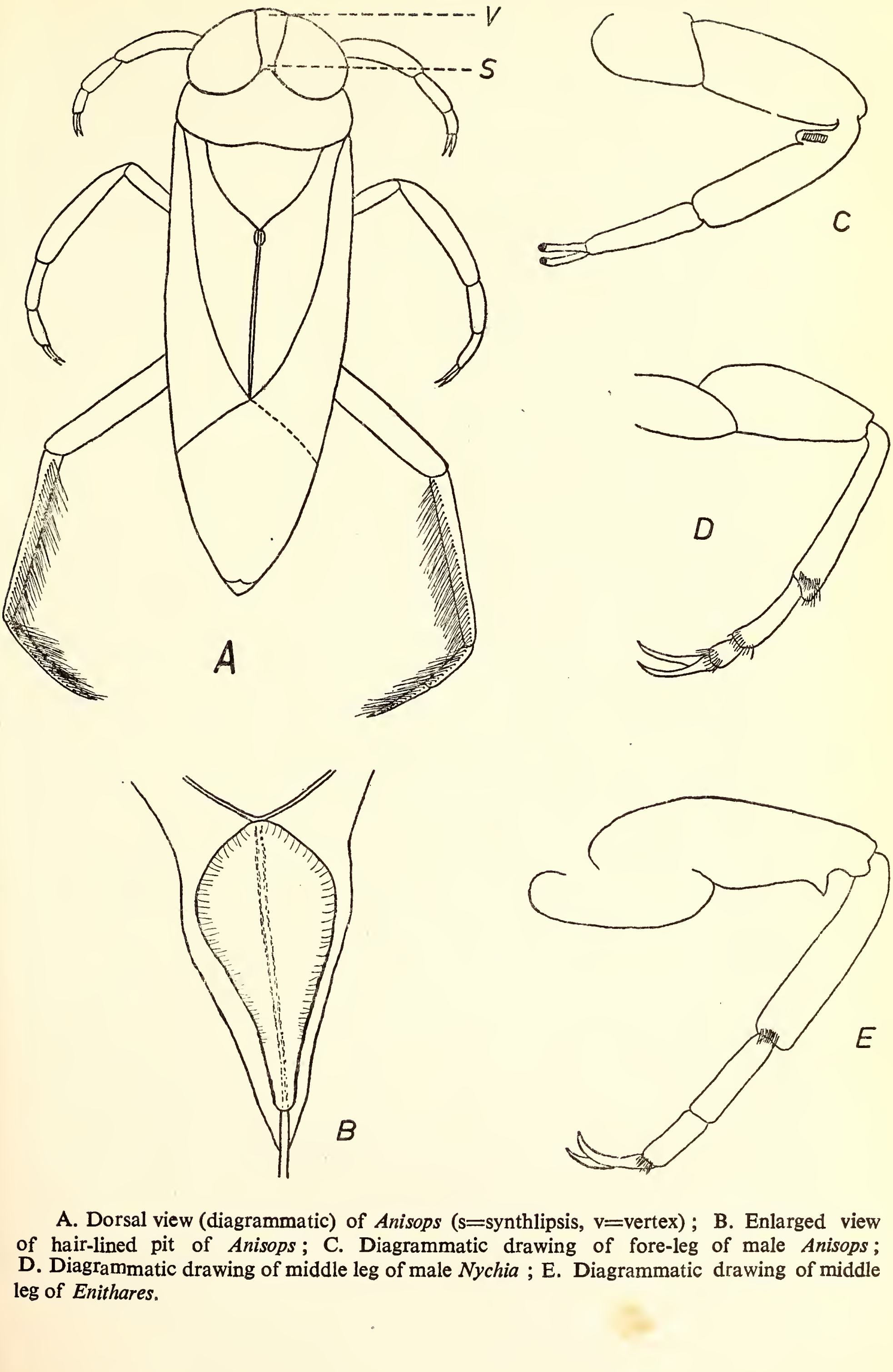
Eggs are inserted into the soft parts of plants (stems and leaves). Stridulation has been recorded in some species. Little is known of the biology of *Anisops* in south-east Asia. The only detailed accounts are those of Hale (1923) in Australia and Poisson (1926) in Africa.

Taxonomy

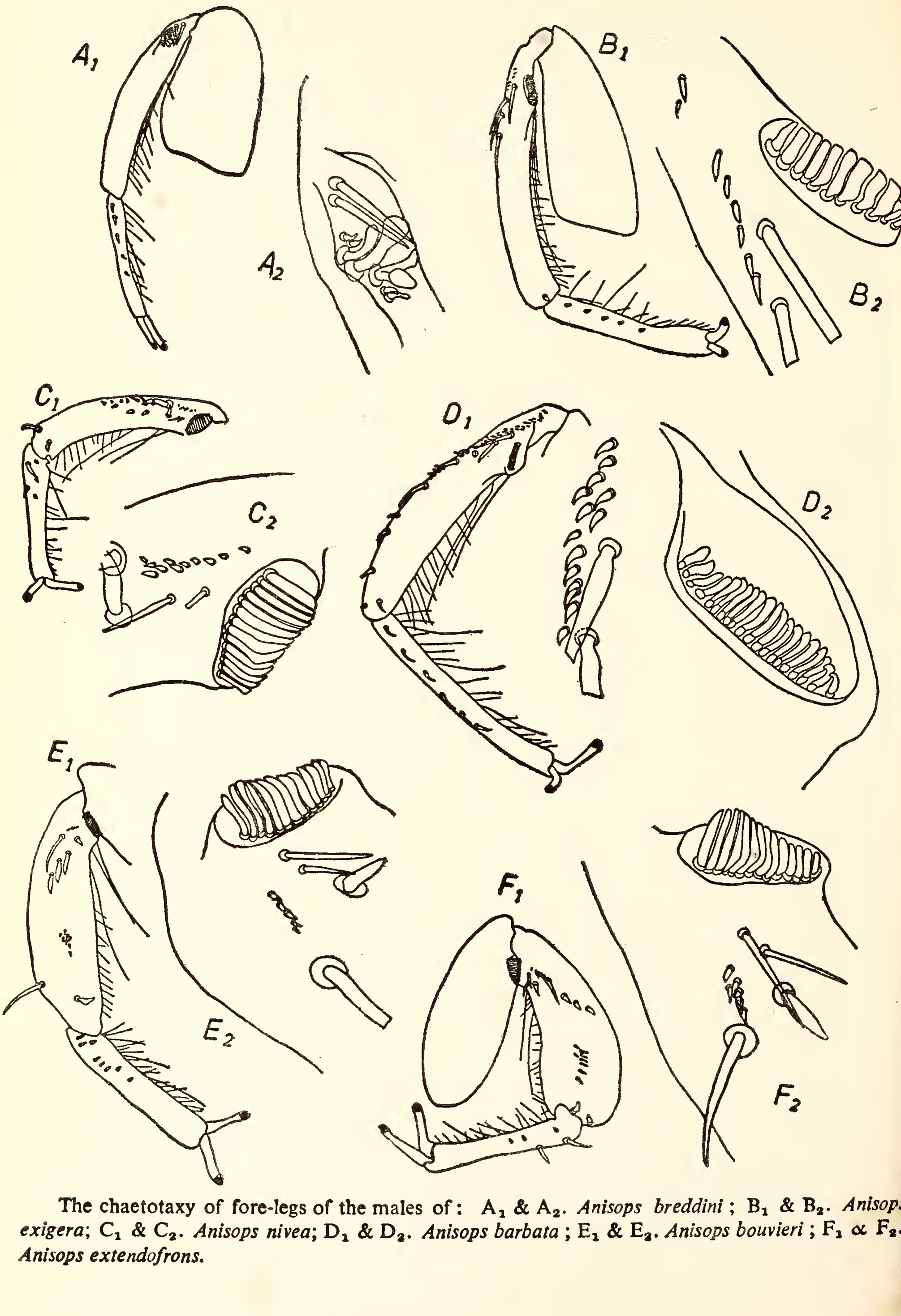
Whilst the generic diagnosis of *Anisops* has proved relatively easy, specific diagnosis was based on unsatisfactory characters like colour and size. This led to considerable confusion until Brooks (1951) revised the genus including all species so far described. He made use of the chaetotaxy of the fore-legs 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

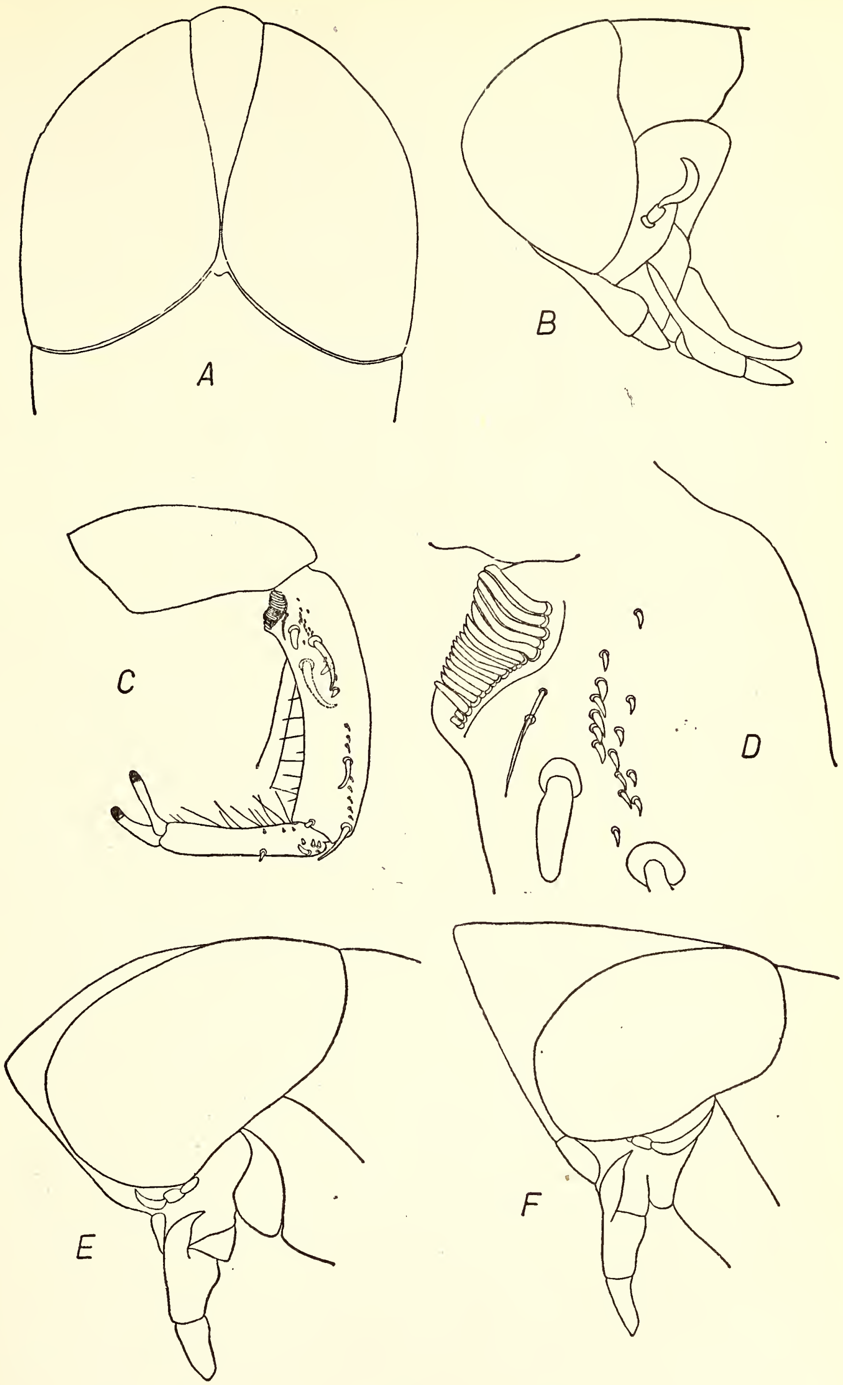
Only a pair of mounted fore-legs of the male was available from Ceylon. The specimen was collected from Ambalantota on 22-5-57. According to Brooks (1951) the male measures 6.4-6.8 in length and 1.5-1.7 in breadth. The females are 6.0 in length and 1.8 in breadth.

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.

References

Brooks, G. T. (1951): A revision of the genus *Anisops* (Notonectidae, Hemiptera). *Kans. Univ. Sci. Bull.* **34** : 301-519.

Dempwolff, H. (1904): Bericht uber eine Malaria-Expedition nach Deutsch-Neu-Guinea. *Zeitschr F. Hyg. U. infectionskrankh* **47** : 81-132

Distant, W.L. (1906): The Fauna of British India. Rhynchota Vol. **3**. Taylor and Francis. London.

——(1911): Rhynchota indica (Heteroptera). *Entomologist* **44** : 104-107.

Fernando, C.H. (1959): Some observations on aquatic insects found in temporary and artificial habitats in Ceylon. *Ceylon J. Sci.* **2** : 1-4.

—— (1961a): Aquatic insects taken at light in Ceylon with a discussion and bibliography of references to aquatic insects at light. *Ceylon J. Sci. (Bio. Sci.)* **4** : 45-54.

—— (1961b): Notes on aquatic insects caught at light in Malaya with a discussion of their distribution and dispersal. *Bull. Nat. Mus. Singapore* **30** : 19-31.

Hale, H.M. (1923): Studies in Australian aquatic Hemiptera. No. 11 Family Notonectidae. *Rec. S. Aust. Mus* : 405-412.

—— (1924): Notes on eggs, habits and migration of some Australian aquatic bugs (Corixidae and Notonectidae). *S. Aust. Nat.* **5** : 133-135.

Hinman, E.H. (1934): Predators of the Culicidae I. The predators of larvae and pupae exclusive of fish. *J. Trop. Med. Hyg.* **37** : 129-134.

Laird, M. (1956): Studies of mosquito and freshwater ecology in the South Pacific. *Bull. Roy. Soc. N.Z.* No. 6, Dunedin : 213 pp.

Lundblad, O. (1933): Zur Kenntnis der aquatilen und semiaquatilen Hemiptera von Sumatra, Java und Bali. *Arch. Fur Hydrobiol. Suppl.* **12**: 1-195 ; 263-498.

Mendis, A.S.& Fernando, C.H (1962): A guide to the freshwater fauna of Ceylon. *Bull. Dept. Fish. Ceylon.* No. 12. Ceylon Govt. Press. (160 pp.)

Poisson, R. (1926): *L'Anisops producta* Fieb. (Hemiptera, Notonectidae) Observations sur son anatomie et sa biologie. *Arch. Zool. exp. gén.* **65**: 181-208.

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 iu 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 $\frac{1}{2}$V-VII ($2\frac{1}{2}$ 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 ; po sterior 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 ⅛ free and thin-walled, middle ⅜ enclosed in gland tissue and posterior ⅜ 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.

1 (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.

1 (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.

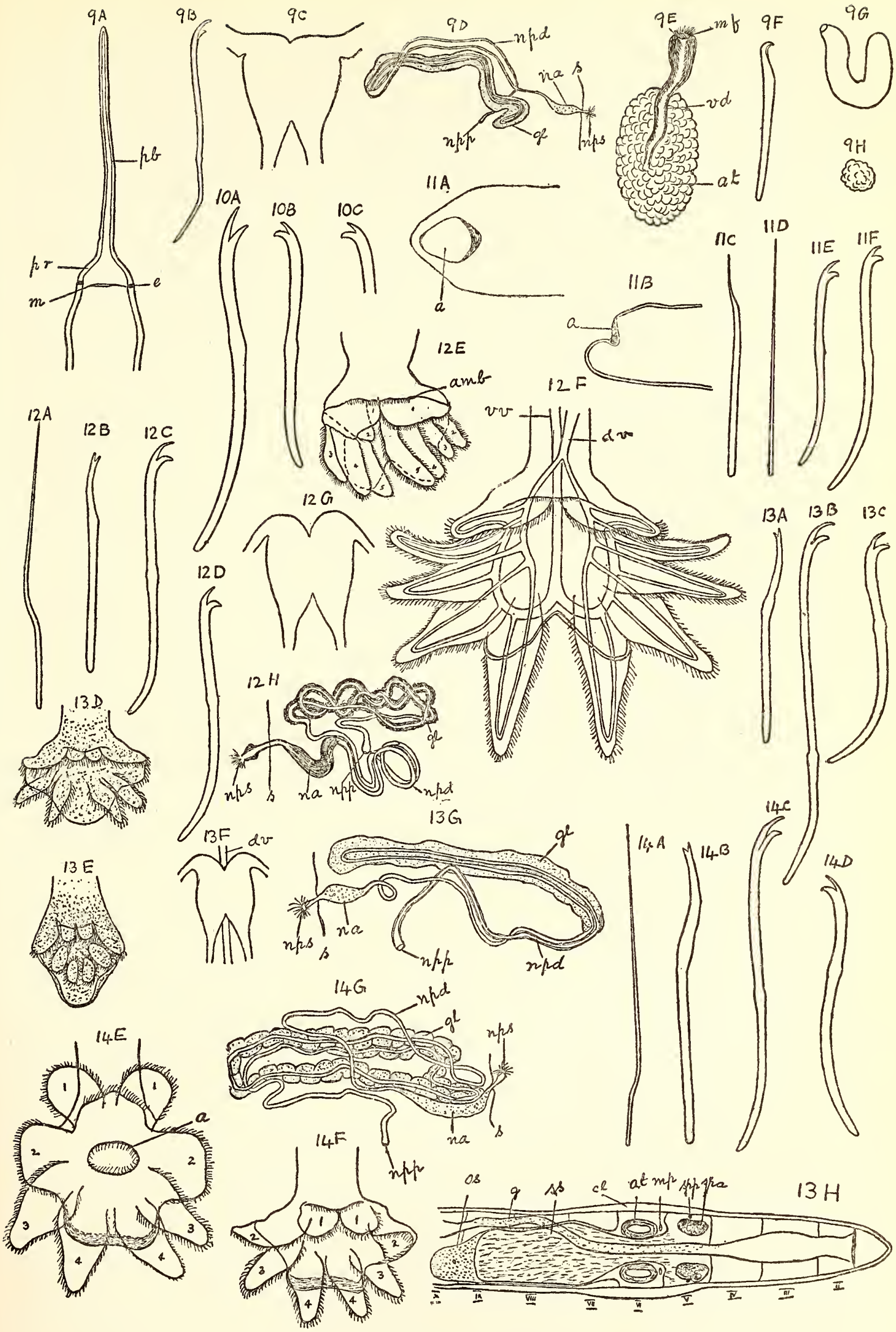
Length of setae in μ and position of nodulus in the ratio D : P : :

	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

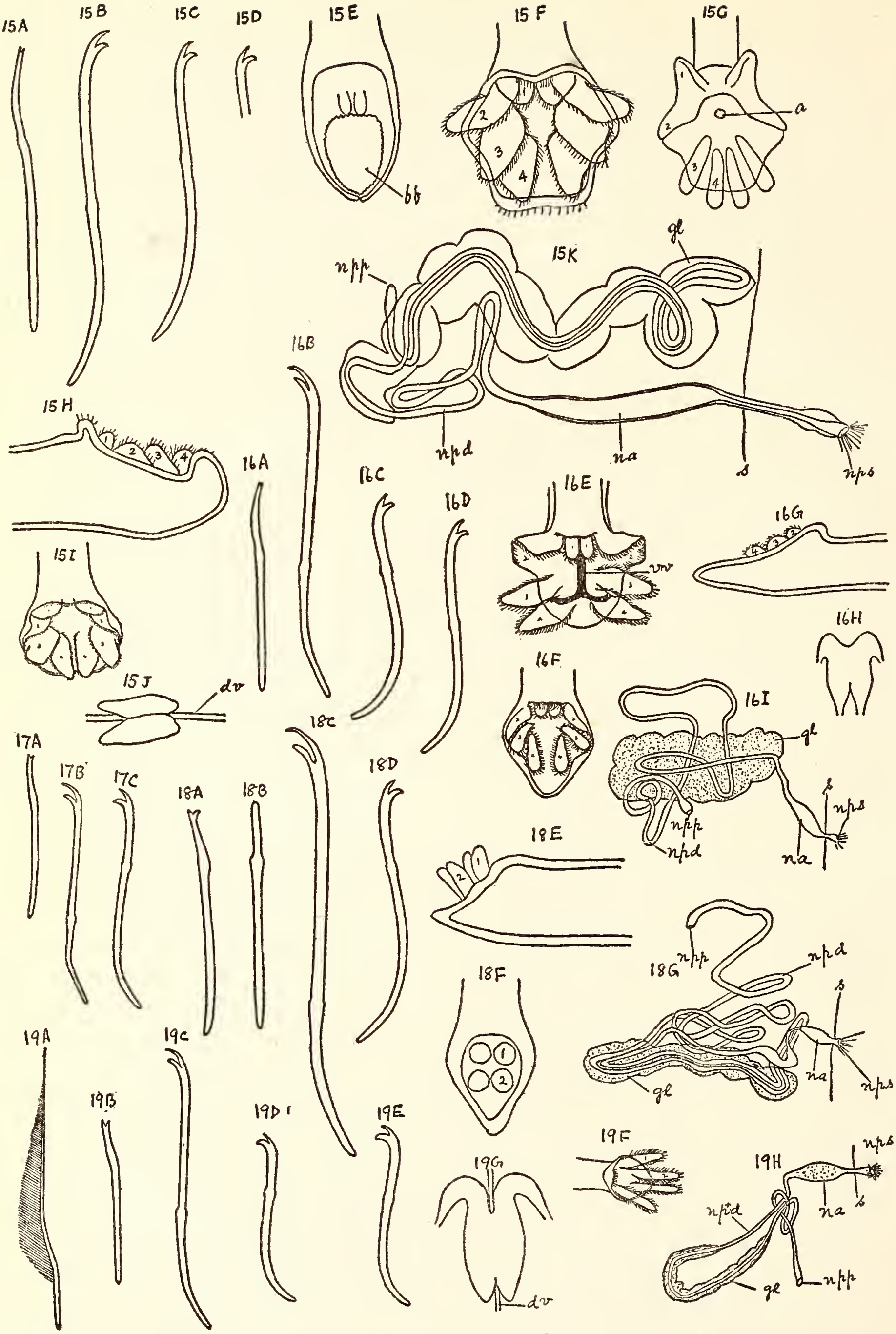
Type : The type specimen is being deposited with the Zoological Survey of India, Calcutta.

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]

CONTENTS

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. 589, 1800, new name on Plumier M.S. (genotype, *Mugil cephalus* Linnaeus).

Arnion Gistel, Naturgeschichte des Thierreichs, p. 10, 1848, substitute name for *Mugil* (genotype, *Mugil cephalus* Linnaeus).

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 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).

---

[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.

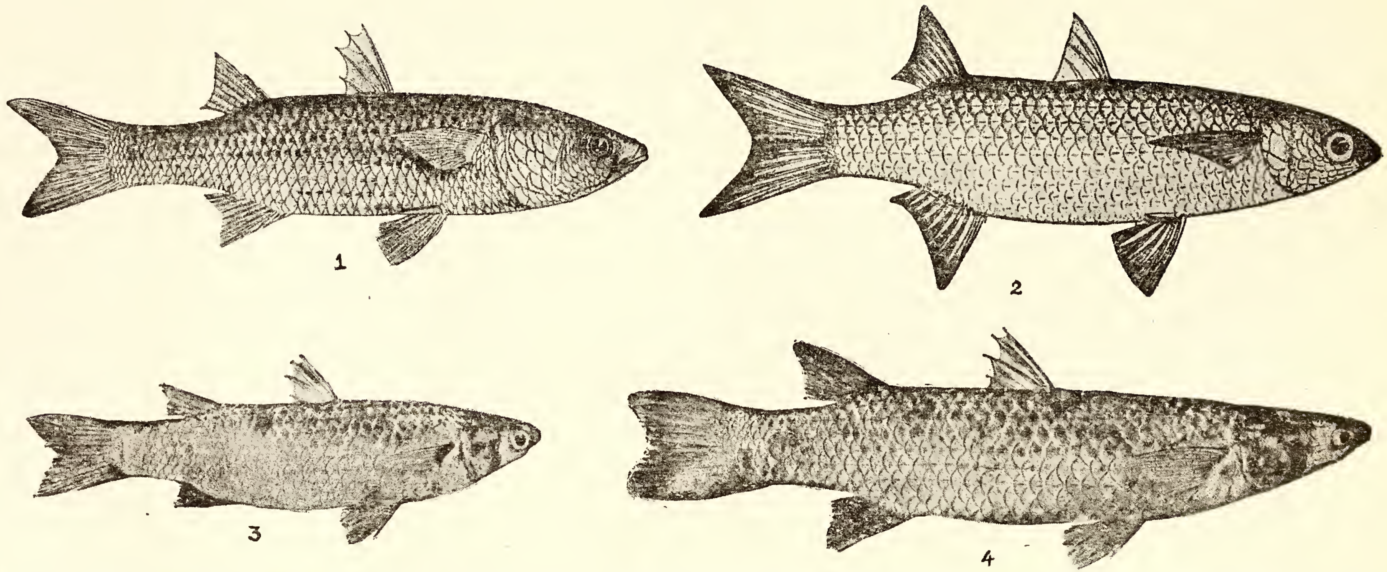
Outside India its distribution is restricted to the Indo-Pacific area, where it occurs in the sea and brackish waters in Indonesia, Philippines, Thailand, Hong Kong, New Guinea, Guam, Australia, Ceylon, and Karachi.

The maximum size attained by this species is about 33 cm.

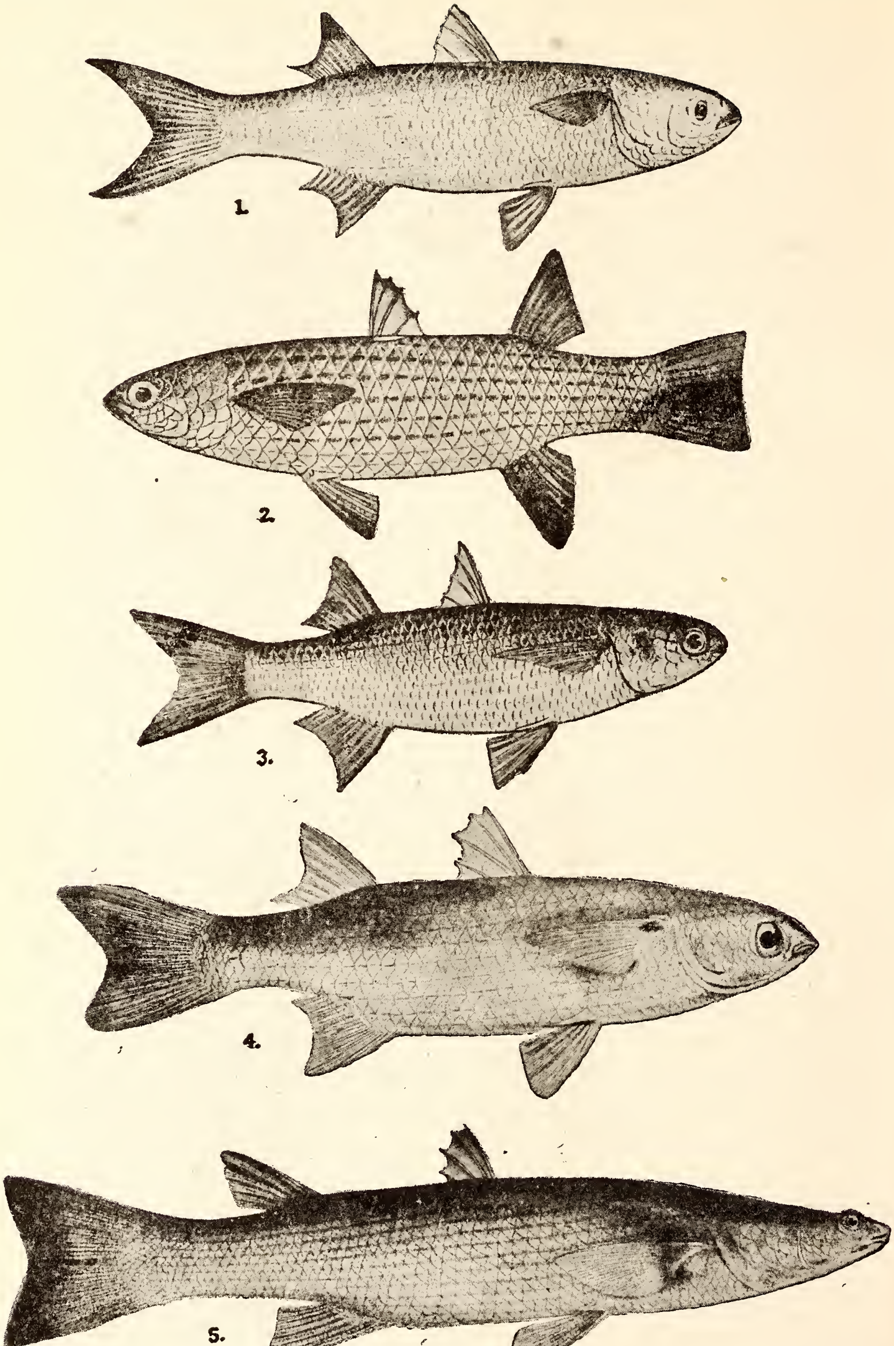
(4) **Mugil tade** Forskål

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 suppositus 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. I. 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.

Acknowledgements

My grateful thanks are due to the late Dr. S. L. Hora for facilities to study the mullet collections in the Zoological Survey of India and for critical perusal of the manuscript and to Dr. H. S. Rao, and Dr. L. P. Schultz (of the U. S. National Museum) for reading through the manuscript and offering their criticisms on it. I am indebted to Dr. N. K. Panikkar and Dr. T. V. R. Pillay for making available freshly preserved specimens of some of the species dealt with in this paper.

References

Bleeker, P. (1853) : Nalezingenop de ichthyologische fauna Von Bengalen Hindustan. *Vorh. Batavia Genoot.* **25** : 1-164.

Chaudhuri, B. L. (1917) : Fauna of the Chilka Lake—Fish, Part III. *Mem. Indian Mus.* **5** (6) : 491-508.

Cuvier, G. & Valenciennes, A. (1836): Histoire Naturelle des Poissons Vol. XI.

Day, F. (1865) : Fishes of Malabar. London.

—— (1870) : Remarks on some of the fishes in the Calcutta Museum. On the freshwater fishes of Burma, pt. 1. *Proc. Zool. Soc. Lond.* 1869 : 511-727, 548-560.

—— (1888) : Fishes of India, 2 Vols. London.

—— (1889) : Fauna of British India, Fishes, 2 vols. London.

Devasundaram, P. (1951) : Systematics of Chilka mullets with a key for their identification. *J. Zool. Soc. India* **3** : 9-29.

Fowler, H. W. (1928) : The fishes of Oceania. *Mem. Bishop Mus., Honolulu* No. 10.

—— (1929) : Further notes and descriptions of Bombay shore fishes. *J. Bombay nat. Hist. Soc.* **33** : 100-109.

—— (1939) : A small collection of fishes from Burma. *Notul. Nat. Acad. Philad.* **17**.

Günther, A. (1861) : Catalogue of Acanthopterygian Fishes in the British Museum. Vol. III.

Hamilton, F. (1822) : An account of the fishes found in the river Ganges and its branches. London.

Herre, A.W.C.T. (1941): Fishes from the Andaman Islands. *Mem. Indian Mus.* **13**: 331-403.

—— (1953): Checklist of Philippine fishes. *U. S. Fish and Wildlife Service Res. Rept.*: 20.

Hora, S. L. (1923): Fauna of the Chilka Lake—Fish, Part V. *Mem. Indian Mus.* **5** (11): 739-69.

Jacot, A. P. (1920): Age, growth and scale characters of the mullet *Mugil cephalus* and *Mugil curema*. *Trans. Amer. Mic. Soc.* **39**: 199-229.

John, C. M. (1955): The grey mullets of Kayamkulam Lake, India, and their fishery. *Copeia* **3**: 225-30.

Jordan, D. S. & Seale, A. (1906): The fishes of Samoa. *Bull. U. S. Bur. Fish.* **25**: 175-455.

—— & Swain, J. (1885): A review of the American species of marine Mugilidae. *Proc. U. S. Nat. Mus.* **7**: 261-75.

Oshima, M. (1922): A review of the fishes of the family Mugilidae found in the waters of Formosa. *Ann. Carneg. Mus.* **13**: 240-59.

Pellegrin, J. (1898): Contribution a l'etude ichthyologique de iles Mariannes, d'apres les envois de M. Marche. *Bull. Mus. Hist. Nat., Paris.* **4**: 228-29.

Pillay, T.V.R. (1951): Structure and development of the scales of five species of grey mullets of Bengal. *Proc. nat. Inst. Sci. India* **17** (6): 413-24.

—— (1953): *Mugil poecilus* Day, same as *Mugil troscheli* Bleeker. *J. Bombay nat. Hist. Soc.* **51** (2): 378-383.

—— (1954): The biology of the grey mullet *Mugil tade* Forskål, with notes on its fishery in Bengal. *Proc. nat. Inst. Sci. India* **20**: 187-217.

Roxas, H. A. (1934): A review of Philippine Mugilidae. *Philipp. J. Sci.* **54**: 393-431.

Russel, P. (1803): Descriptions and figures of two hundred fishes collected at Vizagapatam on the coast of Coromandel. Vol. 2. London.

Sarojini, K. K. (1953): *Mugil dussumieri* Valenciennes as a synonym of *Mugil parsia* Hamilton—A biometric study. *Proc. nat. Inst. Sci. India* **19**: 437-45.

—— (1957): Biology and fisheries of the Grey Mullets of Bengal—1. Biology of *Mugil parsia* Hamilton with notes on its fishery in Bengal. *Indian J. Fish.* **4**: 160-207.

Schultz, L. P. (1946): A revision of the genera of mullets, fishes of the family Mugilidae, with descriptions of three new genera. *Proc. U. S. Nat. Mus.* **96**: 377-95.

—— (1953): Fishes of the Marshall and Marianas Islands. *Bull. Smith. Inst. U. S. Nat. Mus.* 202. Vol. 1.

Smith, J. L. B. (1935): The fishes of the family Mugilidae in South Africa. *Ann. S. Afr. Mus.* **30** (19): 587-644.

—— (1948): A generic revision of the mugilid fishes of South Africa. *Ann. Mag. Nat. Hist.* (11) **14**: 833-43.

Thomson, J.M. (1954): The Mugilidae of Australia and adjacent seas. *Austr. J. Mar. Freshw. Res.* **5** (1): 70-131.

Weber, M. & de Beaufort, L. F. (1922): The fishes of the Indo-Australian Archipelago. Vol. 4. Leiden.

Whitehouse, R. H. (1922): The grey mullets of Tuticorin. *Madras Fish. Bull.* **15**: 71-98.

Whitley, C. P. (1930): Five new generic names for Australian fishes. *Aust. Zool.* **6** (3): 250-51.

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	σ d	t	P
Total 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_1 Standard length .. Snout to D_2	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

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 / Height of body	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 / Diameter of orbit	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 eye	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 / Height of head	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 / Width 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 / Inter-orbital distance	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 / Length of pectoral fin	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 caudal peduncle	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 / Least height 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 / Length of caudal fin			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 / Snout to D_1	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_2	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 pelvic fin	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 anal 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

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.

---

[1]Communicated by the Dean, Agricultural College and Research Institute, Coimbatore.

Distribution

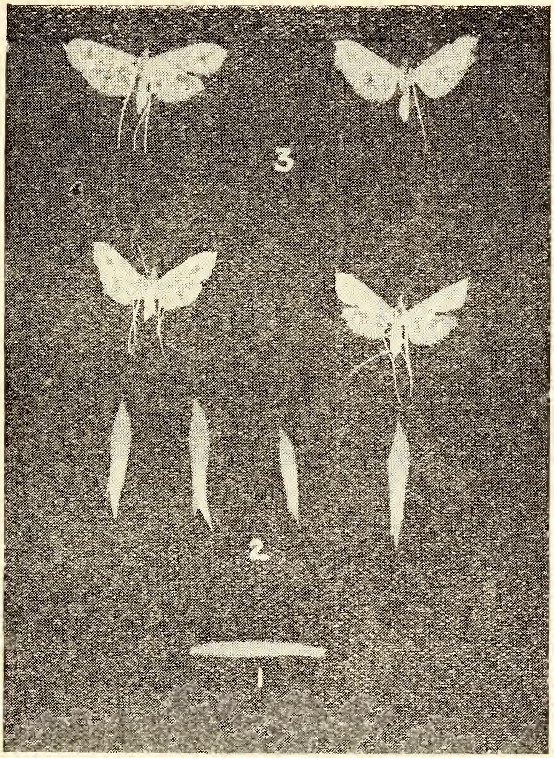
The range of occurrence of the insect given by Hampson (1896), includes west Africa, the whole of India, Ceylon, Burma, Java, Formosa, China, and Australia. In India the localities where it had been collected are not given. So far as south India is concerned, the collection of insects in the Agricultural 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.

References

David, S. Kanakaraj (1958): Insects and mites affecting Jasmine in the Madras State. *Madras agric. J.* **45** (4): 146-150.

Hampson, G. F. (1896): Fauna of British India, Moths **4**: 367.

Ramachandra Rao, Y. (1930): Control of the Jasmine bug (Antestia) by cyanogas. *Madras agric. J.* **18** (1): 2-5.

Ramakrishna Ayyar, T. V. (1940): Handbook of Economic Entomology: 368.

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

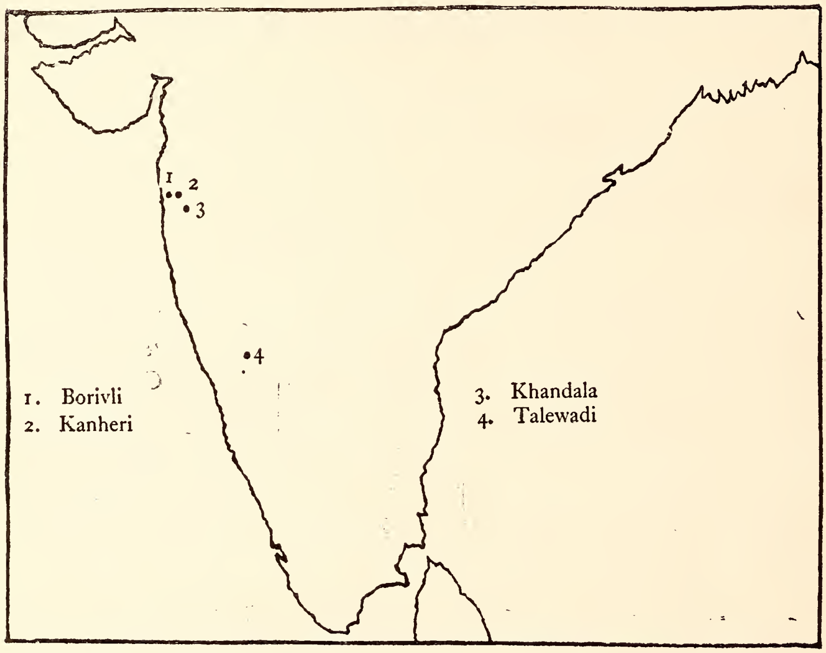
Unmistakable. The size of the forearm and the shape of the nasal leaflets easily separate *Megaderma spasma* from the closely allied species *Megaderma lyra*.

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

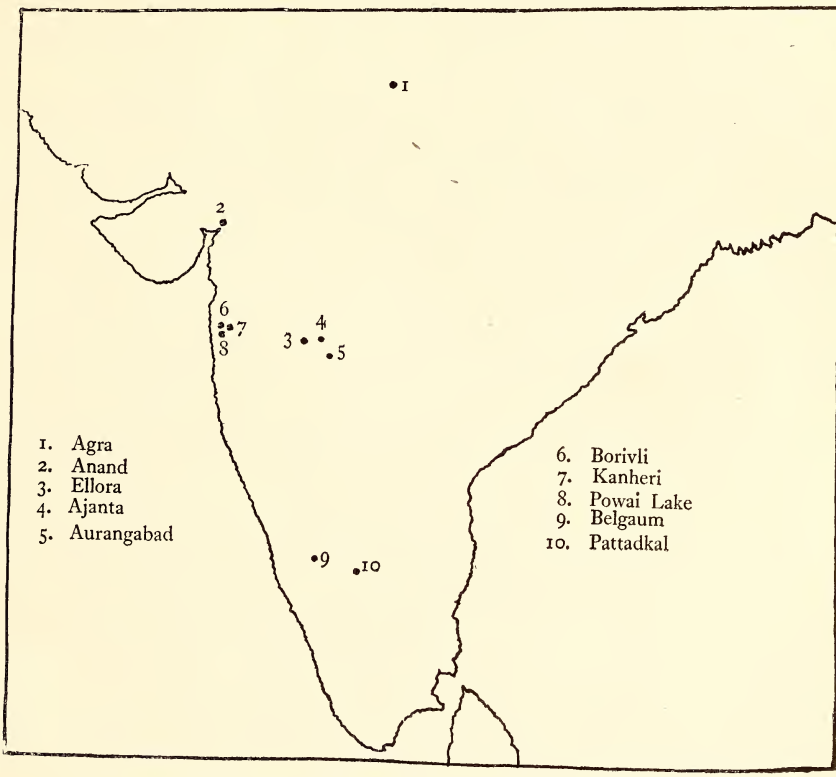
India are *lyra lyra* and the subspecies *caurina* has therefore to be struck off the checklist of Indian bats. (See preceding Table of Measurements.)

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

S e x u a l o r g a n s . 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).

---

[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.

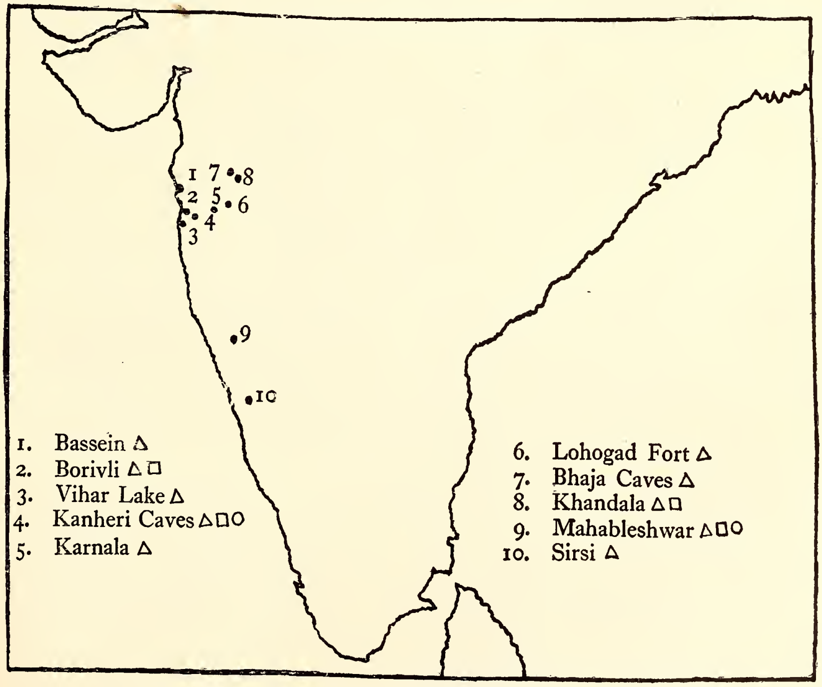
Intermediate individuals, red-brown, have been seen in several places. All the young are dull grey.

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
	1st Phalange	12	11	11	12	12	12	11
	2nd Phalange	17	18	17	17	17	18	17
4th finger	Metacarpal	28	31	29	30	31	30	29
	1st Phalange	9	8	9	9	9	9	9
	2nd Phalange	11	11	9	11	10	10	9
5th finger	Metacarpal	28	30	29	30	31	30	29
	1st Phalange	9	10	9	11	10	10	9
	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

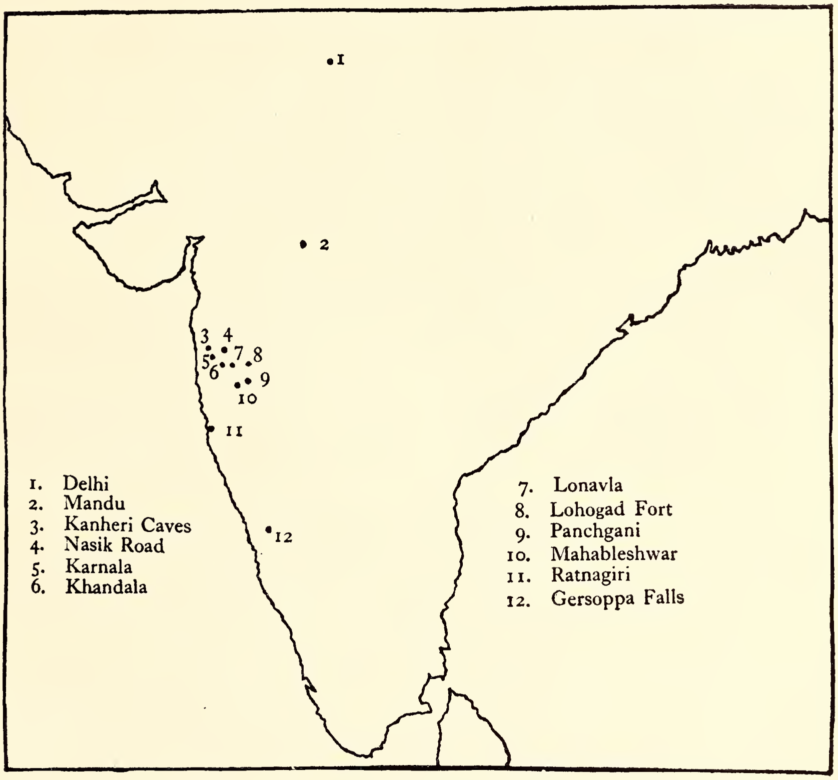
Similar to the preceding species, but much smaller. At close quarters the shape of the nasal leaflets is different. This bat also possesses several types of coloration: a grey-brown type, a fawn colour type, and a pale grey type. The pale grey type of specimen is normal from the dry part of northern 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
	1st Phalange	21	23	22	22	25	25	25	24
	2nd Phalange	35	32	31	33	38	36	35	35
4th finger	Metacarpal	45	45	40	44	44	44	44	45
	1st Phalange	12	12	12	12	16	14	14	14
	2nd Phalange	22	23	22	23	23	22	22	20
5th finger	Metacarpal	44	46	47	43	50	49	50	45
	1st Phalange	12	13	11	12	14	13	14	14
	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.

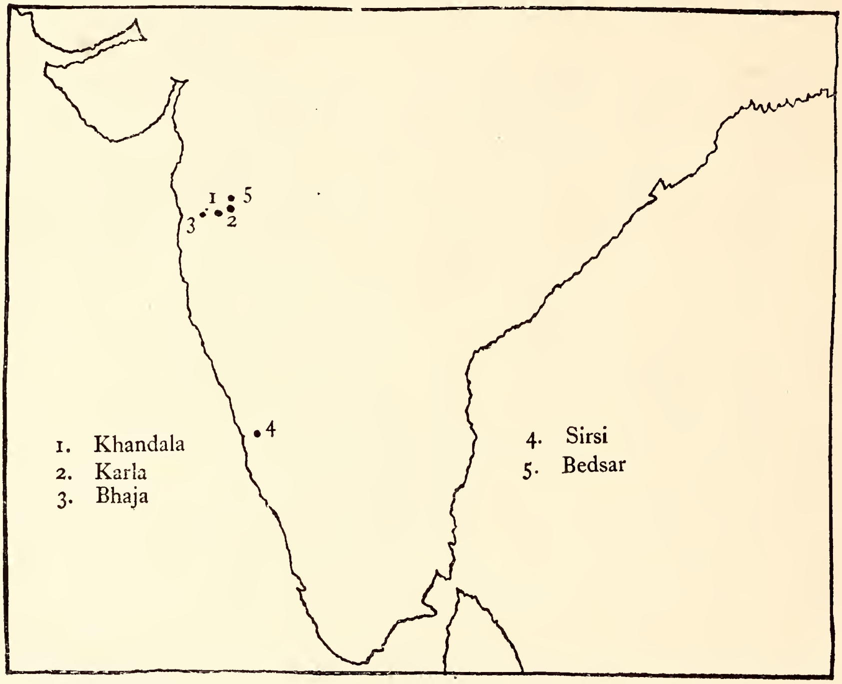
Several good subspecies are known. The race *beddomei* characterized by its relatively small size inhabits the mountain ranges of western and south India, and Ceylon.

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

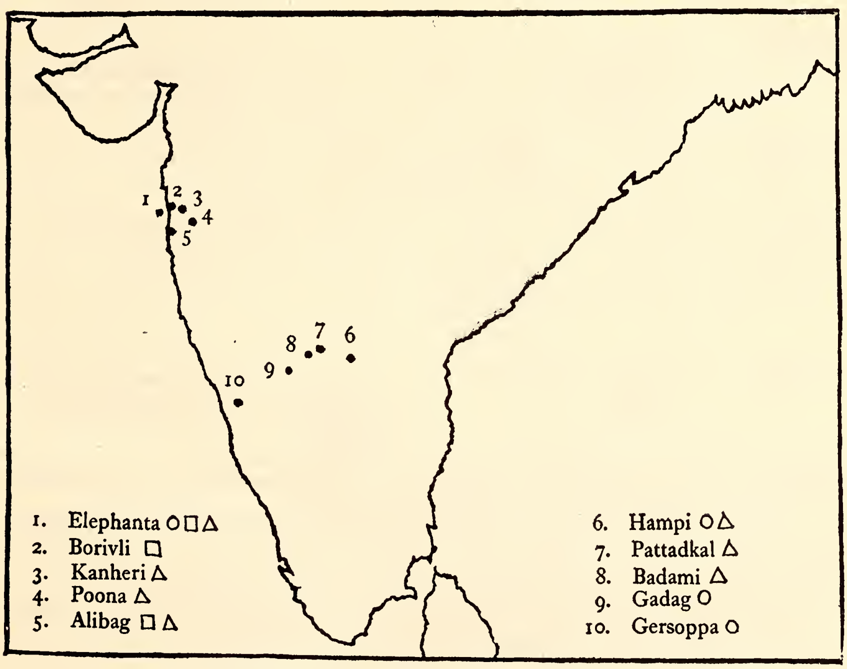
A grey type—the colour of the young and immature individuals.

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
	1st Phalange	18	18	18	17	18	18	17
	2nd Phalange	20	20	20	20	20	20	20
4th finger	Metacarpal	31	30	29	32	32	32	30
	1st Phalange	13	12	12	13	12	13	13
	2nd Phalange	12	11	10	10	11	11	11
5th finger	Metacarpal	32	30	29	32	32	32	31
	1st Phalange	14	14	14	14	14	14	14
	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 :

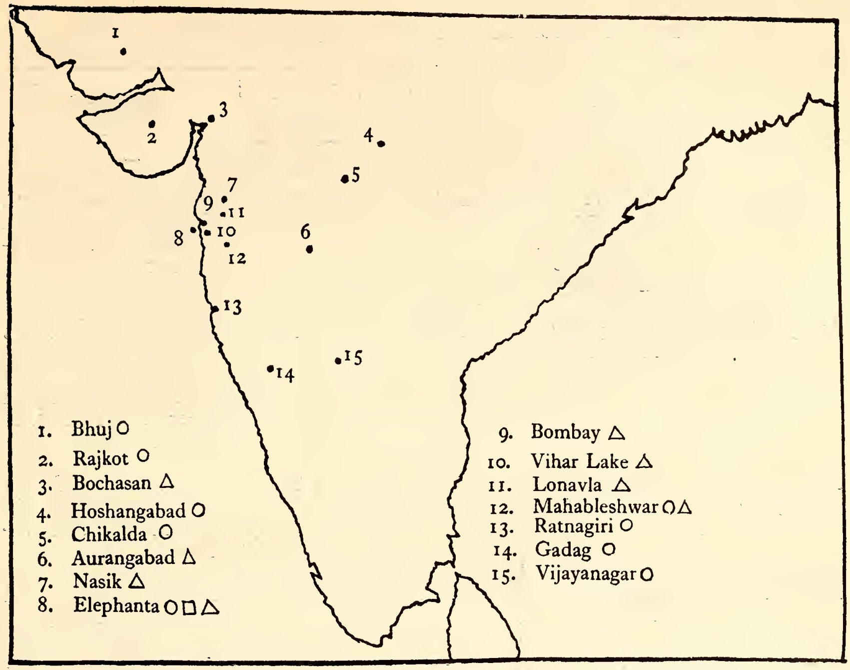
	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Aurangabad ♂	19	9.5	12	7	8

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.

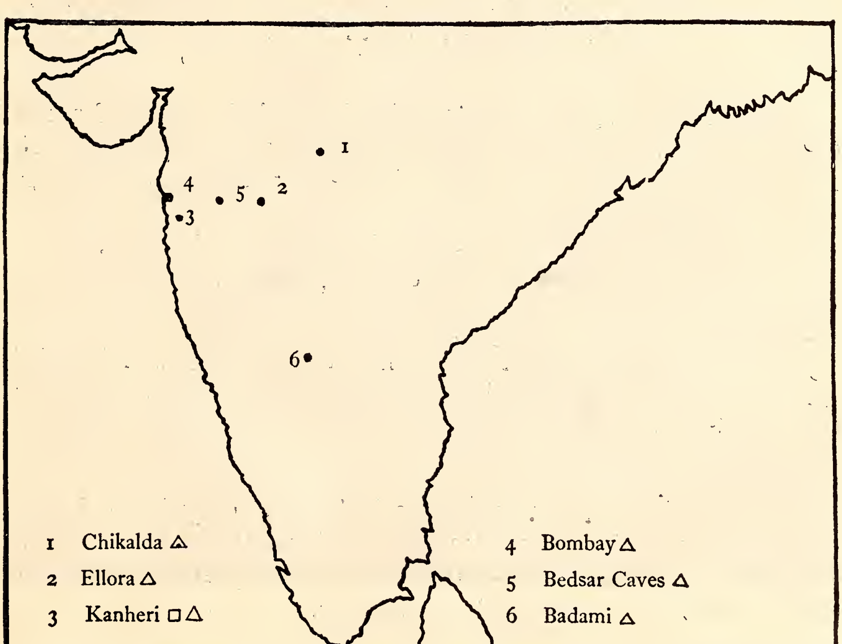
The former type inhabits the humid area of Konkan, and the latter the dry area of the Deccan and Mysore (Chikalda, Badami).

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
	1st Phalange	27	27	27	30	26	26	26	25
	2nd Phalange	25	25	28	29	25	25	26	25
4th finger	Metacarpal	52	52	55	55	55	55	56	56
	1st Phalange	20	20	20	20	20	21	20	20
	2nd Phalange	15	15	13	14	13	13	13	15
5th finger	Metacarpal	49	48	52	52	48	51	50	49
	1st Phalange	22	21	21	21	20	21	20	20
	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.

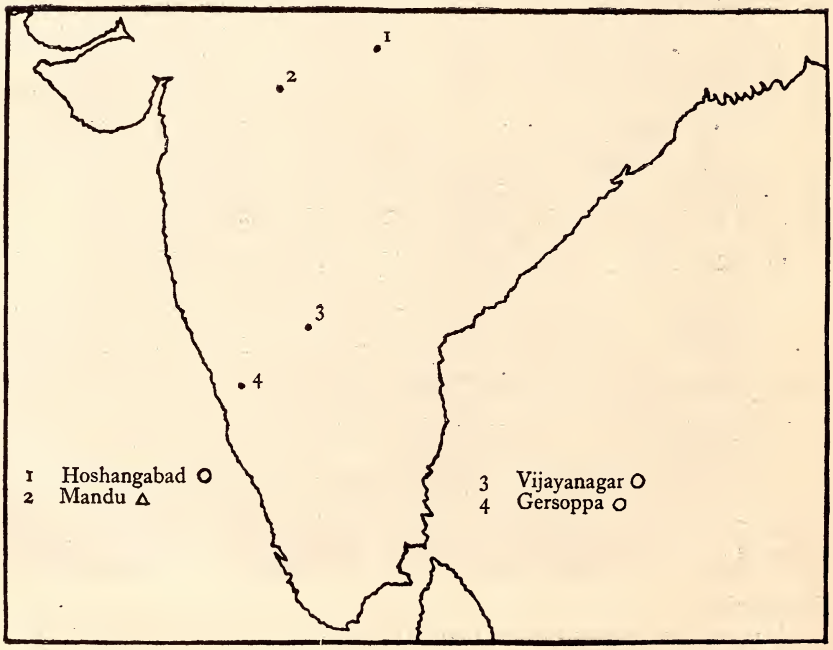
A creamy type. Very pale. This rare type of coloration has been observed in a few individuals in Mandu.

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 *Motacilla* 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, HUGH ALLEN
Piparia, M.P.,
August 6, 1962.

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, E. P. GEE
April 30, 1962.

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., TUN YIN
RANGOON, BURMA,
July 24, 1962.

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, EDITORS
BOMBAY 6,
July 10, 1962.

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, JULIAN P. DONAHUE
June 21, 1962.

REFERENCES

Allred, B. W. (1950): Practical Grassland Management. Interstate Printers and Publishers, Inc., Danville, Illinois. 285 pp.

Bombay Natural History Society (undated): Breeding Waterbird Sanctuary: Keoladeo Ghana, Bharatpur. Bombay. 28 pp.

Chapline, W. R. & C. K. Cooperrider (1941): Climate and grazing. Climate and Man: 1941 Yearbook of Agriculture. United States Department of Agriculture: 459-476. Washington, D. C.

Odum, Eugene P, (1959): Fundamentals of Ecology, 2nd ed. W. B. Saunders Company, Philadelphia. 546 pp.

Oosting, Henry J. (1958): The Study of Plant Communities, 2nd ed. W. H. Freeman and Company, San Francisco. 440 pp.

Sampson, Arthur W. (1959): Range Management—Principles and Practices. John Wiley & Sons, Inc., New York. 570 pp.

Sharma, Y.M.L. (1959): Lessons in Forestry. Indian Council of Agricultural Research, New Delhi. 186 pp.

United States Department of Agriculture (1948): Grass: The 1948 Yearbook of Agriculture. Washington, D. C. 892 pp.

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, A. NAVARRO, S.J.
July 28, 1962.

[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 'Boatswainbird', *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, EDITORS
BOMBAY 6,
June 30, 1962.

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

---

[1] See P. W. Gideon *et al.*, (1957) : On the Marine Fauna of the Gulf of Kutch. A Preliminary Survey. *J. Bombay nat. Hist. Soc.* **54** (3): 690-706.

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,
AHWA, VIA BILIMORA,
DANGS DISTRICT, GUJARAT STATE,
July 25, 1962.

ERNEST M. SHULL

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., M. C. A. JACKSON
KERALA STATE, SOUTH INDIA,
March 24, 1962.

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.

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, Dzhambul, 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

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, Dzhambul, region, Kazakh SSR, *c.* 43° 03′ N. × 74° 43′ E.	Reported by the Bird Ringing Centre, USSR Academy of Sciences, Moscow, USSR. 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.
Bombay A-12039	*Passer hispaniolensis transcaspicus*	3-4-1962* ad. ♂.	do.	29th May 1952	do.	

* 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

N a r b a d a R i v e r. 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 $1\frac{1}{2}$ 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

Jingran, V.G. & Chakraborty, R.D. (1958): Destruction of major carp fingerlings in a section of river Ganga and its probable adverse effect on fish production. *Indian J. Fish.* **5**: 291-9.

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

Day, Francis (1878): The Fishes of India. London

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.

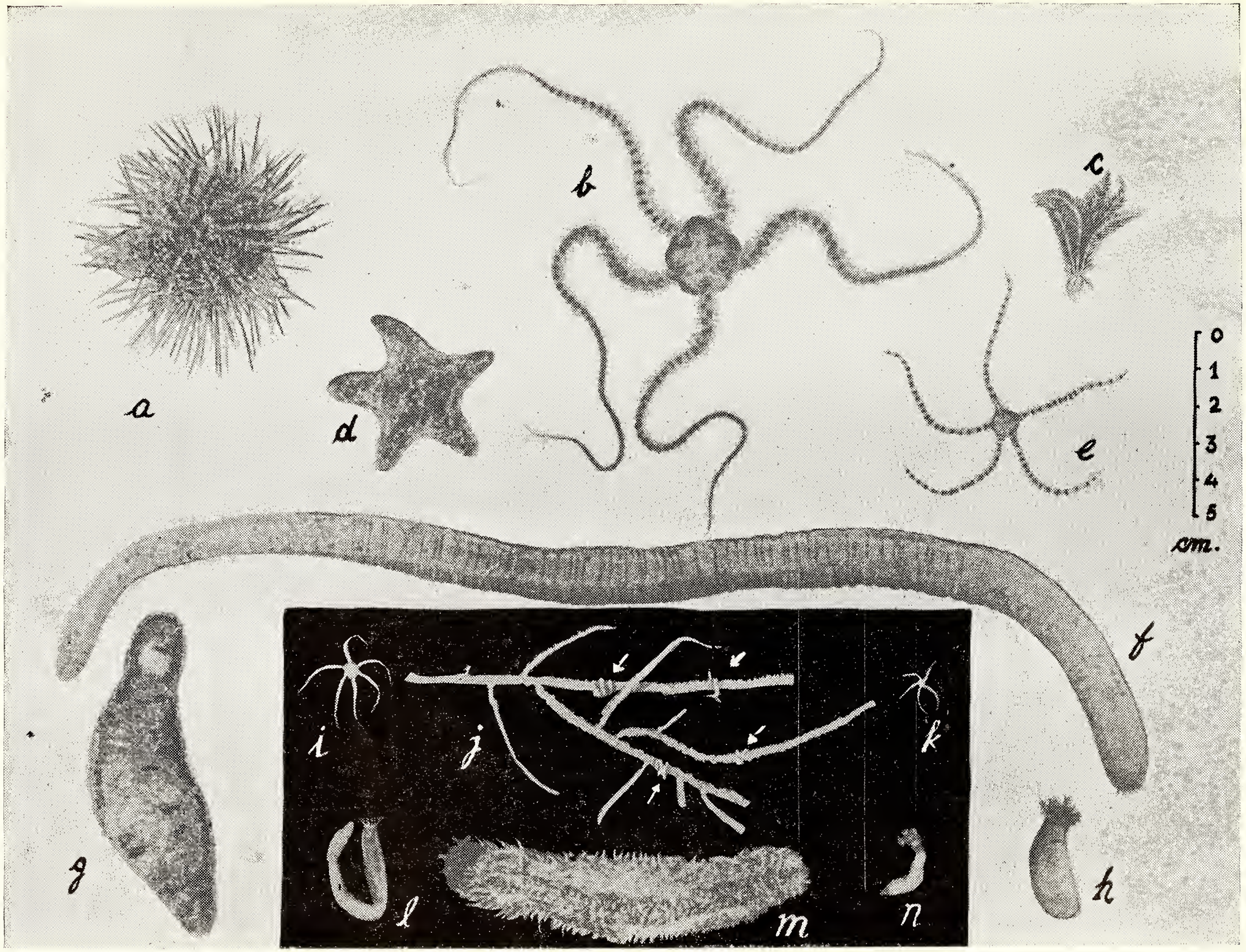
Collections were confined to the inter-tidal zone at various parts along the foreshore in Greater Bombay, viz. Cuffe Parade, Chowpatty, Worli, Mahim, Danda, and Versova. They were also extended to Manori which, although not within the limits of Greater Bombay, was included as it harbours large numbers 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*

---

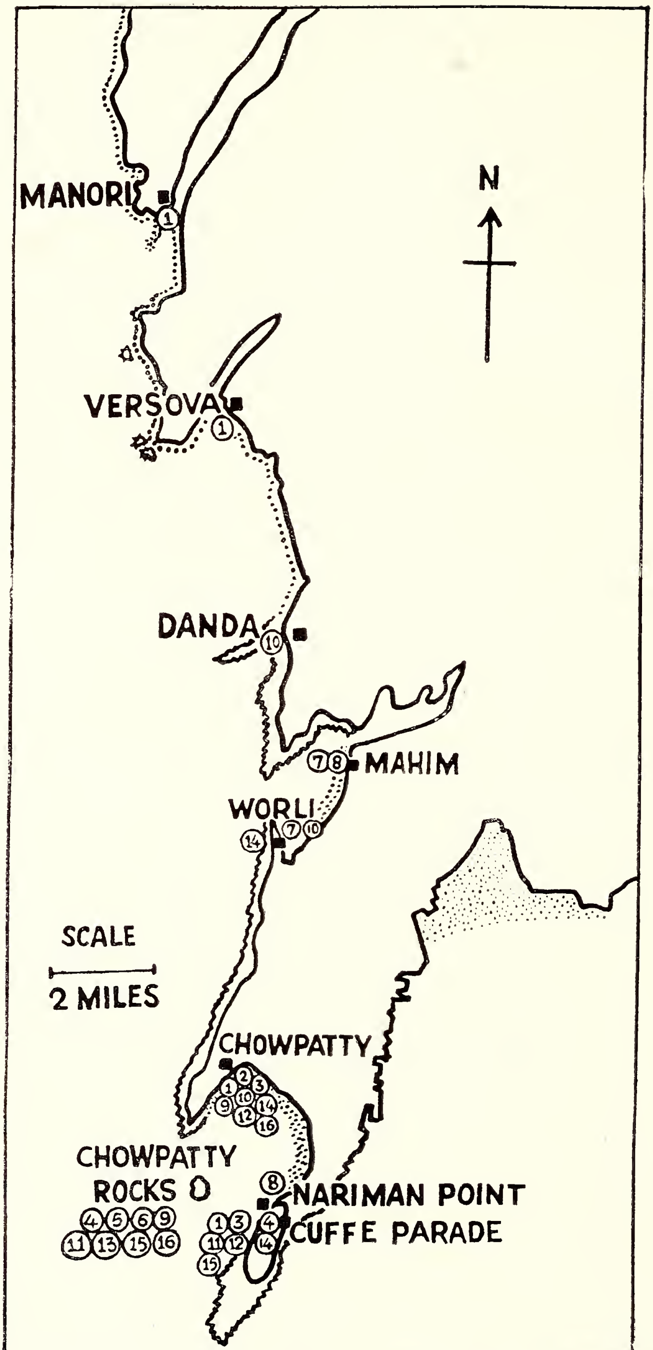
[1] The Echinodermata are characterized by radial symmetry, a calcareous exoskeleton in the form of plates or spicules usually beset with tubercles or spines, which give the phylum its name. Locomotion is by tube-feet. They are marine forms without exception, and none are colonial. They comprise the 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

References

Anderson, A. R. S. (1894): Natural History Notes from H. M. Indian Marine Steamer 'Investigator'. Ser. ii, No. 16. On the Echinoidea collected during the season 1893-94. *Journ. As. Soc. Bengal* (2) **63** : 188-195.

Bell, F. J. (1888*a*): On the Echinodermata of the sea of Bengal. *Rep. Brit. Asscn.*: 718.

—————— (1888*b*): Report on a collection of Echinoderms made at Tuticorin, Madras, by Mr. Edgar Thurston, C.M.Z.S., Superintendent, Government Central Museum, Madras. *Proc. Zool. Soc. London* : 383-389.

Clark, A. H. (1909): New recent Indian crinoids. *Proc. Biol. Soc. Washington* **22** : 143-151.

—————— (1912*a*): The Crinoids of the Indian Ocean. *Echinoderma of the Indian Museum*, part VII : 1-325.

—————— (1912*b*): On a small collection of recent Crinoids from the Indian Ocean. *Rec. Indian Mus.* **7** : 267-271.

Clark, A. H. (1932): On a collection of Crinoids from the Indian Ocean and Bay of Bengal. ibid. 551-556, pls. xix-xx.

Gravely, F. H. (1927): The littoral fauna of Krusadai Island in the Gulf of Manaar, with appendices on the vertebrates and plants. *Bull. Madras Govt. Mus.* (*nat. hist. section*) (1) **1** : 163-173.

Koehler, A. & Vaney, C. (1908): An account of the littoral Holothuroidea collected by the R.I.M.S.S. 'Investigator'. *Echinoderma of the Indian Museum*, part IV : 1-54, pls. i-iii.

Koehler, R. (1898): Echinodermes recueillis par l'Investigator dans l'Ocean Indien. Mém. 2. Les ophiures littorales. *Bull. Scient. France Belgique* 31.

—————— (1900): Illustrations of the shallow-water Ophiuroidea collected by the R.I.M.S.S. 'Investigator' *Echinoderma of the Indian Museum* part II : 1-4, pls. xv-xxi.

—————— (1910): Astéries du musée de Calcutta. II. Les astéries littorales. ibid., part VI : 1-191, pls. i-xx.

Koehler, R. (1914): Échinides du musée a Calcutta. I. Spatangidés. *Echinoderma of the Indian Museum,* part VIII : 1-258, pls. i-xx.

——— (1922): ibid. II. Clypeastridés et Cassidulidés. ibid., part IX : 1-161, pls. i-xv.

——— (1927): ibid. III. Echinides réguliers. ibid., part X: 1-158, pls. i-xxvii.

Kurian, C.V. (1953): A preliminary survey of the bottom fauna and bottom deposits of the Travancore coast within the 15-fathom line. *Proc. Nat. Inst. Sci. India* (6) **19** : 747-775.

Patil, A.M. (1953): Study of the marine fauna of the Karwar coast and the neighbouring islands. Part IV. Echinodermata and other groups. *J. Bombay nat. Hist. Soc.* **51** : 429-434.

Thurston, E. (1887): Preliminary report on the marine fauna of Rameswaram and the neighbouring islands. *Govt. Central Mus., Madras, Science Ser.*, No. 1: 1-41, 6 pls.

——— (1895): Rameswaram Island and fauna of the Gulf of Manaar. 2nd Ed. *Bull. Madras Govt. Mus.* No. 3.

Wood-Mason, J. & Alcock, A. (1891): Natural History notes from H.M. Indian Marine Survey Steamer 'Investigator', Commander R.F. Hoskyn, R.N., Commanding. No. 21, *Ann. Mag. nat. Hist.* (6) **7** : 1-19, 186-202, 258-272.

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, C. BROOKE WORTH
Trinidad, W. Indies,
July 8, 1962.

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

---

[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, CHARLES McCANN
January 16, 1961.

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,

---

[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*)

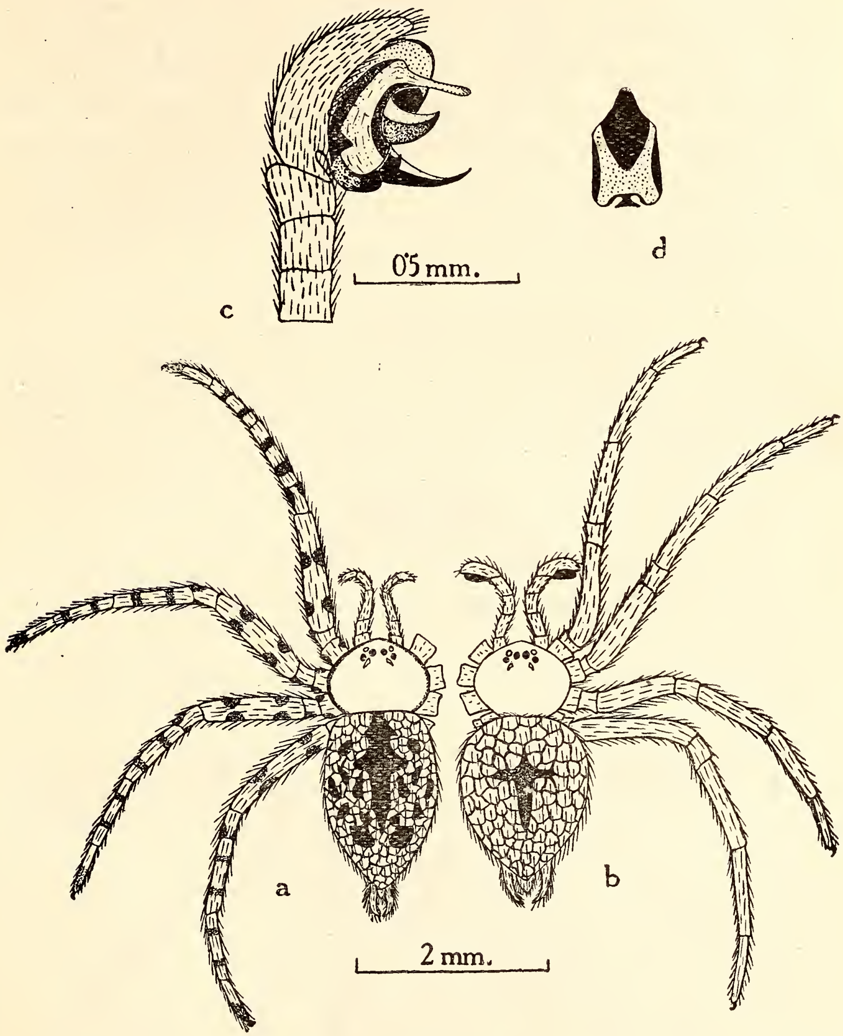
INTRODUCTION

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

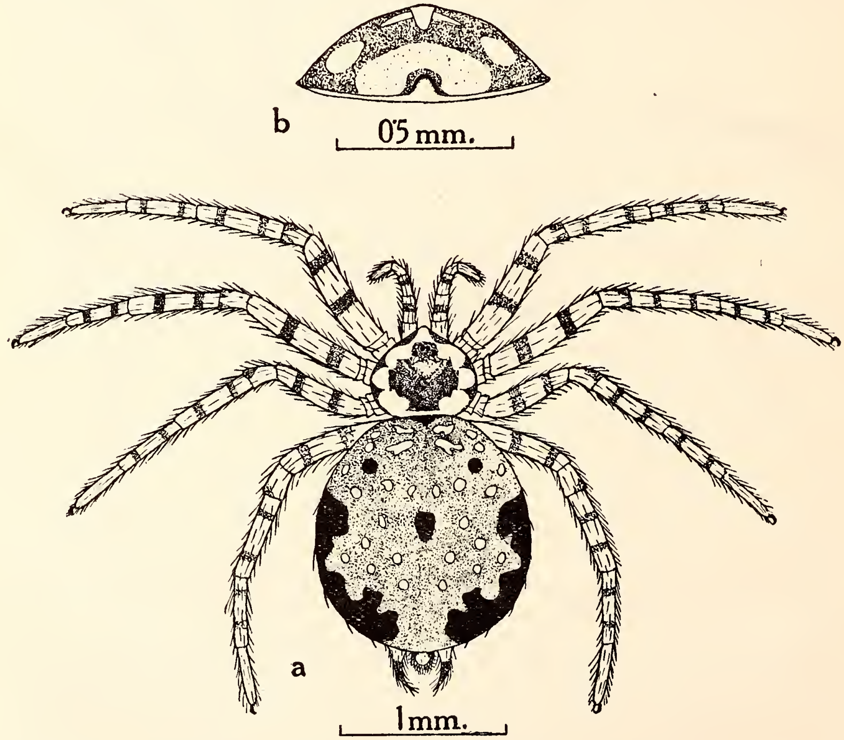
Cephalothorax: Wider than long, depressed on the centre but cephalic region slightly high and eyes group situated on the top, margin encircled by a deep brown line. Eyes unequal in size and dissimilar in form. The anterior median and posterior lateral eyes dark in colour and others pearly white; posterior 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, mid-dorsally 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

REFERENCES

Comstock, J. H. & Gertsch, W. J. (1940): The Spider Book. New York.

Dyal, (1935): *Bull. Zool. Punjab Univ.* **1**: 119-252.

Simon, E. (1892): *Histoire naturelle des Araignees*, Paris, **1**: 244-247.

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.

References

1. Birdwood, H. M. (1896) : A catalogue of the flora of Matheran and Mahableshwar. *J. Bombay nat. Hist. Soc.* **10** : 394-439.
2. Blatter, E. (1929-30) : The flowering of bamboos. ibid. **33** : 899-921, 1929; **34** : 135-141, 447-467, 1930.
3. Burkill, I. H. (1917) : The flowering of the pigeon orchid, *Dendrobium crumenatum*. *Gard. Bull. Str. Setl.* **1** : 400-405.
4. Coster, C. (1926) : Periodische Blüteneracheinungen in den Tropen. *Ann. Jard. Bot. Bitenz.* **35** : 125-162.
5. Duthie, J. F. (1890) : Periodical flowering of *Strobilanthes* spps. and of *Aechmanthera tomentosa* Nees. *J. Bombay nat. Hist. Soc.* **5** : 417-418.
6. Graham, J. (1839) : A Catalogue of Plants growing in Bombay and its Vicinity. Bombay.
7. Hutton, A. F. (1949) : Mass flowering of *Strobilanthes kunthianus* on the High Wavy Mts., in August 1948. *J. Bombay nat. Hist. Soc.* **48** : 614.
8. Robinson, M. E. (1935) : The flowering of *Strobilanthes* in 1934. ibid. **38** : 117-122, tt. 1-8.
9. Santapau, H. (1950) : The flowering of *Strobilanthes*. ibid. **49** : 320-321.
10. ——— (1951) : The Acanthaceae of Bombay. *Bot. Mem. Univ. Bombay* **2** : 38 in note.
11. ——— (1952) : The flowering of *Strobilanthes* in Khandala. IV. *J Bombay nat. Hist. Soc.* **50** : 430-431.
12. — (1960) : The flowering of *Strobilanthes*. ibid. **56**: 677, t 1.
13. ——— (1960) : The Carvi Plant. *State Trans. Rev. Bombay* **10** (11) : 38-40, t. 1.
14. Steenis, C. G. G. J. van. (1938) : Gregarious flowering of *Strobilanthes* (Acanthaceae) in Malaysia. *Ann Roy. Bot. Gard. Calcutta* 150th Anniv. Numb. pp. 91-97.
15. Talbot, W. A. (1911) : Forest Flora of the Bombay Presidency and Sind. **2** : 330.

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.

---

[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.,
May 30, 1962. K. M. VAID

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

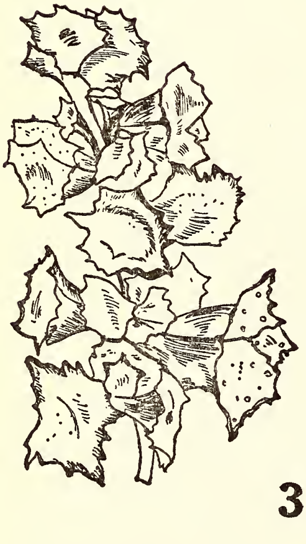
References

Beddome, R. H. (1892) : Handbook to the Ferns of British India : With Supplement. Calcutta.

Ching, R. C. (1958) : The Fern genus *Plagiogyria* on the mainland of Asia. *Acta. Phytotax. Sinica.* 7 : 108-154.

1

2



3

4

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 $\times$ 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.

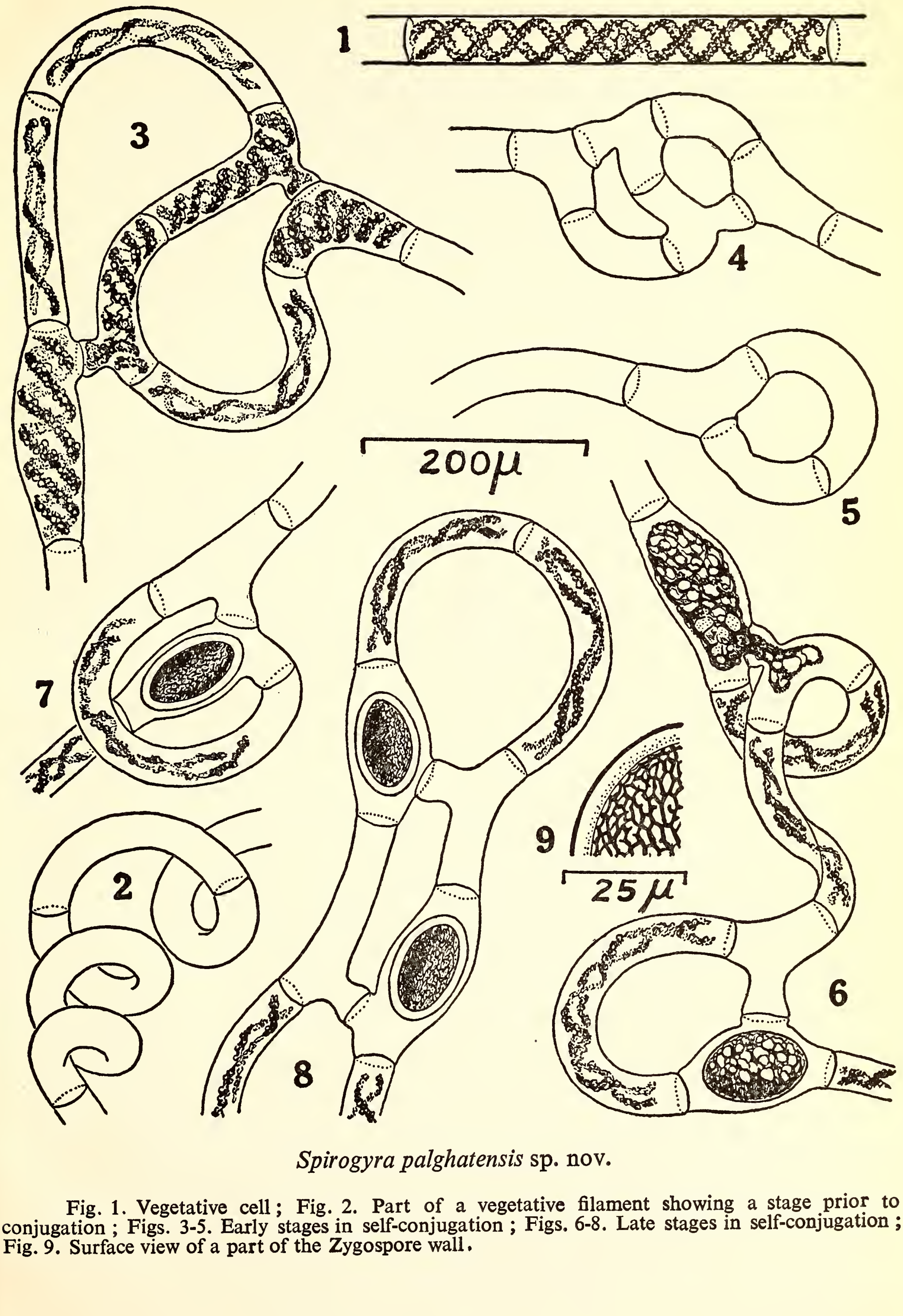
Cellulae vegetativae cylindricae, 6 plo. - 15 plo. longiores quam latae, 33 - 38.5 × 225 - 630 μ; parietes terminales plani; chloroplasta vulgo bina, raro terna, rotationes 3.5 ad 7 efficientia.

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

REFERENCES

Iyengar, M. O. P. (1940): Notes on three species of *Temnogametum* from South India. *Proc. 27th Indian Sci. Congr.* Part III (Abstract).

——— (1958a): Three New species of *Temnogametum* from South India. *Jour. Ind. Bot. Soc.* **37** : 212-215.

Randhawa, M. S. (1959): 'Zygnemaceae'—a monograph. I. C. A. R. publication.

Singh, K. P. (1958 a): Some observations on Conjugation in *Sirocladium kumaoense* Randh. *Current Sci.* **28** : 22-3.

Singh, K. P. (1958. b): Some peculiarities in conjugation in *Zygnema terrestre* Randh. *Sci. & Culture* **24** : 331-2.

Singh, R. N. (1938): The Zygnemoideae of United Provinces, India II. *Jour. Ind. Bot. Soc.* **17** : 378.

Transeau, E. N. (1934. b): The genera of the Zygnemataceae. *Trans. Amer. Micr. Soc.* **53** : 227.

——— (1951): The Zygnemataceae. Ohio State Univ. Press. Columbus.

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, HUMAYUN ABDULALI
BOMBAY 6,
July 10, 1962.

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.

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
10 CHURCH ROAD, VEPERY, MADRAS—28-11-1962. C8060
EDITORS: H. SANTAPAU & HUMAYUN ABDULALI

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. With many coloured and monochrome plates. 2nd (revised) edition. *(In preparation)*

Birds

Game Birds of India, by E. C. Stuart Baker. Vol. III. Pheasants, 1st Edition. **Rs. 20**
(*Price to Members Rs.* 15)

The Book of Indian Birds, by Sálim Ali. With 64 coloured and many monochrome plates, 6th edition, revised and enlarged. **Rs. 25**
(*Price to Members Rs.* 20)

A Synopsis of the Birds of India and Pakistan, by S. Dillon Ripley II. An up-to-date checklist of all the birds resident and migrant, including those of Nepal, Sikkim, Bhutan, and Ceylon. **Rs. 25**
(*Price to Members Rs.* 20)

Snakes

Identification of Poisonous Snakes. Wall chart in English, Gujarati, and Marathi. **Rs. 10**
(*Price to Members Rs.* 8)

Miscellaneous

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 2nd edition. Revised by W. T. Stearn. **Rs. 20**
(*Price to Members Rs.* 16)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. **Rs. 22**
(*Price to Members Rs.* 17.50)

Butterflies of the Indian Region, by M. A. Wynter-Blyth. With 27 coloured and 45 monochrome plates. **Rs. 28**
(*Price to Members Rs.* 22.50)

Indian Molluscs, by James Hornell. With 2 coloured and many monochrome plates, and text-figures. **Rs. 6**
(*Price to Members Rs.* 4.50)

Glimpses of Nature Series Booklets :

1. Our Birds I (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.80**
   Kannada **Rs. 0.62**
2. Our Birds II (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.62**
3. Our Beautiful Trees (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.62**
4. Our Monsoon Plants (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.80**
5. Our Animals (with 8 coloured plates) in English. **Rs. 1.25**

Back numbers of the Society's Journal. Rates on application.

Obtainable from :

The Honorary Secretary,
Bombay Natural History Society,
91, Walkeshwar Road, Bombay 6-WB.

Agents in England :

Messrs. Wheldon & Wesley Ltd.,
Lytton Lodge, Codicote, Nr. Hitchin,
Herts., England.

The Society will gratefully accept back numbers of the *Journal*, particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 and a life membership fee of Rs. 500.

Ordinary Members pay an entrance fee of Rs. 5 and an annual subscription of Rs. 30.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postal registration (Rs. 2.50), if required—in all Rs. 32.50—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-10-0 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 26 Bishopsgate Street, London, E.C. 2.

CONTENTS

Journal of the Bombay Natural History Society

Vol. 59, No. 3

Editors
H. SANTAPAU, S.J., & HUMAYUN ABDULALI

DECEMBER 1962

Rs. 15

NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and subspecific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri.*

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8.20×5.60 cm. (No. 2 Brownie) and on glossy glazed paper.

6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name with the abridged titles of journals or periodicals underlined (italics), and titles of books *not* underlined (roman type), thus:

Banerji, M. L. (1958): Botanical Exploration in East Nepal. *J. Bombay nat. Hist. Soc.* **55** (2) : 243-268.

Prater, S. H. (1948): The Book of Indian Animals. Bombay.

Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Banerji, 1958).

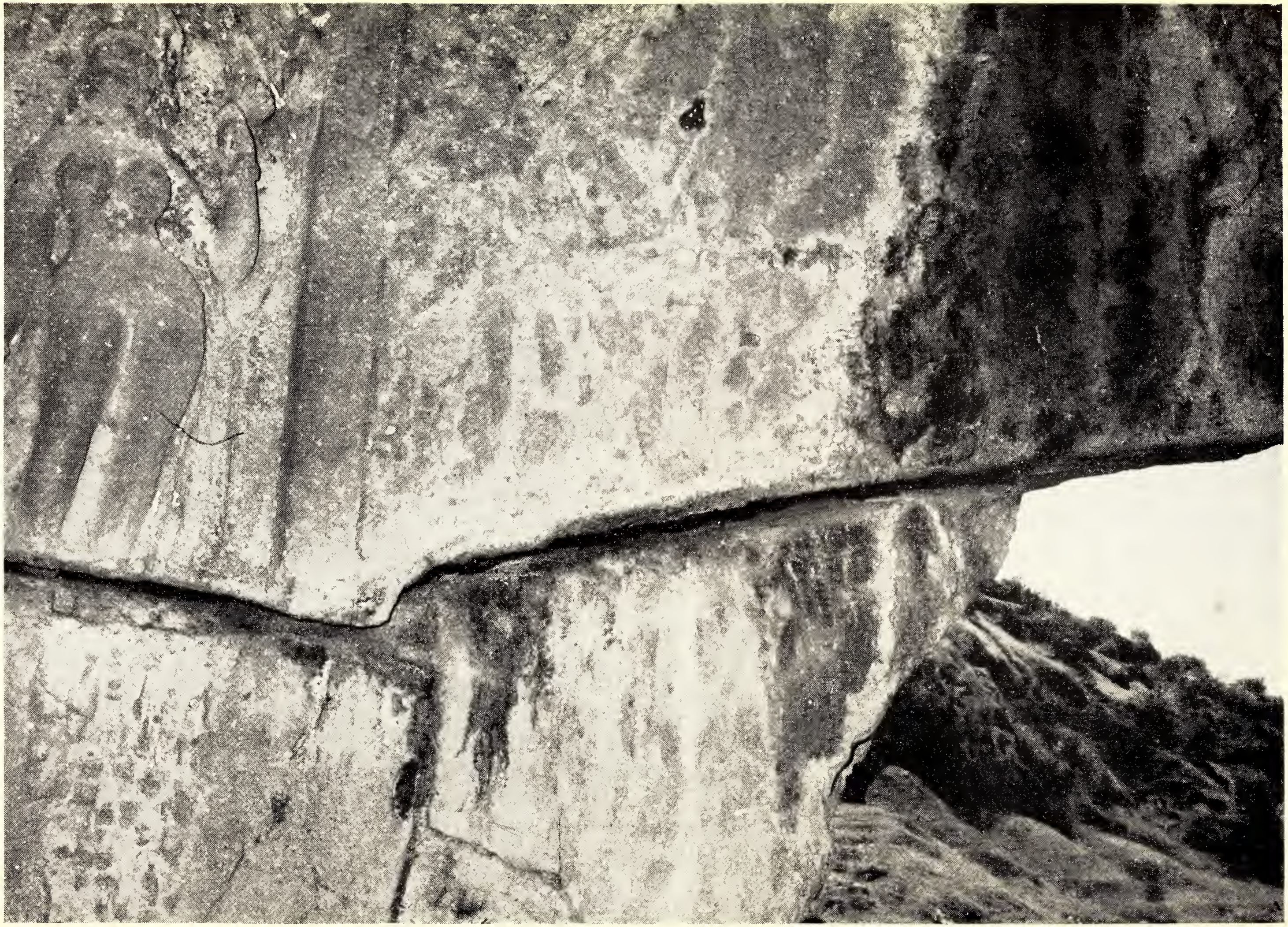
9. *Synopsis:* Each scientific paper should be accompanied by a concise, clearly written synopsis, normally not exceeding 200 words.

10. *Reprints:* Authors are supplied 25 reprints of their articles free of charge. In the case of joint authorship, 50 copies will be given gratis to be distributed among the two or more authors. Orders for additional reprints should be in multiples of 25 and should be received within two weeks after the author is informed of the acceptance of the manuscript. They will be charged for at cost plus postage and packing.

EDITORS,
Journal of the Bombay Natural History Society.

91, Walkeshwar Road.
Bombay 6-WB.

CONTENTS OF VOLUME 59, NO. 3



Typical biotope of *Tadarida aegyptiaca*. A large colony of this species inhabits these cracks. (Aurangabad, 1960)

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1962 DECEMBER Vol. 59 No. 3

The Bats of Central and Western India

PART III

BY

A. BROSSET

(*With nine maps, one text-figure, and one plate*)

[*Continued from Vol.* **59** (2): 624]

Family MOLOSSIDAE

Genus *Tadarida*

Subgenus *Tadarida*

Tadarida aegyptiaca (E. Geoffroy, 1818)

Measurements (in mm.) :

		Localities						
		Aurangabad △ ♀	Aurangabad △ ♂	Aurangabad △ ♀	Aurangabad △ ♀	Mandu △ ♂	Anand □ ♂	Anand □ ♀ juv.
	Forearm	49	47	45	46	48	52	45
	2nd Finger	44	45	42	43	46	50	41
3rd finger	Metacarpal	46	46	45	46	46	52	41
3rd finger	1st Phalange	18	18	18	19	19	20	14
3rd finger	2nd Phalange	17	17	16	18	17	24	19
4th finger	Metacarpal	46	40	41	45	44	49	41
4th finger	1st Phalange	16	16	15	15	17	18	12
4th finger	2nd Phalange	10	9	9	9	9	13	6
5th finger	Metacarpal	27	26	25	26	25	33	25
5th finger	1st Phalange	13	12	11	13	14	13	13
5th finger	2nd Phalange	8	8	8	7	8	7	5
	Tarsus	13	16	15	15	15	15	12
	Tail	48	42	39	41	42	57	45

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Aurangabad	19.5	12	13.5	8.7	8.7
Aurangabad	19.5	12	14	8.5	8.5

As is often the case in the other species of *Tadarida* the measurements in *Tadarida aegyptiaca* are rather variable.

Description

The *Tadarida*, or Wrinkle-lipped bats, are unmistakable. The head is extraordinary, the round, broad, and thick ears being joined on the front of the muzzle, in the manner of a shade. The upper jaw is deeply wrinkled. The body is heavy, and the wings narrow. The fleshy tail projects out of the membrane for about half its length. The feet show rows of stiff hairs.

Two allied species are found in India. These are *Tadarida tragata* and *Tadarida plicata.* The former possesses 6 incisors in the lower jaw (against 4 in *Tadarida aegyptiaca*) and the latter (subgenus *Chaerephon*) has no palatal emargination, which special character is shown by all species of the subgenus *Tadarida.*

Like most species of bats, *Tadarida aegyptiaca* shows great variations in the colour of the fur. Two principal types have been seen in western India:

A : Warm brown above and lighter brown-grey below,
B : Reddish brown both above and below.

Three subspecies, described on the basis of differences of size and colour are known for western India. They are:

T. a. gossei Wroughton, 1919 (Poona),
T. a. thomasi Wroughton, 1919 (Bhuj, Kutch, and Dharwar),
T. a. sindica Wroughton, 1919 (Upper Sind Frontier).

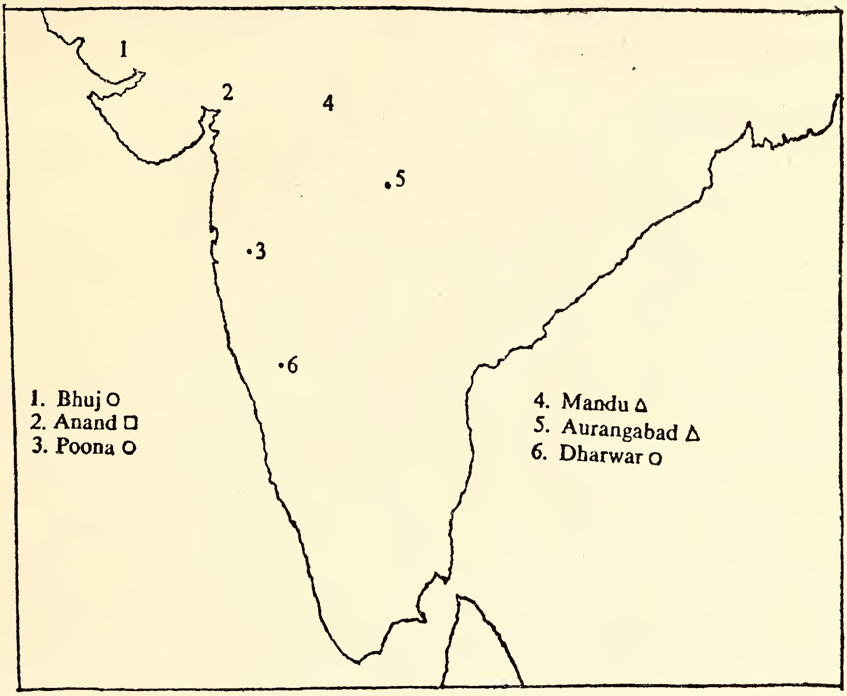
A few specimens of each race are known. From the biogeographical point of view, it seems improbable that *Tadarida aegyptiaca* of Poona (*gossei*) should be different from *thomasi* which is found both north (Bhuj) and south (Dharwar) of Poona. Also the specimens named *thomasi* (Bhuj) and *gossei* (Poona) in the Bombay Natural History Society's collection are morphologically inseparable. Allowing for the high degree of individual variability in *Tadarida aegyptiaca* and the insufficient material seen by Wroughton, we may consider that the distinctions made by this author on the basis of size and colour are without real value. Probably, all *Tadarida aegyptiaca* of western India are of the same form.

General Distribution

Egypt, Kenya, India.

Distribution in western and central India

Probably all over, but never numerous.



Map 21. Localities where *Tadarida aegyptiaca* were studied

The Diurnal Biotope

Narrow and deep crevices in the stones of cliffs or large buildings, where they are inaccessible to man.

Table of Diurnal Biotopes of *Tadarida aegyptiaca*

Locality	Date of observations	Size of the colony	Number of specimens captured	Nature of biotope
Aurangabad	March, August	30-50	11	In a deep and narrow crevice of a cliff, at about 3 m. from the ground
Mandu	February	2	1	Narrow crack in a pillar of the principal mosque
Mandu	December	?	2	The individuals collected blundered into houses at night
Poona	?	?	Several (in BNHS and BM collection)	In the Sassoon Hospital

Nocturnal Territory

It seems to be far from the diurnal haunt. None was observed around the cliff of Aurangabad after members of the colony left the diurnal biotope at sunset.

Field Characters

In the diurnal biotope. The Wrinkle-lipped bats are very well concealed, but extremely noisy even during the day. The smell of their guano is unmistakable. The smell and the screaming make it possible to trace them in narrow crevices. A glance inside the crack confirms the identity of its dwellers which retire backwards to the deeper and more inaccessible corners of the haunt.

In the hunting territory. This bat flies out early at sunset. At Aurangabad, the members of the colony started off in waves from the top of the crevice, 3 to 7 bats threw themselves off together into empty space and immediately went far away with a swift and straight flight. About 3 minutes after the first departure, the crevice was completely empty. On 28 August 1960, no individuals returned to the haunt during the first two hours of night. Verschuren states that the African *Tadarida* do not come back to their diurnal biotope during the night, and we can presume that this behaviour, unusual in bats, also exists in the Asian species of the genus.

Reproduction

Generally speaking, the reproduction of all species of the genus *Tadarida* is as badly known in Asia as in Europe and Africa.

Among 7 females got in Aurangabad on 29 August 1960, six were heavily pregnant and a general parturition in September appeared certain for the females of this colony. A young individual obviously born in September-October was collected in Anand, by A. Navarro. A single foetus was found in all the females of Aurangabad.

Food, hibernation, and migrations

Not known.

Genus *Otomops*

Otomops wroughtoni (Thomas, 1913)

Measurements (in mm.):

		Localities						
		Barapede Cave △ ♀	Barapede Cave △ ♀	Barapede Cave △ ♂	Barapede Cave △ ♂	Barapede Cave ○ ♀	Barapede Cave ○ ♀	Barapede Cave ⊙ ♀
	Forearm	65	65	62	62	66	65	66
	2nd Finger	64	63	62	62	63	63	66
3rd finger	Metacarpal	66	65	60	61	62	64	65
	1st Phalange	25	24	23	24	24	24	24
	2nd Phalange	24	22	23	23	27	28	24
4th finger	Metacarpal	56	55	55	56	59	58	58
	1st Phalange	16	15	15	16	15	15	15
	2nd Phalange	12	..	11	11	12	12	12
5th finger	Metacarpal	29	25	29	27	31	30	30
	1st Phalange	21	20	19	21	22	21	22
	2nd Phalange	9	8	8	8	9	10	8
	Tarsus	21	20	20	21	19	19	19
	Tail	45	44	43	50	50	50	45

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
♂	25	13	16.5	9.5	10
♀	25	13	17	9.5	10

Description

Remarkable for its rarity and its extraordinary morphology. In this *Journal*, Thomas (1913) has given a precise description of *Otomops wroughtoni* (Vol. **22** : 87). It is therefore unnecessary to describe this unmistakable species a second time.

I will however note that in *Otomops*, also, at least two types of colour can be observed. Certain individuals are grey below, and others are bright rufous. The shade of the fur, warmly and curiously parti-coloured in the living animal, quickly fades in the skins.

Both sexes have the same deep gular sac, concealed under the fur of the upper chest.

Distribution

Otomops wroughtoni is known from a single place all over the world: the Barapede Cave, Talewadi, Belgaum district. Jean Dorst, in a general survey of the genus *Otomops*, has drawn attention to the scarcity of all species of this genus throughout the area of their distribution (Tropical Africa, Asia, and Oceania). In fact, most of them are known by a few specimens only.

Otomops wroughtoni was found for the first time in Talewadi 50 years ago. Since 1912 this species had not been seen again. In May 1961 with Mr. Humayun Abdulali and the staff of the Bombay Natural History Society, I organized a camp in the Belgaum district. We were able to reach the Barapede Cave, and find *Otomops wroughtoni* again, where this bat was discovered half a century ago. Due to these circumstances, a certain amount of new data can be added to the original observations recorded in 1913 (loc. cit.).

Ecology

The diurnal biotope is a vast natural cave at an altitude of 800 m., situated in remote country, on a plateau rising above a forested valley. The porch, high and broad, opens on to a grassy maidan, the grazing place of herds of bison. Trees and bushes conceal the entrance. Many wild pigeons live there.

The cave is about 40 m. deep, 25 m. broad, and 6-7 m. high, with dark corners, permanent patches of water, and a high degree of humidity. The *Otomops* hide in the ceiling, at great heights from the ground. They inhabit two types of holes:

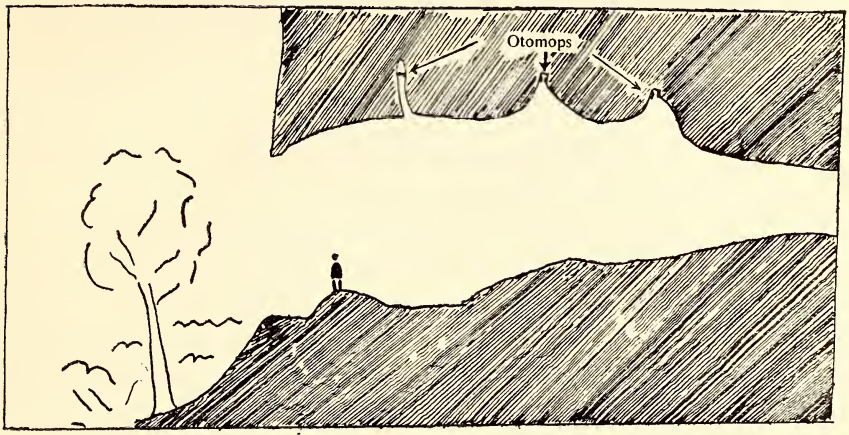
(i) a deep narrow crack in the roof not far from the entrance;

(ii) cavities in the shape of overturned funnels, situated in the lateral ramifications of the cave.

The duration of our stay in Talewadi was unfortunately too short to allow observations of *Otomops* in its hunting territory.

Field Characters

The location of *Otomops* in its diurnal biotope is not easy. The bats keep silent and motionless, hidden in deep hollows and crevices, high in the ceiling. They hang in packs of 5 to 7, and only the extremity of their muzzles can be seen from below. The guano under inhabited crevices betrays their presence. When disturbed, this bat flew inside the cave from one hollow to another. The flight is very strong, fast, and straight. If caught, *Otomops* emits sharp cries.



The Barapede Cave and the diurnal biotope of *Otomops*

Food

The dentition is relatively weak, and unsuitable for crushing big and hard insects. Prater's observation regarding an *Otomops* eating banana and figs was probably due to the fact that the individual was kept in captivity and suffered from dehydration. In fact, it is very improbable that *Otomops* eats fruit in the wild state, its guano being that of a typical insectivorous bat.

Reproduction

The 12 specimens collected in May 1961 were in a state of sexual rest. The dissections of the genital tract of one male and one female confirmed the external examination.

On the reproduction of *Otomops wroughtoni* Prater mentions the finding of a female in December with a young one clinging in front and of 3 or 4 more with single foetuses (*J. Bombay nat. Hist. Soc.* **23**: 788). Reproduction in winter is a unique fact amongst Indian bats. In India, the species which have a periodical reproduction give birth to their young in spring and summer. Nevertheless, *Tadarida aegyptiaca*, another Indian Molossid, delivers in September. Perhaps Asian Molossidae have a sexual cycle quite contrary to the annual cycle of the greater number of Indian bats.

Social Life

The specimens collected in 1961 were 7 males and 5 females. Prater had noticed that the colony of *Otomops wroughtoni* showed no segregation of the sexes. It seemed that the whole colony at

Talewadi was made up of about 40 individuals, scattered in packs of half a dozen in the crevices of the cave.

A few *Megaderma spasma* and *Rhinolophus* lived in the cave inhabited by *Otomops*.

Family Vespertilionidae

Subfamily vespertilioninae

Genus *Myotis*

The systematics of this genus have not been clearly worked out for the Indian species. In western India they are rare and not many specimens are available today in the collections to permit a clarification. My own opinion on the subject is also not based on sufficient definite evidence, because I had little material for comparison at my disposal. However, I believe that at least two species of *Myotis* inhabit western India. They are:

Myotis peshwa (Thomas, 1915),
Myotis peytoni (Wroughton & Ryley, 1913).

Ellerman & Morrison-Scott are certainly wrong when they bring together *Myotis peytoni* and *M. emarginatus*, the latter being of the Palaearctic area. Great differences in the measurements, shape, and size of the skull and the teeth amongst other characters have been noticed between these two bats. *Myotis peytoni* is closely allied to *Myotis sicarius* Thomas, 1915. The general appearance and the shape of the skull are similar. But *peytoni* is noticeably smaller; its second premolars are well developed and in the line of the other teeth, whereas in *sicarius* the second premolars are extremely small, and crushed on the internal side of the jaw. Differences can be also noticed in the shape of the ears. *Myotis peytoni* seems a good species allied to *sicarius*.

The material available for comparison was 12 specimens of *M. peytoni*, two of *M. sicarius*, and five French specimens of *M. emarginatus*.

The identity of *Myotis peshwa* was not easy to settle. While I got a single individual of this species, no specimens exist in the collection of the Bombay Natural History Society, and the type is in the British Museum in London. I do not know the whereabouts of the other specimens, if any. Thomas's description of *M. peshwa* corresponds with the morphology of my specimens, and the place of the capture of these two bats is Bombay. So it is certain that the bat called *Myotis peshwa* by Thomas and the specimen of *Myotis* caught by me belong to the same species.

Can we bring together, as has been done in the more recent works of systematics, *Myotis adversus* and *Myotis peshwa*? Certainly not. The skulls of the two species show great differences, and *adversus* and *peshwa*, if the material of the former species belonging to the Bombay Natural History Society[1] is correctly identified, cannot be said to be synonyms. The facial part of the skull is more massive in *Myotis adversus*, with a depression at the contact of the cranial part, which is not found in *Myotis peshwa*. The upper and lower premolars are well developed and in the dental row in *Myotis peshwa*. In *Myotis adversus* the upper second premolar is very small and crushed internally and the lower is almost invisible.

Thomas says that *Myotis peshwa* is allied to *Myotis horsfieldi* of Java. This question needs to be reviewed again. Until better information is available, I consider *M. peshwa* as being a good species.

Myotis peytoni (Wroughton & Ryley, 1913)

Measurements (in mm.):

		Localities						
		Gersoppa Falls ♀	Gersoppa Falls ♂	Gersoppa Falls ♀	Gersoppa Falls ♀	Gersoppa Falls ♂	Gersoppa Falls ♀	Gersoppa Falls ♀
	Forearm	46	48	46	46	45	46	47
3rd finger	Metacarpal	42	42	40	39	38	41	41
	1st Phalange	16	16	15	15	15	15	16
	2nd Phalange	20	24	22	21	20	22	22
4th finger	Metacarpal	40	40	38	38	36	40	41
	1st Phalange	10	12	10	10	10	12	12
	2nd Phalange	7	10	..	10	..	..	..
5th finger	Metacarpal	39	38	37	37	38	38	39
	1st Phalange	10	10	9	9	10	10	9
	2nd Phalange	7	9	8	8	8	8	8
	Tarsus	17	19	19	19	19	17	19

Greatest length of skull : 18 mm.

[1] The specimens of *adversus* of the Bombay Natural History Society are called *hasselti* Temm., which is now recognized as conspecific with *adversus*.

Description

Bat of middle size, with long and pointed tragus, and ears emarginated externally. Above, the fur is entirely chestnut-brown and, below, the hair is brown at the base and yellowish at the tip. Examination of the skull and the dentition shows immediately the relationship of this bat to the genus *Myotis*.

Distribution

This bat has been found only in one place: the Gersoppa (Jog) Falls, in North Kanara. It has not been seen again since 50 years ago, when it was described by Wroughton & Ryley, 1913, ['A new species of *Myotis* from Kanara' (*J. Bombay nat. Hist. Soc.* **22** : 13)].

Biology

Shortridge found them swarming among rocky crevices at the foot of the Jog Falls. Living in swarms is normal for bats of the genus *Myotis*. Amongst 12 specimens collected in May, 4 were young and obviously born at the beginning of April.

Myotis peshwa (Thomas, 1915)

Measurements (in mm.):

A single specimen, collected by me in Elephanta, has been examined.

	Forearm	38
	2nd Finger	34
3rd finger	Metacarpal	35
	1st Phalange	16
	2nd Phalange	18
4th finger	Metacarpal	34
	1st Phalange	11
	2nd Phalange	25
5th finger	Metacarpal	33
	1st Phalange	10
	2nd Phalange	8
	Tarsus	16

The skull measurements are as follows:

Greatest length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
15	10.5	12	7.5	8

Description

Like a big *Pipistrellus*: with woolly hair, brown above and lighter rufous-brown below; muzzle, jaws, and ears very dark, almost black; long whiskers, large feet, and narrow and relatively long ears with an external emargination.

Examination of the skull and the dentition proves immediately the relationship of this bat with *Myotis.*

Distribution

Known from Poona, Thana (Wroughton), and from Elephanta (Brosset). Certainly a rare species.

Biology

Nothing is known of the biology of *Myotis peshwa.* The individual collected by me at Elephanta (19 March 1961) was roosting in a hole in the ceiling in the room of the lingam, in the Main Cave. It was with another individual, which escaped. This species is agile, aggressive in spite of its small size, and bites severely.

Genus *Pipistrellus*

Pipistrellus coromandra (Gray, 1838)

Measurements (in mm.):

		Localities						
		Phonda ○ ♀	Ratnagiri ○ ♂	Palanpur ○ ♂	Bombay ○ ♀	Hampi △ ♀	Hampi △ ♀	Hampi △ ♀
	Forearm	29	29	27	29	31	29	28
3rd finger	Metacarpal	28	27	29	28	28	28	28
	1st Phalange	10	10	12	12	11	11	12
	2nd Phalange	..	..	..	..	9	9	9
4th finger	Metacarpal	27	26	28	27	28	28	28
	1st Phalange	12	11	11	12	12	11	12
	2nd Phalange	8	10	9	10	9	10	9
5th finger	Metacarpal	26	24	27	27	27	27	26
	1st Phalange	7	6	5	6	7	7	6
	2nd Phalange	4	4	4	4	4	4	4
	Tarsus	10	10	10	11	12	12	11
	Tail	..	..	..	..	25	25	25

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Hampi ♀	13	7.5	9.5	5	6

Description

More than a hundred species of *Pipistrellus* are described in the Old World. They include small or very small bats, often very difficult to identify correctly. Representative material with skulls and specimens in spirit is required to study properly the classification of this large genus.

The colour of the fur of the western Indian species is very variable from specimen to specimen and, except for *Pipistrellus dormeri* which is whitish below, the colour is a useless character for correct identification. The dry skins of the museums are often material which cannot be utilized, and many confusions can be seen in collections. Nevertheless, with good material for comparison, the systematics of the Indian *Pipistrellus* appear clear and well established.

General Distribution

Southern China, Hainan, Indo-China, Burma, Bhutan, Sikkim, India, and Ceylon.

Distribution in western and central India

Perhaps all over, especially in the south. The species has been found in most places where bats have been collected. Nevertheless, it does not seem so common as the other species of the same genus.

Biology

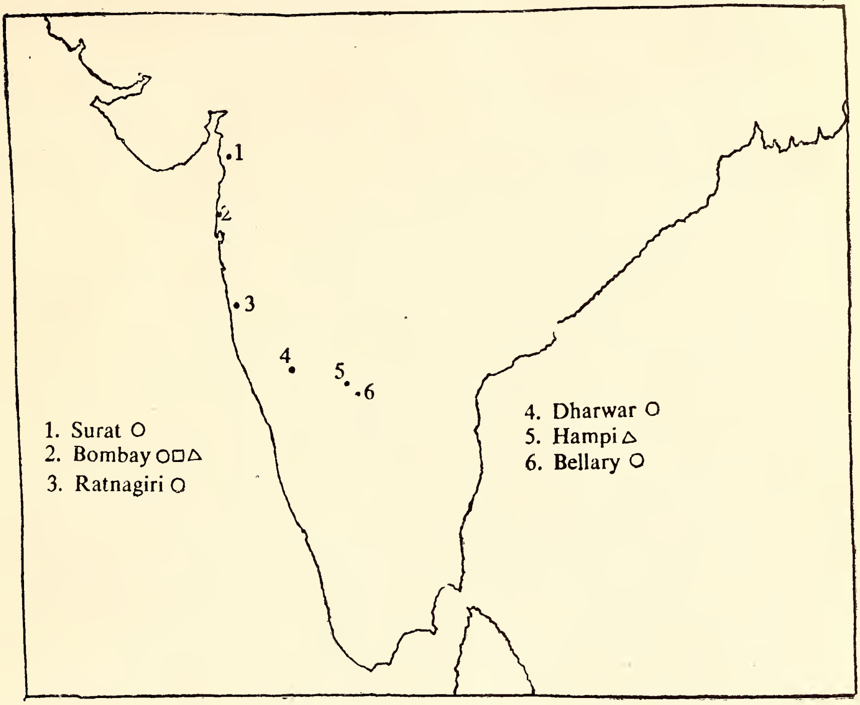
The biology of this common species is not well known.

Ecology

I saw two colonies of *Pipistrellus coromandra.* One of them was under the bark of a big *Ficus,* in Hampi. Four specimens, all females, were collected. The second colony, which included at least a dozen individuals, inhabited the roof of the house of Mr. Humayun Abdulali; three specimens were obtained from this place.

Field Characters

In Hampi, the individuals of the colony flew away very early at sunset, and we saw members of the second colony coming back to their roost place in the morning, a quarter of an hour after the day was beginning to dawn. This species seems to be the earliest and the latest flyer amongst bats of western India.



Map 22. Localities where *Pipistrellus coromandra* were studied

In Hampi, individuals were hunting around big trees, and often entered inside the foliage and entanglements of branches. The flight is rather slow, and very fluttering and erratic.

Food

In Hampi, the specimens collected a few minutes after sunset were eating small flies, which abounded around a big *Ficus* bearing ripe fruits. The stomach and bowels of these small bats were full of an astonishing quantity of these insects.

Reproduction

Two young were found by Mr. Humayun Abdulali in May. One female, heavily pregnant, was also collected by him in September[1]. At least two periods of reproduction seem to occur in the annual cycle for this species.

---

[1] This female and the two young ones were found under an electric bell in the verandah of the first floor which appeared to be the regular roosting place of one or two *Pipistrellus*, some 50 ft. away from the larger colony in the roof.—Eds.

The number of foetuses found in the female collected in September was two.

Hibernation, social life, and migrations have not been observed in this species.

Pipistrellus mimus Wroughton, 1899

Measurements (in mm.):

		Localities			
		Anand □ ♂	Anand △ ♀	Anand △ ♀	Vedtial △ ♂
	Forearm	25	27	26	28
3rd finger	Metacarpal	25	27	25	27
	1st Phalange	11	10	11	12
	2nd Phalange	7	7	7	8
4th finger	Metacarpal	25	27	24	26
	1st Phalange	10	10	10	10
	2nd Phalange	8	7	8	8
5th finger	Metacarpal	23	25	23	25
	1st Phalange	8	8	8	7
	2nd Phalange	5	5	5	5
	Tarsus	11	10	11	11
	Tail	25	25	24	28

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Anand ♀	11	7.5	8	4.5	5

Description

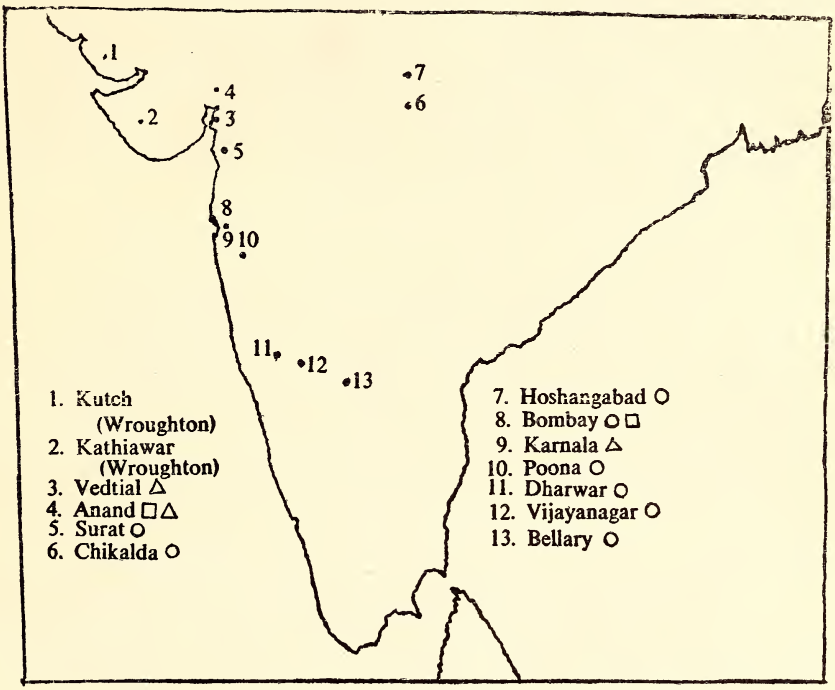
Measurements permit the identification of this bat, the smallest Indian species. *P. ceylonicus* and *dormeri* are much bigger; *coromandra* is slightly larger and the shape of the skull is different in this species.

General Distribution

Approximately Ceylon, India, Sikkim, east to western Burma, and Annam.

Distribution in western and central India

A common species found all over except in mountainous areas like Mahableshwar and Khandala.



Map 23. Localities where *Pipistrellus mimus* were studied

The Diurnal Biotope

TABLE OF DIURNAL BIOTOPES OF *Pipistrellus mimus*

Locality	Date of observations	Size of the colony	Number of specimens captured	Nature of biotope
Anand	December	11	11	Behind frames against a wall of an external corridor of the Catholic Mission
Vedtial	February	?	1	Crack between a wall and the wood of a window
Kanheri Karnala	All over the year	Individuals seen one by one	1	Individuals hunting at sunset in heavy forest. Probably living during the day in holes of trees, under bark or in empty bamboos

The species probably frequents all sorts of places with narrow cracks and crevices where the bat can slip in with the back and the underparts of the body in contact with stone or wood.

Nocturnal Territory

Pipistrellus mimus prefers woody country, although the species is not rare even in towns. Wroughton says that it is an inhabitant of the heavy jungle. In fact, around Bombay, this small *Pipistrellus* is the commonest bat in patches of forest, as in Kanheri or Karnala. It can be found near or far from houses.

Field Characters

In the diurnal haunt, this species is very difficult to identify with certainty. The capture of a specimen, and careful examination and comparison with other specimens is almost always necessary.

On the wing, the species can be more easily recognized, especially in forest. The very small size and the erratic and fluttering flight are distinctive features. This bat hunts early at sunset, along and around big trees or clumps of bamboo, between 5 and 15 m. high.

Reproduction

No records for India. In Ceylon, Phillips saw females with young (one or two for each) in March, May, and December. The specimens obtained in Anand in December were in a state of complete sexual rest.

Social Life

These bats seem to gather in small colonies in their diurnal haunts. Males and females were mixed together at Anand (5 ♂♂ and 6 ♀♀).

Hibernation

All individuals observed in Anand in December were in a state of deep hibernation. Their capture was made at midday, when the temperature was 25° C. Nine of them, placed on their backs, in the hot sun, stayed in this position for about 10 minutes before they flew away. Nevertheless, on the same day and at the same place, I saw several individuals hunting at sunset.

Pipistrellus ceylonicus (Kelaart, 1852)

Measurements (in mm.):

		Localities						
		Junnar △ ♀	Bombay △ ♂	Poona △ ♀	Kanheri △ ♀	Karla △ ♀	Karla △ ♂	Baroda △ ♀
	Forearm	38	36	37	37	38	36	39
	2nd Finger	33	33	33	33	34	33	36
3rd finger	Metacarpal	35	35	36	34	36	35	39
	1st Phalange	14	13	14	13	14	13	14
	2nd Phalange	11	10	10	10	10	10	11
4th finger	Metacarpal	35	34	35	33	35	33	37
	1st Phalange	14	13	14	12	14	13	13
	2nd Phalange	8	7	8	8	8	8	9
5th finger	Metacarpal	33	33	34	32	33	33	36
	1st Phalange	9	8	8	8	8	8	8
	2nd Phalange	6	6	6	7	7	6	6
	Tarsus	14	14	15	14	15	14	14
	Tail	35	32	35	32	35	33	36

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Bombay ♂	15	10	11	6	7
Poona ♀	15	10	11	6	7

Description

The relatively large size separates this species from the other *Pipistrellus* of western India (see measurements).

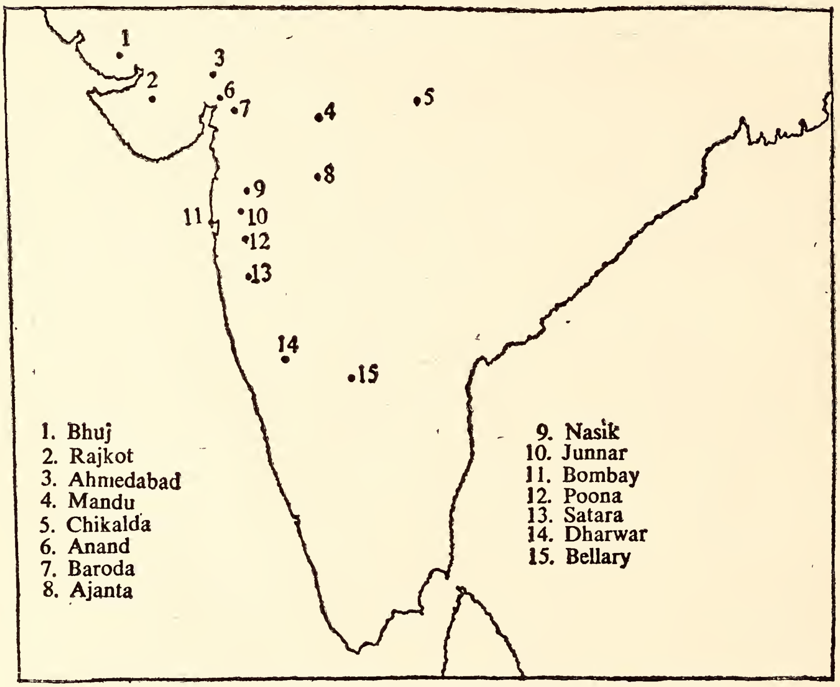
The colour of the fur is extremely variable and shows various shades of brown, rufous, and grey. Bright reddish specimens are not rare, and it is such an individual which is the type of the species described by Wroughton as *chrysothrix*, a species later recognized as invalid. In fact, reddish and brown individuals are found in the same colonies, and these variations of colour are individual characters.

General Distribution

India, probably Burma, and Indo-China.

Distribution in western and central India

Extremely common all over. Specimens were obtained at every place where bats were collected, and the number of individuals of this species exceeds that of all the other species put together.



Map 24. Localities where *Pipistrellus ceylonicus* were studied

The Diurnal Biotope

In Ceylon, Phillips reported having seen the species in holes in trees, and hollow branches. *Pipistrellus ceylonicus* is an eclectic species which can be found in all sorts of cracks, holes, and crevices in wood as well as in stone or other material.

Nocturnal Territory

Especially in towns and villages, these bats are so numerous that it is difficult to determine if an individual territory exists for each bat. But it is improbable, because their number varies from one sunset to another, and the hatching of ants attracts them from afar, sometimes hundreds of individuals being seen together. It seems

TABLE OF DIURNAL BIOTOPES OF *Pipistrellus ceylonicus*

Locality	Date of observations	Size of the colony	Number of specimens captured	Nature of biotope
Bombay	July	1	1	In the Kanheri Caves
Junnar	May	2	2	In a crack of the ceiling of a cave, in the Shivneri Fort
Poona	January, February, April	One at each time	1 but caught again several times	Under a roller-blind in the Wellesley Hotel
Karla	May, August, December	100-150	47	In the cracks of the ceilings of several Buddhist Caves
Lonavla	?	?	6	In houses (observations of A. Navarro)
Anand	December	2	2	Under frames, against a wall
Mehmadabad	December	At least 6	—	In a well, in cracks of the stone
Near Poona	May	At least a dozen	1	Under entanglements of aeria roots of a large banyan
Gadag	?	Plentiful	?	Hiding in crevices, in a Hindu temple, at Gadag (observations by Shortridge)

that these bats often gather temporarily in places where the food is plentiful, and, contrary to several other species, there is no individual territory.

Field Characters

In their diurnal haunts, all species of *Pipistrellus* are more or less similar. Capture and careful examination is usually necessary to identify the species.

In the nocturnal territory, *Pipistrellus ceylonicus* appears early at sunset. The flight is rather fast, sometimes very high, sometimes close to the ground. It spends the greatest part of the night in its diurnal place, and seems to be out only for short hunting periods (observations made in Poona).

Reproduction

In Ceylon, Phillips saw two (sometimes only one) young in September. Wroughton, for the Konkan, made similar observations. Two young born in autumn. A female collected by me on 24th September had two foetuses. On the other hand, I dissected one female on 8 April 1960, two on 12 June 1960, 21 on 10 August 1961, and no foetus was seen in the genital tract of these females. The parturition—probably a single one in the annual cycle—takes place in October in western India.

Hibernation

This species hibernates quite continuously during the day, and even during the night. The individual observed in Poona was caught by me three times at the same place, by day and night, always in a state of deep hibernation. Similar observations were made in Junnar, Bombay, Karla, Anand, Mehmadabad at practically all seasons.

It is a known fact that in temperate countries the *Pipistrellus* are quite continuously in a state of torpor even during the summer, activity being restricted to short periods. We observed the same behaviour in tropical *Pipistrellus*, in spite of the hot temperature and the availability of insects. The hibernatorial behaviour of these bats is not necessarily connected with the climatic and ecological conditions.

Pipistrellus dormeri (Dobson, 1875)

Measurements (in mm.) :

		Localities						
		Anand □ ♀	Anand □ ♀	Anand □ ♀	Anand □ ♀	Anand △ ♂	Anand △ ♂	Anand △ ♂
	Forearm	36	35	35	35	34	36	35
	2nd Finger	34	35	33	34	33	33	32
3rd finger	Metacarpal	33	35	33	34	34	35	33
	1st Phalange	13	13	13	13	14	13	13
	2nd Phalange	10	10	10	10	10	10	10
4th finger	Metacarpal	35	36	32	35	33	34	32
	1st Phalange	12	12	12	12	12	13	12
	2nd Phalange	7	8	8	8	9	8	9
5th finger	Metacarpal	34	34	32	32	34	33	32
	1st Phalange	10	9	10	11	9	9	10
	2nd Phalange	5	5	6	6	6	6	5
	Tarsus	12	12	12	12	12	12	12
	Tail	35	34	35	35	35	35	33

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Anand ♂♂	14	10	11	6	7
	14.5	10	11	6	7

Description

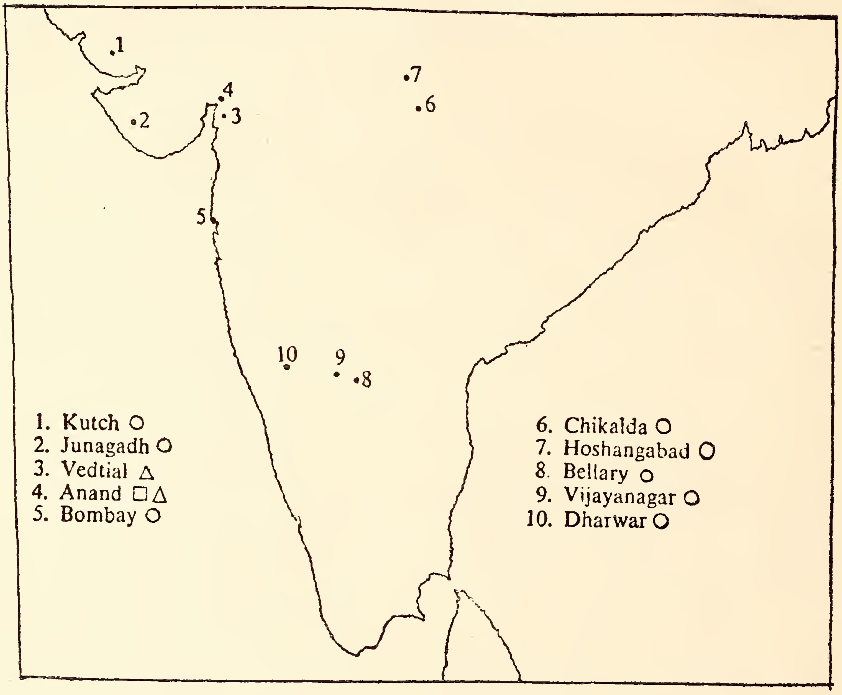
Much lighter than the other species of *Pipistrellus.* Whitish below, grey above, the membranes and skin having little pigment and being almost transparent. A single incisor of large size appears in the upper jaw, although two are easily visible in the other species.

General Distribution[1]

India from Kutch, Kathiawar, Bengal, Bhutan Duars, south of Bombay, Dharwar, and Bellary.

Distribution in western and central India

Probably all over. The species seems common in Gujarat.



Map 25. Localities where *Pipistrellus dormeri* were studied

Biology

The biology of *Pipistrellus dormeri* is practically unknown. Wroughton's remarks about this species are vague and not convincing. Navarro got 5 females in Anand under the tile of a roof. In the same place at sunset I caught two males flying away from a roof with a minaret.

These bats are noisy in their diurnal haunts. They fly out about 10 minutes after sunset.

[1] I would remind the reader that General Distribution of the species is taken from Ellerman and Morrison-Scott's CHECKLIST OF PALAEARCTIC AND INDIAN MAMMALS 1758 to 1946.

Genus *Hesperoptenus*

Hesperoptenus tickelli (Blyth, 1851)

Measurements (in mm.):

		Localities						
		Bombay △ ♀	Bombay □ ♀	Poona ○ ♀	Dharwar ○ ♂	Dharwar ○ ♀	Bombay ○ ♀	Bombay ○ ♀
	Forearm	57	55	55	58	58	57	54
	2nd Finger	53	51	53	55	54	53	49
3rd finger	Metacarpal	49	49	51	53	51	51	47
	1st Phalange	22	24	23	23	24	24	20
	2nd Phalange	20	19	22	22	22	24	20
4th finger	Metacarpal	47	48	50	50	51	51	46
	1st Phalange	19	21	19	19	18	20	17
	2nd Phalange	18	14	15	15	17	16	15
5th finger	Metacarpal	46	48	49	50	49	50	44
	1st Phalange	12	12	11	10	12	12	11
	2nd Phalange	8	8	9	10	11	10	9
	Tarsus	20	21	23	20	23	23	18
	Tail	50	51	53	55	57	51	54

The skull measurements are as follows :

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Bombay ♀	19	13	11.5	8.5	7

Description

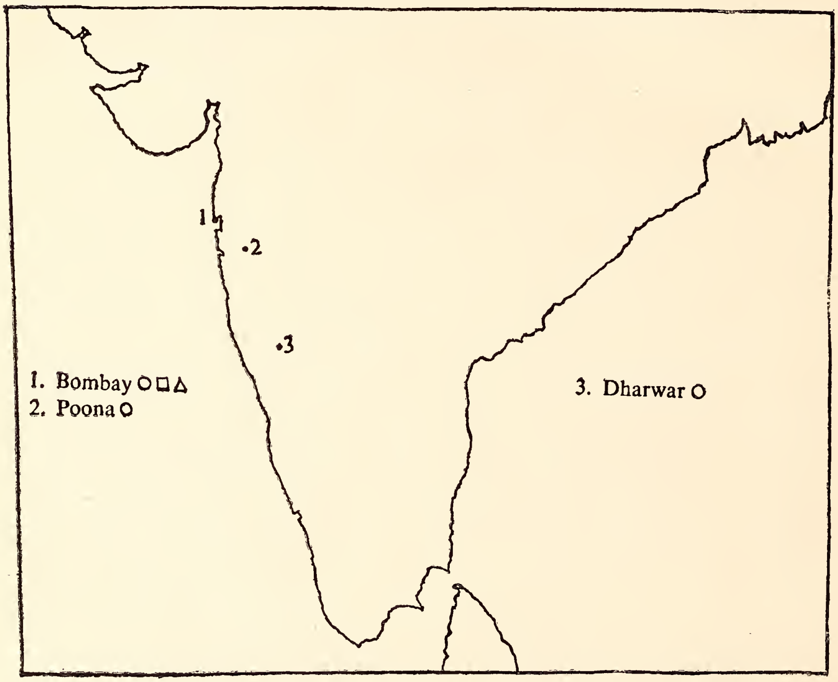
Rather large bat. The fur, pale yellowish grey becoming pure grey on the head, extends broadly on to the membranes and the external surface of the uropatagium. A tuft of whitish hairs exists at the base of the ears. The naked parts of the body, ears, muzzle, forearm, and fingers are of a fleshy colour. The wings are long, and the third finger is ended by a third phalange. This remarkable character appears to have been noted only in a few of the Vespertilionidae and in the Phyllostomatoidae of the New World.

General Distribution

India and Ceylon.

Distribution in western and central India

Probably a common species all over this area. But its capture is difficult, and there are only a few records.



Map 26. Localities where *Hesperoptenus tickelli* were studied

Biology

Practically nothing is known of the biology of this species in western India. The specimens obtained by the Mammal Survey, Navarro, and myself in Bombay were individuals which had accidentally flown into flats or houses. The only specimen I got was discovered during the night in the verandah of my flat, hanging on the wire-work of an empty cage. This bat was in a state of torpidity and was easily caught.

Some interesting data on this species were recorded by Phillips in Ceylon. He said it appears very early. The flight is rather slow and steady, wheeling in large circles, each bat keeping more or less strictly within its own territory. The diurnal haunt is probably in hollow trees, but it is very difficult to discover the retreats of this bat. The young, a single one per female, are born in May.

Genus *Tylonycteris*

Tylonycteris pachypus (Temminck, 1840)

Measurements (in mm.):

		Localities				
		Sirsi O♀	Belgaum O♂	Dharwar O♀	Belgaum O♀	Sirsi O♀
	Forearm	28	28	28	24	27
	2nd Finger	23	25	25	23	23
3rd finger	Metacarpal	24	26	25	23	23
3rd finger	1st Phalange	24	26	25	23	23
3rd finger	2nd Phalange	11	11	11	11	11
4th finger	Metacarpal	24	26	25	23	23
4th finger	1st Phalange	11	11	11	11	11
4th finger	2nd Phalange	9	9	9	9	9
5th finger	Metacarpal	23	26	25	23	23
5th finger	1st Phalange	8	8	8	5	6
5th finger	2nd Phalange	6	6	?	5	6
	Tarsus	12	12	11	11	?
	Tail	24	26	24	22	22

Description

With *Pipistrellus mimus* this is the smallest Indian bat. *Tylonycteris pachypus* may be easily separated from the *Pipistrellus* by the golden rufous colour of its fur, and by the soles of the feet being expanded into fleshy pads. The upper jaw has only one premolar, although there are two in *Pipistrellus*. The third finger possesses a third phalange, as in *Hesperoptenus*.

Two subspecies have been described for India on the basis of colour. They are *fulvida* Blyth, from the eastern part of the country, and *aurex* Thomas from Belgaum and Kanara. Small series of both exist in the collections of the Bombay Natural History Society. I cannot separate specimens of *aurex* and *fulvida*, and these subspecies are probably without value.

General Distribution

Approximately Yunnan, southern China, Burma, Sikkim, India, Tonkin, Laos, and Annam, Indo-China, Malay States, Borneo, Java, Bali, Sumatra.

Distribution in western and central India

Known only from Kanara (Belgaum, Dharwar, Sirsi).

Biology

The biology of this species in India remains practically unknown. It seems to be a bat of heavy forest. Shortridge and Wroughton say that *Tylonycteris pachypus* is 'an early and erratic flyer . . . probably roosting, as it does in Java, in parties of from ten to twenty in hollow bamboos, especially in those used in house roofs, and in the thinner hollow branches of trees.'

Genus *Scotophilus*

Scotophilus temmincki (Horsfield, 1824)

Measurements (in mm.):

		Localities				
		Sirsi O ♀	Sirsi O ♂	Palanpur O ♂	Junagadh O ♂	Junagadh O ♂
	Forearm	48	47	47	46	45
	2nd Finger	45	46	46	47	47
3rd finger	Metacarpal	44	44	44	44	44
3rd finger	1st Phalange	16	15	16	15	15
3rd finger	2nd Phalange	21	20	20	20	20
4th finger	Metacarpal	43	43	44	43	43
4th finger	1st Phalange	13	12	12	13	12
4th finger	2nd Phalange	12	9	10	9	9
5th finger	Metacarpal	40	40	40	40	40
5th finger	1st Phalange	9	7	8	7	8
5th finger	2nd Phalange	7	6	6	7	6
	Tarsus	16	16	17	16	17
	Tail	42	45	39	42	40

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Gadag	18	12	14	7	8
Dharwar	19	13	15	7	8

Description

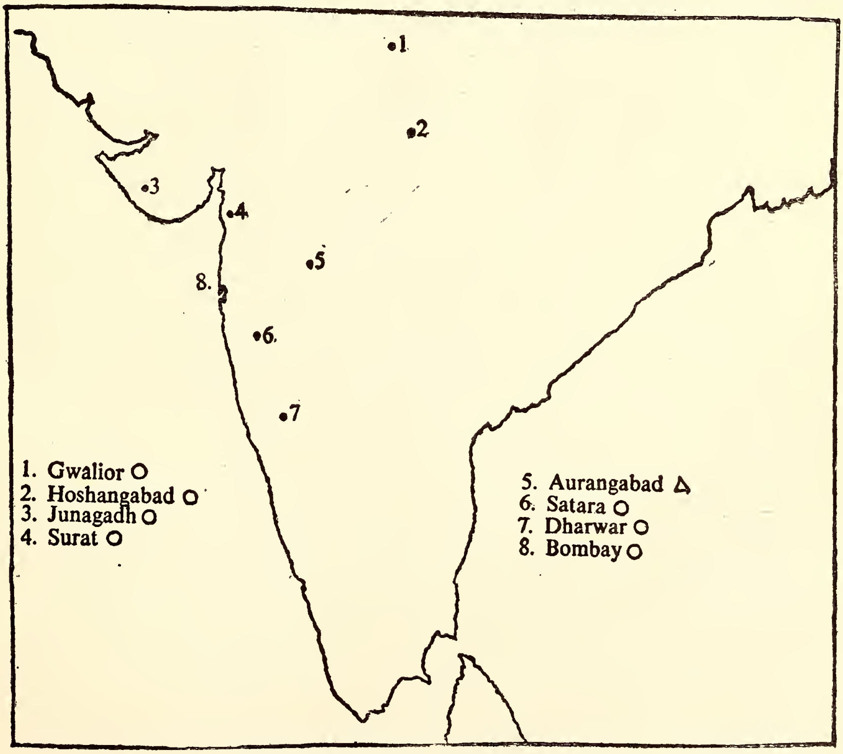
A vespertilionid of middle size, rufous-brown above, light yellowish brown below. The *Scotophilus* have a single incisor and a single premolar on each upper jaw. The tragus is narrow, long, and pointed.

General Distribution

Hainan, Formosa, Ceylon, peninsula of India where widely distributed, Sikkim, Bhutan, Burma, Tenasserim, Siam, Annam, Indo-China, Malay State, Java, Bali, Burma, and the Philippines.

Distribution in western and central India

This species, although probably common is difficult to find, and few records are known in this area.



Map 27. Localities where *Scotophilus temmincki* were studied

Biology

Navarro has never met this species around Bombay and in the Ghats. I observed only a single colony in Aurangabad. This colony, of a few individuals, was roosting under a roof, and in holes of walls. An immature specimen was collected there in July.

Wroughton says that 32 specimens were collected by C. A. Crump in Kathiawar: 'All found in the palmyra palms, where they hide in the dead leaves, which hang down the trunk . . . . Both sexes were found together.'

The best information available on the biology of this species, especially their reproduction is given by A. Gopalakrishna [Studies on the embryology of Microchiroptera, Part IV. An analysis of implantation and early development in *Scotophilus wroughtoni* (Thomas). *Proc. Indian Acad. Sci.* **30** B (4) : 226-242, 1949]. The data recorded by Gopalakrishna in Mysore is probably correct for central and western India.

Scotophilus heathi (Horsfield, 1831)

Measurements (in mm.):

	Localities							
	Elephanta △ ♀	Elephanta △ ♀	Elephanta △ ♀	Elephanta △ ♀	Belgaum △ ♀	Belgaum △ ♀	Belgaum △ ♂	Ahmedabad △ ♂
Forearm	57	59	59	58	64	62	64	56
2nd Finger	55	55	55	55	59	59	59	50
3rd finger Metacarpal	55	55	56	55	62	60	59	51
3rd finger 1st Phalange	21	20	21	20	22	21	21	18
3rd finger 2nd Phalange	16	16	15	15	16	15	16	15
4th finger Metacarpal	55	55	55	55	62	59	59	50
4th finger 1st Phalange	16	16	16	16	17	17	17	14
4th finger 2nd Phalange	13	13	12	13	13	13	11	11
5th finger Metacarpal	51	49	51	51	57	55	53	46
5th finger 1st Phalange	11	10	10	10	11	11	11	9
5th finger 2nd Phalange	8	8	8	8	9	9	8	7
Tarsus	24	23	24	24	26	25	25	24
Tail	62	58	65	62	55	65	60	42

The skull measurements are as follows:

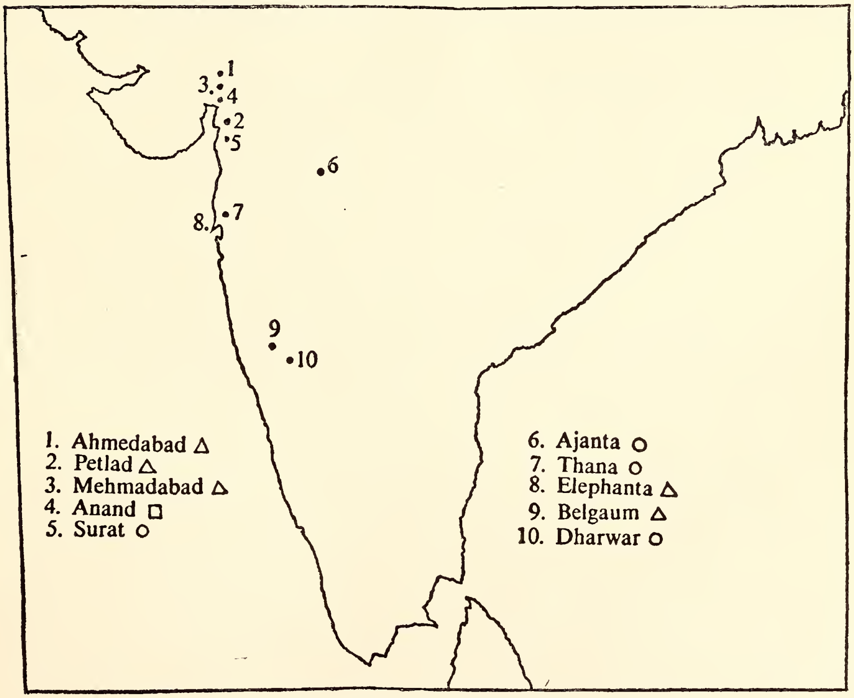
	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Belgaum ♀	22	16	16	9	10
Ahmedabad ♂	21	15	15	8	9

Description

The light canary yellow of the underparts is the most striking feature in this bat, no other Indian species showing this colour, which serves to identify it at the first glance. Nevertheless, a reddish type also occurs; the young are not so bright, and the silky gloss of the fur fades quickly after the death of the animal.

This bat possesses relatively short ears, and a long tail entirely included in the membrane. The skull is strongly built, with a developed sagittal crest. The living animal emits a very peculiar *sui generis* smell. Usually, many parasites are found on this bat.

The size and colour of *Scotophilus heathi* is subject to large variations. Some of them are perhaps connected with ecological factors, or with the localisation of the populations. More material for comparison would be necessary to permit any definite opinions.



Map 28. Localities where *Scotophilus heathi* were studied

General Distribution

Yunnan, Hainan, Burma, Bhutan Duars, Sikkim, India, Ceylon, Tonkin, Annam, Indo-China, Lower Siam.

Distribution in western and central India

A very common species all over, except in mountains and in forested areas.

The Diurnal Biotope

TABLE OF DIURNAL BIOTOPES OF *Scotophilus heathi*

Locality	Date of observations	Size of the colony	Number of specimens captured	Nature of biotope
Belgaum	May, October	6	4	Under the roof of Green's Hotel
Petlad (Gujarat)	December	12-15	2	Between a wall and the wood of the roof
Ahmedabad	November	?	1	In the Moghul wells several individuals were seen in cracks and in corners of the arches
Anand	April	Several individuals	1	In an old temple (observations of A. Navarro)
Mehmadabad (Gujarat)	December	10-15	1	In crevices of vaults of Moghul well
Elephanta	May	18	12	In a hole of the ceiling of the Main Cave, near the 'Mahashivamurti'

Several other observations were made on individuals inhabiting roofs or timber work. This species most often slips into narrow crevices or cracks, but may also be observed in swarms in large holes in ceilings, as at Elephanta. Complete darkness of the diurnal haunt is not necessary.

Hunting Territory

I had the opportunity to see individuals in many places in their hunting territory. This species is one of the bats which can easily be seen everywhere around towns and villages, at sunset. The well-marked territory is in the immediate vicinity of the diurnal haunt. It is not large; the individuals inhabiting Green's Hotel, Belgaum, hunted every sunset below the gardens and in the grass-lands close to the building.

This species spends the greatest part of the night in the diurnal haunt. In Belgaum on the night of 20 October 1960, after the departure of the colony, I put a mist net at the entrance of their hole in the roof, and very quickly caught three individuals coming back. Their haunt was situated in the wood of the roof, just above my bed, and on previous nights my sleeping time had been disturbed by the bats fighting and pursuing one another almost without a stop. One of them finally fell down on my mosquito net where it was caught. When satiated with insects, the *Scotophilus* came back to their diurnal place, where they seemed to enjoy animated and noisy 'parties'.

Field Characters

In the diurnal biotope. A big bat, of pale colour, with short ears, usually silent and motionless. The animal keeps itself wedged into a crack, a corner, or a hole in the ceiling, hanging by its forelimbs. A state of hibernation is normal during the day, and not a single one of those observed by me was then really active. If disturbed with a stick, for instance, they do not fly away but widely open the mouth, and emit grinding cries, in the same manner as the other Vespertilionidae disturbed during their period of hibernation. Later, they creep backwards to the deeper corners of the cavity, and refuse to leave.

In the hunting territory. The flight is unmistakable to those accustomed to observe bats hunting at sunset. This species appears very early, immediately after the *Pipistrellus*. It is a large bat, with broad wings, long tail, and wheels in large circles, at middle height, around houses and big trees in gardens. Usually three or four individuals hunt together.

Food

The individuals caught in Belgaum during the night had an enormous quantity of flying ants in the digestive tube.

Reproduction

Females dissected in October and December had no foetus. Ten females were caught on 16 May 1961; six of them had two foetuses each, three a single one, and one female none.

The state of development was not the same in all, and we can estimate that the first parturition takes place around 15 June and the last around 10 July. These dates are concordant with those of *Scotophilus temmincki* observed by Gopalakrishna in Mysore.

A single young is the rule for the majority of Indian bats.

Nevertheless, the *Scotophilus* and the *Pipistrellus* give birth most often to two young.

Hibernation

The state of torpor is normal for this species during the day. They also cover prolonged periods of complete hibernation. During these periods, the bat sleeps in the diurnal haunt even during the night (cf. Brosset, L'hibernation chez les chiroptères Tropicauax. *Mammalia*, December 1961).

Several observations on hibernating individuals were made by me in western India:

November—*Ahmedabad* : 2 in deep hibernation,
December—*Petlad* : 12-15 individuals in hibernation during day and night,
December—*Mehmadabad* : 10-15 individuals, all hibernating,
May —*Elephanta* : 18 individuals, all in torpid state.

Subfamily MINIOPTERINAE

Genus *Miniopterus*

Miniopterus schreibersi (Kuhl, 1819)

Measurements (in mm.):

		Localities					
		Robbers' Cave, Mahableshwar △ ♀	Robbers' Cave, Mahableshwar △ ♂	Robbers' Cave, Mahableshwar △ ♀	Robbers' Cave, Mahableshwar △ ♀	Robbers' Cave, Mahableshwar △ ♂	Robbers' Cave, Mahableshwar △ ♂
	Forearm	47	48	46	48	46	47
	2nd Finger	43	43	40	43	42	43
3rd finger	Metacarpal	45	44	41	43	42	45
	1st Phalange	12	12	11	10	11	10
	2nd Phalange	26	28	29	31	31	29
4th finger	Metacarpal	42	41	39	41	40	41
	1st Phalange	10	10	10	8	10	8
	2nd Phalange	18	19	18	16	18	16
5th finger	Metacarpal	38	38	37	38	38	38
	1st Phalange	10	10	9	9	9	9
	2nd Phalange	9	10	9	7	7	7
	Tarsus	20	21	19	19	20	21
	Tail	57	62	60	61	60	65

The skull measurements are as follows:

	Total length	Zygomatic breadth	Mandible	Upper dental row	Lower dental row
Mahableshwar ♀	16	8.5	12	6	8
Mahableshwar ♂	16	8.5	12	6	7.5

Description

Rather small bat, with long wings and tail. The head is small, with short ears, and a convex forehead. The penis is very long in the male, and the fur gives shelter to an astonishing quantity of large parasites.

Several subspecies of *M. schreibersi* have been described from Asia, on the basis of the colour of the fur. This colour is extremely variable even in specimens belonging to the same population. For instance in the colony at the Robbers' Cave in Mahableshwar, grey brown more or less dull, bright reddish, and creamy white specimens have been collected together. All intermediate types between these different colours were also observed there. These variations in the colour of the fur are of no taxonomic value. All *Miniopterus schreibersi* of Europe, Africa, and western and southern Asia probably belong to the nominate form *Miniopterus schreibersi schreibersi*.

General Distribution

Amongst the many species of bats, *Miniopterus schreibersi* probably has the largest area of distribution. This covers the entire southern part of the Palaearctic region, from France to Japan, North Africa, Formosa, Hainan, Ceylon, India, Nepal, Burma, Java, Borneo, Sumatra, Philippine Islands, New Guinea, and northern Australia.

Distribution in western and central India

The colonies of this bat are extremely rare. One was examined, unique but enormous, near Mahableshwar. At least 100,000 individuals are living there, and this colony seems to be the largest known anywhere in the world.

Ecology

The ecology of this species was partially disclosed by the studies of Constant and myself in France. My experience in Europe, Africa, and Asia showed very peculiar and consistent characters.

The principal element of the biotope is always a large natural cave, usually with a subterranean river inside. This cave, invariably situated in hilly and forested country, constitutes the 'mother house' of the colony. It is there that one can observe the largest swarm of individuals, the annual cluster of young, and it is also the sleeping place of the colony during the winter, i.e. in temperate countries. Within a radius of 70 kilometres of the 'mother house', there are several other secondary habitats, where groups of individuals belonging to the colony go and stay periodically. These secondary habitats are almost always natural caves of smaller size, and rarely buildings (churches). The *Miniopterus* which live in the secondary habitats are not permanent residents, but frequently travel to and from the 'mother house'. This behaviour has been studied in France, where thousands of *Miniopterus schreibersi* were marked (cf. Constant & Brosset for France, and Brosset for North Africa).

The 'mother houses' are always very far from each other, and the bats from each have large areas to move over. The cave of Rancogne seems to be the centre of periodical dispersal and regrouping of all *Miniopterus* of western France. In Africa the cave of Zegzel appears to be used in the same way by the *Miniopterus* of western Morocco. Probably, the Robbers' Cave is the 'mother house' of all *Miniopterus* of the northern part of the Western Ghats. A secondary habitat was noted in one of the caves situated above Panchgani, and we can presume that there are several others within a large radius around the Robbers' Cave.

Description of the Robbers' Cave

The cavity is situated near Mahableshwar, at an altitude of about 1200 m. in a depression in a partly forested plateau. The origin of the cave is not quite clear, limestone being absent in the neighbourhood. In shape the cavity is like a simple gallery, about 5 m. broad, 2.5 m. high, and 60 m. deep. A portion of the roof has fallen in lighting up the first 30 m. of the gallery, which becomes quite dark afterwards. The floor of the cave is partially filled with guano, mixed with water. The observer who wishes to go further than the entrance must enter into this foul-smelling mud more than half a metre deep and covered with varying depths of water at different seasons. The water maintains the humidity of the cave, and also protects its inhabitants against predators. The walls and the ceiling of the cavity are completely covered with the bats. The bottom is closed by the classical syphon, which very often marks the end of natural caves.

The secondary habitat at Panchgani is a natural cavity, rather large and well lighted, high but not deep, with ramifications facing outwards on the cliff above the town.

Hunting Territory

For such an enormous colony, the territory must be immense, and probably covers all the forests and mountains far around the Robbers' Cave.

I had the opportunity of noting their evening departure which lasted for about 20 minutes. After numerous goings and comings at the entrance of the cave, the bats fly out early at sunset. They do not stay near the cave, but immediately go far away, all following their own ways above paths or between the trees. Their ways lead them in all directions. Each bat perhaps has its own well-established hunting territory, for the start of each individual is made without hesitation, in a direction apparently familiar to the animal.

I saw some *Miniopterus* hunting around the village of Mahableshwar, 4 kilometres from the Robbers' Cave.

Field Characters

In the diurnal biotope, the proximity of a colony of *Miniopterus* is betrayed by the screaming of these bats which reminds one of the noise of fish put in hot oil for frying! Each cry is probably weak, but when uttered by thousands at a time, as is usually the case, the noise may be detected from afar. The smell of the guano is strong, and sometimes permitted location of the haunt from more than 200 metres. Finally, the sight of thousands of bats closely pressed, covering the ceiling of the cave in several layers, is an amazing sight usually sufficient to identify the species.

On the wing, *M. schreibersi* appears as a strong and fast flyer. Due to the long tail and wings, the silhouette of this bat recalls that of swallows. The individuals seen in their hunting territory were flying alone, wheeling in large circles, at middle height.

Food

The analysis of the guano is difficult, if not impossible. I was able to recognize therein wings of Diptera, and small pieces of Coleoptera. The dentition, sharp but weak, denotes that *M. schreibersi* is an eater of small and soft insects.

Reproduction

The reproduction of *Miniopterus* presents remarkable peculiarities. I will give here a summary of my observations which will be developed in detail in another paper (cf. Brosset, La reproduction des chiroptères de l'Ouest de l'Inde. *Mammalia,* August 1962).

Reproduction begins for both males and females after the first year. In fact, during the spring, non-pregnant young females and males without secondary sexual characters (baldness of the top of the head) seemed numerous (about one-third) in the colony at the Robbers' Cave. The rut probably takes place at the end of winter. The duration of pregnancy seems exceptionally long for a small insectivorous bat. Three females dissected on 7 April had foetuses 11 mm. long, seven dissected on 13 May had foetuses 19 mm. long, and the birth of all young takes place around 25 June. It seems that the duration of pregnancy is about five months. The periodicity of the reproduction is absolutely strict; parturition for all females takes place at the same time at the end of June, with a single young for each one. So on 6 August 1960, all the young were about 40 days old, with a difference of not more than 4 or 5 days between the youngest and the oldest.

The young are not carried by the mothers, but are put all together in an enormous swarm, which in the Robbers' Cave contained thousands of young. The parents are not mixed with them, but are among the swarms of adults at the sides. The suckling of the young is not an individual but a communal business. The female places herself on the surface of the swarm of young and suckles the first that contacts her. Often, two young feed together. If a young is not active enough, another takes its place. This behaviour was principally observed in France, but there can be no doubt that it is the same in the Robbers' Cave.

For the first 50 days, the young, even when as large as the parents, are a flesh-coloured pink, and completely naked. According to my observations in Europe and Africa, the growth of the fur is exceedingly fast, and only requires a few days. The young are able to attend to their own needs when two months old.

Social Life

The highly gregarious *Miniopterus schreibersi* form the largest known colonies amongst bats, in Europe, Palaearctic Africa, and India. Without experience it is not possible to estimate correctly the number of individuals living in one colony. I had the opportunity of attempting a census of individuals in the colonies at Rancogne in

France, and Panchgani in India. I was lucky enough to find the former colony, one day in April, in a state of deep hibernation. It was easy to separate a measured section of the bat-covered surface, count the bats in it, and calculate the total number by the rule of three. The surface counted was 0.20 sq. metres, in which area the number of bats was 400. In Panchgani Mr. Humayun Abdulali and I dealing with a small swarm of *Miniopterus* counted a test area of 0.20 sq. metres and found almost the same density. A French naturalist and friend of mine, G. Goguyer, made in France a census of this species; his conclusions are approximately the same: an average density of 2000 per square metre. If we consider that the colony in the Robbers' Cave covers about 80 sq. metres of the ceiling, we can confidently say that this colony consists of more than 100,000 individuals.

In the swarm, the bats keep their heads down, extraordinarily pressed together, and often in several layers. Isolated individuals hanging by their fore limbs are scattered all round. There is no segregation of the sexes, immatures, adult females, and males are all mixed together (observations in Europe, Africa, and India, and supported by 7000 captures). Only the non-flying young lived aside separately.

Migrations

It seems that the displacements or movements of the individuals are connected with the ecology of the species. Frequently, they travel from the 'mother house' to their secondary habitat and then return. In France, where this behaviour has been studied by ringing, the secondary habitats were within a radius of 70 km. around the main cave.

Similar displacements are certain in India. The caves of Panchgani which constitute a secondary habitat of the giant colony at the Robbers' Cave, was inhabited by 20-30 individuals in February, 5-10 in May, and 400-500 in August. These bats, although all adult, had no young with them in August and were apparently not reproductive individuals. In France, also, reproduction was never observed in the secondary habitats.

Connection with man

The colonies of *Miniopterus* are usually situated in areas rich in insects, and the bats are probably a very important element in the natural balance of species in their biotopes. Thousands of millions of insects are certainly destroyed each year by a single colony like that at the Robbers' Cave. We see, unfortunately, in Europe, such colonies decreasing and even disappearing, due to the arrangements made for tourists, or the disturbance caused by the repeated visits of naturalists. We hope that similar errors and destruction will be avoided in India.

Subfamily KERIVOULINAE

Genus *Kerivoula*

Kerivoula picta (Pallas, 1767)

Measurements (in mm.):

		Localities				
		Khandala □ ♂	Dharwar ○ ♀	Bombay ○ ♀	Bombay ○ ♂	Borivli ○ ♀
	Forearm	33	32	35	35	35
	2nd Finger	33	34	33	30	36
3rd finger	Metacarpal	33	33	34	34	34
	1st Phalange	17	16	16	15	16
	2nd Phalange	25	23	25	25	24
4th finger	Metacarpal	34	34	33	34	34
	1st Phalange	12	12	10	10	10
	2nd Phalange	12	12	10	11	12
5th finger	Metacarpal	33	33	32	32	34
	1st Phalange	11	11	9	9	9
	2nd Phalange	11	12	10	9	10
	Tarsus	14	14	14	14	14
	Tail	34	35	35	35	40

Description

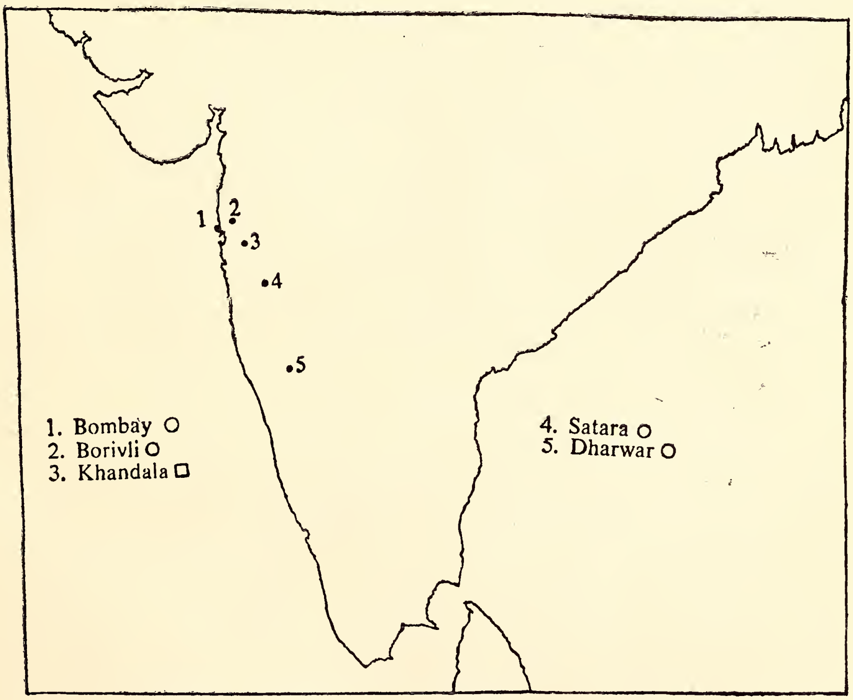
The bright colour of the fur and the membranes make this bat unmistakable. It is reddish, more or less bright above and lighter below, varying from rufous to orange. These colours extend largely on to the wings, and along the fingers. The ears are funnel-shaped, and the tragus is very long, narrow, and transparent. A row of stiff hair can be seen on the border of the uropatagium membrane.

General Distribution

Approximately southern China, Hainan, Ceylon, India, Burma (Blanford), Malay States, Sumatra, Java, Bali, and Borneo.

Distribution in western and central India

Probably a common species, at least in the Ghats, the Konkan, and Kanara. But the capture and even the observation of this bat is difficult and all specimens known for India seem to have been found accidentally.



Map 29. Localities where *Kerivoula picta* were studied

Biology

Phillips has given a few notes from Ceylon. He said it was usually discovered hiding singly or in pairs in the dry hanging leaves of a plantain or other large-leaved tree. The flight he says is rather fluttering similar to that of a large moth. When handled it opens its mouth as wide as possible and stays in that position emitting an inaudible sound.

Navarro made enquiries at Bassein, Bombay, where plantains are largely grown and got no information regarding any species of bat frequenting the area.

Chapters on the History of Botany in India

V. THE UNDERTAKING OF TWO GREAT ENTERPRISES, THE FLORA OF THE HIGHER PLANTS AND THE FOREST SERVICE

BY

I. H. BURKILL

[*Continued from Vol.* **59** (2) : 359]

1. A TEXT-BOOK FOR THE TAXONOMY OF INDIAN FLOWERING PLANTS

In 1861 **Daniel Oliver** was appointed Professor of Botany in the University of London in succession to John Lindley. In 1864 he published a small book entitled LESSONS IN ELEMENTARY BOTANY which was intended to supplement the teaching of his British students in taxonomic botany on British types. Substituting Indian types he sought to adjust the book for use in India, and as the floras of Britain and India are so diverse the whole had to be rewritten and the illustrations replaced. With the title FIRST BOOK OF INDIAN BOTANY it appeared in 1869 and long held its place. Who they were who bought and referred to it is hard to say ; but it was fitted to be a refresher to surgeons serving in India and a vade-mecum to those beginning service.

THE INDIA OFFICE REALISES THE PRIOR NEED OF A FLORA

It has been mentioned in the last chapter how it was that the FLORA INDICA of **Hooker & Thomson** came to an end from Hooker's failure to obtain financial aid towards its printing. As he was at the time receiving help from the Admiralty towards the publication of his Antarctic results, the unwillingness of the East India Company to see his work through was a great blow. They had given a grant which covered rather less than one half of his travel-expenses and with that their subvention ended ; it is not incorrect to say that the Directors' subvention was a buying of geographic information which they needed ; the Botany did not interest them. Hooker had sought support in other places without success.

About 1870 the India Office had decisions to take touching Botany in India ; and someone reminded the Office that Hooker had proposed a FLORA seeking financial support from the East India Company.

So far had this proposal gone out of sight that all the Office's papers could not be found and some had to be replaced by copies from files at Kew. Thomson was still alive but in poor health ; Hooker was available and moreover had all the resources of Kew behind him. Hooker was asked if he could undertake to produce a FLORA and consented. By way of economy there was to be compression ; and the whole was to be in English. Thus originated Hooker's FLORA OF BRITISH INDIA in seven volumes ; and, because the FLORA INDICA that Hooker and Thomson had commenced could be used as far as it went, the first volume of the new work was out of the press in 1872. The admission of the Directors that it was a duty to plan Education bound their successors in the India Office to see to the publication of a FLORA.

2. Charles Baron Clarke (1832-1908)

This brilliant mathematician—the third Wrangler of his year at Cambridge—spent the next 10 years of his life quietly teaching mathematics and using his leisure to botanize in Britain, Switzerland, and Madeira. In 1866 he left Cambridge to teach in the Presidency College, Calcutta. As if to call attention to his change he published a list of the plants of his native town, Andover, a very small town on the edge of the Salisbury Plain. It was the only publication made by him to that date. He returned to his interest in the Madeira flora later. He had been in India but two years when Thomas Anderson was invalided and he was appointed to act for him. The following statement corrects several confusions that have appeared in print.

Thomas Anderson had taken up his post in 1861 and had received instructions to establish Cinchona in the Sikkim Himalaya ; he proceeded at the end of that year to Java with plants for the Dutch in exchange for others that he brought back. He discovered in Java that Kurz would accept a post in the Calcutta Botanic Garden, and on his return arranged it. Anderson had the assistance of A. T. Jaffray in getting the Java Cinchona and Cinchonas from the Nilgiri Hills to Darjeeling. Jaffray belonged to Madras and went back. To Anderson **John Scott** was sent out (1864) and was followed by **James A. Gammie** (1865). When **Robert Scott**, the then Horticultural Curator in the Botanical Garden resigned (1865), John Scott was called to Calcutta to take his place. Kurz had settled down to write a FLORA OF BENGAL ; but a report on the forest wealth of the Convict Settlement in the Andamans was wanted and Kurz was delegated (1872). After the Andamans flora Kurz was directed to that of Burma, on which he began to publish in 1872 and on which were all the further publications of his life.

C. B. Clarke had arrived in Calcutta in 1866. He made use of his first long vacation to visit and collect in the Khasia Hills. Then

Anderson's health gave way entirely and Clarke was appointed to act. He took over charge in Calcutta and then of the Cinchona plantation at Mungpu where James Gammie was extending his planted area. He seems to have contrived in Sikkim to do a little collecting. In the next year he visited the Nilgiri plantations and also collected. In 1871 he was again in Sikkim to enable King to take over from him. In each of the following years he made one long collecting journey : the Khasia Hills for the second time (1872), Kangra and Chamba (1874), Sikkim (1875) again, and lastly, before taking leave, Kashmir and through to Karakoram (1876). Through Clarke's two years it seems that the Cinchona undertaking moved on the lines that Anderson had given it and John Scott was doing what he could to restore the damaged Calcutta Garden ; Kurz was on a profitable line of work and all that he wanted were facilities for it. By the way in which Clarke threw himself into collecting when back to the Education Service, he probably chafed when tied to Calcutta until Surgeon Captain George King, who had now had 6 years in India, was appointed Superintendent of the Garden in 1872 and relieved him.

Between inspections of schools up and down the Bengal plain he went on with his collecting. There the weeds of cultivation may be said to have intruded on his interest, for most of his travelling was through the cultivated fields, where the glare of the sun combined with his shortness of sight made him in general look down. Nevertheless his near vision was excellent. These circumstances seem to have heightened his interest in the Cyperaceae, Commelinaceae, and little Scrophulariaceae—three families in which field-weeds abound.

He botanized further away in the school vacations, sometimes going far, and did it with the methodic ways of a mathematician : the specimens were always ticketed and annotated before there was any chance of information going astray. When long leave became due to him, which was in 1877, he took to Britain very considerable collections from the north of India, including the Khasia Hills, Sikkim, the north-west Himalaya, both the forward parts and back to the Upper Indus and beyond to Askole. Along with these of the north of India, he had plants from the Nilgiri Hills. He took all to Kew for elaboration, and he offered his services there to Sir Joseph Hooker, who had now commenced the printing of the second volume of the FLORA. The reader will find information in § 3 below regarding his substantial aid. When the termination of his leave approached an arrangement was made by which he continued to work at the FLORA at Kew until 1883. Returning to India after that he had a further four years in the East, half of it in Bengal and half of it in Assam.

Every botanist familiar with the Herbarium at Kew, knows the geographic arrangement of the species-covers : the planning of it was largely Clarke's. He interested himself in geographic botany and wrote on it.

As recorded in the last chapter Hooker and Thomson elaborated in the first half of the only published volume of the FLORA INDICA a way of dividing India into what they called provinces. It is impossible to deal with plant-geography without putting forward such divisions ; Clarke came to it and treated the flora differently, though there is evidence that there had been discussion between him and Hooker. Clarke's use of the word ' area ' for a geographic expanse is thoroughly commendable and so is his use of sub-area and sub-sub-area for divisions of the area. Hooker started from a different position. He, and Thomson working with him, had a political unit and this they divided into three parts that they called regions. Their regions are geographic, not phyto-geographic. Clarke starts with geographic south-eastern Asia—his adjective is Indo-Chinese—and he takes out of it a sub-area which is India. He is still geographic here : but at the next stage—his sub-sub-area stage—he endeavours to be phyto-geographic, i.e. to have got down to an area small enough to have distinguishing characters in its vegetation. To the problems raised by this approach to phyto-geography I shall need to return later. What I desire here is to attribute to Clarke his due. The chief paper in which he laid out his facts is the presidential address that he gave in 1898 to the Linnean Society.

Clarke's interest extended over the ferns and he published a monograph of those of northern India. He reprinted at his own cost Roxburgh's FLORA INDICA, not because he had a liking for the Linnean system of classification, but because he felt that the medical students had a need of a classification and that such a work in the Natural System as Griffith suggested was not a thing for which he had time.

3. HOOKER'S HELPERS AND PROGRESS WITH *FLORA OF BRITISH INDIA*

It has been mentioned that the preparation of Hooker's FLORA OF BRITISH INDIA began with a revision of families that had had a place in Hooker & Thomson's FLORA INDICA. Hooker, tied by his official duties, enlisted the co-operation of several eminent botanists : **Thomas Anderson, Alfred William Bennett, Michael Pakenham Edgeworth, William Turner Thiselton-Dyer, Maxwell Tylden Masters, William Philip Hiern,** and **Malmaduke Alexander Lawson** ; between them they relieved him of two-thirds of a volume of 700 pages, published in 1872. There were larger and more exacting families just ahead. Of these **John Gilbert Baker** took the Leguminosae ; Hooker reserved the Rosaceae for himself, and entrusted the Myrtaceae to **John Firminger Duthie**. Meanwhile **Charles Baron Clarke** appeared at Kew on leave from India and began to take part, writing all but a very little of the remaining part of volume 2 which was out in three parts, 1876, 1878, and 1879. Clarke's work began to appear in the last of these three parts. He had brought his own most extensive collections to aid. A fourth botanist, **George Henslow**, had a small part in this volume. Clarke continued to aid ; of volume 3 he wrote almost 200 pages and 520 out of the 734 pages of volume 4, Hooker writing the rest. It was Clarke's permission to stay in Britain that enabled him to give this great help ; but the time came when a return had to be faced and consequently to the last three volumes his only contribution was the Cyperaceae. All the difficult families of these three volumes were elaborated by Hooker but the sub-order ' Bambuseeae ' which was the work of General **William Munro.** Hooker's work on the Gramineae was wonderful. The self-effacing work of Clarke is to all botanists a matter of extensive gratitude. The last volume of the FLORA was published in 1897.

4. Sir George Campbell endeavours to promote the teaching of botany with an unforeseen result

Sir **George Campbell,** Lieut.-Governor of Bengal, whose interest in the rural economy of his Presidency led to the building up of the collections of the Bengal Economic Museum, suggested that Botany and Chemistry should be taught in the Presidency College, Calcutta. The proposal became exceedingly controversial ; and it is difficult to see how it could have been otherwise. But he carried his advocacy so far as to get from Britain a teacher (professor) for each subject. The teacher chosen for the botanical professorship was **George Watt.**

George Watt (1851-1930) had newly qualified in Medicine at the University of Glasgow. He asked for a little delay in sailing and when he reported his arrival in Calcutta (November 1873), Sir George Campbell had taken leave prior to retirement and the opponents of bringing Botany into the teaching of the Presidency College held the field. It happened that Clarke had to receive Watt for the head of his Department and tell him, which he did with a measure of hesitation, that he would not teach in the College, but that a post at Hoogli was open to him, and that certain compensation would be given if he would accept it. Watt did, and went to Hoogli.

A fitting reward had been offered for a text-book, and it was to get it that Watt wrote his FIRST STEPS IN BOTANY. This the Government caused to be translated and published in Bengali (1876). It had no sale as there were no students. Watt followed it up by a smaller book written (1877) at the suggestion of a mission, but it is not known to have been used for teaching. It would have been exacting on one so new to India to hit on the perfectly apt plants for illustration, but the writing was to him invaluable in that during writing he himself was learning. In vacations he made collecting trips—one (1879) to Kulu in the north-west

Himalaya, and one (1881) to Jongri in Sikkim. He began to think there was in travel a way out of his frustration and made attempts to induce the Government to give him opportunities. They gave him one : he was attached as a Surgeon to a commission demarcating the Burma-Manipur boundary. He made good use of his time in the field, but did not work out his collections as he saw another opening, for which immediately after the months in Manipur, he asked. It was employment on the staff of the Calcutta Exhibition of 1883-1884 ; and he got it. Now at last, with 10 years of Indian experience behind him, he was where his genius came to the front. He threw his immense energy into amassing exhibits. He brought his ability for organizing into action and by a great effort compiled in a few months a statement of over 1700 pages enumerating the economic products of India, a statement which served firstly as an indent on the Provinces and secondly as a catalogue for the exhibits, and thirdly as a scheme for their arranging. A man who could do this was clearly capable of more ; for instance he could put his knowledge into a cyclopaedia ; and he was given the work of compiling his DICTIONARY OF THE ECONOMIC PRODUCTS OF INDIA. Furthermore he was told that he would be required for the forthcoming Indian and Colonial Exhibition in London.

Watt commenced the compiling of his DICTIONARY while waiting for the time of departure for London and had the first volume in print before he sailed. Called to teach in the Presidency College, he never did so ; but was from this time devoted to the service of a much larger audience to whom it was his to expose the ' wealth of India '.

When the Indian Court of the Indian and Colonial Exhibition had been closed and he had returned to Calcutta, his first duty was to complete the writing of his DICTIONARY. Then followed the creating of a permanent exhibition for Calcutta ; one may call it the DICTIONARY illustrated for the illiterate as well as the literate. And lastly came the exhibition of Indian Art at the Delhi Durbar of 1902. On the occasion of this last he was knighted—a very great man on the instruction side of applied Botany in India.

His last work was a revision of the major articles in the DICTIONARY being those on products which command a place in trade.

5. THE SAHARANPUR GARDEN DURING THE TIME OF THE SECOND CALCUTTA GARDEN, AND AFTER

For the resuscitation of the Saharanpur Garden with **George Govan** in charge, the reader is referred to Chapter I, [*J. Bombay nat. Hist. Soc.* **51** (4), p. 871]. The charge was given, because Govan was the Civil Surgeon and quite competent to take it as an addition to his medical work. Govan soon retired ; and **Royle** succeeded him as Civil Surgeon and in charge of the Garden. He was active in stocking it with pretty plants and economic plants ; and by reason of climate and distance from Calcutta he did this without overlapping. When he took long leave—leave from which he did not return—the post went to **Hugh Falconer**, who had been for such a short time in India that the promotion is astonishing : but Falconer was of outstanding ability. In this appointment he had 9 years but through two of them he was away exploring. His arrival in Upper India coincided with the discovery of fossilized mammal bones where the Canal Engineers were constructing the intake of the Jumna Canals and being at heart a geologist he entered into a study of them with zeal and with immense credit to himself. In 1841 his health gave way, and he was forced to leave. The post now went to **William Jameson** who held it for 33 years. He had been in India only 4 years when appointed to it. The reader may be reminded that this was the third time that the appointment had gone to a comparative novice, whereas that of Calcutta was reserved for older men ; and it may be called to his attention that two of the Saharanpur superintendents became, when older, superintendents of Calcutta. The Calcutta post was intended to be a larger responsibility.

William Jameson (1815-1882) had qualified in medicine in Edinburgh. He reached India in 1838 and for a short time was in Calcutta where he aided the Asiatic Society in their Museum. During his long tenure of the Saharanpur post he did much towards pushing crops into the neighbouring hills, but comparatively little that was botanical. He would collect if a demand reached him, but not determine what he had collected. In this way he made collections for Hooker when he expected Hooker and Thomson to elaborate their FLORA INDICA at once. He had an unpleasant adventure in the very beginning of his service, when having gone to the Indus below Attock to enquire what the cause had been of disastrous floods there, the Chief of Kohat set on his company and imprisoned him.

In his economic work there was a lack of incisiveness which let him labour too long at causes which were destined to disappoint. The Kangra tea planting was one. Royle and Falconer had so stoutly recommended trials, that he was bound to try the crop. And he did, and succeeded in demonstrating that within the species *Thea sinensis* races exist suited for the north-west Himalaya. But to raise a crop does not insure a market if quality be lacking ; that was patent. Yet Jameson went on and he actually became a planter himself on retirement. A second quest on which he spent much time was directed towards getting the flax plant raised for fibre. It could be raised for linseed, why not for fibre ? Again the inhibition was economic. A third quest was in potato raising. The raising was all right : Simla, for instance got its potatoes from close at hand ; but when the crop was harvested, the rain carried away the now bared soil and sterilized the hillside. Much hill-soil went down the Sutlej and Jumna.

Of course during Jameson's 33 years in the Saharanpur post there were several periods of leave. In one of them **J. L. Stewart** acted; in another **George King.**

When Jameson's retirement came, **J. F. Duthie** was appointed his successor (1876), the post going outside the Medical Service, for Duthie was not a Surgeon, he had been holding a professorship in the Agricultural College at Cirencester. It looks as if those who selected Jameson's successor were seeking a man of economic interests such as Jameson was; instead they obtained a man of strong taxonomic interests, but all the same he gave to the Government much in point relating to economic plants. The following is, in a very curtailed form, Duthie's outline.

John Firminger Duthie (1845-1929) with a degree taken at Cambridge in the Natural Sciences (1867) and, after travelling in the Mediterranean collecting plants, became the Professor of Natural History at the Cirencester Agricultural College, followed in the next year (1876) by appointment to the care of the Saharanpur Garden, where he started by taking stock of the flora, wild and cultivated. Of the wild he compiled an enumeration. The great need of fodder in the dry north-west drove him to pay attention particularly to the grasses, on which he wrote and which he illustrated. Jointly with **Joseph Bampfylde Fuller** (afterwards knighted) he illustrated in a like way the crops, starting in 1882. Year by year he made a long exploring expedition, bringing into the Saharanpur herbarium considerable material. These expeditions were more often in the Himalaya than in the low country and were spread from Gilgit to the western edge of Nepal. By degrees the information on the plants of the plains grew adequate for the compiling of a FLORA, and he published his first part in 1903, by which time he had been collecting material for it for a quarter of a century. He was extremely particular in matters of detail; and this so delayed him that he did not finish it. Moreover the area which he accepted was large, being as the title has it a FLORA OF THE UPPER GANGETIC PLAIN AND OF THE ADJACENT SIWALIK AND SUB-HIMALAYAN TRACTS. The lay-out deserves great praise. On the other hand for the north-western Himalaya there never was, nor could have been the material for a FLORA: Duthie's labours caused materials to accumulate. He returned to Britain in 1903 and was for a short time Assistant for India at Kew; the position enabling further work, notably a full report on the plants of Sir **Richard Strachey**'s traverse of the Kumaon Himalaya from the Gangetic Plains to the upper or gritty Tibetan Plateau.

Duthie trained a notable collector, **Inayat Khan,** who came to know the vegetation of the District of Hazara with remarkable thoroughness; and Duthie also exercised considerable influence over **Upendranath Kanji Lal,** whose FLORA OF THE SCHOOL CIRCLE, DEHRA DUN, has the lay-out of Duthie's FLORA. He caused the Saharanpur Garden to be a collecting centre to which Army officers sent gatherings from remote places, so saving them from being lost. His teaching in the Forest School at Dehra Dun by excursions with the pupils was of immense value to the Forest Service.

It is convenient to mention here in passing a botanist of the Punjab of almost the same years as Duthie, but not closely associated with him. This was **James Ramsay Drummond** (1851-1921), nephew of two men who made their mark as collectors in different parts of the world—James Drummond (1784-1863) in Australia and Thomas Drummond (?-1835) in North America. James Ramsay Drummond collected in India as if collecting were in the blood, employing trained men. His considerable collections were given to Kew.

6. Prairie Fires

Prairie fires and forest fires intrude into our history. Their effects are so obvious as to compel a botanist's attention ; they reshape the medium in which he works, their economic consequences keep them in the highest lights. Prairie fires are fed by grasses and spread under the open sky ; forest fires spread under and among trees. They grade into each other, the first the less destructive. The cumulative effects of forest fires at close intervals prepare the surface for prairie fires ; and the cumulative effect of prairie fires is degenerated prairie.

On a hot cloudless afternoon in the hottest part of the year it happened once that my work took me to the border of the Toung-Yin teak forest in Tenasserim. I had crossed the level land from Moulmein and had just reached the first rise of the Dawna Hills within which this forest begins, when a line of fire arrived through the virgin forest of the plain. The flames were gentle ; they scarce exceeded 12 inches in height. My road happened to part the level from the first rise of the hills. A spark leapt across it, and there followed a rush of flame up the hill through shrubs, small bamboos, and the lanky grasses that straggled into these. The bamboos exploded as the grass about them burned. Timid animals appeared from hiding places and fled. The contrast between the fire on the level and the fire on the slope was great. Nature was helping the latter in two ways : one was by the rising of the ground ; the other in the deteriorated scrubby state of the vegetation as the result of the passing of previous fires. Nature greatly helps. In this case the aid was remotely through the drainage of the slope of the hillside ; secondly by the advantage to the fire of a slope to ascend ; and thirdly by the use of an established fire-path. The big trees had gone from it ; fires attack them by killing their seedlings as well as by exposing to drying the damp soil which suits them. The light let in had favoured grasses and bamboos ;

and the fire was the fiercer consequently. As I saw at the foot of the Dawna Hills, so everywhere the effect of firing varies with its relation to the contribution that Nature makes.

An extreme case of contribution is when a big river sterilizes areas by depositing sand as sandbanks.

After accepting that areas are naturally exposed in varying degree to the effects of fire the next step is to note the consequences of recurrent firing, and that the longer lived by nature the trees that are removed the more remote becomes recovery.

My readers if they have access to Sir **Dietrich Brandis's** book, INDIAN TREES (1906), will find interesting facts in it to which I would now refer. At various pages he directs attention to relatively lowly woody plants which grow in places frequently fired and survive by possessing the power of making good after a fire has passed, from underground stems ; and it is the covering of soil which secures survival. They have evolved the provision of protected buds where buds are relatively unusual in their allies. One of these plants is *Indigofera hamiltonii.* Its specificity was not admitted in the FLORA OF BRITISH INDIA, where the above name will be found as a synonym under *I. atropurpurea* Ham. Others are *Flemingia nana* Roxb. and *F. sericans* Kurz, and *Erythrina resupinata* Roxb., equally belonging to the family Leguminosae ; *Ochna pusilla* Ham. of the Ochnaceae ; *Olax nana* Wall. of the Olacaceae ; *Careya herbacea* Roxb. of the Myrtaceae ; *Combretum nanum* Ham. of the Combretaceae ; *Mussaenda uniflora* Wall. and *M. incana* Wall. of the Rubiaceae ; *Premna nana* Collett & Hemsl. of the Verbenaceae; and *Jasminum smalesianum* Brandis of the Oleaceae. To these may be added *Grewia scabrophylla* Roxb. of the Tiliaceae in which the character is rather variable, for it grows into a tall shrub if not annually burned down.

Further, attention may be drawn to such herbs as the orchid, *Pachystoma senile* Reichenb. f., whose annual cycle keeps it underground through the months when grass-fires are liable to spread. More could be cited ; but those named suffice. I ask my reader to keep in mind the presence of such plants in India ; and I have further to ask him to note that they are Indian apparently by origin and for that reason evidence of grass fires in India over their time of evolution.

My reader, having consented that the existence of such plants is evidence of exposure to fires for as long a time as their evolution has required, asks where did the exposure take place. And the answer, taken from their present distribution, is—in the part of Asia which is now India and most probably in India itself. The answer implies firing in India.

Grass can be fired by agencies which Man does not control—by lightning for instance ; by sparks that a landslide produces when its stones collide ; by long continued friction in a steady breeze of one dry bamboo over another. But such occurrences would seem to be far too rare for a plant to develop characters to counteract. On the other hand pastoral Man's deliberate incendiarism suffices. Over how many centuries can its operation be claimed? The cultivator in south-western Asia can be shown to have started his selection of cereals 7 or 8 millenia ago and probably earlier (See *Proc. Linn. Soc. Lond.* **164,** p. 42, 1953). The pastoralist came before him, and it were not unreasonable to think of 10,000 years as serving the pastoralists. Inasmuch as the cultivation of annual crops has extracted from them cultigens, the pastoralists would have had time enough for their annual fires to have led to the evolution of new species in the grasslands, so long as Nature co-operated with them. I am prepared to think that as remotely as the passing away of the Glacial Period such firing could have commenced to be fairly regular in the Near East with extension to northern India. I am also prepared to think that in the course of time this incendiarism spread down the peninsula of India on the eastern side of the Western Ghats. And I recommend the problems raised to those who can study the northern plains, the southern grassy hills, and the patanas of Ceylon.

The pastoralist who begins to use fire would continue until it became a religious observance carried out even without needing to fire in order to get herbage for animals.

It is impossible to travel about the wide plains of the Indus and the Ganges without recognizing that at one time they carried trees that have gone.

Forest destruction colours the imagery of the Mahabharata, and the suggestion has been made that Alexander the Great was favoured in his crossing of the Indus to attack Poros by trees then existing in concealing density (326 B.C.). It is impossible to look at many southern hillsides without thinking of their lost trees. The removal of forest brings interference with the springs by drying of the ambit of their sources. This was effectively brought to the notice of those who built the first permanent houses in the Nilgiri Hills ; they found their supply of water uncertain. The villagers, too, found that they had further to go for water as for fuel. A realization of this, unreasonably late in time, led to ideas of the importance of forests and contemporaneously ecological ideas touched the more thoughtful in India. It is with this that my next sections deal.

7. Safeguarding the growth of Teak in Burma

In the year 1826 by a treaty between the East India Company and the King of Burma, the province of Tenasserim was put into the charge of the Company ; and Wallich was immediately sent to report on the teak forests. He returned saying that there was plenty of standing teak and that a crop should be taken, but that the teak forests should be declared ' preserved ' at once, otherwise they would be ruined in a scramble for that timber. The Company acted on his advice for no longer than two years and then took the short cut of substituting a system of leasing out rights to exploit. It is not necessary here to discuss this ; it suffices to note the rapidity with which Moulmein grew rich when the Administration had thus put itself into blinkers. One hundred and nine ships were built in the 20 years between 1830 and 1850 with a great wastage of timber, not in the dockyard but in the forests where the logs were felled in preparation for marketing and then not removed.

In 1837 an Austrian explorer **Johann Wilhelm Helfer** arrived in Tenasserim, having an idea that he would like to settle there, and the Company, thinking to get good independent advice, sought it from him. He said, as others were saying, that the forests were being destroyed. Two years later the Company sent **Hugh Falconer** to visit the two forests that were exploited from Moulmein, that of the Toung-yin and that of the upper Attaran River. Falconer reported on the latter ; his time ran out before he could visit the former ; but the opinion he gave applies to both. It was that distant control, attempted from Moulmein by officers who had other affairs to attend to, was ineffectual.

Falconer pointed out that the teak tree is there invariably in a minority among the associated trees and that competition is a normal factor in its life. He listed the competitors ; but the end of the fine weather coming, he could not get far.

As a result of what Falconer said, the Company sent **McClelland** to the Pegu forests that he might collect the competing species there, which he did thoroughly enough. His report (1855), not however by its matter but by the circumstance that the receipt of it drew the attention of the Governor-General Lord Dalhousie to teak, led to the writing of a most important memorandum on the policy which he thought should be pursued. Then began a search for an administrator with the required preliminary knowledge of botanical methods and the choice fell on Dr. **Dietrich Brandis**, son of a Professor of the German University of Bonn and himself a teacher of Botany there.

Falconer's suggestion that the teak tree normally lives in competition did not give rise to the thought that there might be compensations. Ecology was too primitive for the idea that the mixed forest by the resultant isolation of the individual could get a measure of protection against the spread of diseases. Meanwhile the coffee planters in Ceylon were leading up to a position that made obvious the possibility. Teak very rarely grows in small pure stands.

Here we part with McClelland. He remained in India until 1865 having reached it in 1830. He has been described as having mediocre ability, but ' born to be a hodman '. He arrived in India with a reputation for geology and was employed studying soils in the hills of Kumaon and was there when required to report on the soils where tea could be found, and so went to Assam with Wallich and Griffith (1835). His report was held to be good. After this he was in and out of Calcutta and for a time worked on the collections of the Asiatic Society, writing a report on the species of carp in India. His central position in Calcutta led to the founding (1841) of his *Calcutta Journal of Natural History* which lasted to 1847. His comradeship with Griffith ended in worship ; and it was to Griffith that he became hodman. When he had reported on his work in Pegu, the successor to whom the forests were handed was Sir Dietrich Brandis.

8. Teak in the peninsula of India

Ring the bark of the ripe teak trees ; and let the trunks die standing : they will grow light enough to float and then, felled, use all possible water-porterage to get them to where they are wanted. That treatment has made them peculiarly serviceable down the Bombay coast. We know that teak beams were carried to the Euphrates at least as early as 800 B.C. If teak was carried, teak ships conveyed it. Where were they built ? The merchant Cosmas Indikopleustes, writing much later however of ' sesame logs exported from Calliana ', apparently referred to teak that was sent westwards from the Bombay coast. The trade would be slow but continuous. Teak could reach the sea down rivers on the Malabar coast from the Narbada southwards, and on the side of the Bay of Bengal from the Godavari southwards. We read later of *navies* in the Bay.

The East India Company's activity in their Bombay Dockyard produced a demand which strained the supply from time to time and provoked demands for control. I have mentioned in Chapter 1 (*J. Bombay nat. Hist. Soc.* **51** (4), p. 874) an attempt about 1800 A.D. at controlling felling in the southern part of Malabar to safeguard the dockyard's supply. The control was not allowed to last long ; but there was another demand in 1822 and with it a claim that the control was workable as it had succeeded in the limited area of Travancore. There was nothing botanical in these spasmodic controls, nor requiring our attention until 1842 when the Government of the Presidency of Madras ' to safeguard the future ' permitted the Collector of the District of Malabar, **H. V. Conolly,** to buy up worked-out teak forest and to spend money on planting teak in it. Within what was his District are the Nilambur forests with conditions ideal for teak ; and he is said to have planted over 50,000 seedlings. Conolly has been mentioned in Chapter 3 (*J. Bombay nat. Hist. Soc.* **58** : 680) and along with him Lieutenant Michael who made an attempt at fire-protection by sweeping dead leaves from the seedling plants. Michael's operations were done in the Anaimalai Hills and so a little to the south of Conolly's. Cleghorn, who had earlier recommended fire-protection ,obtained his first knowledge of teak further to the north in the Shimoga District. Michael's protective sweepings begin the real history of care for the teak tree in peninsular India. The Swiss horticulturist, **Georges Samuel Perrottet,** employed in Pondicherry, passing by, was asked what he thought of Michael's sweepings and with an illuminating insight suggested the need of directions from a ' vegetable physiologist '. Conolly's wish for a ' properly qualified conservator ' suggests that he too was aware of his and his associates' inadequacy. Michael gained a commendation from the Company's Directors in London for a report made in 1849, and the expression of a hope that the forests under him would escape ' the serious injury that other forests had incurred '. So we see that the Company was awake : indeed they had before this appointed Conservators of Forests, **Cleghorn** and **Gibson,** for Madras and Bombay respectively. Appreciating Michael's activity they sent him to Moulmein in 1861 to learn the Tenasserim way of transporting logs, which seems to have been good. The Moulmein fault was waste in the forests by felling and neglecting to take away.

Cleghorn took the position that the fault in Mysore was letting forest fires run through the forests ; and he had a temporary administrative success in getting shifting cultivation prohibited ; but the Mysore Government went back. Later he experienced the same vacillation from the Presidency Government whose land records were in a confusion which took years to unravel. This briefly was why the Madras Forest Act came to be the last of its series ; it came only in 1882.

Passing to Bombay, attention falls on **Alexander Gibson** (1800-1867). He, like Cleghorn, was an Edinburgh student, but took his qualification in Medicine twenty years earlier. He went to Bombay in 1825, and in the first part of his service was connected with the Company's shipping. In 1836 he was employed through the Deccan and Khandesh in vaccinating, and this rural occupation was the introduction to charge of the Dapuri Experimental Garden at Poona (1838) in succession to Lush. Among the many reports that he wrote from Dapuri was one on teak (1840). It led, but not immediately, to the post of Conservator of Forests falling to him (1847). It seems that the practice of shifting cultivation was on the increase ; and he had a difficult position to maintain. Presumably he had been collecting and drying plants from the days when the work of vaccinating came to him (1836). He seems to have continued to collect to 1867 when his herbarium, which contained contributions from Stocks and Dalzell, was given to the Calcutta Garden.

A custom, very extensive on the Malabar side of India, is that called *rab*. The rice plot is prepared by lighting fires about its surface, and the forest in its neighbourhood is raided to add fuel to the fires. There is no doubt in regard to the benefit of the firing and therefore resistance was to be expected from interference with the cultivators. Gibson had to save the teak which they would lop ; and to do it against resistance which came to actual violence ; but in the end he succeeded in getting the use of teak forbidden and later the use also of the branches of *Dalbergia latifolia*, the Black Wood.

Four years before his death Gibson published A DESCRIPTIVE LIST OF THE FOREST TREES OF INDIA, a book which covers rather more than the title indicates, for it contains a discussion of conservancy, i.e. it touches on the life of the tree that has been described.

9. Two illustrations of silviculture as applied ecology

The deodar (*Cedrus libani* var. *deodara*) is a very valuable timber tree which occurs gregariously in the Himalaya ; a companion which grows with it is the woody climber, *Clematis montana*, a lover of the sun, which when it has the opportunity will gain the sun and rob the deodar by climbing on it even to surmounting it. Its seedlings take advantage of the humidity of the shade marginal to the deodar ; the grown plant gets the sun in its turn as soon as it can. The perennial stems leaf each year to the detriment of the host and the pretty flowers follow. Lady Amherst, who has been mentioned as one of the first botanists of Simla, saw it there and sent it into cultivation in Europe. An Indian forester knows that by cutting the *Clematis* down he has an easy way of giving back the advantages to the deodar. Should he do so, he is applying an elementary ecological observation to a simple silvicultural operation.

The second illustration is taken from the teak tree, *Tectona grandis*. The ecologist uproots a seedling and observes the size of its taproot ; he sees it to be large and by the simplest of reasoning deduces that there is a value to the plant in its capacity ; and clearly one of the materials it holds is water to secure growth. Then he sees that there is an advantage to the seedling in the cover of the accompanying vegetation, for it keeps the moisture from evaporation in the direct sunlight ; but the seedling is seen to be light-hungry and disadvantaged if the associated vegetation takes the light. A silvicultural problem appears with the question how can the seedling get the best of its position. The seedling is of rapid growth if favourably placed. Moreover it is desired to encourage the single stem which under the best circumstances will result in a straight and well-grown trunk. The silviculturist has problems of competition to consider and the responsibility on him of a harvest distant may be a hundred years and more, with moreover reproduction thrown in. Advanced silviculture discovers that it can be possible to welcome a little firing if it frees the teak from competitors. However, this is not the place in which to show that the advanced silviculturist needs exceedingly high qualifications, which were not at all in view when Michael swept fallen leaves away and Falconer listed competing trees.

Everything recommendable is then qualified by its expense. The end is reached in this way not by, but through, Botany.

10. The Indian Forest Service had three stages

The Indian Forest Service developed from nothing, not evenly, but in three stages. The first covered operations directed at safeguarding the supplies of the timber of one particular tree, the teak tree. These operations were extended to other trees, notably trees useful for fuel, and by provisions for soil-conservancy and water-conservancy, for which the wardens, all, even the lowest, required an elementary knowledge of these trees. The third stage came when the forests were treated as a whole and there was importance in a knowledge of the grasses and herbs of the carpet under the trees, among at least a leaven of the more responsible.

One may say that the Forest Service lived experimenting not only with their material but with their personnel. As to personnel it suffered from the disadvantage that, while able to obtain from Europe experts trained in the methods of the Forester, they had been trained in their application to trees that the Forester was not to encounter in India. These Foresters had inevitably to learn the Indian trees after their arrival in India, in other words to go on learning even under difficulties. The Forest Officer who proved at the same time a conspicuous botanist was manifestly an enthusiast in Botany.

11. Sir Dietrich Brandis and those under him in the Forest Service who were botanically-minded

Dr. **Dietrich Brandis** (1824-1907, knighted in 1887) was son of a Professor of Philosophy in the German University of Bonn. After a prolonged education there and elsewhere he became a teacher of Botany in the University. He married a daughter of the Calcutta scholar and missionary, John Clark Marshman, whereas another daughter married the soldier Sir Henry Havelock whose conspicuous service to India is so well known. Thus Brandis had obtained an indirect connection with India a little before his name was brought to the Governor-General when the appointment of an officer to save the teak in Burma was under consideration. It was natural to think of the possibility of the right man being found in Germany as the care of the forests in that country was a matter of some pride to the landowners. In the end Brandis was appointed to the charge of the Pegu forests, Cleghorn and Gibson being at the time respectively Conservators of such Madras and Bombay forests as had not been alienated. All three gained their position as botanists, the two already in India, also as tried administrators. Brandis had his administrative reputation to gain.

Brandis passed through Calcutta at the end of the year 1855, seeing the Governor-General to whom he outlined his plans and from whom he got not only approval but the remark that the plans would prove of great value. Brandis went forward to Rangoon and took over what had been McClelland's last charge.

Few records connected with Brandis are so enlightening as his first report ; but I will quote first in Brandis's own words what he regarded as his duty : ' The object of my being appointed in January 1856 by Lord Dalhousie to the charge of the Pegu forests was purely practical. My duty in Burma was to place the management of the teak forests upon a safe footing so as to ensure the maintenance and gradual improvement of the valuable growing stock while utilizing timber not exceeding the amount annually produced in the forests '. It would have been strange if Brandis had not visited the Botanic Garden in Calcutta when passing through. That he did, seeing some of the trees planted in Kyd's time which were still growing, and making a personal estimate of the years to maturity on which his average fellings would have to be calculated.

Brandis sent in his first report as annual from the time of his arrival, i.e. January to December. Later the reports were based on the Government's year that ended with March.

I revert to his first report ; in it with a kind of austerity Brandis keeps the teak tree as his only subject ; there is no mention of any other. The austerity was characteristic ; Brandis allowed himself to be a botanist when Forestry was not in view ; when it was, he was wholly a Forester ; and in dealing with his staff he expected the same of them. I have referred earlier (§ 6) to his book INDIAN TREES. It was written in retirement, when he could allow himself to see plants botanically. Of course in his first years he was learning what names belonged to the associates of the teak ; but until they came within a Forester's interest they were to him outside the day's work. He mapped the areas whence teak could be drawn at mercantile costs without compromising the future and planned extraction. And the report was so well received that in the next year the Tenasserim forests were added to his charge.

In the years from 1856 to 1862, during which Brandis did service entirely in Burma, he made his reputation. Powerful interests sought to frustrate him, as he himself records. Those competent to judge call his appraisal of the position correct and praise him for prevailing.

There was not much ordered knowledge of the Burma flora when he arrived ; but there was a missionary at Moulmein engaged in getting it together. This was **Francis Mason** (1799-1874). He had resided at Tavoy for a time and then moved to Moulmein. He was a man after the mould of William Carey, of great industry ; and he was intent on collecting all the knowledge that he could about things Burmese. In 1850 he published as a small book the first edition of his NATURAL PRODUCTIONS OF BURMAH, OR NOTES ON THE FAUNA, FLORA AND MINERALS OF THE BURMESE EMPIRE, a second edition following in 1860. Later (1882-1883) came Theobald's edition, a completely changed book.

Brandis would find Mason's equating of Burmese and botanical plant names useful. **Kurz** joined in that work, but not until 1866 when he tried to extract plant names from Burmese convicts in the Andaman Islands. Kurz renewed his efforts when shortly he began to travel in Burma.

Cleghorn and **Alexander Gibson** alike published on Forestry in 1861 ; then Gibson retired. Meanwhile the Government began to consider the possibility of a Forest Service for the whole of India. Two circumstances hindered them ; one was inability to get at Cleghorn because he was on leave and the other the anticipation that they would need to give Brandis leave.

When Cleghorn returned to India in November 1861, he was not allowed to go back to the Madras Presidency, but was sent to the Punjab to study the timber and wood-fuel supplies. By then trains were being hauled in the Punjab plains by engines using wood for fuel and this in a part of India where fuel counted for much. Fuel was also in short supply elsewhere, even in the very south where fuel was wanted for smelting. It is easy to understand why the north-west of India was marked out for fuel study. Moreover there were wise men in Simla with a demonstration at their doors of waste of hill land by the washing away of soil bared of forest in the raising of potato crops (see § 5).

In 1862 Brandis, now back from his leave, was called to Simla and brought into a prolonged contact with Cleghorn to debate the possible service. Their joint report was in print in January, 1864. The Government retained the contact between Brandis and Cleghorn making them jointly Inspectors-General. Meanwhile a little engaging of staff had been done ; but the number required was so enormous that great courage was needed to face it. There were in India capable men who fancied life at a distance from the cities ; men for instance like General Michael who became a great game-hunter. A few of such men came forward ; but made barely a handful. There were no means of learning Forestry in Britain such as might serve in supplementing the influx : but there were Forestry Schools in continental Europe ; and they were drawn on. The French had a most efficient school at Nancy where young men learned how to take care of growing oaks, pines, and other trees of their countrysides and look after the water supplies. German landowners had combined to create institutions in which their young men qualified for managing the production of timber. By agreement provision for training at the French school at Nancy was arranged. Brandis in 1866 asked that he might be allowed to recruit two trained men from Germany and personally selected **Wilhelm Schlich** and **Berthold Ribbentrop.** Cleghorn retired from India in 1867 and became an adviser at the India Office on the selection of entrants whether students from Nancy or with other qualifications. Ribbentrop tells us in his FORESTRY IN INDIA (p. 227) that between 1871 and 1880, i.e. within the period with which we are concerned, 95 men were accepted who had received teaching at Nancy. They had had the opportunity of learning Botany, up to what was considered qualifying and of course illustrated by trees of a temperate climate, very generally artificially consociated. The Nancy students were by no means exclusive ; but just some among many.

Brandis on Cleghorn's retirement became the sole Inspector-General with a great deal of legislation to help forward. He may be said to have inherited the services of two botanists, **N. A. Dalzell** and **R. H. Beddome**, the first in Bombay and the second in Madras. There was at the time in the Punjab Medical Service **John Lindsay Stewart** (1832-1873) who reached India in 1856 from Edinburgh and was so botanically-minded that he set to work at once accumulating notes with the intention of writing a FLORA. He continued to do so for the rest of his life and he could say in 1873 that he had tramped over all the districts of the Punjab. Brandis secured him as Conservator of Forests, Punjab, in 1864, and later we find the two touring together. Brandis secured **Gustav Mann** in the next year in quite a different way.

Gustav Mann (1838-1916) was born in Germany and trained in horticulture, proceeding to Kew in 1859 for further experience. When at Kew he was offered the post of botanist on the Niger Expedition in the place of William Balfour Baikie who had died ; and he accepted it. After returning from the Guinea Coast he was offered service in India and sent to Assam and Sikkim (1863 to 1881). The India-rubber plantation at Charduar on the Brahmaputra was of his establishing.

I call these four men—Dalzell, Beddome, Stewart, and Mann—Brandis's botanical scouts. That was exactly their place ; behind them as Brandis's front line were other men, engaged in India or brought out from Britain.

I have in previous pages made it clear to the reader that the East India Company brought out ' surgeons ' and picked them over when they happened to need a botanist. After the four scouts, recruiting of botanists into the Forest Service was not unlike the East India Company's way ; they imported botanists as it were by accident. Those among the Foresters sufficiently botanically-minded showed their flair after reaching India ; they had perhaps some knowledge of the names and ways of European trees ; setting foot in India they were learners still, the trees different, the conditions different, and of a certainty presenting difficulties. With those entrants who did not turn to Indian Botany we are not concerned ;

but among the few who did we find some in the front line. It is convenient to name them at once and give the dates of their arrival in India : **Schlich** and **Ribbentrop** had as said, been recruited in 1866 ; **William Rogers Fisher**, 1866 ; **George King** 1869, serving only to 1871 ; **James Sykes Gamble** 1871 ; **Alexander Talbot**, 1875 ; **James William Oliver**, 1874 ; **John Nisbet**, 1875 ; **John Henry Lace**, 1881, and **George Michael Ryan**, 1883, but of the Bombay Presidency Service.

Brandis had been himself in 1856 in the same position as the new-comers into the service from 1866 forward, namely in need to learn his material, but fortunate in the instructions centred on the teak tree. Transfer to Simla brought the need of learning the ways of a very unlike lot of trees. Certain it is that he looked with great hope on the assistance of Stewart. After appointments as Conservator, Stewart had leave and took his collections to Kew for authoritative naming ; then he returned for further work, Brandis expecting a FLORA from him ; but Stewart died (1873) with it unwritten, whereon Brandis, being on leave, hastened to Kew and, getting Stewart's memoranda, within a rather astonishingly short time wrote his own version of the FLORA, namely the story of the woody plants. By Brandis's energy the volume was out of the press in 1874, under the title : Stewart & Brandis, FOREST FLORA OF NORTH-WEST AND CENTRAL INDIA ; and Brandis added to it a volume of plates by the botanical artist, **John Nugent Fitch.** It is a pity that he devised the name ' Forest Flora ' for botanists had long accepted the word ' Flora ' as something of geographic import and here was a new and undefined class of guide-book. Perhaps one should say it is a pity that the Forest Service in India adopted the term, for successive compilers were never sure what to omit.

One reason why Brandis was so prompt with his book was that by omitting all the herbaceous families he avoided that which would have delayed him, namely in general the Gamopetalae and Monocotyledons, which Hooker had not yet reached in his FLORA OF BRITISH INDIA. He owed extensively to Hooker for that which Hooker had already done.

The make-up of the book indicates how much more Brandis was casting a line for a Forester than for a Botanist. It is difficult to see how it could have been otherwise, as Brandis was working against time.

Just before Brandis went on the leave in which he took Stewart's place, he had seen through a major event in the history of his Service ; it was the setting up of the Forest Survey Office at Dehra Dun. I call it ' major ' chiefly because it clinched the connection between the Service and Dehra Dun. The great surveyor, George Everest, had made the connection between surveying and Dehra Dun.

I have called Stewart one of Brandis's scouts. Brandis by taking up the writing of the FOREST FLORA put himself into that exploratory position. It is time to turn to what I have called his front line. I would remark in doing so, that the front line had more need of ecology than the scouts ; and of course there could be no preparatory teaching of it in the undeveloped state of that branch of Botany.

Brandis was in the Indian service for 27 years. Schlich and Ribbentrop were under him for 17 years, Gamble 14, Talbot 12, Oliver 9, Nisbet 8, and Lace only 2.

Schlich by his close association with Brandis influenced the service more than any other after Brandis. He proved the apostle of forest education. It has been suggested that Brandis contemplated a teaching staff; but whatever he thought was not presented to Government so as to quicken matters ; action there was but it is Schlich's name that is particularly connected with the course forest education took.

Wilhelm Schlich (1840-1925), his school years over, entered the University of Giessen ; he associated with his studies the Forestry training available in Germany ; and had completed that when Brandis, seeking for two trained men whom he was authorized to engage, found him and persuaded him to adopt India for his profession. His University in 1867 awarded to him a doctor's degree. After arriving in India he had service successively in Pegu, Arakan, Sind, and Bengal ; and the service in Bengal extended over the years 1872 to 1881. His task in Arakan was a rather special one, it was to extend a measure of control over the extraction of the timber of *Xylia dolabriformis*, the *pyinkadu* of the Burmese, which had come into demand for railway sleepers. The REPORT ON THE PYINKADOH FORESTS OF ARAKAN published after he had been in India for 4 years holds the names, both botanical and Burmese, of many associated trees and thus is definitely, as could be expected, a study of the forest and in making it Kurz seems to have joined. After this Schlich was transferred to parts of India where Burmese names were not the help that they had been where his native staff was Burmese ; and it must have been brought home to him then that Forest Rangers needed a common nomenclature ; and he would recognize that the only naming that could possibly suffice is that of Botany.

For seeing what could be done in this direction at small cost Brandis had the experiment tried of sending Forest Rangers in training to the engineering schools where they were to get appropriate teaching. The apprentices, their year's course done, returned to forest work under the Conservators and those of Bengal came from Roorkee to serve under Schlich who had become Conservator. Schlich reported in 1873 that they returned, maybe, with a good deal of useful engineering knowledge but with little or nothing gained in forestry. However, only in 1878 did the logical action follow ; it was agreed then to set up a school, and Dehra Dun was chosen for the situation. The teaching commenced in 1881, in which year Schlich succeeded Brandis as Inspector-General, and that being so, we may ascribe the early guiding of the school to

Schlich. The teaching of the lower classes was in the vernacular and so the School could not serve the south of the Peninsula nor Burma. Schools in these parts came later and did not function within the period under our consideration. This northern School was firmly established before Schlich, in 1885, left India to found and organize forest education in Britain at Cooper's Hill and to guide its subsequent removal to Oxford (1905). From Oxford Schlich, though he wrote nothing purely botanical, wrote much of value in applied botany and encouraged others most extensively to do the same. Gamble, as a very junior member of the service, came under Schlich in 1872 and owed to Schlich's broad-minded outlook the facilities he had for doing excellent botanical work during his years in northern Bengal.

Schlich just before he left India had done another thing for the Dehra Dun organization—one of importance as great as the original founding ; he had assigned the preparation of working plans to Dehra Dun and that assured a double portion of the botanical ability of the Service being concentrated there.

In 1869, i.e. three years after Schlich joined the Service, **William Rogers Fisher** (1846-1910) was recruited. He was an Australian by birth ; then took a degree in Cambridge and a training in Forestry at Nancy where his course was interrupted by the Franco-Prussian War. During his years in India he took to translating works on Forestry and that led to a transfer to a teaching post at Cooper's Hill and later to the Professorship of Forestry at Oxford in succession to Sir William Schlich. In this way his mark on Indian Forestry fell only indirectly. Gamble's was very different.

James Sykes Gamble (1846-1925) had taken mathematical honours at Oxford, before deciding on Forestry as his life-work and so proceeded late to the Ecole Nationale des Eaux et des Forêts at Nancy in France. Then his course was interrupted by the Franco-German war, but escaping to Britain he went under the tuition of Cleghorn in Edinburgh for a while, until he could return to Nancy to finish his course. He reached India in 1871. During service in northern Bengal (1872 forward) he compiled A LIST OF THE TREES AND SHRUBS FOUND IN THE DARJEELING DISTRICT (1878, revised 1896). He followed this up by a paper, the like of which no one in India had thought of : it was an account of the distribution of species of trees on the Darjeeling hills—a most interesting ecological study. Gamble was now a marked man, and was appointed Personal Assistant to the Inspector-General (1877-1879). During these years he prepared the first edition of his MANUAL OF INDIAN TIMBERS. A second edition came out in 1902 and had been entirely rewritten. After 1879 he was Conservator of Forests, Bengal, then later of Madras, then of Uttar Pradesh, with the Directorship of the Imperial Forest College as part of his duties. We may call him an administrator sent to large charges to bring them to pattern. When retirement set him free he gave himself over to taxonomic research aiding Sir George King by taking over the unfinished MATERIALS FOR A FLORA OF THE MALAY PENINSULA ; and he commenced a FLORA OF MADRAS. Ten years passed from the arrival of Gamble to the arrival of J. H. Lace.

John Henry Lace (1857-1912) reached India in 1881. For him there were two charges in succession of north-western areas, the first the forests of the State of Chamba which had been put under the direction of the Forest Service by the ruler of the State, the second the forests of the Quetta uplands in Baluchistan. Of each he compiled lists of the flora. In 1900 he was appointed Assistant Inspector-General of Forests and collected then about Simla. After this administrative exigencies sent him to Bengal (1901) and after that to Burma (1904) and kept him there until retirement in 1913. Lace throughout his time was a diligent and critical collector, a pioneer both as to the floras of Chamba and Baluchistan ; and he would have issued a FLORA OF MAYMYO in the Shan Hills had he lived a little longer. Generous with his material he supplied much to Kew, Calcutta, Dehra Dun, and what he had at the time of his death was given to the Botanic Garden, Edinburgh.

William Alexander Talbot (1847-1917) went to India in 1875 and spent his whole time in the Bombay Presidency. He compiled A SYSTEMATIC LIST OF THE TREES, SHRUBS, AND WOODY CLIMBERS OF THE BOMBAY PRESIDENCY (1894), and followed it by a FOREST FLORA OF THE BOMBAY PRESIDENCY AND SIND (in two richly illustrated volumes, 1909 and 1911). The reader will note that he, Gamble, and Lace were all students from Nancy. In the years when Brandis was a teacher of Botany at Bonn he would instruct taxonomically by a German system ; wisely, he conformed to the taxonomic usages of Britain so as not to disturb the knowledge which candidates for enrolment brought to their work ; and when these men came to know enough of their forests to list the species, they inevitably arranged them by Hooker's FLORA. Brandis did his best to build on the work that the taxonomic botanists were doing and to the furtherance of this came the accident—accident it was as far as he was concerned—of Hooker's sequence leaving the herbaceous Monocotyledons to the last. By the date of Brandis's retirement Hooker had published on the majority of the families that are woody.

I would have the reader note that the botany of those who came to their service under Brandis was taxonomic. This was natural. The Forest Service had not reached an ecological level ; and did not before 1880, so that Professor Troup needs to point out that of instructions for forest treatment none before that date were deserving of the name of Working Plans.

In 1881 when the function of preparing these was assigned to the College at Dehra the first period of the Forest Service was over.

Brandis as soon as he had seen through the press his FOREST FLORA left taxonomy alone for a time and became again the forester ; and though he published during his years up to retirement a variety of papers they were strictly practical. Collections of dried plants such as came to him, he passed over to taxonomists. A Conservator of the very early years, **Richard Horatio Ely Thompson**, had the forests of Oudh which were under him, collected over : he sent the collection to Brandis (1870) and Brandis sent it, as received, to Kew. The collections of a Moravian missionary seeking to get determination for use in a Tibetan dictionary were treated in the same way. About the same time a collection went to Berlin from another missionary named Herzog.

To make it easy to get the early Forest Service into perspective I propose to list the dates in series :

1855 : Lord Dalhousie, the Governor-General lays down a policy for safeguarding the supplies of Burmese Teak, and Dr. Dietrich Brandis, a teacher at the University of Bonn, is engaged and appointed Conservator of the Pegu forests, a large part of which had been having some protection under Burmese rule.

1856 : Brandis takes over, and in 1857, the forests further south are added to his charge.

1862 : H. F. C. Cleghorn having experience as Conservator of Forests, Madras, is brought to the Punjab to widen his experience ; and Brandis is brought into contact with him that the two may advise on a Forest Service for the whole of India where a scarcity of woods other than teak was also causing concern.

1864 : The joint report printed.

1865 : The first Indian Forest Act passed.

1866 : Recruitment of staff in progress. The first recruits from Nancy and two trained in German methods arrived ; local engagement on general ability.

1867 : Cleghorn retired. Brandis left the sole adviser.

1872 : Surveying of the forests in charge of a special branch provided with offices at Dehra Dun where the Headquarters of the Great Trigonometrical Survey had long been.

1872 : Plans for the teaching of Forest Rangers. Brandis realized that tuition would be needed ; he experimented by sending Rangers in training to the Engineering schools for a year.

1873 : Schlich, if not also others, condemned the result and advocated teaching within the Service.

1874 : Brandis devised the FOREST FLORA which shows a kind of tuition he thought needed by the executive staff.

1877 : J. S. Gamble initiated the working lists by an enumeration of the woody plants of the Darjeeling District.

1878 : Effect given to the recommendation that there should be teaching for locally recruited staff, by planning a School at Dehra Dun.

1881 : Teaching begins in the School ; **J. F. Duthie** called in to help.

1881 : Schlich succeeded Brandis as Inspector-General.

1881 : The first edition of Gamble's MANUAL ON INDIAN TIMBERS.

1882 : The Madras Forest Act, completing the series. Schlich assigned the work of preparing working plans to Dehra Dun.

1885 : Schlich left India to organize the teaching of Forestry in Britain, B. Ribbentrop succeeding him as Inspector-General.

Dehra Dun was pre-eminently suitable for the central place, for there was place available through which Duthie, called in to help, would lead students in parties among the trees teaching them to know their botanical names. In time the College became self-contained. Stewart had already written on the flora of the Siwalik Hills. The College produced in time an ideal teacher among its own men, **Upendranath Kanji Lal.** It was not altogether without irregularities that the Forest Service spread ; Kerala for a time remained outside the area of the Imperial Forest Service. During these years Lieutenant-Colonel **Alfred Augustus Davidson** collected in the State and gave his collections to Kew in 1883. When Kerala obtained a Forest Officer, he was **Thomas Fulton Bourdillon** who had been coffee planting. Ceylon in like manner provided itself with a Forest Officer, who had formerly planted coffee. This was **Frederick Lewis** (1857-1930). After a service of 15 years he was transferred to Land-settlement. He was connected with the introduction of Para rubber, planting out the first for the Government.

12. The third Calcutta Garden : the garden of Sir George King and Sir David Prain

Sir **George King** (1840-1909) lost his parents at a very early age and had a business training under an uncle who was his guardian, but as soon as he was at liberty to shape his own course, an inherent love of Nature led him to decide to enter the Medical profession, which then was the only avenue holding promise to a Naturalist. He wished also for travel and that particularly in the East. He qualified in Medicine in the University of Aberdeen (1865). The avenue to employment in India had been closed in 1860 ; there was no recruitment of surgeons ; but to his delight it was reopened just in time for him, and to Bengal he went. He was stationed in Calcutta, but illness supervened ; on that account in the hope that a drier climate might cure it, he was sent to the Upper Gangetic plains and had service successively at Agra, Mathura, Goona, Deola, Mount Abu, and Jodhpur. Such leisure as he had in these places was employed in collecting data on famine foods. Then came a short spell as acting Superintendent of the Garden at Saharanpur (1868), followed by a spell (1869-1870) at Dehra Dun as an Assistant Forest Conservator, during which he was called on to put an end to a deep network of extensive frauds and did so with conspicuous effect, which led to the offer of permanent employment in the Forest Service ; but the Secretary of State for India had to find a successor for Thomas Anderson who had been invalided, and he appointed King to the post in the Calcutta Garden. Thus he returned to Calcutta, not now a surgeon in its hospitals, but with the triple duties of (i) Superintendent of the Garden, (ii) Professor of Botany in the Medical College, and (iii) the responsibility for the Cinchona experiment in the Darjeeling Himalaya. Something, I do not know what, though it may have been the change from rule by the Company to rule by the Crown, caused him to hope that there would be made an Imperial Botanic Service, and he was disappointed; but his friends and counsellors pointed out that the Bengal Government had a deeper pocket than the Government of India and an intenser urge to restore the Garden. King settled to his arduous responsibilities and, with the hope of an Imperial Service gone, he proposed that the botanists under the various presidential and lesser Governments be united into a loose federation with the advantage of a common journal for publication. The command of the journal would be in itself the promoting of research on connected lines. King from this became charged with direct access to the Government of India as Director of the Botanical Survey with the *Records of the Botanical Survey of India* as its Journal (1891).

King's awareness that India provided for no survey of the lowest plants, caused him to ask for the addition of a Cryptogamic Botanist to his staff ; but he met with a refusal.

By agreement a regional interest was recommended to the different centres of botanical work by which Calcutta had priority in the Eastern Himalaya, Bengal, Assam, Burma, and eastward in general.

When King was appointed Superintendent, **Kurz** and **John Scott** were both alive and at their posts in Calcutta, and **James Gammie** was manager of the Cinchona plantation. Scott seems to have aided King with the Herbarium work after Kurz's death ; then Scott retired. The post that Kurz had had was given to **Lewis Jones Knight Brace** (1852-1938) but Brace became ill very soon after his appointment and, though he nominally occupied the post to 1886, he was never for long at a time fit for work. His successor was **David Prain** (1857-1944, knighted in 1912). Sir David Prain had qualified in Medicine both in Aberdeen and in Edinburgh (1883) and then had entered the Indian Medical Service. He acted as Curator of the Calcutta Herbarium in 1886 for half of the year, Brace being ill ; and in 1887 was appointed to the post which he held to 1897, when illness driving King into retirement, he succeeded him in all the four duties that had been King's. In 1905 he was appointed Director of the Royal Botanic Gardens, Kew, and held that great responsibility with its wide ramifications until 1922.

King had collected plants in central India during his first years, then he collected when serving temporarily in the Forest Service in the Kumaon Himalaya ; after appointment to the Calcutta Garden, he collected on a short trip in the Sikkim Himalaya and on a visit to the Malay peninsula, but the responsibilities at home in Bengal outgrew his ability to find time and he stimulated collecting by friends and employed collectors when he could find such as were reliable. His use of Mungpu as a centre from which to collect has been mentioned (p. 357 above). His largest effort in this line was the employment of an Australian, **Hermann Kunstler,** over the years 1880-1886 to collect for him in the Malay peninsula. At that time Sir Joseph Hooker was interested in Malay plants because he was requested to include the Malay peninsula in his FLORA OF BRITISH INDIA ; and lest the sum of information about them be very meagre, King undertook this work of helping ; there was also a proposal that Hooker and King should work them out together which, when Hooker decided that he could not find time, was reduced to a MATERIALS FOR A FLORA OF THE MALAY PENINSULA by King. It was an exacting work and, although the Monocotyledons were handed over to **Henry N. Ridley,** King did not live to finish it. This was done by J. S. Gamble, and an appendix was added by V. Narayanaswamy of the Calcutta staff in 1931, made necessary largely by Scortechini's erratic spelling of place-names. King was able to send **George Gammie** collecting up the Brahmaputra Valley to Sadiya. **G. A. Gallatly** collected for King in the Khasia Hills, **J. G. Prazer,** a professional orchid collector, in Cachar and then in the Salween Valley ; his Garden collectors **Abdul Huq, Abdul Khalil,** and **Shaik Moqim** collected in the remoter districts of the Irrawaddy and in the Shan Hills. This was keeping to the understanding that Calcutta's field of interest was to the eastward of Calcutta. That, of course, did not limit the direction from which good friends sent dried plants. The zoologist, Dr. **John Scully,** stationed in Kathmandu sent dried Nepalese plants, in part collected by Mrs. Scott, wife of one of the Residency staff. The reader sees here a weakening of the botanical momentum of the Garden ; the Superintendent tied by his duties to his desk ; contact with living vegetation left to others. Prain so long as he was Curator of the Herbarium was able to travel. His longest travel was by the Government's Survey ship to the Andaman Islands and the quiescent volcano, Barren Island. He travelled next through upper India in connection with field weeds, seeking with Lieutenant-Colonel **D. D. Cunningham** an alternating host for rust of wheat. Another collecting trip was a brief one to Khambajong in Tibet where the Mission of 1903 was halted. Other journeys in India there were but they were not collecting trips.

A visit to the Laccadive Islands had been intended for 1897, but could not be arranged ; and collecting from the '*Investigator*' which went thither for coastal survey, was done instead by Colonel **William Alcock,** the Surgeon-Naturalist and by the ship's apothecary, **John Fleming.**

When in 1897 Prain stepped from the post of Curator of the Herbarium to that of Superintendent of the Garden, the post of Curator was given to Surgeon-Captain **Andrew Thomas Gage** and he like those before him travelled collecting until the larger responsibilities fell on him. He collected along the southern margin of the Lushai Hills in 1899 and later he collected through the Burmese District of Minbu from east to west. There had been also a short trip in the hills of Ganjam. The reader will note the considerable but not absolute measure in which eyes were directed east in Calcutta agreeable to the understanding that Calcutta's interests were on that side. King's paid collectors were employed almost entirely to the east of the Bay of Bengal.

Under King the Herbarium grew greatly and a new fire-proof building was provided for it. The precaution was underlined as wise when later Gamble's small collection of the Forest Service at Darjeeling and the whole herbarium at Poona were destroyed by fire.

King had had the idea that centres of Forest work would be more efficient if the officers had a small collection for reference and was prepared to make up sets ; but seems to have been discouraged by Brandis who saw in them an invitation to scatter energy away from the few economic trees of the very young service.

One of King's constant thoughts was how to forward Hooker's progress with the FLORA OF BRITISH INDIA. It was done not only by the flow of herbarium material, but by the preference he gave to work on families of complexity. The Government of Bengal sanctioned the publication of King's illustrated taxonomic monographs as the sumptuous ANNALS OF THE ROYAL BOTANIC GARDEN, CALCUTTA as fulfilling this purpose. The Asiatic Society agreed to publish the descriptions of the Malayan plants.

King's solicitude extended to the use that he made of funds that he had for sending out collectors. They were sent eastward under the agreement that Calcutta's special interests were towards the east. By their work, the Shan Hills were explored and also the Ruby Mine District of Burma and some mountainous parts of Assam which were penetrable to these men. Under King and after King these served—Abdul Huq, Abdul Khalil, Badam Khan, and Shaik Moqim. The last named went with Pottinger in 1896 into the wild country north of Myitkyina.

Immediately east of Sikkim is the Chumbi Valley, politically Tibetan, but a valley of wild roses, smiling and in features mid-Himalayan. Into this valley an expedition went in 1888 and serving on it was Surgeon-Captain **Henry Alfred Cummins** of the Royal Army Medical Corps, and finally Professor of Botany at Cork, an enthusiast who collected whereever he went, as well as in the Chumbi Valley. Another who collected in the valley at this same time was **E. H. Walsh,** the political officer. Some years later a member of the Chinese Customs Service, **H. E. Hobson,** was stationed at Yatung within the valley and made collections too which were given to Kew. Later, but after 1900 an engineer making a road, **Searight**, added his quota. The consequence is that an interesting list of the plants is possible.

Contemporaneously, collecting was done on the northern frontier of Sikkim ; it was commenced by Sir **Francis Younghusband** when he arrived at the frontier on a mission to Tibet. Sir David Prain was enabled to make a short visit to the same centre and collect. The collecting was then taken by the surgeon, Walton, who continued it all the way to Lhasa. Another surgeon also collected ; this was Lieut-Col. Lawrence Austine Waddell. Prain had intended to study these collections but pressure of work prevented him.

King's handling of the reconstruction of the Garden was masterly. The reader recalls that the double disaster was due to overmuch water in two forms, saline tidal at the first flooding, saturation of the soil at the second. King saw that the filling of hollows behind the banks was the remedy needed. He took the measure of the earth required to fill these hollows completely ; he calculated the increase of area of the tanks in the Garden that would be necessary to supply it. He plotted its dispersal in a way that would enable visits to be made in favourable positions ; he calculated the cost of the labour that would be adequate ; he proposed the spreading of the work over a series of years—nine was agreed on—and in nine it was done. The tanks making one-ninth of the whole surface, were connected by underground pipes and provision made for pumping water into or out of the system. It is probable that no other superintendent in the succession had such clear artistic appreciation as King ; at any rate they had not shown it. Roxburgh may have been a victim of circumstances ; he had to build slowly and therefore patchily. Wallich seems to have been unappreciative. Griffith was an iconoclast and the remark that Falconer had to close little winding paths shows McClelland to have lacked taste. Falconer apparently did not have time for planning ; Thomson probably lacked the energy and Anderson the opportunity. King's designing was bold and his business-like way, along with that, got him such great credit that he was asked to plan the new Zoological Garden and the gardens of official residences in Calcutta and in Darjeeling. Trust in King brought him sanction for large improvements in the Garden, new lattice plant-houses, propagating pits and their adjuncts, new quarters for staff and, most important of all, the fireproof building for the Herbarium.

In 1870 a resident in Darjeeling, **William Lloyd,** generously gave land for a garden in the station ; and this land became an annexe to the Calcutta Botanic Garden, serving it as the Mussoorie Garden served Saharanpur, for experiments with plants impatient of the climate of the plains. If when King was appointed Superintendent, the state of the Garden was depressing, the state of the cinchona experiment almost one of despair. The East India Company had found the establishment of tea expensive, but it had been worth while, as the preliminary expenditure could be called buying knowledge ; likewise a large preliminary expenditure was incurred over cinchona which was justified, but after that the two enterprises were not parallel because a new item had been brought into the estimates for cinchona, the need of splitting profit between a natural gain and a philanthropic attack on malaria. They were optimists who, envisaging that the claim for the latter could be satisfied, asked of King the apparently unattainable. However, King's horticulturists were succeeding in the part that was theirs.

King in 1884 had cause to visit the Netherlands on a quest not connected with Cinchona ; but when there an accident brought to him a little light on the manufacture of quinine which he passed to the chemist, **C. D. Wood**, who after his work on Cinchona at Mungpu (p. 353 above) was now in London. Wood of his own free will resumed chemical investigations and produced a laboratory process, which King took to Gammie and Gammie converted into a manufacturing process. There was now the possibility that if the medical faculty would accept the total alkaloids of *Cinchona succirubra* for use in India, a cheap malaria remedy could be made available. King put that to the faculty and on the observations of a number of physicians in India it was accepted. King's factory at Mungpu made the febrifuge ; the prisons made it up in doses ; the post-offices throughout India sold it and the middle man who had tried to intervene was kept outside a country-wide undertaking.

Truly King deserved well of the country of his service.

Prain, working under King from 1887 to 1897, was as King in all the Garden's undertakings, save that a slight preference for economic botany began to show itself in his publications, a preference that was to develop. It fell to Prain to prepare plans against contingencies ahead. King's plans were largely scenic. Prain prepared for gradually sorting the trees on a geographic base ; for instance, trees A and B, both natives of Australia, which had now by chance come to be displayed at opposite ends of the Garden by Prain were destined to come together, when one or the other should need to be replaced.

Prain, except that he contrived to make a short collecting visit to Khambajong in Tibet in 1903, was as King had been a prisoner of his administrative work.

Gage when Curator of the Herbarium made a collecting trip to the southern Lushai border in 1898-1899 and another in Ganjam in the company of C. E. C. Fischer. After 1900 he made a journey through the Burmese District of Minbu from the Irrawaddy River to the waterparting towards Arakan. Reports on the first and the last may be found in the *Records of the Botanical Survey.* He remained Superintendent of the Calcutta Garden until 1895, but left India with leave prior to retirement in 1924.

Facts show how deeply the Cinchona experiment acted on the Calcutta Garden. Teak and Tea had broken into the Superintendent's routine at different periods and for short times ; but Cinchona entered into the routine and there was no travel for the sake of collecting for the Superintendent as for the Curator. The voluntary collector, the botanist whose pleasure it was to collect lost none of his importance, now Prain realized that and tried to work up the Botanic Survey.

(*To be continued*)

Early Stages of Old World Lepidoptera—XII[1]

BY

E. P. WILTSHIRE, F.R.E.S.

(*With four plates*)

Previous articles in this series have mostly appeared with the title 'Early stages of Palaearctic Lepidoptera'. A few Tropical species, penetrating the Palaearctic Zone, have been described in them. My present sojourn in Bahrain (lat. 26° N.), closer to the Tropical Zone than hitherto, has led me to study a local fauna with a higher percentage of Tropical species. In fact the oasis fauna of the island (which of course must be differentiated from the desert fauna) is at least half Tropical Indian. Four or five species, therefore, described in the present article are more Tropical than Palaearctic and it seems appropriate to modify the title accordingly, though the numbering follows on after that of my previous 'Early stages' article (which appeared in October 15, 1957, *Zeits. d. Wiener. Ent. Ges.* **42**, B. 68: 149-155); it falls quite naturally into that series.

As did previous articles, the present article publishes hitherto unrecorded biological and morphological details, with photographs, of the immature stages in most cases; but before proceeding to the descriptions I should like here to summarise three or four points of general interest:

i. The foodplant in the Middle East of the local races of the widespread butterfly *Junonia orithya* L. can now, for the first time, be given, and proves to belong to a botanical family not hitherto reported for this butterfly. The particular race at Bahrain is the little-known subspecies *cheesmani* Riley.

ii. In its first larval instar *Drasteria yerburyi* Butler (=*Syneda pica* Brandt, syn. nov.) has its abdominal feet much less developed

---

[1] For the convenience of our readers we give the references to the previous articles in the series: I 1935, *Ent. Rec.* **47**; II 1936, ibid. **48**; III 1939, *Mitt. Muench. Ent. Ges.* **29**; IV 1940, *Ent. Rec.* **52**; V 1944, *J. Bombay nat. Hist. Soc.* **43**; VI 1946, ibid. **44**; VII 1944, *Ent. Rec.* **56**: VIII 1946, ibid. **58**; IX 1948, ibid. **60**; X 1952, *Bull. Soc. Fouad. I.* **36**; XI 1957, *Zeits. d. Wiener. Ent. Ges.* **42**.—EDS.

than in its final instar. This genus belongs to the Noctuidae-Quadrifinae, a group of subfamilies distinguished from the Trifinae by hindwing neuration and usually larval abdominal feet; some of the largest Quadrifine genera (e.g. *Catocala, Anua, Clytie,* and *Pandesma*), though not transitional in neuration to the Trifinae, have hitherto been regarded as so transitional in larval foot-structure. It is now clear that *Drasteria* must be added to this group; I note, however, from Forbes Pt. III (Memoir 329) that in some Acronyctinae (that is, Trifinae) the young larvae are 'semi-loopers' so it is doubtful whether this observation of the early instar of Quadrifinae is of taxonomic significance. It should also be noted that other Quadrifine larvae, also described in this article, namely *Thiacidas*, *Cerocala,* and *Acantholipes* do not follow *Drasteria* (and presumably *Catocala* etc.), as the degree of development of their abdominal feet does not change with larval growth; in the former, though its neuration is Quadrifine, the larva, even in its early instars, is indistinguishable from the Trifinae, having five pairs of equally developed abdominal feet; but the other two have but three pairs.

iii. *Raphia cheituna* Brandt has proved to be a synonym of the Indian species *Thiacidas postica* Walker, but, as it was not a true *Raphia*, only the subgeneric name *Tiessa* Brandt and the specific name *cheituna* need sink to Walker's names. The larvae and cocoons shed further light on the anomalous group of genera placed under Pantheinae (=Mominae), and the chaetotaxy, neuration, and genitalia are also illustrated.

iv. Rather different phenological rhythms have been observed in Bahrain from those observed further north in the Palaearctic Desert Zone; in some species (e.g. *Drasteria yerburyi* and *Cerocala sana*, both of which are desert species), a summer diapause alternates with a bivoltine, overlapping winter phenology; but in the oasis-dwelling species *Semiothisa syriacaria* there is a multivoltine overlapping summer phenology; yet despite great variation in the length of the pupal period, the moths emerged strictly at a given hour in the evening. The phenology of the oasis-dwelling *Thiacidas* also contrasts with these types.

Family NYMPHALIDAE

Junonia orithya subsp. **cheesmani** Riley (Plate I, Figs. 1, 2, 3, 4)

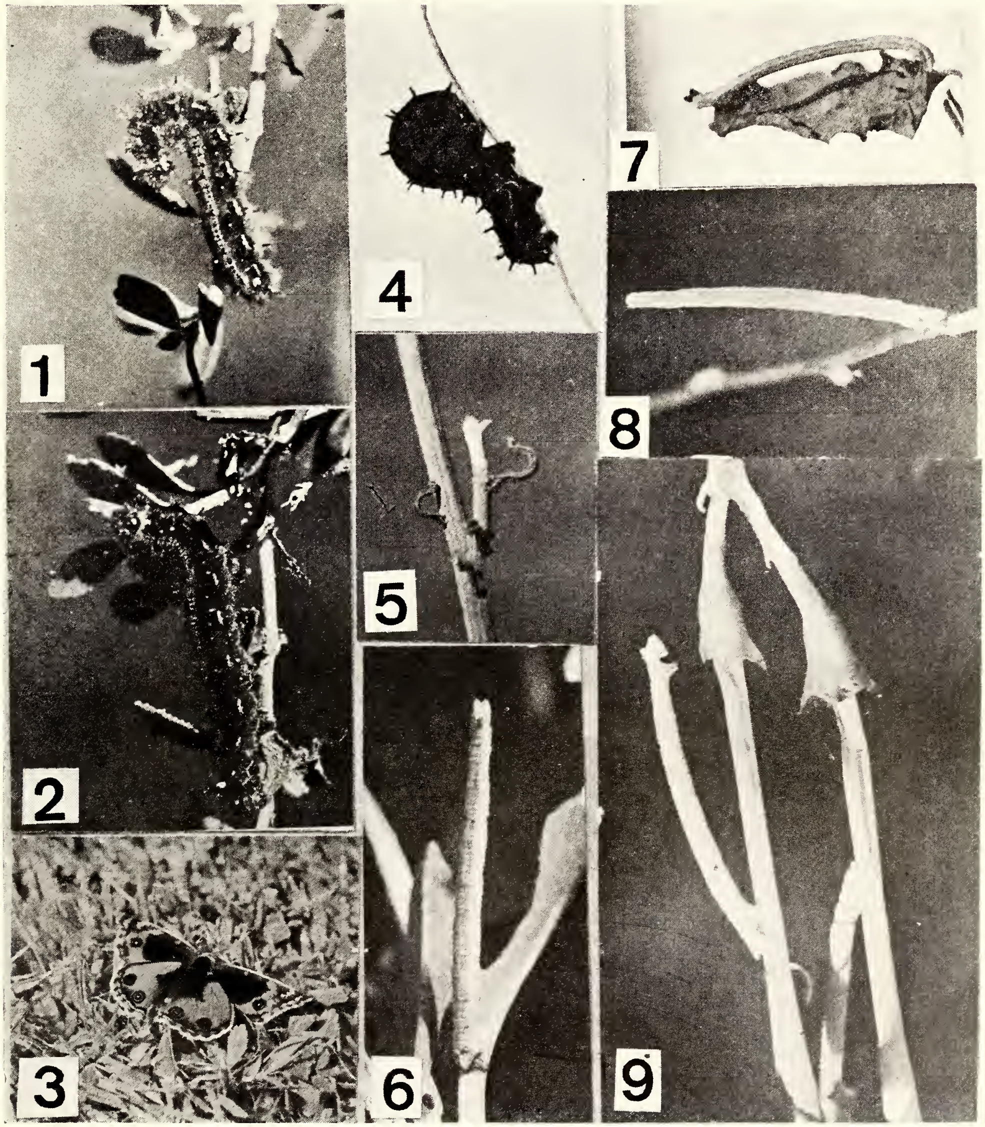
D. G. Sevastopulo, in 'The Early Stages of Indian Lepidoptera' Pt. VIII (*J. Bombay nat. Hist. Soc.* **42** (4), Dec. 1941, p. 748) gives some references to earlier descriptions, and redescribes the larva and pupa of the Indian subspecies *ocyale* Hubn. The Bahrain race lacks the orange mark on the head and the orange collar there described. J. C. S. Marsh, in HONG KONG BUTTERFLIES (Hong Kong, 1960), in a very brief description of the typical race, also mentions an orange neck. The foodplant in Hong Kong would appear to be violets, while in India it is recorded as Acanthaceae. For many years I have been unable to discover what this butterfly's foodplant in the Middle East is, and my final discovery of this in Bahrain probably will be valid also for Iraq and Persia, where the race is subsp. *here* Lang.

The full-grown larva in Bahrain is velvety black dorsally, dark grey ventrally, and it is, of course, equipped with typically Nymphalid spines. The two dark areas, particularly the dorsal, are marked with many fine white points, widely spaced, and arranged in lines, the dorsal stripe is broad, suffused, yellowish white with a finer black interrupted central line. There are white lateral circumflex-marks on somites 5-9. All spines are black but the lateral and sublateral ones have brown bases. A fine white sublateral line, almost uninterrupted, runs along somites 4-10, but on somites 1-3 it is widely interrupted. The head is glossy black. The feet are brown marked with glossy black. Ventral line, smoky black.

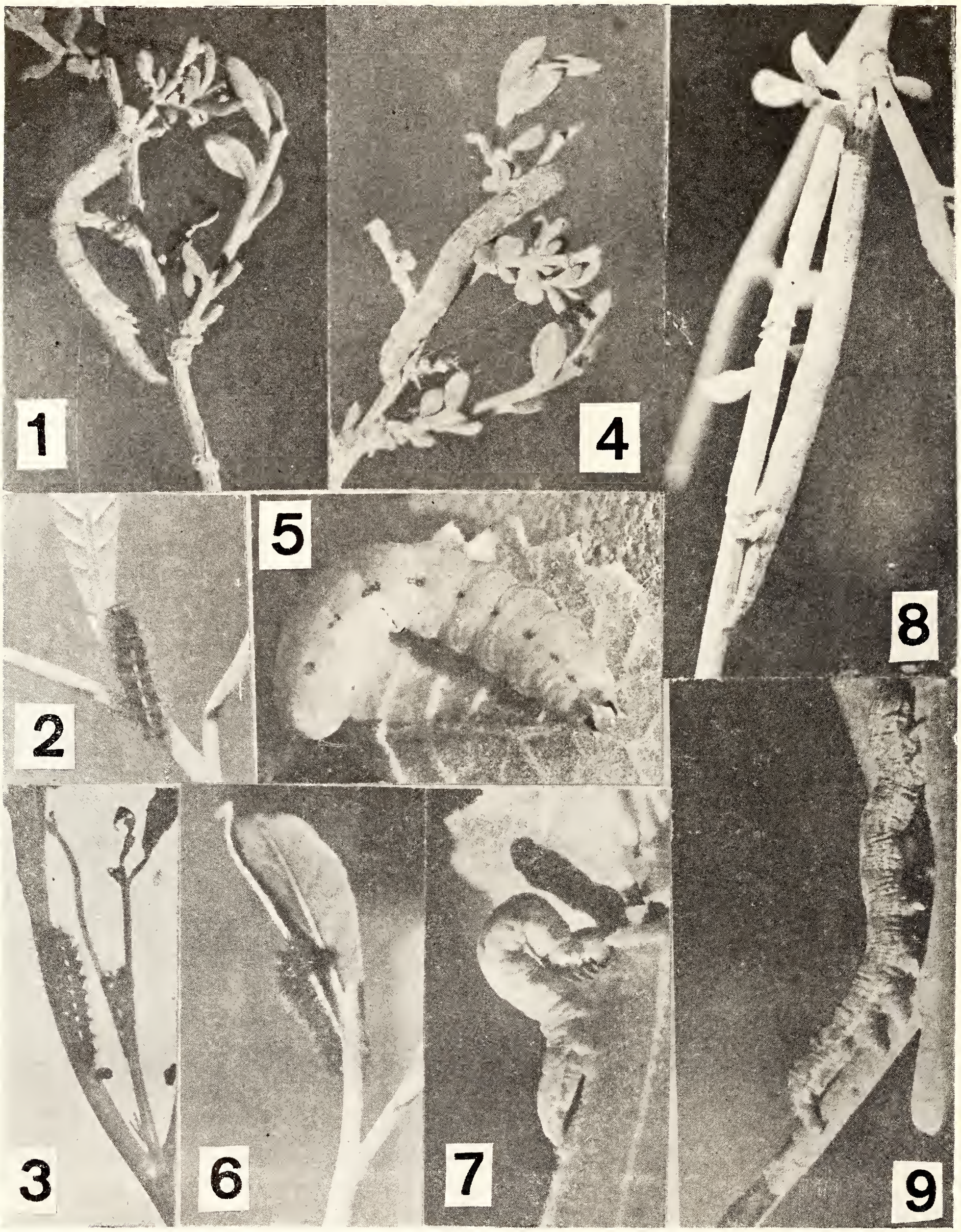
The pupa is suspended by the tail; it is inconspicuously coloured, blackish and pale whitish brown, without any metallic glint, resembling rather a fragment of wood. The figure 5a in Horsfield & Moore, 1857, Plate V, CATALOGUE OF THE LEPIDOPTEROUS INSECTS IN THE MUSEUM OF THE HON. EAST-INDIA COMPANY, 1857-9, well depicts the pupa as in Bahrain also, but Fig. 5 id. does not match the Bahrain larva. Pupal period, in March, 12 days.

Foodplant: A creeping vervain *Lippia nodiflora*. (This family of plants has not been mentioned for this butterfly before; perhaps each race is monophagous on a different plant-genus or species.) It is an obscure oasis plant but sometimes spreads on lawns and is then regarded as a pest, as it kills off the grass. In Bahrain one sees females settling on lawns not infrequently, doubtless attracted by the plant and perhaps even ovipositing. However, the larva would hardly survive on a mown lawn, and is best looked for in wet ditches in date-palm gardens, where the foodplant also grows. Fig. 3 shows a male on this foodplant on a lawn; the male exhibits the peculiar character of the Bahrain and East Arabian subspecies, the complete blue suffusion of the post-discal white band of other races.

One presumes that little migration from other parts of the Middle East, where subsp. *here* Lang flies, to Bahrain and eastern Saudi Arabia takes place, otherwise the subsp. *cheesmani* would not be distinctive,



A. *Junonia orithya cheesmani* Riley: Fig. 1, 2, 4. Larva on foodplant *Lippia*; Fig. 3. Male imago and foodplant. B. *Sterrha mimetes* Brandt: Fig. 5. Larvae on foodplant *Taverniera*. C. *Chlorissa discessa* Walker: Fig. 6, 9. Larvae on foodplant *Clerodendron*. D. *Scopula adelpharia* Pung.: 7. Larva on foodplant *Convolvulus*. E. *Scopula ochroleucaria* H.-S.: Fig. 8. Larva.



A. *Cerocala sana* Stgr. : Fig. 1, 4. Larva on foodplant *Helianthemum*. B. *Euproctis cervina* Moore : Fig. 2, 6. Larva on foodplant *Terminalia catappa*. C. *Nola harouni dilmuna* Wilts. : Fig. 3. Larva on foodplant *Trifolium*. D. *Perigea illecta* Walker : Fig. 5. Larva on foodplant *Pluchea*. E. *Mocis frugalis* F. : Fig. 7. Larva. F. *Acantholipes circumdata* Walker : Fig. 8. Larva on foodplant *Taverniera*. G. *Drasteria yerburyi* Butl. : Fig. 9. Larva on foodplant *Taverniera*.

and would lack the blue suffusion and other characters. This is strange, because the butterfly is generally migratory, and I have heard of considerable migrations of *here* in Iraq.

Family NOLIDAE

Nola harouni dilmuna Wilts., 1951 (Plate II, Fig. 3)

This subspecies was described in *J. Bombay nat. Hist. Soc.* **58** (3), and the species placed in *Celama*; however, my attention has now been drawn to the fact that *Celama* is a synonym of *Nola* (of which the typical species is *cucullatella* as pointed out by Franclemont in *Cornell Exp. Station Memoir* 371, Forbes Pt. IV, 1960), both having similarly bilobate male valves. According to that work, the genus which I have hitherto called *Roeselia* becomes *Meganola*.

The early stages of *N. harouni* now observed in Bahrain confirm its close relationship to *N. centonalis* (*aerugula*) as both have papilionaceous foodplants, low herbs, but the somewhat different pattern confirms the specific distinctness.

The ovum is pale grey, bun-shaped, with fine vertical sculpture; they are laid in small adhesive masses of, say, six ova.

The freshly hatched larva is yellow-grey with long black sub-dorsal hairs springing from warts; head, blackish brown.

When 11 days old, the larva is 5 mm. long, pale brown, with a yellowish or pale olive-green dorsal line edged with darker brown, wider at the anterior part of each somite. Each somite has a band of six warts, three on either side of the dorsal line; the dorsal stripe thus lacks verrucae; from these warts spring short, black hairs; there are also many longer pale hairs. Head, brown. I could find no pattern of V-marks as described by English authors for *aerugula*.

One month after the ova were laid and 22-23 days after the larvae hatched, they spun cocoons; about 2 weeks later the moths emerged, making a total life cycle, in April-May, of 36-7 days. The cocoon is boat-shaped, cryptic, and in captivity is woven out of paper fragments, if paper is supplied.

Phenology: Multivoltine, perhaps with a summer diapause; I have only taken the moth from December to May, in Bahrain.

Foodplant: *Prosopis stephaniana*, and several trefoils. The moth is mainly an oasis moth, but I have taken it in certain tracts of desert, not far from gardens, and with comparatively good vegetation.

Family LYMANTRIIDAE

Euproctis cervina Moore (Plate II, Figs. 2, 6)

See my article (1961) in *J. Bombay nat. Hist. Soc.* **58** (3) for taxonomic notes on this species and its close relatives, and their distribution.

Ova, laid in piled-up masses consisting of about 100, covered with pale yellow wool from the mother's anal tuft, the second batch, laid on the second night in a different place, less well covered; green, globular. They hatch in 8 or 9 days in March, also in May.

The larvae are semi-gregarious, feeding in small groups, but readily falling off if frightened; this must tend to reduce the size of the groups and to scatter the larvae. They do not change much in appearance during growth, but naturally the markings are clearest when full grown.

The full-grown larva is a black 'woolly bear' with a fine, white, double dorsal stripe and two white dorsal spots just behind the head. Sooty-brown hair tufts stand up in a manner recalling somewhat *Syntomis* larvae. Head, small, glossy black; maxillary palps, white-marked. On somites 9 and 10 are small crimson dorsal tubercles. Abdominal feet, marked laterally with orange-brown and appearing paler than the rest of the body which is pitch black; thoracic feet, black. Spiracles, inconspicuous. Lateral stripe, pale grey. The larvae of a single batch feed at unequal rates of growth; the quickest-growing in May spun up 35 days after hatching, the slowest 59 days; The pupal period, however, is less variable; in March it is 14 days; in May it is 9 days. Pupa, glossy yellow-brown, with inconspicuous short concolorous hairs on thorax and abdomen; the cremaster is a cone, tipped with at least six short pale brown bristles. The pupa is formed in an oval, semi-transparent but blackish cocoon.

Both the ova-masses and the cocoons are hidden low down. The female moth seldom flies, is paler than the male, and has obscure habits; in fact only the male is conspicuous, and that only in the perfect stage. The male flies freely an hour before sunset and also after dark when it will come to light.

The habitat is localized; certain restricted, well-watered grassy gardens.

Foodplants: Tropical almond (*Terminalia catappa*) which is planted as a tree in these gardens, and also the undergrowth thorn *Alhagi* (Camel-thorn). The tree is more widespread than the attendant moth, and the moth's smaller habitat may well be due to the fact that, in most places in the island where the tree is planted, the garden is an adjunct to a house, a flower garden rather than a date palm garden, and has little or no undergrowth, so that if the young larva once falls off the tree there is no alternative foodplant, and its chances of finding the tree again are small; moreover this sort of garden is full of ants, which are particularly active on *Terminalia* leaves, being attracted by their glands. These ants are, however, also carnivorous and are probably an enemy of this moth.

Mating takes place immediately after sunset. The moths remain united for a couple of hours, after which the female starts laying. The moth emerges from the cocoon late at night, between 10 p.m. and 2 a.m. There are at least three broods between March and October, and the caterpillar continues to feed throughout the winter; the moth is thus multivoltine, without diapause but they do not emerge during the cooler months.

Family NOCTUIDAE

Perigea illecta Walker (Plate II, Fig. 5)

Warren-Seitz wrongly sunk to *capensis* Gn. a number of old world Tropical species of *Perigea* (=*Propsalta*). The genus seems attached to *Pluchea* and possibly other composite fleabanes. At least the Egyptian and the Persian Gulf species, distinct from one another, both seem to have the same foodplant, which is also fed on by *Hadjina viscosa* Freyer in both countries. The Egyptian species, widespread in Africa, is *P. pauperata* Wkr. (=*Propsalta coptica* mea, syn. nov.) of which the male genitalia, with simple harpe, were illustrated in *Bull. Soc. Fouad. Ent.* (*Cairo*) **32**, 1948, p. 254, Fig. 35 in my list of Egyptian lepidoptera and also by Viking Nystrom in his 'Macrolepidoptera from the Cape Verde Islands', Fig. 54, (*Comm. Biol.* **17** : 7; Helsingors, 1958). Those of *P. illecta* Walker, the Indian species, which I have recently studied in Bahrain, are distinguished from those by the bifurcate harpe in the male genitalia.

The larva is bright green with yellowish somital joints, and five equally developed pairs of abdominal feet. The dorsal and sub-dorsal lines are represented by a few faint white spots. The head is marked with two black triangles, apex towards the mouth. At full maturity a widely interrupted purple dorsal line appears, leading to a white purple-rimmed spot on somite 11. The thoracic feet are black and glossy, the abdominal, brownish. The spiracles, white, black-rimmed. Before spinning up the larva turns entirely purple-brown.

Foodplant: *Pluchea* (*Conyza*) *dioscorides*.

The pupa is glossy red-brown; the abdominal somites do not taper, the tail being rounded and blunt; the cremaster consists of two straight spines. The pupal period in March-April is twelve days. The foodplant only seems to grow in Bahrain in certain well-watered gardens and consequently the moth is rather scarce and local. It is probably multivoltine.

Gardner's description of *Perigea capensis* Gn. (*Indian Forest Records* **6** : 269, 1941) disagrees completely with the larva described above but may well be some congeneric species; his following description (id.) of a different species, which he failed to name, merely referring to it as '*Perigea* sp.' appears to be identical with my *illecta* larva.

Spodoptera mauritia Boisd. (Plate III, Fig. 5)

The larva is numerous, often destructive, on lawns in Bahrain; it is widespread in the Tropics. In Bahrain it occurs together with *S. cilium* subsp. *latebrosa* Gn. which penetrates further north into the Palaearctic zone. The moth is common to light in oases, and occasionally migrates across the desert.

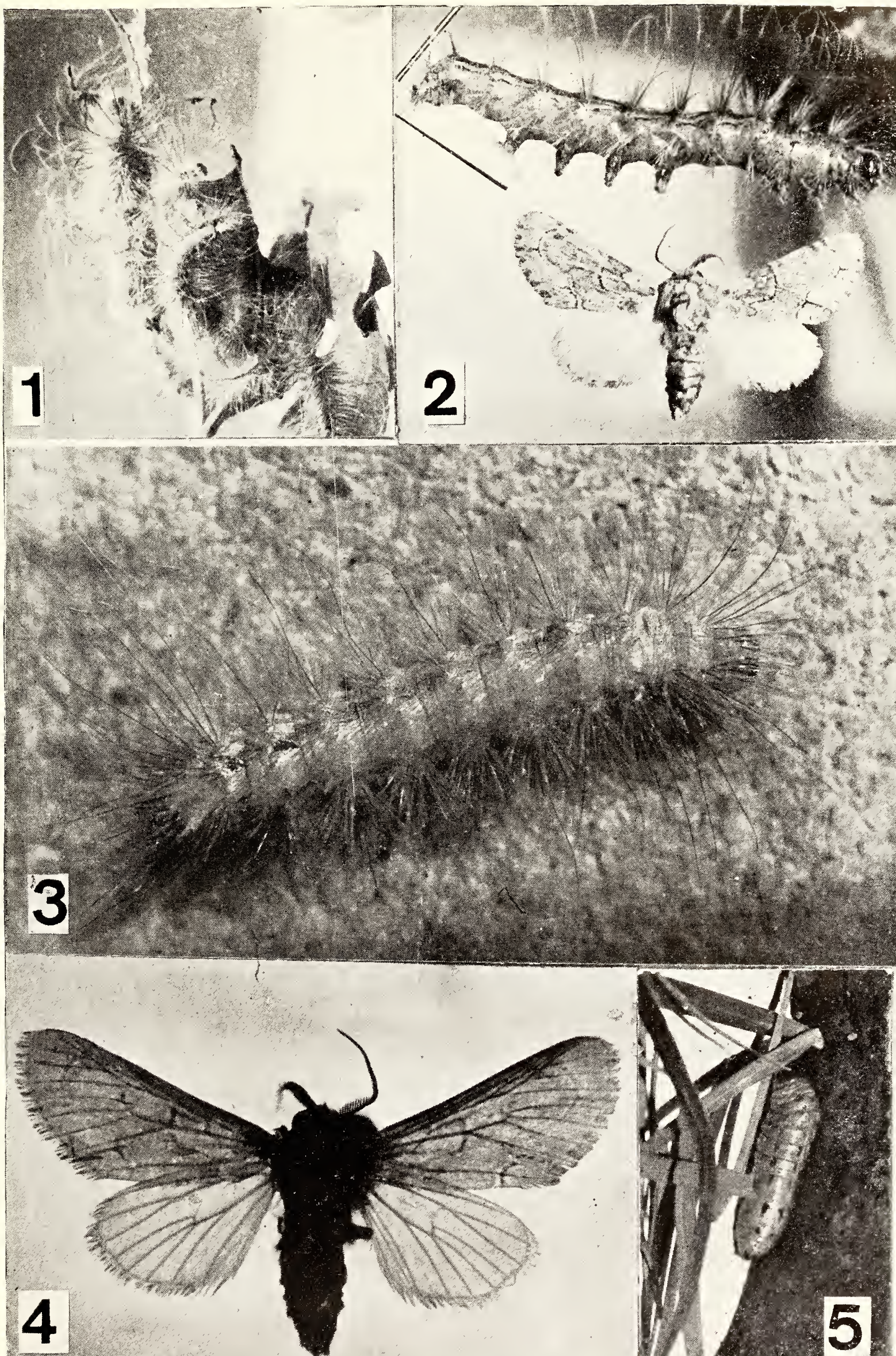
The ova are pale olive-green and are laid in neat batches in close diamond formation, one batch containing about 100 ova. They hatch after 5 days.

The freshly hatched larva is grey-green, with black head. The setae and legs are glossy black.

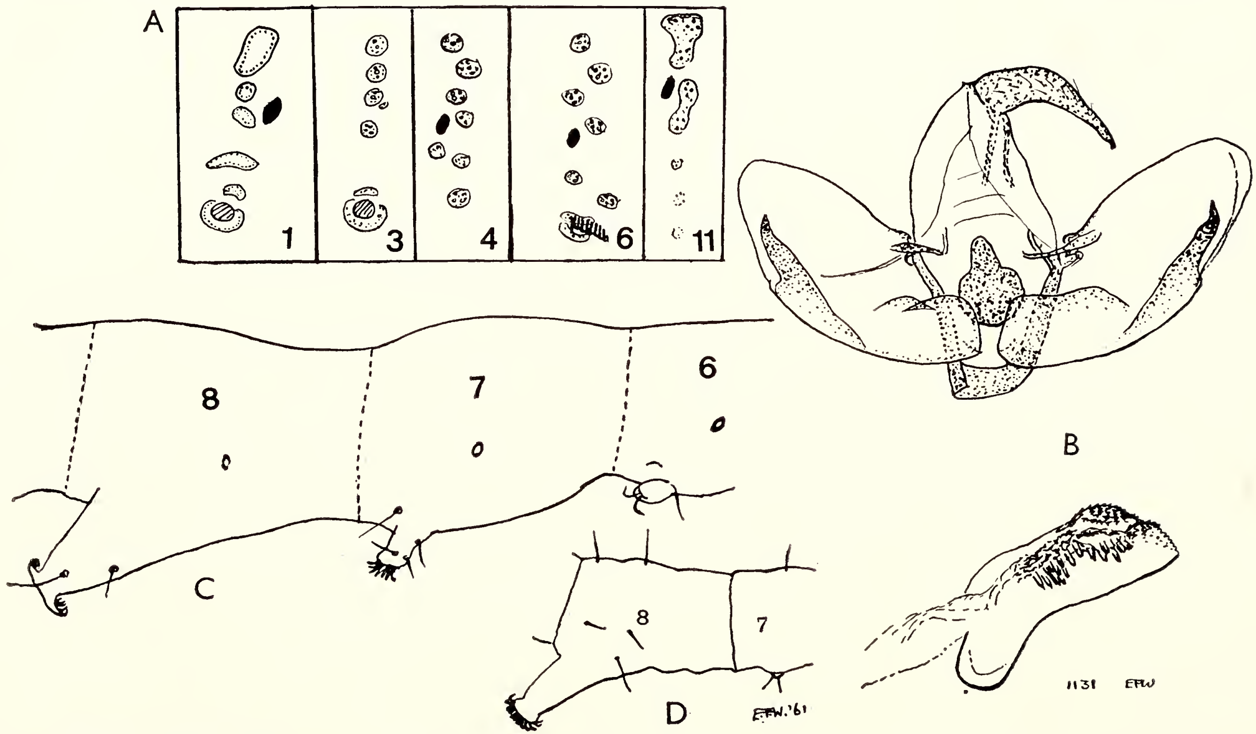
The full-grown larva is very different; it is not unlike that of *S. cilium latebrosa*, described in the preceding article in this series (1957); the character which distinguishes it from that most readily is the black marking on the sub-dorsal stripes; this is in the form of an interrupted black edge, and the black streaks are in *mauritia* broader and less circumflex-formed, being also rather irregular in form, particularly on the upper edge; moreover, the two pairs of black marks on somites 10 and 11 are roughly wedge-shaped, that on 10 tapering tailwards, that on 11 the reverse; they thus form a kind of open box mark. The thoracic somites lack black sub-dorsal markings. Thoracic and anal plates, dull brown with whitish lines. Ground colour, glossy pink, green ventrally and sublaterally. The pale sub-dorsal stripes are rather broad but not outstanding. The lateral stripe is also broad and is freckled pinkish, but its upper edge is fine, clear white, and interrupted. Spiracles pink, black-rimmed. Head, glossy brown. Setae, black, very fine.

Pupa, red-brown, glossy; cremaster, a two-pronged fork.

Pupal period, 10 days



A. *Thiacidas postica* Walker: Fig. 1. Larvae in third moult on foodplant *Zizyphus spina-christi*; Fig. 2. Larva preserved skin, lateral view, and imago, male; Fig. 3. Larvae, full grown, dorsal view; Fig. 4. Male imago, showing neuration. **B.** *Spodoptera mauritia* Boisd.: Fig. 5. Larva and foodplant, lawn-grass.



Thiacidas postica Walker : A. larval chaetotaxy ; left side of somites 1, 3, 4, 6, and 11 ; B. Male genitalia, ventral open position with aedeagus separated. *Drasteria yerburyi* Butl. C, D, larva, abdominal feet at different stages of growth (C. somites 6, 7, and 3 of mature larva ; D. somites 7 and 8 of larva as in first three instars).

Foodplant: Grass.

When lawns are flooded (which is done twice a week, as a rule) numbers of these larvae are disturbed, and fall a prey to sparrows which gather in flocks.

Thiacidas postica Walker (=*Raphia cheituna* Brandt, syn. nov.) (Plate III, Figs. 1-4 ; Plate IV, Figs. *A* & *B*.)

This larva was described by J. C. M. Gardner in *Indian Forest Records* **6** (8 & 9) (1941). It is not however a Lymantriid, as was first pointed out by Dyar, 1897, *Canad. Ent.* **29** : 12; Dyar said it seemed to be a Noctuid, perhaps of the Apatelinae. However, the hindwing neuration, so clearly Quadrifid (see Fig. 4) makes it fall rather into the Pantheinae (=Mominae) as defined by Forbes (Lepidoptera of New York and the neighbouring States, Pt. III, p. 290). *Raphia* Hubner is placed by him in this subfamily, and he gives details of the larvae. It is clear from this and other facts that the genus *Raphia* is attached to the tree-genus *Populus* and has an Holarctic range; the larvae are smooth and green, quite unlike those of *Thiacidas* and other Mominae. Brandt's subgenus *Tiessa* created especially for *cheituna* is a pure synonym of *Thiacidas* Walker, which was monotypic. But *Raphia* is a good genus, of which *Thiacidas* (=*Tiessa*) cannot be considered a subgenus.

The larva is gregarious for the first three instars, and the third moult is performed gregariously; there are usually little groups of caterpillars, about six per leaf at this stage, nearly always on the same branch, doubtless all from a single egg-batch. The coloration does not change markedly during the growth of the larva. The ground colour is pale green, sometimes olive-yellow at full growth, but reverting to green in the pre-pupal diapause. Sub-dorsal lines, wavy, interrupted, yellowish green; they are heavily edged with black on somites 9 and 10, but the black edging is not connected, taking the form of two triangles, of which the base rests on the dorsal area, and the equilateral apex, pointing downwards, is rounded off by a downward wave of the sub-dorsal line; the triangular form is, however, only approximate. Below this is a darker, blue-grey, wide lateral stripe contrasting with the paler dorsal area. Long light brown hairs are arranged in bands across the centre of each somite, thickest on the back and scantiest on the sides. Long single black hairs issue laterally from these bands. A pale brown dorsal tuft on somite 10 is conspicuous. All the hairs arise from large pale brown warts. The head is glossy black with small white spots near the mouth and a large white triangular central spot in front, apex uppermost. The black-rimmed spiracles are placed just below a pale yellow sublateral stripe edged with black below. The thoracic feet are brown; the abdominal feet are, all five pairs, equally developed, and pale green.

After the third moult (see Plate III, Fig. 1) the larvae grow too big to be more than one on a single leaf; but they usually remain near one another on a single branch till full growth. They are thus easily found by the patch of defoliation in one part of a tree, and by the droppings underneath.

Foodplant: Christ-thorn, *Zizyphus spina-christi* (Arabic: *Nebk, Sadr*).

I have only found larvae in October and November in Bahrain, though the moth flies twice a year. When full grown, the larvae leave the tree and scatter widely before pupating in some remote cranny. The cocoon is strong but thin, and composed of silk into which are woven larval hairs. Usually a long pre-pupal diapause ensues before the larva finally pupates. During this time the larva is green, naked except for a few short hairs near the head and tail, and with warts very prominent, now greenish; the black lateral markings and black head offer contrast.

One larva which spun up on November 13 produced a moth on March 25 next; but all others, and I have bred several scores, continued the pre-pupal diapause through the following summer and pupated in late September or early October, and the moths emerged about three weeks later. Some moths fly in the wild state in March-April, others in October, giving the appearance of a bivoltine phenology; but it is curious that despite search I have never found larvae in April-May.

The pupa is light brown, very glossy, with a cremaster composed of two spines, rather short and wide apart.

In Plate IV, I illustrate the larval chaetotaxy and male genitalia. The latter show affinity to *Panthauma* Stgr. and *Trissuloides* Butl. as illustrated by Kozhantsikov, FAUNA OF USSR **12**. The former is not unlike the chaetotaxy of *Diphthera* Ochs., id. All these three genera were placed in the Mominae by that author, who includes, like Forbes, *Raphia* Hubn. in the same subfamily despite the smooth larva; I agree with Forbes rather than Kozhantsikov, however, in placing this subfamily in the Noctuidae-Quadrifinae, not the Orgyidae (Lymantriidae).

Mocis frugalis F. (Plate II, Fig. 7)

J. C. M. Gardner (*Indian Forest Records* **6** : 285, 1941; and *Trans. R. Ent. Soc. Lond.* **98**, pt. 4, p. 66, 1947) has described the chaetotaxy of this larva, and some other characters from Indian material. The pupa was not described there.

The full-grown larva is pinkish yellow laterally, more greyish dorsally. The dorsal line is partly double, fine light brown, white-edged externally, the white edging in turn being dark-edged. The lateral stripes are fainter than the dorsal, and are double, brown. Spiracles, inconspicuous, black-rimmed, placed on a double brown stripe. The rather flat, rounded head is yellowish, shaded with dark grey and edged below with a white stripe on either cheek, below which five ocelli (Gardner says six) can be distinguished under magnification. Setae, fine, black, placed eccentrically on a whitish oval. Ventral stripe, fine, black, variable. Under magnification, the longitudinal striation appears as faint orange-brown lines on a milky grey ground. The spiracular stripe is creamy and contains one brown strand; it is blackish or purplish-edged below. Abdominal feet, purplish-marbled, three pairs only, equally developed; at their base, mauve or blackish pencilling forms a sublateral stripe.

Foodplant: Grass. (The photograph shows the larva on a leaf of *Pluchea*; it was in fact found on this, showing that it wanders, but it never ate any of this shrub.) It is so coloured that it would be inconspicuous amongst grass; in fact its markings are much the same as those of many grass feeders, Satyridae and Hadenidae 'Wainscots'. The latter Wainscots when alarmed fall into the grass roots and roll up into a circular spiral; *Mocis* however, being a semi-looper, falls and rolls up but not into a circle but rather into a flattened elongated ring, head to tail; at such a time the characteristic *Mocis* black marks, absent in most Wainscot larvae, appear; these are narrow black transverse bands across the back in the somital joints between somites 4, 5, and 6; these marks also sometimes appear when the larva is moving, and tensely looped, but normally are hidden. Their visual effect would be to disrupt the larva-shape and render it perhaps less recognizable.

The pupa is red-brown with a lilac bloom, purplish on the thorax, but the abdominal segments lack bloom and are darker brown. The spiracles are dark brown. The tail is blunt and rounded, the cremaster consisting of several ridges and about eight fine looped setae. There are, as in all Noctuidae, five entirely exposed abdominal somites posterior to the wing-cases. Pupal period, under two weeks. The moth is multivoltine and flies both by day and night, though in its day-flight it keeps to shady places. It inhabits the moister, grassier gardens of the Bahrain oasis, never the desert. It may be seen at most times of the year. I have received slightly larger paler forms of this moth from south-west Arabia, and it is widespread in the Tropics of the Old World.

Before leaving the subject of this moth, I would like to add that its genitalia have been illustrated very well, but under the wrong name, by Nystrom in the same work referred to under *P. illecta* Walker above; p. 33, Fig. 92 represents *frugalis*, not *Anticarsia irrorata* F., as stated there.

Cerocala sana Stgr. (Plate II, Fig. 1, 4)

This moth inhabits warm, rather sandy deserts in the Middle East. Its early stages were quite unknown before, as also those of its congeners.

The ovum is sub-oval, yellowish nacreous, unsculptured, but with a shallow depression on one side; though it adheres slightly it seems, in captivity, to be laid at random. The ovum hatches in two weeks in November.

The young larva has three pairs of abdominal feet; the head is black, the thoracic plate brown, glossy and small; before eating, the body is yellowish grey with interrupted purplish crimson double sub-dorsal lines, of which the outer strand is thickened in the middle of each somite. When about 1 cm. long, the larva is pale grey with purplish or olive-brown stripes; the dorsal line is fine, olive-brown and slightly interrupted; the sub-dorsal stripe is double, purplish, with its upper strand slightly interrupted, its lower strand thicker and darker, broadening on each somital joint. Setae, black, very fine. Abdominal feet, grey, yellowish distally; thoracic feet, pale, yellow-tipped. Thoracic plate, pale grey, with two U-marks on either side of a central line, open forwards. Head, light brown.

In the last two instars, when about one inch long, the larva retains the above general pattern and colouring but acquires a dorsal lozenge-pattern also; the lozenges are pale, with a wider, basal part towards the posterior of each somite, and a dark, diffuse, oblique shade on each side arising from the deep purple lateral spot forms the anterior part of each lozenge.

If one preserves the larval skin by blowing, the colour fades due to the scanty pigmentation; the skin appears whitish with crimson-brown markings. From such a skin the following details were noted: anal flap, rounded, sclerotised; pale brown; the two well-developed pairs of feet on somites 8 and 9 have a glossy chitinous, ivory-coloured skin and uniordinal brown crochets; on somites 6 and 7, instead of claspers there are simply pairs of long ventral setae not different from those on somites 4 and 5; i.e. there is no swelling, wart, or rudimentary abdominal feet on these segments. The thoracic plate is pale brown with a darker fine brown posterior border; head, light brown, with black ocelli; all setae are inconspicuous except the ventral tactile ones.

Foodplants: *Helianthemum kahiricum* and *H. lippii*; these are two characteristic dwarf desert shrubs, leafless for much of the year, widespread on limestone desert in the south of Bahrain, and also quite widespread in Middle East deserts. The larva feeds at night, grows rather slowly. From ova laid in November larvae attain full growth in mid-March.

The moth seems to appear on the wing in the southern deserts of Bahrain regularly every year in November, whether rain has fallen by then or not; in some years I have also taken it in these localities in January, March, and April, but not all; perhaps a lack of rain inhibits further flights. In slightly more northerly localities (e.g. Ahwaz, in S. Iran, or the coast of the Lebanon, where it is confined to coastal dunes) the moth appears from its flight, in March and October, to be bivoltine, but my breeding experience now makes me doubt this. Only when a number of larvae have been successfully brought through the pupal stage in different months will the truth appear.

A curious feature of the larva's behaviour is that, if alarmed, it often drops and remains limp; sometimes, however, it will appear limp and lifeless without falling, remaining attached by the hooks of one clasper; or by the forelegs. Plate II, Fig. 1, illustrates this pose.

Drasteria yerburyi Butl. (=*Syneda pica* Brandt, syn. nov. = *Syneda albifasciata* Gaede, syn. nov.) (Plate II, Fig. 9)

This is a desert moth ranging from Somaliland, whence Gaede described it as new, to South Persia, whence Brandt did likewise. The type was taken at Aden, and it now proves to inhabit Bahrain.

Ovum, bun-shaped, unsculptured, pearly white. The period is short, but was not noted exactly.

The young larva has three pairs of abdominal feet well developed, but the pairs on somites 6 and 7 are represented by tiny papillae each bearing two setae. This is so until the third instar. In the last instar, the two anterior pairs of abdominal feet are still less developed than those on somites 8, 9 and 12, but by then have developed to an intermediate stage; the pair on somite 7 are equipped with crochets, while the pair on somite 6 has no crochets, but still consists of papillae with two apical setae, and also a few setae at its base. I have confirmed this by observations in two successive years, the first with larvae bred ex ovo, the second with larvae bred to imagines, all being examined microscopically (see Plate IV, C & D).

In colouring the larva is at first greenish, later pinkish grey; the skin is ridged transversely; spiracles, oval, yellow-brown, black-rimmed. Under magnification the pattern consists of white longitudinal lines pencilled with mauve-grey. Underside of head, marked heavily with black; upperside of head, marked with white stripes continuing from the body's sub-dorsal, lateral and sublateral stripes, and clearer than those. The five ocelli are arranged in a sickle-like row; the uppermost three are brown, the lower two and endmost of the the row are black. In the last instar, when over 3 mm. long, the larva's linear markings are more distinct, consisting of a pale grey dorsal stripe containing darker grey transverse bands towards the posterior edge of the somites, divided by the dorsal line and adjacent to paler sub-dorsal stripes resembling the dorsal but with more diffuse central line; lateral stripes, more olive-grey than the dorsal; subspiracular stripe, pale grey, continuous on somites 1-7, thereafter interrupted and wavier. Ventral surface, dappled olive-grey.

Foodplant: *Taverniera spartea,* a pink-flowered desert-broom characterised by blue-green stems and small scanty oval leaves; the larva is monophagous on this, and eats, not the flowers or leaves, but the green rind of the stem. The photograph shows a part of the stem thus eaten, behind the larva. It feeds at night, and hides in the soil by day, at least when large.

Pupa, in a weak flimsy cocoon hardly worthy of the name, below the surface of the soil; red-brown, the cremaster being a blunt sclerotised tongue-like projection with two terminal spines. Pupal period in February, March, 30-40 days. Pupae, formed later, died but probably over-summer. The moth flies between October and April, and larvae of different sizes may be found during the cooler season while the moth still flies. There would thus appear to be two generations linked by a spread emergence of the first brood; the whole life cycle is interrupted by a strong diapause during the very hot summer months but it has not been observed in what stage this takes place.

Acantholipes circumdata Walker (Plate II, Fig. 8)

This moth is widespread in India and also inhabits South Persia; in Bahrain it is rather rare, inhabiting deserts together with the preceding moth, *D. yerburyi,* which is commoner here, but more truly eremic.

The larva has only three pairs of abdominal feet, even when full grown, and no traces of rudimentary feet on somites 6 and 7. It is grey, slender, tapering, with a fine, paler, double dorsal line clearest on the somital joints; the other markings are intricate but weakly defined; the head is flattened, the hindmost feet or claspers are stretched backwards and complete the spindle-formed stream-lined silhouette; the larva is thus only easy to see when moving.

Foodplant: *Taverniera spartea*, at night. It is smaller and less common than the larva of the preceding species but, like it, eats only the green rind of the plant stem. It may well feed on some other papilionaceous shrub in India and elsewhere in its range, and in that case probably does not confine itself to the rind; this diet characterises lepidopterous larvae on *Taverniera* of which, doubtless, the rind is the most nutritious and permanent available pabulum.

Pupa, very slender and tapering; the thorax and wing-cases are dull green until the end of the pupal period, the abdomen yellow-brown, terminating in a blunt short cylinder without hooks or true cremaster. The pupa-case, after emergence, is light yellow-brown all over. The pupal period is about two weeks.

I have only observed two vernal generations of this moth but presume that its phenology resembles that of *D. yerburyi*, above.

Acrobyla kneuckeri Rebel

This is a widespread Saharan-Sindian moth, its largest and darkest form having been described under the name *ariefera* Hamps., inhabiting the deserts around Karachi; it extends westward across Arabia and North Africa.

The ovum is glossy yellow, bun-shaped, and very faintly sculptured. It hatches after 9-10 days. The young larva has only three pairs of abdominal feet, but has bristly setae representing the pairs on somites 6 and 7; the whole larva appears bristly at this stage owing to the prominent grey setae on every somite, springing from wide black hoops or bands. Its general appearance is of a black and grey banded, bristly semi-looper. It proved impossible to breed further, rejecting all kinds of foodplant offered.

The moth is bivoltine, flying in March and November. It is very local in Bahrain, doubtless because its foodplant is localized; as I have only taken it at the Acacietum near Sakhir, it seems very likely that *Acacia arabica* is its foodplant; however there are one or two other herbs characteristic of this peculiar habitat, namely *Lithospermum* and *Heliotropium tuberculosum*; the larva refused all of these, so its life-history is a mystery. It is mostly found elsewhere in rather southerly deserts with *Acacia* stands.

Family GEOMETRIDAE

Chlorissa discessa Walker (Plate I, Figs. 6 & 9)

This Indian Emerald moth is found on both sides of the Persian Gulf, e.g. at Bushire and Bahrain. Its larva and pupa are generally similar to those of *C. faustinata* Mill. in aspect but not foodplant; the latter species has been observed on *Acacia arabica* in Egypt.

The ovum of *discessa* is green, glossy, flattened, oval and minutely reticulated; it hatches after 5-6 days.

The young larva is pinkish white with pale bristles but after feeding it becomes dirty yellow-green or yellow in colour, with a pink dorsal line also sometimes visible. Slight transverse wrinkles are also to be noted, the most marked of which are the whitish somital joints. The head is rounded on top, and somite 1 has two pairs of small rounded dorsal protuberances. The setae are white and at this stage, under magnification, prove to be bifurcate, branching parallel to the body surface, recalling minute palm-trees, in silhouette. There are two pairs of abdominal feet; head and feet, whether thoracic or abdominal, yellowish or dirty yellowish green.

After two weeks (of growth in the cool season) the larva is mauve-grey, tinged with pale green at head and tail; the skin is roughened with whitish warts, the larger of which are arranged in two sub-dorsal rows, leaving a mauve-grey dorsal area irregularly dotted with smaller white specks. At this stage, a few only of these warts have the tree-like branching setae noted earlier. On the sides, similar warts are arranged in interrupted oblique short lines, between which and the sub-dorsal warts there is a lateral area similar in colour and markings to the dorsal. The head is now strongly bicornuate, and the first somite has as before two pairs of dorsal protuberances mimicking the two head points; this character is found in all the larvae of the subfamily (Hemitheinae) known to me. The head is pale dirty green, with fine white specks; on each side near the mouth two ocelli stand out, black; the thoracic and abdominal feet are still coloured as the head; the anal flap has two particularly long setae but is otherwise of normal form. The spiracles are inconspicuous. The length is now about 7 mm.

The rate of growth varies individually; some larvae when already half-grown begin to show dorsal arrow-marks.

When full grown, the larva is dull olive-grey, rather pale, peppered with white spots of various sizes, circular and wart-like; the setae are black. A purple dorsal suffusion concentrated at the somital joints in the best-marked forms resembles a series of dorsal arrows pointing forwards. The foremost pair of abdominal feet is laterally purple suffused, the final pair less so. The two hindmost pairs of thoracic feet (those on somites 2 and 3) are now purplish, peppered with white specks, while the foremost pair is lighter coloured; there is also a purplish tinge on the head tips and the tips of the dorsal protuberances on somite 1. Each somite is divided into seven or eight rings demarcated by skin wrinkles less deep than the somital joints.

The frail cocoon is spun between leaves and in litter.

The pupa is light wood-brown, sometimes rosy-tinged, with a clear black dorsal line, and infuscated wing-cases. Under magnification the thorax appears pale orange-brown with fine black setae, a dorsal line is black on the head and somite 1 only; the wing-case is more greyish, less rosy with forewing neuration indicated in heavy black. On top of the head, close to the dorsal line, are two little eye-like knobs. The abdomen is more transparent grey, with whitish grey freckling; on the abdomen the dorsal line is black, almost continuous, and sublateral lines are considerably interrupted wider and vaguer black; the spiracles are black-rimmed, but less conspicuous than the lateral setae. The remarkable cremaster consists of a flattened tongue-like process from which issue eight hooks with curly ends, arranged laterally and symmetrically, in an elegant pattern recalling wrought iron; these hooks however are brittle.

Foodplant: Chiefly the common hedge-shrub *Clerodendrum inerme* sometimes called 'false jasmine'. The larva will however also eat, if offered, a little *Caesalpinia* and grass.

The moth's habitat is strictly oasis in Bahrain, i.e. gardens not desert. There may well be a summer diapause; in any case, in two consecutive years I obtained ova from females flying in November from which moths were bred in January and February. As I have also taken the moth on the wing in May there appear to be three generations a year. There is another Emerald moth which flies in Bahrain, namely *Microloxia herbaria*; it is smaller than *C. discessa* and inhabits certain parts of the desert.

Sterrha mimetes Brandt (Plate I, Fig. 5)

This eremic moth is found in deserts along both sides of the Persian Gulf.

The ova are laid loose and are oval, blunt at either end, with longitudinal ribbing sculptured, each rib being notched transversely, coloured a dull matt pearl, later orange.

The freshly hatched larva, under magnification, appears purplish black with two fine greenish white dorsal lines and a broad greenish lateral stripe. The head is yellow-brown, and the thoracic plate has three fine white dorsal lines. The setae are fine, sparse, frosted white.

When full grown, the larva is pinkish grey, roughened with transverse ridges; the dorsal stripe is broad, dark brown, transversely black between ridges in two places at each somital joint with a continuous fine whitish central line and a whitish sub-dorsal edging consisting of white dots, each ridge being a white dot; this edging follows a wavy course rendering the stripe now narrower, now broader. Below this sub-dorsal line is placed a series of blackish dots or streaks, widely separated. The setae are short, springing from fine white points. The sublateral stripe is whitish, broad, diffuse, and continuous, with an interrupted white lateral stripe above it; below it, is a darker purplish grey sublateral area. The spiracles are inconspicuous. The head is pale buff, and the thoracic plate similar in colour, but composed of two crenate transverse ridges, the posterior being the lesser.

In March the ovum hatches after 12-14 days and the larva is full grown a month later. The moth flies from September to November and again from February to April in both desert and oasis but mainly the former.

The foodplant has not been observed wild; this genus is often polyphagous on low herbs; in captivity I could only persuade the larvae to feed on desert herbs, which are rather hard to keep fresh; they rejected the more succulent garden herbs. Among those they ate with relish were the flowers of the Composita *Launaea nudicaulis* and the flowers of *Helianthemum lippii* and *kahiricum*. As these are available for a short season only I found that the easiest way to rear them was to give them the pink-flowered desert broom *Taverniera spartea*; of this they eat not the leaves or flowers but the green rind of the stem, as can be seen in the illustration. This desert plant is rather local and the moth also inhabits parts of the desert where it is unknown, though perhaps commonest where it grows abundantly.

Sterrha granulosa Warr. & Roths.

This eremic moth was described from the Sudan and also inhabits the eastern desert of Egypt; its characters were given by me in *Bull. Soc. Fouad. Ent.* (*Cairo*) **33**, pp. 404-5 (1949). In Bahrain, curiously, where I also discovered it to fly, it inhabits oases and is very local. The identity of Bahrain examples has been confirmed from the female genitalia which are characteristic.

The ovum is irregularly oval in form, resembling a lemon somewhat, and whitish in colour. The ova hatch after two weeks. I failed to rear the larvae.

The moth seems to be bivoltine, flying in May, and September-October.

Scopula adelpharia Pung. (Plate I, Fig. 7)

This moth, previously known from Palestine and Egypt has been found commonly in Bahrain flying together with *Scopula ochroleucaria*

H.-S. which has more denticulate fasciae. Both moths are oasis moths, inhabiting Bahrain gardens, not deserts. The larva of the latter species has already been described and is shown in the same plate (Fig. 8). It may be useful, however, if I redescribe it here, after describing the larva of *adelpharia*.

The ovum of *adelpharia* is at first whitish, later reddish; it is long-oval, sculptured with longitudinal ridges which are counter-notched. It hatches after ten days in March, after only six days in May.

The freshly hatched larva is purplish, and, like other *Scopula* larvae, assumes a coil-like pose. When more mature they are long and slender and rest extended. They are longer and thinner than *Sterrha* larvae.

When half grown the larva is darker than that of *ochroleucaria*, but later becomes paler; the whole dorsal area at this stage is purplish black with only interrupted fine white sub-dorsal lines faintly showing; the lateral stripe is broad, pale olive-green; the sublateral and ventral areas are almost as dark as the dorsal area. Ten days later, when mature, the larva is pale green-grey with a darker grey or purplish sublateral area terminating between the pairs of abdominal feet. Under magnification, fine transverse ridges may be seen, but leave smooth areas of skin on the anterior part of each somite on the back, sides and venter; this area is interrupted by a raised sublateral ridge, identical with the sublateral stripe. The head is pale, powdery purple-grey with two white sub-dorsal lines on each lobe; on the body, the dorsal and sub-dorsal lines are paler and dark-edged for the whole length of the body, the edging of the dorsal line being the darkest. Some forms have black lateral spots just above the sublateral stripe on somites 4-8; below this stripe, on some somites, are similar black spots, but these are not placed immediately below the upper lateral spots. Dark forms have the sublateral and whole ventral areas purplish, the purple hue being most intense on the sublateral.

Foodplant: *Convolvulus, Prosopis stephaniana.*

The pupa is lightly chitined, yellow-brown, the eyes soon turning black; the spiracles are fine and black. It is formed in an oval, rather weakly built, cocoon among litter and leaves.

From ova laid on March 12, a first generation of moths hatched between April 30 and May 11. From these a further generation of moths was bred, hatching between mid-June and mid-July. The moth is certainly multivoltine and might probably be obtained in almost any month of the year, perhaps excluding August,

Scopula ochroleucaria H.-S. (Plate I, Fig. 8)

The ovum is at first pale green, then dull honey-coloured irregularly spotted with rose, giving it a reddish aspect except under magnification; the sculpture, consisting of longitudinal ribbing, is faint. The ova hatch after eight days in the cool season (January-February).

The freshly hatched larva is purplish dorsally and ventrally but pale green laterally; it adopts a pose resembling a cursive capital L. On the thoracic somites are visible pale green dorsal and sub-dorsal lines, widening towards head; feet, pale green. Head, pale green, purplish marked.

When half grown, the larva often still adopts the same coil-like pose. Its pattern is now more variegated, and there are two distinct colour forms, yellow and olive-green. The anal flap is rounded; the skin, transversely wrinkled; there are very short pale hairs. In the yellow form, the dorsal area is darker grey and bordered by an interrupted yellow sub-dorsal line; it contains only traces of a fine dorsal line after somites 1-3. The sides are yellowish grey, the feet pale yellowish. In the second form the markings are more developed; in addition to those mentioned for the yellow form there are also black sub-dorsal marks, and the dorsal pattern is complicated, in places resembling a chain of arrow marks pointing backwards. Head, olive-green, with white spots and fine black specks; feet, pale green; sub-lateral line, pale yellow or white, wavy, almost continuous. Ventral surface, darker, containing a fine, pale ventral line.

Foodplants: *Convolvulus*, Nasturtium, Rose.

Cocoon and pupa, similar to the preceding.

The description by Turati, quoted by Prout in Seitz IV, Supplement, p. 37, should also be noted.

Semiothisa syriacaria Stgr.

Having already described the larva, in the third article in this series (*Mitt. Muench. Ent. Ges.* **29** : 1, 1939) I will confine myself here to describing the pupa, and giving biological-phenological notes made recently in Bahrain. The larva there is as described already, except that brown forms were not observed at all.

The foodplant is, in Bahrain, as in Iraq and Iran, *Prosopis stephaniana*; it is remarkable how the larvae will die of starvation rather than eat the foliage of *Prosopis spicigera*, so widely planted in Bahrain, or the various kinds of *Acacia* which somewhat resemble the true foodplant and are not distant in relation. The foodplant is deciduous and leafless in winter; while *P. spicigera* is evergreen Despite this advantage, *spicigera* does not find favour with the lepidoptera (there are several species) attached to *stephaniana*, The ovum hatches after only four days, even in the first generation in March, as well as in mid-summer, as already noted. The life-cycle is, however, very variable due mainly to the varying length of the pupal stage. I bred two generations in captivity and of these the life-cycle of both varied somewhat similarly. From ova laid in March and hatching after four days, four moths emerged after a life-cycle of 30 days, one of 32 days, one of 59 days, one of 66 days, two of 67 days, and one of 76 days; the emergences were thus spread between April 11 and May 27. The second generation, from ova laid on April 12, emerged between mid-May and late July, one moth having a life-cycle of 33 days, one of 36 days, one of 37 days, one of 45 days, two of 66 days, one of about 80 days (exact date not observed), one of 91 days, one of 97 days, and one of 106 days. The actual pupations took place within a week of each other. While the length of the pupal period varied so strikingly, the hour of emergence was invariably shortly before midnight, usually 10 p.m.

The pupa is heavily chitined, deep purple-brown; the cremaster is a single strong forked spine.

The Bahrain race of this moth is strongly banded with black, even the weakest-marked form being f. *tenuiata* Stgr. I have taken the imago on the wing at Bahrain from March to August. Whether it flies in the autumn is doubtful; it certainly does not fly in the coolest month when its foodplant is leafless, though many other species of moths fly at this season. Presumably the cool weather acts on the pupa and causes it to delay its emergence, in all cases, instead of, as in summer, only in some individuals.

Family PYRALIDAE

Ceutolopha isidis Z.

The larva is green, browner dorsally, reddish at the somital joints; there is a double white dorsal line and a broader white spiracular stripe; the spiracles are white. On each side of somite 11 there is a conspicuous white seta above the spiracle, and there is a similar pair of setae on the anal flap.

The larva lives in a shelter formed of the leaves of its foodplant which is *Acacia nilotica* ('Sunt'). This observation was made in Egypt in 1947, and the imago which hatched from the above larvae was recently determined by Dr. H. G. Amsel. The larvae were taken at Maadi near Cairo in September and the moth hatched the same month. The phenology is probably multivoltine.

Prochoristis crudalis Led.

It seems likely that the genus *Prochoristis* is attached to the plant genus *Capparis* (Caper). At least I can state that the species *P. rupicapralis* Led. can be best obtained by beating Caper bushes in northern Iraq, and another species, *crudalis* Led., described below, has been found feeding on the same foodplant in Cyprus.

The larva tapers slightly towards the head and more towards the tail; it is green, pale brown dorsally, orange laterally, with a series of black lateral spots or setae, especially large on the thoracic setae. Top of head, black; rest of head, olive-brown. Dorsal line, double, darker olive; on either side of it are two double, pale olive, sub-dorsal lines; legs and ventral area, green.

Foodplant in Cyprus: *Capparis spinosa.*

Pupal period in spring 27 days.

Family TORTRICIDAE

Enarmonia coluteana Amsel, 1959 (*Laspeyresia coluteana* Ams., *Bull. Soc. Ent. Egypte* **43** : 59)

The larva feeds internally in the pods of a leguminous shrub; it is ivory-coloured without markings, and with a brown head; the feet are pale, the spiracles inconspicuous. In another form, however, the larva is green with vague purple sub-dorsal stripes and the head and small anal plate are brown-marked. The tracheae are visible forming dark bluish webs internally from the spiracles. In a third form, the larva is purplish; this form was noted in a rather dried-up pod.

The pods inhabited by the larva were yellowish with small brown holes and larger brown stains. The habitat of this moth and its foodplant were Middle Heights, the woodland zone, Kurdistan, northern Iraq; the actual locality, Salah-ud-Din, 2500 ft.

I regret that although the types were labelled as having been bred from pods of *Colutea*, there has probably been an error in determination of the foodplant, as *Colutea* has disc-like pods, while the pods in which this larva was found were more like pea-pods; in fact they were most probably *Anagyris foetida.*

Cnephasia orientana Alph.

The larva is about half an inch long, fairly fat, dull green with paler lines. The spiracles are black, the setae, fine, black and whitish circled.

Foodplant: *Verbascum*; locality: Shiraz.

The moth is fairly common and widespread in Persia.

The pupal period is short; a larva found full grown in early April produced an imago in late April.

Family GELECHIIDAE

Anacampsis malella Amsel, 1959 ('Irakische Kleinschmetterlinge.' *Bull. Soc. Ent. Egypte* **43** : 65)

The larva was found between leaves, spun together, of apple (*Pyrus malus*). On May 2, they had already pupated in this position and the two moths from which this species was described emerged on May 5 and 6. The locality was an apple orchard on the west bank of the Tigris at Baghdad.

Family GRACILLARIIDAE

Lithocolletis turanica Graeser

The larva mines the largest leaves of its foodplant close to the central rib, causing a kind of blister-mine, over which the leaf half curls up. In 1956 such leaves were collected in late February and produced moths in early March, but in 1957, a more severe winter, leaves picked on December 30 1956 produced a moth on March 20.

Foodplant: Apple (*Pyrus malus*). The locality is the same as for the preceding species.

Eco-toxicology and Control of the Indian Desert Gerbille, *Meriones hurrianae* (Jerdon)

I. Feeding behaviour, energy requirements, and selection of bait

BY

ISHWAR PRAKASH AND C. G. KUMBKARNI
Central Arid Zone Research Institute, Jodhpur

(*With two figures*)

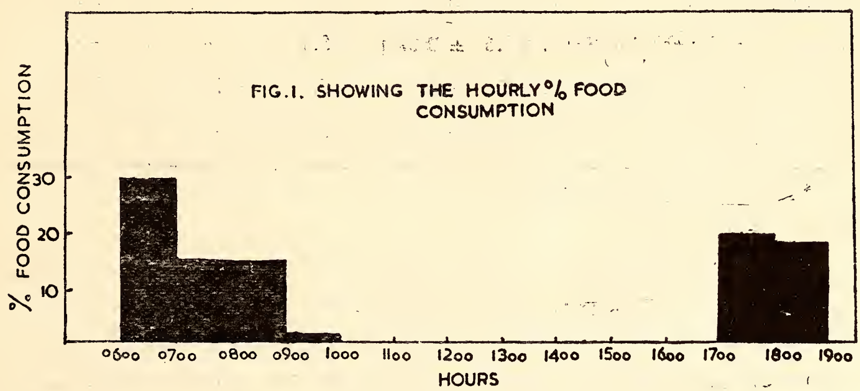
INTRODUCTION

The Indian Desert Gerbille, *Meriones hurrianae* (Jerdon) (Gerbillinae, Rodentia), is the dominant mammal species in the Rajasthan desert (Prakash, 1961). Being a herbivore it is extremely destructive to vegetation (Prakash, 1959a). This was known as early as 1890; the Forest Administration Report of the former Jodhpur State of the year 1890 mentions that during the winter months considerable damage was caused to young seedlings and transplants in Jodhpur plantation by 'field rats' (meaning thereby gerbilles): 'They appeared in swarms and devoured all the young vegetation'. Wagle (1927) declared this gerbille as 'harmless' in rice fields but Prakash (1959, 1959a, 1960, 1962) pointed out its colossal damaging propensities. Recently Ganguli & Kaul (1962) tried two poisons to eradicate this rodent. Since unplanned poisoning is hazardous to farm animals, the minimum lethal dose of the proposed poisons and their toxicity should be studied before measures on a large scale are tried in the field. Also, the correct assessment of the most preferred food of *Meriones* and its daily consumption must be made in order to select a suitable medium for poison-baiting. With this viewpoint trials were conducted in the laboratory. Besides this, the paper deals with feeding behaviour, the effect of various feeds on body weight, particularly that of the seeds of plants found in the natural habitat and of those which are of afforestation importance, and the energy requirements.

Observations and Discussion

Feeding behaviour

Meriones hurrianae is essentially a diurnal species. In nature, it comes out of its burrow for feeding just after dawn and retires after a few hours before it is too warm. It again comes out at about 6 p.m. and retires at 7.30-7.45 p.m. In winter, however, it is out of its burrow throughout the day but not during the mornings and evenings when it is quite cold. Due to human intervention in the laboratory the gerbilles adjusted their feeding times to avoid the working hours (Fig. 1). 62% of the total daily intake was consumed from 6 a.m. to 10 a.m. and the rest between 5 p.m. and 7 p.m. This was observed all the year round.



Total daily intake (TDI)

The gerbilles did not accept any food when they were freshly brought under captivity, although the size of the cage was large, viz. 225×75×75 cm., and not more than six gerbilles were kept in one cage. After 3-4 days the rodents started eating meagre amounts and about 10 days after their capture their TDI became stationary. Table 1 shows the average TDI of various grains and pulses as consumed in 24 hours per gerbille. During this series of experiments only one food item was tried at a time with a group of 6 to 12 gerbilles. Water was provided for drinking during every trial. It is observed that wheat flour is most preferred. Table 1 also shows the calorific values of the various TDI. It is calculated that with food giving 12-15 calories of energy a day, one gerbille of 45-55 gm. weight group can maintain its body weight.

TABLE 1

Average Total Daily Intake of Gerbilles and its Calorific Value*

Food	TDI in gm.	TDI % Body wt.	% moisture	Calorific value of TDI
Wheat flour ..	7.04 ± 0.38	11.3	12.2	24.71
Sorghum, *Sorghum vulgare* ..	6.5 ± 0.28	10.5	11.9	22.11
Millet, *Pennisetum typhoideum.*	5.5 ± 0.26	8.9	12.4	19.8
Moong (green gram), *Phaseolus radiatus* ..	5.0 ± 0.48	8.06	10.4	16.7
Whole wheat, *Triticum aestivum* ..	4.0 ± 0.15	6.4	12.8	13.92
Bengal gram, *Cicer arietinum* ..	4.0 ± 0.56	6.4	9.8	14.0
Maize, *Zea mays* ..	3.8 ± 0.41	6.1	14.9	13.0
Moth, *Phaseolus aconitifolius* ..	3.6 ± 0.67	5.8	—	—
Barley, *Hordeum vulgare* ..	3.4 ± 0.35	5.4	12.5	13.3
Guar, *Cyamopsis tetragonoloba*	1.98 ± 0.30	3·2	—	—

* After Aykroyd *et. al.* (1960)

Seed consumption

It was observed earlier that in nature the gerbilles consume seeds up to 60% in January, and thereafter the percentage decreases to 10 in July; it then increases to 60 in December (Prakash, 1962). Seeds of the following plant species could be identified from the stomach contents of gerbilles which were collected and analysed all the year round: *Cenchrus* spp., *Boerhavia diffusa, Tephrosia purpurea, Crotalaria burhia, Farsetia jacquemontii, Capparis decidua, Zizyphus* spp., *Cynodon dactylon, Trianthema portulacastrum, Cucumis trigonus, Colocynthis vulgaris, Prosopis juliflora,* and *Eragrostis ciliaris.* It was, therefore, considered that the seeds of plants found in the gerbille habitat form their main food. This was confirmed by the Silviculture Section of the Institute, more than 50% of the sown seeds being destroyed by the gerbilles. Therefore, seeds of plants found around gerbille burrows and those of afforestation and grassland importance were given to them to study the seed consumption in 24 hours. Trials were conducted with groups of animals after their adaptation to captivity. In some groups water was provided, and in others the gerbilles were maintained without water, but there was no appreciable difference in the consumption. The data in Table 2 show the average amount of seeds consumed during 24 hours per gerbille. When compared to millet (*Pennisetum typhoideum*) and sorghum (*Sorghum* sp.) controls, the TDI of seeds is significantly very low. Amongst the grass seeds, those of *Panicum antidotale* were consumed in larger quantities. Next higher consumption was of *Dichanthium annulatum*, *Lasiurus hirsutus*, and *Cenchrus setigerus* seeds. Amongst other plant seeds those of *Zizyphus nummularia* were consumed at the average rate of 1.75 ± 0.65 gm. during 24 hours per gerbille. Seeds of *Acacia* spp. were least consumed.

TABLE 2

Average Seed Consumption per Gerbille during 24 hours

Seeds of	Consumption in 24 hours in gm. per gerbille
1. *Panicum antidotale*	3.25 ± 0.79
2. *Dicanthium annulatum*	2.5 ± 0.76
3. *Lasiurus hirsutus*	2.1 ± 0.48
4. *Cenchrus ciliaris*	0.85 ± 0.25
5. *Cenchrus setigerus*	2.1 ± 0.41
6. *Zizyphus nummularia*	1.75 ± 0.65
7. *Tecomella undulata*	1.50 ± 0.33
8. *Prosopis juliflora*	1.21 ± 0.36
9. *Albizia lebbeck*	1.20 ± 0.40
10. *Aerva tomentosa*	0.66 ± 0.17
11. *Acacia senegal*	0.40 ± 0.05
12. *Acacia arabica*	0.37 ± 0.16

Significance at 5% level Items 2-12 $P < .001$ with millet and sorghum control
Item 1 $P < \cdot 01$ with millet control
Item 1 $P < .001$ with sorghum control

Seed preference

There are many factors governing the seed consumption when seeds of only one plant species are provided to gerbilles for preference trials. The seeds may have spines, they may be very hard, or when there is only one food for the starving gerbilles they may be forced to feed upon that particular seed. As in the previous trials, the amount of seed consumption may not be indicative of their true seed preference. Seeds of various plants were, therefore, given to gerbilles in combinations. The gerbille was placed in a smaller cage (75×75×75 cm.) and the experimental food was given in equal quantities in two petri dishes of the same size. To minimize the factor of availability during every trial the positions of the samples were rotated. Combinations of two and three seeds were tried. The preference was denoted by the amount of seeds consumed during 24 hours. The results are expressed in Tables 3 and 4, following the method of Cott (1951) and Prakash (1957). The arrows point toward the preferred species. By comparing data in Table 2, 3, and 4 it will be observed that the preference and choice of gerbilles is quite consistent.

TABLE 3

Showing Preference of Grass Seeds

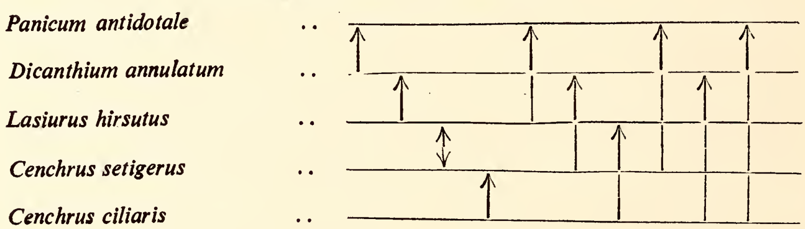
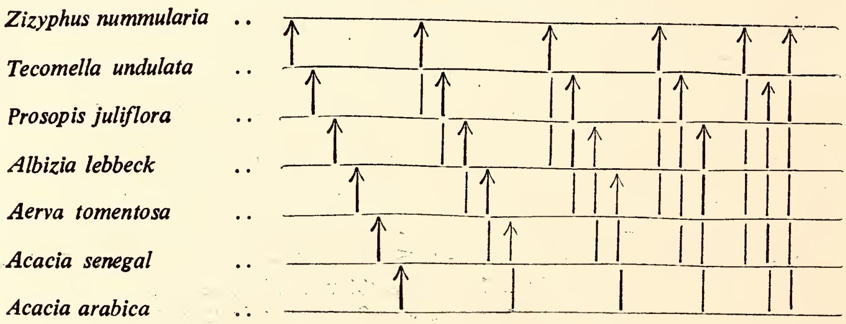


TABLE 4

Showing Preference of other Plant Seeds



Body weight in relation to feeding without water

Meriones practically do not get drinking water in nature. In captivity they readily accept water and on an average a gerbille consumes 2.78 ± 0.18 ml. water during 24 hours when being fed on air-dried seeds. To ascertain the influence of water consumption on body weight, wheat was provided to gerbilles with and without water. The experiment lasted for about a month. The group of gerbilles being fed without water lost weight considerably but the other group maintained body weight (Fig. 2). These results from experiments in captivity are particularly interesting since gerbilles not only maintain but add to their body weight when they do not get any water in nature.

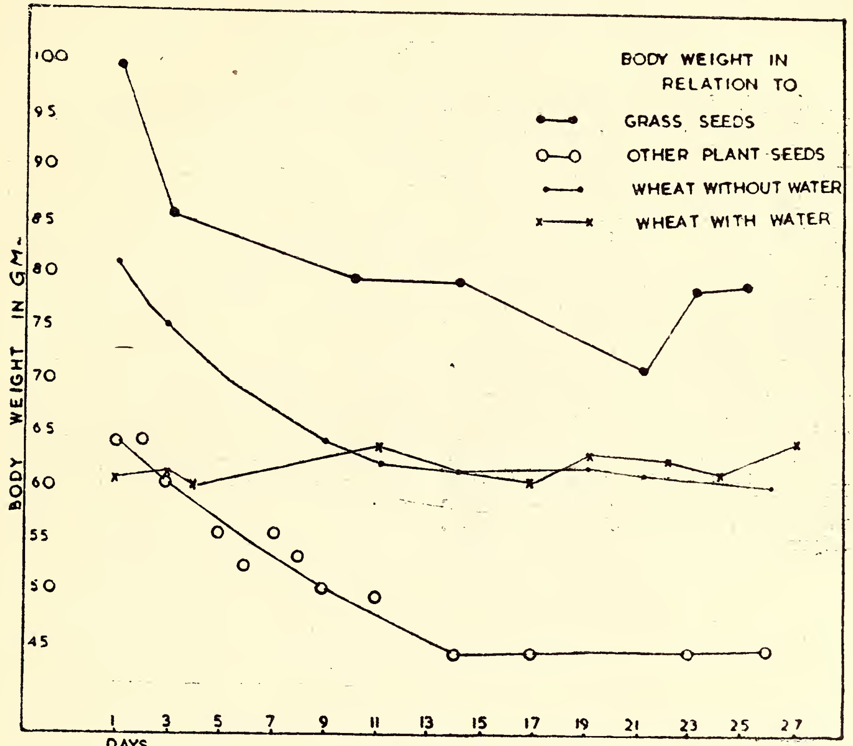


FIG. 2

. BODY WEIGHT IN RELATION TO VARIOUS FEEDS

Body weight in relation to seed food

The graph (Fig. 2) indicates two curves, one showing the body weight losses when a group of gerbilles was fed on grass seeds and the second shows the body weight on other seeds. Till the 21st day while feeding on grass seeds, the curve declines steeply whereafter there is an increase in body weight, but when the gerbilles were fed on other seeds the body weight fell so much in 12-14 days that the gerbilles started dying and strong cannibalistic tendencies were induced due to starvation. After this critical period the body weight was maintained by the remaining gerbilles of the group.

ACKNOWLEDGEMENTS

Our grateful thanks are due to the Director, Dr. P. C. Raheja, for providing facilities and making suggestions during the progress of the work, and to Dr. P. K. Ghosh, Animal Physiologist, for suggestions and help.

REFERENCES

Aykroyd, W.R., Patwardhan, V.N., & Ranganathan, S. (1960): The nutritive value of Indian food and the planning of satisfactory diets. *Health Bull.* No. 23. Govt. of India, New Delhi.

Cott, H. B. (1951): The palatability of the eggs of birds: Illustrated by experiments on the food preference of the hedgehog (*Erinaceus europaeus*). *Proc. Zool. Soc. London* **121**: 1-41.

Ganguli, B.N., & Kaul, R.N. (1962): Preliminary study on the behaviour and control of Indian desert gerbille (*Meriones hurrianae*). *Indian For.* **88**: 297-304.

Prakash, Ishwar (1957): A survey and ecological studies of the mammals of the desert of Rajasthan with special reference to food and feeding habits of certain insectivores and rodents. Doctoral Thesis. University of Rajasthan, Jaipur.

Prakash, Ishwar (1959): Food of Indian desert mammals. *Jour. Biol. Sci.* **2**: 100-109.

——— (1959a): Destruction of vegetation by desert animals in Rajasthan. *Indian For.* **85**: 251-253.

——— (1960): Food of certain insectivores and rodents in captivity. *Univ. Raj. Studies*, **4**: 1-18.

——— (1961): Die saugetiere der Rajasthan Wuste in Indien. *Natur und Volk* **91**: 443.

——— (1962): Ecology of the gerbilles of the Rajasthan desert, India. *Mammalia* **26**: 311-331.

Wagle, P.V. (1927): Injurious field rats of lower Sind and their extermination. *Dept. Agri. Bull.* No. 138, Bombay.

The Birds of Nepal

PART 8

BY

BISWAMOY BISWAS

Zoological Survey of India, Indian Museum, Calcutta

[*Continued from Vol.* 59 (2) : 429]

Subfamily MUSCICAPINAE

615. **Terpsiphone paradisi leucogaster** (Swainson). Himalayan Paradise Flycatcher.

DUN : Hitaura : 1 juv. ♂ (June 11).

The Paradise Flycatcher is not an uncommon bird in certain areas of central Nepal, such as Kathmandu and its suburbs in the Nepal Valley and in the dun. However, we did not find it common in the Hitaura region. It occurs in the gardens of Kathmandu town from about the last week of March, and in other areas on bushes or trees in the forests as well as about villages.

Rand & Fleming (1957) did not report it from Nepal.

My specimen is a male in chestnut plumage without streamers, and has the chin and throat dark grey, and the breast ashy grey.

616. **Monarcha azurea styani** (Hartlaub). Northern Indian Blacknaped Flycatcher.

DUN : Hitaura : 9 ♂♂, 1 ♂ ?, 4 ♀♀, 1 chick in down (May 12-29).

The Blacknaped Flycatcher was not uncommonly found by us in the forests around Hitaura in central dun. It was seen in pairs along the edges of forests as well as some distance inside.

Scully (1879), Ripley (1950b), and Rand & Fleming (1957) failed to find it in Nepal. Ours, therefore, appears to be the only record of this bird from Nepal since Hodgson's days.

The specimen (May 21) referred to above as '♂ ?' is labelled ♂, but has female coloration.

Chick in down (May 29): Feathers are just growing on head. Neck and upper back naked. Lower back, rump and wings brown. Tail feathers just growing. Feather track along the midline of chin and throat just appreciable, as also the track along the edges of lower mandible to the angle of the jaw. Breast to vent silky white down, tipped smoky brownish on the breast.

Measurements :

	9 ♂♂	1 ♂?[a]	4 ♀♀
Wing:	70 (2), 71 (2), 72, 74 (3), 75	71	68, 71 (3)
Tail:	69, 70, 71, 71.5, 72 (2), 74, 74.5, 76	73	69, 72 (2), 72.5
Bill:	15.5 (2), 16 (5), 16.5, 17	16	15.5 (2), 16, 17

[a] Marked ♂ on the label, but has female coloration.

*617. **Ficedula parva subrufa** (Hartert & Steinbacher). Western Redbreasted Flycatcher.

Proud (1955, p. 61) is responsible for the only record of the occurrence of the western race of the Redbreasted Flycatcher in Nepal. She observed it only once, obviously a stray one, in Kathmandu on April 10.

618. **Ficedula parva albicilla** (Pallas). Eastern Redbreasted Flycatcher.

BHABAR : Amlekhganj : 1 ♂ (March 6). CHITLANG VALLEY : Chitlang : 1 ♀ (April 19). NEPAL VALLEY : Thankot : 1 ♀ (April 12).

The Redbreasted Flycatcher was found by us in small numbers in central Nepal from the bhabar up to the Nepal Valley during March-April. It was seen on bushes, hedges and lower branches of trees near villages.

Rand & Fleming (1957, p. 174) reported it also from western, west-central and eastern Nepal from *c.* 275-1370 m. in winter.

Measurements :

	Wing	Tail	Bill
1 ♂ :	72	51	14
2 ♀♀ :	66, 67	49 (2)	14 (2)

619. **Ficedula strophiata strophiata** (Hodgson). Orange-gorgetted Flycatcher.

Siphia strophiata Hodgson, 1837, *India Rev.* **1**(12) : 651. (Nepal.)

Siphia strophiata euphonia Koelz, 1939, *Proc. biol. Soc. Wash.* **52** : 67. (Kulu, Kangra Dist., Punjab.)

CHITLANG VALLEY : Chitlang : 1 ♂ (April 22). NEPAL VALLEY : Thankot : 3 ♂♂, 2 subad. ♂♂, 5 ♀♀, 4 subad. ♀♀ (March 22-31, April 10, 11).

The Orange-gorgetted Flycatcher was not uncommonly found by us in the Nepal Valley at bases of the surrounding hills during March and April. It occurred on bushes and trees along the edges of forests.

Ripley (1950b, p. 404) states that it is 'not found in the Valley except in winter in late November'. However, Scully's (1879, pp. 278-279) specimens from the Nepal Valley were collected in March and May ; Smythies (1950, p. 515) saw it only above *c.* 2440 m. on Phulchauki and Sheopuri ranges where, according to him, a few pairs were probably summer residents ; our specimens were taken in March and April ; and Rand & Fleming's (1957, p. 175) in January and February. In the northern regions of central Nepal, it was reported by Proud

(1952a, p. 364) from the Gandak-Kosi watershed at *c.* 3475 m. in spring, by Polunin (1955, p. 892) from the Langtang Valley at *c.* 3050 m. in summer, and by Lowndes (1955, p. 32) from Manangbhot at *c.* 2590 and 3655 m. in summer. Rand & Fleming (loc. cit.) found it in western through eastern Nepal at *c.* 915-1830 m. in winter. Biswas (1960a) reported it from the Dudh Kosi Valley, Khumbu, eastern Nepal, at *c.* 3655 m. in April, preparing to breed.

The specimens designated above as subadult all have somewhat juvenile coloration and pointed tips of rectrices. The throat is not bluish black, but light chestnut, sometimes mixed with light blue-grey except in a male (March 23) where the throat is almost wholly dark blue-grey with traces of rufous on the tips of a few worn feathers.

Measurements :

	4 ♂♂	2 subad. ♂♂	5 ♀♀	4 subad. ♀♀
Wing :	72, 76, 78, 79	68, 74	70(2), 71, 73(2)	68, 69, 70, 71
Tail :	59, 61.5, 62,—	52, 58	55(3), 57, 58	52, 53, 54(2)
Bill :	13.5, 14, 14.5, 15	13.5, 14	14(3), 15,—	13, 13.5, 14,—

The paratypic series of Koelz's *euphonia* is too similar to the above-mentioned topotypic series of *strophiata* to justify recognition (see also Vaurie, 1954e, p. 5; Ripley, 1961, p. 424).

*620. **Ficedula monileger monileger** (Hodgson). White-gorgetted Flycatcher.

The only two post-Hodgsonian records of this flycatcher from Nepal are Stevens's (1924b, p. 63) from the Mai Valley (eastern Nepal) in April, and Rand & Fleming's (1957, p. 175) from Godavari (Nepal Valley), at *c.* 1675 m. in January.

Although Sharpe (1879, p. 461) listed three specimens presented by Hodgson to the British Museum, this species was curiously not included in either edition of the catalogue of Hodgson's collection, and Baker (1924, p. 244) did not even include Nepal within the range of the species.

621. **Ficedula hyperythra hyperythra** (Blyth). Rufousbreasted Blue Flycatcher.

BHABAR : Amlekhganj : 1 ♂, 2 ♀♀ (March 7, 8). MARKHU VALLEY : Deorali : 2 ♂♂, 1 ♀ (April 29-May 1). CHITLANG VALLEY : Chitlang : 3 ♂♂, 3 ♀♀ (April 19-25). NEPAL Valley : Thankot : 1 ♂ (April 11).

The Rufousbreasted Blue Flycatcher was found by us in small numbers in central Nepal during March-May. It was seen singly on bushes and shrubs in the undergrowth of forests.

Scully (1879) did not record it from Nepal. Stevens (1924b, p. 61) found it in the Mai Valley, eastern Nepal, below 2135 m. in April-May. It was also reported by Ripley (1950b, p. 405) from western to eastern Nepal, and Rand & Fleming (1957, p. 175) from western to central Nepal.

One of my specimens (♂, April 24) is very worn, A female specimen (April 19) has traces of blue on the forehead.

Measurements :

	7 ♂♂	6 ♀♀
Wing :	59+, 60.5, 61 (2), 61.5, 62 (2)	56.5, 58 (2), 58.5, 59, 60
Tail :	41+, 42, 43, 44 (2), 45 (2)	39 (2), 39.5, 40 (2), 41
Bill :	12.5, 13 (4), 13.5,—	12.5 (2), 13 (3), —

622. **Ficedula hodgsoni** (Verreaux). Rustybreasted Blue Flycatcher.

CHITLANG VALLEY : Chitlang : 2 ♀♀ (April 21, 26). NEPAL VALLEY : Thankot : 1 ♂, 1 unsexed (March 29, 31).

The Rustybreasted Blue Flycatcher was encountered by us only on Chandragiri, both on the Chitlang and Thankot sides, where it was found to occur in dense oak forests, in thick scrub as well as on trees.

This species has been reported only recently from west of Sikkim, namely in the Nepal Valley by Proud (1955, p. 61) who observed it as fairly common there in winter and early spring.

The unsexed specimen is in feminine plumage.

Measurements :

	Wing	Tail	Bill
1 ♂ :	74	58	12.5
2 ♀♀ :	66, 68	50, 54	12, 12.5
1 unsexed :	71	55	13

623. **Ficedula westermanni collini** (Rothschild). Indian Little Pied Flycatcher.

DUN : Bhimphedi : 3 ♂♂ (May 4). CHITLANG VALLEY : Chitlang : 2 ♀♀ (April 18). NEPAL VALLEY : Thankot : 1 ♂ (April 1).

We did not find the Little Pied Flycatcher particularly common in central Nepal, small parties or pairs being seen by us only a few times on both the sides of the Chandragiri and the Mahabharat Range (above Bhimphedi), between *c.* 1220 and 2135 m.

Scully (1879) and Ripley (1950b) did not report it from Nepal. Polunin (1955, p. 892) occasionally observed it in the Langtang Valley, central Nepal, at *c.* 2745 m. in summer. Rand & Fleming (1957, p. 176) reported it from western, central and eastern Nepal.

One of my female specimens (Chitlang, April 18) has traces of blue on the forecrown.

This flycatcher was breeding in April.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	57, 58, 59, 61	42, 43 (2), 45	12.5, 13 (2), 13.5
2 ♀♀ :	57, 60	40, 43	13, 14

624. **Ficedula superciliaris aestigma** (G. R. Gray). Little Blue-and-White Flycatcher.

BHABAR : Amlekhganj : 1 ♂ (March 6). MARKHU VALLEY : Deorali : 2 ♂♂ (May 2, 3). CHITLANG VALLEY : Chitlang, Chandragiri above Chitlang : 6 ♂♂, 1 (♂) (April 14-27). NEPAL VALLEY : Thankot, Crest of Chandragiri : 5 ♂♂, 3 ♀♀, 1 (♀) (March 25-April 14).

The Blue-and-White Flycatcher was not uncommonly found by us in central Nepal, usually above 1525 m. from March. It was observed in pairs or small parties in fairly deep forests on bushes or low trees, sometimes even on tops of lofty trees.

An almost breeding bird (with fairly enlarged but not fully developed gonads) was obtained as early as March 27.

Colours of soft parts : Iris dark brown ; bill black ; legs dark to very dark horny ; feet horny to very dark horny ; claws black ; pads greyish white to pure white.

Measurements :

	15 ♂♂	4 ♀♀
Wing :	60, 60.5, 61, 62(2), 62.5, 63(3), 64(4), 65, 66	60(2), 61, 62
Tail :	40+, 43, 45(6), 46(4), 47.5, 48, —	42, 43, 44, 45
Bill :	14(2), 14.5(3), 15(6), 15.5, —(3)	13.5(2), 14, 15

The series from central Nepal is intermediate between the birds from western Himalaya (Punjab-Kumaon) and eastern Himalaya (Bhutan) and Assam. The major distinguishing characters of these populations (in males) may be summarized as follows :

	W. Himalaya (46 ex.)	C. Nepal (21 examined)	Bhutan, Assam (18 ex.)
White patch on base of outer rectrices	Large and prominent	Large and prominent in 8 specimens Absent in 7 specimens Intermediate (i.e. present but not large or conspicuous) in 6 specimens	Absent
White supercilium	Well defined	Well defined in 4 specimens Absent in 2 specimens Intermediate in 15 specimens	Very faint or absent
Coloration of the upper parts	Paler	Generally darker	Darker

It may further be added that Sikkim-Darjeeling birds are almost as variable as those of central Nepal.

The western Himalayan bird has the name *superciliaris* Jerdon, 1840; and it has been customary to apply the name *aestigma* Gray, 1846, to birds from Nepal eastward. Now, *aestigma* was described on the basis of Nepal specimen(s) having a very inconspicuous or no white patch on outer rectrices and supercilium, and the *superciliaris*-type of bird from the same collection was described as *hemileucura* by Gray (loc. cit.). It would appear, therefore, that *aestigma* refers, strictly speaking, to the intermediate population. But since this name alone has been in use for the past 116 years for the eastern bird without whie on tail and supercilium, it should be retained for that bird, inappropriate though it appears to be. If, however, this is not acceptable, the eastern bird should be known as *cleta* Koelz, 1954 (type locality Mawphlang, Khasi Hills, Assam).

Vaurie (1954e, pp. 5-6) has also discussed the variation in the Nepal birds.

625. **Ficedula tricolor tricolor** (Hodgson). Western Slaty Blue Flycatcher.

Digenea tricolor Hodgson, *Proc. zool. Soc. Lond.* : 26. (Nepal = central hills of Nepal, according to Gray & Gray, 1846, p. 92.)

Cyornis tricolor notatus Whistler, 1930, *Bull. Brit. orn. Cl.* **50** : 70. (Guud, Kashmir.)

BHABAR : Amlekhganj : 1 ♂ (March 8). DUN : Bhimphedi : 1 ♂ (March 11). NEPAL VALLEY : Thankot : 1 ♂, 4 ♀♀ (March 25—April 1).

This flycatcher did not appear to be common in central Nepal. It was observed by us singly or in pairs on bushes and trees in forests.

Both Scully (1879) and Ripley (1950b) were unable to locate it in Nepal. Polunin (1955, p. 892) observed it in the Langtang Valley, central Nepal, at *c.* 3050 m. in summer. Proud (1955, p. 62) found it also along the new road west of the Nepal Valley at *c.* 915 m. in winter. Rand & Fleming (1957, p. 176) reported it from western through central Nepal.

Measurements :

	Wing	Tail	Bill
3 ♂♂ :	61(2), 62	55(2), 56	12.5, 13(2)
4 ♀♀ :	54, 58, 59, 60	47.5, 50.5, 51(2)	12.5, 13, 13.5(2)

In his studies on the geographical variation in *Ficedula tricolor*, Vaurie (1953b, pp. 3-4) has restricted the type locality of nominate *tricolor* to eastern Nepal, because 'there is no certainty that the type came from central Nepal. It may have come from eastern Nepal or even Sikkim, for . . . Hodgson had left Nepal for Sikkim in 1843.' In point of fact, however, Hodgson left Nepal in 1843 but *went to England and lived there till* 1845 when he returned to India to live in Darjeeling. Moreover, the name *tricolor* was first published as a *nomen nudum* by Hodgson in 1844 (in Gray's Zool. Misc., p. 84) when he was in England. Furthermore, before Hodgson left Nepal, he donated portions of his collections to various museums of the world, including the Museum of the Asiatic Society of Bengal, Calcutta and the British Museum, London, both these institutions receiving their shares in 1842. In the Asiatic Society's collections (which are now with the Zoological Survey of India), there is a specimen of *tricolor*, still bearing Hodgson's label with number 795. The British Museum received two specimens (Gray & Gray, 1846, p. 92). It would appear, therefore, that Hodgson's description of *tricolor* was based on those specimens which were collected while he was stationed in Kathmandu, hence very likely from the Nepal Valley. In any case, since Gray & Gray (loc. cit.) had already restricted its locality to the central hills, Vaurie's restriction is superfluous.

As Vaurie (op. cit., p. 3) has already shown, the specimens of the species from central Nepal are indistinguishable from those of Kashmir and northern Punjab. Whistler's *notatus* should, therefore, be considered a synonym of the nominate *tricolor*. For the darker eastern race the name *minuta* Hume, 1872 (type locality Sikkim) is available.

*626. **Ficedula sapphira** (Blyth). Sapphireheaded Flycatcher.

Since Hodgson's days, the Sapphireheaded Flycatcher has been reported from Nepal by Stevens (1924b, p. 62) in the Mai Valley, eastern Nepal, at *c*. 2135 m. in April, and Ripley (1950b, p. 405) from Chatra, Kosi Valley, eastern Nepal, at *c*. 150 m. in February.

627. **Niltava grandis grandis** (Blyth). Large Niltava.

MARKHU VALLEY : Deorali : 3 ♂♂, 1 ♀ (May 1, 2). CHITLANG VALLEY : Chitlang, Chandragiri above Chitlang : 3 ♂♂, 1 ♀ (April 16-27). NEPAL VALLEY : Thankot : 1 ♂, 2 ♀♀ (March 22-31).

The Large Niltava was occasionally observed by us in central Nepal on hills round the Nepal Valley, on the southern slope of the Chandragiri, and on the Mahabharat Range. It occurred in dense forests, in undergrowths and on shrubs or smaller trees.

Scully (1879) did not include it in his list.

The birds were breeding in April. A male taken April 18 had fully developed testes, measuring R : 7 × 4.5 and L : 8 × 4.5 mm.

Colours of soft parts : Iris very dark brown; bill, legs, feet and claws black ; pads grey.

Measurements :

	7 ♂♂	4 ♀♀
Wing :	104, 105, 106, 107(2), 109, 112	101, 102, 103, 104
Tail :	88, 90, 92, 93, 96, 97, 100	90(2), 91(2)
Bill :	20, 20.5, 21(2), 21.5(2),—	20, 20.5, 21(2)

The length of the tail given by Baker (1924, p. 257) is 65-70 which is very much smaller than what it actually is. Forty-eight specimens from Nepal east to Assam measure :

27 ♂♂ : 88-100 (av. 93.2) ; 21 ♀♀ : 85-95 (av. 88.9).

628. **Niltava macgrigoriae macgrigoriae** (Burton). Western Small Niltava.

DUN : Bhimphedi : 5 ♂♂, 1 ♀ (March 13, May 4-12). CHITLANG VALLEY : Chitlang : 1 ♂ (March 15). NEPAL VALLEY : Thankot : 4 ♂♂, 7 ♀♀ (March 21-April 2, 14).

The Small Niltava is not uncommon in central Nepal above 1065 m.

during March-May. It occurs in dense forests and usually not far from streams.

Ripley (1950b, p. 406) and Rand & Fleming (1957, p. 177) reported it also from western and west-central Nepal.

One of my female specimens (Thankot, March 23) had developing ova, yet it is in adult male plumage.

Measurements :

	10 ♂♂	8 ♀♀
Wing :	62, 63(3), 64(3), 66(2), 67	63(3), 64(2), 64.5, 65(2)
Tail :	49, 50, 51, 52, 53(4), 54(2)	50(2), 51(4), 52.5, 55
Bill :	13, 13.5(5), 14(3),—	13(2), 13.5(5), 14

Rand & Fleming (op. cit., pp. 177-178) have shown that this species is best divided into two subspecies, namely nominate *macgrigoriae* (Punjab to Nepal) and *signata* Horsfield, 1840 (Sikkim to Indo-China).

629. **Niltava sundara sundara** Hodgson. Indian Rufousbellied Niltava.

CHITLANG VALLEY : Chitlang, Chandragiri above Chitlang : 10 ♂♂, 3 ♀♀ (April 16-25). NEPAL VALLEY : Thankot : 11 ♂♂, 5 ♀♀ (March 21—April 14).

The Rufousbellied Niltava is a common bird on hills round the Nepal Valley. It prefers bushes in dense forests.

Scully (1879) did not include it in his list. Ripley (1950b, p. 406) and Rand & Fleming (1957, p. 178) found it also in western and west-central Nepal. Biswas (1960a) observed it at *c.* 1800 m. in the Likhu Valley, eastern Nepal, in February.

It was breeding in April.

Measurements :

	20 ♂♂	8 ♀♀
Wing :	78+, 79, 80(2), 81(2) 81.5, 82(6), 83(5), 85, 86	76, 77, 79, 80 (3), 81, 81.5
Tail :	64+, 65(2), 67(5), 68, 69, 70(4), 71(4), 72, 73	62, 63, 65, 66(2), 67, 68(2)
Bill :	16.5(5), 17(9), 17.5(3), 18(2),—	16, 16.5, 17(5),—

630. **Niltava poliogenys poliogenys** (Brooks). Brooks's Flycatcher.

BHABAR : Amlekhganj : 1 ♂, 3 ♀♀ (March 6, 7). DUN : Hitaura : 6 ♂♂, 1 ♀ (May 13-23).

This flycatcher was occasionally encountered by us in the central bhabar and dun, where it occurred in the open parts of forests, sometimes on the edges of forests, on bushes and undergrowths, as well as on trees.

Ripley (1950b, p. 406) obtained it for the first time west of northern Bengal in eastern Nepal at Chatra, Kosi Valley (*c.* 150 m.) in February. Later, Rand & Fleming (1957, p. 178) reported extension of its western limit to the west-central Nepal tarai.

Measurements :

	Wing	Tail	Bill
7 ♂♂ :	72, 74, 75(4), 76	60, 62(2), 63(2), 64, 65	15.5, 16(4), 16.5, 17
4 ♀♀ :	71.5, 72(2), 74	56, 59(2), 62	15, 15.5, 16(2)

631. **Niltava unicolor unicolor** (Blyth). Pale Blue Flycatcher.

DUN : Hitaura, Bhimphedi : 6 ♂♂, 5 ♀♀ (May 4-16).

The Pale Blue Flycatcher appeared rather uncommon in central Nepal. It was noted by us in the Hitaura dun, presumably breeding, and it occurred in dense forests on undergrowths, bushes and sometimes on trees.

This species has not so far been known to occur in Nepal, its westernmost limit being Sikkim-Darjeeling. The present record from central Nepal, therefore, extends its range westward by about 320 km.

A female (May 4) bird was laying.

Measurements :

	Wing	Tail	Bill
6♂♂ :	80, 82, 83(2), 84.5, 85	70(2), 71, 73, 74, 76	17, 17+, 17.5, 18(3)
5♀♀ :	80, 82(2), 83, 84	69, 70(2), 71, 72	16.5, 17(2), 17.5,18

632. **Niltava rubeculoides rubeculoides** (Vigors). Bluethroated Flycatcher.

DUN : Hitaura, Kusumtar, Bhimphedi : 20 ♂♂, 2 juv. ♂♂, 5 ♀♀, 3 juv. ♀♀, 3 juv. unsexed (May 3-June 6). NEPAL VALLEY : Thankot, Phulchauki Danda above Godavari : 2 ♂♂ (April 5, May 15).

The Bluethroated Flycatcher did not appear to be at all common in the Nepal Valley during March-May, but was very common in the central dun during May-June. It was found by us in the forests on bushes, smaller trees and undergrowths.

Rand & Fleming (1957) did not record this species from Nepal.

One of my male specimens (Hitaura, May 22) exhibits partial gynandromorphism, having feminine coloration on the left side of the head, neck, chin and throat. There are also a few olive-brown feathers amongst normal blue feathers on the right side of the posterior crown and nape.

The juvenile specimens agree with the description of ' young ' birds given by Baker (1924, p. 232).

It was breeding in April-May. A male taken on May 15 had fully developed testes, measuring 9 × 6 mm. each.

Colours of soft parts : Iris dark brown ; bill black (pale yellow on gape in juvenile) ; legs and feet slaty horny (legs pale yellowish fleshy and feet fleshy in juvenile) ; claws horny (fleshy horny in juvenile) ; pads yellowish white to white.

Measurements :

	22 ♂♂	5 ♀♀
Wing :	69(2), 70(3), 71(5), 71.5, 72, 72.5, 73(6), 74, 74.5, 75	68.5, 69(2), 70.5, 71
Tail :	53(3), 54(5), 54.5, 55(3), 56(4), 56.5, 57, 58(2), 59(2)	52, 53.5, 54, 55,—
Bill :	14, 14.5(2), 15(11), 15.5(4), 16(2), 16.5,—	15(4),—

The tarsus measurements ' about 20 ' for the male and ' about 19 ' for the female as given by Baker (loc. cit.) are not correct. In birds from all over its range, the tarsus measures :

25 ♂♂ : 15.5-18.5 (av. 17.2) ; 15 ♀♀ : 15.5-18 (av. 17.1)

*633. **Niltava banyumas magnirostris** (Blyth). Largebilled Blue Flycatcher.

Although this flycatcher was not listed in either edition of Hodgson's collections, two specimens presented by Hodgson to the British Museum were listed by Sharpe (1879, p. 454). The only other Nepali record is Lowndes's (1955, p. 33) from the Marsiyandi Valley, central Nepal, at *c.* 2590 m. in summer.

*634. **Niltava tickelliae tickelliae** (Blyth). Tickell's Blue Flycatcher.

Rand & Fleming's (1957, p. 179) report from the western and west-central lowlands of Nepal constitutes the only definite record of Tickell's Blue Flycatcher from that country. It was not listed in either edition of catalogue of Hodgson's collections, but Sharpe (1879, p. 449) mentioned two Hodgson specimens from ' Behar '.

*635. **Muscicapella hodgsoni** (Moore). Pygmy Blue Flycatcher.

Since Hodgson's original specimens were obtained in Nepal, the Pygmy Blue Flycatcher has been reported from that country by Stevens (1924b, p. 63) in the Mai Valley, eastern Nepal, in March ; Ripley (1950b, p. 405), Proud (1955, p. 62) and Rand & Fleming (1957, pp. 179-180) in the Nepal Valley in winter and summer.

I agree with Ripley (1955a, pp. 86-87) in recognizing the genus *Muscicapella* Bianchi to accommodate this flycatcher.

636. **Muscicapa sibirica cacabata** Penard. Nepal Sooty Flycatcher.

DUN : Bhimphedi : 1 ♂ (May 5). MARKHU VALLEY : Deorali : 1 ♂, 2 ♀♀, 1 unsexed (April 29-May 1). CHITLANG VALLEY : Chitlang : 1 ♂ (April 23). NEPAL VALLEY : Thankot. Chandragiri above Thankot, Phulchauki Danda above Godavari : 6 ♂♂, 4 ♀♀, 1 unsexed (March 30-April 12, May 12).

The Sooty Flycatcher was observed by us in central Nepal from the last week of March, becoming commoner from early April. It occurred singly on tops of trees from where it would hawk for insects in the typical flycatcher fashion.

Scully (1879) did not report it from Nepal. Stevens (1924b, p. 60) found it breeding in the Mai Valley, eastern Nepal, at *c.* 2135 m. in April-May. In the northern regions of central Nepal, it was reported in summer by Polunin (1955, p. 891) from the Langtang Valley at *c.* 2745 m., and by Lowndes (1955, p. 32) from the Marsiyandi Valley at *c.* 2440 m.

In a male taken on March 31, the testes had just commenced enlargement, and measured R : 2.5 × 1.5, L : 3 × 1.25 mm. only, while a female taken on May 12 had a granular 5 × 2.5 mm. ovary.

Colours of soft parts : Iris dark brown ; bill, legs, feet and claws black ; pads grey.

Measurements :

	9 ♂♂	6 ♀♀	2 unsexed
Wing :	70, 71, 72(2), 73, 75, 75.5, 76(2)	70, 71, 73, 73.5, 74, 75	74, 76
Tail :	46(2), 46.5, 48(2), 49(3),—	47(2), 48, 49, 50, 52	49, 50
Bill :	12(7), 12.5(2)	11.5, 12(4), 12.5	12.5(2)

Baker (1924, p. 204) gave 50-55 and ' about 13 ' as the lengths of its tail and tarsus respectively. Twenty-five specimens from all over its range, however, measure as follows :

	Tail	Tarsus
15 ♂♂ :	45-51 (av. 47.7)	10.5-12.5 (av. 11.3)
10 ♀♀ :	47-52 (av. 48.6)	10.5-12.5 (av. 11.3)

637. **Muscicapa latirostris** Raffles subsp. ? Brown Flycatcher.

DUN : Hitaura, Bhimphedi : 2 ♂♂ (May 6, 16).

The Brown Flycatcher appeared rather uncommon in central Nepal. The few that we observed were rather shy. Scully (1879, pp. 276-277), however, found it common in the Nepal Valley, and social except during the breeding season. Proud (1949, p. 705) and Ripley (1950b, p. 404), on the other hand, came across but a few examples there. Rand & Fleming (1957) did not list it.

Measurements : 2 ♂♂ : Wing 72, 73 ; tail 50, 52 ; bill 15.5 (2).

There have been some divergent opinions regarding the Indian form(s) of *Muscicapa latirostris.* Thus, Baker (1924, pp. 249-250) identified all Indian birds as *poonensis* Sykes (type locality Poona, Maharashtra). Whistler & Kinnear (1932c, p. 85) were of the opinion that *poonensis* was based on a seasonal variation in the plumage and they treated it as a synonym of nominate *latirostris* (type locality Sumatra). Vaurie (1954e, p. 7) accepted Whistler & Kinnear's view. Deignan (1957b, pp. 340-342) held that there appeared to be two subspecies in India, one breeding in the Himalayas, while the other was widely distributed over the plains, and pointed out the difficulties of correctly assigning the two available names, *poonensis* Sykes and *terricolor* Blyth (type locality Nepal) to one or the other of them. Recently, Ripley (1961, p. 421) treats *latirostris* as a monotypic species with *poonensis* and *terricolor* as synonyms.

It has not been possible for me to go into this question in detail, mainly for want of suitable material, but from whatever material I have examined, I am inclined to agree with Deignan that two subspecies are involved in India.

638. **Muscicapa ruficauda** Swainson. Rufoustailed Flycatcher.

MARKHU VALLEY : Deorali : 1 ♂ (May 2). NEPAL VALLEY : Thankot : 1 ♂ (April 13).

We did not find the Rufoustailed Flycatcher at all common in central Nepal. It was observed only on a few occasions on the Chandragiri near Thankot and on the Mahabharat Range at Deorali, between *c.* 1830 and 2135 m. on bushes in forests.

Lowndes (1955, p. 33) was the first to report its occurrence in Nepal. He took a single example out of two in Manangbhot, northern central Nepal, at *c.* 3655 m. in July. Rand & Fleming (1957, p. 180) also obtained a single specimen on the Phulchauki Danda in the Nepal Valley at *c.* 2440 m. in May.

The breeding range of this species has been known up to Garhwal in the east, but the specimens collected by Lowndes, Rand & Fleming, and by us, presumably all from the breeding grounds in central Nepal, extend it by about 640 km. eastward.

Measurements: 2 ♂♂: Wing 73, 77; tail 57, 60; bill 15, 15.5.

*639. **Muscicapa ferruginea** (Hodgson). Ferruginous Flycatcher.

Since Hodgson's days, the Ferruginous Flycatcher has been recorded only twice from Nepal; by Stevens (1924b, p. 60) in the Mai Valley, eastern Nepal, at *c.* 2135 m. in April-May, and by Proud (1955, p. 61) on Sheopuri Lekh, Nepal Valley, *c.* 2440 m. in May.

640. **Muscicapa thalassina thalassina** Swainson. Verditer Flycatcher.

DUN: Bhimphedi: 1 ♂, 1 ♀, 1 juv. ♀ (May 5-10). MARKHU VALLEY: Deorali: 1 ♂ (April 28). CHITLANG VALLEY: Chitlang, Chandragiri above Chitlang: 4 ♂♂, 2 ♀♀ (March 15, April 20-22). NEPAL VALLEY: Thankot, Chandragiri above Thankot, Crest of Chandragiri, Godavari: 11 ♂♂, 7 ♀♀ (March 21-April 23, May 13).

The Verditer Flycatcher is a very common bird of central Nepal from above Bhimphedi up to the Nepal Valley during March-May. It occurs singly or in pairs, in light or open parts of forests.

In the northern regions of central Nepal, it was reported by Proud (1952a, p. 364) from the Gandak-Kosi watershed up to *c.* 2590 m. in spring, by Polunin (1955, p. 892) from the Langtang Valley at *c.* 2745 m. in summer, and Lowndes (1955, p. 32) from the Marsiyandi Valley at *c.* 1980 m. in summer. Rand & Fleming (1957, p. 180) found it in western, west-central and central Nepal at *c.* 275-1525 m. in January and March.

It was breeding during late March-May.

The juvenile female specimen (May 10) has no spots on the dorsal side except on the forecrown and the sides of the head. On the ventral side it has elongated fulvous spots except on the abdomen where the spots are larger, round and white.

Colours of soft parts: Iris dark brown; bill, legs, feet and claws black; pads grey.

Measurements :

	17 ♂♂	10 ♀♀	1 unsexed
Wing :	80 (2), 82, 83 (4), 84 (3), 85 (2), 86 (3), 87 (2)	79, 79.5, 80 (4), 80.5, 82 (2), 83	81
Tail :	65, 66, 68, 69 (3), 70 (6), 71, 72, 73 (3)	64, 64. 5 (2), 65, 66, 67, 68 (2), 69,—	72
Bill :	13.5, 14 (8), 14.5 (6), 15 (2)	13.5 (3), 14 (7)	14

641. Culcicapa ceylonensis pallidior Ticehurst. Himalayan Greyheaded Flycatcher.

DUN : Bhimphedi : 2 ♂♂, 2 ♀♀ (March 11, 12, May 3, 6). MARKHU VALLEY : Deorali : 1 ♂ (May 2). CHITLANG VALLEY : Chitlang : 4 ♂♂, 1 ♀, 1 unsexed (April 18-23). NEPAL VALLEY : Thankot, Chandragiri above Thankot, Godavari : 3 ♂♂, 2 ♀♀, 3 unsexed (March 25-April 4, May 11, 13).

The Greyheaded Flycatcher is quite common in central Nepal from Bhimphedi upwards to the Nepal Valley from about mid-March. We found it in mixed feeding parties with other smaller birds, usually in light forests, on undergrowths, smaller trees, etc.

Ripley (1950b, p. 406) recorded it also from the western and eastern tarai in winter. Lowndes (1955, p. 33) found it in the Marsiyandi Valley, central Nepal, at *c.* 1980 m. in summer. Rand & Fleming (1957, pp. 180-181) reported it from western through central Nepal in November, January and March. Biswas (1960a) found it breeding in the Hongu Valley, eastern Nepal, at *c.* 2745 m. in June.

The birds were breeding from late March till mid-May at least. One of the female specimens (Chitlang, April 18) had its functional ovary on the right side instead of the left (already reported by Biswas, 1960b).

Colours of soft parts : Iris dark brown ; upper mandible horny to dark horny, darker still on tip, or the whole of it very dark horny ; lower mandible fleshy with or without horny on the sides of anterior portion ; legs and feet yellowish brown or horny brown (once yellowish fleshy with pale horny on front of legs) ; claws pale horny to horny (once with pale tips) ; pads yellowish white to pale orange.

Measurements :

	10 ♂♂	5 ♀♀	6 unsexed[1]
Wing :	63, 64(2), 64.5, 65 (4), 66, 68	57, 59, 60 (2), 66	59, 60, 62, 64, 65, 6
Tail :	54, 56(2), 56.5, 57 (2), 58 (4)	51, 52(2), 53, 58	53 (3), 55, 57, 58
Bill :	12 (2), 12.5 (2), 13 (2), 13.5, 14,—(2)	12 (4), 13.5	11.5, 12 (3), 12.5, 13

The Greyheaded Flycatcher from West Pakistan and Kashmir to Sikkim was separated as *pallidior* by Ticehurst (1927, type locality Simla) from the nominate *ceylonensis* Swainson of the rest of India and Ceylon (type locality). Whistler (1944, p. 154) accepted *pallidior* and showed that *ceylonensis* should be regarded as an insular race. In his review of the species Deignan (1947) admitted the insular status of *ceylonensis*, but united all non-Ceylonese populations from India, Burma, China, Indo-China, Siam, Malaya and western Sumatra under one subspecies,

[1] Including additional Nepalese material present in the Zoological Survey of India.

namely *calochrysea* Oberholser, 1923 (type locality Tenasserim, peninsular Burma), with *pallidior* as a synonym. Ripley (1950b, p. 406 ; 1961, p. 434) and Rand & Fleming (1957, pp. 180-181) followed Deignan in designating their birds from Nepal as *calochrysea*. From an examination of the material available at the British Museum and the American Museum of Natural History (including the Koelz Collection), I am unable to agree with Deignan in synonymizing *pallidior* with *calochrysea*. The populations from western Himalaya and Tenasserim appear to me sufficiently distinct to be treated as two separate subspecies. Birds from Nepal and Sikkim, though showing some leaning towards *ceylonensis* (see also Whistler, loc. cit.), are closer to western Himalayan birds.

A thorough revision of the species with adequate and fresher material seems necessary.

642. **Rhipidura hypoxantha** Blyth. Yellowbellied Fantail Ftycatcher.

Rhipidura hypoxantha Blyth, 1843, *J. Asiat. Soc. Beng.* **12** : 935. (Darjiling.)
Chelidorhynx hypoxantha noa Koelz, 1939, *Proc. biol. Soc. Wash.* **52** : 58. (Naggar, Kulu, Panjab.)

DUN: Bhimphedi: 1♂ (March 14). CHITLANG VALLEY: Chitlang : 1 ♀ (March 15). NEPAL VALLEY : Thankot : 2 ♂♂, 1 (♂), 3 ♀♀ (March 23-April 9).

The Yellowbellied Fantail Flycatcher was found by us in small numbers during March-April in central Nepal from the upper dun to the Nepal Valley. It occurred in forests on bushes and low trees, sometimes also on tall trees about cultivated areas in or near forests. Ripley (1950b, p. 406) thought that it left the Valley before April, but we took specimens there (about Thankot) up to April 9, and observed it on the Chandragiri above Thankot at least up to April 20. Again, Smythies (1950, p. 515) found a few pairs as summer residents on Phulchauki and Sheopuri above *c.* 2440 m.

Ripley (loc. cit.) reported it also from the western tarai. Polunin (1955, p. 892) recorded it in the Langtang Valley, central Nepal, at *c.* 3655-3960 m. in summer. Rand & Fleming (1957, p. 181) found it in west-central Nepal through eastern in winter. Biswas (1960a) noted it in the Khimti Valley, eastern Nepal, at *c.* 1830 m. in February, and in Khumbu at *c.* 3655-3960 m. in March-May.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	55, 57(2), 58	56, 58 (2), 58.5	10.5,11 (2), 11.5
4 ♀♀ :	53, 54 (3)	54,56, 58 (2)	10.5 (2),11 (2)

643. **Rhipidura albicollis albicollis** (Vieillot). Whitethroated Fantail Flycatcher.

BHABAR : Amlekhganj : 1 ♂, 1 ♀ (March 6, 7). DUN : Hitaura, Bhimphedi : 4 ♂♂, 1 ♀, 1 juv. ♀ (May 6-14, 29). MARKHU VALLEY : Deorali : 1 ♀ (May 1).

We came across the Whitethroated Fantail Flycatcher in small numbers in central Nepal from about 300 to 1675 m. during March-May. It was observed in undergrowths of forests, and on bushes along the forest edges.

Scully (1879) did not find it in Nepal. Ripley (1950b, p. 407) and Rand & Fleming (1957, p. 182) recorded it also from western and eastern Nepal.

The juvenile specimen (♀, May 6) matches well with the description given by Baker (1924, p. 280).

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	75, 78, 79, 81, 82	97, 99, 103 (2), 107	14, 15 (3), 16
3 ♀♀ :	72, 73, 76	97 (2), 100	14, 15 (2)

Koelz (1939, p. 68) described the western Himalayan birds as *canescens* (type locality Bhadwar, Kangra Dist., Punjab), but Whistler (1942, p. 35) cast doubt on its validity. I am, however, inclined to agree with Ripley (1955b, p. 41) in accepting Koelz's *canescens* as a distinct subspecies. According to Ripley (1961, p. 436) *canescens* and *albicollis* intergrade in western Nepal.

644. **Rhipidura aureola aureola** Lesson. Whitebrowed Fantail Flycatcher.

BHABAR : Amlekhganj : 1 ♀ (March 6). DUN : Hitaura : 1 ♂ (May 6).

The Whitebrowed Fantail Flycatcher appeared scarce in central Nepal. We encountered it only on a few occasions in undergrowth as well as on trees in thick forests near Amlekhganj and the Hitaura dun.

Scully (1879) did not record it from Nepal. Ripley (1950b, p. 406) found it only in the western tarai in winter. Rand & Fleming (1957, p. 181) reported it from the western and eastern tarai in winter.

My male specimen (May 6) is worn and looks browner.

Measurements :

	Wing	Tail	Bill
1 ♂ :	82	91	16
1 ♀ :	78	86	15

(*To be continued*)

Odontotermes paralatigula, a new species of termite from Burma. (Isoptera: Termitidae: Macrotermitinae)

BY

P. N. CHATTERJEE AND P. K. SEN-SARMA
Branch of Forest Entomology, Forest Research Institute, Dehra Dun

(*With three text-figures*)

Through the courtesy of the Central Silviculturist, Burma Forest Department, a good collection of termites from Burma was received in 1950. Two papers on this collection were published earlier by Mathur & Sen-Sarma (1958), and Roonwal & Sen-Sarma (1960). In this paper a new species of *Odontotermes* is described.

Frequency distribution of the measurements (in mm.) and indices of each body part has been given in stick-diagrams on the basis of measurements of 50 samples. This method presents the numerical data in the original form which can be utilised for subsequent statistical analysis when more data accumulate. We consider this an improvement over the current practice of presenting the numerical data in tabular form, giving only the range and mean value of each measurement.

Odontotermes paralatigula sp. nov.

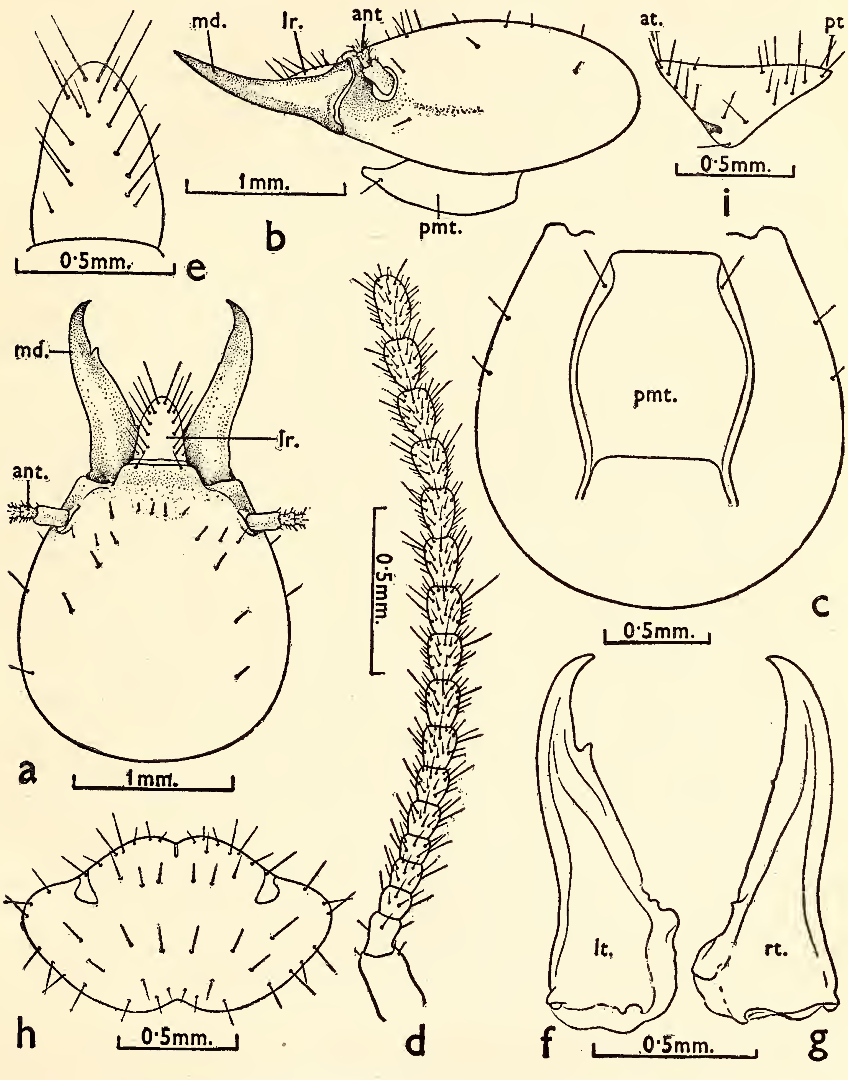
MATERIAL

One vial containing numerous soldiers in spirit, collected from a mound at Hlegu Range, Insein Forest Division, Burma, by the Range Officer.

DESCRIPTION

1. IMAGO: Not known so far.
2. SOLDIER: (Text-fig. 1-3, Table)

General. Head-capsule brown to chocolate brown; antennae paler than head-capsule, distal segments slightly darker than proximal segments; labrum almost as dark as head-capsule; mandibles paler



Odontotermes paralatigula sp. nov., soldier caste

Text-fig. 1. (*a*) Head, dorsal view. (*b*) Head, side view (left). (*c*) Head-capsule, ventral view. (*d*) Antenna. (*e*) Labrum, dorsal view. (*f-g*) Left and right mandibles, respectively. (*h*) Pronotum, dorsal view. (*i*) Pronotum, side view (left).

ant. antenna ; *at.* anterior ; *lr.* labrum ; *lt.* left ; *md.* mandible ; *pmt.* postmentum ; *pt.* posterior ; *rt.* right

All figures are drawn from paratype specimen from the holotype colony.

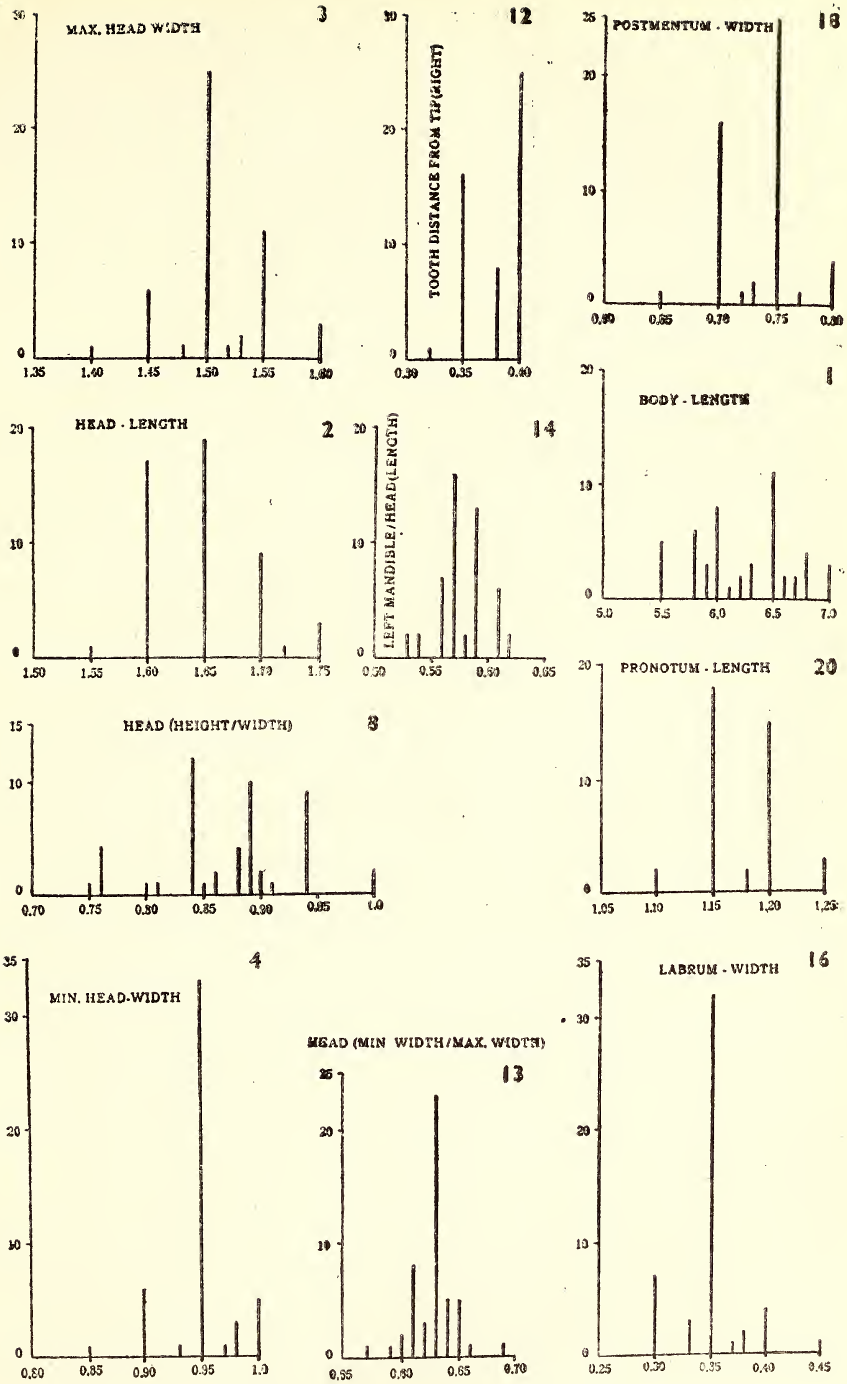
basally, darker distally; pronotum, legs and body pale yellow to light brown; head and pronotum moderately hairy; legs and body densely pilose. Approximate total body length (straight line distance) 5.5-7.0 mm.

Head. Head-capsule suboval, widest at the occiput whence sides progressively narrow down anteriorly; in profile, arched, both dorsally and ventrally; somewhat egg-shaped; posterior margin convex. *Fontanelle.* Indistinct. *Antennae.* With 17 segments; segments 1 and 2 sparsely and others densely pilose; segment 1 largest and cylindrical; 2 longer than 3; 3 and 4 subequal; 5 shortest; remaining segments progressively increasing in length and becoming club-headed *Clypeus.* Postclypeus distinguishable from frons by weak elevation; rectangular, broader than long; with a pair of hairs anteriorly. Anteclypeus narrow; rectangular, white, membraneous and apilose. *Labrum.* Tongue-shaped; longer than broad; with long setae almost arranged in 2 rows. *Mandibles.* Sabre-shaped, thin and rather sharply hooked at the tip; more than half the length of head-capsule (head mandibular index 0.53-0.62). Left mandible with a prominent tooth situated a little posterior to outer third (tooth index 0.65-0.70); basally with 1-2 small teeth anterior to molar projection. Right mandible with two very minute teeth, one situated a little anterior to the middle and another lying basally, the basal tooth slightly larger than the anterior one. *Postmentum.* Large; in profile, greatly arched ventrally; margined with dark chitin; widest at the middle whence the sides gradually converge both anteriorly and posteriorly; anterior margin transversely truncated; with two long hairs anteriorly.

Thorax: Pronotum. Saddle-shaped; hairy; much narrower than head-capsule; length a little more than half the width (index 0.57-0.64); in profile, the middle area only weakly concave, with deep depressions laterally; both anterior and posterior margins incised. *Mesonotum.* Narrower than pro- and meta-notum; posterior margin of both meso- and meta-notum weakly emarginate medially. *Legs.* Long, slender, and hairy; tibial spurs 3 : 2 : 2; tarsi 4-segmented and ending in weak claws.

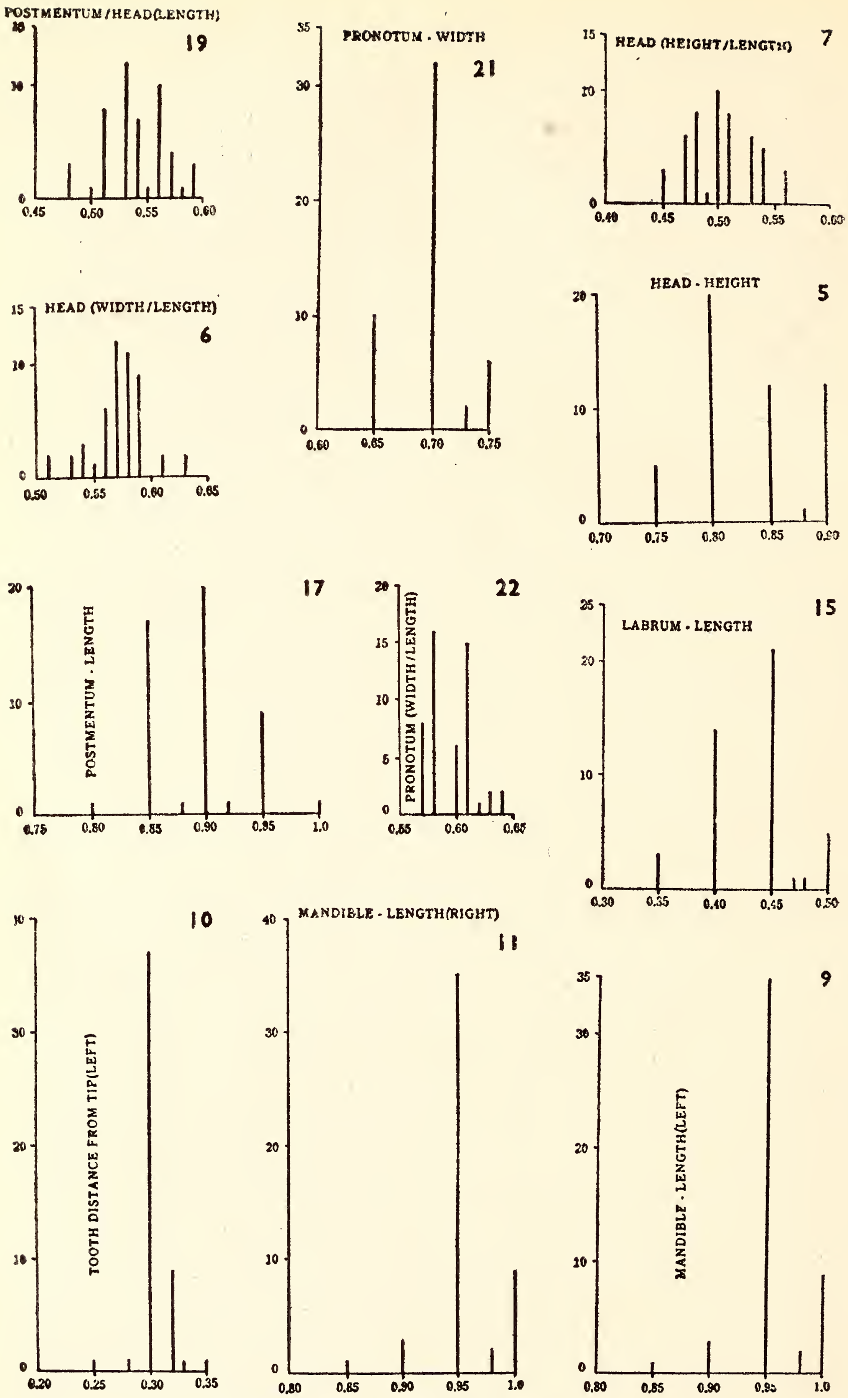
Abdomen. Elongate and hairy; hairs on tergites shorter than those of sternites. Cerci short and hairy; 2-segmented, basal segment broad, distal segment narrow and chitinised.

3. WORKER: Unknown



Odontotermes paralatigula sp. nov.

Text-fig. 2. Stick diagrams showing frequency distribution and measurements (in mm.) and indices (shown along abscissae) of body parts of soldiers of *Odontotermes paralatigula* sp. nov., based on measurements of 50 specimens. Ordinates represent number of individuals. Bold numerical figure at top right hand corner of each diagram indicates serial number of body parts etc. in Table at p. 825.



Odontotermes paralatigula sp. nov.

Text-fig. 3. Stick diagrams showing frequency distribution of measurements (in mm.) and indices (shown along abscissae) of body parts of soldiers of *Odontotermes paralatigula* sp. nov., based on measurements of 50 specimens. Ordinates represent number of individuals. Bold numerical figure at top right hand corner of each diagram indicates serial number of body parts etc. in the Table at p.825

TABLE

Measurements (in mm.) and indices of various body parts of soldiers of *Odontotermes paralatigula* sp. nov.

Serial No.	Body parts	No. of speci-mens	Range	Mean	Mode with frequency in bracket
1.	Total body length (head+body) ..	50	5.50-7.00	6.23	6.50 (11)
2.	Head length to lateral base of mandible ..	,,	1.50-1.75	1.65	1.65 (19)
3.	Maximum width of head..	,,	1.40-1.60	1.49	1.50 (25)
4.	Minimum width of head at base of mandible ..	,,	0.85-1.00	0.95	0.95 (33)
5.	Height of head (postmentum) ..	,,	0.75-0.90	0.83	0.80 (20)
6.	Head index I (width/length ..	,,	0.51-0.63	0.57	0.57 (12)
7.	Head index II (height/length) ..	,,	0.45-0.56	0.50	0.50 (10)
8.	Head index III (height/width) ..	,,	0.75-1.00	0.69	0.84 (12)
9.	Length of left mandible (from condyle) ..	,,	0.85-1.00	0.95	0.95 (35)
10.	Left mandibular tooth distance from distal tip ..	,,	0.25-0.35	0.30	0.30 (37)
11.	Length of right mandible (from condyle) ..	,,	0.85-1.00	0.95	0.95 (35)
12.	Right mandibular tooth distance from distal tip	,,	0.32-0.40	0.38	0.40 (25)
13.	Head contraction index (minimum width/maximum width) ..	,,	0.57-0.69	0.63	0.63 (23)
14.	Head mandibular index (mandible length/head length) ..	,,	0.53-0.62	0.58	0.57 (16)
15.	Length of labrum ..	,,	0.35-0.50	0.44	0.45 (26)
16.	Maximum width of labrum ..	,,	0.30-0.45	0.35	0.35 (32)
17.	Length of postmentum ..	,,	0.80-1.00	0.89	0.85 (17)
18.	Maximum width of postmentum ..	,,	0.70-0.80	0.74	0.75 (25)
19.	Postmentum head index (postmentum length/head length) ..	,,	0.48-0.59	0.54	0.53 (12)
20.	Length of pronotum ..	,,	0.65-0.75	0.70	0.70 (32)
21.	Maximum width of pronotum ..	,,	1.10-1.25	1.19	1.15 (23)
22.	Pronotum index (length/width) ..	,,	0.57-0.64	0.60	0.58 (16)

TYPE SPECIMENS

All specimens from a single source.

Holotype. Soldier, in spirit, in a vial deposited in the Entomological Collection of the Forest Research Institute, Dehra Dun.

Paratype. Soldiers from the holotype colony are distributed as follows: (i) Forest Research Institute, Dehra Dun: 20 soldiers; (ii) Prof. Alfred E. Emerson, University of Chicago, Chicago (U.S.A.): 5 soldiers; (iii) Zoological Survey of India, Calcutta: 5 soldiers; (iv) Indian Agricultural Research Institute, New Delhi: 5 soldiers.

Type Locality

Burma: Hlegu Range, Insein Forest Division.

Comparison

The soldiers of *Odontotermes paralatigula* are very close to *O. latigula* Snyder from which, however, they differ on the following characters: (i) Larger species; (ii) head-capsule more globular in shape; (iii) right mandible with two minute teeth, one lying anterior to middle and another basally placed; (iv) antennae with 17 segments, segment 3 as long as 4th.

References

Mathur, R. N. & Sen-Sarma, P. K. (1958): Hitherto unknown imago caste of the species of *Globitermes*, *Microcerotermes*, and *Odontotermes* from Indo-Malayan region (Isoptera: Termitidae). *Indian For. Bull.* (Ent.), Delhi, No. 219, pp. 1-9 plus 3 pls.

Roonwal, M. L. & Sen-Sarma, P. K. (1960). Contributions to the systematics of Oriental termites. *Indian Counc. agric. Res.*, Ent. Mongr. No. 1, **14** plus 404 pp. including 65 pls.

Critical Notes on the Orchidaceae of Bombay State

X. SOME OF THE SMALLER GENERA (CONTINUED)

BY

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

(*With two plates*)

[*Continued from Vol.* 59 (2): 404]

19. *LUISIA* Gaud.

LUISIA Gaud. Freyc. Voy. Bot. 426, 1826; Benth. & Hook. f. Gen. Pl. 3: 571, 1883; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6): 210, 1889; Hook. f. Fl. Brit. Ind. 6: 22, 1890; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8: 201, 1898; Duthie, ibid. 9 (2): 139, 1906; J. J. Smith, Fl. Buitenz. 6: 544, 1905; Schltr. Orchid. 549, 1927; Holttum, Rev. Fl. Malaya 1: 689, 1953. *Birchea* A. Rich. in Ann. Sc. Nat., Ser. 2, 15: 66, 1841.

The generic name *Luisia* commemorates Don Luis de Torres, a Spanish botanist.

The genus consists of about 25 species, native in India through SE. Asia to Japan. The genus is best represented in Burma.

Type species: *L. teretifolia* Gaud.

KEY TO THE SPECIES OF *LUISIA* OF BOMBAY

1. Leaf-apex acute, obtuse or slightly apiculate; inflorescence 2-4-flowered; flowers ± 7 mm. long; petals equalling or slightly longer than sepals .. .. *teretifolia*
1. Leaf-apex obtuse, apiculate or caudate; inflorescence 1-flowered; flowers ± 18-25 mm. long; petals 1½ to 2½ times as long as sepals:
    2. Leaf-apex with a jointed tail; flowers about 18 mm. long; lip somewhat pandurate in outline .. .. *tenuifolia* var. *evangelinae*

2. Leaf-apex obtuse, often with a conical apiculum on outer side; flowers about 25 mm. long; lip oblong in outline .. .. .. *macrantha*

1. **Luisia teretifolia** Gaud. Bot. Freyc. Voy. 427, t. 37, 1826; Hook. f. 22; Grant, Orch. Burma 236, 1895; King & Pantl. 202, t. 271; Prain, Beng. Pl. 1018, 1903; Cooke, Fl. Pres. Bomb. 2: 701, 1907; Gammie in Journ. Bombay nat. Hist. Soc. 18: 588, 1908; Blatt. & McC. ibid. 35: 491, 1932; Brühl, Guide Orch. Sikk. 123, 1926; Fischer, Fl. Pres. Madr. 1948, 1928; Alston, Kandy Fl. 75, f. 401, 1938. *Cymbidium triste* Roxb. Hort. Beng. 63, 1814, nom. nud.; Bot. Mag. t. 3648, 1838; Wight, Icon. 3: 11, 1844-1845 (descr. tantum); (non Willd. 1805). *C. tenuifolium* Wight, Icon. 5: t. 1689, 1851. *Luisia truncata* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35: 491, t. 9, 1932.

Erect *epiphytes*. *Stems* up to 40 cm. long, about 2-5 mm. thick, brown or ash-grey. *Leaves* 2.5-12 cm. long, 3-5 mm. thick, uniformly thick throughout, falcate, green mottled with purple, the apex rounded or somewhat acute, purple, often the young leaves completely purple. *Inflorescence* 2- to 4-flowered, extra-axillary; peduncles stout, about 3-7 mm. long. *Flowers* 3-4 mm. across, drooping, fleshy, shortly pedicellate, bracteate. *Bracts* 1.25 × 1 mm. persistent, subscabrid, 1-nerved, oblong or quadrately-oblong, obtuse or subacute, minutely irregularly serrulate. *Sepals* 3-5 × 2-3 mm. fleshy, pale green, tinged with reddish-brown more so towards apex, acute, entire, glabrous, faintly 3-nerved; dorsal sepal ovate, the apex slightly incurved; lateral ones subconcave, somewhat keeled below, ovate, boat-shaped. *Petals* 3-5 × 2 mm., narrowly oblong, obtuse, entire, faintly 3-nerved, pale green, tinged or rarely spotted with purple. *Lip* 3-5 × 2-3 mm., panduriform in outline; hypochil quadrate, subconcave, green, broadly margined with purple and with a broad purple patch at the base; epichile somewhat deflexed, rhomboid or obscurely 3-lobed, truncate or obtuse at the apex, pale green margined and faintly streaked with purple. *Column* 2 mm. long, stout, oblong, deep purple. *Anther* pale yellow with 2 central reddish lines and a truncate, reddish anterior lip; pollinia 2, yellow, ovoid-orbicular, attached to a stout caudicle with a broad-oblong gland. *Stigmatic surface* large, oblong-orbicular, pale yellow. *Ovary* with *pedicel* 5 mm. long, curved, green, pale brownish at base. *Capsules* 18-20 × 3-5 mm., narrowly spindle-shaped, tapering towards the base, strongly ribbed.

Flowering: The general time of flowering is May. But our specimens, collected in December, flowered in January, probably as a result of constant watering.

Occurrence in Bombay State: KONKAN: Vettora, *Sabnis*. N. KANARA: Devicop, *Sedgwick* 5786; Usheli, *Ritchie*; Wadehukli, *Bell*; Yellapur, *Bell*; *Kapadia* 1972; Gundh, *Bole* 1502; *Kapadia* 1731-1734; Castle Rock, *Bell*; *Santapau* 17825; Samphkand, *Hallberg & McCann* 34195.

Distribution : India : Sikkim, Bengal, Khasia Hills, Andamans, Konkan, N. Kanara, W. Ghats, Vizagapatam Hills. *World :* Ceylon, India, Burma, Java, China.

Notes : This species shows a considerable amount of variation in the size of the leaves, flowers and fruits. King & Pantling remark that Blume's figures show much larger flowers than those of the Indian plants. We have observed that in specimens from Andhra (*S. K. Wagh* 2815, 2935 and *Santapau* 20764, 20857), the flowers are considerably larger; the capsules are up to 30×5 mm.

Blatter & McCann have described their *L. truncata* from illustrations of Miss E. Bell and manuscript notes of Mr. T. R. Bell; they do not cite any specimens examined by them. After a careful examination of their description and plenty of fresh material from the N. Kanara area, we have come to the conclusion that *L. truncata* Blatt. & McC. is identical with *L. teretifolia* Gaud.

Blume referred *Epidendrum triste* Forst. to *Luisia teretifolia* Gaud. O. Kuntze followed him, and made the combination *L. tristis*. Hooker f. keeps *Epidendrum triste* Forst. apart from *L. teretifolia* Gaud., stating that the petals and lip are different; he makes *Epidendrum triste* Forst. the basionym for his *L. tristis*.

2. **Luisia tenuifolia** Bl. var. **evangelinae** (Blatt. & McC.) Sant. & Kapadia, stat. nov. *L. evangelinae* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 493, t. 11, 1932. *L. tenuifolia* Hook. f. Fl. Brit. Ind. 6 : 24, 1890 (partim); Cooke 702; Gammie 589; Blatt. & McC. 492. (?).

Slender *epiphytes*. *Stems* brownish-green; internodes about 15 mm. long, 3-5 mm. thick, longitudinally striated. *Leaves* up to 25×0.2 cm., terete, dark green, usually straight, caudate at apex; the cauda 0.2-3 cm. long, $\pm$ jointed to the leaf and at an angle to it. *Peduncles* very short, stout, sheathed, dark-brown. *Flowers* opening one at a time, fleshy, pedicellate, bracteate. *Bracts* minute, brown, somewhat woody. *Pedicel* with *ovary* 12-14 mm. long, twisted, greenish and straight, but curved at apex. *Sepals* subequal, narrowly ovate-oblong, acute, mucronate on the back a little behind the apex, entire, glabrous; dorsal sepal $8\text{-}10 \times 3\text{-}4$ mm., slightly keeled on the back, the sides somewhat connivent, giving it a linear-oblong appearance; lateral ones $8\text{-}12 \times 3\text{-}5$ mm. boat-shaped, very much keeled on the back. *Petals* $15\text{-}20 \times 2\text{-}3$ mm., narrowly linear-oblong, somewhat falcate, obtuse, entire, faintly 1 nerved, glabrous, green in the upper half, purplish below. *Lip* 10-13 mm. long, somewhat pandurate or obovate-oblong, more or less square at the base with 2 small rounded lobes, much constricted towards the apex, ending in 2 divergent, upturned, oblong-orbicular lobes ; hypochil smooth, separated from the epichile by its purple markings and by the origin of the 3-callate disc of the latter ; central callus thick, triangular in transverse section, highest in the middle, ending in a mucronulate apex in between the apical lobes of the epichile, the lateral calli of uniform height, slightly diverging from the origin, shorter than the middle one. The general colour of the lip is white, often tinged with green, the hypochil has a central quadrate-oblong, deep purple spot which continues into the basal lobes partly or completely ; the central larger callus of the epichile often has a V-shaped purple marking, the hollow side facing inwards, which may be reduced to a spot. *Column* 5×3 mm. semiterete, broader on top ; the large oblong-orbicular stigmatic surface dark purple. *Anther* 3.5×2.5 mm., nearly white, quadrately-oblong, the lip truncate ; pollinia about 1.5 mm. in diam., somewhat diverging on a large caudicle and slightly infolded gland. *Capsules* 3×0.5 cm. purplish, fusiform ; pedicles 1 cm. long.

Flowering : March to April. *Fruiting* : April onwards.

Occurrence in Bombay State : DECCAN : Koina Valley, *Kapadia* 2912-2915. N. KANARA : *Bell* 5397 ; Astoli, *Bell* ; Chandwadi, *Bell* ; Castle Rock, *Bhide* ; *Kapadia* 2777-2780, 2803-2812 ; Anmod, *Kapadia* 1888-1891.

Distribution : Deccan, N. Kanara.

Notes : Blatter & McCann have described their species from T. R. Bell's manuscript notes and a painting by Miss Evangeline Bell, no specimens having been examined by them. According to Art. 7 (Note 3), a *neotype* for the taxon must be selected ; in the absence of the original plate, which was never published, we choose *Kapadia* 1891 as the neotype for this variety.

Blatter & McCann differentiate their 2 species, *L. pseudotenuifolia* and *L. evangelinae*, from *L. tenuifolia* Blume ; but no reference is made to the similarities between the 2 species themselves, which in reality are considerable. After a very careful comparison of the original descriptions of *L. pseudotenuifolia* Blatt. & McC. and *L. evangelinae* Blatt. & McC., we have come to the conclusion that they are identical. The only apparent differences between the 2 species, from the original descriptions, may be put down thus :

L. pseudotenuifolia	*L. evangelinae*
Leaves forming a knee 2 or 3 cm. from the apex and becoming much thinner and ending in a very sharp point.	*Leaves* long-tailed at the apex ; tail about 2 cm. long and more or less jointed to the rest of the leaf, and projecting in a different plane.
Dorsal sepal linear rounded.	*Dorsal* sepal obtuse.

From this comparison it appears that the characteristic shape of the leaf-apex is identical in both the species, although the descriptions have been worded differently. The linear shape of the dorsal sepal can be accounted for by the fact that it is deeply concave with its margins more or less erect, giving it apparently a linear-oblong appearance ; but actually when it is properly spread out the sepal is found to be clearly ovate-oblong, and not linear.

We have selected *evangelinae* as the epithet for the taxon in preference to *pseudotenuifolia* because the former taxon is figured and is more fully described than the latter.

The only difference between *L. evangelinae* Blatt. & McC. and *L. tenuifolia* Bl. lies in the caudate and more or less jointed leaf-apex in the former species ; the flowers being identical. In the literature available to us, there is no mention of a caudate and jointed leaf-apex in *L. tenuifolia* Bl. In fact Cooke mentions the leaf-apex to be obtuse. Wight (under *Cymbidium triste* in *Ic.* t. 911, 1844-1845) and A. Richard (under *Birchea teretifolia* in *Ann. Sc. nat.*, ser. 2, 15 : 66, t. 10, 1841) illustrate the leaf-apex as obtuse or subacute. Santapau's photograph of Law & Stocks's sheet of *L. tenuifolia* Bl. from the Konkan (preserved in Kew Herbarium), shows the leaf-apices to be distinctly caudate as in *L. evangelinae* Blatt. & McC. ; the photograph of *Bourne* 5979 from the Nilgiris shows the leaf-apices acute or obtuse, not tailed. It appears, then, that 2 distinct types of leaf-apices are met with in *L. tenuifolia* Bl. However, we have no means of checking them, since we have had no access to either the type specimen or the original description of the species.

For these reasons we have reduced *L. evangelinae* Blatt. & McC. to a variety of *L. tenuifolia* Bl.

It is doubtful whether the true *L. tenuifolia* Bl. with the rounded or acute leaf-apex occurs in Bombay State. Law & Stocks's specimen from Konkan has a caudate leaf-apex. Neither Blatter & McCann nor their assistants have collected it. Under *L. tenuifolia* Bl. they cite ' *Locality* : Add : *W. Ghats* : Castle Rock (Bhide !) '. We have examined the specimens of Bhide in the Herbarium of the Bot. Surv. of India (West. Circ.), Poona ; these have caudate and jointed leaf-apices, characteristic of the variety. We have collected only the variety, from several places in Bombay State. Cooke seems to be the only person to mention the obtuse leaf-apex for our Bombay specimens.

3. **Luisia macrantha** Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 492, t. 10, 1932.

Stout *epiphytes*. *Stems* up to 50 cm. in length ; internodes 2.5-3.5 cm. long, about 5 mm. thick, scabrid, dark greenish-brown. *Leaves* 10-20×0.3-0.5 cm. ascending, straight or flexuose, dusty green, terete, the apex bluntly rounded, often with a short conical apiculum on the outer side. *Inflorescence* short, extra-axillary, arising from a short woody cylindrical axis, which is covered by small membranous, closely appressed, brownish-grey sheaths. *Buds* deep purple, oblong in outline, strongly 2-angled, convex on the dorsal side, subconcave on the ventral, the apex truncate-emarginate. *Flowers* facing downwards, bracteate, shortly pedicellate, variable in size, the basic apple-green colour of the freshly opened flower changing to deep brown-yellow with age. *Sepals* 17-22 × 10-13 mm. subequal, apple-green or yellow, blotched and speckled with dark maroon, more so towards the base, glabrous, entire ; dorsal sepal subconcave, obovate-elliptic ; lateral ones boat-shaped, oblong-elliptic, subemarginate-mucronate, the mid-nerve strongly keeled below. *Petals* 25-35×2-3 mm. apple-green or yellow, blotched with dark maroon patches at the base, spreading, strap-shaped, subclavate, obtuse. *Lip* 22-28×7-9 mm., oblong, broadest a little before the middle ; hypochil somewhat square, 4-6 mm. broad at the base with 2 small rounded, ear-like lobes at the corners ; epichile oblong, slightly raised upwards ending in 2 processes which are rhomboid-orbicular, obtuse, 6×5 mm. Calli on the epichile 3, the middle one triangular, 2-3 mm. high, ending in a small, blunt, yellow mucro, in between the apical processes ; lateral ones much smaller, rounded. The basic colour of the lip is apple-green or yellow ; lower surface with a broad, purple patch ; hypochil deep purple except for the margin ; epichile apple-green or yellow, the calli deeper. *Column* 4-5×2-3 mm., white, oblong, subclavate above. *Anther* white suffused with purple, somewhat square, the anterior lip truncate ; pollinia 1×0.75 mm. ovoid, foveolate on the back, the caudicle 2×2 mm. oblong, broadly tapering to the narrow, transversely-oblong, gland. *Stigmatic surface* white. *Ovary* with short *pedicel* 19-22×2-3 mm., narrowly oblong, brownish-yellow. *Capsules* 7×0.5 mm., narrowly spindle-shaped, tapering at the base, strongly ribbed ; pedicels about 0.8 cm. long, twisted.

Flowering : This species seems to flower practically throughout the year. We have collected the flowers in November, December, March and also in June.

Occurrence in Bombay State : N. KANARA : Yellapur, *Bell* ; *Pirson* ; *Kapadia* 1764-1766, 1989-1990, 2353 ; Anmod, *Sedgwick* ; *Kapadia* 1865-1867, 1880-1882, 1905 ; Siddhapur, *Kapadia* 2351 ; Dandeli, *Kapadia* 1678 ; Devimane, *Hallberg & McCann* 34567.

Distribution : This species seems to be wide-spread in N. Kanara, apparently endemic. It may also be found further south.

Notes : The type of this species is *Bell* 5397.

20. *VANDA* R. Br.

VANDA R. Br. in Bot. Reg. t. 506, 1820 ; Endl. Gen. Pl. 204, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 578, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 214, 1889 ; Hook. f. Fl. Brit. Ind. 6 : 49, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 214, 1898 ; Duthie, ibid. 9 (2) : 144, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 590, 1905 ; Schltr. Orchid. 550, 1927 ; Holttum, Rev. Fl. Malaya 1 : 709, 1953.

The generic name *Vanda* has been derived from the Sanskrit name of the first species described, *V. roxburghii.*

This genus consists of about 30-40 species, which are native in India, Ceylon, E. Indies, Malaya, Borneo, Philippines, Java and Tropical Australia.

Vanda can be principally distinguished from its close ally *Angraceum* by its fleshy, 3-lobed lip ; on the other hand *Ascocentrum* is merely a much reduced *Vanda.* As a rule most of the Vandas have fairly long and wide, flat leaves with the mid-nerve depressed above ; but *V. hookeriana* Reichb. f. and its hybrid offspring *Vanda Miss Joaquim* and a few others form a special group with terete leaves and long-climbing habit. For this latter group Schlechter has proposed a new generic name, *Papilionanthe.* According to Holttum, however, a careful examination of the longitudinal section of the flowers and of their pollinia shows no essential differences from the other Vandas.

The genus *Vanda* lends itself very well to the creation of inter-specific and inter-generic hybrids, as has been well discussed by Holttum. Many hybrids have been produced between the terete and the non-terete-leaved groups of *Vanda.* These have leaves intermediate between the two types, i.e. they are narrow and deeply channelled, and are often called *semi-terete.* The plants are also intermediate in habit, with longer internodes than the usual non-terete *Vanda*, but do not have quite the climbing habit of the true terete-leaved species. Among the inter-generic hybrids may be mentioned *Vandaenopsis* (*Vanda* × *Phalaenopsis*) and *Aranda* (*Vanda* × *Arachnis*).

Sect. *Anota* (containing *V. densiflora* Lindl. and *V. violacea* Lindl.) of Bentham & Hooker f. and Hooker f. was made an independent genus by Schlechter. J. J. Smith and Holttum consider *V. violacea* Lindl. to be a *Rhynchostylis* ; the other species (*V. densiflora* Lindl.) has often been referred to the genus *Saccolabium.*

Our 2 Bombay species belong to sect. *Euvanda* of Lindley, the name of which must be changed to *Vanda* sect. *Vanda* in accordance with Art. 22 of the Code, since it contains the type species of the genus, *V. tessellata* Hook. ex G. Don (= *V. roxburghii* R. Br.).

Type species : *V. tessellata* Hook. ex G. Don.

KEY TO THE SPECIES OF *VANDA* OF BOMBAY

Sepals and petals pale yellow, about 8 mm. long ; capsule with pedicel 4-5 cm. long ..	*testacea*
Sepals and petals about 23-25 mm. long, greenish-yellow somewhat brown tessellated on the upper surface, the lower one being pure white ; capsule with pedicel 12-13 cm. long	*tessellata*

1. **Vanda testacea** (Lindl.) Reichb. f. in Gard. Chron. II, 166, 1877 ; Alst. Kandy Fl. 75, f. 402, 1938. *Aërides testaceum* Lindl. Gen. Sp. Orch. 238, 1833. *A. wightianum* Lindl. [in Wall. Cat. 7320, 1832, nom. nud. et] Gen. Sp. Orch. 238, 1833, et in Journ. Linn. Soc. 3 : 40, 1858 ; Wight, Icon. 5 (1) : 8, 1851 ; Dalz. & Gibs. Bomb. Fl. 265, 1861; Thwaites, Enum. Pl. Zeyl. 305, 1864. *Vanda spathulata* Graham, Cat. Bomb. Pl. 204, 1839 (non Spreng. 1826). *V. parviflora* Lindl. in Bot. Reg. 30 : Misc. 45, 1844; Wight, Icon. t. 1669, 1851 ; Hook. f. 50; Grant, Orch. Burma 256, 1895 ; King & Pantl. 215, t. 286 ; Duthie 144, et Fl. Upp. Gang. Pl. 3 : 210, 1920 ; Prain, Beng. Pl. 1021, 1903 ; Cooke, Fl. Pres. Bomb. 2 : 703, 1907 ; Gammie in Journ. Bombay nat. Hist. Soc. 19 : 624, 1909 ; Blatt. & McC. ibid. 35 : 494, 1932 ; Haines, Bot. Bih. Or. 1181, 1924 ; Brühl, Guide Orch. Sikk. 129, 1926 ; Fischer, Fl. Pres. Madr. 1444, 1928.

Epiphytes. *Stem* 1-1.5 cm. thick, sheathed. *Leaves* spreading, 3-15 $\times$0.4-0.7 cm., channelled, coriaceous, oblong or linear-oblong, irregularly 2- or 3-toothed at apex. *Racemes* 3-17 cm. long, erect; peduncles 1-3 mm. thick, terete, brown with a few, 2-4 mm. long, oblong-acute, sheaths. Peduncles are persistent and often 9 or more old ones may be seen on the same plant. *Flowers* pale yellow, long-pedicelled, bracteate, generally produced at the apical region of peduncle. *Bracts* 2.5$\times$2.5 mm., ovate or ovate-oblong, acute, scabrid, brown, irregularly serrulate or subentire, 3-nerved. *Sepals* subequal, 8$\times$5 mm., obovate-oblong, obtuse, pale-yellow, the lateral ones slightly broader and subacute. *Petals* 8$\times$4 mm., broadly obovate-oblong, somewhat clawed, obtuse, rarely slightly retuse, entire, glabrous, 1-nerved, pale yellow. *Lip* 3-lobed ; lateral lobes adnate to foot of column, arising from the sides of the mouth of the spur, oblong, obtuse ; midlobe 6$\times$4 mm., decurved, oblong or cunneate-oblong, the apex dilated, somewhat 3-lobed or perfectly semicircular, obtuse or retuse, subentire or irregularly crenulate, the portion below the apex with 2 blue-lilac caruncled ridges and a central channel in between. *Spur* 2.5 mm. long, conical, obtuse, yellow, formed by the direct continuation of the lateral lobes of lip. *Column* small, pale yellow, with a short foot. *Anther* 2.5$\times$2 mm., oblong-orbicular, apex emarginate ; pollinia 2, cleft, globose, with a short caudicle and a small transversely-oblong gland. *Ovary* with *pedicel* 8 mm. long, shallowly grooved, pale yellowish-green. *Capsules* 2-2.5×0.7 cm., fusiform or oblong-elliptic ; pedicels 1-1.5 cm. long.

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

Occurrence in Bombay State : DANGS : Waghai, *Kapadia* 1163-1164. KONKAN : *Stocks* ; *Law* ; *Gibson* ; *Woodrow* ; S. Konkan, *Dalzell & Gibson* ; Thana, *Santapau* 10970 ; *Kapadia* 1166. W. GHATS : Kasara, *Kapadia* 901. DECCAN : Mawal, *Woodrow* ; hills round Mahableshwar, *Cooke* ; Koinanagar, *Kapadia* 2899 ; Belgaum-Kolhapur, *Ritchie*. N. KANARA : Devicop : *Sedgwick* 5927 ; Yellapur, *Sedgwick* ; Wadehukli, *T. R. Bell* ; Gundh, *Kapadia* 1739 ; Kumbelli Mines, *Kapadia* 2689.

Distribution : India : Kumaon, Sikkim, Assam, Chota Nagpur, Dangs, Konkan, W. Ghats, N. Kanara, southern peninsular India in the hilly tracts from 300 to 1200 m. *World :* India, Nepal, Burma and Ceylon.

Notes : Hooker f. distinguishes two varieties under *Vanda parviflora* Lindl. : var. *testacea,* with brown sepals and petals from Ceylon ; and var. *albiflora,* with white sepals and petals, the lip white with red speckled ridges and broader spur, from Moulmein. In our opinion these colour variations do not warrant even varietal rank. Therefore, we have united *Vanda testacea* Reichb. f. (=*Aërides testaceum* Lindl.) with *Aërides wightianum* Lindl. following Lindley himself (in *Journ. Linn. Soc.* 3 : 40, 1858). Moreover, Alston describes the Ceylon plants with cream-coloured flowers ; which further goes to prove that the slight variations in flower-colour should be included within the same species. The earliest valid specific epithet is *testaceum* of Lindley, and the correct binominal is *Vanda testacea* Reichb. f.

2. **Vanda tessellata** (Roxb.) Hook. ex G. Don in Loud. Hort. Brit. 372, 1830 ; Haines 1181 ; Blatt. & McC. 494 ; Fischer 1445. *Epidendrum tessellatum* Roxb. Pl. Corom. 1 : 34, t. 42, 1795. *Cymbidium tessellatum* Sw. in Nov. Act. Upsal. 6 : 75, 1799 ; Roxb. Fl. Ind. 3 : 463, 1832. *C. tesselloides* Roxb. Fl. Ind. 3 ; 463, 1832. *Vanda roxburghii* R. Br. in Bot. Reg. 6 : t. 506, 1820 ; Graham 204 ; Wight, Icon. 3 (2) : 10, t. 916, 1844-1845 ; Thwaites 303 ; Hook. f. 52 ; Grant 257 ; Prain 1021 ; Duthie t. 116, et Fl. Upp. Gang. Pl. 3 : 210, 1920 ; Cooke 704 ; Gammie 625, t. 9. *V. roxburghii* R. Br. var. *spooneri* Gammie in Journ. Bombay nat. Hist. Soc. 19 : 625, 1909. (See Plate LI.)

Epiphytes. Stem 0.5-1.2 cm. thick, sheathed. *Leaves* spreading, recurved, coriaceous, 5-25×0.4-1.2 cm., linear-oblong, strap-shaped, entire, the apex irregularly praemorse with usually 2 unequal rounded lobes and an acute one in between. *Racemes* usually longer than the leaves, 2-to 10-flowered ; peduncle 6-14 cm. long, terete, erect or sub-pendulous, about 2-3 mm. thick, with bracts, which are 2-3 mm. long, ovate, acute, acabrid, sheathing. *Flowers* about 5 cm. across, bracteate, pedicellate. *Bracts* small, scabrid, persistent. *Sepals* subequal, the inner surface greenish-yellow tessellated with brown, pure white on the outer surface, 2.5×1.5 cm., obovate-oblong, the dorsal sepal with a longish claw, obtuse, margins irregularly waved and crisped. *Petals* 2.3×1.5 cm., clawed, similar to sepals. *Lip* 3-lobed ; lateral lobes 1×0.3 cm. white, erect, parallel, obliquely elliptic, subfalcate, acute ; midlobe 1.6×1 cm., $\pm$panduriform, thick, fleshy, sides deflexed ; apex dilated, 2-lobed with a wide retuse sinus in between ; upper surface of midlobe ridged, varying in colour from purplish-blue to red, with white streaks or white with yellow streaks. *Spur* 7×4 mm., conical, obtuse, pubescent within. *Column* 8×5 mm., oblong, clavate, white ; foot short, centrally grooved with 2 yellow patches on either side. *Anther* 4×2 mm., oblong-obovate, base truncate, apex mucronate, white ; pollinia 2, waxy, yellow, globular, with a broad oblong caudicle and a small transversely-oblong gland which is folded upwards. *Stigmatic surface* cordate-oblong, white. *Ovary* with *pedicel* 5 cm. long, twisted, white, ribbed. *Capsules* 8×1.5 cm., oblong, sharply winged, the wings 3 mm. broad ; pedicels 4 cm. long.

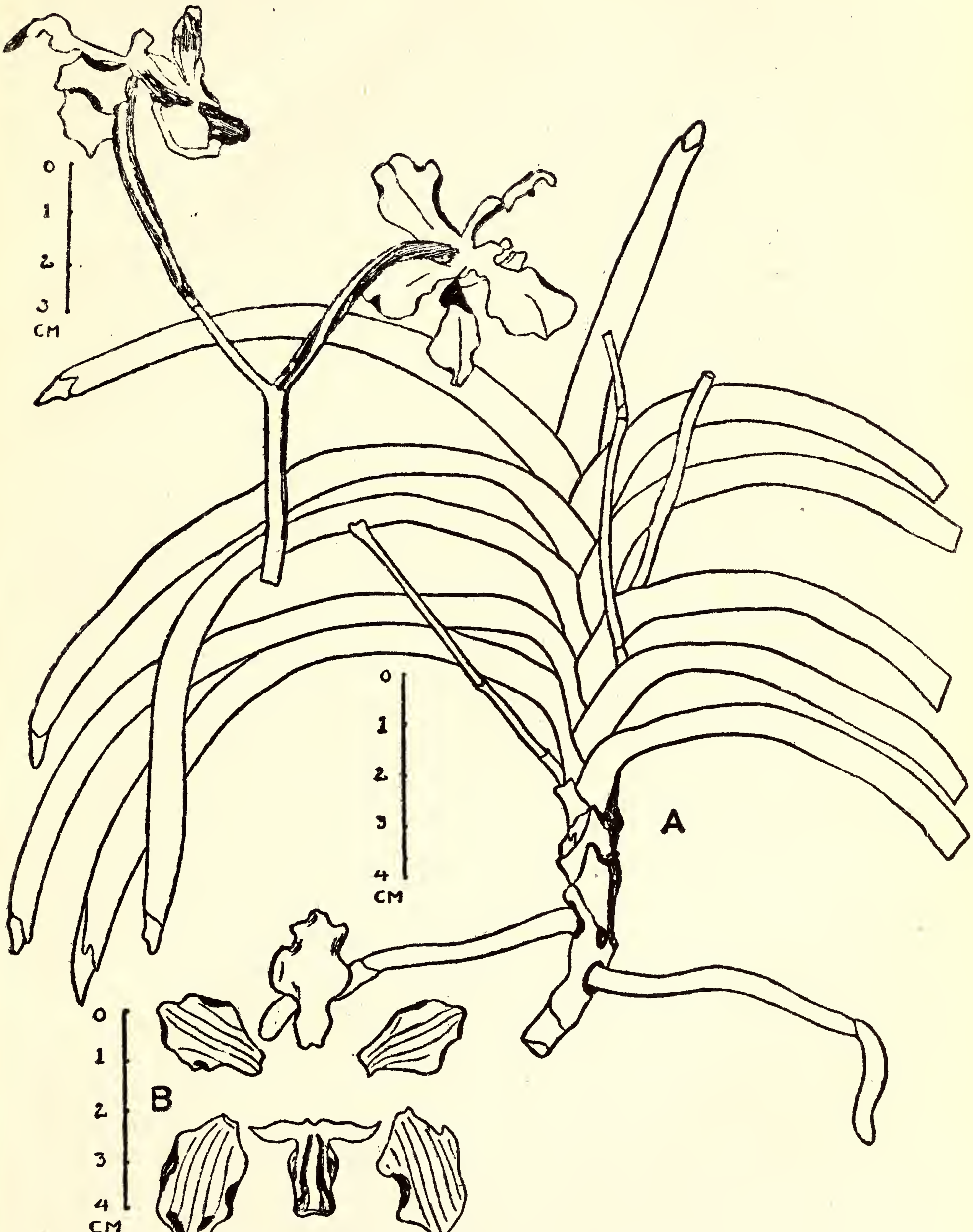
Flowering : March to June. *Fruiting :* April onwards.

Occurrence in Bombay State : GUJARAT : Chikli, *Gibson.* DANGS : Waghai, *Kapadia* 1160 ; Pimpri, *Kapadia* 1583. KONKAN : *Woodrow.* N. KANARA : *Bell* 5398 ; Kalanaddi, *Ritchie* ; Astoli, *Bell* ; Anmod, *Kapadia* ; Castle Rock, *Kapadia* 2830-2832.

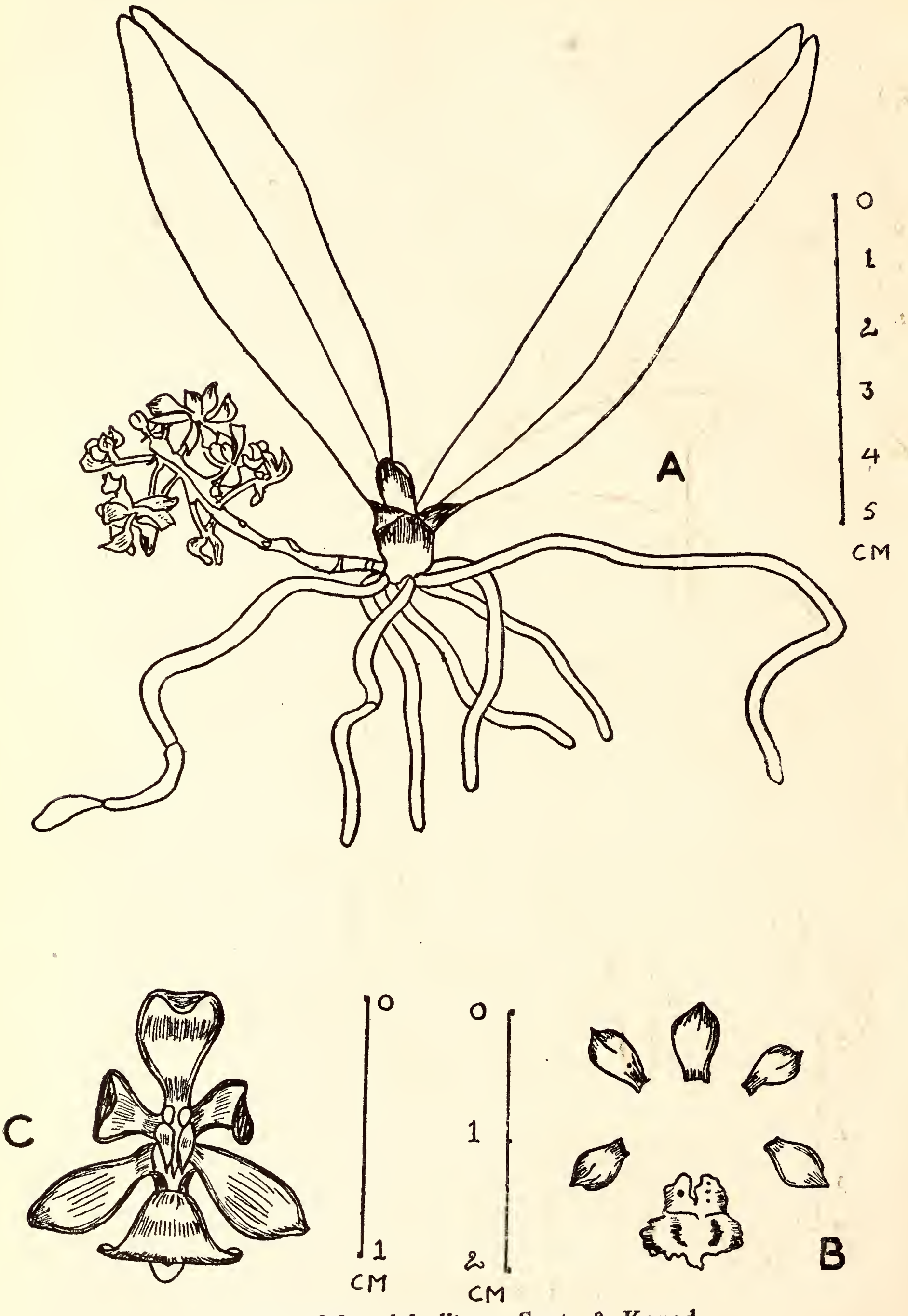
Distribution : India : Dehra Dun, Sub-Himalayan tracts of Rohilkhand and N. Oudh, Bengal, Bihar, Chota Nagpur, Madhya Pradesh, Gujarat, Dangs, Konkan, N. Kanara, southern peninsular India from sea-level to about 600 m. *World :* India, Ceylon.

Notes : The colour of the flowers of this species varies considerably ; some plants show an over-all greenish-blue tint in sepals and petals with a bluish-purple midlobe of lip ; others have reddish sepals and petals with pale pink midlobe. In our plants from Castle Rock sepals and petals were dull yellowish-brown, the lip pure white with a central orange-yellow spot in between the lateral lobes. Such variations in the colour may be noted even on one and the same plant ; some of our plants, when collected in the Dangs forest, showed a bluish lip ; under cultivation in Bombay, the flowers of the next season had pale pink lips.

It is clear, then, that such variations in colour, as noted by Gammie for his var. *spooneri*, cannot be made the basis of a variety, in a species which is noted for its colour variations.



Vanda tessellata Hook.



Gastrochilus dalzellianus Sant. & Kapad.

A. Whole plant. B. Sepals and petals dissected. C. Front view of flower.

21. *COTTONIA* Wight

Cottonia Wight, Icon. 5 (1) : 22, 1851 ; Benth. & Hook. f. Gen. Pl. 3 : 572, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 211, 1889 ; Hook. f. Fl. Brit. Ind. 6 : 26, 1890 ; Schltr. Orchid. 569, 1927.

The generic name *Cottonia* was given in honour of Maj.-Gen. Cotton of the Madras Engineers, collector and cultivator of orchids, who found *Cottonia macrostachya* for the first time in Malabar.

This genus consists of a single species *C. peduncularis* Reichb. f. (=*C. macrostachya* Wt.), native in the south-western parts of India and of Ceylon.

Type species : *C. peduncularis* Reichb. f.

Cottonia peduncularis (Lindl.) Reichb. f. in Cat. Orchid. Schiller 52, 1857 ; Thwaites, Enum. Pl. Zeyl. 303, 1864. *Vanda peduncularis* Lindl. Gen. Sp. Orch. 216, 1833. *Cottonia macrostachya* Wight, Icon. 5 (1) : 21, t. 1755, 1851 ; Lindl. in Journ. Linn. Soc. 3 : 39, 1858 ; Dalz. & Gibs. Bomb. Fl. 263, 1861 ; Bot. Mag. t. 7099, 1890 ; Hook. f. 26 ; Cooke, Fl. Pres. Bom. 2 : 702, 1907 ; Gammie in Journ. Bombay nat. Hist. Soc. 18 : 589, t. 6, 1908 ; Blatt. & McC. ibid. 35 : 494, 1932 ; Fischer, Fl. Pres. Madr. 1439, 1928.

Epiphytes. Stem 0.7-1 cm. thick, closely sheathed. *Leaves* 5-17 $\times$1-2 cm., lorate, spreading, straight or recurved, sessile, narrowly elliptic-oblong, entire, coriaceous, keeled on the underside and abruptly ending in 2 unequal rounded lobes with a broad acute sinus in between. *Peduncles* 9-80 cm., greyish-green mottled with purple, bracteate at the nodes, with a few branches usually near the apex. *Flowers* few in a raceme at the very apex of the branches of peduncle, bracteate, pedicellate, usually opening one at a time. *Bracts* minute, cupular, brown. *Pedicel* with *ovary* about 1.2 cm. long, slightly curved, greenish-brown. *Sepals* and *petals* recurved backwards $\pm$ along the ovary, brownish-yellow with 4-6 reddish-brown longitudinal streaks ; dorsal sepal 9$\times$4 mm., obovate-oblong, concave in the upper half, acute ; lateral sepals 8$\times$4.5 mm., ovate-oblong, subobtuse, 5-nerved ; petals 8-9$\times$3 mm., narrowly obovate-oblong, obtuse-truncate, 5-nerved. *Lip* 1.4$\times$0.8 cm., fleshy purple with a central brownish-yellow streak about 0.6 cm. long, and a golden-yellow villous margin ; lateral lobes ear-like, small ; mid-lobe panduriform with an abruptly acute apex. *Column* 5$\times$4 mm., puberulous, footless, yellowish-brown ; from the sides of the column just above the stigmatic surface 2 projections are given out which meet in the centre to form a ledge, on which the gland of the pollinia rests. *Anther* 2-celled, subpandurate, broadly retuse at apex ; the underside reddish-brown with a central blue-black streak on the upper half, and yellow on the lower half ; pollinia 2, yellow, waxy, ovoid ; caudicle 1 mm.

long, with a small, somewhat square gland. *Stigmatic surface* U-shaped, yellow with a red margin and 2 red longitudinal streaks in the centre. *Capsules* 5-6×0.5-0.7 cm., oblong-fusiform, strongly ribbed, pedicels 2 cm. long.

Flowering : March to May. *Fruiting :* May onwards.

Occurrence in Bombay State : KONKAN : *Stocks* ; *Dalzell* ; Thana, *Kapadia* 1167. W. GHATS : Khandala, *Santapau*. N. KANARA : Supa, *Ritchie* ; Kumbelli Mines, *Kapadia* 2557 ; Poutelli Ghat, *Kapadia* ; Yellapur, *Sedgwick* ; *Kapadia* 1981-1982, 2864-2865 ; Astoli, *Bell* ; Sirsi-Siddhapur, *Hallberg & McCann* 34580 ; Sirsi, *Santapau* 18697 ; Londa, *Santapau* 10815-10818, 10867 ; Anmod, *Kapadia* 1910-1911 ; Castle Rock, *Kapadia* 1815 ; Dandeli, *Kapadia* ; Gundh, *Kapadia* 1721.

Distribution : India : Konkan, W. Ghats, N. Kanara, Anaimalais, Travancore. *World :* India, Ceylon.

Notes : We have noted this species on a large number of trees and shrubs ; it is usually found in open deciduous forests and is very easy to locate on account of its long erect branching peduncles.

The earliest valid specific epithet for this species is *peduncularis* of Lindley which, therefore, must be reinstated. *Index Kewensis* credits the binominal *Cottonia peduncularis* to Thwaites ; Pfitzer gives Reichenbach f. as the author ; Hooker f. follows Pfitzer.

22. *GASTROCHILUS* D. Don

GASTROCHILUS D. Don, Prodr. Fl. Nep. 32, 1825 ; O. Kuntze, Rev. Gen. Pl. 2 : 660, 1891 (partim) ; Schltr. Orchid. 573, 1927 ; Holttum, Rev. Fl. Malaya 1 : 656, 1953 ; (non Wall. 1832). *Sarcochilus* Spreng. Syst. Veg. 3 : 721, 1826 (partim). *Saccolabium* Endl. Gen. Pl. 205, 1837 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 217, 1898 ; Duthie, ibid. 9 (2) : 146, 1906 ; (partim, non Blume 1825). *Micropera* Dalz. in Hook. Kew Journ. Bot. 3 : 282, 1851 (non Lindl. 1832). *Sarcochilus* sect. *Micropera* (Dalz.) Benth. & Hook. f. Gen. Pl. 3 : 575, 1883. *Saccolabium* sect. *Longilabellatae* Benth. & Hook. f. Gen. Pl. 3 : 579, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 213, 1889. *Saccolabium* sect. *Calceolaria* Hook. f. Fl. Brit. Ind. 6 : 60, 1890. *Saccolabium* sect. *Platyrhizon* Hook. f. ibid. 6 : 63, 1890. *Saccolabium* sect. *Gastrochilus* (D. Don) J. J. Smith, Fl. Buitenz. 6 : 632, 1905.

The generic name *Gastrochilus* is derived from the Greek words *gaster*=belly, *cheilos*=lip, in allusion to the inflated, ventricose hypochil of the lip in the species.

This genus contains about 15 species distributed from India, and Ceylon through Malaya to Java and northwards to Japan.

In 1825, D. Don erected the genus *Gastrochilus* with a single species *G. calceolaris*, based on the manuscript name *Epidendrum calceolare* of Hamilton. Lindley (*Gen. Sp. Orch.* 223, 1833) reduced this to *Saccolabium* Bl. Subsequent authors, including Endlicher, Bentham & Hooker f., Hooker f., Pfitzer, King & Pantling, etc. follow Lindley in fusing *Gastrochilus* with *Saccolabium* or at the most keeping it as section under various names.

J. J. Smith in 1905 put *Gastrochilus* as a section of *Saccolabium* ; but in 1927 raised it to generic rank. Several modern orchidologists, including Schlechter, Hayata, Ames & Quisumbing, and Holttum, have recognized the generic status of *Gastrochilus*.

Gastrochilus D. Don can be differentiated from its close allies *Sarcochilus* R. Br. and *Saccolabium* Bl. by the following characters : (1) Flowers fleshy, wide-opening, lasting for several days. (2) Lip not movable, with a cup-shaped saccate base and the midlobe, which is flat semicircular, brim-like, wider than the cup, often hairy and fringed. (3) Column very short, footless. (4) Pollinia shorter than the narrow caudicle.

The generic name *Gastrochilus* D. Don (Feb. 1825) is listed as a rejected name in favour of the later conserved *Saccolabium* Bl. (Dec. 1825), in the list of Conserved generic names in App. 3 of the International Code of Botanical Nomenclature (1956 edit.). But Art. 14 (Note 4) states : ' When a name has been conserved against an earlier synonym, the latter is to be restored, subject to Art. 11, if it is considered the name of a genus distinct from that of the *nomen conservandum*. We do consider *Gastrochilus* D. Don as distinct from *Saccolabium* Bl.

Two of the Bombay species, described by Dalzell under *Micropera*, *M. viridiflora* and *M. maculata*, clearly belong to the genus *Gastrochilus*. Gen. Plant. and Fl. Brit. India include them under *Saccolabium*. Cooke puts them under *Sarcochilus*.

Type species : *G. calceolaris* D. Don.

KEY TO THE SPECIES OF *GASTROCHILUS* OF BOMBAY

1. Midlobe of lip fringed or fimbriate .. *dasypogon*
1. Midlobe of lip neither fringed nor fimbriate :
    2. Inflorescence usually longer than the leaves, racemose ; flowers yellow with or without a reddish spot .. .. *maculatus*
    2. Inflorescence shorter than the leaves in a cluster at the apex of the rachis ; flowers greenish-white .. .. *dalzellianus*

1. **Gastrochilus dasypogon** (Sm. ex Rees) O. Kuntze, Rev. Gen. Pl. 2 : 661, 1891. *Aërides dasypogon* Smith in Rees, Cycl. 39 : n. 10, 1818. *Saccolabium dasypogon* Lindl. Gen. Sp. Orch. 222, 1833 ; Hook. f. 66 ;

King & Pantl. 224, t. 299. *Saccolabium flabelliforme* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 722, f. 1, 1931.

Epiphytes. Stems very short, stout, about 1 cm. thick. *Leaves* 2-5, each 4-14 $\times$ 1-2.5 cm., narrowly oblong or linear-oblong, rarely narrowly oblong-elliptic, coriaceous ; apex shallowly, unequally 2-lobed, the lobes rounded. *Inflorescence* about 2-2.6 cm. long, somewhat corymbose, few- to several-flowered. *Flowers* pedicellate, bracteate. *Bracts* 3 $\times$ 2 mm., persistent, scabrid, ovate-oblong, acute or subobtuse. *Pedicel* with *ovary* 7-9 mm. long, slightly curved or straight. *Sepals* and *petals* 7-8 $\times$ 2 mm., somewhat obovate-oblong, spreading, fleshy, obtuse or rarely subretuse, entire, glabrous ; petals slightly shorter and narrower. *Lip* with minute, erect lateral lobes ; sac (hypochil) about 3-4 mm. in diam., nearly hemispherical, slightly laterally compressed ; midlobe (epichile) about 3 mm. long, 6-8 mm. wide, slightly deflexed, almost semicircular, outer edge minutely fimbriate. *Column* very short, about 2 mm. long, footless. *Anther* convex, oval ; pollinia 2, minute, globular with the slender caudicle as long as the diam. of both together.

The colour of floral parts, according to Blatter & McCann, is the following : sepals and petals apple-green sometimes with a rose-coloured spot ; spur greenish, often sparsely pale-purple-spotted ; midlobe of lip white with a central fleshy yellow triangle, which is bordered with rose-coloured dots and short lines ; column white, usually strongly suffused with deep rose ; anther yellow ; pollinia orange-yellow.

Flowering : September to October.

Occurrence in Bombay State : N. KANARA : *Bell* 5424 ; Devimane Ghat, *Gammie* ; *Sedgwick & Bell* ; *Hallberg & McCann* 34568, 34464 ; Sirsi, *Sedgwick* ; Sirsi-Siddhapur, *Hallberg & McCann* 34381 ; *Kapadia* 2442-2443 ; Yellapur, *Bell* ; *Kapadia.*

Distribution : India : Sikkim, Assam, and southwards to N. Kanara. *World :* India and Nepal.

Notes : The specimens of *Saccolabium flabelliforme* Blatt. & McC. in Blatter Herbarium clearly agree with *Saccolabium dasypogon* Lindl. as figured and described by King & Pantling. The latter authors give the following note under *Saccolabium dasypogon* Lindl. : ' . . . This is closely allied to *S. calceolare* Lindl. with which for many years it has been confused. The two plants, although much alike, are not really difficult of separation. In the first place they live at different elevations and flower at different seasons. *S. calceolare* is found between 4,000 and 6,000 feet, and flowers during March and April ; while *S. dasypogon* is found at or below 1,000 feet and is in flower during November and December. The leaves of *S. dasypogon* are broader, and the apical notch is less than is the case in the leaves of *S. calceolare,* and the stem of *S. dasypogon* is shorter. The colouration of the flowers of *S. calceolare* is constant ; but in that of *S. dasypogon* the perianth may be pale or deep yellow, and either without spots or with numerous spots. Finally the lips of the two differ. In *S. calceolare* the sac is smaller ; the apical lobe is papillose-hairy ; while in *S. dasypogon* the apical lobe has deeply laciniate edges and its upper surface is perfectly smooth.'

O. Kuntze in making the transfer of *Saccolabium dasypogon* Lindl. to *Gastrochilus* gives ' (Sw.) Lindl.' as the authors from whom the specific epithet is derived. The original author of the specific epithet is, however, Smith, and not Swartz.

2. **Gastrochilus maculatus** (Dalz.) O. Kuntze, Rev. Gen. Pl. 2 : 661, 1891. *Micropera maculata* Dalz. in Hook. Journ. Bot. 3 : 282, 1851 ; Lindl. in Journ. Linn. Soc. 3 : 38, 1858 ; Dalz. & Gibs. Bomb. Fl. 263, 1861. *Sarcochilus maculatus* Pfitz. Vergl. Morph. Orch. 15, 1881 ; Cooke, Fl. Pres. Bomb. 2 : 698, 1907 ; Blatt. & McC. 488. *Saccolabium maculatum* (Dalz.) Hook. f. Fl. Brit. Ind. 6 : 64, 1890; Gammie in Journ. Bombay nat. Hist. Soc. 20 : 127, 1910.

Stem about 1 cm. long. *Leaves* 2-3, coriaceous, sheathing at the base, 4-8 $\times$ 1.7-2.3 cm., narrowly oblong, dark greyish-green often mottled with purple, tapering at the $\pm$plicate base, entire, emarginate with unequal lobes, 1-nerved. *Inflorescence* up to about twice as long as the leaves, several-flowered, arising from the base of the leaves somewhat horizontally ; often 2 or more per plant. *Peduncles* 1-2 mm. thick, subterete, purplish. *Flowers* about 8 $\times$ 10 mm. almost sessile, bracteate. *Bracts* 1.5-2.5 $\times$ 2 mm., broadly oblong-ovate, persistent, coriaceous, brown. *Ovary* with short *pedicel* 3 mm. long, stout, erect. *Sepals* and *petals* subequal, yellow with a purple spot, or pure yellow, free, obovate-oblong, rounded, entire, glabrous, faintly 1-nerved ; dorsal sepal 6 $\times$ 3.5 mm., concave and hooded in the upper half, slightly narrowed to the base ; lateral sepals 5 $\times$ 3 mm. tapered towards the rounded submucronulate apex ; petals 5 $\times$ 3 mm., $\pm$ incurved in apical half and somewhat connivent over column. *Lip* fleshy, white flushed with pink, 3-lobed ; lateral lobes 2.5 mm. long, erect, nearly meeting at the base just above the midlobe, about 3 mm. apart at the narrow, subacute apex, anterior margins pink ; midlobe (epichile) 2 $\times$ 4.5 mm., obscurely 3-lobed, entire, rounded, forming a sort of brim to hypochil, somewhat like a side-saddle. *Spur* broadly conical, 5 mm. long below the midlobe. *Column* 2 mm. long, stout, footless, semiterete ; rostellum divided, pointing downwards. *Anther* 1.25 $\times$ 1.75 mm., opercular, conical, anterior lip obtuse ; pollinia 2, 0.75 mm. in diam., caudicle 1-1.25 mm. long, narrow ; gland small, thin.

Flowering : May.

Occurrence in Bombay State : W. GHATS : *Dalzell* ; Phunda Ghat, *Ritchie.* N. KANARA : Idigangi, *Bell* ; Yellapur, *Sedgwick* ; Anmod, *Kapadia* 1883-1884 ; Jog, *Kapadia* 1850.

Distribution : Apparently endemic in N. Kanara.

3. **Gastrochilus dalzellianus** (Sant.) Sant. & Kapadia, comb. nov. *Sarcochilus dalzellianus* Santapau in Kew Bull. 1948 : 498, 1949 et in Rec. Bot. Surv. Ind. 16 (1) : 302, 1953. *Micropera viridiflora* Dalz. in Hook. Journ. Bot. 3 : 282, 1851. *Saccolabium viridiflorum* Lindl. in Journ. Linn. Soc. 3 : 36, 1858 ; Dalz. & Gibs. 263 ; Hook. f. 63. *Sarcochilus viridiflorus* (Dalz.) T. Cooke, Fl. Pres. Bomb. 2 : 697, 1907 ; Blatt. & McC. 488 ; (non Hook. f. 1890). (See Plate LII.)

Epiphytes. Stem very short, sheathed. *Leaves* usually 2 with a small one in between, 3-9 × 1.5-2 cm., elliptic-lanceolate, tapering at base, entire, unequally bilobed at apex, lobes entire. *Racemes* corymbose-umbellate, at apex of peduncle ; peduncles suberect, about 1-2 mm. thick, 3-5 cm. long, terete, bracteate ; bracts 1.5-2 × 1.2 mm., lower ones completely ensheathing the peduncle, upper ones not so, broadly ovate-oblong, entire, subobtuse to acute. *Flowers* greenish-white, pedicellate, bracteate. *Pedicel* with *ovary* 7 mm. long, brownish-green. *Sepals* subequal, broadly obovate and tapering at base, entire, rounded or mucronulate, pale green ; dorsal sepal 7 × 3-3.5 mm., often with a few yellowish-red spots at base ; lateral sepals 6 × 3-3.5 mm. *Petals* 6-7 × 3.5-4 mm., pale green, obovate and tapering at base, entire, obtuse, slightly falcate, with somewhat incurved apices. *Lip* fleshy, white ; lateral lobes erect, about 1 mm. long, acute, their anterior margins red-streaked ; midlobe (epichile) semicircular, 2.5-3 × 5-7 mm., apiculate ; spur 3.5 mm. long, fleshy, conical, rounded, white with a crimson patch at back inside corresponding to the red streaks of lateral lobes of lip. *Column* about 2 mm. long, stout, semiterete, footless ; clinandrium green with dark reddish-brown patches on top and sides. *Anther* pale yellow, 1.5 × 1.25 mm., broadly obpyriform with a truncate apiculum ; pollinia 2, deeply grooved, 0.5 mm. in diam. ; caudicle 1.5 mm. long, narrow ; gland narrow, linear, erect, 0.5 mm. long. *Capsules* 3-5 cm. long, narrowly fusiform, ribbed, purplish-brown.

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

Occurrence in Bombay State : KONKAN : *Dalzell.* W. GHATS : Mahableshwar, *Cooke* ; Khandala, *Santapau* 487, 1352, 4521, 9077 ; *Kapadia* 1939-1940 ; Lonavla, *Kapadia* 1121, 1171 ; Amboli Ghat, *Gammie.* DECCAN : Koina Valley, *Bole* 1179; *Kapadia* 2904-2905, 2908-2909; Amba, *Bhide*; *Acland* 1178. N. KANARA : Ushelli, *Ritchie* ; Chandwar, *Ritchie* ; Tinai Ghat, *Bhide* ; Castle Rock, *Acland* 177 ; *Kapadia* 2774, 2798 ; Dandeli, *Santapau* 18794.

Distribution : Apparently endemic to Bombay State.

Notes : This is an inconspicuous plant, often seen epiphytic on various species of *Ficus*.

The earlier specific epithet *viridiflorus* Dalz. cannot be used here on account of *Gastrochilus viridiflorus* (Lindl.) O. Kuntze.

(*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 5

BY

M. S. Mani, D.Sc., F.L.S., and Santokh Singh, Ph.D., F.R.E.S.

(*With thirteen text-figures*)

[*Continued from Vol.* 59 (2) : 381]

IV. Peculiarities of the Distribution of the Nival Insects

Correlated with the specific ecologic characters and the topography of the Himalaya, the distribution of the nival insects above the timber line shows many striking peculiarities. Some of these are characteristic of the distribution of mountain autochthone species in general, but many are also to be attributed directly to the massiveness of the trend lines of the mountain ranges and the high altitudes of the elevated areas in the NW. Himalaya. When we carefully examine the distributional range of the individual species, we may recognize the following important features : 1. Localization ; 2. Discontinuity ; 3. Concentration ; and 4. Isolation (Fig. 42).

Localization. Localization results when the range of a species is small and restricted wholly to a relatively small area, often along a single spur of a given mountain range, and the species does not occur anywhere else. The range is often so small that the species may be said to be scarce in the NW. Himalaya. Sometimes this localized area of the species is comparatively large. In discussing the distribution of the different orders, we have already had occasion to refer to numerous examples of localization of species and genera. We may therefore consider here only a few examples. *Tibetocoris*, an endemic genus of Heteroptera, occurs, for example, only on the Chang Chenmo spurs in the neighbourhood of Pongong Tso (Fig. 43) and is never found below an elevation of 5000 m. *Phimodera rupshuensis* Hutchinson (Fig. 10), another endemic

Heteroptera that never descends below an elevation of 4000 m., is similarly strictly localized on the Zaskar Range in the Tso Morari area. The area of the endemite *Bembidion hutchinsoni* Andrewes (Fig. 44), which

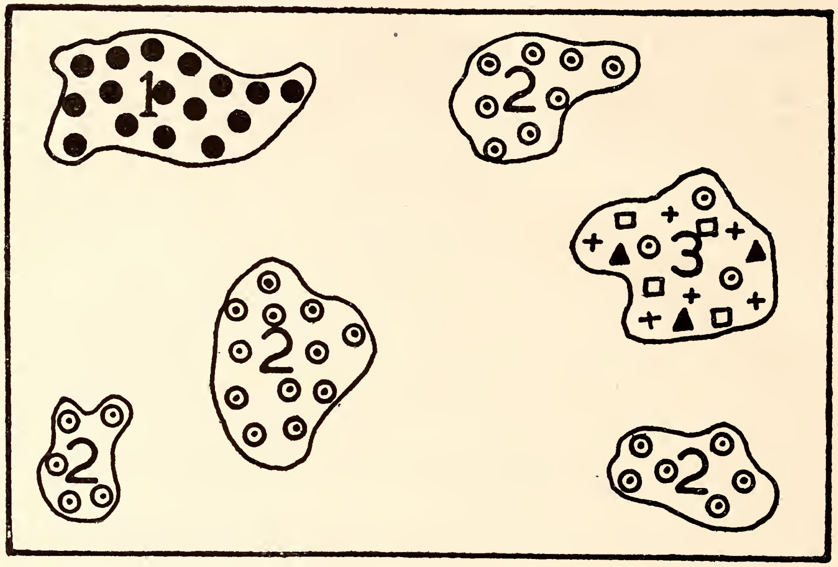


Fig. 42. Distribution patterns of nival insects in NW. Himalaya above timber line : 1. Localization ; 2. Discontinuity ; 3. Concentration

is an inhabitant of elevations above 4500 m., is likewise localized in a most interesting manner near Kyam Hot Spring on the Chang Chenmo spurs north of the Pongong Tso. A great many endemic species of *Atheta* are also localized. The two endemic species of *Blaps* are strictly localized on a spur from the Ladakh Range in the Pongong Tso area. Not only are most of the endemites localized in this manner in one area or the other, but the distribution of the non-endemites is also mostly localized. *Colias leechi* Gr.-Gr., of the Pamir-central-Asian faunal element, is strikingly localized in the Kardong Pass area of the Ladakh Range. Another Pamir form, *Bembidion petrimagni* Net., is localized in the area of the Baltoro Glaciers. The interesting central Asian Diptera, *Ephydra glauca* Meigen (which is also known from south Russia and Romania), is strictly localized in the Tso-Kar area in Rupshu. The Tibetan-Himalayan *Amara brucei* Andrewes and *Bembidion nivicola* Andrewes are localized in the Pongong and Karakorum Pass area.

Discontinuity. Although several species are localized in a single more or less small area, a considerable proportion of both endemites and others are generally localized in more than one, irregular, unequal, and often more or less widely separated patches. The range of these species, though relatively extensive, is conspicuously discontinuous. The distribution of nearly 80% of the endemites is in such localized, discontinuous, and isolated patches. *Bembidion irregulare* Net., an endemite from the mountain ranges drained by Indus River and occurring generally above an elevation of 4500 m., is localized for example in two widely separated and unequal patches (Fig. 45), one of which is situated on the central Karakorum and the other on the Great Himalaya in the neighbourhood of Nun Kun Peaks. The total range of another extremely interesting endemite, *Bembidion luntaka* Andrewes, is similarly broken up into two irregular discontinuous patches, a larger patch (Fig. 45) on the spurs between the Ladakh and Zaskar ranges and a smaller patch on the south slope of the Great Himalaya in the neighbourhood of Bara Lacha La. The ranges of *Bembidion ladas* Andrewes, *Bembidion leve* Andrewes, *Bembidion livens* Andrewes, and *Bembidion ixion* Andrewes, all of which are endemites, are similarly characterised by the same patchiness and discontinuity. *Bembidion aquilum* Andrewes, an endemite occurring at elevations ranging from 3000-4500 m., has its total range broken up in four isolated and widely separated patches (Fig. 46), the largest of which lies on the north slope of the Great Himalaya near Nun Kun Peaks. The localized range of the central Asian *Bembidion fuscicrus* Motsch. is broken in three patches in the Indus drainage area (Fig. 47).

Localization and discontinuity characterize the distributional ranges of nearly 210 endemites. Nearly 153 non-endemic species also exhibit a similar pattern of distribution. The remaining 7 endemites, though widely distributed in the whole of the NW. Himalaya, still have their total range broken into numerous isolated patches on all the mountain ranges. The ranges of 14 non-endemic species, which occur throughout the NW. Himalaya, are again split up into many isolated patches, scattered likewise on all the mountain ranges. This pronounced tendency for severe localization and discontinuity, a characteristic of mountain insect life, has been observed by Holdhaus (65) and several others in the Alps, and is greatly exaggerated in the case of the insect fauna above the timber line in the more massive NW. Himalaya. References to some of these peculiarities have already been made by us in another connection (100).

Concentration. Owing to the peculiar ecologic conditions, the nival species are localized in areas where alone they find the specific optimal conditions for existence. Localizations of large numbers of species of different orders tend to condense into certain centres. The centres of localization of several species thus superimpose to a greater or lesser extent, and we therefore find corresponding concentrations of species. Several species are thus localized in the same area. Some of the localized and isolated concentrations contain as many as 40 species belonging to several orders like Heteroptera, Coleoptera, Hymenoptera, Lepidoptera, Diptera, Thysanura, and Collembola. The great majority of the species of such localized concentrations do not occur outside the area of concentration. Localized concentrations in the Tso Morari area include, for example, about a dozen species like *Bryodema luctuosa* Stoll., *Phimodera rupshuensis* Hutchinson, *Microplax hissarensis* Kiritsch., *Atracthelophorus frater* d'Orch., *Aleochara* (*Coprochara*) *bilineata* Gyll., *Atheta* (*Bessobia*) *submetallica* Cameron, *Atheta* (*Microdota*) *ladakiana* Cameron, *Parnassius acco tagalangi* Bang-Haas, *Parnassius actius yelyangi* Bang-Haas, *Parnassius simo zarraensis* (Bang-Haas), and *Ephydra glauca* Meigen.

The localized concentrations of species are generally grouped in a most significant manner along the main ranges of the NW. Himalaya or on its major spurs. Nearly 170 endemites and 115 non-endemites are thus localized in concentrations on the main ranges and about 55 species on the major spurs. Localizations of species of *Bembidion* are concentrated along the Ladakh, Zaskar, and the Great Himalaya Range (Fig. 44). *Bembidion ladas* Andr., *Bembidion leve* Andr., *Bembidion livens* Andr., and *Bembidion ixion* Andr. are, for example, concentrated on the Ladakh and Zaskar ranges. The general pattern of localized concentrations of the insect fauna of the nival zones in the NW. Himalaya is an unmistakable indication that the distribution of various species follows the general trend line of the Himalayan ranges. In other words, we have the general average picture of a more or less parallel series of linear arrangements of localized and discontinuous concentrations of species (Fig. 48). The concentrations of species on the different mountain ranges are also on the whole in the immediate vicinity of and around the high peaks and crest lines. In areas with a close group of several high peaks (Fig. 49), the concentrations are extensive and massed. A map of peaks above an average elevation of 6000 m. would more or less exactly reflect the pattern of distribution of nival insects. The massing of the nival insect species around high peaks is so constant that chance coincidence cannot explain it. An unmistakable connection exists between the distribution of peaks of an average altitude of 6000 m. and the distribution of nival insects. From ecological considerations and on the basis of the available evidence of past distribution, such a massing of the greatest bulk of the nival forms around high peaks should naturally be expected.

Massed concentrations of species around high peaks is particularly conspicuous in areas which were formerly more or less heavily glaciated and from which the Pleistocene ice sheets and valley glaciers have since receded (27). Several species occur so constantly in such areas alone that they may be considered as indicator species. We thus find a remarkable wealth of species around many of the glacial lakes like Pongong Tso (29) and Tso Morari (Fig. 50). In these areas are also grouped together a very large number of peaks rising above an elevation of 6000 m.

The single largest massing of localized concentration of nearly 43 species in the NW. Himalaya is perhaps in the vicinity of Pongong Tso. The following species are massed around high peaks in this area:

SOME TYPICAL INDICATOR SPECIES OF FORMERLY GLACIATED AREAS

1. *Hyphinomus fasciata* Uvarov
2. *Dolmacoris deterrana* Hutchinson
3. *Emblethis horvathiana* Hutchinson
4. *Lamprodema brevicollis* Fieb.
5. *Nysius ericae* (Schill.)
6. *Nysius ericae alticola* Hutchinson
7. *Chlamydatus pachycerus* Kiritsch.
8. *Dicyphus physochlaenae* Hutchinson
9. *Dicyphus senggae* Hutchinson
10. *Tibetocoris margaretae* Hutchinson
11. *Chiloxanthus alticola* Kiritsch.
12. *Amara ambigene* Bates
13. *Amara brucei* Andrewes
14. *Bembidion hutchinsoni* Andrewes
15. *Bembidion nivicola* Andrewes
16. *Cymindis championi* Andrewes
17. *Cymindis rubriceps* Andrewes
18. *Potamonectes* (*Potamonectes*) *griseostriatus* (Deg.)
19. *Agabus* (*Gaurodytes*) *adustus* Guignot
20. *Helophorus* (*Helophorus*) *splendidus immaensis* d'Orch.
21. *Helophorus* (*Lihelophorus*) *ser* Zaitz.
22. *Helophorus* (*Meghelophorus*) *aquaticus* Linn.
23. *Laccobius* (*Laccobius*) *hingstoni* d'Orch.
24. *Atheta* (*Dimetrota*) *hutchinsoni* Cameron
25. *Blaps ladakensis* Bates
26. *Blaps perlonga* Bates
27. *Bombus alticus* Eversm.
28. *Subterraneobombus melanurus* (Lepel)
29. *Doliphilodea tibetana* Kimmins
30. *Parnassius delphius ladakensis* Avinoff
31. *Colias cocandica thrasibulus* Frusch.
32. *Colias leechi* Gr.-Gr.
33. *Ephydra tibetensis* Cresson
34. *Ctenolepisma* sp.
35. *Machilanus hutchinsoni* Silv.
36. *Friesea excelsa* Denis
37. *Isotoma spinicauda* Bonet
38. *Proisotoma ladaki* Denis
39. *Mydonius hutchinsoni* (Denis)
40. *Orchesellides boraoi* Bonet
41. *Seira brahmides* (Denis)
42. *Sminthurides aquaticus* (Bourlet)
43. *Sminthurides* (*Stenacidia*) *violaceus* (Reuter)

The environs of Tso Morari contain another large concentration of about 16 species, of which *Nysius ericae*, *Chlamydatus pachycerus*, and

Potamonectes (*Potamonectes*) *griseostriatus* also occur near Pongong Tso.

It is also extremely interesting that in the distribution of species, we can readily recognize a very pronounced tendency for clustering near present day glaciers (Fig. 51). Localized concentrations of several species are massed together in areas where there are larger glaciers, more than in case of some of the smaller glaciers. The extensive occurrence of many species in the neighbourhood of the present day larger glaciers justifies us in calling them indicators of the glacier localities. The following species are, for example, exclusively massed near present day glaciers :

SOME TYPICAL INDICATOR SPECIES OF AREAS OF PRESENT GLACIERS

1. *Bembidion bucephalum* Net.
2. *Bembidion pamiricola* Lut.
3. *Atheta* (*Acrotona*) *fungi kashmirensis* (Gr.)
4. *Ocyusa* (*Ocyusa*) *quadrisulcata* Bernh.
5. *Myrmeca smythiesi cachmirensis* Forel
6. *Parnassius delphius shigarensis* Bang-Haas
7. *Parnassius delphius workmani* Avinoff
8. *Colias eogene francesca* Watkin

Isolation. The existence of considerable ecologic isolation in the insect life above the timber line was described by us in an earlier paper (100). The pronounced localization and discontinuity of concentrations have the concomitant result of isolation in the greatest majority of species.

The isolation is either geographical, topographical, or also ecological. The populations of each of the species with discontinuous patches of distribution are truly allopatric. Though macrogeographically apparently sympatric, in actual practice the distribution is a case of microgeographically allopatric. Isolations are brought about by a variety of conditions like steepness, slope (aspect), altitude, topography, habitats, and other ecological conditions. Though thus often not geographically separated, most species are actually completely separated topographically, or ecologically. In some cases however the isolation does not appear to be total, and hybrid populations are met with at the areas of contact of the two species or subspecies, especially among *Parnassius* and *Colias*. Though allopatric populations are the general rule, such hybrid populations in areas of contact of two ranges in the Lepidoptera of the Alps have also often been described (118, 119, 120). The high endemism and the existence of numerous local geographical subspecies are without doubt to be correlated with the pronounced isolation and rapid evolution on high massifs. The extensive researches of several workers like Bäbler (7), Lindroth (84, 85, 86, 87), Holdhaus (57, 58), Janetschek (75, 76), and others have shown that discontinuity and isolation characterize the distribution of nival insects, especially the terricolous Coleoptera, from the Alps also. Most of these alpine distributional peculiarities are more or less conspicuously exaggerated in the case of the much more massive NW. Himalaya.

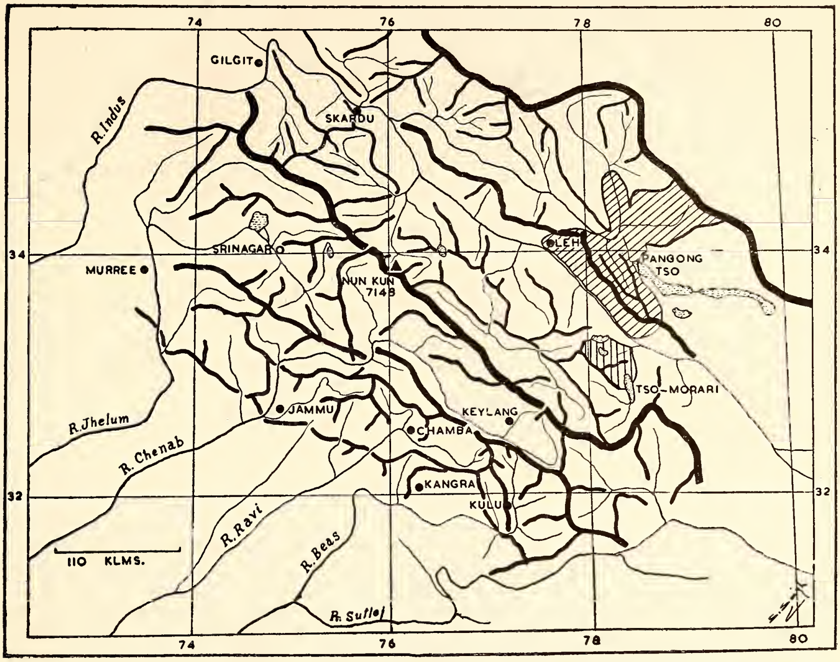


Fig. 43. The localization of the endemic nival Heteroptera in areas, which were under heavy valley glaciers during the Pleistocene : for example, the Pongong Valley area, with *Tibetocoris* (area obliquely striped) district and the Tso Morari area (vertically striped) with *Phimodera* district. The *Tibetocoris*-group of species are distributed on the Ladakh Range and across the Chang Chenmo spurs to the southern slopes of Karakorum. In this and in the following figures, the thick black lines indicate the crest lines of the mountain ranges, and the thin lines, the ridges.

V. The Factors governing the Distribution of Nival Insects

The peculiarities of distribution and the faunal characters of the nival insects, which we have outlined above, are closely linked up with their past distribution, their special ecologic characters, some of the more recent phases of the orogenic movements leading to the uplift of the Himalaya, and a number of other factors. Some of the major factors governing the distribution of these insects can partly be observed in the field and others can be readily deduced from their known distribution. A great many of the distributional peculiarities may be traced to the high ecologic specialization of the nival insect fauna (100). The nival insects are cold-adapted species, which inhabit the montane tundras above an elevation of 3000 m. They are predominantly endogeous or terricolous, flightless, hygrophiles, with a pronounced preference for

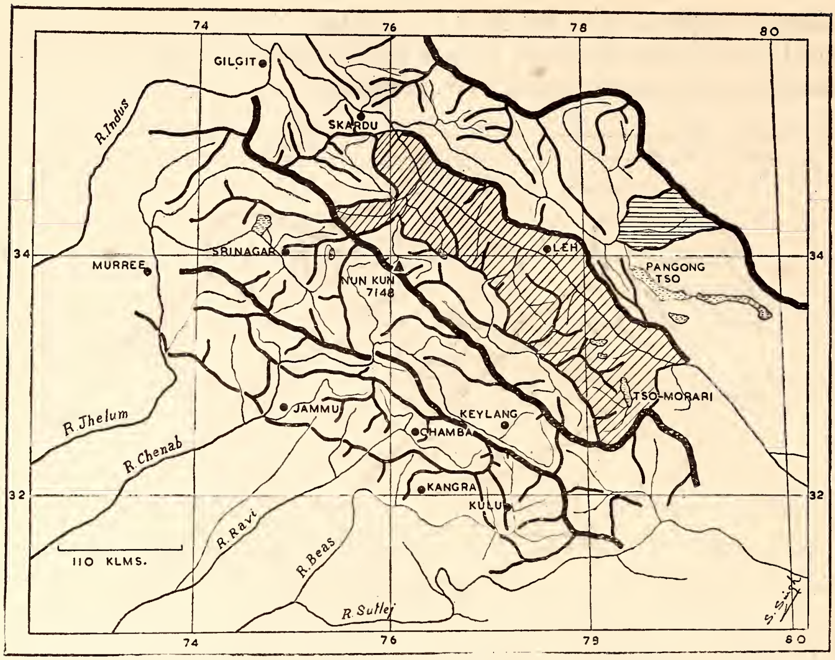


Fig. 44. The distribution of *Bembidion ladas* Andr., *Bembidion ixion* Andr., *Bembidion leve* Andr., and *Bembidion livens* Andr., which are localized between the Ladakh Range and the Zaskar Range in the area drained by R. Indus (Indus Valley glacier of the Pleistocene) (striped oblique). Note the extension to the north slope of the Great Himalaya on the spurs near Nun Kun Peak. The Chang Chenmo area (striped horizontal), north of the Pongong Tso is the centre of localization of *Bembidion hutchinsoni* Andr.

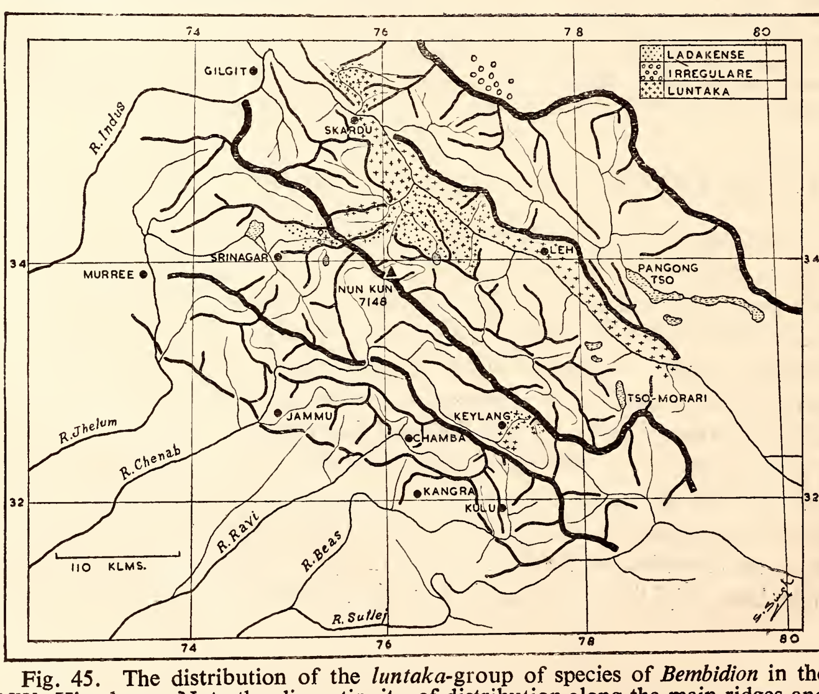


Fig. 45. The distribution of the *luntaka*-group of species of *Bembidion* in the NW. Himalaya. Note the discontinuity of distribution along the main ridges and spurs. The crest line of the Great Himalaya (with Nun Kun Peak) is crossed only at two points, viz. near the Baralacha Pass and the Zojila Pass.

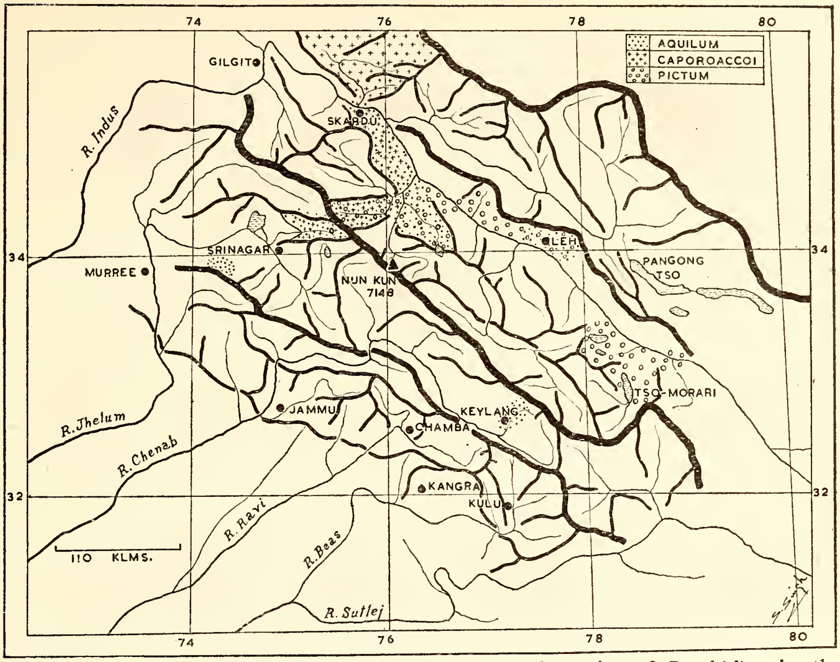


Fig. 46. The distribution of the *pictum*-group of species of *Bembidion* in the NW. Himalaya.

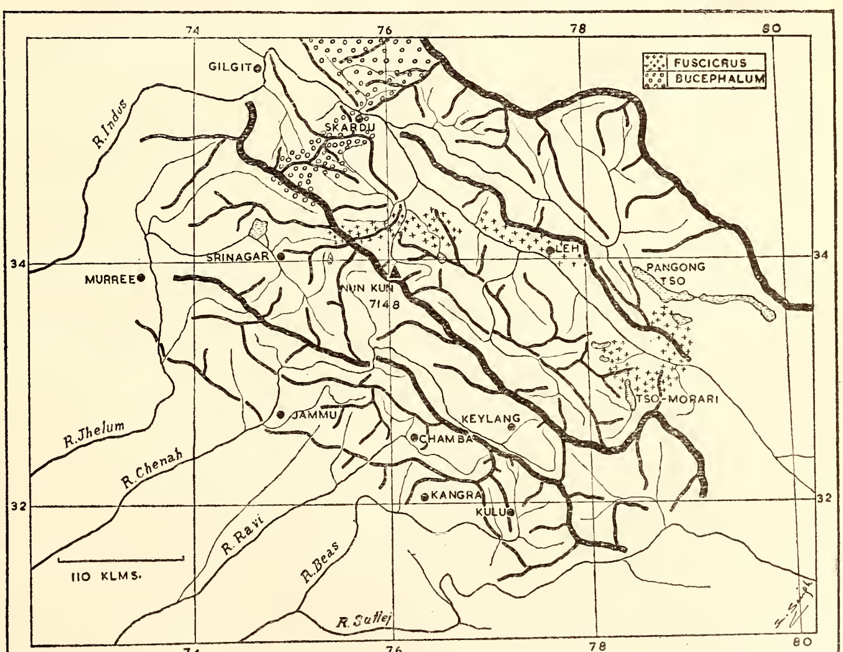


Fig. 47. The distribution of *Bembidion fuscicrus* Motsch., *Bembidion bucephalum* Bates, *Bembidion dardum* Bates, *Bembidion pamiricola* Lutch., and *Bembidion petrimagni* Net. in the NW. Himalaya.

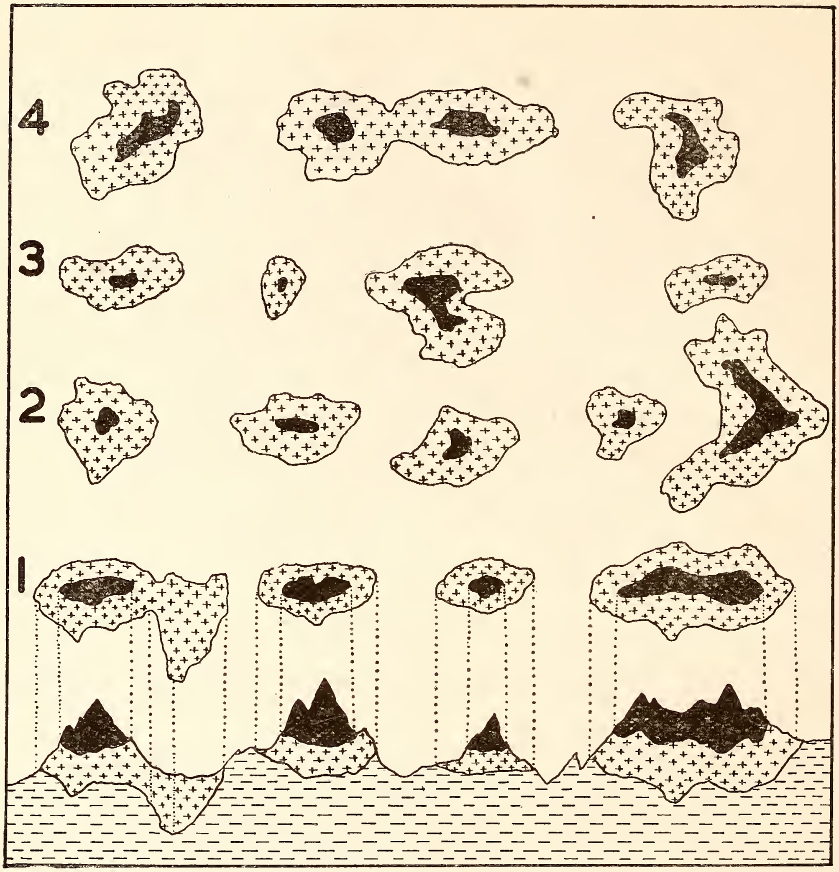


Fig. 48. Parallel series of linear, localized, and discontinuous concentrations of nival species in the neighbourhood of high peaks.
Peaks with permanent snow shown black ; concentrations of nival insects with +. Bottom row shows elevation, and rows 1-4 on different ranges as viewed from the air.

areas seasonally under snow cover. The maximum ecologic stability in the majority of the species is reached at about an elevation of 4000 m. above m.s.l. but many species are integral parts of the environment far above the permanent snow line. All the species are characterized by prolonged hibernation under snow cover, with a relatively short and active period of rapid development in the brief summer. The specific optima of ecologic requirements for nearly all the species are found only in irregular, discontinuous, greatly isolated patches or islets, which alone have the concentrations of population. These ecologic specializations have largely contributed to the localization, discontinuity, and concentration in isolated patches. The factors which admittedly govern the distribution include the means of dispersal, topography, the massiveness of the NW. Himalaya, permanent snow line, geology, and Pleistocene glaciations. We shall briefly consider some of these factors.

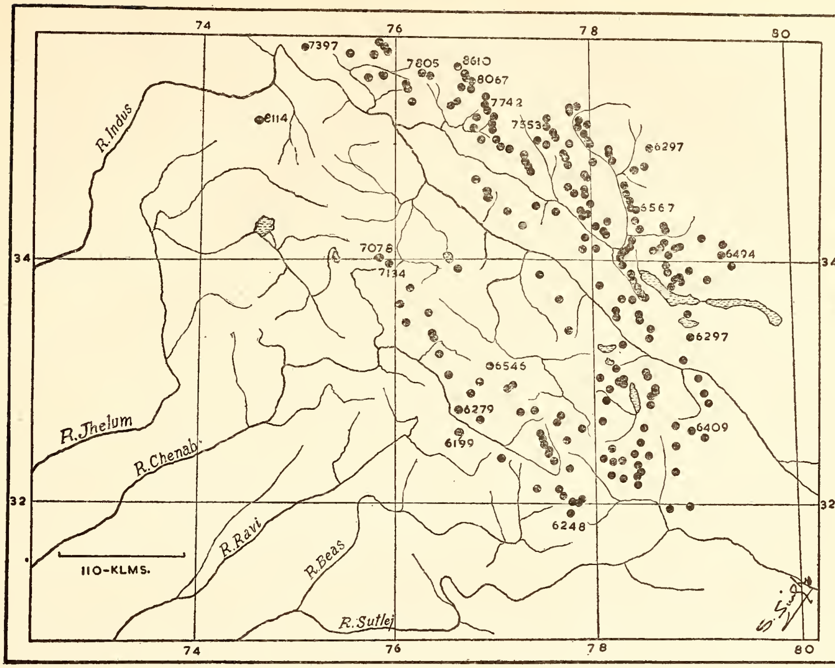


Fig. 49. Map of the region of the NW. Himalaya, showing the location (black circles) of the high peaks of an average altitude of 6000 metres above mean sea level and higher. Note that the areas of masses of peaks are also the areas of heavy concentrations of the nival insect species.

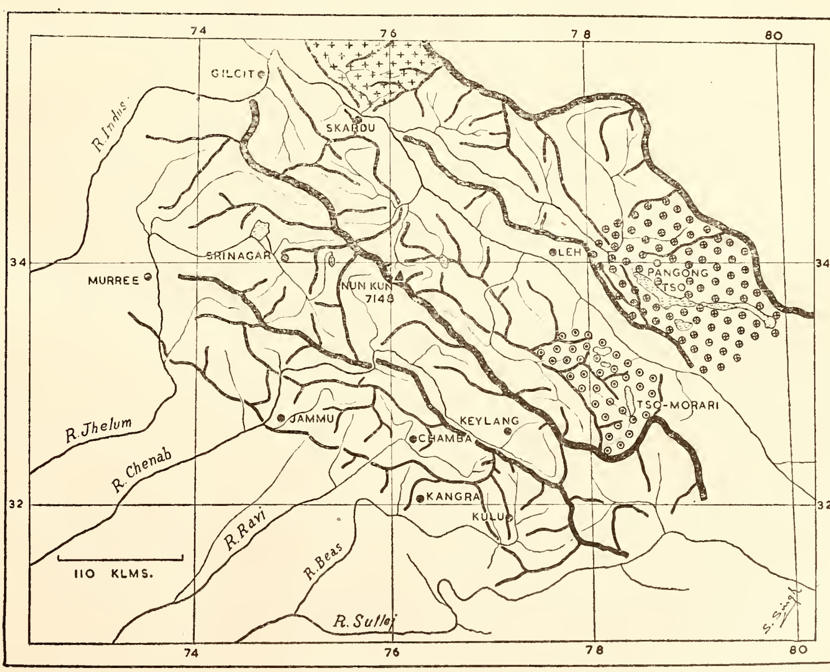


Fig. 50. Map of the region of the NW. Himalaya, showing the concentrations of species in areas which were formerly glaciated (+ inside circles) and areas of the present day glaciers (+)

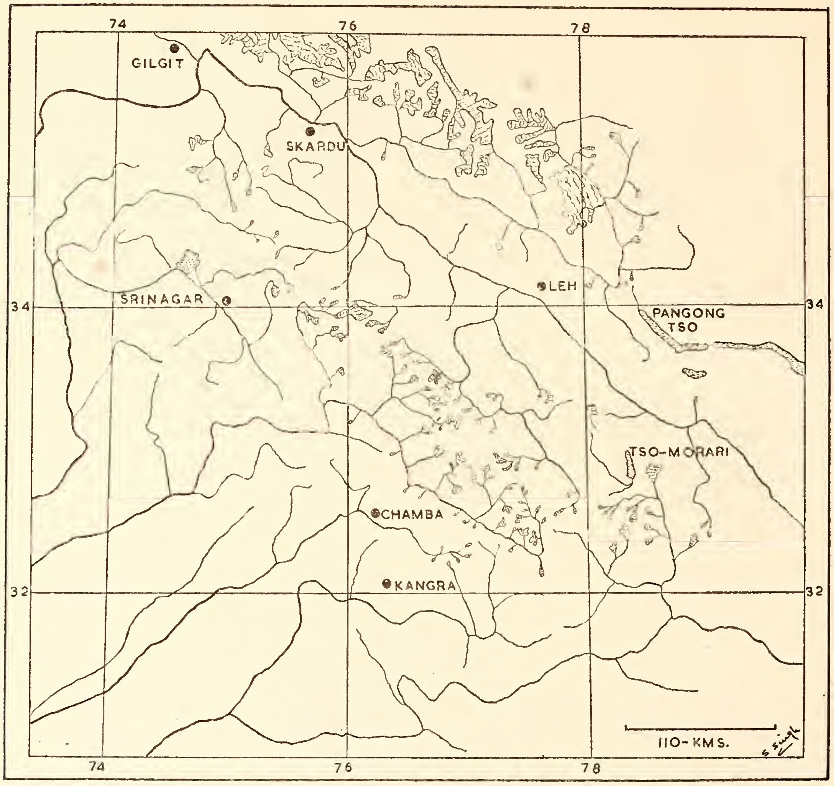


Fig. 51. Map of the region of the NW. Himalaya, showing the more important present day glaciers.

Means of Dispersal. An ecologically highly specialized group of insects, comprising predominantly flightless, endogeous or terricolous forms, have greatly limited means of dispersal. The dispersal of the greatest majority of the nival species is more or less purely passive and is often brought about by glacier movements, erratics, avalanches, etc. The slow sliding of the submerged stones helps the passive dispersal of most torrential types. The active dispersal of species, which still retain wings and are thus capable of sustained flight, such as is the case with Lepidoptera and many Diptera, is mostly restricted by the localization of their larval food plants and limited flight range and is therefore not appreciably faster than passive dispersal. It is indeed interesting that in the case of species with active means of dispersal, the distribution is more localized and the isolation greater than in those with passive means of dispersal. The dispersal is in all cases limited to the short and fleeting summer, when the snow cover is temporarily lifted for a brief period. The actual range of the greatest bulk of the nival species therefore persists substantially unchanged, often for prolonged periods.

Topography. The topographical peculiarities, which are important from the point of view of the distribution of the nival insects, centre around the trend lines of the parallel and more or less converging mountain ranges, the disposition of the inter-connecting spurs and ridges, the water partings and the location of the high peaks. These peculiarities act not merely as physical barriers to dispersal but have often also favoured and in many cases routed the distribution of different species and of faunal exchanges with neighbouring regions. The effects of topographical differences may often be more or less masked at lower elevations, but are generally greatly exaggerated above the timber line. The nival species, especially the endemites, the Pamir-central-Asian elements and the Tibetan-Himalayan elements are distributed along the trend lines of the main ranges and their spurs. The parallel series of discontinuous localized concentrations of species, with greater or less isolation and microgeographically allopatric populations, described above, are mostly mirror images of the locations of the massive high peaks along the trend lines and main crest lines of the different mountain ranges. It is only where the southern slope of a mountain range impinges on the northern flank of the neighbouring range as, for example, in the mountain knot of the Bara Bangahal in the Chenab-Beas drainage system, or when sufficiently high spurs connect the ranges, as for example, near the Nun Kun Peak in the Indus drainage area, that the distribution is at right angles to the general trend line of the Himalaya. These places are also the actual lines of inter-communication between the species complex of the different mountain ranges. Particular attention should, in this connection, be drawn to the fact that the endemites are mostly associated with the high massifs, the Mediterranean elements have spread mostly on the southern slopes, and the Indo-Malayan elements have penetrated through the valleys. Another point of interest is that the crest line of the Great Himalaya continues unbroken and unpierced by the rivers, right from the River Sutlej to the River Indus, the whole length of the NW. Himalaya. The mass of granite of the Great Himalaya seems to constitute an effective barrier to faunal exchanges between the Indus drainage area and that of the Chenab-Beas and Jhelum in the south. Such faunal exchanges occur only near the Baralacha La and the Zojila Pass. Localizations and discontinuous concentrations are admittedly the result of the ruggedness of the terrain and the differences in the ecologic optima on the different mountain ranges, their major spurs and ridges. The major details of the distribution of any species change only when the topography becomes altered conspicuously in any part of its total distributional range.

The permanent snow line. The distribution of a great many species is undoubtedly limited by the permanent snow line. Many species like *Dolmacoris deterrana* Hutchinson, *Nysius ericae* (Schill.), *Colias eogene* *francesca* Watkins, *Argynnis algaia vitatha* Moore, and *Proisotoma subornata* (Denis) may be considered as indicators of the permanent snow line and are never found at lower elevations. There are numerous other species which occur exclusively at elevations far above the permanent snow line. The Heteroptera, *Emblethis horvathiana* Hutchinson (5520 m.) and *Tibetocoris margaretae* Hutchinson (5180-5365 m.) are, for example, confined to elevations above the permanent snow line. *Nysius ericae alticola* Hutchinson (5000-5300 m.), and *Chlamydatus pachycerus* Kiritschenko (4525-5335 m.) are found immediately below the permanent snow line and also at higher elevations. The same is the case with the Carabid, *Amara brucei* Andrewes (4350-5300 m.). The Staphylinid *Atheta* (*Dimetrota*) *hutchinsoni* Cam. is confined to elevations from 5300 to 5600 m. above m.s.l. and naturally much above the permanent snow line. Five local subspecies of *Parnassius delphius* Eversm. occur at elevations ranging from 5330 m. to nearly 5800 m., all above the permanent snow line. *Parnassius simo zarrensis* (Bang-Haas) and *Parnassius stoliczkanus stoliczkanus* Bang-Haas ascend up to nearly 5600 m. *Colias leechi* Gr.-Gr. and *Colias stoliczkanus* Moore both occur at elevations higher than 5600 m. Numerous Collembola like *Friesea excelsa* Denis (5500 m.) and *Orchesellides boraoi* Bonet (5200-5600 m.) also belong to the areas above the permanent snow line. The distribution of these species above the permanent snow line is confined to nunataks (*vide infra*). The permanent snow line on the different mountain ranges of the NW. Himalaya seems to greatly influence the abundance and extent of the seasonal snow cover which, as discussed in an earlier paper (100), is an important favourable factor for the distribution of most species of nival insects. The permanent snow line on the different mountain ranges thus exerts a profound influence on the abundance of species and the elevations at which they occur. Most species ascend higher where the permanent snow line is high. The wealth of species is however distinctly large where the permanent snow line is relatively low. We have, for example, a much larger concentration of species at elevations on the Ladakh Range (permanent snow line 5640 m. on the north slope and 5790 m. on the south slope) than on the Zaskar Range (permanent snow line above 6000 m. on the south slope and 5940 m. on the north slope). The south slopes of the Karakorum, drained by the River Indus, with the permanent snow line at about 5640 m., are the areas of the distribution of much larger numbers of species than the Zaskar Range. The minor fluctuations in the permanent snow line from year to year are generally reflected in similar fluctuations in the distributional pattern of the species immediately above and below.

Geology. As is well known, geologists generally recognize three more or less distinct stratigraphical zones. The northern or the so-called Tibetan stratigraphical zone lies mostly to the north of the main crest line of the Great Himalaya and comprises continuous series of marine fossiliferous sedimentary rocks ranging from the Palaeozoic Era to the Eocene. A central Himalayan zone of crystalline and metamorphic rocks like granite, gneiss, schists, etc., often also with ancient unfossiliferous sedimentary rocks, comes next. We then have the so-called sub-Himalayan zone comprising mostly the Upper Tertiary river sedimentaries and conglomerates (Figs. 52, 53). The geological characters

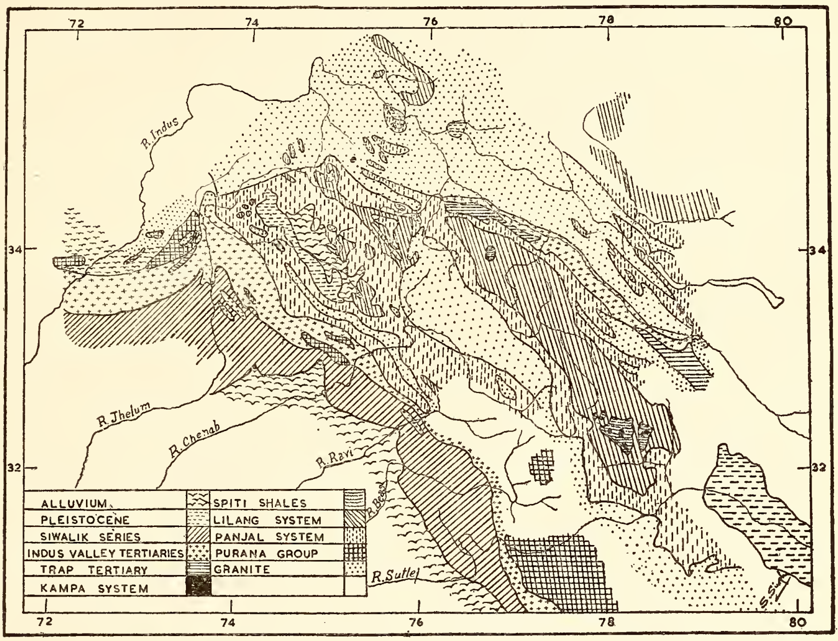


Fig. 52. Geological map of the region of the NW. Himalaya. (*After Burrard & Hayden*,'18)

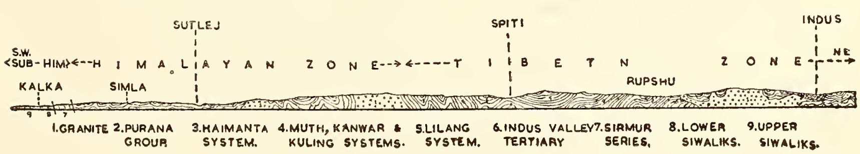


Fig. 53. Diagrammatic section of south-north through the region of the NW. Himalaya, showing the general geological structure.

of the substratum are likely to influence the distribution of a number of species through their action as limiting factors on the distribution of their larval food plants. The marine sedimentary strata north of the crest line of the Great Himalaya, with the typically arid *Artemisia*-steppes, are, for example, characterized by a remarkable community of species, which are, as far as is known at present, apparently confined wholly to these areas. Both the Indo-Malayan and the Mediterranean faunal elements also appear to be more or less restricted to the Indus Valley shales and the Spiti shales. The relation between the distribution of the nival insects and the geological peculiarities of the NW. Himalaya is discussed further below.

Pleistocene Glaciations. The Pleistocene climatic changes are probably also at the back of the dominance of several typical nival groups like Diptera, Lepidoptera, and Coleoptera and the total or almost complete absence of others like Odonata (118). The large valley glaciers of the Pleistocene occupied the gorges and the valleys and remoulded them in many localities, transported large boulders and other erratics, and profoundly altered the general topography of the region and thus indirectly influenced the spread of most species. The effects of the Pleistocene glaciations on the nival insect fauna from the NW. Himalaya are referred to again further below.

VI. Faunal Sub-Divisions

The analysis of the distribution of the endemites and of the concentrations of species in general, presented in the foregoing sections, shows an unmistakable tricentric pattern. There are three general centres of species endemism and massing of species, coincident with the three major drainage areas and separated from each other by more or less well-marked water partings. The main water parting largely coincides with the main crest line of the Great Himalaya Range.[1] To the north of this is the vast area drained by the River Indus. South of the main crest line of the Great Himalaya we have the areas drained by two distinct systems, separated by another water parting, viz. the Chenab-Beas system (including Ravi River) in the east and the River Jhelum in the west. The three chief drainage areas constitute also three natural faunal sub-divisions or faunal provinces of the NW. Himalaya (Fig. 54). The nival insect fauna have apparently had different histories in the three provinces.

The Indus province includes the mountain ranges drained mainly by the River Indus in its upper reaches, before turning south near Bunji, viz. the north slopes of the Great Himalaya, the Ladakh Range, the Zaskar Range, parts of the Karakorum and Kailas ranges. The whole of Ladakh, Baltistan, Zaskar, Rupshu, northern parts of Kashmir in the area of Nanga Parbat, Deosi, and parts of Gilgit are within the Indus faunal province. Its boundaries are defined in the north by the main crest line of the Karakorum and in the south by the main crest line of the Great Himalaya, from the Shipki Pass in the area drained by River Sutlej on the India-Tibet border in the east and stretching north-westward to

[1]The water parting lies north of the crest line of the main range in the portion of the Himalaya east of River Sutlej; it is only in the NW. Himalaya that the water parting and the crest line coincide, so that none of the rivers cut across the main range from the north, but run parallel to it for great distances.

the River Indus after its Bunji bend to the south, to the north-west of Nanga Parbat. This faunal province contains the maximum number of high peaks and present-day glaciers and also the largest number of areas which were more or less heavily glaciated during the Pleistocene. The

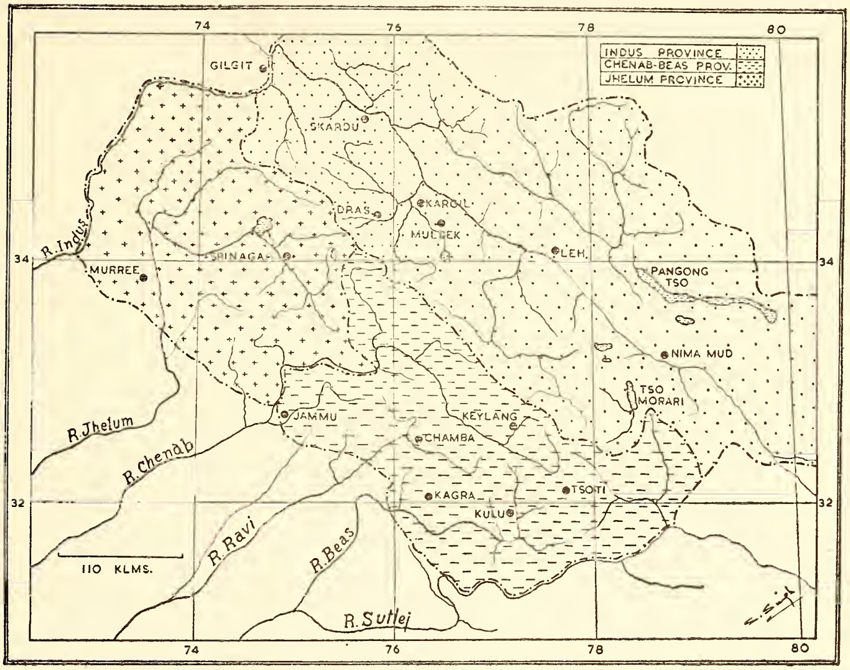


Fig. 54. The faunal sub-divisions of the region of the NW. Himalaya. The three faunal provinces coincide with the three natural drainage areas.

Indus province is also more arid than the Chenab-Beas and the Jhelum faunal provinces. Nearly 240 species have been collected from about 100 localities in the Indus province. The Chenab-Beas faunal province comprises the mountain ranges drained by the rivers Beas, Ravi, Chenab, and partly also the Sutlej, viz. the southern slopes of the Great Himalaya Range, the Great Pir Panjal Range, and the Dhaula Dhar. Lahaul, Spiti, Kulu, Kangra, Mandi, and Chamba are within the limits of this faunal province. The crest line of the Great Himalaya demarcates the northern boundary and in the west the water parting between the Jhelum and Wadhwan (a tributary of Chenab River) to Kishtwar. There are fewer high peaks than in the Indus faunal province and also fewer and shorter glaciers. Atmospheric aridity is high but not so high as that of the Indus province. The general elevation is high in the east and shows a general tendency to diminish in the west. Nearly 150 species have been collected so far from about 60 localities in this faunal province. The Jhelum faunal province contains the areas drained by the River Jhelum and its tributaries, viz. the western parts of the south slopes of the Great Himalaya, the western end of the Pir Panjal, Kashmir Valley, and parts of Pakistan. The number of high peaks and glaciers is lowest as also the general elevation. Aridity is least marked in the whole region. About 160 species have come from about 30 localities.

The percentages of the nival species of the different orders and their faunal component elements in the three faunal provinces are summarized in tables XI and XII respectively.

TABLE XI

Analysis of the percentage abundance of species in different orders in the three faunal provinces

Serial No.	Order	Total species	Indus Prov.	Chenab-Beas Prov.	Jhelum Prov.
1	Plecoptera	5	—	100.0	—
2	Odonata	4	—	25.0	75.0
3	Orthoptera	14	46.1	7.6	46.1
4	Dermaptera	3	33.3	66.6	33.3
5	Heteroptera	17	94.1	5.8	—
6	Homoptera	1	100.0	—	—
7	Coleoptera	187	53.0	33.0	49.0
8	Hymenoptera	36	75.0	28.1	15.6
9	Neuroptera	1	100.0	—	—
10	Trichoptera	11	54.0	9.0	63.7
11	Lepidoptera	91	76.0	36.2	37.3
12	Diptera	7	57.1	—	57.1
13	Thysanura	3	100.0	—	—
14	Collembola	15	60.0	40.0	6.6

Note.—The percentages are calculated out of the total species of the order in the NW. Himalaya ; in the case of Hymenoptera the percentages are out of only 32 species, because the exact distribution of the 4 remaining species is not known at present.

TABLE XII

Analysis of the faunal elements in the three faunal provinces

Serial No.	Province	Total species	Autochthone %	Palaearctic Total %	Palaearctic Medit. %	Indo-Malayan %
1	Indus	240	42.6	97.0	4.0	2.0
2	Chenab-Beas	121	26.0	97.0	58.0	3.0
3	Jhelum	155	22.0	95.0	5.0	5.0

Note.—The percentages are out of total species from the province, except in the case of the Mediterranean elements, where it is out of the total Palaearctic of the province.

A reference to Table XII will show that the largest number of autochthone species is found in the Indus province, in other words the species endemism is here at the maximum. There are as many as 102 endemites (47%) and about 60 non-endemites on the mountains drained by the River Indus. The Indus province is also a region of maximum localized concentrations of nival species. Among Coleoptera nearly 54% of the nival Carabidae, 86% of Hydrophilidae, the whole of Tenebrionidae, and about 70% of Chrysomelidae are found in the province. About 75% of the Bombidae and 92% of the Formicidae are Hymenoptera of the Indus province. In Lepidoptera, it is interesting to observe that the percentage of species in the major families is similarly high, viz. Papilionidae 71%, Pieridae 95%, and Nymphalidae 63%. Almost all the central-Asian elements so far known from the NW. Himalaya occur in the Indus province. Localizations to the south of the crest line of the Great Himalaya in the Chenab-Beas province include about 32 endemites and 30 non-endemic species. In the Jhelum province we have about 37 endemites and 25 non-endemites. About 14% of the species found in the Indus province also occur in the Chenab-Beas province and about 28% in the Jhelum province. The percentage of the Indo-Malayan element is highest, viz. 5%, in the Jhelum province. The Mediterranean elements are high (8%) in the Chenab-Beas province. The Indo-Malayan and the Mediterranean elements are low (2% and 4% respectively) in the Indus province. The area of contact of the Indo-Malayan and the Palaearctic Realms thus appears to be situated between the crest lines of the Great Himalaya and the Pir Panjal ranges.

(*To be continued*)

On the Botany of Lucknow District[1]

BY

S. L. Kapoor

National Botanic Gardens, Lucknow

(*With a map*)

Synopsis

The present paper is a revision of Anderson's work (1859) on the flora of Lucknow District, Uttar Pradesh, and gives a comprehensive list of the plants of the district, both wild as well as commonly cultivated. In all 914 species have been recorded, of which 391 are additions to Anderson's catalogue. Salient notes on the location and topography of the district, soil, factors influencing the vegetation, and vegetation in general have also been given.

Important families met with in the area are, in order of dominance, Gramineae, Leguminosae, Compositae, Cyperaceae, Euphorbiaceae, Acanthaceae, Convolvulaceae, Scrophulariaceae, Amaranthaceae, Labiatae, Malvaceae, and Polygonaceae. The flora of the district can be styled as agrarian with an introduced flora of considerable amount and a large number of truly cultivated species. As indicated by the climatic conditions, the tropical element is dominant. There are practically no natural formations, as the trees have been cut and the forests removed in the past by growing population.

Introduction

Anderson, an Assistant Surgeon in the garrison at Fort William about the middle of the 19th century, published his paper 'Notes on the flora of Lucknow with catalogues of the cultivated and indigenous plants' in the year 1859, which seems to be the only work on the flora of Lucknow, besides the recently published bulletin on the economic plants of Lucknow by the National Botanic Gardens and Patil's list (1960) of common grasses with a key to the genera. After Anderson's work no worthwhile detailed study appears to have been made to sup-

[1] Communicated by the Director, National Botanic Gardens, Lucknow.

plement his list. Duthie (1903-1929), in FLORA OF THE UPPER GANGETIC PLAIN, includes very few species from Lucknow.

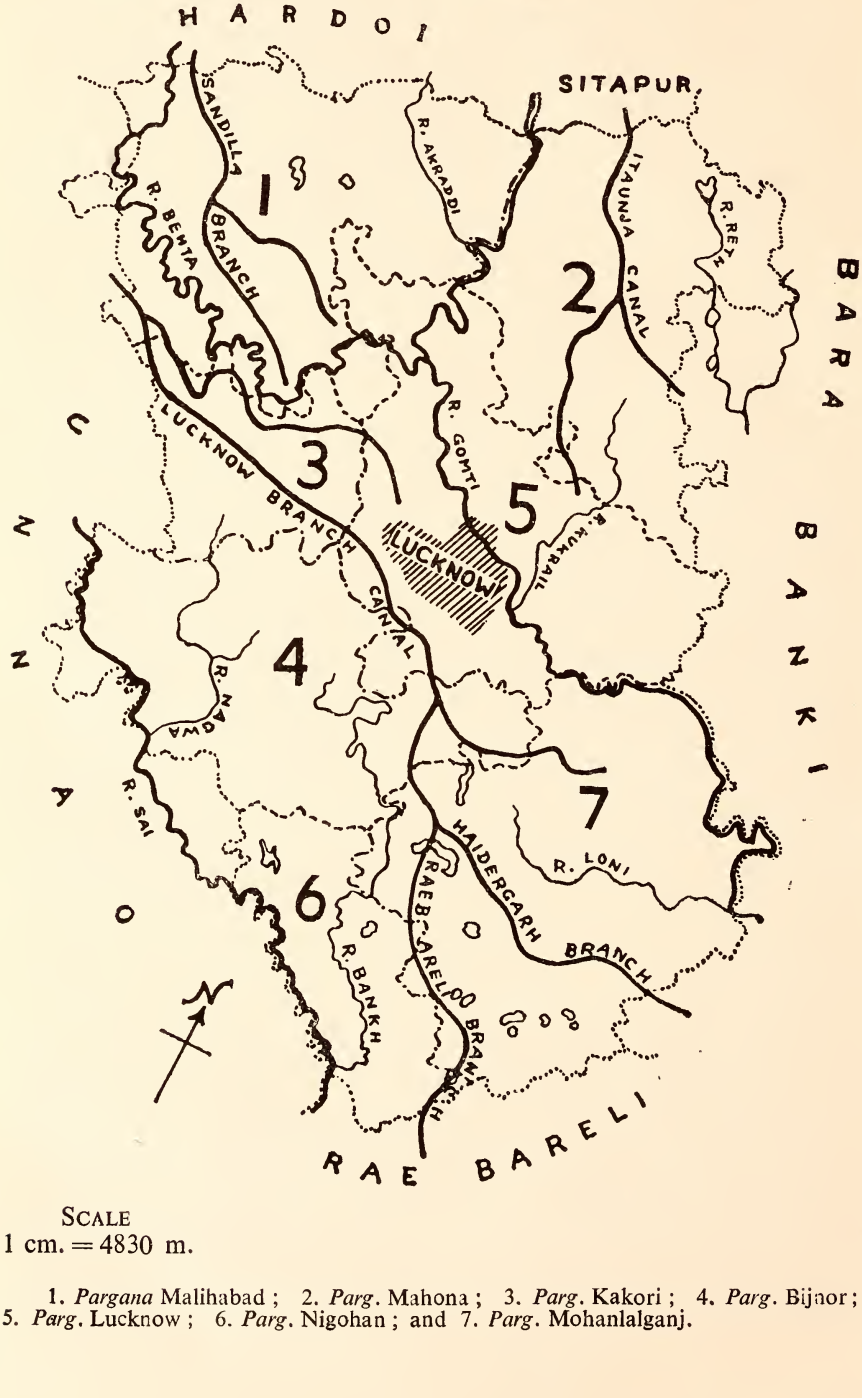
Anderson could not publish a complete list ; as he explains : ' my list is not so complete as it might be, for, as my original collections were lost during the mutinies, it has been compiled from a set of duplicates I sent to Dr. Thomson, and from a small collection I made, while on service at Lucknow last year '. Again he could not give any climatological data as his records of meteorological observations ' were destroyed during the mutinies of 1857 '. It has been difficult to ascertain the actual boundaries of the district at the time Anderson made his collections, for the first recorded settlement took place only during 1862-71 (LUCKNOW GAZETTEER, 1958). At that time the *parganas* of Kursi and Dewa on the north and north-east, and Auras-Mohan on the south-west were transferred to the districts of Barabanki and Unnao respectively. Since then the boundaries of the district have remained unchanged.

Considering the above mentioned facts it appeared quite desirable for some worker in the field to study the flora of Lucknow in detail. Even otherwise the flora of a region normally requires reinvestigation after a period of 25 years as there can be introduction of a large number of species and the disappearance of many, besides the nomenclatural changes. Santapau (1956)[1] has emphasized the importance of local floras when he observed : ' The area to be selected for botanical exploration should not be too big ; . . . I would recommend that an area about 10 miles in diameter . . . be taken as first object of exploration ; . . . the area may then be expanded . . . , and thus gradually the whole of India may be finally covered by the research workers . . . ' Thus there is a great need to have detailed district-wise floras. The author has, therefore, attempted here a comprehensive list of the plants of Lncknow together with notes on location and topography, factors influencing thc vegetation, and vegetation in general. The list is based on the author's observations spread over a period of five years during which he worked out the Weed Flora of the National Botanic Gardens also, supplemented with the specimens lodged at the herbarium of the National Botanic Gardens, Lucknow.

Location. The district of Lucknow lies between 26° 30′ – 27° 10′ N. and 80° 30′ – 81° 13′ E. It is bounded on the north by the district of Sitapur, on the south by that of Rae Bareli, on the east by that of Barabanki, on the north-west by the district of Hardoi and on the south-west by that of Unnao. The river Sai forms the only natural boundary for a short distance on the south and south-west. It is an irregular quadrilateral with an average length of 72.5 kilometres (45 miles) and an

[1] The Botanical Exploration of India (Presidential Address delivered at the 35th Annual Meeting of the Indian Botanical Society held at Agra in January 1956). *J. Indian bot. Soc.* 35 : 4-5.

average breadth of 40.3 kilometres (25 miles), the city and cantonment of Lucknow being situated almost in the centre. The area of the district



SCALE
1 cm. = 4830 m.

1. *Pargana* Malihabad ; 2. *Parg*. Mahona ; 3. *Parg*. Kakori ; 4. *Parg*. Bijnor ; 5. *Parg*. Lucknow ; 6. *Parg*. Nigohan ; and 7. *Parg*. Mohanlalganj.

is 624,900 acres (*c.* 253,700 hectares) (being worked out by the Survey of India according to LUCKNOW GAZETTEER). It is the smallest district in Uttar Pradesh with the exception of the district of Rampur.

Topography. The district falls in the main Gangetic Plain of Uttar Pradesh. It is almost level except for some deep ravines caused by the rivers and rivulets. There could be three natural divisions, viz. the Gomti basin, the Sai and its catchment area, and the central upland on the higher watershed, running from the north-west to the south-east.

The Gomti basin has Gomti River meandering and forming a deep bed with high banks that are cut up at places by ravines or rivulets that join the river. It includes parts of the *pargana* of Malihabad on its right, those of Mahona on its left, the central portion of Lucknow *tahsil* and the north-eastern part of *tahsil* Mohanlalganj. The valley of the river is alternately narrow and wide and the banks may be steep, sloping, or almost at the level of the river. At places there may be moist *tarai* or *khadir* land between the two banks formed from silt deposited by floods. This *tarai* land is very fertile and, if free from the floods of the river, yields good crops. The high banks of the river Gomti consist either of wide tracts of undulating sand or raised ridges of rugged ground from which the soil has been washed and cut away by the rains. These sandy dunes are fit for nothing except the cultivation of poor crops of *bajra* or thatching grass. The light sandy soil in *parganas* Malihabad and Mahona is remarkable for excellent crops of melons for which Lucknow is so famous. The course of the tributaries of the Gomti is mostly marked by unculturable land abounding in beds of *kankar* and locally called *usar.*

The Sai and part of its catchment area lie to the south and south-east of the district and are characterized by the presence of large areas of alkaline lands or *usar.* The tracts of barren land extend sometimes for several miles and present practically no sign of vegetation excepting a few scrubby plants and some hardy species here and there. The bed of the river Sai is shallow in comparison with that of the river Gomti and the land on its banks is also less broken by ravines. The river has sandy tracts similar to those of the Gomti but the *tarai* of the river is very small extending over a few villages only.

The central upland, which forms the most fertile part of the district, lies between the Gomti basin and the Sai and its catchment-area.

The whole area is dotted with numerous depressions which dry up in hot weather, shrinking into small ponds containing about only 90 cm. depth of water ; during rains the level of water in these rises to as much as 4.5 m. or so. Among such important ditches or lakes is the Karaila *jhil* of Mohanlalganj, which is estimated to cover an area of about 320 hectares. The Hardoiya *jhil* has an area of about 80 hectares while the Sissendi *jhil* is a smaller one with an area of about 60 hectares. In *pargana* Bijnor, the only lake of any importance is the Khartola *jhil* with an area of about 20 hectares. Near Amausi there is another *jhil* called the Kusela *jhil* covering an area of about 200 hectares. The Kathauta *tal* of Chinhat and Moti *jhil* of Aishbagh are also important.

There is a gradual slope in the land of the district from the north and north-west to the south and south-east with an imperceptible fall of about 19.0 cm. per kilometre. At its extreme north near Mahona the level is 137 m. above the mean sea-level. At Alambagh which may be considered almost in the centre of the district near Lucknow, the altitude is 120 m. And at Nagram on the south-east it is only 113.3 m. above sea-level.

Soil.[1] In the *pargana* of Malihabad there runs a narrow irregular belt of light loam across the centre from the border of Hardoi up to the town of Malihabad. This portion of the *pargana* is drained by the small Akraddi and Jhingi streams. The west and centre of the *pargana* is occupied by a somewhat low-lying and ill-drained tract of stiffish loam with patches of *usar*. The extreme west and south of the *pargana* has a soil generally of light loam. The north-western part of *pargana* Mahona lies in the *tarai* of the river Gomti whereas the western centre has got a stretch of undulating sand. There is a narrow belt of *dumat* along the Sitapur road and flanking the *tarai* and *bhur* soils. Further towards the south-east along the metalled road to Kursi there are *usar* lands with patches of *reh*. The land in the north-east is covered with clay. In the *tahsil* of Mohanlalganj the tracts along the river Gomti in the north-east are characterized by *bhur*. The soil in the neighbourhood of the river Bakh, a tributary of the river Sai, is generally a loam of fair quality, changing into sandy *bhur* as it approaches the river Sai. The rest of the Mohanlalganj *tahsil* consists of an extensive *matiyar* plain which is suitable for rice cultivation. The north-central tract, however, consists of *dumat* soil. In addition to these there exist some *tarai* areas, which are mostly inferior, along the Gomti and the Sai. The watersheds of the rivers Gomti and Sai are seldom well defined and frequently stretches of low-lying, ill-drained land are found in which the water collects to form large *jhils* and where *usar* has been formed as the result of saturation. In the *pargana* of Lucknow the upland overlooking the Gomti and its tributaries is sandy, while further inland there are villages on either side of the river possessing fertile loam of a better texture. In the extreme west and south of the district flows the river Behta, whose course is characterized by ravines and inferior sandy soil with numerous reefs of *kankar*. South

---

[1] *dumat* (or loam), a mixture of *matiyar* and *bhur* in various proportions ; *matiyar* (or clayey soil) contains compounds of silica and alumina, iron, potash, soda, and other substances ; *bhur* (sandy soil).

of Malihabad, in the *pragana* Kakori, the area north of Ghazi-ud-din Haider Canal has a soil of a fair light loam. In the southern area of the canal and also in the extreme south of *pargana* Lucknow the soil is stiffish heavy loam with vast shallow depressions. In the *pargana* of Lucknow most of the central portion has *matiyar* soil. Here the cultivation of rice is important. The north-eastern part comprising the Gomti region has a fair light loam degenerating into sand on the slopes of ravines and on the edge of the high banks of the Gomti.

The district of Lucknow forms a portion of the Indo-Gangetic plain formed by the deposits of the rivers laid in the post-tertiary period. The geology of the district exposes nothing but the ordinary Gangetic alluvium. The nature and depth of this alluvium shows coarse sand and sandy silt with occasional beds of clay and *kankar*. Apart from *kankar*, brick earth and marl beds occur in various parts of the district.

Factors determining the Vegetation of the District[1]

Climatic Factors

Rainfall. The average annual rainfall is 953.2 mm., as indicated in Table 1.

From the table it will be seen that 88.6% of the annual rainfall occurs during the four monsoon months, viz. June, July, August, and September. The month of October receives only 3.4% of rain while March, April, and May together receive only 3.2% of the annual rainfall. The cold months of November, December, January, and February receive together 4.7% of the annual rainfall only. July and August are the rainiest months of the year receiving 30.3% and 28.7% of rain respectively.

The number of rainy days varies from month to month (see Table 1).

During the monsoon months the rains may at times be torrential, at times gentle, and may last for one or more days. The intense heat and drought of the days bakes hard the soil and wherever the drainage has been established the violent rains quickly run off. Consequently under such conditions erosion is heavy and the soil is wet only to a slight depth. The water may get stored up in shallow depressions to form seasonal lakes.

Large variations in rainfall from year to year are not infrequent. Table 2 illustrates the annual variations.

---

[1] Dudgeon's paper on the ecology of the Upper Gangetic plain has formed the basis for this discussion.

TABLE 1[1]

Months	Rainfall in mm.	Percentage of rainfall	Mean no. of rainy days	Mean daily max. temp. in °C.	Mean daily min. temp. in °C.	Mean range of temp. in °C.	Highest max. temp. recorded in °C.	Lowest min. temp. recorded in °C.	R. H. in % at 8.00 hours	R. H. in % at 17.00 hours	Average R. H. in %	Range in R. H.
January ..	17.6	1.8%	1.5	23.4	8.4	15.0	30.2	1.67	81	47	64	34
February ..	15.5	1.6%	1.6	25.9	10.8	15.1	35.0	1.67	71	43	57	28
March ..	8.4	0.9%	0.9	32.7	15.9	16.8	41.2	7.22	51	25	38	26
April ..	5.3	0.6%	0.6	38.6	21.6	17.0	45.6	12.75	39	19	29	20
May ..	16.5	1.7%	1.3	40.8	25.8	15.0	47.2	17.8	46	28	37	18
June ..	107.0	11.2%	5.5	39.0	27.7	11.3	48.9	13.9	64	51	57.5	13
July .	289.0	30.3%	13.4	33.6	26.4	7.2	45.6	22.2	82	75	78.5	7
August ..	273.0	28.7%	13.7	32.6	25.9	6.7	39.0	22.2	86	77	81.5	9
September ..	176.1	18.4%	7.9	33.4	24.8	8.6	39.2	17.8	82	71	76.5	11
October ..	32.2	3.4%	1.7	33.1	19.2	13.9	40.0	11.1	72	58	65	14
November ..	4.8	0.5%	0.4	28.9	12.3	16.6	34.5	5.55	73	52	62.5	21
December ..	7.8	0.8%	0.7	24.4	8.5	15.9	33.2	1.67	80	54	67	26
Over 12-month period	953.2		49.2	32.2	19.2							

[1] Meteorological observations have been taken from the DISTRICT GAZETTEER (1958).

TABLE 2

Year	Annual rainfall in mm.	Year	Annual rainfall in mm.
1933	650.0	1950	714.0
1934	1073.0	1951	542.0
1935	564.0	1952	840.0
1936	1618.0	1953	1263.0
1937	848.0	1954	1011.0
1947	1260.2	1955	1255.0
1948	1364.0	1956	855.0
1949	1240.0	1957	1032.0

The highest annual rainfall for Lucknow, during a period of 83 years ending 1951, was 1867 mm. in 1915, which is 196% of the normal. The lowest rainfall was 365.8 mm. in 1876, which is 38% of the normal. The heaviest rainfall in a day in the district did not exceed 330.2 mm. during the period from 1891-1920. As regards the frequency of the rainfall covering the years 1868-1950, 14% of the years recorded rainfall exceeding 125% of the normal and 18% of the years received rainfall less than 75% of the normal. 41% of the years had rainfall greater than normal.

Temperature. The climate of the district is distinctly continental. The nearest large body of water, the Bay of Bengal is more than 960 km. eastward. As a result of this the temperature exhibits a large range between day and night.

Table 1 shows the mean maximum and minimum monthly temperatures. The highest and the lowest temperatures ever recorded in the district are also given in the table based on observations from 1881 to 1940—as usual the temperatures have been recorded at a height of 1.22 m. (4 ft.) above the ground.

The table shows that the lowest mean daily maximum and minimum temperatures occur in January (23.4°C. and 8.4°C. respectively). February is slightly warmer, the maximum and minimum temperatures being 25.9°C. and 10.8°C. respectively. After this there is a rapid rise in both maximum and minimum temperatures up to June. As seen from the averages, May is the hottest month of the year with the temperatures ranging between 25.8°C. and 40.8°C., but the highest temperatures of the hot months are recorded in the month of June. The highest temperature recorded on any day within a period of 70 years is 48°C. and the lowest is 1.7°C. The data collected in recent years show that in the months April to June, the temperature may exceed 38°C. on an average of 3 to 6 hours daily. At this time the hot dry winds further aggravate the situation which is detrimental to plant life. From July to October the maximum temperature is almost constant while the minimum temperature gradually falls from 26.4°C. in July to 24.8°C. in September and then suddenly it falls to 19.2°C. in October. After this the fall in both maximum and minimum temperatures is rapid, reaching ultimately 24.4°C. and 8.5°C. respectively in the month of December.

Table 1 also shows that the daily range of temperature is large throughout most of the year. In the monsoon it reaches a minimum of 6.7°C. in August, whereas it rises to 17.0°C. during the month of April. The highest daily range of temperature may easily extend to 22°C. on individual days.

Humidity. Table 1 gives the mean monthly R. H. in per cent at two times of the day (the figures are based on observations from 1881 to 1940).

The abovementioned table shows that from 81% in January the R. H. falls rapidly to a minimum of 39% in April and then rises again to 86% in August. There is a slow fall in September to 82% and in October to 72% after which it again starts rising. It falls very rapidly to the minimum in April as there is a rapid rise in temperature and very scanty rain.

The daily humidity range is highest in the month of January and lowest in July. As a rule the range is great throughout the winter season and least throughout the rainy season ; during the hot season it is intermediate.

It may be pointed out that the month-wise figures of mean relative humidity give a very inadequate picture of the severe conditions to which plants are subjected in the hot season. For example, during April the mean values at 8.0 hrs. and 17.0 hrs. have been recorded as 39% and 19% respectively while there are many days when it falls as low as 10%.

During the rainy season the humidity is generally high and at all times very favourable for plants. During the cold season the highest mean maximum is 81% in January. The daily range is greatest during this period. There is a heavy fall of dew also at night. The humid nights permit the vegetation to recover from the drought of day. During the hot season, however, there is little opportunity for recovery following the extremely dry day and none but the most xerophytic of the herbaceous plants are able to survive during this difficult period.

Wind. Uttar Pradesh experiences NW. winds during the cold season, causing a winter monsoon. The wind during this period is mostly dry with only occasional slight precipitation. During May and June and sometimes even in April, there is a strong hot wind (*loo*) from NNW. which starts before 11.00 hours and continues till 17.00 hours or sometimes all the 24 hours of the day, exerting a powerful dessicating effect on vegetation so that practically no herbaceous vegetation is able to survive. Only those plants that are favourably situated with regard to water supply are protected from the dessicating effect of *loo*.

Climate and climatic seasons. From the foregoing it will be clearly seen that the climate is characteristically periodic like that of the whole of northern India, with its three well-marked seasons, viz. rainy, cold, and hot; corresponding to them are three distinct vegetational seasons. The district has a sub-tropical monsoon type of climate.

The rainy season begins about 20 June and lasts to the end of September or beginning of October. Sometimes, depending upon the monsoon from the Bay of Bengal, the rainy season may commence as early as the beginning of June or may be delayed as late as the first week of July. It is characterized by high rainfall, low insolation, high temperature, and high humidity. July and August may be taken as the typical months of the rainy season. In July the R. H. ranges from 75% to 82% and the temperature from 26.4°C. to 33.6°C.; in August R. H. from 77% to 86% and the temperature from 25.9°C. to 32.6°C. Such conditions are optimum for plant growth and therefore, a luxuriant herbaceous vegetation, springs up.

The rainy season gradually merges into the cold season which extends from early October to the end of February. It is characterized by low rainfall, high insolation, low temperature, and relatively high humidity. December and January may be selected as the typical months of the cold season. In December R. H. ranges from 54% to 80% and the temperature from 8.5°C. to 24.4°C.; in January R. H. from 47% to 81% and the temperature from 8.4°C. to 23.4°C. Such conditions result in a vegetation that is mesophytic comprising a large proportion of temperate plants.

The hot season extends from beginning of April to the end of June, the month of March being transitional. This season is characterized by low rainfall, high temperature, high insolation, low humidity, and strong winds. May is the typical month of the hot season with the R. H. ranging from 28% to 46% and the temperature from 25.8°C. to 40.8°C. The climatic conditions during summer months are distinctly xerophytic, with the result that the mesophytic vegetation of the cold season disappears and only those plants that are adapted to conditions of severe drought are able to survive. In some areas, where there is a sufficient supply of moisture, the mesophytic vegetation is also able to sustain itself forming a distinctly green cover.

Biotic Factors

Biotic factors are also quite responsible and important in shaping the vegetation of the district. In this connection it will be of interest to throw a glance at the growth of population in the district. From 1869 to 1951 the population of the district has increased from 7,78,195 to 11,28,101 in an area of 624,900 acres (*c.* 253,700 hectares) or from 1.2 per acre to 1.8 per acre. Besides the human population a large number of domestic grazing animals, like cattle and buffaloes, sheep and goats, and horses and donkeys, etc., interfere with the vegetation.

The influence on the vegetation due to increase in human population has resulted in extensive as well as intensive cultivation, as also in grazing by animals and cutting down of plants for fodder and fuel.

Cultivation. Of the total area of the district 60.5% was under cultivation in 1956-57, whereas only 3.3% was covered with forest. Forests have been cut down. Wild plants have been uprooted and their place has been taken up by annual ruderals. Cultivation tends to make an area more and more xerophytic, as after the harvest of the crops the soil is left practically bare and dries up speedily. Of this Lucknow is a glaring example.

Grazing by animals. Because of increased domesticated animals the uncultivated land is subjected to progressive denudation, the effect of which becomes pronounced in the cold season. Ultimately during the hot summers all grasses and other associated plants are eaten down to the soil surface and the ground is left practically bare, exposing the earth to dry hot winds. Even sporadic thorny shrubs and small trees, with a few inedible exceptions, do not escape, as the animals which are very often subjected to famine conditions in summer browse upon them.

Cutting for fodder and fuel. Men indiscriminately lop off the tall woody shrubs and small trees and also the xeric grass covering the soil surface, rendering the dry earth further exposed to scorching heat and dessication. The trees planted along the roads are also no exception to this cruel treatment. This cutting for fuel has been responsible to a considerable extent for reducing the forest areas in the district of Lucknow.

Wild grazing animals are of no importance so far as Lucknow district is concerned. Earthworms are abundant during the rains and their burrows are of importance in promoting aeration and water penetration which is helpful in maintaining the vegetation.

Vegetation

It has already been stated that a major part of the district has been under cultivation from time immemorial and has practically no natural formations. There is evidence indeed to show that the district of Lucknow at one time had a considerable area under forests. As the population increased, the biotic factors became active and the area under forests diminished to practically nil. The total area under jungle (under trees or bushes) during 1901-1902 was reported to be about 30,000 hectares which dwindled down to 10,000 hectares in 1951-52, which is about 4.3% of the total area of the district and, as already stated, in 1956-57, only 3.3% was under forest cover. Kukrail Forests situated on both sides of the river Kukrail before it joins the river Gomti form a compact block of 2,043 hectares, reserved by the Government of U.P. recently. A large number of economically important plants have been introduced here and this afforestation will be beneficial in preventing soil-erosion although it may take years to transform the area into a rich and dense forest. Small areas of scrub jungles which might have been thick deciduous forests at one time may be seen in the *parganas* of Mohanlalganj, Mahona, and Malihabad.

The flora of the district can correctly be styled as agrarian with an introduced flora of considerable amount and with a large number of truly cultivated species. Many species indigenous to other parts of the country or belonging to foreign countries were planted in the past in local gardens. As these old gardens were abandoned the introduced plants continued to grow and spread as escapes throughout the area. Ultimately many of these plants have become completely naturalized, and have become well established within the area as wild plants. To these may be further added other widely spread species introduced by various foreigners from time to time. Thus the main constituents of the vegetation as seen in the forests of the district of Lucknow are : *Acacia arabica A. leucophloea*, *Adina cordifolia*, *Alangium salvifolium*, *Albizzia lebbeck*, *Azadirachta indica*, *Butea monosperma*, *Capparis decidua*, *C. sepiaria*, *C. zeylanica*, *Carissa spinarum*, *Casearia tomentosa*, *Clerodendrum phlomoides*, *Cordia dichotoma*, *C. rothii*, *Diospyros montana*, *Ehretia laevis*, *Ficus hispida*, *Flacourtia indica*, *Gardenia turgida*, *Gmelina arborea*, *Mitragyna parvifolia*, *Oroxylum indicum*, *Phoenix sylvestris*, *Randia dumetorum*, *Stereospermum personatum*, *Streblus asper*, *Zizyphus mauritiana*, *Z. nummularia*, *Z. oenoplia*, etc.

The common shrubby elements which are found dispersed throughout the area are : *Adhatoda vasica*, *Calotropis procera*, *Datura innoxia*, *D. metel*, *Jatropha gossypifolia*, *Lantana camara* var. *aculeata*, and *Pluchea lanceolata*.

The herbaceous vegetation is seasonal mostly either during the rains or during winter.

The common rainy season plants are: *Acalypha ciliata, Anisomeles indica, Borreria hispida, B. stricta, Cassia occidentalis, C. tora, Cleome icosandra, Commelina* spp., *Corchorus aestuans, Cyperus* spp., *Euphorbia hirta, Fimbristylis* spp., *Gynandropsis gynandra, Indigofera enneaphylla, I. linifolia, Justicia* spp., *Leucas aspera, L. cephalotes, Malvastrum coromandelianum, Murdannia nudiflora, Oldenlandia* spp., *Peristrophe bicalyculata, Phyllanthus* spp., *Physalis minima, Rungia pectinata, Scirpus* spp., *Sida* spp., *Solanum nigrum, Tephrosia purpurea, Trianthema decandra, T. portulacastrum,* and scores of other species, and many grasses.

The common winter season herbs, a large number of which occur as common weeds also, are: *Ageratum conyzoides, Amaranthus gracilis, A. spinosus, Anagallis arvensis, Argemone mexicana, Blainvillea acmella, Blumea* spp., *Chenopodium album, C. murale, Conyza aegyptiaca, Coronopus didymus, Crotalaria medicaginea* var. *luxurians, Eclipta prostrata, Euphorbia hirta, E. thymifolia, Fleurya interrupta, Fumaria indica, Gnaphalium indicum, G. purpureum, Launaea nudicaulis, Lindernia ciliata, L. crustacea, Mazus japonicus, Melilotus alba, M. indica, Portulaca oleracea, Potentilla supina, Ranunculus sceleratus, Salvia plebeia, Scoparia dulcis, Spergula arvensis, Stellaria media, Tribulus terrestris, Vernonia cinerea, Veronica agrestis,* etc.

The common species in and around the lakes and ponds are: *Aeschynomene aspera, A. indica, Aponogeton crispum, A. monostachyon, Azolla pinnata, Bacopa monniera, Ceratophyllum demersum, Eichhornia crassipes, Eriocaulon sieboldianum, Hydrilla verticillata, Hygroryza aristata, Ipomoea aquatica, Jussieua repens, J. suffruticosa, Lagarosiphon alteranifolius, Lemna polyrrhiza, Monochoria vaginalis, Nelumbo nucifera, Neptunia oleracea, Nymphaea* spp., *Nymphoides cristatum, N. indicum, Ottelia alismoides, Pistia stratiotes, Potamogeton crispus, P. pectinatus, Sagittaria guayanensis, S. sagittifolia, Typha angustata, Utricularia flexuosa, U. stellaris, Vallisneria spiralis, Wolffia arrhiza, Zannichellia palustris,* etc.

The insectivorous plants of the district of Lucknow are: *Utricularia flexuosa* and *U. stellaris,* which can be collected from Chinhat and other lakes.

The important parasitic plants of the district are: *Cuscuta reflexa, Dendrophthöe falcata, Striga euphrasioides,* and *Orobanche indica.*

Common roadside trees of the district are: *Albizzia lebbeck, Azadirachta indica, Cassia fistula,* and other *Cassia* spp., *Dalbergia sissoo, Delonix regia, Emblica officinalis, Ficus benghalensis, F. glomerata, F. lacor, F. religiosa, Holoptelea integrifolia, Madhuca indica, Mangifera* *indica*, *Pterospermum acerifolium*, *Schleichera oleosa*, *Syzygium cumini*, and *Tamarindus indica*.

Plants commonly planted near the temples are : *Hibiscus rosa-sinensis*, *Jasminum multiflorum*, *J. sambac*, *Lochnera rosea*, *Mirabilis jalapa*, *Nerium indicum*, *Nyctanthes arbor-tristis*, *Rosa* spp., *Tabernaemontana coronaria*, *Tagetes erecta*, and *Thevetia peruviana*.

The orchard trees in the district are mainly mango, guava, *jamun*, and *litchi*. The *dassehri* and *safeda* varieties of the mangoes of Lucknow are famous and the former are exported to earn foreign exchange. The other famous fruit of Lucknow is *kharbooza* (melon) which is thin-skinned and has no rival in softness and sweetness.

Important plants of medicinal value found in Lucknow are *Adhatoda vasica* (*aroosa*), *Andrographis paniculata* (*kalmegh*), *Azadirachta indica* (*neem*), *Boerhavia diffusa* (*punarnava*), *Centella asiatica* (*brahmi*), *Cissampelos pareira* (*ambashtha; parhee*), *Cocculus hirsutus* (*chhimta*; *jamti-ki-bel*), *Curculigo orchioides* (*musli*), *Dioscorea* spp. (*ratalu* and its forms), *Hemidesmus indicus* (*anantmool*), *Ocimum* spp. (*tulsi* and its forms), *Pedalium murex* (*bada-gokhru*), *Piper longum* (*pipli*), *Rauwolfia serpentina* (*sarpgandha*; *dhamarbarua*; *chhota chand*), *Tinospora cordifolia* (*gurch*), *Tribulus terrestris* (*chhota-gokhru*), etc.

Some of the species reported by Anderson as indigenous to the area have very meagre chances of occurring in Lucknow. These are : *Nasturtium palustre* DC.* (it is a temperate species), *Malva rotundifolia* Linn.* (it occurs in N.W.P., Kumaon, Sindh, Bengal, and Mysore), *Trigonella* sp. (?)*, *Ammannia octandra* Linn.* (it is distributed in the Deccan, Ceylon, Chittagong, and Malaya), *Myriophyllum spicatum* Linn.* (it is found in Kashmir and Kumaon), *Blumea hieracifolia* DC. (Duthie has reported it doubtfully from the region of Upper Gangetic Plain), *Cirsium wallichii* DC. (=*Cnicus wallichii* Hk. f.; it is a Himalayan species, also occurring in the Nilgiri Hills; a variety of this species has been reported to occur at Dehra Dun), *Carissa edulis* Vahl* (not in F.B.I.), *Cynoglossum furcatum* Wall.*, *Ipomoea cymosa* R. & S.* [=*Merremia umbellata* (Linn.) Hall. f.], *Leucas zeylanica* R. Br.* (it occurs only in Assam, Cachar, and Chittagong), *Desmochaeta atropurpurea* DC. * (=*Pupalia atropurpurea* Moq.; it is found in Nepal, Bengal, and the Deccan), *Chenopodium hybridum* Linn.* (it is a temperate species occurring in Ladakh etc.), *Rumex acutus* Roxb. (= *R. maritimus* Linn.; included by Duthie in his FLORA doubtfully), *Chrozophora tinctoria* A. Juss.* (it occurs in the Punjab, Sindh, and Deccan), *Euphorbia helioscopia* Linn.* (it is found in the Punjab and Western Himalaya and also introduced in the Nilgiris), *Isolepis squamosa* (?)*,

* Not reported in Duthie's FLORA OF UPPER GANGETIC PLAIN, besides the species of Gramineae.

Crypsis schoenoides Lam. (it occurs in the Punjab, W. Tibet, Sikkim, and Kashmir), *Phalaris canariensis* Linn. (J. D. Hooker says in F.B.I.: 'is given as a N.W. India Grass by Duthie and others, but I have seen no specimens ; it closely resembles *P. minor*, differing in the quite entire wings of the gls.' It is found in North Africa and Europe. *P. canariensis* Wall. is a synonym of *P. minor* Retz. and this species has been included in my list), *Alopecurus agrestis* Linn. (= *A. myosuroides* Huds.; it occurs in temperate and subtropical Himalayas and in Khasia Hills), and *Eragrostis interrupta* Nees (?).

The probability of the occurrence of the following species, reported by Anderson as indigenous to Lucknow, cannot be ruled out, though they have not been included in the present list as they have not been spotted by the author himself : *Tamarix gallica* Linn., *Waltheria indica* Linn., *Corchorus depressus* Linn. (= *C. antichorus* Roeusch.), *C. trilocularis* Linn., *Glycosmis pentaphylla* Corr., *Ameletia indica* DC. (= *Ammannia peploides* Spreng.), *Ammannia pentandra* Roxb., *A. rotundifolia* Buch.-Ham., *Vahlia viscosa* Roxb., *Blumea aurita* DC. (= *Laggera aurita* Schult.-Bip.), *Matricaria chamomilla* Linn., *Glossogyne pinnatifida* DC., *Machlis hemisphaerica* DC. (= *Cotula hemisphaerica* Wall.), *Erythraea roxburghii* Don, *Hydrolea zeylanica* Vahl, *Ehretia aspera* Roxb., *Solanum verbascifolium* Linn., *Herpestis hamiltoniana* Benth. [= *Bacopa hamiltoniana* (Benth.) Wettst.], *Bonnaya veronicaefolia* Spreng. (Syn. *B. verbenaefolia* Spreng.), *Verbascum thapsus* Linn., *Amaranthus tenuifolius* Willd., *Aerva javanica* Juss. [= *A. javanica* (Burm. f.) Spreng.], *Typha elephantina* Roxb., *Potamogeton indicus* Roxb., *Eriocaulon quinquangulare* Linn., *Carex wallichianus* Presc., *Eleocharis palustris* R. Br., *Mariscus dilutus* Nees (= *M. microcephalus* Presl.), *Panicum umbrosum* Retz. [= *Brachiaria reptans* (Linn.) Gard. & Hubb.], *Digitaria sanguinalis* Scop., *Aristida setacea* Retz., and *Eragrostis koenigii* [= *E. interrupta* (Lamk.) Beauv.].

Isöetes sp., *Ophioglossum reticulatum* L., *Azolla pinnata* R. Br., *Marsilea quadrifolia* Linn., and *Equisetum debile* Roxb. have also been collected from Lucknow, of which the third and fourth have been reported by Anderson also. *Equisetum arvense* L. included in Anderson's catalogue may also be found. The species of *Algae* as reported by Saxena (1960) have been excluded.

Of the 914 species of Phanerogams enumerated in the list, 391 are new to Anderson's catalogues.

A botanical survey of Lucknow District reveals that in order of dominance the first ten positions for the families are : Gramineae, Leguminosae, Compositae, Cyperaceae, Euphorbiaceae, Acanthaceae, Convolvulaceae, Scrophulariaceae and Amaranthaceae, Labiatae, and Malvaceae and Polygonaceae. This compares well with the position in Gangetic Plain where the order of dominance is: Leguminosae, Gramineae, Compositae, Cyperaceae, Euphorbiaceae, Acanthaceae, Urticaceae, Malvaceae, Rubiaceae, and Labiatae.

Acknowledgements

The author is grateful to Prof. K. N. Kaul for facilities for work. Thanks are also due to Sri Hira Lal Yadav, National Botanic Gardens, Lucknow, for helping the author during the identification of specimens.

SYSTEMATIC ENUMERATION OF PLANTS

The arrangement of the families is practically in the same order as in Hooker's F.B.I. Raizada's papers on name changes and volumes of WEALTH OF INDIA, RAW MATERIALS have been consulted in order to give the most up-to-date name. INDEX KEWENSIS has helped in tracing out Anderson's old synonyms. The symbols used are * for specimens not recorded by Anderson, and + for specimens cultivated. The species of grasses reported from Lucknow recently by Patil are marked †. The second name in brackets under a species is the synonym used by Anderson.

Ranunculaceae

Delphinium ajacis Linn.+

Nigella sativa Linn. +*

Ranunculus sceleratus Linn.

Magnoliaceae

Michelia champaca Linn.+

Annonaceae

Annona reticulata Linn.+

A. squamosa Linn.+

Miliusa velutina Hook. f. et T.*

Polyalthia longifolia Benth. et Hook. f.+
(*Gautteria longifolia* Wall.)

Menispermaceae

Cissampelos pareira Linn.

Cocculus hirsutus (Linn.) Diels.
(*Cocculus villosus* DC.)

Tiliacora acuminata Miers.*

Tinospora cordifolia Miers.

Nymphaeaceae

Nelumbo nucifera Gaertn.
(*Nelumbium speciosum* Willd.)

Nymphaea pubescens Willd.
(*Nymphaea lotus* auct.)

N. stellata Willd.

Papaveraceae

Argemone mexicana Linn.

Papaver rhoeas Linn.+

P. dubium Linn. +
Not seen by the author.

P. somniferum Linn.+

Fumariaceae

Fumaria indica Pugsley
(*F. parviflora* Lam. var. *vaillantii*)

Cruciferae

Brassica campestris Linn.
var. **sarson** Prain +*
B. juncea Czern. et Coss. +
(*Sinapis juncea* Linn.)
Reported by Anderson as cultivated and indigenous both ; it is seen growing as escape.
B. napus Linn. +
B. oleracea Linn. var.
botrytis Linn.+
B. oleracea Linn. var.
capitata Linn.+
Capsella bursa-pastoris (Linn.) Moench.*
Cheiranthus cheiri Linn.+
Coronopus didymus Sm.*
Eruca sativa Mill. +
Lepidium sativum Linn.
Reported by Anderson as cultivated but it has now run wild.
Raphanus sativus Linn.+
Sisymbrium irio Linn.

Capparidaceae

Capparis decidua Edgew.
(*C. aphylla* Roth)
C. sepiaria Linn.*
C. zeylanica Linn.
(*C. horrida* Linn.)
Cleome icosandra Linn.
(*Polanisia viscosa* DC.)
Crataeva nurvala Buch.-Ham.*
Gynandropsis gynandra Briq.
(*G. pentaphylla* DC.)

Violaceae

Hybanthus enneaspermus F. Muell.
(*Ionidium suffruticosum* Ging.)

Flacourtiaceae

Flacourtia indica (Burm. f.) Merr.
(*F. sapida* Roxb.)

Polygalaceae

Polygala chinensis Linn.
(*P. arvensis* Willd.)
P. erioptera DC.
(*P. vahliana* DC.)

Caryophyllaceae

Arenaria serpyllifolia Linn.*
Dianthus chinensis Linn.+
Polycarpaea corymbosa Lamk.
Reported by Anderson under Paronychiaceae.
Polycarpon indicum (Retz.) Merr.
(*Hapalosia loeflingiae* Wall.)
Reported by Anderson under Paronychiaceae.
Saponaria vaccaria Linn.+
Reported by Anderson as indigenous ; has been seen growing as escape
Silene conoidea Linn.
Spergula arvensis Linn.*
S. pentandra Linn.
Stellaria media Cyrill.
(*S. media* Sm.)

Portulacaceae

Portulaca grandiflora Hook.+*
P. quadrifida Linn.
P. oleracea Linn.
P. tuberosa Roxb.*

Tamaricaceae

Tamarix articulata Vahl?*

T. dioica Roxb.*

Elatinaceae

Bergia ammannioides Roxb.

Malvaceae

Abelmoschus esculentus Moench+
A. moschatus Medic.+
Reported by Anderson as indigenous, though it is only cultivated and has often been seen growing as escape.
Abutilon indicum Sweet
Adansonia digitata Linn.+*
Althaea rosea Cav.+
Gossypium arboreum Linn.+*
G. herbaceum Linn.+
Hibiscus cannabinus Linn.+
H. lobatus O. Ktze.*
H. mutabilis Linn.+
H. rosa-sinensis Linn.+
H. sabdariffa Linn.+
Malvastrum coromandelianum Garcke*
Malva sylvestris Linn.+
M. verticillata Linn.*
Salmalia malabarica Schott. et Endl.
(*Bombax malabaricum* DC.)
Under Bombaceae in Anderson's catalogue.
Sida acuta Burm. f.
S. cordifolia Linn.
S. rhombifolia Linn.
(*S. retusa* L.)
S. spinosa Linn.*
S. veronicaefolia Lamk.
(*S. humilis* Willd.)
(*S. mysorensis* W. et A.)
Thespesia populnea Soland.+*
Urena lobata Linn.

Sterculiaceae

Guazuma ulmifolia Linn.*
Melochia corchorifolia Linn.
Pentapetes phoenicea Linn.+
Pterospermum acerifolium Willd.+*
P. semisaggitatum Ham.+*

Tiliaceae

Corchorus aestuans Linn.
(*C. acutangulus* Lam.)
C. capsularis Linn.
C. olitorius Linn.
C. tridens Linn.*
Grewia asiatica Linn.+
Has been seen growing as escape.
Triumfetta bartramia Linn.*
T. pentandra A. Rich.*
Duthie includes it from Lucknow.

Linaceae

Linum usitatissimum Linn.+
Reinwardtia trigyna Planch.+
(*Linum trigynum* Roxb.)
Anderson has reported it both as indigenous as well as cultivated but it is only cultivated.

Zygophyllaceae

Tribulus terrestris Linn.

Oxalidaceae

Averrhoa carambola Linn.+
Has been collected as apparently wild.
Biophytum sensitivum DC.*
Oxalis corniculata Linn.
O. latifolia H.B.K.
O. martiana Zucc.*

Balsaminaceae

Impatiens balsamina Linn.+

RUTACEAE

Aegle marmelos Corr.+
Reported by Anderson as indigenous.
Citrus aurantifolia Swingle+*
C. aurantium Linn.+
(*C. bergamia* Risso.)
C. limettioides Tanaka+
(*C. limetta* Risso.)
C. maxima Merrill+
(*C. decumana* L.)
C. medica Linn.+
C. paradisi Macf.+*
Feronia limonia Swingle+
(*F. elephantum* Corr.)
Reported by Anderson as indigenous.
Murraya koenigii Spreng.+
(*Bergera koenigii* L.)
M. paniculata Jack.+*
Ruta graveolens Linn. var.
angustifolia Hook. f.+
(*R. angustifolia* Pers.)

SIMARUBACEAE

Ailanthus excelsa Roxb.+
Balanites aegyptiaca Del.*

BURSERACEAE

Garuga pinnata Roxb.+*

MELIACEAE

Azadirachta indica A. Juss.
Also cultivated.
Melia azedarach Linn.+
M. sempervirens Roxb.+
Soymida febrifuga A. Juss.+*

CELASTRACEAE

Celastrus paniculatus Willd.*

RHAMNACEAE

Zizyphus mauritiana Lam.
(*Z. jujuba* Lam.)
Also cultivated.
Z. nummularia W. et A.*
Z. oenoplia Mill.
Z. vulgaris Linn.+
Now rarely cultivated.

AMPELIDACEAE

Ampelocissus latifolia Planch.*
Cayratia carnosa Gagnep.*
Cissus quadrangularis Linn.+*
Vitis tenuifolia W. et A.*
V. vinifera Linn.+

SAPINDACEAE

Cardiospermum halicacabum Linn.*
Dodonaea viscosa Jacq.+
Also seen as escape.
Litchi chinensis Sonner.+
(*Nephelium lichi* W. et A.)
Sapindus emarginatus Vahl
Also cultivated.
Schleichera oleosa Oken.+*

ANACARDIACEAE

Mangifera indica Linn.+

MORINGACEAE

Moringa oleifera Lam.
(*M. pterygosperma* Gaertn.)

Papilionaceae

Abrus precatorius Linn.
Aeschynomene aspera Linn.*
A. indica Linn.
Alhagi camelorum Fisch.
(*A. maurorum* Lour.)
Alysicarpus bupleurifolius DC.
A. monilifer DC.
A. rugosus DC.*
A. rugosus DC. var.
heyneanus Hk. f.*
A. vaginalis DC.
A. vaginalis DC. var.
nummularifolius Miq.
(*A. nummularifolius* DC.)
Arachis hypogaea Linn.+*
Butea monosperma Taub.
(*B. frondosa* Roxb.)
Cajanus cajan Millsp.+*
Also seen growing as escape.
Canavalia ensiformis DC.+
(*C. gladiata* DC.)
Cantharospermum scarabeoideum Bail.*
Cicer arietinum Linn.+
Clitoria ternatea Linn.+
Crotalaria chinensis Linn.*
C. juncea Linn.
Also cultivated.
C. medicaginea Lam.*
C. medicaginea Lam. var.
luxurians Baker
(*C. luxurians* Benth.)
C. medicaginea Lam. var.
neglecta Baker
(*C. neglecta* W. et A.)
C. mysorensis Roth
C. sericea Retz.
C. verrucosa Linn.*
Cyamopsis tetragonoloba Taub.+
(*C. psoraloides* DC.)
Reported as indigenous by Anderson.
Dalbergia sissoo Roxb.
Also cultivated.
Desmodium gangeticum DC.
D. gangeticum DC. var.
maculatum Hk. f.*
D. latifolium DC.
D. triflorum DC.
Dolichos lablab Linn.+
(*Lablab vulgare* Savi and *L. cultratum* DC.)
Erythrina suberosa Roxb.+*
E. variegata Linn. var.
orientalis Merr.+
(*E. indica* Lam.)
Heylandia latebrosa DC.
Indigofera cordifolia Heyne ex Roth*
I. enneaphylla Linn.
I. hirsuta Linn.
I. linifolia Retz.
I. tinctoria Linn.
Reported by Anderson both as cultivated as well as indigenous; now rarely cultivated.
I. viscosa Lamk.*
Lathyrus aphaca Linn.*
L. sativus Linn.
Reported by Anderson as cultivated; but it has now run wild.
L. sphaericus Retz.*
Lens culinaris Medic.+
(*Vicia lens*)
Medicago denticulata Willd.
M. lupulina Linn.
M. sativa DC.+
Melilotus alba Desr.
(*M. leucantha* Koch.)
M. indica All.
(*M. parviflora* Desf.)
Millettia ovalifolia Kurz +*
Mucuna capitata W. et A.+*
M. prurita Hook.
Also cultivated.
Phaseolus aconitifolius Jacq.
Reported by Anderson as cultivated, but it has now run wild.
P. lunatus Linn.+
P. mungo Linn.+
P. radiatus Linn.+
Pisum sativum Linn.+
Has been seen growing as escape.
Pongamia pinnata Pierre.+ *
Psoralea corylifolia Linn.
Also cultivated.
Rhynchosia capitata DC.*
R. minima DC.
(*R. medicaginea* DC.)
R. sericea Span.*
Sesbania bispinosa W. F. Wight
(*S. aculeata* Pers.)
S. grandiflora Poir.+*
S. paludosa Jacq. ex. DC.+ *

Sesbania sesban Merr.
(*S. aegyptiaca* Poir.)
Also cultivated.
Tephrosia pauciflora Grah.*
T. purpurea Pers.
T. tenuis Wall.*
T. villosa Pers.*
Teramnus labialis Spreng.
(*Glycine labialis* Linn.)
T. labialis Spreng. var.
mollis Bak.*
Trigonella foenum-graecum L. +
Also seen growing as escape.
T. occulta Del.*
Uraria picta Desv.
Vicia faba Linn.
V. hirsuta Gray
V. sativa Linn.
Reported by Anderson as cultivated; but it has now run wild.
Vigna catiang Walp. +
(*Dolichos sinensis* Linn.)
Zornia diphylla Pers.
(*Z. angustifolia* Sm.)

Caesalpiniaceae

Bauhinia racemosa Lam. +
(*B. parviflora* Vahl)
B. tomentosa Linn. + *
B. triandra Roxb. +
(*B. purpurea* Linn.)
B. variegata Linn.
Also cultivated ; a white flowered form reported by Anderson under the name of *B. variegata* var. *candida* is also cultivated.
Caesalpinia bonduc Roxb. +
(*Guilandina bonduc* Ait.)
Reported by Anderson both as cultivated as well as indigenous.
C. pulcherrima Swartz +
(*Poinciana pulcherrima* Linn.)
Cassia absus Linn.*
C. auriculata Linn. +
C. fistula Linn. +
C. occidentalis Linn.
Reported by Anderson as cultivated; but it grows wild.
C. pumila Lam.
C. siamea Lam. + *
C. sophera Linn.
C. sumatrana Roxb. + *
C. surattensis Burm. f.
(*C. suffruticosa* Kön.)
C. tora Linn.
Delonix regia Rafin. + *
Parkinsonia aculeata Linn. +
Peltophorum pterocarpum Backer ex K. Heyne + *
Saraca indica Linn. + *
Tamarindus indica Linn. +
Also seen in forests.

Mimosaceae

Acacia arabica Willd.
A. auriculaeformis Cunn. ex Bth. + *
A. catechu Willd.*
A. farnesiana Willd. +
Reported by Anderson as indigenous, but it is only cultivated.
A. leucophloea Willd.*
Albizzia lebbeck Benth. +
(*Acacia serissa* Buch.)
A. procera Benth. + *
Mimosa pudica Linn. +
M. rubicaulis Lam.
Neptunia oleracea Lour.
(*Desmanthus natans* Willd.)
Pithecelobium dulce Benth. + *
Has a tendency to spread.
Prosopis juliflora DC. + *

Rosaceae

Eriobotrya japonica Lindl. +
Potentilla supina Linn.
Prunus persica Stokes +
(*Amygdalus persica* L.)
Anderson has reported var. *nectarina* and var. *cordifolia* Roxb. also.
Prunus triflora Roxb. +
Though not seen by the author.
Pyrus sinensis Lindl.
Rosa centifolia Linn. +
R. indica Linn. +

Crassulaceae

Bryophyllum pinnatum Oken.+
(*B. calycinum* Salisb.)

Combretaceae

Quisqualis indica Linn.+*
Terminalia arjuna W. et A.+*
T. muelleri Benth.+

Myrtaceae

Eucalyptus citriodora Hook.+*
E. umbellatus Dornin.+*
Eugenia jambos Linn.+
Psidium guajava Linn.+
(*P. pyriferum* Linn. and
P. pomiferum Linn.)
Syzygium cumini Skeels.+
(*Eugenia jambolana* Lam.)

Lythraceae

Ammannia baccifera Linn.
(*A. vesicatoria* Roxb.)
A. multiflora Roxb.
A. salicifolia Monti *
Punica granatum Linn.+
Lagerstroemia indica Linn.+
L. parviflora Roxb.+*
L. speciosa Pers.+*
Lawsonia inermis Linn.+
(*L. alba* Lam.)
Also seen growing in forests.
Woodfordia fruticosa Kurz +*

Onagraceae

Jussiaea repens Linn.
J. suffruticosa Linn.*
Ludwigia parviflora Roxb.
Oenothera rosea Soland.+*
Trapa bispinosa Roxb.

Samydaceae

Casearia tomentosa Roxb.*

Passifloraceae

Passiflora foetida Linn.

Caricaceae

Carica papaya Linn.+

Cucurbitaceae

Bryonopsis laciniosa Naud.
(*Bryonia laciniosa* Linn.)
Citrullus colocynthis Schrad.+
Doubtfully wild
C. vulgaris Schrad.+
(*Cucurbita citrullus* Linn.)
C. vulgaris Schrad. var. **fistulosus**
Duthie et Fuller +*
Coccinia cordifolia Cogn.
(*C. indica* W. et A.)
Cucumis melo Linn.+
C. melo Linn. var. **agrestis** Naud.*
C. melo Linn. var. **momordica**
Duthie et Fuller +
(*C. momordica* Roxb.)
C. melo Linn. var. **utilissimus**
Duthie et Fuller +
(*C. utilissimus* Roxb.)
C. sativus Linn.+
Also seen growing as escape.
C. trigonus Roxb.*
Cucurbita maxima Duch.+
C. moschata Duch. ex Poir.+*

CUCURBITACEAE—(*contd.*)

Cucumis pepo Linn.+
Also seen growing as escape.
Lagenaria vulgaris Ser.+*
Also seen growing as escape.
Luffa acutangula Roxb.+
Also seen growing as escape.
L. cylindrica M. Roem.+
(*L. pentandra* Roxb.)
Also seen growing as escape.
L. echinata Roxb.+*
Also seen growing as escape.
Melothria maderaspatana Cogn.
(*Bryonia scabrella* Linn.)
Momordica charantia Linn.+
Anderson has reported it both as indigenous as well as cultivated but it has only been seen growing as an escape from cultivation.
M. dioica Roxb. ex Willd.*
Trichosanthes anguina Linn.+
Also seen growing as escape.
T. cucumerina Linn.
T. dioica Roxb.+*
Also seen growing as escape.

CACTACEAE

Opuntia dillenii Haw.+
(*Cactus indicus* Roxb.)

FICOIDEAE

Gisekia pharnaceoides Linn.*
Glinus lotoides Linn.
G. oppositifolius A. DC.
(*Mollugo spergula* Linn.)
Mollugo nudicaulis Lam.
M. pentaphylla Linn.
Trianthema decandra Linn.
(*T. pentandra* L.)
T. portulacastrum Linn.
(*T. obcordata* Roxb.)
T. triquetra Willd. ex Rottl.
(*T. crystallina* Vahl)

UMBELLIFERAE

Anethum graveolens Linn.+
(*A. sowa* Roxb.)
Also seen growing as escape.
Centella asiatica Urban.
(*Hydrocotyle asiatica* L.)
Coriandrum sativum Linn.+
Also seen growing as escape.
Cuminum cyminum Linn.+*
Also seen growing as escape.
Daucus carota Linn.+*
Foeniculum vulgare Mill.+
Oenanthe javanica DC.*
Trachyspermum ammi Sprague +
(*Ligusticum ajowain* Roxb.)
Has been seen growing as escape.
T. roxburghianum Craib +
(*Pimpinella involucrata* W. et A.)
T. stictocarpum Wolff. *

ALANGIACEAE

Alangium salvifolium Wang.*

RUBIACEAE

Adina cordifolia Hook. f.
(*Nauclea cordifolia* Roxb.)
Also cultivated.
Borreria hispida Schum.
(*Spermacoce hispida* L.)
B. stricta Schum.
(*Bigelowia lasiocarpa* W. et A.)
Dentella repens Forst.*
Gardenia florida Linn.+
G. lucida Roxb.+*
G. turgida Roxb.*
Hamelia patens Jacq. +*
Hamiltonia suaveolens Roxb. +
Ixora coccinea Linn.+
Mitragyna parvifolia Korth.*
Morinda tinctoria Roxb.
(*M. citrifolia* Linn.)
Also cultivated.
Mussaenda frondosa Linn. +
Oldenlandia corymbosa Linn.
(*Hedyotis burmaniana* Br.)
O. dichotoma Hook. f.*
O. diffusa Roxb.*
O. gracilis Hook. f.*
Randia dumetorum Lam.
R. uliginosa DC.*

Compositae

Ageratum conyzoides Linn.*
Artemisia vulgaris Linn.+
(*Artemisia indica* Willd.)
Reported by Anderson both as indigenous as well as cultivated—now only cultivated.
Bidens biternata Merr. et Sherff.
(*B. decomposita* Wall.)
Blainvillea acmella Phil.
(*B. latifolia* DC.)
Blumea amplectens DC.*
B. glomerata DC.*
B. lacera DC.
B. laciniata DC.*
B. membranacea DC.*
B. oxyodonta DC.
B. wightiana DC.*
Caesulia axillaris Roxb.
Calendula officinalis Linn.+
Callistephus chinensis Nees +
Carthamus tinctorius Linn.+
Also seen growing apparently wild.
Centaurea cyanus Linn.+
C. moschata Linn.+
(*Amberboa moschata* DC.)
Centipeda minuta A. Br. et Aschers.
(*Myriogyne minuta* Less.)
Chrysanthellum indicum DC.
Chrysanthemum indicum Linn.+
C. sinense Sabine +
Cichorium intybus Linn.+*
Also seen growing as escape.
C. endivia Willd.+
Not seen by the author.
Cnicus arvensis Hoffm.*
Conyza aegyptiaca Dryand.*
C. ambigua DC.?*
Cosmos bipinnatus Cav.+*
Cotula anthemoides Linn.*
Echinops echinatus Roxb.
Eclipta prostrata Linn.
Elephantopus scaber Linn.
Emilia sonchifolia DC.
Galinsoga parviflora Cav.*
It is surprising to find one specimen of this species in N.B.G. herbarium collected from Lucknow proper ; probably it got accidentally introduced.
Gnaphalium indicum Linn.
G. luteo-album Linn.
G. pulvinatum Del.
(*Filago prostrata* DC.)
G. purpureum Linn.*
Goniocaulon glabrum Cass.+
(*Amberboa indica* DC.)
Grangea maderaspatana Poir.
Gynura aurantiaca DC.+*
Seen growing as escape.
Helianthus annuus Linn.+
H. tuberosus Linn.+
Inula vestita Wall.
Launaea aspleniifolia Hook. f.
(*Microrynchus asplenifolius* DC.)
L. nudicaulis Hook. f.
(*Microrynchus nudicaulis* Less.)
Mikania scandens Willd.?*
There is a single poor specimen collected by the author.
Pluchea lanceolata Cl.
(*Berthelotia lanceolata* DC.)
P. tomentosa DC.+*
Pulicaria crispa Sch.-Bip.
(*Francoeuria crispa* Cass.)
Sonchus arvensis Linn.*
S. asper Hill*
S. oleraceus Linn.
Sphaeranthus indicus Linn.
(*S. mollis* Roxb.)
Spilanthes acmella Murr.+*
Also seen growing as escape.
Tagetes erecta Linn.+
T. patula Linn.+
Tridax procumbens Linn.*
Vernonia cinerea Less.
Vicoa indica DC.
Volutarella ramosa Santapau
(*Microlonchus divaricatus* DC.)
Xanthium strumarium Linn.

Campanulaceae

Campanula canescens Wall.
Sphenoclea zeylanica Gaertn.*
Wahlenbergia gracilis Schrad.*

Primulaceae

Anagallis arvensis Linn.

Sapotaceae

Madhuca indica Gmel.+
(*Bassia latifolia* Roxb.)

Manilkara hexandra Dub.+*

M. kauki Dub.+
(*Mimusops kauki* Linn.)

Ebenaceae

Diospyros montana Roxb.*

D. tomentosa Roxb.+

Oleaceae

Jasminum humile Linn.+
(*J. revolutum* Sims)

J. multiflorum Andr.+
(*J. pubescens* Willd.)

J. officinale Linn. var. **grandiflorum** Kob.+
(*J. grandiflorum* Linn.)

J. sambac Ait.+
Reported by Anderson as indigenous though it is only cultivated.

Nyctanthes arbor-tristis Linn.+

Salvadoraceae

Salvadora persica Linn.

Apocynaceae

Allamanda cathartica Linn.+

Alstonia scholaris R. Br.+*

Carissa congesta Wt.+
(*C. carandas* auct.)

C. spinarum Linn.*

Ervatamia coronaria Stapf+
(*Tabernaemontana coronaria* R. Br.)

Holarrhena antidysenterica Wall. ex G. Don +*

Ichnocarpus frutescens Br.*

Lochnera pussilla Schum.
(*Vinca pusilla* Murr.)

L. rosea Reichb.+
(*Vinca rosea* L.)

Nerium indicum Mill.+
(*N. odorum* Lam.)

Plumeria rubra Linn. forma **acutifolia** Woodson+
(*Plumeria acuminata* Ait.)

Rauvolfia serpentina Benth.*

R. tetraphylla Linn.*

Thevetia peruviana Schum.+
(*T. nereifolia* Juss.)

Vallaris heynei Spreng.+*

Wrightia tinctoria R. Br.+*

Asclepiadaceae

Calotropis gigantea R. Br.+
Reported by Anderson as indigenous.

C. procera Br.

Ceropegia longifolia Wall.*

Gymnema sylvestre R. Br.+
Reported by Anderson as indigenous.

Hemidesmus indicus R. Br.*

Leptadenia pyrotechnica Dcne.*

L. reticulata W. et A.*

Marsdenia tenacissima W. et A.*

Oxystelma esculentum R. Br.*

Telosma pallida Craib.
(*Pergularia pallida* W. et A.)

Loganiaceae

Buddleia lindleyana Fortune+*

B. neemda Buch. ex Roxb.+*

Strychnos nux-vomica Linn.+*

Gentianaceae

Canscora diffusa R. Br.*
Enicostema littorale Blume
(*Slevogtia orientalis* Griseb.)
Hoppea dichotoma Willd.*
Nymphoides cristatum Ktze.
(*Limnanthemum cristatum* Griseb.)
N. indicum Ktze.*

Polemoniaceae

Phlox drummondi Hook.+*

Boraginaceae

Arnebia hispidissima DC.
Coldenia procumbens Linn.*
Cordia dichotoma Forst. f.+
(*C. myxa* auct.)
Has also escaped to the forests.
C. macleodii Hk. f. et T.+*
C. rothii R. et S.
Ehretia laevis Roxb.
Heliotropium eichwaldi Steud. ex DC.
(*H. europaeum* L.)
H. indicum Linn.*
H. scabrum Retz.*
H. strigosum Willd.
(*H. brevifolium* Wall.)
Trichodesma indicum R. Br.

Convolvulaceae

Argyreia nervosa Boj.+
(*A. speciosa* Swt.)
Convolvulus arvensis Linn.
C. microphyllus Sieb.*
C. pluricaulis Choisy
Cuscuta reflexa Roxb.
Evolvulus alsinoides Linn.
E. nummularius Linn.*
Ipomoea alba Linn.+*
I. angulata Lam.+
(*Quamoclit phoeniceum* Choisy)
I. aquatica Forsk.
(*I. reptans* Poir.)
I. batatas Lam.+
(*Batatas edulis* Choisy)
I. cairica Sweet+*
I. hispida R. et S.
(*I. sessiliflora* Roth)
I. learii Paxt.+*
I. maxima Don ex Sweet
(*I. sepiaria* Koen.)
I. muricata Jacq.
(*Calonyction muricatum*)
Reported by Anderson as cultivated; it has now run wild.
I. nil Roth
(*Pharbitis nil* Choisy and *P. coerulescens* Choisy)
Reported by Anderson both as wild as well as cultivated but not preferred for cultivation now.
I. obscura Ker-Gawl.*
I. pes-tigridis Linn.
I. pilosa Sweet
I. purpurea Lam.+
(*Convolvulus purpureus* L.)
Has a tendency to spread.
I. quamoclit Linn.+
(*Quamoclit vulgare* Choisy)
A white-flowered form reported by Anderson under the name of *Q. vulgare* var. *album* has also been seen.
Merremia aegyptia Urban.
(*Batatas pentaphylla* Chois.)
M. dissecta Hall. f.*
M. emarginata Hall. f.*
Operculina turpethum Silva-Manso+*
Porana paniculata Roxb.+*

Nolanaceae

Nolana paradox Lindl.+*

SOLANACEAE

Capsicum annuum Linn. var. **acuminatum** Fingh.+
(*C. annuum* Linn.)
Datura innoxia Mill.*
D. metel Linn.
(*D. alba* Nees and *D. fastuosa* L.)
Hyoscyamus niger Linn.+
Reported by Anderson as indigenous but it is only cultivated and has been seen growing as escape near cultivation.
Lycopersicon esculentum Mill.+
Nicotiana plumbaginifolia Viv.*
N. rustica Linn.+*
N. tabacum Linn.+
Physalis minima Linn.
P. peruviana Linn.+
Solanum incanum Linn.*
S. melongena Linn.+
S. nigrum Linn.
S. tuberosum Linn.+
S. xanthocarpum Schrad. et Wendl.
(*S jacquini* Willd.)
Withania somnifera Dunal
(*Physalis flexuosa*) L.

SCROPHULARIACEAE

Antirrhinum majus Linn.+*
A. orontium Linn.
Bacopa monniera Pennell
(*Herpestes monniera* Humb. et Kunth)
Dopatrium junceum Buch.-Ham.
Limnophila indica Druce
(*L. gratioloides* R. Br.)
Lindenbergia indica Ktze.
(*L. urticaefolia* Lehm.)
Lindernia ciliata Pennell
(*Bonnaya brachiata* Link et Otto)
L. crustacea Muell.*
L. hirsuta Pennell*
L. parviflora Haines
(*Ilysanthes parviflora* Benth. and *Bonnaya parviflora* Benth.)
Mazus japonicus Ktze.
(*M. rugosus* Lour.)
Russelia juncea Zucc.+
Scoparia dulcis Linn.*
Striga euphrasioides Benth.*
Torenia fournieri Lind.+*
Also seen growing as escape.
Verbascum coromandelianum Ktze.
(*Celsia coromandeliana* Vahl)
Veronica agrestis Linn.
V. anagallis Linn.

OROBANCHACEAE

Orobanche indica Buch.-Ham.
(*Phelipaea indica* G. Don)

LENTIBULARIACEAE

Utricularia flexuosa Vahl*
U. stellaris Linn. f.

BIGNONIACEAE

Heterophragma adenophyllum Seem.+ *
Has a tendency to spread.
Millingtonia hortensis Linn. f. +
Oroxylum indicum Vent. *
Stereospermum personatum Chatt.*
Tecoma stans H.B.K. + *

MARTINIACEAE

Martinia annua Linn. (*Martynia diandra* Glox.)

PEDALIACEAE

Pedalium murex Linn.*
Sesamum indicum Linn. +*
Also seen growing as escape.

Acanthaceae

Adhatoda vasica Nees
Andrographis paniculata Wall. ex Nees
Duthie includes it from Lucknow.
Asteracantha longifolia Nees
Barleria cristata Linn. +
Anderson has reported it as wild but it is only cultivated.
B. prionitis Linn.
Also cultivated.
Blepharis maderaspatensis Heyne ex Roth*
B. molluginifolia Pers.*
Elytraria acaulis Lindau*
Hemigraphis hirta T. Anders.*
H. latebrosa Nees var. **rupestris** Cl.
(*Ruellia latebrosa* Roxb.)
Hygrophila polysperma Anders.*
Justicia diffusa Willd.
(*Rostellaria procumbens* Roxb.)
J. gendarussa Burm. +*
Also seen growing as escape.
J. quinqueangularis Koen. ex Roxb.*
J. quinqueangularis Koen. var. **peploides** C.B.Cl.*
J. simplex D. Don*
Peristrophe bicalyculata Nees
Ruellia prostrata Lam.
(*R. ringens* Roxb. and *Dipteracanthus dejectus* Nees)
R. tuberosa Linn.*
Rungia pectinata Nees
R. repens Nees

Verbenaceae

Clerodendrum infortunatum Linn.*
C. phlomidis Linn. f.*
Duranta plumieri Jacq. +*
Gmelina arborea Roxb.*
G. asiatica Linn. +
Anderson has reported it both as indigenous as well as cultivated but it is only cultivated in the whole of Upper Gangetic Plain and is often seen growing as escape.
Lantana camara Linn. var. **aculeata** Mold.*
Also cultivated.
Petrea volubilis Linn. +*
Phyla geminata (H.B.K.) +*
Lippia geminata H.B. et K. nov. gen. et sp. ii : 266
P. nodiflora Greene.
(*Lippia nodiflora* Rich.)
Stachytarpheta indica Vahl +*
Verbena officinalis Linn.
Also cultivated.
Vitex negundo Linn.
Also cultivated.
V. negundo Linn. var. **incisa** Cl. +
(*V. incisa* Lam.)

Labiatae

Anisomeles indica O. Ktze.
(*A. ovata* R. Br.)
Hyptis suaveolens Poit.*
Leonotis nepetaefolia R. Br. +
Also grows spontaneously here and there.
Leucas aspera Spr.
L. cephalotes Spr.
Mentha viridis Linn. +
Nepeta hindostana Haines
(*N. ruderalis* Hamilt.)
Ocimum americanum Linn.*
Also cultivated.
O. basilicum Linn.
Also cultivated.
O. kilimandscharicum Guérke. +*
Also seen growing as escape.
O. sanctum Linn.
(*O. inodorum* Koen.)
Also cultivated.
Orthosiphon pallidus Royle ex Benth.*
Duthie reports Anderson's specimen from Lucknow though Anderson has not included it in his catalogue.
Pogostemon plectranthoides Desf.*
Salvia plebeia R. Br.

Plantaginaceae

Plantago major Linn.
Reported to be cultivated also.
P. ovata Forsk. +
(*P. isphagula* Roxb.)

Nyctaginaceae

Boerhavia diffusa Linn.
Bougainvillea buttiana Holtt. et Standl.*
B. glabra Choisy+*
B. spectabilis Willd.+*
Mirabilis jalapa Linn.+

Amaranthaceae

Achyranthes aspera Linn.
Aerva lanata Juss.*
A. sanguinolenta Blume*
Alternanthera echinata Sm.*
A. paronychioides St.*
A. sessilis R. Br.
Amaranthus blitum Linn.*
A. caudatus Linn.+*
Also seen growing as escape.
A. gracilis Desf.*
A. spinosus Linn.
A. tricolor Linn.
(*A. gangeticus* L., *A. polygamus* L.) *A. oleraceus* L., and *A. polygonoides* L.)
May be cultivated also.
Celosia argentea Linn.
C. cristata Linn.+
Digera muricata Mart.
(*Desmochaeta muricata* DC., and *Digera arvensis* Forsk.)
Gomphrena celosioides Mart.*
G. globosa Linn.+
Nothosaerva brachiata Wt.*
Pupalia lappacea Juss.
(*Achyranthes lappacea* L.)

Chenopodiaceae

Basella rubra Linn.+
(*B. alba* L.)
Beta vulgaris Linn.+
(*B. bengalensis* Roxb.)
Chenopodium album Linn.
C. ambrosioides Linn.*
C. murale Linn.*
Kochia indica Wight*

Phytolaccaceae

Rivina humilis Linn.*

Polygonaceae

Antigonon leptopus Hook. et Arn.+*
Fagopyrum esculentum Moench.+*
Polygonum glabrum Willd.
P. hydropiper Linn.*
P. hydropiper Linn. var. **glandulosissima** Gage°
P. lanigerum R. Br.
P. limbatum Meissn.*
P. plebeium R. Br.
(*P. roxburghii* Meisen.)
Reported by Duthie also from Lucknow.
P. plebeium R. Br. var. **effusa** Gage*
P. serrulatum Lagasc.
(*P. flaccidum* Roxb.)
Rumex dentatus Linn.*
R. nepalensis Spreng.*

Piperaceae

Peperomia pellucida H.B.K.*
Piper betle Linn.+
P. longum Linn.+*

Loranthaceae

Dendrophthöe falcata Etting.
(*Loranthus longiflorus* Desr.)

Santalaceae

Santalum album Linn.+

Euphorbiaceae

Acalypha ciliata Forsk.*
A. indica Linn.*
Antidesma diandra Heyne+
Reported by Anderson as indigenous.
Baliospermum montanum Muell. Arg.*
Chrozophora parvifolia Klotz.*
Duthie reports Anderson's specimen from Lucknow, though Anderson has not included it in his catalogue.
C. prostrata Dalz.*
C. rottleri A. Juss.
(*C. plicata* A. Juss.)
Cicca acida Merr.+
(*C. disticha* L.)
Croton bonplandianum Baill.*
Emblica officinalis Gaertn.+
Euphorbia antiquorum Linn.+
E. dracunculoides Lam.
E. geniculata Orteg.*
E. granulata Forsk.*
E. hirta Linn.
E. hypericifolia Linn.
(*E. parviflora* Roxb.)
E. microphylla Heyne ex Roth*
E. milii Ch. des Moulins+*
E. pulcherrima Willd.+*
E. thymifolia Linn.
E. tirucalli Linn.+
Jatropha curcas Linn.+
J. gossypifolia Linn.*
Kirganelia reticulata Baill.*
Manihot esculenta Crantz.+*
Pedilanthus tithymaloides Poit.+
Phyllanthus niruri Linn.
P. simplex Retz.
P. urinaria Linn.*
Putranjiva roxburghii Wall.+*
Ricinus communis Linn.+
Has a tendency to spread.
Securinega virosa Paxt. et Hoffm.
(*Fluggea retusa* Roxb.)

Urticaceae

Artocarpus integrifolius Linn. f.+
Cannabis sativa Linn.+
Also seen growing as escape.
Ficus bengalensis Linn.+
(*F. indica* L.)
Also seen growing spontaneously on building walls and tree trunks.
F. carica Linn.+
F. glomerata Roxb.+*
Has a tendency to spread.
F. hispida Linn. f.*
F. lacor Buch.-Ham.+*
F. palmata Forsk
(*F. caricoides* Roxb.)
F. religiosa Linn.+
Also seen growing spontaneously on building walls and tree trunks.
F. rumphii Blume+*
Fleurya interrupta Gaud.*
Holoptelea integrifolia Planch.+*
Morus alba Linn.*
Also cultivated.
M. laevigata Wall.+
Anderson has reported *M. cashmeriana* Royle as cultivated but this binomial is untraceable in INDEX KEWENSIS.
Streblus asper Lour.
(*Trophis aspera* Retz.)

Casuarinaceae

Casuarina equisetifolia Forst.+*

Salicaceae

Salix babylonica Linn.+
S. tetrasperma Roxb.

Ceratophyllaceae

Ceratophyllum demersum Linn.*

Coniferae

Cupressus sempervirens Linn.+
Pinus roxburghii Sarg.+*. Not cultivated commonly.
Thuja orientalis Linn.+

CYCADACEAE

Cycas circinalis Linn. + *
C. rumphii Miq. + *

HYDROCHARITACEAE

Hydrilla verticillata Royle
Lagarosiphon alternifolius Druce*
Ottelia alismoides Pers.*
Vallisneria spiralis Linn.*

ORCHIDACEAE

Zeuxine strateumatica Schlect. (*Z. sulcata* Lindl.)

SCITAMINEAE

Canna indica Linn. +
Costus speciosus Smith*
Curcuma longa Linn. +
Zingiber officinale Roscoe +

BROMELIACEAE

Ananas comosus Merr. + (*A. sativa* L.)

IRIDACEAE

Iris chinensis Curt. +

AMARYLLIDACEAE

Agave americana Linn. + *
A. cantala Roxb. +
A. sisalana Perr. + *
Crinum asiaticum Linn. +
C. defixum Ker.-Gawl. + *
C. latifolium Linn. +
Furcraea gigantea Vent. + *
Pancratium zeylanicum Linn. +
Polianthes tuberosa Linn. +

DIOSCOREACEAE

Dioscorea aculeata Linn. var. **fasciculata** Prain et Burkill + *
Duthie includes it from Lucknow.
D. alata Linn. +
D. bulbifera Linn.*
D. wallichii Hook. f. ? + *

LILIACEAE

Allium ascalonicum Linn. +
(*A. ascalonum* L.)
A. cepa Linn. +
A. porrum Linn. +
A. sativum Linn. +
Asparagus racemosus Willd. +
Reported by Anderson as indigenous.
Asphodelus tenuifolius Cav.
(*A. fistulosus* L.)
Gloriosa superba Linn.
Also cultivated.
Hemerocallis fulva Linn. +

PONTEDERIACEAE

Eichhornia crassipes Solms.*
Monochoria vaginalis Presl.*

COMMELINACEAE

Commelina benghalensis Linn.
C. forskalaei Vahl*
C. hasskarlii Cl.*
C. obliqua Buch.-Ham.
(*Commelina communis* L.)
Cyanotis axillaris Schult. f.*
C. cristata Schult. f.*
Murdannia nudiflora Brenan.
(*Aneilema nudiflora* Kunth)

Juncaceae

Juncus bufonius Linn.

Palmae

Borassus flabellifer Linn. +

Caryota urens Linn. +

Cocos nucifera Linn. +
At a few places only

Phoenix sylvestris Roxb.

Pandanaceae

Pandanus tectorius Soland. ex Park. + (*P. odoraitssimus* Roxb.)

Typhaceae

Typha angustata Chaub. et Bory.*

Araceae

Amorphophallus campanulatus Bl. + *

Colocasia antiquorum Schott. +

Pistia stratiotes Linn.*

Typhonium trilobatum Schott.*

Lemnaceae

Lemna polyrrhiza Linn. (*L. orbicularis* Roxb.)

Wolffia arrhiza Wimm.*

Alismaceae

Sagittaria guayanensis H.B.K.*

S. sagittifolia Linn.*

Potamogetonaceae

Aponogeton crispum Thunb.*

A. monostachyon Linn. f.*

Potamogeton crispus Linn.*

P. pectinatus Linn.*

Zannichelliaceae

Zannichellia palustris Linn.*

Eriocaulonaceae

Eriocaulon sieboldianum Sieb. et Zucc. ex Steud.*

Cyperaceae

Bulbostylis barbata Kunth
(*Isolepis barbata* R.Br.)

Cyperus aristatus Rottb.*

C. compactus Retz.*

C. compressus Linn.

C. difformis Linn.

C. distans Linn.f.

C. esculentus Linn.*

C. exaltatus Retz.
(*C. racemosus* L.)

C. iria Linn.

C. laevigatus Linn.
(*C. mucronatus* Rottb.)

C. niveus Retz.

C. pumilus Linn.

C. rotundus Linn.

C. tuberosus Rottb.*

Eleocharis atropurpurea Kunth*

E. plantaginea R.Br.*

Fimbristylis annua R. et S. var. **diphylla** Kuk.
(*F. communis* Kunth)

CYPERACEAE—(*contd.*)

Fimbristylis bisumbellata Babeni*
F. ferruginea Vahl*
F. junciformis Kunth*
F. miliacea Vahl*
F. monostachya Hassk.*
F. quinquangularis Kunth*
F. schoenoides Vahl*
Juncellus pygmaeus C.B.Cl.
(*Cyperus pygmaeus* Vahl)
Kyllinga brevifolia Rottb.*
K. monocephala Rottb.
K. triceps Rottb.
Mariscus paniceus Vahl var. **roxburghianus** Cl.*
Scirpus articulatus Linn.*
S. grossus Vahl*
Anderson has reported it as indigenous.
S. maritimus Linn.
S. maritimus Linn.var. **affinis** Cl.*
S. mucronatus Linn.
S. roylei Beetle.
(*Isolepis lupulina* Nees)
S. supinus Linn.
(*Isolepis supina* R.Br.)

GRAMINEAE

Acrachne verticillata Chiov. †
(*Eleusine verticillata* Roxb.)
Alloteropsis cimicina Stapf*
Apluda mutica Linn.var. **aristata** Pilger †
(*A. aristata* Linn.)
Aristida depressa Retz.*
Arundinella nepalensis Trin. ? *
Author has seen a single specimen at N.B.G. herbarium collected at Gomti *bandha*; might have been introduced through the river.
Arundo donax Linn.
(*A. bifaria* Retz.)
Also cultivated.
Avena fatua Linn.
Bambusa sp. +
Bothriochloa odorata A. Camus + *
Brachiaria brizantha Stapf + *
B. distachya Stapf*
B. ramosa Stapf* †
Cenchrus barbatus Schum.
(*C. echinatus* Linn.)
C. ciliaris Linn. †
(*Pennisetum cenchroides* Rich.)
C. pennisetiformis Steud.*
C. setigerus Vahl*
Chloris dolichostachya Lag.*
C. gayana Kunth + *
C. inflata Link.
(*C. barbata* Swartz)
C. montana Roxb.*
C. virgata Sw.*
Chrysopogon fulvus Chiov. + *
Coix lachryma-jobi Linn.
Cymbopogon jwarancusa Schult.* +
(*C. iwarancusa* Roxb.)
Anderson has reported it as indigenous.
C. martinii Wats. + *
Cynodon dactylon Pers. †
Also cultivated.
C. plectystachyum Pilger + *
Dactyloctenium aegyptium Beauv. †
(*D. aegypticum* Willd.)
Dendrocalamus strictus Nees + *
Desmostachya bipinnata Stapf †
(*Poa cynosuroides* Retz.)
Dichanthium annulatum Stapf*
D. caricosum A. Camus*
Digitaria adscendens Henr.*
D. bicornis R. et S.*
D. biformis Willd.*
D. granularis Henr.* †
D. preslii Henr.*
D. stricta Roth*
D. timorensis Bal. ?*
Echinochloa colonum Link. †
(*Panicum colonum* Linn.)
E. crusgalli Beauv.* †
E. frumentacea Link. +
(*Oplismenus frumentaceus* Roxb.)
E. stagnina Beauv.*
Eleusine coracana Gaertn. +
(*E. stricta* Roxb.)
E. indica Gaertn. †
Eragrostis ciliaris Link.*
E. curvula Nees*
E. diarrhena Steud.*
E. gangetica Steud.*

Eragrostis japonica Trin.*
E. megastachya Link.
(*Poa flexuosa* Roxb.)
E. nutans Nees ex Steud.
E. pilosa Beauv.
(*E. verticillaris*)
E. poeaeoides Beauv.
(*E. poaeformis* Link.)
E. tenella Beauv. ex R. et S. †
(*Poa tenella* L. and *P. viscosa* Retz.)
E. tremula Hochst.*
E. unioloides Nees ex Steud.*
Eremopogon strictus A. Camus*
Erianthus munja Jesweit.*†
Eriochloa procera C. E. Hubb.*†
Eulalia leschenaultiana Ohwi*
Eulaliopsis binata C. E. Hubb.* †
(*Andropogon involutus* Steud.)
Anderson has reported it as indigenous.
Garnotia elata Janowsky*
Hackelochloa granularis O. Ktze.*
Hemarthria compressa R. Br.†
Heteropogon contortus Beauv. ex R. et S.
Hordeum vulgare Linn.†
(*H. hexastichon* L.)
Hygroryza aristata Nees
(*Zizania aristata* Kunth)
Imperata cylindrica Beauv.†
(*I. arundinacea* Cyr.)
Ischaemum rugosum Salisb.*
Iseilema laxum Hack.†
Leptochloa chinensis Nees* †
L. panicea Ohwi †
(*L. tenerrima* R. et S.)
Lolium temulentum Linn.
Mnesithea laevis Kunth*
Oplismenus burmannii Thw. †
(*Panicum burmannii* Retz.)
Oropetium thomaeum Trin.*
Oryza perennis Moench + †
(*O. sativa* L.)
Anderson has reported it both as cultivated as well as indigenous.
Panicum antidotale Retz.* †
P. austroasiaticum Ohwi*
P. maximum Jacq. +
Reported by Anderson as indigenous.
P. miliaceum Linn. +
Also seen growing as escape.
P. paludosum Roxb.
P. repens Linn.
(*P. uliginosum* Roxb.)
P. trypheron Schult.*
Paspalidium flavidum A. Camus* †
P. punctatum A. Camus.*
Paspalum dilatatum Poir. + *
Also seen growing as escape.
P. distichum Linn.†
P. scrobiculatum Linn. +
Also seen growing apparently as wild.
Pennisetum orientale Rich. + *
P. purpureum Schum. + *
Also seen growing as escape.
P. typhoides Stapf et Hubb. +
(*Panicum spicatum* Roxb. and *Penicillaria spicata* Willd.)
Anderson records it both as indigenous as well as cultivated but it is only cultivated within the area.
Perotis indica O. Ktze.
(*P. latifolia* Ait.)
Phalaris minor Retz.*
Phragmites karka Trin. ex Steud.
Poa annua Linn.
Pogonatherum paniceum Hack. + *
Polypogon monspeliensis Desf.*
Rottboellia exaltata Linn.f.*
Saccharum officinarum Linn. +
S. spontaneum Linn. †
Schizachyrium exile Stapf*
Setaria barbata Kunth* †
Probably accidentally introduced.
S. glauca Beauv.
S. italica Beauv. +
(*Pennisetum italicum* R.Br.)
S. pallidifusca C. E. Hubb.*
S. tomentosa Kunth* †
S. verticillata Beauv. †
(*Panicum verticillatum* Linn.)
Sorghum vulgare Pers.*
S. halepense Pers.* †
Sporobolus coromandelianus Kunth*
S. diandrus Beauv.* †
S. marginatus Hochst. ex A. Rich. ? *
S. orientalis Kunth*
Themeda arundinacea A. Camus*
Tragus biflorus Schult.
(*Lappago racemosa* Willd.)
Triticum aestivum Linn. +
(*T. vulgare* Willd.)
Also seen growing as escape.
Urochloa panicoides Beauv.
(*Panicum repens* Roxb.)
Vetiveria zizanioides Nash.*
Zea mays Linn. +

References

Anderson, T. (1859) : Notes on the Flora of Lucknow with Catalogues of the Cultivated and Indigenous Plants. *Journ. As. Soc. Bengal* **28** (2) : 89-120.

Anon. (1895-1959) : Index Kewensis.

——— (1958) : Plants of Economic Importance of Lucknow District. Bulletin No. 9. (Published by National Botanic Gardens, Lucknow).

——— (1948-59) : Wealth of India : Raw Materials.

Dudgeon, W. (1920) : A Contribution to the Ecology of the Upper Gangetic Plain. *J. Indian bot.* **1** : 296-324.

Duthie, J. F. (1903-29) : Flora of the Upper Gangetic Plain and of the Adjacent Siwalik and Sub-Himalayan Tracts.

Hooker, J. D. (1872-97) : Flora of British India.

Kapoor, S. L. : Weed Flora of the National Botanic Gardens, Lucknow. (Ined.)

Patil, R.P. (1960) : A Key to the Genera of the Common Grasses of Lucknow and its Environs. *Proc. Indian Acad. Sc.* Sec. B. **51** : 122-32.

Raizada, M.B. (1958) : Name Changes in Common Indian Plants. *Indian For.* **84** : 467-538.

——— (1959) : Name Changes in Common Indian Grasses. ibid. **85** : 473-509.

Saxena, P.N. (1960) : Algal Flora of 'Usar' Lands in Uttar Pradesh. *Sc. and Cult.* **25** : 542-43.

Sharma, V.C. (1959) : Uttar Pradesh District Gazetteers. Vol. 37. Lucknow.

Studies on the Freshwater Oligochaeta of South India

I. Aeolosomatidae and Naididae

Part 4

BY

K. Vanamala Naidu

Government Arts and Science College, Chittoor (A.P.) [1]

(*With eight text-figures*)

[*Continued from Vol.* **59** (2) : 545]

Subgenus **Aulophorus** Schmarda, 1861

Subgeneric characters : No eyes. Dorsal bundles with hairs and needles ; ventral setae of II-V distinct from the rest. Stomach present or absent ; intestinal anti-peristalsis and ascending ciliary vibration occur ; chloragogues from VI on. Coelomocytes present or absent. Branchial organ with non-contractile, avascular palps. Dorsal vessel contractile, ventrally to the left for the greater part, mid-dorsal in 5-6 anterior segments. Ventral vessel non-contractile and mid-ventral, divides posteriorly into 2, branches traverse the margin of the fossa supplying vascular loops to the gills ; loops on emerging from the gills unite to form dorsal vessel. Contractile lateral vessels connect the main vessels. Budding zones provide prostomium and 5 head segments to posterior zooid, and some hind segments and branchial organ to anterior zooid, before fission. Sperm-sac and ovi-sac, posterior diverticula of septa 5/6 and 6/7, former within latter, extend backward. Penial setae absent. Spermathecae a pair in V.

Key to all the known and valid Species of *Aulophorus*

A-1 Dorsal setae beginning in IV .. **superterranus*

A-2 Dorsal setae beginning in V

B-1 Needles bifid with intermediate teeth

C-1 Intermediate teeth 2-4 between main teeth of needles ; 4 pairs of gills .. **pectinatus*

C-2 One short intermediate tooth between main needle teeth ; 3 pairs of gills .. *indicus* sp. nov.

B-2 Needles simply bifid without intermediate teeth

---

[1] Present address : S. R. R. and C. V. R. Government College, Vijayawada-4.

D-1 Needle teeth of equal length; with 4 pairs of gills .. **borellii*

D-2 Needle teeth of unequal length

E-1 Distal tooth thinner and shorter than proximal .. *furcatus*

E-2 Distal tooth thinner and longer than proximal

F-1 Hairs bayonet-shaped; no coelomocytes; 3 pairs of foliate gills .. *hymanae* sp. nov.

F-2 Hairs simple; coelomocytes present; 4 pairs of digitiform gills .. *michaelseni*

A-3 Dorsal setae beginning in VI

G-1 Needles simply bifid without intermediate teeth .. *gravelyi*

G-2 Needles bifid with intermediate teeth

H-1 Needles with minute short blunt intermediate teeth between main teeth without webbing; 4 pairs of gills .. **beadlei*

H-2 Needles with short teeth with a concave intermediate webbing between main teeth; 3 pairs of gills .. **caraibicus*

G-3 Needles palmate

I-1 Ventral setae of II-V more than twice as long as the rest .. **flabelliger*

I-2 Ventral setae of II-V twice or less as long as the rest

J-1 Web of the needle with ribs .. **huaronensis*

J-2 Web of needle without ribs

K-1 Needles with intermediate teeth .. **vagus*

K-2 Needles without intermediate teeth

L-1 Dorsal bundles with 1 hair and 1 needle .. **schmardai*

L-2 Dorsal bundles with 1-2 hairs and 1-2 needles

M-1 Needles 64-80 μ long; branchial organ with 2 pairs of gills normally; spermathecae absent .. *tonkinensis*

M-2 Needles 80-120 μ long; branchial organ with 3 pairs of gills; spermathecae present .. **carteri*

---

*Species not known from the Indian sub-continent

20. **Aulophorus furcatus** (O.F. Müller, 1773)

Fig. 20 A-G

Dero furcata Oken. Brode, 1898, p. 143.

Aulophorus furcatus (Oken). Stephenson, 1915b, p. 784 ; 1925b, p. 46. Lastočkin, 1918, p. 62 ; 1927, p. 66. Cordero, 1931a, p. 350 ; 1931b, p. 334. Michaelsen, 1933, p. 338. Weisenberg-Lund, 1937, p. 339, fig. 403. Chen, 1944, p. 7. Du-Bois Raymond Marcas, 1947, pp. 6-7. Sperber, 1948, pp. 191-194, fig. 20B-D ; 1950, pp. 72-73, fig. 25; 1958, p. 49. Causey, 1953a, p. 55.

Material examined: Numerous worms collected from the Bugga stream, Cuddapah in October 1953, May and December 1955 ; from the Balaji tank, Kakinada in November 1956 ; from the Brucepettah tank, Bellary, Langford Town tank and Ulsoor tank, Bangalore in May 1958.

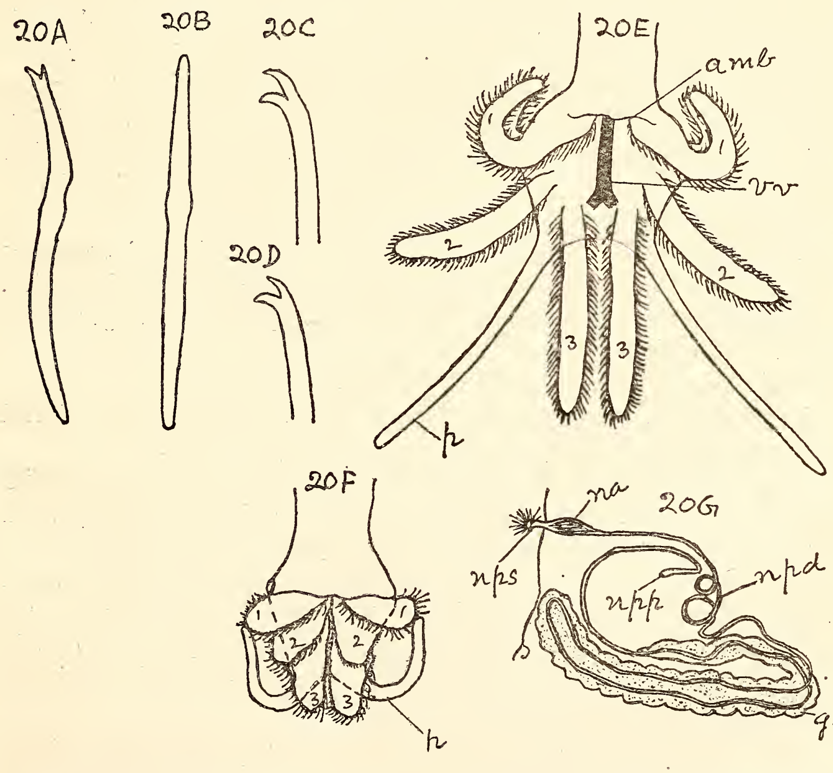


Fig. 20. *Aulophorus furcatus* (Müller). A. Needle seta × 900 ; B. Needle seta (front view) × 900 ; C. Distal end of ventral seta of II × 900 ; D. Distal end of ventral seta of VII × 900 ; E. Branchial organ relaxed ; F. Branchial organ preserved ; G. Nephridium.

amb : anterior margin of branchial fossa ; *gl* : gland ; *na* : nephridial ampulla ; *npd* : nephridial duct ; *npp* : nephridiopore ; *nps* : nephrostome ; *p* : palp ; *s* : septum; *vv* : ventral vessel ; 1, 2, 3 : I, II, and III pair of gills.

Worms small, light brown. Prostomium bluntly conical with stiff sensory hairs.

Dorsal setae start in V, 1 hair and 1 needle per bundle. Hairs 130-145 μ long, smooth, slightly curved. Needles (Fig. 20 A, B) sickle-shaped bifid, 49-55 μ long with distal nodulus (D : P : : 6 : 9), distal tooth thinner, shorter, and straighter than proximal. Ventral setae (Fig. 20 C, D) 4 per bundle anteriorly, 2–3 per bundle posteriorly; in II-IV longer than in others, 63-70 μ long, with median nodulus (D : P : : 10 : 10 or 10 : 9), prongs equally thick, distal 1.5 times longer than proximal; in others 49-60 μ long with distal nodulus (D : P : : 7 : 9), distal prong shorter and thinner than proximal. Length and thickness of crotchets, and length of distal prong, position of nodulus vary from seta to seta in bundles.

Branchial organ (Fig. 20 E, F) funnel-shaped, with 2 thin palps provided with sensory hairs, 0.4 mm. long and 70 μ wide at base, gradually tapering; they diverge in distension, and curl their tips upwards with an obtuse angle between in contraction. Gills 3 pairs, foliate, I pair arise from supra-anal diverticulum, II pair from inside lateral margins, and III pair from the floor of fossa; in distension I pair stretches laterally and curls upwards, II pair extends laterally, III pair stretches posteriorly; in contraction they are withdrawn into fossa, when I pair is invisible.

Pharynx in II-V, wide. Oesophagus in VI-VII, thin and continues into intestine in VIII. Stomach absent. Chloragogues brownish. Septa well developed, each with colourless, transparent swellings; septal glands in IV and V.

Brain incised anteriorly and posteriorly.

Blood yellow. Contractile vessels 5 pairs in VI-X, connect dorsal and ventral vessels. Simple non-contractile loops in II-V.

First pair of nephridia (Fig. 20 G) in VII, pre-septal funnels with nephrostomes in VI; post-septal is a highly coiled duct, early part in gland tissue, later part opening by nephridiopore ventro-laterally.

Worms have 1-5 fission zones as in Argentine worms (Cernosvitov, 1942). After formation of first budding zone about the middle of the worm, two zooids develop and further fission zones appear successively in either zooid alternately. In a chain of 5 zooids, I and III zooids are composed of more segments than others.

Clitellum in $\frac{1}{2}$V-VII ($2\frac{1}{2}$ segments). Gonads absent in sexually mature worms. Sperm-sac with spermatozoa and ovi-sac with single ovum extend to VIII and XI respectively, former within latter. Sperm-funnels cup-shaped, open in sperm-sac; vasa deferentia thin, enter atria antero-dorsally. Atrial ampulla ovoid, with short ejaculatory duct opening at the position of ventral bundles of VI. No penial setae. Spermathecae long, club-shaped with ampullae twice as wide as ectal duct, extend to VII or VIII in sperm-sac ; open slightly lateral to ventral bundles of V.

1 (p.) = 2-4 mm.; d (p.) = 0.22 mm.; s = 30-41 ; n = 16-20.

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	—	—	—	129.5	133	133	136.5	133	133	133	136.5
Needle	—	—	—	52.5	49	49	49	49	49	49	49
				6:9	5:9	5:9	5:9	5:9	5:9	5:9	5:9
V. seta	70	66.5	63	56	59.5	59.5	56	56	57.7	56	52.5
	10:10	10:9	9:9	8:8	8:9	8:9	7:9	7:9	7:9.5	7:9	6:9

Distribution in Indian sub-continent : Lahore (Pakistan) ; Bombay and Khed (W. India) ; Madras and Trivandrum (S. India). Now recorded from Cuddapah, Kakinada, Bellary, and Bangalore (S. India.)

Habits : Constructs tubes with mucus and foreign matter and lives in them. Buries anterior part of the body in mud, keeps the hind end protruded in water with gills distended, withdraws it into mud when disturbed. Swims with brisk horizontal transverse movements.

Remarks : The worms described here have no stomach, and have five pairs of contractile lateral vessels in VI-X, and a ventro-lateral dorsal blood vessel. In the absence of a stomach and in the presence of five pairs of contractile vessels, they resemble those of Stephenson (1923) and differ from the Swedish worms with a stomach and 2 pairs of contractile vessels. The dorsal vessel is ventro-lateral as in the Swedish worms, and Stephenson's statement that it is dorsal must be incorrect, as it is never found to be so in any species of *Aulophorus.* Setae length of the present worms agrees with those found in literature. The gills are foliate as in the Chinese worms (Chen, 1940). The spermathecae are club-shaped as in the Brazilian worms (Marcus, 1943).

Sexual organs resemble those of the Bombay (India) worms (Stephenson, 1916) and the Brazilian worms of Marcus (1943), except in the shape of the spermathecae. Stephenson described the spermathecae as ovoid sacs, when actually they are long and club-shaped. He examined, as he states, preserved, 'not quite fully mature', worms, and so there is every possibility of the spermathecae still being in coiled condition giving an ovoid appearance. His statements—the clitellum, 'not distinguishable except in sections', and 'the individuals which were examined by sections had already copulated (presence of spermatozoa in the spermathecae)'—are contradictory. The worms could not have copulated before the full development of the clitellum, and the spermathecae cannot contain spermatozoa without copulation. Hence it is obvious that the 'spermatozoa and granular matter' in the 'ovoid sacs,' were actually the cut ends of the coils of the long ectal duct and ampulla of the spermatheca. The differences in the shape of the atria and the position of entry of the vasa deferentia into the atria between the Bombay worms of Stephenson on the one hand and the Brazilian and the present worms on the other are, again, due to the immature condition of the sexual organs in the former.

Aulophorus africanus Michaelsen (1914), with very slight incision in the dorsal border of the branchial organ and flattened form of the gills, has no distinct taxonomic status, as the gills have been found to be flat (foliate) in *A. furcatus* from China by Chen (1940) and in the present worms; further the branchial organ varies considerably in the members of a species. Stephenson's (1931b) key for the species of *Aulophorus* is :

'1.	Dorsal setae begin in segment IV		*A. superterranus*
	Dorsal setae begin in segment V	2	
	Dorsal setae begin in segment VI	6	
2.	Two or three pairs of gills	3	
	Four pairs of gills	4	
3.	Palps diverge at an obtuse angle		*A. furcatus*
	Palps close together, diverge but slightly		*A. africanus*'

It is clear from the above that he could not find more tangible characters for separating *A. africanus* from *A. furcatus*, and hence differentiated them on the very trivial character of the divergence of the palps. Hence *A. africanus* is a synonym of *A. furcatus*.

Dero roseola Nicholls (1921) from Australia agrees with *A. furcatus* in all characters except in the larger size of the zooids, rarer budding zones, and value of n = 11-25 for *furcatus* in literature and n = 28 for *roseola*. These minor differences do not call for a specific status for *roseola*. As suggested by Marcus (1943) and Sperber (1948) this is also a synonym.

21. **Aulophorus michaelseni** Stephenson, 1923

Fig. 21 A-E

Aulophorus palustris Michaelsen. Stephenson, 1916, p. 306.

Aulophorus michaelseni Stephenson, 1923, pp. 93-94, fig. 35 ; Aiyer, 1930, p. 43, fig. 18.

Material examined : Many worms collected from the Bugga stream, Cuddapah in April 1954, May and December 1955 ; from the Kandakam tank, Bellary in April 1954 ; and from the Ulsoor tank, Bangalore in May 1958.

Worms of medium size, and pale red. Eyes absent. Prostomium bluntly conical.

Dorsal setae from V, 1 hair and 1 needle per bundle. Hair 175-200 μ long, smooth, nearly straight, shorter than body-diameter. Needle sickle-shaped (Fig. 21A) 65-70 μ long, with distal nodulus (D : P : : 7 : 12),

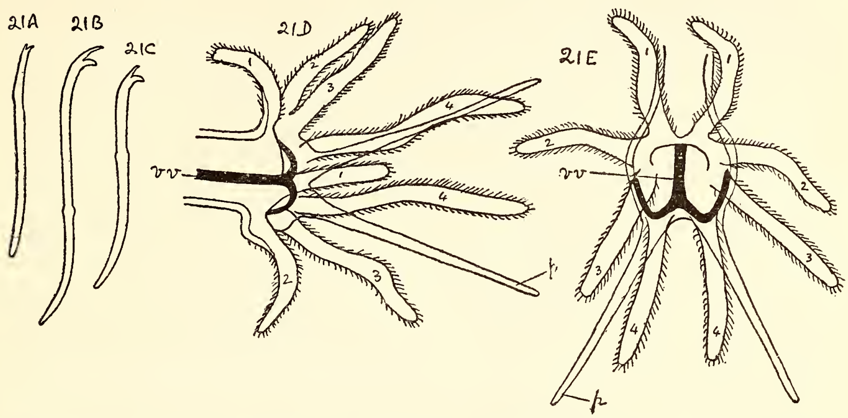


Fig. 21. *Aulophorus michaelseni* Stephenson : A. Needle seta × 450 ; B. Ventral seta of II × 400 ; C. Ventral seta of VIII × 450 ; D. Branchial organ relaxed under cover glass ; E. Branchial organ fully relaxed.

p : palp ; *vv* : ventral vessel ; 1, 2, 3, 4 : I, II, III, and IV pair of gills.

teeth small, equally thick, distal longer than proximal. Ventral setae (Fig. 21 B, C) 2-4 per bundle ; in II-IV, 77-98 μ long, with proximal nodulus (D : P : : 15 : 13), thinner, less curved than in others, prongs equally thick, distal 1.5-2 times longer than proximal ; in other segments 60-73.5 μ long, with distal nodulus (D : P : : 8 : 11), distal prong half as thick as proximal. Length and thickness of setae and nodular position vary from seta to seta in bundles. Distal prong is longer, equal to, and shorter than proximal in outer, middle, and inner setae respectively in a bundle.

Branchial organ (Fig. 21 D, E) funnel-shaped, anterior margin entire, ciliated, posterior margin bears 2 non-contractile elongated, thin, diverging palps. Gills 4 pairs, digitiform ; I pair dorsal, II pair lateral, III and IV pairs ventral. From I-IV pair length increases. In full distension gills curl in all directions like tentacles.

Pharynx in II-V, wide and whitish. Oesophagus in VI-VIII, thin, wavy, continues into intestine without stomach intervening. Septa well developed ; septal glands on septa 4/5 and 5/6. Chloragocytes brownish. Coelomocytes spherical, colourless with 15 μ diameter.

Blood deep orange-red. Simple contractile vessels 4 pairs in VII-X connecting dorsal and ventral vessels.

First nephridium in VII, its pre-septal ciliated nephrostome opening into VI : post-septal nephridial duct opening by nephridiopore ventro-laterally in VII.

Budding zone 1, rarely 2; when 2, second fission zone always appears about the middle of posterior zooid.

1 (p.) = 4-5 mm.; d (p.) = 0.3 mm.; s = 40-45 + undifferentiated zone and branchial organ ; n = 23—27.

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
Hair	—	—	—	182	182	175	175	175	175	175
Needle	—	—	—	70	66.5	66.5	66.5	66.5	66.5	64.8
				8:12	7:12	7:12	7:12	7:12	7:12	7:11.5
V. seta	98	98	96.2	85.7	73.5	70	70	70	66.5	70
	15:13	15:13	15:12.5	11.5:13	9:12	9:11	9:11	9:11	8:11	8:12

Distribution in Indian sub-continent : Kandy (Ceylon), Trivandrum (Travancore, S. India). Now recorded from Cuddapah, Bangalore, and Bellary (S. India).

Remarks : Stephenson (1923) separated the Indian specimens of *Aulophorus palustris* Michaelsen under the name *A. michaelseni* from those described by Michaelsen (1905a) on account of the needles of the former having been referred to ' Hakenborsten,' which term Stephenson considers applicable only to setae resembling the form of ventral setae. Stephenson is right as needle with proximal tooth thicker than the distal is referred to as ' Hakenborsten ' by Michaelsen in *A. palustris* (1905a), and *A. borelli* Michaelsen (1900) differs considerably from the needles with equally thick teeth in *A. michaelseni* Sperber (1948). Sperber (1948) probably unable to distinguish *A. michaelseni* as a distinct species from the available descriptions included it with *A. furcatus* giving a comprehensive diagnosis for the latter. Characters of *A. michaelseni* warrant a specific status, hence it is here reassigned as a separate species after Stephenson (1923) with a diagnosis.

Habits : The worms swim with a transverse horizontal movement. When disturbed they coil into loose spirals, and uncoil and move away after a short time. Live along with *Limnodrilus hoffmeisteri.*

Diagnosis of Aulophorus michaelseni *Stephenson* : No eyes. Dorsal setae begin in V, 1 hair and 1 needle per bundle ; hairs simple, nearly straight ; needles with distal nodulus, bifid, teeth small, equally thick, distal tooth longer than proximal. Ventral setae 2-4 per bundle ; in II-IV thinner, straighter than others, with proximal nodulus, prongs equally thick, distal 1.5-2 times as long as proximal ; in others nodulus distal, distal prong half as thick and longer, equal to, or shorter than proximal. Branchial fossa with 4 pairs of digitiform gills, 1 dorsal, 1 lateral, and 2 ventral. Stomach absent. Septal glands on 4/5 and 5/6. Coelomocytes occur. Dorsal vessel ventrally to left ; hearts 4 pairs in VII-X. First nephridium in VII. Budding zone buds 5 head segments,

22. **Aulophorus hymanae**[1] sp. nov.

Fig. 22 A-F

Material examined: Many worms collected from the Bugga stream, Cuddapah in September 1953, May 1955; from Miller's tank, Langford Town tank, and Ulsoor tank, Bangalore in May 1958.

Worms large and sturdy. Prostomium bluntly conical, longer than broad, with fine sensory hairs.

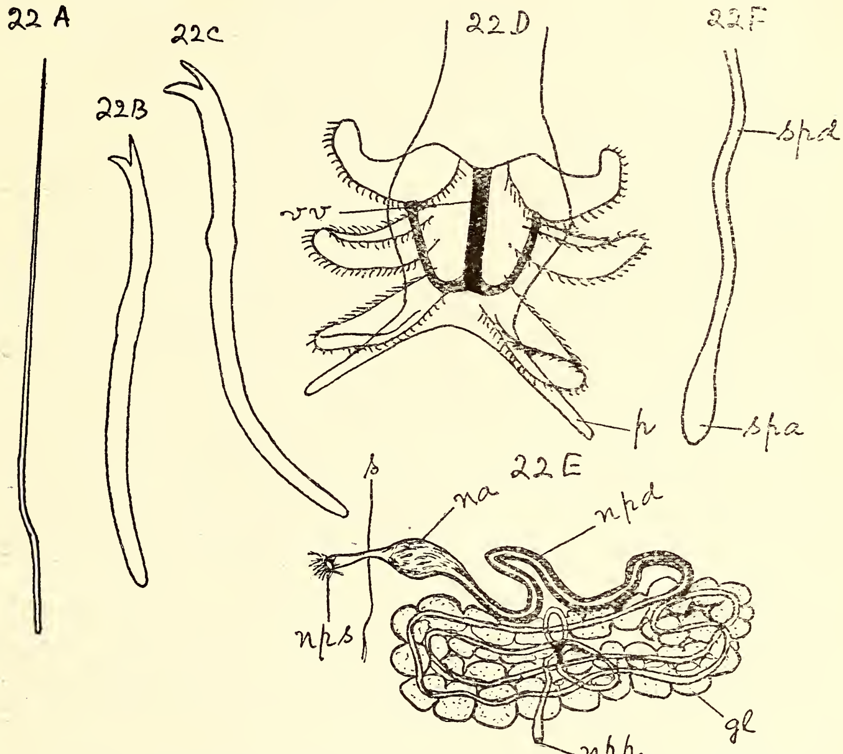


Fig. 22. *Aulophorus hymanae* sp. nov. : A. Hair seta × 275; B. Needle seta × 700; C. Ventral seta of II × 650; D. Branchial organ fully relaxed; E. Nephridium; F. Spermatheca.

gl: gland; *na*: nephridial ampulla; *npd*: nephridial duct; *npp*: nephridial pore; *nps*: nephrostome; *p*: palp; *s*: septum; *spa*: spermathecal ampulla; *spd*: spermathecal duct; *vv*: ventral vessel.

Dorsal setae start in V, 1 hair and 1 needle per bundle. Hair (Fig. 22 A) smooth, bayonet-shaped, 224-273μ long. Needle (Fig. 22 B) sickle-shaped bifid with distal nodulus (D : P : : 7 : 14), shaft above nodulus curved with longitudinal ridge on outer margin, 73.5-80.5 μ long, distal tooth straighter, thinner, and slightly longer than curved proximal. Ventral setae (Fig. 22 C) 4-5 per bundle decreasing to 2-3 posteriorly, in

[1] Named after Dr. Libbie Henriette Hyman of the American Museum of Natural History, New York.

II-IV, 91-98 μ long, thinner, straighter than in others, nodulus median (D: P : : 14:14 or 13:14), distal prong longer (less than twice as long) and thinner than proximal ; in others, 73.5-87.5 μ long, distal prong thinner than and about equal in length to proximal ; position of nodulus, lengths of setae and outer prong vary from seta to seta in bundles.

Length of ventral seta	Position of nodulus D : P : :	Relative length of distal prong to proximal
84.0 μ	11 : 13	longer
80.5 μ	10 : 13	slightly longer
80.5 μ	10 : 13	equal
78.5 μ	9 : 13.5	shorter

Branchial organ (Fig. 22 D) funnel-shaped with 1 pair of long non-contractile, avascular palps and 3 pairs of digitate gills ; I pair arises from supra-anal diverticulum, II and III pairs spring from floor of fossa ; longest gills shorter than palps.

Pharynx in II-V, wide, yellowish, with dorsal diverticulum, eversible through mouth during feeding. Oesophagus thin, starts in VI, insensibly continues into intestine. Stomach absent. Chloragogues greenish grey. No coelomocytes. Septa well developed, each with 2 lateral colourless glassy swellings.

Brain incised anteriorly and posteriorly.

Blood red. Dorsal vessel contractile, mid-dorsal in head segments and ventrally attached to left of the gut from VI on, divides into 3 branches, which unite in II with non-contractile mid-ventral ventral vessel. Non-contractile simple loops in II-V ; contractile vessels 6 pairs in VI-XI.

First pair of nehpridia (Fig. 22 E) in VII, pre-septal funnel with nephrostome in VI, a slender neck connects it to post-septal, consisting of a fusiform ampulla followed by a duct, whose proximal part is thick-walled, middle part glandular, and ectal part thin-walled, with a vesicle before opening ventro-laterally.

Fission zones 1-2 common. In a 3-zooid chain, I fission zone is behind XXIV ; after some segments are budded for anterior zooid, II zone is developed at the same place as the I (i.e. between XXIV and first new segment). Composition of 3 zooids in one chain is : anterior zooid has 24 segments of parent body ; middle zooid has all newly budded segments ; posterior zooid has posterior segments of parent body and a few newly budded segments.

Clitellum from ½V-VII (2½ segments), weaker between male pores. In fully mature sexual worm gonads absent, sexual elements present. Sperm-sac and ovi-sac extend to X and XI respectively when full, former within latter. Sperm-funnels thick-walled cups on anterior face of septum 5/6, with vasa deferentia entering atria in VI. Atrial ampullae ovoid, their ejaculatory ducts open at the position of ventral bundles of

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	XIII	XIV	XV	XVI
Hair	—	—	—	224	238	245	245	234.5	248.5	248.5	252	259	245	245	248.5
Needle	—	—	—	77	78.7	77	80.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	78.7
				8:14	8:14.5	8:14	8:15	7:14	7:14	7:14	7:14	7:14	7:14	7:14	8.5:14
Crotchet	98	91	94.5	84	87.5	85.7	84	80.5	80.5	84	84	84	80.5	77	80.5
	14:14	13:13	13:14	11:13	11:14	10:14.5	10:14	9:14	10:13	10:14	9:15	9:15	9:14	9:13	9:14

VI on papillae, round which clitellum is absent. Female funnels not observed, female pores indistinct in VII ventrally. Spermathecae (Fig. 22 F) a pair in V, club-shaped, extend to VIII in sperm-sac ; open lateral to ventral bundles of V. No penial setae.

1(p.) = 8-10 mm.; d (p.) = 0.4 mm.; s = 50-80; n = 22-39.

Habits : Worms live in mucus tubes with anterior $\frac{1}{2}$-$\frac{2}{3}$ buried in mud, and the rest protruding vertically up in water with gills fully distended. When disturbed, they withdraw their hind ends and disappear into mud. Hind part of body is not waved about. Swim with horizontal transverse undulations.

Commensals : Vorticellids are found attached to setae at either end of body.

Taxonomic discussion: Of the 15 species (13 of Sperber, 1948, *Aulophorus michaelseni,* and *A. indicus* sp. nov. created here) this resembles only 5 species in its dorsal setae starting in V. Amongst these it further resembles *A. furcatus* (Müller), *A. borelli* Michaelsen, and *A. michaelseni* Stephenson in having bifid needles (*A. pectinatus* Stephenson and *A. indicus* sp. nov. have pectinate and trifid needles respectively). It resembles closely *A. furcatus* in having 3 pairs of gills and differs from *A. michaelseni* and *A. borelli* both with 4 pairs of gills. With the distal tooth of the needle longer than proximal and the hairs peculiarly bayonet-shaped, it differs from *A. furcatus* with distal needle tooth shorter than proximal and hairs simple, nearly straight. Minor differences are more hearts (6 pairs as against 5 pairs); greater body size (8-10 mm. as against 2-4 mm.) and greater size of setae (hairs 224-252 μ long as against 85-200 μ, needles 73.5-80 μ long as against 45-62.5 μ; ventral setae 77-98 μ long as against 52-72 μ).

Diagnosis of Aulophorus hymanae *sp. nov.* : No eyes. Dorsal setae start in V, 1 bayonet-shaped hair and 1 bifid needle, with distal tooth straighter, thinner, and slightly longer than curved proximal, per bundle. Ventral setae 4-5 per bundle anteriorly, 2-3 posteriorly; in II-IV longer, thinner, straighter than in others, nodulus median, distal prong longer and thinner than proximal ; in others distal prong thinner, about equal in length to proximal, position of nodulus, lengths of setae and distal prong vary from seta to seta in bundles. Branchial fossa with 1 pair of long palps and 3 pairs of foliate gills, one dorsal and 2 ventral. Stomach absent. No coelomocytes. Septa with colourless swellings.

Blood red. Dorsal vessel ventrally to left, simple non-contractile loops in II-V, contractile lateral vessels 6 pairs in VI-XI. Clitellum in $\frac{1}{2}$V-VII ; seminal funnels cup-shaped ; atria ovoid ; no penial seta ; spermathecae club-shaped.

Budding present, 5 head segments are budded.

Type : The type specimen is being deposited with the Zoological Survey of India, Calcutta.

23. **Aulophorus indicus** sp. nov.

Fig. 23 A-D

Material examined : A few worms collected from the Bugga stream, Cuddapah in April 1954.

Worms of medium size and crimson colour. Prostomium bluntly triangular without sensory hairs. Eyes absent.

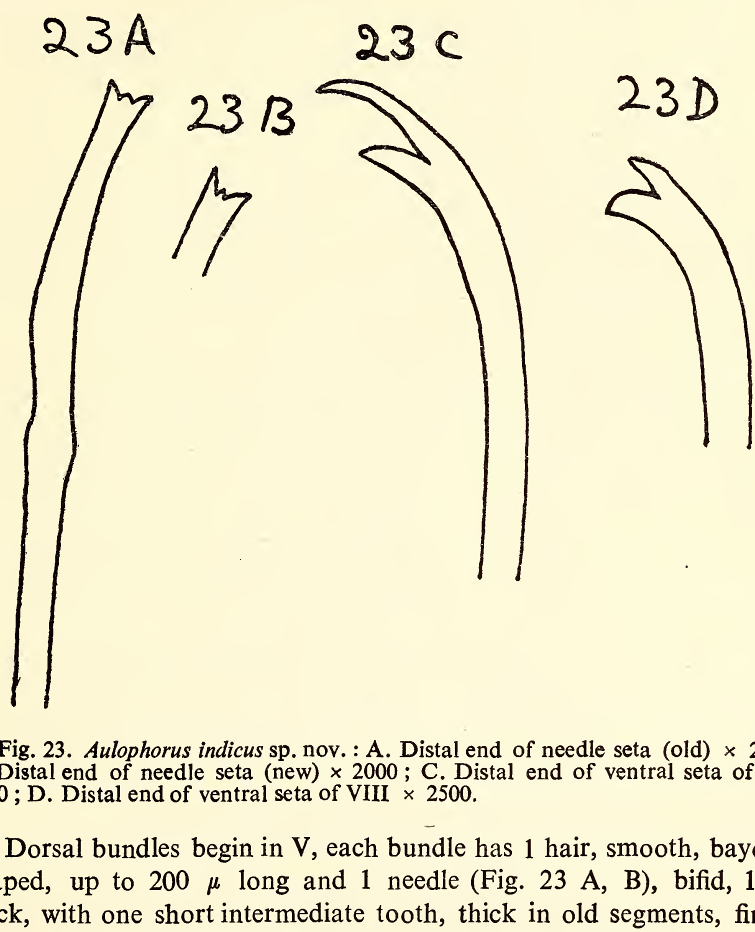


Fig. 23. *Aulophorus indicus* sp. nov. : A. Distal end of needle seta (old) × 2000 ; B. Distal end of needle seta (new) × 2000 ; C. Distal end of ventral seta of II × 2500 ; D. Distal end of ventral seta of VIII × 2500.

Dorsal bundles begin in V, each bundle has 1 hair, smooth, bayonet-shaped, up to 200 μ long and 1 needle (Fig. 23 A, B), bifid, 1.5 μ thick, with one short intermediate tooth, thick in old segments, fine in newly budded segments, main teeth equally long, proximal thicker than distal, nodulus distal, 21 μ from distal end. Ventral setae (Fig. 23 C, D) in II-V, 3 per bundle, 2 μ thick, with proximal nodulus, equally thick prongs, distal more than twice as long as proximal ; in others, 3-4 per bundle anteriorly, 1-2 posteriorly, with distal nodulus, 2.8 μ thick, prongs equally long in anterior segments, distal prong decreasing in length posteriorly, proximal twice as thick as distal.

Branchial organ wide, cup-shaped with postero-dorsal opening, 1 pair of short palps and 1 pair dorsal and 2 pairs ventral gills; palps thin and fold over fossa in contraction.

Pharynx in II-V, wide. Oesophagus in VI-VII, thin. Stomach in VIII-IX. Intestine narrow in X and XI, wide behind; ascending ciliary action and anti-peristalsis occur. Chloragogues from VI on. Coelomocytes opaque, spherical, and morula-like. Septa well developed; septal glands not observed.

Blood crimson red. Dorsal blood vessel ventrally to left from hind end to VI, mid-dorsal cephalad. Simple contractile loops 4 pairs in VI-IX, first 2 pairs thinner than others. Ventral vessel median and wavy.

First nephridium in X, its preseptal funnel in IX.

Brain incised medianly at either end.

No budding zones observed in 8 worms. Fragmentation seems to occur. In one worm segments behind XXX are smaller and younger, evidently regenerated after fragmentation. From newly developed first dorsal bundle in V, it is obvious that 5 segments are regenerated anteriorly for posterior fragment.

Sexual worms not encountered.

l (p.) = 3-6 mm.; d (p.) = 0.2 mm.; s = 47-60 + undifferentiated region ending in branchial fossa; n = 30 (in one).

Taxonomic discussion: This species closely resembles *Aulophorus pectinatus* Stephenson. In having a small, short, intermediate tooth between main needle teeth, 3 pairs of gills, and a distinct stomach, it differs from the latter with 2-4 long intermediate teeth between main needle teeth, 4 pairs of gills and no stomach. Hence it is given the status of a new species.

Diagnosis of Aulophorus indicus *sp. nov.:* No eyes. Dorsal setae start in V, 1 hair and 1 needle per bundle. Hair bayonet-shaped; needle bifid with short intermediate tooth, nodulus distal. Ventral setae of II-V straighter, longer, and thinner than rest, 3 per bundle with proximal nodulus, equally thick prongs, distal more than twice as long as proximal; in others 1-4 per bundle, teeth equally long in anterior segments, distal tooth decreasing in length posteriorly; proximal twice as thick as distal. Stomach, coelomocytes, septal glands absent. Gills 3 pairs, 1 dorsal, 2 ventral. Architomy (fragmentation) occurs, 5 head segments are regenerated.

Type: The type specimen is being deposited with the Zoological Survey of India, Calcutta.

24. **Aulophorus tonkinensis** (Vejdovsky, 1894)

Fig. 24 A-H

Aulophorus tonkinensis (Vejdovsky). Stephenson, 1913b, pp. 738, 744, 757. Sperber, 1948, pp. 196-197 ; 1958, pp. 49-50, figs. 8-9.

Material examined: Numerous worms collected from the Bugga stream, Cuddapah in March 1954, May 1955, January 1956 ; from the Pullalamadugu stream near Cuddapah on 10-6-1954 ; from the Balaji tank, Kakinada in November 1956 ; from the Langford Town tank, Bangalore in May 1958.

Worms small, pale white, and transparent. Head end swells in preservation. Prostomium bluntly triangular with stiff sensory hairs. Eyes absent.

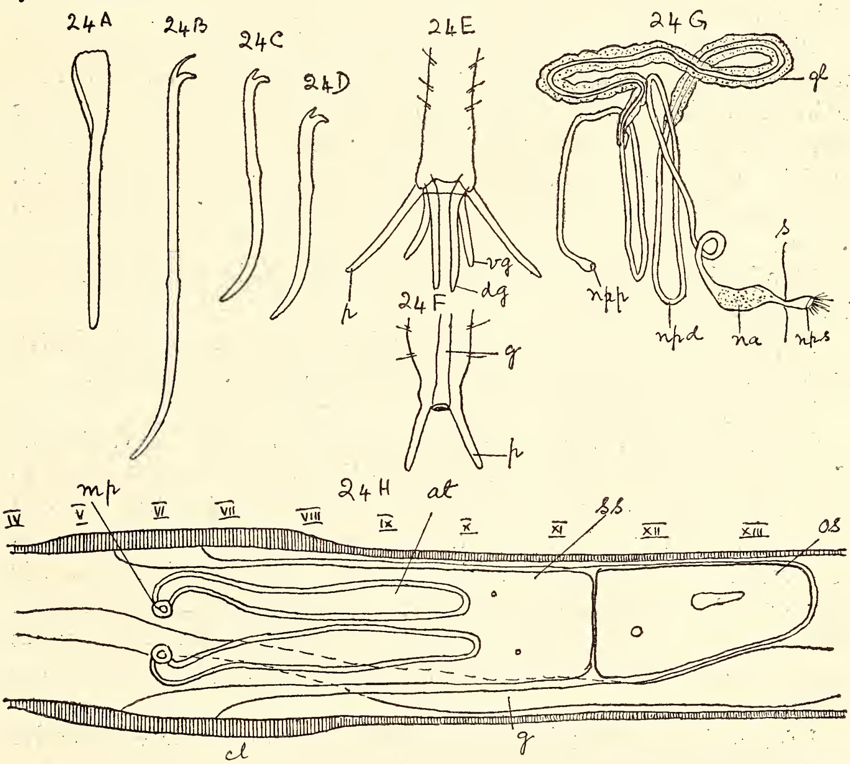


Fig. 24. *Aulophorus tonkinensis* (Vejdovsky): A. Needle seta × 500; B. Ventral seta of II × 500 ; C. and D. Ventral seta of the posterior segment × 500 ; E. Branchial organ (relaxed) ; F. Branchial organ (contracted) ; G. Nephridium ; H. Anterior part of sexual worm.

at : atrium ; *cl* : clitellum ; *dg* : dorsal gill ; *g* : gut ; *gl* : gland ; *mp* : male pore ; *na* : nephridial ampulla ; *npd* : nephridial duct ; *npp* : nephridial pore ; *nps* : nephrostome; *os* : ovi-sac ; *p* : palp ; *s* : septum ; *ss* : sperm-sac ; *vg* : ventral gill.

Dorsal setae begin in VI, 1 hair and 1 needle (occasionally 2 of each) per bundle. Hairs bayonet-shaped, smooth, 105-122.5 μ long, shorter than body-diameter. Needles (Fig. 24A) palmate, nearly straight, 63-70 μ long, nodulus distal (D : P : : 7 : 11), with 2 very long teeth with webbing, without ribs, resembling oars. Ventral setae (Fig. 24 B, C, D) in II-V straighter, thinner than others, 4-5 per bundle, 80-98 μ long, with proximal nodulus (D : P : : 17 : 10 or 16 : 10), distal prong longer and thinner than proximal ; from VI on 3-4 per bundle, 49-56 μ long, with distal nodulus (D : P : : 6 : 9), distal prong shorter and thinner than proximal.

Branchial organ (Fig. 24 E, F) cup-shaped, fossa opening posteriorly with 2 palps, armed with stiff sensory hairs, palps parallel in contraction and diverge in relaxation. Gills 2 pairs, digitiform, shorter than palps ; 1 pair dorsal, longer, stretching backwards, gills parallel to each other ; 1 pair ventral, shorter, diverge slightly and curl upwards in relaxation and are completely withdrawn into fossa in contraction.

Pharynx in II-V, ciliated and thick-walled, eversible through the mouth in the form of disc-like sucker, used for feeding and locomotion. Oesophagus in VI-VIII, thin. Stomach in IX, marked. Intestine thin in X-XI, thick from XII on ; chloragogues cover gut from VI, greyish. Coelomocytes spherical and granular. Septal glands absent.

Brain incised deeply in front and behind with a faint dorso-median groove.

Blood yellow. Simple contractile vessels 2 pairs in VII-VIII, connect dorsal and ventral vessels.

Nephridia commence with VIII or IX, one per segment (Fig. 24 G), pre-septal in anterior, post-septal in posterior, of the two segments.

Budding zone single.

Clitellum from V-½VIII (3½ segments), weak ventrally in V. Gonads absent in sexually mature worms (Fig. 24 H). Sperm-sac with developing sperms and ovi-sac with single large ovum extend to XII and XIII when full, former within latter. Sperm-funnels and ovi-ducts not observed in living worms. Atrial ampullae club-shaped, enormously long, extend to VIII within sperm-sac, when full. Penial setae absent. Male pores in the situation of ventral bundles of VI, female pores in the groove between VI and VII vebtro-laterally. Spermathecae absent.

1 (p.) = 1.2-2.0 mm.; d (p.) = 0.16-0.18 mm.; s = 20-25 + formative zone ending in branchial organ ; n = 15.

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
Hair	—	—	—	—	122.5	122.5	122.5	119	105	112
Needle	—	—	—	—	63 7:11	63 7:11	63 7:11	66.5 7:12	66.5 8:11	66.5 8:11
V. seta	98 18:10	96.2 16:11.5	94.5 17:10	91 16:10	52.5 7:8	54.2 7:8.5	54.2 9:5	52.5 6:9	56 7:9	56 7:9

Distribution in Indian sub-continent : Calcutta, Lucknow, Bhim Tal (N. India); Travancore (S. India). Now recorded from Cuddapah, Bangalore, and Kakinada (S. India).

Habits : Worms live in thin transparent chitinous tubes covered with fragments of leaves and wood, dark granules, sand, etc., tubes hang down with one end attached. They move freely within the tubes and can turn round interchanging positions of head and branchial organ. While resting, head end and branchial organ are protruded out of tubes. Extending the anterior part of its body some distance in front of the tube, it everts pharyngeal sucker and stretches anterior ventral setae, fixes them to substratum and contracts the body, dragging the tube along. Swim with brisk horizontal undulations when freed from tube.

Remarks : Present worms have a marked stomach. Stephenson (1923) indicates presence of stomach in IX. Chen (1940, p. 62) in his diagnosis points out : ' no special stomachic dilatation. Oesophagus swelling in VIII '. His ' Oesophageal swelling in VIII ', obviously is the stomach.

Though Michaelsen (1914) suggested that *Aulophorus oxycephalus* Schmarda, 1861 is identical with *A. tonkinensis* (Vejdovsky, 1894), and Chen (1940) united the two into one under the former name on nomenclatural priority ; it is difficult to determine the identity of the former either as a distinct species or a synonym of the latter. All the characters that are available of the former from the original description are : (1) presence of two short appendages (palps) at the posterior end, (2) circular mouth with a pharyngeal sucker, (3) presence of a tube round its body, (4) dragging type of locomotion similar to that seen in *A. tonkinensis* and *A. vagus*, (5) absence of a stomach, (6) length : 5 mm., diameter : 0.25 mm., (7) dorsal bundles with 3 hair-like setae and ventral bundles with 3 forked setae. In characters (1) to (4) it resembles *A. tonkinensis*. It differs in the absence of a stomach. Length of 5 mm. is greater than that known for *A. tonkinensis* (3.5 mm.) and the 3 setae in the ventral bundles are the minimum found in the hind segments of *A. tonkinensis*. The absence of information regarding the shape etc. of the needles and the setal lengths does not permit of a definite identity. Further investigation on this form is necessary before any decision is reached.

Dero stuhlmanni Stieren (1892) from Trinidad, West Indies, with dorsal setae starting in VI with 1 hair and 1 simple pointed needle ; ventral bundles with 5 setae ; branchial organ, with 2 pairs of gills and 1 pair of palps ; length : 2 mm., agrees with *A. tonkinensis* except in the simple-pointed condition of the needles. As pointed out by Michaelsen (1914), the palmate needles often show themselves on their narrow side, when they appear simple-pointed. It is highly probable that Stieren observed the needles on their narrow side and described them as simple-pointed, which is erroneous. This form is most probably a synonym of *A. tonkinensis.*

8. Genus **Allonais** Sperber, 1948

In the diagnosis of the genus, Sperber (1948) includes absence of stomachal dilatation as one of the characters. In the three species I examined the stomach is present. It is barrel-shaped from XIV-XX or XXI in *A. inaequalis*, fusiform from XI-XII in *A. rayalaseemensis*, and weak from IX-X in *A. gwaliorensis.* Its presence evidently was not clear in the single preserved worm of *A. gwaliorensis* examined by Stephenson (1920) and was overlooked by Chen (1940).

A. gwaliorensis has penial setae, as is the case with all other species of the genus. Chen (1940) seems to have overlooked them.

Generic characters : Eyes absent. Prostomium bluntly triangular. Dorsal setae normally from VI, hairs and double-pointed or pectinate needles ; ventral setae of II-V only slightly different from those of other segments. Stomach present (or absent ?) ; intestinal anti-peristalsis and ascending ciliary vibration occur ; chloragocytes from VI on. Septal glands absent ; coelomocytes present. Dorsal vessel contractile, attached ventrally to the gut on the left side from the hind end to VI, mid-dorsal in 5 anterior segments ; ventral vessel non-contractile and mid-ventral ; usually a vascular plexus in II-V ; and simple vessels in following segments present. Budding zones absent ; fragmentation occurs ; 5 or 6 head segments budded. Sperm-sac and ovi-sac, posterior diverticula of septa 5/6 and 6/7, the former within the latter, extending backwards ; vasa deferentia enter atria above the atrial duct ; no prostate gland cells ; penial setae present.

Generic type : *Allonais inaequalis* (Stephenson)

Key to all the known and valid Species of *ALLONAIS*

A-1 Needle setae bifid
- B-1 Needle teeth curved (distal end horse-shoe shaped) .. ** chelata*
- B-2 Needle teeth straight
  - C-1 Distal tooth of needles longer than proximal .. *gwaliorensis*
  - C-2 Proximal tooth of needles longer than distal
    - D-1 Needles with noduli ; dorsal setae beginning in VI ; regenerate anterior 5 segments

E-1 Needle teeth parallel .. *paraguayensis paraguayensis*

E-2 Needle teeth diverging .. *rayalaseemensis* sp. nov.

D-2 Needles without noduli; dorsal setae beginning in VII; regenerates anterior 6 segments .. * *paraguayensis aequitorialis*

A-2 Needle setae pectinate

F-1 Needles have proximal tooth longer and thicker than the distal .. *inaequalis*

F-2 Needles have equally long and thick teeth .. *pectinata*

* Species not known from the Indian sub-continent.

25. **Allonais inaequalis** (Stephenson, 1911)

Fig. 25 A-C

Allonais inaequalis (Stephenson). Sperber, 1948, pp. 201-202, Fig. 21A-D.

Material examined : A few worms from the Bugga stream, Cuddapah in January 1956.

Largest of all naidid worms in the locality, light brown, with irregular reddish brown patches near dorsal bundles. Eyes absent. Prostomium longer than broad, without sensory hairs.

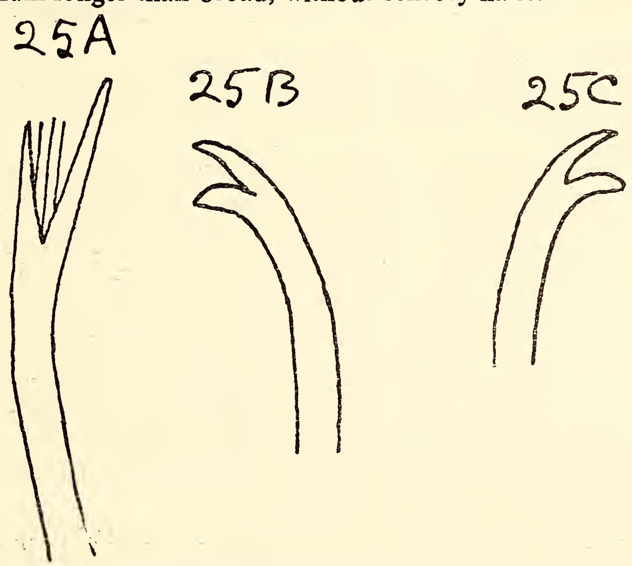


Fig. 25. *Allonais inaequalis* (Stephenson) : A. Distal end of needle seta, B. Distal end of ventral seta of II; C. Distal end of ventral seta of a middle segment.

Dorsal setae begin in VI, 1-2 hairs and 1-2 needles per bundle. Hairs smooth, slightly curved and about half the body-diameter. Needles (Fig. 25A) have 2 straight teeth with 1-3 fine, long, intermediate teeth, nodulus 3/8 - 2/5 from distal end, proximal tooth thicker and 1.5

14

times longer than distal. In one worm hairs 192.5-364 μ long, needles 98 μ in VI and 129.5-143 μ long in others ; ventral setae 101.5-105 μ long, in II-V and 115.5-127.7 μ long in others. Ventral setae (Fig. 25 B, C) have median nodulus in II-V, distal in others ; prongs unequal, distal thinner than proximal, length of distal prong slightly longer to equal in the setae of bundles.

Pharynx in II-V, wide, protrusible in the form of bulb through mouth for feeding. Oesophagus in VI-XIII, narrow. No pharyngeal and oesophageal glands. Stomach in XIV-XX or XXI. Intestine narrow in XXII and XXIII, wide behind ; chloragogues brown. Coelomocytes granular. Septa well developed, no septal glands. Anus postero-dorsal in a miniature fossa.

Brain incised in front and behind.

Blood red. Dorsal vessel mid-dorsal in anterior 5 segments, laterally to left in remaining segments. Contractile vessels 10 pairs in VII-XVI, connect dorsal and ventral vessels. Anterior segments with vascular plexus.

Nephridia begin in VIII, 1 per segment, pre-septal funnel with ciliated nephrostome, connected by slender duct to post-septal, consisting of fusiform brown ampulla and a long duct, its middle part passing through gland tissue, ectal duct ending in nephridiopore ventro-laterally.

No budding ; fragmentation occurs. Hind fragment regenerates 5 head segments and prostomium, anterior fragment an indefinite number of hind segments.

Clitellum from V-VIII (4 segments), absent between male pores. Gonads not seen in sexually mature worms. Sperm-sac with sperms and ovi-sac with single ovum extend to VIII and X respectively. Sperm funnels thick-walled cups opening into sperm-sac. Atrial ampulla spherical, with short, thick ejaculatory duct opening by transverse pore slightly lateral to penial setae in VI. Penial setae 2-3 per bundle with simple distal hook. Female pores large and transverse in intersegmental groove of VI and VII, in a line with ventral bundles. Dorsal bundles of VI-VIII are lost in sexual worms. Spermathecal ampullae ovoid (smaller than atrial ampulla) in V with their pores a little median to and in front of ventral bundles of V.

1 (p.) = up to 20 mm. ; d (p.) = 0.7 mm. ; s = up to 110 + undifferentiated zone ; n = 47 (in one).

Distribution in Indian sub-continent: Agra (N. India) ; Bheemanagar (Travancore, S. India). Now recorded from Cuddapah (S. India).

Habits : Live in aquatic plants and decaying vegetable matter, feeding on them. Swim by slow horizontal undulations.

Remarks : Setal measurements of the present worms are larger than those found in literature.

26. **Allonais rayalaseemensis** sp. nov.

Fig. 26 A-F

Material examined : Several worms collected from the Bugga stream, Cuddapah in November 1953, January 1954 ; from the Kandakam tank, Bellary in April 1954.

Worms large, yellowish brown, with orange-red patches in head segments at sexual maturity. Eyes absent. Prostomium bluntly triangular, longer than broad, with sensory hairs, enclosing coelomic fluid and corpuscles.

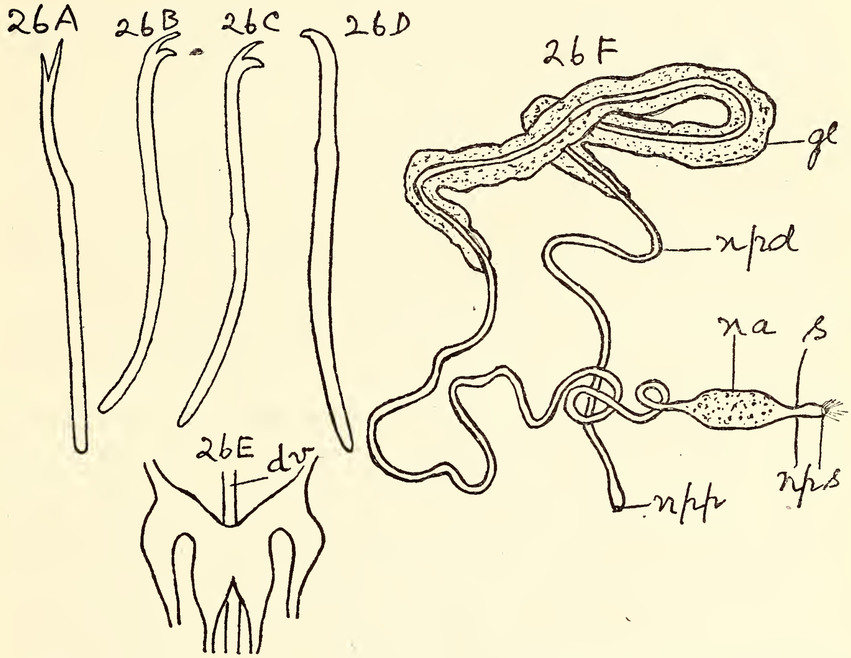


Fig. 26. *Allonais rayalaseemensis* sp. nov. : A. Needle seta × 500 ; B. Ventral seta of II × 500 ; C. Ventral setae of XIII × 500 ; D. Penial seta × 575 ; E. Brain ; F. Nephridium.

dv : dorsal vessel ; *gl :* gland ; *na :* nephridial ampulla ; *npd :* nephridial duct *npp :* nephridial pore ; *nps :* nephrostome ; *s :* septum.

Dorsal setae start in VI, 1-2 hairs and 1-2 needles per bundle. Hairs simple, smooth, straight 238-366 μ long. Needles sickle-shaped (Fig. 26 A) bifid, 80.5-105 μ long, nodulus distal (D : P : : 11 : 18), teeth diverging, proximal tooth slightly bent, twice as long and thick as distal. Ventral setae (Fig. 26 B, C) 4-7 per bundle, in II-V with median nodulus (D : P : : 13 : 12), in others distal nodulus (D : P : : 11 : 15) ; in II up to 91 μ long, gradually decreasing to 84 μ in V, abruptly increasing to 91 μ in succeeding segments. Distal prong thinner and longer than proximal.

Pharynx in II-V, wide and ciliated, partly eversible through mouth for feeding. Oesophagus in VI-X, thin and wavy. Stomach in XI-XII, fusiform. Pharyngeal and oesophageal glands absent. Intestine thin in XIII and wide in following segments, ascending ciliary vibration and anti-peristalsis occur. Anus dorsal, extends from side to side, anterior margin medianly incised, and resembling miniature fossa with inner surface ciliated. Chloragogues from VI, greenish brown. Coelomocytes granular, spherical, 14-17 μ in diameter. Septa well developed, no septal glands.

Brain (Fig. 26 E) incised deeply behind and less deeply in front.

Blood orange-red. Dorsal vessel attached to left wall of gut from hind end to VI, mid-dorsal anteriorly, divides into 2 in prostomium, branches unite with ventral vessel in II. Anterior 5 segments have a plexus of blood vessels formed of lateral vessels ; contractile vessels 6 pairs in VI-XI.

First nephridium (Fig. 26 F) in VII with its nephrostome in VI, connected by a neck passing through septum to post-septal, consisting of an anterior fusiform, granular ampulla and a long coiled nephridial duct, middle part passing through gland tissue and ectal part forming a vesicle before opening to exterior ventro-laterally.

Budding absent ; fragmentation occurs. Posterior fragment regenerates 5 head segments and prostomium ; anterior fragment regenerates several hind segments.

Clitellum opaque from ½V-½VIII (3 segments). In worms with clitellum gonads absent, evidently absorbed after production of sexual cells. Male and female funnels not observed owing to opacity of clitellum. Atria with ovoid ampullae and short thick ejaculatory ducts open near ventral bundles of VI. Penial setae (Fig. 26 D) 4-5 per bundle 119 μ long and hooked distally. Sperm- and ovi-sac, back-pouchings of septa 5/6 and 6/7, extending to X and XIII respectively, the former within the latter. Spermathecal ampullae ovoid and open by pores in front of ventral bundles of V.

1 (living) = 18-20 mm.; 1 (preserved) = 11-13 mm. ; d (p.) = 0.4 mm.; s = 93-118 + undifferentiated zone; n = 48 and 54 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	IX	X	XI
Hair	—	—	—	—	280	245	294	322	301	366
Needle	—	—	—	—	91	101.5	105	101.5	101.5	101.5
					9:17	11:18	10:19	11:18	11:18	11:18
Crotchet	91	87.5	84	84	87.5	87.5	91	91	91	87.5
	14:12	13:12	12:12	12:12	11:14	11:14	12:14	12:14	11:15	11:14

Habits: Live among algae and decaying vegetable matter feeding on them. Worms left in a vessel of water (without any aquatic plants) entangle themselves with one another to form knotty masses ; on removal to a slide with some water, they move away in all directions. Swim by slow transverse movements.

Taxonomic discussion : Of the 5 species in this genus, it closely resembles *Allonais paraguayensis paraguayensis* (Michaelsen) in the possession of non-pectinate needles with proximal tooth thicker and longer than distal; and differs from it in having diverging needle teeth (teeth nearly parallel in *paraguayensis*), and smaller setae (larger in *paraguayensis*).

Diagnosis of Allonais rayalaseemensis *sp. nov.*: No eyes. Dorsal setae begin in VI. 1-2 hairs and 1-2 needles with straight diverging teeth, proximal twice as long and as thick as distal ; nodulus distal. Ventral setae 4-7 per bundle, all about equally long with distal prong slightly longer and thinner than proximal, in anterior segments nodulus median, in others distal. Vascular system forms a plexus in II-V ; 6 pairs of contractile lateral vessels in VI-XI. Stomach in XI-XII. Clitellum in $\frac{1}{2}$V-$\frac{1}{2}$VIII ; atria ovoid ; penial setae with simple distal hook, 4-5 per bundle. Fragmentation occurs.

Type : The type specimen is being deposited in Zoological Survey of India, Calcutta.

27. **Allonais gwaliorensis** (Stephenson, 1920)

Fig. 27 A-F

Allonais gwaliorensis (Stephenson). Sperber, 1948, pp. 205-206.
(?) *Allonais gwaliorensis* (Stephenson). Sperber, 1958, p. 50, figs. 10-12.

Material examined : Several worms collected from the Bugga stream, Cuddapah, all round the year from 1952-55 and 1957 ; from the Balaji tank, Kakinada in July and November 1956.

Worms of medium size, delicate, slender, and pale white. Prostomium bluntly triangular, slightly longer than broad without sensory hairs.

Dorsal bundles of setae begin in VI, 1-2 hairs and 1-2 needles per bundle. Hairs simple, smooth, 140-161 μ long. Needles sickle-shaped (Fig. 27 A), bifid with weak nodulus, a third from distal end, 59.5-66.5 μ long, distal tooth thinner, slightly longer, and straighter than proximal, with deep acute angle between the teeth. Ventral setae (Fig. 27 B, C) in II-V, 4-5 per bundle, 56-63 μ long, 2 μ thick, thinner, straighter than others, prongs equally thick, distal longer and more hooked than proximal ; in others, 4-6 per bundle, 52.5-56 μ long, 2.5 μ thick, distal prong thinner and slightly longer than proximal. Nodulus slightly proximal in

II-IV, median in V, and distal in others; position of nodulus is fairly constant in setae of bundles.

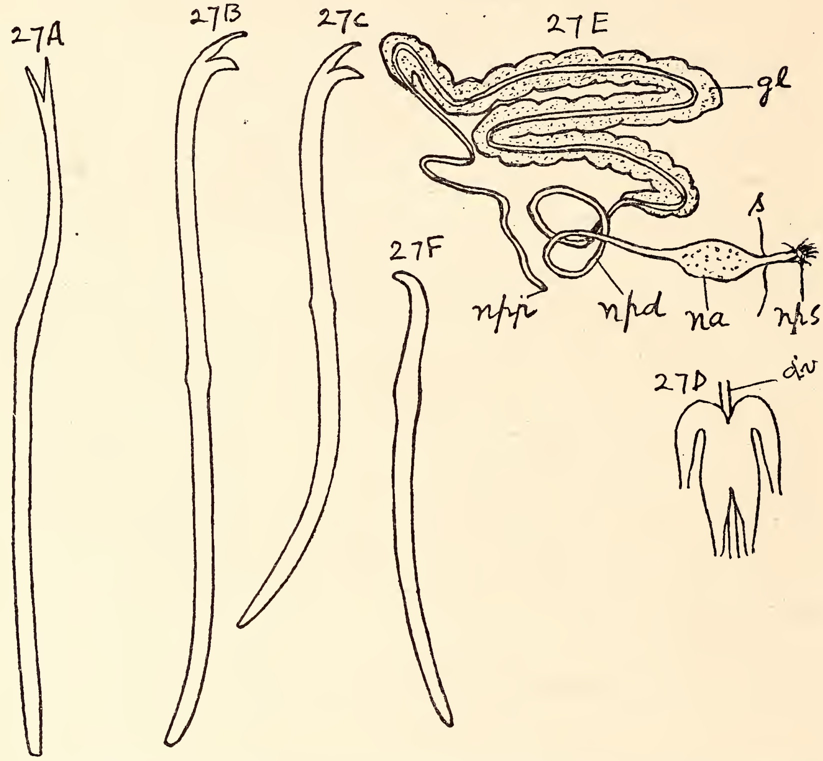


Fig. 27. *Allonais gwaliorensis* (Stephenson): A. Needle seta × 1200; B. Ventral seta of II × 1200; C. Ventral seta of XIII × 1200; D. Brain; E. Nephridium; F. Penial setae × 800.

dv: dorsal vessel; *gl*: gland; *na*: nephridial ampulla; *npd*: nephridial duct; *npp*: nephridial pore; *nps*: nephrostome; *s*: septum.

Pharynx in II-V, ciliated, wide, and eversible through the mouth in the form of a bulb for feeding. Oesophagus in VI-VIII, narrow. No pharyngeal and oesophageal glands. Stomach in IX-X, weak. Intestine thin in XI and XII, wide in rest. Anus is postero-dorsal. Chloragogues greenish brown. Coelomocytes whitish, spherical 10-14 μ in diameter. Septa well developed, no septal glands.

Brain (Fig. 27 D) incised deeply posteriorly and less deeply anteriorly.

Blood yellowish. Contractile lateral vessels 3 pairs in VI-VIII; non-contractile vessels 4 pairs in II-V.

Nephridia (Fig. 27 E) start in VII, one per segment, placed to left; pre-septal funnel with ciliated nephrostome in one segment, and post-septal with a brown, fusiform ampulla followed by a coiled duct partly passing through gland tissue and opening ventro-laterally in next segment.

Budding absent ; fragmentation occurs. A worm kept in a tube of water for a day fragmented into 2, each fragment with 29 segments. Posterior fragment regenerated 5 head segments and prostomium and anterior fragment regenerated several hind segments.

Sexual worms abundant in winter. In January 1954 several sexual worms were collected. Testes and ovaries develop first in V and VI, after production of sex cells they are resorbed. Clitellum develops later from ½ V-VII (2½ segments). Sperm- and ovi-sac extend to XII and XIII respectively when full, the former within the latter. Sperm-funnels cup-shaped with ciliated margins, open in sperm-sac. Vas deferens thin, coiled, and open into large ovoid atria in VI. Atrial ejaculatory ducts short and open to exterior ventro-laterally in a shallow depression by the side of penial setae in VI. Penial setae (Fig. 27 F) 3-5 per bundle, 63 μ long. Female funnels not observed. Spermathecae ovoid, thin-walled, 1½-2 times as long as broad, ectal ducts short and open in front of ventral bundles of V. Clitellum begins to form before male funnels and spermathecae are fully formed, but only after sperm- and ovi-sac are fully developed.

1 (living) = 4-12 mm.; d (living) = 0.2 mm.; s = 23-86 ; n = 29 (in one worm).

Lengths of longest setae in μ and position of nodulus in the ratio D : P ::

	II	III	IV	V	VI	VII	VIII	IX	X
Hair	—	—	—	—	140	157.5	157.5	164	140
Needle	—	—	—	—	59.5	63	63	63	63
					5:12	6:12	6:12	6:12	6:12
V. seta	63	59.5	56	56	56	52.5	52.5	52.5	52.5
	9:9	9:8	9:7	8:8	7:9	7:8	7:8	7:8	7:8

Distribution in Indian sub-continent: Gwalior (central India). Now recorded from Cuddapah and Kakinada (S. India).

Habits: Worms live in algae and aquatic vegetation; do not construct tubes. Swim by transverse undulations.

Commensals : Number of sessile Vorticellids are found attached to setae of these worms.

Parasites : Holotrichous astomatous Ciliates akin to *Anoplophrya* are seen in the gut of some worms.

Remarks : The descriptions of *Allonais gwaliorensis* available in the literature are incomplete. Details regarding the blood colour, vascular system, lacking in the descriptions, are here included. Penial setae are present, 3-5 per bundle, and are similar in shape to those of *Nais variabilis*. Chen (1940) seems to have overlooked them. Stomach, stated to be absent by the previous authors, is also present.

(*To be continued*)

The BNHS/WHO Bird Migration Study Project—2

Activities from 15-12-61 to 15-10-62.

BY

SÁLIM ALI

Chief Investigator, BNHS/WHO Bird Migration Study Project

[*Continued from Vol.* **59** (1) : 130]

1. Edanad, Kerala: 21 December 1961 to 25 January 1962 and 18 March 1962 to 6 April 1962

In December 1961, soon after I returned from the exploratory trip in north-eastern India, intimation was received from Mr. P. V. George of Kerala—one of the Baroda University Zoology post-graduates who had assisted in the field camps in Saurashtra and Rajasthan earlier—of the discovery of some large roosts of Yellow Wagtails (*Motacilla flava*) at Edanad near Chengannur (*c.* 60 miles S. of Cochin, 9° 20′ N.×76° 38′ E.) in standing fields of sugarcane. The story of how the roosts were located after a fortnight's trailing of the birds has been related elsewhere (*J. Bombay nat. Hist. Soc.* **59** : 294-6). I sent off two of Bombay Natural History Society's experienced field assistants to assist Mr. George who meanwhile had managed to recruit some local helpers.

Netting started in the area on 21 December but, owing to difficulty in getting adequate supplies of rings, work was intermittent and finally closed down on 25 January pending the arrival of further rings from Europe. In the 20 days of irregular netting 1897 birds were netted and ringed. Attention was restricted to migrant species; resident birds that blundered into the nets were merely examined for ectoparasites, and if negative were promptly released. Owing to pressure of time and the labour involved in handling such large catches this was the only practicable course.

I visited Kerala in the latter part of January to inspect the scene of operations, arriving at Edanad via Cochin on the 21st and returning to Bombay on the 26th.

The wagtails spend the day feeding in the dyked paddylands of Kuttanad in Vembanad Lake (near Alleppey) and commute 20 to 25 miles SE. every evening to roost among the sugarcane fields at Edanad in fantastically large numbers. On arrival at the roosting ground they mill around 50 to 100 feet over the cane fields filling the sky from horizon to horizon, looking like a swarm of locusts. Gradually the birds begin to drop into the cane at a steep angle, first singly, then in twos and threes, and then in scores and hundreds. By half an hour after sunset all the birds have settled in, leaving the sky clear again. Soon their soft chittering dies down so that there is nothing to suggest the presence of the enormous numbers hidden within the cane. It shows how easily one could miss even such a large roost unless one chanced to be on the spot during just the crucial half hour or so into which all the activity is packed.

A line of nets, a couple of feet higher than the cane tops, had been strung along the edge of the fields. Since the birds entered the cane by dropping from above very few were caught at the time of settling. After all the birds had settled, and while there was still some daylight left, a couple of men entered the cane field from the opposite side to disturb the birds, which then flew out more or less horizontally and straight into the nets. In this way it was possible to make sizeable catches at the same roost day after day without scaring the birds away.

On the replenishment of the stock of rings, work on the Kerala wagtails was resumed. A field camp was set up at Edanad under the leadership of Mr. George. He was assisted by four staff members of the Bombay Natural History Society, four of his zoology students from St. Berchman's College, Changanacherry, and Rev. A. Krebs, a Danish missionary from Madras State.

During the period between 18 March and 6 April, a further 4067 birds were caught and ringed by the Kerala party, all but 4 of which were Yellow Wagtails (*M. flava*) of at least four subspecies representing populations from more or less the entire Palaearctic Region, west to east (see list below).

2. Mahim, Greater Bombay, Maharashtra: February 1962

In the interval, in February 1962, a fortunate circumstance had led to the discovery of a populous roost of the migratory Eastern Swallow (*Hirundo rustica gutturalis*) almost at our doorstep, so to say, right within the limits of Bombay City. It was situated in a dense patch of mangroves adjoining the dilapidated hovels of squatters along the edge of Mahim Creek at the Bandra (northern) end of the Causeway.

Several thousand swallows concentrate to roost in this mangrove patch, not more than a couple of acres in extent, from their widespread foraging around the City. During three evenings 497 swallows were ringed. Since then, much public interest has been aroused in bird migration and in the Society's ringing activities by the showing all over the country of a documentary news film of our operations at Mahim made on that occasion by the Films Division of the Government of India.

Work was held up thereafter for want of rings of the appropriate size. There was a gap of 15 days till a further supply was procured, but in the interval the birds were found to have abandoned the roost completely. Whether they had suddenly shifted to some other roost, or had already started on their northward emigration was uncertain. However, the discovery of this roost so near Bombay opens up promising possibilities for ringing migratory swallows—and, may be, also wagtails and other species—throughout their winter sojourn in these parts. These possibilities will be fully explored in the coming season.

3. Bharatpur, Rajasthan: 16 March 1962 to 3 April 1962

The second camp for the spring migration ringing was again conducted in Bharatpur (Rajasthan). Local clues furnished by H.H. the Maharaja led to the discovery of a gigantic communal roost of migratory sparrows, the Eastern Spanish (*Passer hispaniolensis transcaspicus*) and the Turkestan House Sparrow (*P. domesticus parkini* and/or *bactrianus* ?). The former's breeding range extends from Asia Minor eastward to Transcaucasia, Iran, Russian Turkestan, and northern Afghanistan; the latter breeds throughout Hazara, Kashmir, and Baltistan, to Ladakh, Turkestan, etc. They both visit north-western India in winter, usually keeping in mixed flocks, but neither my own experience nor the literature had ever suggested such unbelievable hordes within Indian limits. Guesswork estimates are always unsatisfactory, but a million birds for this roost would perhaps be on the cautious side. The area of the roost, situated about 7 miles out of Bharatpur on the Deeg road, perhaps a hundred acres or somewhat more, shows signs of monsoon inundation and is dotted with bushes, shrubs, and small (mostly thorny) trees, singly and in mixed clumps, of *Zizyphus, Capparis aphylla, Acacia, Prosopis spicigera, Salvadora,* etc. The sparrows gather here at sunset from the wide expanse of surrounding wheat fields where they commit their depredations throughout the day. They fly about in dense black clouds, settling from time to time on the ripening wheat crops. When shouted off by the watchmen, the cloud rises only to resettle in a neighbouring field. The slings and yells of the farmers merely serve to keep the birds on the move and prevent concentrated damage in any one area. Before retiring into the roosting bushes at sunset the birds fly about restlessly, perching in thick clusters on leafless bush- and tree-tops, silhouetted against the sky like a crop of dense foliage. Apart from a strategic deployment of the nets in the shrubbery across the line of the birds' approach, much success was experienced by two persons carrying an open net stretched between bamboo poles and raised high against a roosting bush after dark. When disturbed from the opposite side, masses of birds flew out straight into the net, often in such quantities that it became difficult for the netters to support the weight.

In 19 days of netting in the Bharatpur area nearly 3000 birds were caught and ringed. The majority of these consisted of the two sparrows, but also included were about 300 wagtails and 78 Garganey Teal (the latter got from professional fowlers). All the wagtails, chiefly *Motacilla flava* and *M. citreola*, were taken at the reedbed roost in Keoladeo Bird Sanctuary where about 150 had been ringed in May last year. One of the latter (*M. citreola* No. A-5542, ringed 15-5-1961) was recaptured in the identical spot on 26-3-1962, presumably having been to its homeland and back during the interval.

The grand total of migratory birds ringed at all stations during the period from 15-12-'61 to 15-4-'62 is 8931, broken up as under:

Motacilla alba dukhunensis	..	12
Motacilla flava beema	..	2573
Motacilla flava thunbergi	..	1270
Motacilla flava melanogrisea	..	303
Motacilla flava simillima	..	364
Motacilla flava subspecies ?	..	1232
Motacilla citreola	..	355
Motacilla indica	..	355
Hirundo rustica rustica	..	9
Hirundo rustica gutturalis	..	501
Passer hispaniolensis transcaspicus	..	1294
Passer domesticus parkini and/or *bactrianus* ?	..	457
Acrocephalus stentoreus	..	13
Erithacus svecica subspecies ?	..	21
Emberiza bruniceps	..	33
Anas querquedula	..	78
Total of other species less than 10 each	..	61
Total	..	8931

Yellow Wagtails in immature and winter plumages are notoriously difficult to distinguish. In the list above I feel almost certain that many *M. f. simillima* at least have been misidentified as either *M. f. melanogrisea* or *M. citreola.*

4. Hingolgadh, Saurashtra: 15 September 1962 to 1 October 1962

The physiography of the netting area has been already described [*J. Bombay nat. Hist. Soc.* **59** (1) : 111]. The monsoon had been poor and the rainfall the lowest in years. Up to the time the field work commenced only very little rain had fallen. Grass cover was scarce and depressions, ponds, and tanks were largely dry. Except for some heavy showers that fell on 22-24 September there was practically no more rain, and the monsoon ended with a considerable deficit. Rosy Pastor migration was noticeably weak, but the other passerine migrants appeared in their usual numbers. High winds hampered mist netting seriously, and on a number of days even rendered it impossible.

Owing to the large number of village cattle let into the netting area for grazing, due to scarcity conditions outside the reserve, the damage caused to the nets was considerable and made their use uneconomical. Since the work proved only moderately productive it was decided to close down the Hingolgadh camp on 1st October and transfer some of the personnel to Bharatpur which needed more hands.

Yuvraj Shivrajkumar, who directed the Hingolgadh camp, took the opportunity of inviting the Forest Minister and other officials of the Gujarat Government, together with over 300 local celebrities chiefly Sarpanches[1] from the surrounding villages, to explain and demonstrate to them the BNHS/WHO bird netting and ringing project and to explain its significance for the study of arbor-virus dissemination. This was chiefly in order to enlist local interest and co-operation and to allay prejudicial rumours about our activities. The function was a great success, and the publicity given to the Project should be of considerable help in furthering the field work in Gujarat.

One of the more interesting catches at Hingolgadh was a *Sylvia curruca* (*blythii*) ringed at the same place on 24 September 1961, exactly one year before. With this, and several other similar recaptures, evidence is fast accumulating that many Indian migrants

---

[1] Heads of village councils

are also 'ortstreue' or faithful to their wintering areas, as they have been shown to be to their nesting places.

One *S. hortensis*, in fact, originally ringed at Hingolgadh on 27 September 1960 was recaptured there on 21 September 1961, and then again in the same place on 18 September 1962[1], showing the regularity of return and parochiality of migrants in their winter haunts. The Hingolgadh camp ended with a total of 509 birds (63 species) ringed, of which 353 (25 spp.) were migrants. Prominent among them were *Sylvia communis icterops* 77, *S. curruca blythii* 74, *Calandrella cinerea* (*dukhunensis*) 74, *Muscicapa striata neumanni* 48, *Sylvia hortensis jerdoni* 35, *Anthus campestris* 22.

The netting in Hingolgadh added one more species to the Gujarat and Saurashtra bird list, viz. the Whitecapped Bunting, *Emberiza stewarti*, which has not been recorded so far south in India before[2].

5. Bharatpur, Rajasthan: 15 September 1962 to 15 October 1962

The Spanish Sparrow roost area where some very successful netting was done in March-April 1962 was flooded and not easily approachable except by boat across the intervening deep canals. Flocks of sparrows and Redheaded Buntings (*E. bruniceps*) were, all the same, observed flying to the roost at sunset. The sparrows were mostly *Passer domesticus indicus*, but definitely with numbers of the large migratory race *parkini* among them. Apparently *P. hispaniolensis* arrives somewhat later, since none were identified amongst those observed or taken in the nets.

By watching the steady streams of yellow wagtail flocks flying in a fixed direction before sunset for 3 or 4 successive evenings, the roost was finally traced down to an extensive area (about a square mile or more) of flooded sugarcane fields about 10 miles NE. of Bharatpur (near Pengore village in Kumher tahsil). The number of wagtails arriving at this roost from all directions at sunset defy estimation. The sky above the cane fields just before the birds dropped in for the night was a dense seething mass of milling wagtails—reminiscent of a gigantic swarming of bees. There may be a million birds or just as credibly several million. The large numbers of Redheaded Buntings among them at first seemed to get progressively fewer day by day, presumably as the birds dispersed to other wintering areas.

In spite of the physical difficulties of working this roost, involving a daily round trip of 24 mile car-drive plus 8-10 miles across country

---

[1] *infra*, p. 963.

[2] *infra*, p. 956. [Has been collected at Nagpur, Maharashtra (D'Abreu, 1931 *J. Bombay nat. Hist. Soc.* **35** : 218).—Eds.]

on foot over slippery bunds and swampy fields in the midday heat and staggering back again laden with birds in more or less complete darkness, very satisfactory results were obtained. The Bharatpur autumn session ended with a total of 2102 birds ringed, nearly all of them migrants. For shortage of personnel and pressure of time all resident birds netted were merely examined for ticks and released without ringing, except for a few birds ringed at the beginning of the session.

Twenty-one species of migrants are represented in the above, with *Motacilla flava* (subspecies *beema, thunbergi, melanogrisea, simillima*) 778 and *M. citreola* (2 races) 854 heading the list. Also included are 163 *Erithacus svecicus* (ssp. ?), 172 *Emberiza bruniceps,* 28 *Hirundo rustica,* 19 *Anthus trivialis.*

6. Ectoparasites

Disappointingly enough, from all the hundreds of migratory wagtails and swallows examined for ticks in Kerala, Rajasthan, and Bombay during the winter and spring and early summer (December 1961 to April 1962) only a single *M. f. beema* from Bharatpur (No. A-34052) was found positive for ticks. It carried a single nymph of *Hyalomma m. isaaci,* described as a common ixodid (hard) tick of dry areas of NW. India, adults of which are commonly met with on cattle in Kutch and Saurashtra. The only other tick collected during the spring migration operations was a nymph of *Haemaphysalis intermedia*[1] on a Spanish Sparrow, *Passer hispaniolensis* (No. A-34050), also in Bharatpur. Both of these ticks could have been locally acquired. As against the above it is interesting to note that four of the 330 Yellow Wagtails examined in Bharatpur during the previous autumn immigration (September, 1961) carried larvae and nymphs of *Haemaphysalis m. isaaci.* The differential infestation probably has some seasonal significance. While none of the migratory swallows (*Hirundo rustica*) taken in Bombay or Bharatpur were infested, it is noteworthy that all the four resident Cliff Swallows (*Hirundo fluvicola*) examined in Bharatpur (i.e. 100%) carried argasid (soft) tick larvae (3, 7, 9, and 49 specimens each respectively) of what may prove to be an undescribed species or subspecies of the genus *Argus.*

In the autumn 1962 operations ticks were collected from 85 of the Hingolgadh birds, whereas of the very much larger number examined

---

[1] Kindly identified by the Virus Research Centre, Poona, who report that presently there is some confusion about the name '*intermedia*' which will probably have to be replaced.

in Bharatpur only 19 proved positive. The preserved tick material is being identified by the Virus Research Centre, Poona. For want of laboratory facilities no live ticks were collected for virological study.

Compared to Bharatpur, the percentage of birds positive for ticks at Hingolgadh was considerably higher. This may be because of the nature of the country, the dry scrub jungle being a more suitable habitat for ticks than the swampy fallow and grazing lands and inundated sugarcane fields frequented by the yellow wagtails which formed the majority of the catches in Bharatpur.

The most productive species as regards ticks were:

Hingolgadh :		
Sylvia communis icterops (migrant)	..	33
Saxicoloides fulicata cambayensis (resident)	..	3
Bharatpur :		
Motacilla flava all sub-spp. (migrant)	..	9
Motacilla citreola (migrant)	..	5
Anthus trivialis (migrant)	..	3

At the invitation of W.H.O., Prof. G. I. Netzky, parasitologist of the Institute for Diseases with Natural Foci, Omsk, U.S.S.R., spent about 3 weeks at our Bharatpur camp. The object of the visit was to acquaint himself with the nature of our activities and techniques with a view to devising ways and means for closer co-operation and collaboration with the Omsk Institute. It has seemed unfortunate that, through restriction of their laboratory facilities, the Virus Research Centre, Poona, has not been able to make any virological studies on the arthropod material collected from birds by our field teams. Prof. Netzky will consult his colleagues in Russia and work out a scheme for greater reciprocal usefulness. In addition to ticks he was very anxious that we should also collect Gamasid mites from birds, both migratory and resident, and from birds' nests, since in the opinion of Russian workers Gamasid mites could play a highly significant role in the dissemination of viruses.

Reviews

1. THE MIGRATIONS OF BIRDS. By Jean Dorst. Translated (from the French) by Constance D. Sherman. With a Foreword by Roger Tory Peterson. pp. xix+476 (21×14 cm.). With photographs, maps and diagrams in the text. Heinemann, London, 1962. Price 50*s*. net.

Bird migration and the many mysteries that enshroud it have excited the wonderment of man through the ages. Many theories and beliefs, often quite fantastic, were entertained by the ancients, some of which persisted even till the dawn of what may be called the modern scientific era. The scientific study of bird migration, however, really began at the turn of the century with the initiation (by a Danish schoolmaster) of the method of marking birds with metal rings round their legs, bearing the address of the ringer to enable all recoveries to be reported back. Thus gradually accumulated precise scientific data in place of conjecture and guesswork concerning the lives and seasonal movements of individual birds or geographical populations—knowledge impossible to obtain in any other way. With the progressive refinement and development of the technique, bird ringing—or 'banding' as it is called in America—has now become one of the most important and universally employed tools for bird migration study. The basic information it has yielded has made possible the branching out of migration study into a large number of subsidiary scientific investigations previously unthinkable. Concomitantly with ringing have been developed and perfected other methods of study as a result of modern advanced technology. The rising tempo of investigations and the resulting torrent of migration literature, in many languages and in many countries, made it physically impossible for even a serious worker to keep abreast with current knowledge. Thus, the timely publication of this book by a biologist of Dr. Dorst's stature and experience is a significant event. It contains the distilled essence of all the more important recent publications on bird migration in Europe and America as evidenced by the truly formidable bibliography of no less than 60 pages at the end—a compilation which in itself is of the highest usefulness for the student.

It is not possible in this short review even to attempt to do proper justice to a work of such wide comprehensiveness. One is struck with admiration at the masterly way in which the author has marshalled the vast array of material confronting him, and moulded and condensed it all into the limits of one useful and fascinating volume. It surveys the entire field of bird migration, and the reviewer can do no better than indicate its coverage by the chapter headings and some of the topics discussed:

1. Old Explanations of Bird Migrations
   (Hibernation, lying torpid at bottom of marshes, etc.)
2. Methods of Studying Migrations
   (Visual observation, Ringing, Moon-watching, Radar)
3. Migrations in Europe and Northern Asia
4. Migrations in North America
   (Availability of so much detailed information about routes and goals of migrants indicates the value of large scale ringing with the co-operation of a wide network of amateur bird students and associations)
5. Migrations in the Southern Hemisphere
   [*Contra* the position in the northern hemisphere, although many boreal birds winter in Patagonia (the only land closest to the South Pole with a warm summer and cold winter), not a single austral bird crosses the intertropical zone during the southern autumn migration. Most do not fly north even to the equator]
6. Migrations in Intertropical Regions
   (Influenced chiefly by rhythmic succession of wet and dry seasons which profoundly affect animals and plants, and thus food supply—hatching of insects, ripening of fruits, etc.)
7. Sea-bird Migrations
   (Gives interesting information about the astonishing movements of many species, e.g. albatrosses, penguins, eider ducks, etc., by gliding on widespread wings and drifting with wind currents, or by swimming. Effect of gales in abnormal migrations. Hurricane hazards to sea birds)
8. Modes of Migration
   (Topographical features as guides. Speed. Altitude. Distances covered in a day. Time taken in entire migratory journey. Importance of meteorological conditions. Diurnal and Nocturnal migrants. Greatest activity of latter between 8 p.m. and 4 a.m. with peak just before midnight)
9. Bird Invasions
   (Not true migrations. Influenced by food cycles, often at more or less regular intervals. Pallas's Sandgrouse, Waxwing, Rosy Pastor, etc.)

10. Hibernation in Birds
(Some birds capable of reacting to cold and food scarcity in winter by becoming torpid with reduced temperature and metabolism. Swallow, Swift, Poor-will of California)
11. The Physiological Stimulus of Migration
(The various experiments and theories. Migration depends on a complex internal rhythm, like Moult and Reproduction. Influence of endocrine system, particularly the pituitary gland, on cycle of genital organs, accumulation of fat, and general metabolism)
12. Orientation of Migratory Birds
[The importance of visual and meteorological landmarks. Bearings obtained from constellations at night (Sauer's experiments) and from sun in daytime (Kramer's and Matthew's experiments)]
13. The origin and Evolution of Migrations
(Origin explainable by power of flight in birds and changes in geography and climatology since the Tertiary period. Changes in distribution due to alternation of glacial and interglacial periods. Some curious patterns of migration that have evolved: certain birds from Alaska migrate south-west, right across Asia and Europe to Africa. Process of range extension due to climatic changes as observable even today in Scandinavian countries. Role of migratory birds in the dissemination of plants and viruses)

The book concludes with this significant paragraph:

'All of this reveals that we must be on guard against the over-simplified explanations which have been advanced ever since mankind became interested in ornithology. Migrations, like birds themselves, are multiple and involve a number of different elements which cannot be reduced to a rigid formula.'

This review must not end without a note of high praise for the translator. If the book had been written directly in English it is doubtful if it could have been made more absorbingly readable.

S.A.

2. A HUNTER'S SAGA. By W. Robert Foran. Foreword by Captain C. R. S. Pitman. pp. 192 (22×15 cm.). 8 half-tone plates. London, 1961. Robert Hale Limited. Price 18*s*.

This book is a welcome change from the 'modern' shikar stories written by persons who make fortnight-long trips for 'guaranteed' tiger and other game.

Major Foran commences at the turn of the century and, though his experience in India was over a relatively short period, he shot 3 tigers from a machan in one night, a man-eater while it was fatally mauling a man, and also watched a battle between a cow buffalo and a tiger in which the latter was mangled and killed.

In Africa, he shot 400 elephants in 6 years and the illustrations, which on the whole are indifferent, include a picture of ivory valued at £3000 which he had poached in 6 months in the Belgian Congo. Commercialised hunting of this kind, though it may have appeared laudable and harmless then, has helped to decimate wild life in all parts of the world. There can however be no doubt that the killing of so many elephants, and all on foot, must have produced many reasons for his opinion that the elephant is the most dangerous of all wild animals.

In his long career, he has had many strange and exciting experiences. He was surrounded by cow elephants which continued to enjoy their noontime siesta and, as time dragged on, he remained motionless—legs and arms becoming cramped—'at last I could stand the strain no longer . . . . . cautiously I took the spear from the tracker's hand and swung the weapon to wallop the rump of the cow with a hard blow . . . . . the steel head of the spear hit her posterior with a resounding thud and the shaft broke into 3 pieces . . . . . the cow sprang to life, emitted a shrill and ear-piercing scream, tucked her tail well in and was off into the bush.' The other elephants all stampeded and left the area.

He was tossed by an elephant, and was attacked by a buffalo while lying between the sloping buttress-roots of a tree near a salt lick. Protected between the roots he grasped his hunting knife in both hands and drew its long and keen blade across the bull's shaggy throat!

The small game shoots which were carried out in the mornings on working days 'included greater and lesser bustard, francolin of diverse subspecies, guineafowl, spurfowl, sandgrouse, quail and snipe . . . . . it was rare to return with less than a hundred birds and several times the total was double that.'

Among his experiences in North America, he refers to 'big-horned sheep leaping from a height of approximately 20 or 30 feet and alighting on the spread of their horns and thereby saving themselves from a possible fractured or dislocated bone'.

Sport, then and now, are indeed very different from each other. Conditions have changed completely over this period and much of what he writes reads as out of a fairy tale, but is of course in keeping with what others wrote about the same time.

The author has written several books on shikar and adventure and, with our fast disappearing wild life, such excursions into the past are interesting.

H.A.

3. BIRDS IN THE SUN. Text by Malcolm MacDonald; photographs by Christina Loke. pp. 128 (21.5×28 cm.) including 49 photographs in colour. H. F. & G. Witherby, London/D.B. Taraporevala & Sons, Bombay. Price 48*s*. or Rs. 34.00 net.

Bird-lovers who enjoyed BIRDS IN MY INDIAN GARDEN, have been eagerly asking for more. Here is the answer to their prayer. This magnificent production deals with 43 species of Indian birds, mostly from the Delhi neighbourhood but which may also be met with practically throughout the country.

The book commences with a Foreword by the photographer giving some vital statistics of her technique, the equipment she used, and so on, which persons aspiring to emulate her achievements will value greatly. Let such persons be warned, however,—as the reviewer's sorry experience has taught him over and over again—that in the final reckoning it is perhaps not so much the camera that matters as the man behind, of whichever sex!

The Introduction by the author, which follows, is largely a narration of his bird watching experiences in and around Delhi, and of the circumstances, difficulties, and physical discomforts—even danger—under which many of the photographs were made by Christina Loke. The chapter is, in fact, largely a tribute of admiration to her skill, determination, and sense of dedication to the task she had set out to perform.

For each of the birds illustrated in the succeeding pages there is one facing page of descriptive text. In some species, e.g. Short-toed Eagle, Crimson-breasted Barbet, and Purple Sunbird—where several photographs are devoted to each—the text is spread over two pages or more.

Mr. MacDonald's previous writings have already established his reputation as a keen and observant field ornithologist, and a gifted, highly readable writer. Most of Christina Loke's photographs are superb, and fully corroborate what this reviewer claimed on an earlier occasion, that they are amongst the finest camera studies of Indian birds extant. To which may now be added that they are also the first *colour* photographs of many of the species dealt with. The attractive get-up of the book leaves little to be desired, though it must be said that the reproduction of the plates is rather variable in quality and often does scant justice to the original transparencies. In some cases, e.g. Golden Oriole (p. 93), Tailor-bird (p. 111), Baya Weaverbird (p. 121) the colour rendering is unsatisfactory and even misleading.

BIRDS IN THE SUN is a welcome addition to popular literature on Indian birds, and sure to receive a warm welcome from the perceptibly widening circle of bird lovers in this country.

S.A.

4. JUNGLE AND BACKYARD. By M. Krishnan. pp. 142 (20.5 × 14 cm.). With numerous illustrations by the author. Delhi, 1961. National Book Trust, India, Publications Division, Government of India. Price Rs. 3.00.

This small booklet presents a series of 34 short articles broken up into sections for Beasts, Birds, Pets and Livestock, (animal) Guests and Co-tenants, and Herbs, Shrubs and Trees. The author is a well-known contributor to English dailies and magazines in India, and is one of the few who have been trying to arouse public interest in the much neglected subject of natural history.

He is keenly interested and some of his observations are interesting and provocative of further inquiry. He refers to a cat jumping to a height which is too high to be achieved in a single leap: 'It leaps straight up towards its objective, touching the wall a little over half way up', and says that it kicks sideways to go upwards. He suggests that the African Klipspringer, which is said to reach a vertical height of some 25 feet from a standing start, and the panther, which can jump out of enclosures that are safe for holding tiger, use the same movements.

In the article 'The Lizard on the Wall', he states that the gecko has suckers on its feet and moves less easily on glass than on a wall, for on the former each foot has to be plucked away separately. If the observation is correct, it is due to the fact that the smoother surface of the glass does not have the roughness which the fine 'hair' on the pads of its feet must meet. There is no suction pad, as in the tree-frogs (*Rhacophorus*), and the gecko would not be able to climb on any surface which is technically absolutely smooth.

The essays make pleasant reading and show the great scope for natural history notes of this kind in India. It is unfortunate that they should include references to a panther with a cub being shot at a waterhole at night and the skin of a bear cub, though this was shot ('almost entirely') by accident. Is all shikar in India inevitably linked with methods looked down upon by sport and law?

The booklet has been received for review rather late and at the Society's special request. It is strange that the copy received had obviously been handled and the text was underlined and marked in many places.

H.A.

5. INTRODUCTION TO HIGH ALTITUDE ENTOMOLOGY: INSECT LIFE ABOVE THE TIMBERLINE IN THE NORTH-WEST HIMALAYA. By M. S. Mani. pp. xix+302 (22.3×14.5 cm.). 2 coloured and 8 half-tone plates, and 80 line illustrations. London, 1962. Methuen & Co. Ltd. Price 42*s*.

Most people, if they think of insects at high altitudes at all, think of them as surviving precariously in spite of the intense cold and low atmospheric pressure. This is far from being the case. Between the line where trees cease to grow and the permanent snow line on the Himalayan slopes there is a zone which supports a flourishing insect fauna so well adapted to the prevailing conditions that it survives because of, rather than in spite of, the climate. The nival insects, as they are called, follow the retreating edge of the melting snow in spring. There they find vast quantities of dead insects, pollen grains, and organic debris which have been carried up from the plains by air currents and deposited in the ice. Various Diptera, and a species of Lycaenid butterfly suck the juices from the softening bodies of these derelicts at the edge of the snow. Beetles bite off parts of them, while Collembola feed on pollen grains. Predaceous beetles and spiders follow and hunt these scavengers, and mites parasitize predators and victims equally. When winter comes the nival insects find hiding places for themselves beneath stones and hibernate under the snow till the melt water reactivates them in spring.

There are features common to all the nival insects. They all display some degree of melanism. This serves to protect them against ultra-violet radiation, and to absorb heat efficiently. They are smaller than related species on the plains, so that they can creep into crevices. Most species have atrophied wings, an adaptation due to the mechanical difficulties of flying at reduced atmospheric pressures and in high mountain winds. Finally they avoid high temperatures which could result in dessication at the low humidities prevailing in the zone they inhabit.

Professor Mani has a fascinating story to tell, based on personal acquaintanceship with the north-west Himalaya and its fauna. He has apparently infected his students and his family with his enthusiasm. Their expeditions have resulted in a formidable list of papers, and this book makes much of the acquired knowledge accessible to most of us.

Not the least valuable part of the book are the diagrams which are excellent. They bear the stamp of a professor who is used to making things simple. The main fault of the book, repetition, is also a lecturer's trait. For instance, on pages 35 and 36 we are told in the same section in at least four different ways that there is a complex interdependence of environmental factors, all of which affect insects simultaneously. The value of repetition in lectures to students is undeniable. In a book, however, its value is doubtful. If it were removed from the earlier chapters, there might be room for the author to enlarge on statements like one made towards the end of the book—that in his opinion the fauna of the NW. Himalaya constitutes a separate entity, distinct even from other parts of the Himalaya. This is an interesting point for speculation. But no evidence is cited for this statement. One presumes the opinion is based on geographical isolation of the region and differences in the fauna of different parts of the Himalaya, but one would like to be sure. A glossary of terms would also be useful. The general reader would like to look up 'autochthone'; and 'cryptophile (cold stenotherm)' is not likely to help him. It seems a pity to exclude the general reader when there is so much here to interest him. Finally, the photographs deserve honourable mention.

It would be pleasant to think that there were other people in Indian universities following their obsessions so successfully. We need many more books like this, covering every aspect of our rich and varied natural history.

R.R.

Miscellaneous Notes

1. THE PANTHER OF NAGRI

In the students' mess of the Rangers' College at Coimbatore, above the mantelpiece on the wall, hangs (at least it did so when I last visited in 1960) an old trophy of a medium-sized panther—skin and head—in a dilapidated condition. To a casual visitor it may look a miserable decoration. But there is a story behind, which makes it a prize trophy.

How many will believe that, when I first fired at it, this panther was perched 110 feet above the ground on a branch of a 130 feet tall tree? How many will believe that, when I finally shot it, we were standing face to face on a tiled roof with less than 8 feet between us? It may sound incredible, but it is true. Over five hundred men, women, and children of Nagri village were witnesses, standing all round watching this feat. As for the authenticity of the heights, the students of the senior class of the Rangers' College checked them with instruments.

It happened on the 20th of January 1955 at Nagri, a prosperous village amidst the *sal* forests of South Raipur Division of Madhya Pradesh, of which I was then the Divisional Forest Officer. I was in the verandah of the Forest Rest House, disposing of accumulated dak before my departure from the camp. At about 9.30 a.m., some excited villagers reported that a panther had been sighted on a tree right inside the village *sarna* (*sarna* in that part of the country means a grove of old trees left untouched by villagers out of sanctity). The *sarna* of Nagri was a well-stocked patch, less than 10 acres, of tall forest trees just adjacent to the *abadi* on one side and surrounded by cultivation on the other three. The village itself, together with the area under cultivation, was a much bigger enclave inside extensive *sal* forest.

Cases of panther prowling at night on the village roads in search of goat, dog, or calf were quite common. Usually, before daybreak they would retire to the jungles. This particular panther evidently wished to avoid the trouble of having to cross and re-cross the cultivated belt each night to reach the village *abadi*. His presence was betrayed by an alarm raised by monkeys and peafowl.

When the villagers bring such news to an officer, they expect him to prove his worth by shooting the animal. I had not anticipated any shoot in that camp and so all I had was a double-barrel twelve-bore with one LG and one ball. With these I rushed to the *sarna*.

By that time practically the whole village had poured out to see the fun, and were surrounding the tree. I made them vacate the *sarna*, posting more of them towards the outer edge rather than towards the *abadi*, so that the panther might not escape to the outside forest. I noticed that the tree on which the panther was sitting was an *imli* (*Tamarindus indica*) but, unlike the familiar spreading *imli* trees of the village, this one had a straight clean round bole up to about the half of its total height and, even where the branching started, the crown was like that of a typical forest tree, for it was growing amidst many other tall trees.

From beneath, when I looked up, I saw the panther lying along the horizontal portion of a side branch which was a little thicker than a man's thigh. The panther lay over it lengthwise with its tail straightened, just like a woolly caterpillar sticking on to the green stalk of a plant. It was such a clever way of camouflage that, but for the villagers telling me, I would never have been able to spot the animal even after seeing it half a dozen times. From below all I could see was the white fur of the sides of the belly and two small projecting ears. The rest of the body was completely covered by the thickness of the branch. Despite the shouts and tumult of hundreds of villagers below, the panther did not move a bit for over an hour.

At first, I thought of shooting from the ground; but the animal was not visible from the side, and only barely so when viewed from underneath. Therefore, the chances of hitting the animal squarely were remote. The various attempts to disturb it and to compel it to descend or change position failed. Drums were beaten, smoke created, stones thrown; but there was not even a flicker of the ears.

The villagers started getting impatient and even out of control. Toying with the only two cartridges in my pocket I pondered; and decided, as the only chance, to disturb the animal by one shot (LG) and kill it with the other (ball) as it descended. The villagers were repeatedly warned not to break through and rush. I loaded both the barrels, took off the safety-catch, threw aside my hat, and taking good aim fired vertically up.

The panther immediately rose, his coiled tail straightened and thick like a white bottle-brush! The angry animal descended head first, with full confidence and without hurry, but taking care to avoid my gun by keeping to the diametrically opposite side of the tree trunk, just as a lizard would do when teased by children. Despite my going round and round the bole of the tree, the panther skilfully dodged me. Yet, I kept on saying to myself: 'Let the brute touch the ground and . . . '. Yes, it did come down, and in no time! But, alas! The crowd!

The loud bang of the gun filled the villagers with excitement and they completely ignored my instructions. There was a rush towards the tree from all sides. When the panther touched the ground and gave a side glance at me, my finger was on the trigger. But I hesitated. I thought, if I fire the second shot and miss, I will surely hit at least one villager, if not more. Even if I do not miss, the injured panther will finish off quite a few before actually dying. I, therefore, dared not fire.

Being surrounded by so many men, the panther played its usual trick. It gave a resounding and breath-taking grunt that completely reversed the advance of the villagers. As fewer of them were towards the village the panther easily created a gap in the line of fleeing men. Through this gap it shot like a flame towards the nearest hut and disappeared in the village.

This made the situation worse than I had ever anticipated. The way the animal responded to my shot, I was sure that it was injured. (Later, this was confirmed because the thicker base of one of its earlobes was found to be punctured). It would not have been wise to leave the injured panther inside a house in the village. So, I postponed my departure from Nagri.

Then started a house-to-house hunt. When the panther entered the village it must have found it almost empty, as almost the whole population had come out to the *sarna* to see the *tamasha*. It was a problem for me to organize a house-to-house search. A villager might get mauled. Besides, Nagri is a peculiar village. Its houses are so congested that often there are common walls between adjacent huts, with doors and windows in all possible directions.

The search continued for two hours. While I was combing one end of the village, commotion and shouts from the other end would indicate the presence of the 'thief' there; but before I could reach the spot he escaped and vanished into some other house.

At last came an excited old woman. Being too old to find any interest in the *sarna*-show, she was sitting in her courtyard cleaning the paddy when the big cat rushed past her. She came running towards us using the choicest of bad names in her Chhatisgarhi hindi for the panther who, she swore, had just entered her house and was inside it then. Fortunately her house was a one-roomed hut with only one door. I carefully examined it from outside. Peeping through the door with levelled gun, expecting the panther's charge any moment, I was surprised to find that the room was empty; only a few utensils stood by the *chula*. I stepped back and told the old woman. She said the animal must be sitting on the *atari* (a part-ceiling, just below the roof, on which the villagers store corn, flax, bamboo flute, grain, etc.). Realizing that this might be possible, I quietly closed the door and climbed the tiled roof.

It was not a tall house and the tiles were of the usual country type, flattish and small. Bending down I removed bits of the tiles at one place of the sloping roof and saw, a few inches below, white fur which must have been the tail-end of the panther. Hurriedly I made allowance for the length of the panther's body to ascertain the point on the roof at which the heart of the animal would be located. With the object of putting the muzzle of the gun at the right place, I removed more tiles but on looking through this second aperture I found nothing below. Perplexed I went back to the first aperture. And then I got another and a bigger shock—there was no tail there. What did all this mean? In utter confusion I knelt on the roof and peeped through as much as possible. The *atari* was devoid of any panther.

Just then I heard the distant upsurge of shouts and agitated commotion amongst the people, who by that time had made a wide circle surrounding the house. I looked towards the people, still kneeling on the roof. They were frantically waving their hands. I could not hear them but they were trying to draw my attention to something behind me. I stood on the roof, loaded gun in hand, and looked back. There it was—the panther on the roof, no less perplexed than me! In the history of *shikar* I doubt if anybody had a chance like that before—of levelling a gun from a roof at a panther also on the same roof and firing his last cartridge, with hundreds of men, women, and children below shouting and cheering. The panther fell on the sloping roof, rolled and rolled, and finally dropped down dead with a thud on the vacant bed of the kitchen garden of the old lady, bringing down with it a good number of loose broken tiles. The ovation that I got from the crowd would have beaten even the most fantastic Hollywood scene!

What must have happened? Probably on hearing my footsteps on the roof and seeing light coming through the first aperture, the panther must have tried to escape and found the door was sealed. The only way left was the narrow gap between the roof and the top of the side-wall. He must have tried that. But while getting out he must have seen a thick wall of human beings at a distance but right in front. In trying to avoid them he had no alternative but to mount the roof, little realizing that on the other slope of the roof I was still searching for him.

The dead body of the panther served as a suitable specimen for me to teach the boys of the Forest Rangers' College how to flay for trophies. The skinning was done by the vegetarians amongst the students. I thought it best to present the trophy to their Mess.

INDIAN FOREST COLLEGE,
DEHRA DUN,
August 4, 1962

D. H. KULKARNI,
Dean

2. THE IDENTITY OF THE MALAYAN MOLE

The Malayan Mole was first described by Chasen (1940) from two specimens obtained in the Cameron Highlands, Pahang, Malaya, in 1937. Of these only the type (British Museum No. 47.1418 : Raffles Museum No. 4334) is now available for comparison. Chasen named the new form *malayana*, and placed it in the species *Talpa klossi* Thomas 1929, from Thailand, distinguishing between the two races *klossi* and *malayana* on coat colour alone. In his description he noted that when a fresh skin of *malayana* and the type of *klossi* (collected in 1924) were ' placed side by side *malayana* shows up as dark iron-grey against the paler brownish colour of the more northern form '.

In March 1962 four more moles were caught in the Cameron Highlands (Cranbrook & Medway 1962). Of these, two have been presented to the Department of Zoology in the University of Malaya, Kuala Lumpur, and two to the British Museum (Natural History) in London. All four were ' dark iron-grey ' in colour and should clearly be assigned to *malayana*. The two specimens taken to London were compared with the type of *malayana* in April 1962. This was found to have faded and to be indistinguishable in colour from the type of *T. klossi* (B.M. No. 28.5.3.1) with which it had been compared in 1939. In both the tips of the hairs were ' paler brownish ' and the over-all appearance brown, but in both the ' dark iron-grey ' colour could clearly be seen on the basal two-thirds or so of the hairs when these were parted.

The taxonomy of the moles of SE. Asia is in some confusion, but all specimens known seem to fall into one or other of the species or subspecies originally described as *T. micrura* Hodgson 1841, *T. leucura*

Blyth 1850, *T. klossi* Thomas 1929, and *T. k. malayana* Chasen 1940. Stroganov (1948) distributed them amongst three genera as *Eoscalops micrura*, *Parascaptor leucura*, and *Euroscaptor klossi.* Schwarz (1948) and (following Schwarz) Ellerman & Morrison-Scott (1951) treated *leucura* as a subspecies of *T. micrura*, reducing *klossi* and *malayana* to synonyms. Subsequently Stein (1960) recognized the following :

Genus *Talpa* Linnaeus 1758 : dentition $\frac{1}{1}\frac{1}{1}$ (44)

T. k. klossi Thomas (Thailand, Tonkin). Diagnosis : Coat colour brown

T. k. malayana Chasen (Malaya). Diagnosis : Dark iron-grey as against light brown of nominate form

T. micrura Hodgson (Southern Himalayas, Nepal, Sikkim, Assam). Diagnosis : Tail hidden in fur

Genus *Parascaptor* Gill 1875 : dentition $^{1\,0}$ (42)

P. leucura Blyth (Assam, Burma, to north Thailand and eastward into Yunnan). Diagnosis : Dentition $\frac{1}{1}\frac{0}{1}$ (42)

The dried skins of the forms with 44 teeth, which Stein assigned to the genus *Talpa*, are liable to fade to a greater or lesser extent. As has been shown above, the type of *T. k. malayana* has faded badly. The same may be true of the type of *T. klossi.* The only specimens of *T. k. klossi*, other than the type, available for comparison in London are three collected in Tonkin by Delacour & Lowe in 1929 (B.M. Nos. 33.4.147, 148, & 149). In April 1962 all were dark iron-grey in colour, like the freshly captured specimens of *malayana* from the Cameron Highlands. There are two skulls which have dentition $\frac{1}{1}\frac{1}{1}$ (44).

Blanford (1888) says of *T. micrura* : ' Colour uniformly velvety black when fresh . . . dried skins are often brown.' Of 17 skins of *T. micrura* in the British Museum (Natural History), 15 collected between the middle of last century and 1920 have faded to a ' paler brownish colour ', like that of the types of *T. klossi* and *T. k. malayana* today. In most of them some trace of dark iron-grey remains at the base of the hairs. Two collected in 1947 have a brownish tinge on the tips of the hairs, but look black at first sight. It is clear that the dried skins of *klossi*, *malayana*, and *micrura* are liable to fade and that any diagnosis based on the coat colour of any save freshly caught specimens must be suspect. This is in marked contrast with the skins of the European and western Asiatic species of *Talpa*. Of 150 skins of these in the British Museum all seem to have retained their original colour.

Skins of *leucura*, with 42 teeth, which Stein assigned to the genus *Parascaptor*, may fade to a limited extent though none of those in the British Museum (Natural History) have faded as much as is suggested by Blanford (1888), who says of *leucura* : ' Colour uniformly brown in all the skins that I have seen, but described as black by Anderson, perhaps variable.' Anderson was a collector and saw the animals in the flesh. I collected *leucura* in Upper Burma in 1931, and wrote of freshly caught specimens in my field note book : ' like *T. europaea* (i.e. dark iron-grey) but with a white tail constricted next to the body '. Of nine skins of *leucura* in the British Museum none are ' uniformly brown ' : eight collected between 1908 and 1940 have a slight rusty tinge on the tips of the hairs ; in the ninth, collected in 1937 and badly preserved, the brown is a little more obvious. The degree of browning of the first eight is very slight and I think it is quite possible that with only the recollection of the colour of *T. europaea* in my mind I would have described the animals I caught as being ' like *europaea* ' if they had been the same colour when freshly caught as the dried skins are in 1962. All look black in the museum drawer at first sight, as opposed to the brown skins of *micrura.*

Though the colour of the dried skins of these SE. Asian moles is not a reliable diagnostic feature, *T. klossi* and *malayana* can be separated by a factor other than coat colour. Stein (1960) discussing the Asiatic moles with dentition $\frac{1}{1}\frac{1}{1}$ (44), showed how the tail of *malayana* is both absolutely and proportionately shorter than that of *klossi*, 5% of the head and body length as opposed to 8%. He separated both from *micrura* with ' an extremely short tail, hidden in the fur ', 4% of the head and body length, paraphrasing Blanford (1888) : ' tail exremely short, nearly naked and completely concealed by the fur,' and Hodgson (1841) : ' velvety black . . . The tail very small, rudimentary.' Thomas (1929) in his description of *klossi* said : ' club-shaped tail, about as in *Parascaptor leucurus.*' I have only seen dried skins of *klossi* but I have both *leucura* and *malayana* in the flesh. The tails of both are club-shaped but that of *leucura* is obvious at first sight, projecting well beyond the fur on the rump. The collectors' measurements of the tails of the type of *klossi* and of three specimens from Tonkin are 11, 11, 15, 16 mm. and of 7 specimens of *leucura* 10, 12, 12, 14, 14, 15, 15 mm. respectively. The tail of *malayana* is shorter, only the extreme tip being visible in the fur on the rump. The collectors' measurements of the tails of the type *malayana*, of one other caught at the same time, and of the four obtained in the Cameron Highlands in 1962 are 6, 7, 5, 6, 7, 7 mm. respectively.

Though measurements made by different collectors can only be compared with reservations, *micrura* and *malayana* are much the same size, *klossi* rather smaller. Average and extremes of the head and body lengths of 9 specimens of *micrura* obtained by the same collectors are 128 (106-142) mm., of 6 specimens of *malayana* (2 collectors) 121 (112-132) mm., and of 4 specimens of *klossi* (2 collectors) 110 (100-116) mm.

The status of *klossi* cannot be determined with any certainty until more and fresh material is available from Thailand and Tonkin.

Malayana however is clearly distinct and is very close to *micrura* in size, tail length, coat colour, and tendency to fade. Possibly the two forms are synonymous, but until more material is available from the intermediate areas it is better to regard *malayana* as a subspecies of *micrura* : *Talpa micrura malayana* Chasen.

GREAT GLEMHAM HOUSE,
SAXMUNDHAM, ENGLAND,
September 4, 1962.

THE EARL OF CRANBROOK

REFERENCES

Blanford, W. T. (1888) : Fauna of British India. Mammalia : 225-227. London.

Blyth, E. (1850) : Description of a new species of Mole (*Talpa leucura* Blyth). *J. As. Soc. Bengal* **19** : 215.

Chasen, F. N. (1940) : A handlist of Malaysian Mammals. *Bull. Raffles Mus.* **15** : 13-14.

Cranbrook, Earl of & Medway, Lord (1962) : The Malayan Mole. *J. Malay. Nat. Soc.* (in press).

Ellerman, J. R. & Morrison-Scott, T. C. S. (1951) : Checklist of Palaearctic and Indian Mammals : 35-41. London.

Hodgson, B. H. (1841) : Classified Catalogue of the Mammals of Nepal. *Calcutta J. Nat. Hist.* **2** : 212-221.

Schwarz, E. (1948) : Revision of the Old World Moles of the Genus *Talpa* Linnaeus. *Proc. zool. Soc. Lond.* **118** : 36-48.

Stein, G. H. W. (1960) : Schädelallometrien and Systematik bei altweltlichen Maulwürfen (Talpinae). *Mitt. Zool. Mus. Berl.* **36** : 1-48.

Stroganov, S. U. (1948) : (Systematics of moles. Talpidae). *Trud. Zool. Inst. Acad. Sci. U.S.S.R.* **8** (2) : 1-239.

Thomas, O. (1929) : A new mole from Western Siam. *Ann. Mag. Nat. Hist.* (10) **3** : 206.

3. GESTATION PERIOD OF THE FOURHORNED ANTELOPE *TETRACERUS QUADRICORNIS* (BLAINVILLE)

In March 1958 I reported the gestation period of the Fourhorned Antelope *Tetracerus quadricornis* (Blainville) as 'slightly over eight months, a rather long period for such a small animal' (*J. Bombay nat. Hist. Soc.* **55** : 339).

As the Editors suggested that 'it would be wise to wait for confirmation of the period by further observation' the writer has again checked the gestation period. The female Fourhorned Antelope mated on 24 March 1962 in its small compound at Ahwa, Dangs District, Gujarat State. At no time were the male and female together after mating. It delivered a male fawn on 12 November 1962, a period only twelve days less than eight months. This datum proves that the former period was correct as reported. The first doe had a gestation period of 243 days and the second doe a period of 228 days, a difference of only fifteen days. Such differences are not uncommon among mammals of the same species.

The mother of the present fawn was the antelope which was born on 13 March 1958 and reported in the *Journal.* Thus it was slightly over four years old before mating. It would appear that these antelopes mature rather slowly and that the gestation period is a long one for an animal measuring between twenty-two and twenty-six inches at the shoulder.

The Indian Muntjac or Barking Deer *Muntiacus muntjak,* an animal twenty inches high at the shoulder or occasionally slightly higher, has a gestation period of about six months. The Swamp Deer *Cervus duvauceli* and the Chital or Axis deer *Cervus axis* also have gestation periods of about six months. It should be kept in mind, however, that the Fourhorned Antelope is not a deer nor is it a true antelope. It belongs to the subfamily Tragelaphinae, a group of animals more African than Indian. India is indeed fortunate to have the only antelope in the world with two pairs of horns.

The female antelope was restless from early morning, and had obvious contractions for three hours prior to delivery. The delivery commenced at 6.30 p.m. with the mother lying on the ground. The head of the fawn with the front hooves pressed tightly against the chin came first. The mother then stood up and the fawn dropped to the ground. She started licking the fawn during its delivery and kept up the process until the fawn was strong enough to stand.

At birth the fawn weighed two pounds and fourteen ounces. It weighed ten ounces more than the fawn which was born on 13 March 1958. Its height at the shoulder of ten inches and its length from nose to tip of tail of fifteen inches are the same measurements as of the first young. The mother antelope is twenty-two inches high at the shoulder; thus young antelopes have nearly half of their mature height at birth.

Just thirty-five minutes after birth the young antelope was standing up on its wobbly legs. In another ten minutes it was walking about in its cage. After another half hour the fawn was nursing.

The male Fourhorned Antelope in an adjoining cage was as pugnacious as ever during the birth of the fawn. He kept butting his horns through the wire netting at the female and seemed to be quite unhappy about the whole affair. The male is a year younger than the female. Male Fourhorned Antelopes make dangerous pets. The writer uses a rake while cleaning, watering, and feeding the male. Even then it is a risky process. Nevertheless, raising Fourhorned Antelopes has been very interesting.

From these two observations the gestation period of *Tetracerus quadricornis* would seem to be approximately 7½ to 8 months. This fact too makes the Fourhorned Antelope an unusual animal, though

Prater (THE BOOK OF INDIAN ANIMALS, p. 250) indicates a gestation period of 8 months for the Hog Deer [*Axis porcinus* (Zimmermann)].

DANGS RURAL BOARDING SCHOOL,
CHURCH OF THE BRETHREN MISSION,
AWHA, VIA BILLIMORA,
DANGS DIST., GUJARAT STATE,
November 15, 1962.

E. M. SHULL

4. NOCTURNAL 'PREDATOR' OF YELLOW OLEANDER (*THEVETIA NERIIFOLIA*)

With reference to D. E. Reuben's note in the December number of the *Journal* [**58** (3) : 808] on 'Nocturnal "Predator" of Fruit of Yellow Oleander (*Thevetia neriifolia*)' the following information may be interesting to your readers.

In my office compound there are a few plants of Yellow Oleander. A rat used to bring mature fruits of this plant inside the drawer of my table to which, as I later discovered, it had a secret approach. The soft parts of the fruits were found eaten and the stones left absolutely clean. As the poisonous properties of the plant are well known I expected the rat to die and not return to his 'dining drawer'. But no. On at least five subsequent occasions I found stones of oleander fruit inside the drawer eaten in the same manner, their number varying from 2 to 6. Along with these seeds were also found partly eaten seeds of the Persian Lilac (*Melia azedarach*), areca nuts, sugar cane bits, etc. The nocturnal visits continued for about 20 days after I first noticed the fruits inside the drawer. Then the visits came abruptly to an end with the shifting of the table. Though not unlikely, I doubt if the rat died of the toxic effect of the oleander seeds; if it did, it should be concluded that the effect of the poison is fairly slow. Some books on pharmacology give 8 to 10 seeds or 250 grains of root as the lethal dose.

Seeds thus carried away from the site of the parent plant are an effective means of dispersal of seeds. In this particular case I may mention that the oleander plants are situated 30 to 60 feet away from the place where the seeds were found eaten. The ground beneath them was searched for eaten seeds but none was found in the immediate vicinity.

SADIYA FOREST DIVISION,
TEZU (N.E.F.A.),
June 25, 1962.

S. K. CHATTERJEE,
Assistant Conservator of Forests

5. THE SMALL INDIAN SWALLOW PLOVER, *GLAREOLA LACTEA* TEMMINCK, NEAR BOMBAY

The Small Indian Swallow Plover, or Pratincole (*Glareola lactea* Temminck), though generally said to occur all over India has not been recorded from near Bombay. On 27 October 1962, a small party of 5 or 6 birds was seen on the banks of a *nulla* flowing through rice fields into the mudflats at Panvel, Kolaba District, Maharashtra. My notes also show that I saw a few and obtained specimens at Nandur-Madhmeshwar, Nasik District, on 2 January 1954 and 1 March 1958.

This bird is omitted in Sálim Ali's 'The Birds of Gujarat' (*J. Bombay nat. Hist. Soc.* **54** : 374-458), and Dharmakumarsinhji's BIRDS OF SAURASHTRA, though Littledale (*J. Bombay nat. Hist. Soc.* **1** : 200) has recorded it as breeding on the Mahi River above Sihora in Rewa Kantha State.

BOMBAY NATURAL HISTORY SOCIETY,
91 WALKESHWAR ROAD,
BOMBAY 6,
December 5, 1962.

HUMAYUN ABDULALI

6. PECULIAR BEHAVIOUR OF WHISKERED TERN *CHLIDONIAS HYBRIDA* (PALLAS)

While watching marsh birds about the mudflats and salt pans at Point Calimere (Madras State) earlier this month, I noticed 2 Whiskered Terns [*Chlidonias hybrida* (Pallas)] violently chasing a third who dodged hither and thither, and up and down, to evade them. Suddenly the pursued bird seemed to collapse in mid-air and dropped vertically down on limply fluttering wings including a couple of somersaults, as if shot. It flopped helplessly on to the water below, wings spread-eagled, head thrown back, and feebly bobbed from time to time as if in the last throes of disintegration. I watched its plight from a distance through binoculars for a minute or so and then started walking up to it to investigate. The bird, which had seemed far too gone to struggle any more, made one desperate effort when I was quite close to it and just managed to get air-borne. After some unsteady wobbling it started flying strongly up-ward on quick-beating wings in narrowing circles whirling around like a dancing dervish chased by the devil! It rose higher and higher thus till difficult to see with the naked eye. I was wondering how it was all going to end and whether the exhausted bird would again collapse and drop to earth, as seemed imminent. After a couple of minutes during which the spiralling bird was being blown about in the wind high above, I lost sight of it behind some treetops and was unfortunately unable to follow it further. It seems difficult to explain this extraordinary episode. The bird seemed quite demented. Could it be that it lost an eye in the recent encounter with its pursuers, and this was the natural reaction?

33 Pali Hill,
Bombay 50, SÁLIM ALI
November 25, 1962.

7. EGGS OF THE CROW-BILLED DRONGO, *DICRURUS ANNECTANS* (HODGSON), FROM BURMA

Two clutches of eggs collected by H. C. Smith in the plains of the Shweli drainage, Prome District, would appear to constitute the first breeding record for the Crow-billed Drongo, *Dicrurus annectans* (Hodgson), in Burma, if they prove to belong to this species (Smythies 1953). These clutches are now in the collection of the British Museum (Natural History) (B. M. nos. 1953-3-197; 1953-3-198), and have been critically compared with clutches of eggs of *D. annectans* and of other drongos. Smith's (1943) own notes on them were: '. . . I collected several clutches of drongo's eggs all of the same type—white characteristically streaked with purple. I believe these are the eggs of this bird, they all differed markedly from the eggs of other drongos.'

It was possible to examine a large series of clutches of the eggs of the Dicruridae. Those of *D. annectans* appeared to stand apart by reason of their predominantly streaked patterns. The eggs of most species showed spots or blotches on buff or brown eggs. A careful examination of the eggs of species other than *D. annectans* revealed only two clutches in which the markings tended to be streaks rather than spots. These were clutches of *D. hottentottus*, one from Fohkien, China, and the other from Maymyo, Burma. Both clutches were of white eggs with a light pattern of very pale grey and purplish markings, mostly spots, but the larger tending to form elongated streaks. Apart from the fact that streaks were present they did not bear a very close resemblance to the clutches of *D. annectans* that were examined. Out of twenty clutches of *D. annectans* in the Museum collection sixteen showed a predominantly streaked pattern, the remaining four clutches being more spotted and having a closer resemblance to the eggs of other *Dicrurus* species. Of these sixteen, eight clutches showed mainly purplish streaking on a white ground, two showed purplish streaking on a buff ground, four had shorter and more red streaking on a buff ground, and two showed heavy elongated red and purple streaks on a buff ground producing a pattern that was strikingly similar to that of the eggs of the Paradisaeidae. Baker (1933) comments: 'nine out of ten clutches (of *D. annectans*) can be recognized at a glance by the longitudinal character of the markings, a feature found in the eggs of no other member of the Dicruridae'.

Although some eggs of *D. hottentottus* may resemble those of *D. annectans* in pattern there is a difference in size. Baker (op. cit.) gives the averages of two hundred eggs of the former species, and one hundred of the latter:

	average	maxima	minima
D. hottentottus	29.2 × 21.2	34.5 × 22.0, 31.0 × 22.8	25.0 × 20.5, 27.5 × 19.8 mm.
D. annectans	26.3 × 19.4	29.5 × 20.0, 26.5 × 20.2	24.1 × 18.4, 27.0 × 18.3 mm.

The two clutches of two eggs collected by Smith measure: 25.4 × 19.2, 24.3 × 19.1; 25.5 × 18.4, 25.7 × 18 mm. These agree with the eggs of *D. annectans* in size.

The eggs of Smith's first clutch are white and marked with a fine pattern of purple and purplish grey streaks, running longitudinally, and generally distributed but with a tendency to have a denser zone of markings radiating outwards at the larger end. The second clutch also has a white ground colour but the markings are larger and sparser. They are longitudinal streaks of reddish purple, violet, and grey, with many heavy markings 3-5 mm. long and about 1 mm. in width. There are some smaller and finer markings but these are fewer than in the other clutch. There is again a tendency for a concentration of markings at the larger end. These eggs are virtually indistinguishable from some of the eggs of *D. annectans* taken in Assam by Baker. From the evidence of size, colour, and pattern, it would appear that the eggs collected by Smith in the Prome District of Burma are those of *D. annectans* and constitute a record of its breeding in that area.

BRITISH MUSEUM (NAT. HIST.),
CROMWELL ROAD,
LONDON, SW. 7,
October 1, 1962.

J. O. HARRISON

REFERENCES

Baker, E. C. S. (1933) : Nidification of the Birds of the Indian Empire. Vol. 2. London.

Smith, H. C. (1943) : Notes on the Birds of Burma. Simla.

Smythies, B. E. (1953) : The Birds of Burma. Edinburgh.

8. TAXONOMIC NOTES ON SOME HIMALAYAN PARIDAE

During the course of the Harvard-Yale Expedition (1957-59) to East and West Pakistan, India, and Nepal, sixteen forms of Paridae were collected. The following brief notes are based on a study of this collection.

Parus melanolophus

Parus melanolophus, ranging from extreme western Nepal to eastern Afghanistan, seems to be fairly constant in size throughout its distribution, with the exception of the population at the western terminus of its range. Vaurie's (1950) comparisons of worn adults from Afghanistan with similar birds from Himachal Pradesh and Uttar Pradesh suggest that the western birds may have longer wings and tails. Our series of late autumn specimens from West Pakistan also seem to indicate this. The flattened wings of 18 males from Kalam in Swat and from the Kaghan Valley in Hazara District range between 60.0 and 65.5 mm., with a mean and standard error of 63.91±.37 mm.; the tails of these same birds range from 41.0 to 46.5 mm., with a mean of 44.50±.36 mm. The wings of two males from the Safed Koh Mountains, on the Pakistan-Afghanistan border, a few miles north of Parachinar, Kurram Agency, are 66.0 and 68.0 mm.; the tails of both specimens measure 48.0 mm. Ten females from Kalam and the Kaghan Valley have wings averaging 61.20±.53 mm. and ranging between 58.0 and 63.5 mm., and tails from 40.0 to 46.5 mm., with a mean of 42.85±.60 mm. A single female from near Parachinar has a wing of 66.0 mm. and a tail of 46.0 mm.

Therefore, except for the tail of the females, there is no overlap in the two characters measured.

Our three specimens from the Kurram Agency are slightly darker on the dorsum than a series of 34 birds collected during the same season in Hazara District and Swat.

Although it is almost certain that the westernmost population is morphologically distinct, it seems prudent to defer giving it a name until there is available more fresh material from the Safed Koh and Afghanistan.

Parus major

Two specimens of *Parus major* were obtained at Parachinar, Kurram Agency. Here one would expect to find *P. m. decolorans*, the race described from Jalalabad, Afghanistan, a locality on the other side of the Safed Koh from Parachinar, or *P. m. ziaratensis*, the form of northern Baluchistan[1] and southern Afghanistan. However, both specimens may be placed with *P. m. caschmirensis*. One is indistinguishable from a long series, collected in the same season and year, from Swat and Hazara District; the other is somewhat paler and may be approaching *P. m. ziaratensis*. I can find no support for including *P. m. decolorans* with the avifauna of Pakistan (*contra* Ripley, 1961).

Parus spilonotus and Parus xanthogenys

In recent years *Parus spilonotus* and *P. xanthogenys* have been considered to be conspecific (e.g. Vaurie, 1950; Biswas, 1953; Ripley, 1961), probably because they are somewhat similar morphologically, because they replace one another geographically, and also because their zone of contact is poorly known.

P. xanthogenys, the smaller form, with an unstreaked back and black head and forehead, ranges through higher elevations in peninsular India and in the Himalayas from Murree to eastern Nepal. The easternmost point at which it has been collected (Rand & Fleming, 1957) seems to be Manebhanjan (alt. 5000 ft.), a village lying a short distance north of Sun Kosi River and a few miles south of Okhaldhunga. Presumably it ranges even farther east since Ripley (1950) implies that he saw the species east of Arun Kosi River in Dhankutta District. The inclusion of Sikkim within the range of *P. xanthogenys* (e.g. Baker, 1922) is apparently an error, as has been pointed out by Whistler & Kinnear (1932).

---

[1] Ripley (1961, p. 546) erroneously stated the Khagan Valley to be in Baluchistan, Khagan Valley birds are clearly *P. m. caschmirensis*.

P. spilonotus, a much larger bird with black streaks on the dorsum, a black head, and a yellow forehead, is distributed from extreme eastern Nepal through the eastern Himalayas and south-east Asia to Formosa. It has been collected (Stevens, 1923) in Nepal as far west as the Mai ('Khola') Valley (alt. 7000-8000 ft.), which is near the Indian border and less than 100 miles east of Manebhanjan and even closer to the Arun Kosi River.

While there is still no evidence of sympatry, the two forms occur only a short distance from one another. It appears that future collecting will almost certainly reveal that the populations slightly overlap, or at least abut. Perhaps the reason they have not yet been found sympatrically is the rarity of *P. spilonotus* at the western limits of its range. Stevens (1923) noted that the species is local and sparingly distributed in the Sikkim Himalayas, and during over two months spent collecting at altitudes from 1000 to 12,000 feet in the vicinity of Darjeeling, I observed only two individuals. One, a breeding male, was taken in late June at an altitude of 7200 feet and the other, a male with retrogressing testes, was collected in late July at 5400 feet.

The probability that *P. spilonotus* and *P. xanthogenys* are sympatric, albeit in a narrow belt, is doubtless reason enough for considering them different species. However, support for this belief may be found in two other areas of evidence: first, the fact that the taxa are morphologically very distinct, both in size and colour pattern; second, the failure of collectors to obtain any specimens that even suggest intergradation between the forms, which one would expect if these were allopatric subspecies.

Until there is evidence to the contrary, I believe one must treat *P. spilonotus* and *P. xanthogenys* as full species.

Parus monticolus

Three races of *Parus monticolus* have been described from the western part of the species, viz. nominate *P. monticolus*, with the type locality in the Simla-Almora region; *P. m. lepcharum* from Gangtok, Sikkim; and *P. m. yunnanensis*, with Milati, south-eastern Yunnan, as type locality.

The species shows a cline of increasing pigmentation from west to east; the races are distinguished only by this character. The cline is less steep in the eastern half of the range resulting in considerable difference in opinion as to whether *P. m. lepcharum*, the last named of the three western forms, is worthy of recognition. Stanford &

Ticehurst (1935) merged it with *P. m. monticolus*, as did Ludlow & Kinnear (1937); Vaurie (1950) at first treated it as distinct and later (1957; 1959) combined it with *monticolus*; Rand & Fleming (1957) maintained it separately, but with some doubt; Fleming & Traylor (1961) merged it with the nominate form, as did Ripley (1961).

I have examined a series of 50 newly-taken specimens from the western range of the species, including 13 winter birds from West Pakistan (as far west as Swat, which seems to be the limit of the species), 14 birds collected in December near Pokhara in central Nepal, and 23 moulting summer specimens from Darjeeling District. In addition I have seen 25 older specimens from India and Tibet and 23 skins from Yunnan, including the two syntypes of *P. m. yunnanensis*.

The west to east cline in coloration is distinct but slight, with the amount of pigmentation changing most rapidly in the western part of the cline. A series of fresh skins from West Pakistan can be separated quite readily from new material from central Nepal, although birds from western India are not so easily distinguished from Nepal specimens. The few specimens in good plumage I have seen from Darjeeling District, hence nearly topotypes of *P. m. lepcharum*, are very slightly darker on the dorsum than the central Nepal series and the yellow is somewhat less saturated than topotypic material of *P. m. yunnanensis*. With fresh specimens and long series there is no doubt that one might distinguish three races between West Pakistan and Yunnan. However, there seems no merit in naming the centre of a poorly marked cline. It appears to me, as it has to most recent students, that *P. m. lepcharum* should not be recognized. However, rather than merge it with nominate *P. monticolus*, as has been done consistently, I believe it better placed with *P. m. yunnanensis*, which it so closely resembles. Specimens from central Nepal also seem to fit better within *P. m. yunnanensis*. Thus, the distribution of *P. m. monticolus* should be defined as extending from Swat east to Nepal, where it merges with *P. m. yunnanensis*.

Weights of some Paridae

Knowledge of the weights of birds is becoming increasingly important in taxonomic as well as biological studies. The following table places on record weight data for 16 forms of Asiatic Paridae:

TABLE

Weights of some adult Titmice from the Indian sub-continent

	Sex	No.	Mean	Sx	Range	Locality
P. rubidiventris rufonuchalis	♂	13	13.14	.18	12.3-14.7	Hazara Dist. ; Swat
	♀	8	11.93	.12	11.4-12.4	
P. rubidiventris beavani	♂	9	12.21	.16	11.6-13.0	Darjeeling Dist.
	♀	5	11.38	.34	10.5-12.3	
P. melanolophus	♂	18	9.20	.09	8.3-9.8	Hazara Dist. ; Swat
	♀	10	8.85	.13	8.0-9.5	
P. ater aemodius	♂	5	8.16	.19	7.7-8.6	Darjeeling Dist.
	♀	3	7.56	.23	7.2-8.0	
P. d. dichrous	♂	3	12.90	.32	12-13.5	Darjeeling Dist.
	♀	4	12.10	.50	11.2-13.5	
P. major nipalensis	♂	5	13.94	.18	13.4-14.5	vic. Pokhara, Nepal
	♀	2	12.70	..	12.6-12.8	
P. major caschmirensis	♂	17	15.60	.17	14.1-17.1	Hazara Dist. ; Swat
	♀	16	14.33	.20	13.2-16.2	
P. monticolus yunnanensis	♂	12	14.53	.16	13.5-16.8	Darjeeling Dist. ; vic. Pokhara, Nepal
	♀	10	13.57	.30	12.4-15.3	
P. m. monticolus	♂	8	13.68	.32	12.0-15.2	Hazara Dist. ; Swat
	♀	3	12.53	.24	12.3-13.0	
P. x. xanthogenys	♂	7	15.46	.34	13.7-16.3	vic. Pokhara, Nepal
	♀	6	14.36	.26	13.4-15.9	
P. spilonotus	♂	2	18.35	..	18.3-19.4	Darjeeling Dist.
Melanochlora s. sultanea	♀	1	36.3	..	..	Darjeeling Dist.
Sylviparus m. modestus	♂	6	7.52	.35	6.1-8.5	Darjeeling Dist. ; vic. Pokhara, Nepal
	♀	5	7.04	.25	6.2-7.8	
Aegithalos leucogenys	♂	4	6.88	.21	6.5-7.4	Hazara Dist.
	♀	3	6.70	.30	6.1-7.0	
Aegithalos concinnus iredalei	♂	2	8.75	..	8.5-9.0	Hazara Dist.
	♀	3	7.20	.29	6.7-7.7	
Aegithalos concinnus rubricapillus	♂	5	6.54	.15	6.0-6.9	Darjeeling Dist. ; vic. Pokhara, Nepal
	♀	5	6.44	.29	5.6-7.1	

ACKNOWLEDGEMENTS

The Ministry of Foreign Affairs of the Government of Nepal and the Zoological Surveys of Pakistan and India were most generous in granting us permission to collect. I am indebted to Dr. A. R. Ranjha, Officer-in-Charge of the Zoological Survey of Pakistan, for loaning several specimens in his care.

Mrs. Zeddie P. Bowen, Secretary to the Bird Department, assisted with the statistical calculations.

MUSEUM OF COMPARATIVE ZOOLOGY,
HARVARD UNIVERSITY,
CAMBRIDGE, MASSACHUSETTS,
August 8, 1962.

RAYMOND A PAYNTER, JR.

REFERENCES

Baker, E. C. Stuart (1922): Fauna of British India. Birds, I, xxiii + 479 pp.

Biswas, Biswamoy (1953): A Check-list of Genera of Indian Birds. *Rec. Indian Mus.* **50**: 1-62.

Fleming, Robert L., & Traylor, Melvin A. (1961): Notes on Nepal Birds. *Fieldiana, Zoology*, **35**: 443-487.

Ludlow, F., & Kinnear, N. B. (1937): The Birds of Bhutan and adjacent Tibet. *Ibis*: 1-46.

Rand, Austin L., & Fleming, Robert L. (1957): Birds from Nepal. *Fieldiana, Zoology*, **41**: 218.

Ripley, S. Dillon (1950): Birds from Nepal, 1947-1949. *J. Bombay nat. Hist. Soc.* **49**: 355-417.

——— (1961): A Synopsis of the Birds of India and Pakistan. Bombay.

Stanford, J. K., & Ticehurst, C. B. (1935): Notes on some new or rarely recorded Burmese Birds, Part I. *Ibis*: 38-65.

Stevens, Herbert (1923): Notes on the Birds of the Sikkim Himalayas, Part II. *J. Bombay nat. Hist. Soc.* **29**: 723-740.

Vaurie, Charles (1950): Notes on Some Asiatic Titmice. *Amer. Mus. Novit.* **1459**: 35 pp.

——— (1957): Systematic notes on Palearctic Birds. No. 27. Paridae: The Genera *Parus* and *Sylviparus. Amer. Mus. Novit.* **1852**: 35 pp.

——— (1959): The Birds of the Palearctic Fauna. Passeriformes. London.

Whistler, H., & Kinnear, N.B. (1932): The Vernay Scientific Survey of the Eastern Ghats (Ornithological Section). *J. Bombay nat. Hist. Soc.* **35**: 505-524.

9. OCCURRENCE OF THE WHITECAPPED BUNTING [*EMBERIZA STEWARTI* (BLYTH)] IN GUJARAT

During the field camp of the BNHS/WHO Bird Migration Study Project at Hingolgadh (Jasdan, Saurashtra) a single specimen of the Whitecapped Bunting, *Emberiza stewarti* (Blyth), was captured in a mist net. This bird has not so far been recorded from Gujarat, and seems to be a rare straggler from the western Himalayas and Baluchistan.

Many species which are not normally seen or recorded turn up quite frequently in our mist nets. For instance the Grasshopper Warbler [*Locustella naevia* (Boddaert)] was not recorded from Saurashtra till one was caught in a mist net in September 1960 at Hingolgadh.

THE PALACE,
JASDAN,
SAURASHTRA,
November 7, 1962.

YUVRAJ SHIVRAJKUMAR

10. NOTES ON THE BIRDS OF THE DISTRICTS OF WEST GODAVARI, KRISHNA, AND NORTH ARCOT

Whistler & Kinnear in their report on The Vernay Scientific Survey of the Eastern Ghats published in our *Journal* in the middle '30s referred to the paucity of information regarding some of the commoner species from the eastern part of peninsular India. From time to time various notes have appeared in the *Journal* adding to the information therein recorded and we were fortunate to have had the opportunity of looking over a collection of about 110 specimens obtained by Mr. B. S. Lamba in 1956/57 working for the Virus Research Centre, Poona, in the districts of West Godavari, Krishna, and North Arcot in Andhra State. The following adds to the information already recorded :

Hydroprogne caspia (Pallas) : The Caspian Tern.

♂, Maginpudi, Krishna District, 5 January 1957.

Metopidius indicus (Latham) : The Bronzewinged Jaçana.

2 ♂♂ (wings 154 and 157 mm.) and 1 ♀ (wing 187 mm.) were collected at Alapada and Palevada in Krishna District.

Chlidonias hybrida indica (Pallas) : The Whiskered Tern.

Machlipatam, Krishna District, on 29 November 1956 (wings 231 and 223 mm.).

Gelochelidon nilotica nilotica (Gmelin) : The Gullbilled Tern.

Machlipatam, Krishna District, ♀ on 29 November 1956 (wing 319 mm.) ; Tallapaliam, Krishna District, ♂ on 15 November 1956 (wing 326 mm.).

Tringa terek (Latham) : The Terek Sandpiper.

Tallapaliam, Krishna District, 28 January 1957.

Rev. A. G. Krebs informed us that he saw it at Cuddalore on 26 September 1948.

Tringa glareola Linn. : The Wood Sandpiper.

Bhujabalapatanam, Krishna District, 2 ♀♀ on 7 November and ♂ on 17 Dec. 1956.

Tringa nebularia (Gunnerus) : The Greenshank.

Tallapaliam, Krishna District, 4 specimens in January 1957.

Tringa totanus (Linn.) : The Common Redshank.

2 ♂♂ on 25 and 28 January 1957, Tallapaliam, Krishna District (wings 158 and 166 mm.).

Charadrius mongolus atrifrons Wagler : The Lesser Sandplover.

Tallapaliam, Krishna District, on 5 January 1957.

Cuculus micropterus micropterus Gould : The Indian Cuckoo.

A full-fledged young was obtained at Puttocku, North Arcot, on 26 July 1956.

Accipter badius dussumieri (Temminck) : The Shikra.

3 ♂♂, wings 171, 175, and 180 mm..

H.A. saw one at Chingleput, Madras, on 9 February 1961.

Circus pygargus (Linn.) : Montagu's Harrier.

Colaire, Krishna District, on 11 January 1957.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
November 30, 1962.

HUMAYUN ABDULALI
DANIEL MATHEW

11. NOTES ON THE RANGE OF CERTAIN BIRDS AS GIVEN IN S. D. RIPLEY II (1961) : *A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN*

The following notes, based on a collection of a little over 5000 specimens made in the Punjab, with some from Baluchistan and Ladakh, during the years 1926 to 1947 and presented to the British Museum in 1949, add to the range of certain birds as given in Dr. Ripley's A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN (1961).

All those taken up to 1943 were identified, and kindly kept for me in his private museum, by my friend and mentor Hugh Whistler, whose untimely death in July of that year was such a grievous loss to Indian ornithology. All the records given below are supported by specimens in this collection except in the case of *Anas angustirostris* and *Oxyura leucocephala.*

The numbers and pages refer to those in the SYNOPSIS.

No. 71, p. 23 : **Plegadis falcinellus** (Linnaeus)

Taken in West Pakistan in Jhelum and Gujrat.

No. 92, p. 30 : **Anas angustirostris** Ménétriès

In India twice taken in Ferozepore (1923, *J. Bombay nat. Hist. Soc.* **28** : 807).

No. 123, p. 41 : **Oxyura leucocephala** (Scopoli)

A regular winter visitor to the Punjab Salt Range, Mianwali district and former Bahawalpur State of West Pakistan. Also occurs on the Khushdil Khan Lake in the Quetta-Pishin district of Baluchistan.

No. 130, p. 42 : **Pernis ptilorhyncus ruficollis** Lesson

A summer visitor to the Rawalpindi and Jhelum districts of West Pakistan. Both Whistler and I found it nesting in the former.

No. 138, p. 45 : **Accipiter badius dussumieri** (Temminck)

Breeds in nearly all of the Punjab districts of West Pakistan.

No. 168, p. 53 : **Aquila rapax vindhiana** Franklin

Common in all of the Punjab and Sind districts of West Pakistan.

No. 183, p. 57 : **Gyps indicus jonesi** Whistler

It is not correct that it breeds chiefly in trees. I am acquainted with nesting colonies in the Jhelum portion of the Punjab Salt Range and the Margala Hills in Rawalpindi, where the nest is always in a cliff. The same is the case in the Kala Chitta Hills in Attock (Jones, A. E., 1921, *J.Bombay nat. Hist. Soc.* **27** : 800). Compare Whistler, 1930, *Ibis* : 262.

No. 185, p. 58 : **Gyps bengalensis** (Gmelin)

Common in all of the Punjab and Sind districts of West Pakistan.

No. 188, p. 59 : **Gypaëtus barbatus aureus** (Hablizl)

In West Pakistan its range includes the Punjab Salt Range and the Khirthar and Sulaiman ranges bordering Baluchistan.

No. 237, p. 73 : **Francolinus francolinus henrici** Bonaparte

Its range in West Pakistan includes the Punjab districts of Dera Ghazi Khan, Muzaffargarh, and Mianwali.

No. 337, p. 101 : **Porzana pusilla pusilla** (Pallas)

Winters also in West Pakistan, where I have taken it in the Punjab districts of Rawalpindi, Jhelum, Gujrat, and Muzaffargarh.

No. 373, p. 113 : **Pluvialis dominica fulva** (Gmelin)

Taken once in September in Gujrat District of West Pakistan.

No. 404, p. 123 : **Capella solitaria solitaria** (Hodgson)

Taken at Dras in Ladakh in October. Winters in small numbers in Kangra District (Whistler, 1926, *Ibis* : 779).

No. 503, p. 156 : **Treron phoenicoptera phoenicoptera** (Latham)

Taken in Gujrat District of West Pakistan.

No. 519, p. 161 : **Columba palumbus casiotis** (Bonaparte)

Found breeding in West Pakistan in both the Jhelum and Shahpur portions of the Punjab Salt Range.

No. 573, p. 176 : **Cuculus varius varius** Vahl

In West Pakistan occurs in the Punjab districts of Rawalpindi and Jhelum (in both of which I have taken specimens), Lahore, and Shahpur.

No. 614, p. 187 : **Otus brucei** (Hume)

Taken in both the Jhelum and Shahpur portions of the Punjab Salt Range.

No. 615, p. 188 : **Otus scops pulchellus** (Pallas)

Several observed and three taken in March in Loralai District of Baluchistan.

No. 616, p. 188 : **Otus scops sunia** (Hodgson)

Four, including one from a nest, taken in May at 6000 ft. in the Murree Hills of Rawalpindi District. Compare Whistler, 1930, *Ibis* : 260.

No. 620, p. 189 : **Otus bakkamoena deserticolor** Ticehurst

Taken in the Punjab districts of Muzaffargarh and Shahpur.

No. 650, p. 196 : **Athene brama indica** (Franklin)

Common in all the Punjab Districts of West Pakistan.

No. 663, p. 199 : **Asio otus otus** (Linnaeus)

Once taken in Shahpur District of West Pakistan.

No. 674, p. 203 : **Caprimulgus mahrattensis** Sykes

Breeds at the Punjab Salt Range in the Jhelum and Shahpur districts.

No. 682, p. 205 : **Caprimulgus affinis monticolus** Franklin

In West Pakistan breeds in the Jhelum portion of the Punjab Salt Range.

No. 702, p. 210 : **Apus affinis galilejensis** (Antinori)

Breeds commonly in the West Punjab districts of Jhelum and Shahpur.

No. 749, p. 223 : **Merops orientalis beludschicus** Neumann

Its range includes all the Punjab districts of West Pakistan.

No. 763, p. 227 : **Upupa epops epops** Linnaeus

Breeds in many of the Punjab districts of West Pakistan.

No. 777, p. 232 : **Megalaima virens marshallorum** Swinhoe

Breeds in the Jhelum portion of the Punjab Salt Range.

No. 792, p. 236 : **Megalaima haemacephala indica** (Latham)

In West Pakistan Whistler found it breeding in Gujranwala (1916, *J. Bombay nat. Hist. Soc.* **24** : 700), and I in Lahore, and I have observed it in Jhelum and Rawalpindi. In India I found it not uncommon in Ferozepore, Jullandar, Hoshiarpur, Ludhiana, and Ambala.

No. 807, p. 240 : **Picus squamatus squamatus** Vigors

Resident at Sakesar, *c.* 4500 ft. in the Shahpur portion of the Punjab Salt Range, where I have twice found nests with young.

No. 875, p. 260 : **Mirafra erythroptera sindiana** Ticehurst

Its range in West Pakistan includes the Jhelum and Rawalpindi districts. Three specimens were taken in Rawalpindi District (*J. Bombay nat. Hist. Soc.* **35** : 458).

No. 882, p. 262 : **Ammomanes phoenicurus phoenicurus** (Franklin)

Taken in July, August, and September in the West Pakistan districts of Jhelum and Shahpur.

No. 914, p. 272 : **Hirundo concolor concolor** Sykes

Taken in the Ludhiana and Ambala districts of East Punjab.

No. 921, p. 274 : **Hirundo smithii filifera** Stephens

In West Pakistan found breeding in the Punjab districts of Rawalpindi, Jhelum, Shahpur, and Jhang.

No. 999, p. 299 : **Sturnus vulgaris porphyronotus** Sharpe

Taken in the Attock, Rawalpindi, and Jhelum districts of the Punjab.

No. 1233, p. 368 : **Chrysomma altirostre scindicum** (Harington)

The statement that this is known only from the type needs correction. In 1932 I collected two near Jampur in Dera Ghazi Khan District (*J. Bombay nat. Hist. Soc.* **36** : 748). In 1937 I took six more in the same locality and one near Khanwah in Muzaffargarh. To these were added three taken near Bhamb in Mianwali in 1943. All are now in the British Museum.

No. 1407, p. 421 : **Muscicapa latirostris** Raffles

Ludhiana is in India and not West Pakistan.

No. 1431, p. 429 : **Muscicapa sundara fastuosa** (Lesson)

Taken in winter at 2000 ft. in Rawalpindi, Hoshiarpur, and Ambala districts.

No. 1451, p. 435 : **Rhipidura aureola aureola** Lesson

Taken in the Shahpur, Mianwali, Muzaffargarh, and Dera Ghazi Khan districts of West Pakistan.

No. 1460, p. 437 : **Terpsiphone paradisi leucogaster** (Swainson)
In West Pakistan breeds commonly in the Punjab Salt Range.

No. 1515, p. 454 : **Prinia socialis stewarti** Blyth
Taken in the Gujrat and Jhang districts of West Pakistan.

No. 1524, p. 456 : **Prinia flaviventris sindiana** Ticehurst
Taken in Mianwali District of West Pakistan.

No. 1565, p. 469 : **Sylvia hortensis jerdoni** (Blyth)
In India taken in the Punjab districts of Jullandar, Ambala, and Hissar.

No. 1575, p. 473 : **Phylloscopus collybita tristis** Blyth
Taken in Rawalpindi, Jhelum, Gujrat, Shahpur, Mianwali, Muzaffargarh, and Dera Ghazi Khan in West Pakistan and Jullandar, Ludhiana and Rohtak in India.

No. 1712, p. 518 : **Oenanthe picata** (Blyth)
Found breeding in the Sulaiman Hills on the Punjab-Baluchistan border.

No. 1716, p. 520 : **Chaimarrornis leucocephalus** (Vigors)
Occasionally found in winter in the Punjab Salt Range.

No. 1723, p. 522 : **Monticola cinclorhynchus** (Vigors)
Occurs on autumn passage in the Shahpur portion of the Punjab Salt Range.

No. 1725, p. 523 : **Monticola solitarius longirostris** (Blyth)
Once taken in January in Jhelum District of West Pakistan.

No. 1750, p. 532 : **Turdus boulboul** (Latham)
Taken in the plains in winter in the Punjab districts of Rawalpindi, Ludhiana, and Ambala. A winter visitor in small numbers to Jhelum (Whistler, 1916, *Ibis* : 65).

No. 1752, p. 533 : **Turdus merula maximus** (Seebohm)
A pair taken in June in the Sutlej Valley at Chini in the former Bashahr State.

No. 1763, p. 536 : **Turdus ruficollis atrogularis** Jarocki
In West Pakistan winters commonly in the Attock, Rawalpindi, Jhelum, Shahpur, and Jhang districts and in India in Jullandar, Ludhiana, and Ambala.

No. 1770, p. 538 : **Troglodytes troglodytes neglectus** Brooks
Its range in West Pakistan includes Baluchistan (Christison, A.F.P., & Ticehurst, C.B., 1942, *J. Bombay nat. Hist. Soc.* **43** : 481).

No. 1799, p. 548 : **Parus monticolus monticolus** Vigors
Once taken in the Jhelum portion of the Punjab Salt Range.

No. 1865, p. 571 : **Anthus pelopus** J. E. Gray

Taken in the Jhelum portion of the Punjab Salt Range.

No. 1879, p. 575 : **Motacilla flava leucocephala** (Przevalski)

To Whistler's May 1913 Jhelum record I added one from Attock in April 1938 (*J. Bombay nat. Hist. Soc.* **40** : 561). In April and May 1939 and April 1940 my Indian collector obtained 23 (15 ♂♂, 2 ♀♀, and 6 unsexed) in Rawalpindi District. All are now in the British Museum (cf. Whistler, 1940, *Ibis* : 335-337).

No. 1981, p. 608 : **Coccothraustes coccothraustes humei** Sharpe

Taken in winter in the Jhelum portion of the Punjab Salt Range.

No. 2017, p. 620 : **Carpodacus rhodochrous** (Vigors)

In three consecutive winters I found it in appreciable numbers between 2000 ft. and 3000 ft. near Rawalpindi.

No. 2058, p. 635 : **Emberiza schoeniclus pallidior** Hartert

Taken in the Hoshiarpur, Ludhiana, and Ferozepore districts.

KALABAGH,
MIANWALI DISTRICT, H. W. WAITE
WEST PAKISTAN,
October 10, 1962.

12. RECOVERIES OF RINGED MIGRATORY BIRDS AT HINGOLGADH, JASDAN, SAURASHTRA

During the last field camp of the BNHS/WHO at Hingolgadh in September 1962 the following migratory birds ringed previously in 1960 and 1961 at Hingolgadh were recaptured at the same place:

	Ringed on	Recaptured on	Remarks
Sylvia hortensis (Ring No. A-3065)	27-9-60	18-9-62	This bird was previously recaptured at the same place on 21-9-61.
Sylvia hortensis (Ring No. A-2790)	19-9-60	24-9-62	
Sylvia curruca (Ring No. A-3394)	24-9-61	26-9-62	

THE PALACE,
JASDAN, SAURASHTRA, YUVRAJ SHIVRAJKUMAR
November 7, 1962.

13. RECOVERY OF RINGED BIRDS

Ring No.	Species	Date of Ringing	Place of Ringing	Recovered on	Place of Recovery	Remarks
Moskwa D 410.613	*Tadorna ferruginea*	9-7-1959 juvenile	Lake Son-Kul (Kirghiz) USSR, *c.* 41° 50′ N. × 75° 00′ E.	16-10-1959	Nabipur, near Lahore, West Pakistan, 31° 34′ N. × 74° 21′ E.	Reported by Mrs. J. Miller, Balfour Beatty (Overseas), Water Cantonment, West Pakistan, through Dr. Robert Spencer, Ringing Officer, Bird Ringing Committee, B.T.O., London.
Moskwa A 50.294	*Anser indicus*	23-7-1959 adult	Chatyr-Kul Lake (Kirghiz) USSR, *c.* 40° 40′ N. × 75° 18′ E.	23-12-1960	River Indus, 30 miles east of Dera Ghazi Khan, West Pakistan, *c.* 30° 07′ N. × 70° 56′ E.	Reported by Mr. A. Harrison, Railway Police Lines, Macleod Road, Lahore, W. Pakistan, through Dr. Robert Spencer.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
December 6, 1962.

EDITORS

14. EXTENSION OF RANGE OF THE SKINK *RIOPA GUENTHERI* (GRAY)

Rev. E. M. Shull of Ahwa, Surat Dangs, Gujarat State, recently sent us a collection of reptiles from the Dangs, which included two specimens of the skink, *Riopa guentheri* (Gray), known to range from Matheran (Western Ghats, Maharashtra State) southwards to Travancore.

The present specimens extend the known range considerably northwards.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
December 12, 1962.

J. C. DANIEL
Curator

15. SEX RATIO AND SIZE OF THE GARDEN LIZARD (*CALOTES VERSICOLOR* DAUD.)

Over the last two years 757 adults of the Bloodsucker Lizard *Calotes versicolor* Daud. were collected at Varanasi, U.P., and some of them are still kept alive for the study of their growth rates. The lizards were trapped locally by professionals using *lassa* (a mixture of latex and oil) at the end of a long rod, with no discrimination regarding size or sex. The following observations may be of interest:

(*a*) 239 were females and 498 males, indicating a sex ratio of approximately 2.08 males for every female.

(*b*) No female with a snout to vent length of more than 100 mm. was handled, and we may presume that this is the maximum size to which a female of this species can grow at Varanasi. Males, however, grew to 110 mm., three individuals exceeding this size, 112 mm. (2) and 113 mm. The Varanasi population thus appears to be intermediate, as may be anticipated, between the small Indo-Chinese form (95 mm. maximum body length in males) and the larger peninsular Indian form 120 to 140 mm. (1935, Smith, M. A.: FAUNA OF BRITISH INDIA, II, Sauria, p. 189.)

(*c*) Contrary to popular belief and the statement by Smith, it is not males alone that assume crimson colour and black patches; females and castrates of both sexes also assume this colour, even when they are not excited. In our opinion, this colour character does not belong to the sex complex and should not be treated as a sex character of the males.

DEPARTMENT OF ZOOLOGY,
BANARAS HINDU UNIVERSITY,
VARANASI 5,
August 27, 1962.

G. S. SINGH
J. P. THAPLIYAL

16. EXTENSION OF RANGE OF OLIVACEOUS SMOOTH SNAKE [*RHABDOPS OLIVACEUS* (BEDDOME)]

On 1 September 1962, I collected an Olivaceous Smooth Snake, *Rhabdops olivaceus* (Beddome), under a stone on the flat bare top of a hill, *c.* 1300 m. above m.s.l., west of Koyna Dam, Satara District, Maharashtra State, surrounded by thick forest.

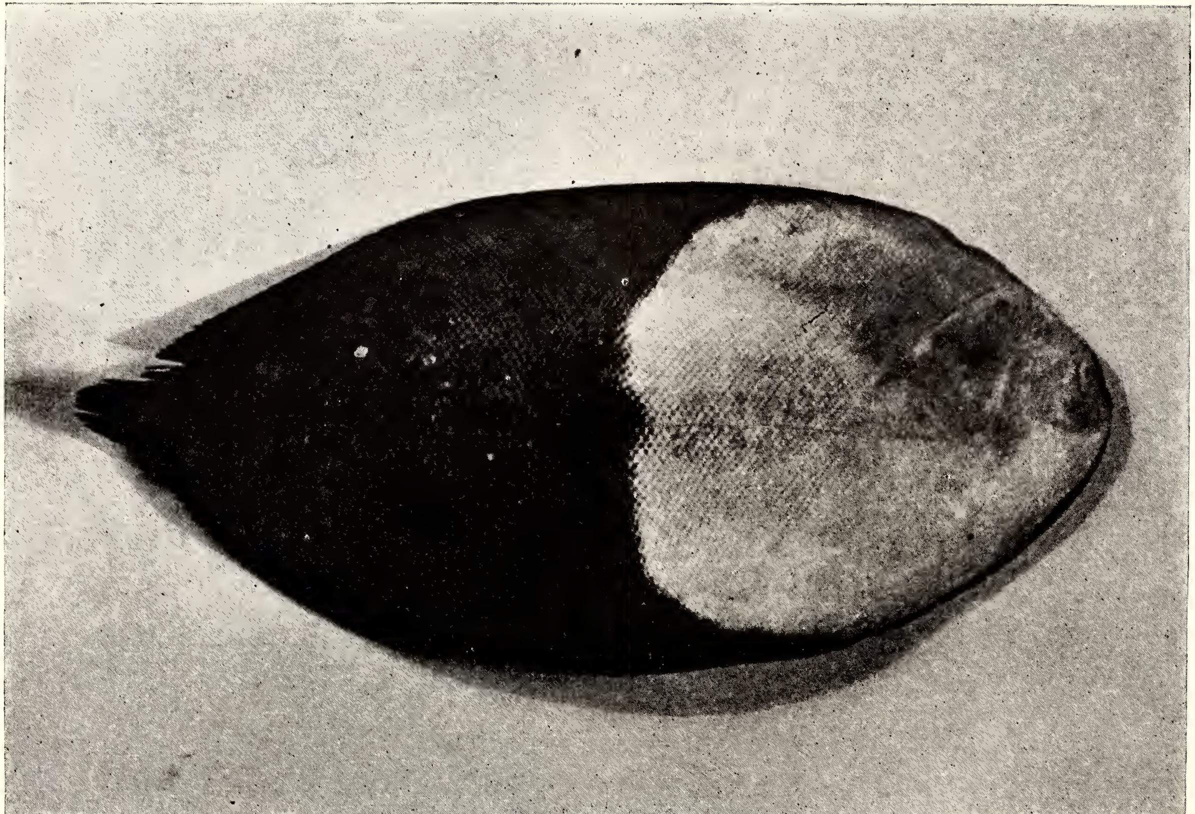
The records in literature are restricted to the Wynaad, but a specimen in the Society's collection was collected by Dr. Edward Taylor at Kottegehar in Kadur, Mysore State, in 1961. The present specimen, a male, has 227 ventrals against 206-215 mentioned in Smith's FAUNA (1943), p. 328, and constitutes the northernmost record of this species.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
December 6, 1962.

P. W. SOMAN

17. EXTENSION OF THE KNOWN RANGE OF THE CATSNAKE, *BOIGA FORSTENI* (DUM. & BIBR.)

A small collection of snakes recently received from Mr. E. M. Shull, Ahwa, Surat Dangs, Gujarat, includes one specimen of *Boiga forsteni* (Dum. & Bibr.). The distribution as recorded in Smith's FAUNA is 'Ceylon and Peninsular India; Western Ghats (Matheran to Travancore); Ganges Valley (Orcha, Fyzabad, Gorakhpur, Balrampur, Purnea, Manbhum); Orissa (Behrampore); Bengal (Sijna); Eastern Himalayas (Darjeeling district, *fide* Wall). It inhabits both the plains and the hills.' The present record appears to extend its known distribution appreciably northwards, though in the Society's copy of Smith's FAUNA there is a pencil entry against the paragraph



Brachirus orientalis (Bloch & Schneider)

View of ambicolourate specimen from blind side of the range of this species reading 'Mt. Abu' and initialled by Charles McCann then Assistant Curator of the Society. This does not appear to have been published and the specimen is not available in our collection.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
December 18, 1962.

J. C. DANIEL
Curator

18. AN INSTANCE OF PARTIAL AMBICOLOURATION IN THE ORIENTAL SOLE, *BRACHIRUS ORIENTALIS* (BLOCH & SCHNEIDER)

(*With a plate*)

Pigmentation on the blind side of flatfishes has been recorded as an abnormality. Cunningham & MacMunn (1893) termed such abnormal specimens as 'ambicolourate' and the phenomenon has since then been called 'ambicolouration'. Amongst Indian flatfishes, ambicolouration was first recorded in the 'Pan' sole, *Brachirus pan* (Hamilton), by Jones & Menon (1950), discussing its ontogenic significance.

Norman (1934) classified the pigmentation on the blind side into three categories as staining, spotting, and true ambicolouration. True ambicolouration is very rare and may be: partial pigmentation, trunk pigmentation, nearly complete ambicolouration, and complete ambicolouration.

On 8 June 1960, during a visit to the Crawford Market at Bombay, the authors came across an ambicolourate specimen of *Brachirus orientalis* (Bloch & Schneider) (see plate) along with a few other normal specimens of the same species. This record may be of interest as it is the first of its kind from this area.

The ambicolourate specimen measured 162 mm. in total length. The uncoloured anterior portion on the blind side is almost heart-shaped and the pigmentation commences from the 33rd dorsal and 9th anal rays. The pigmentation along the anterior region and the fins is darker than the central portion.

The pectoral fin on the blind side was smaller as is normal in the species. Jones & Menon (1950 have referred to a case of nearly complete ambicolouration in *Brachirus pan* in which both pectoral fins were of the same size.

TARAPOREVALA MARINE BIOLOGICAL RESEARCH STATION,
BOMBAY 2,
November 16, 1962.

R. M. PRADHAN
M. J. PRADHAN

REFERENCES

* Cunningham, J. T., & MacMunn, C. A. (1893): *Phil. Trans. Roy. Soc.* **184**: 801-802.

Jones, S., & Menon, P. M. G. (1950): An interesting case of ambicolouration in the 'Pan' Sole, *Brachirus pan* (Hamilton). *Rec. Ind. Mus.* **48** (3): 67-70.

Norman, J. R. (1934): A Systematic Monograph of the Flatfishes (Heterostomata), I, pp. 22-27. London.

* Not consulted in original.

19. MIGRATION OF ELVERS IN THE WEST HIGHLANDS OF SCOTLAND[1]

(*With two plates*)

With reference to Mr. K. H. Ibrahim's Miscellaneous Note at pages 810 to 812 of Volume 58 of the *Journal,* D. E. Reuben has drawn our attention to the following passage in Gavin Maxwell's (1960) RING OF BRIGHT WATER, describing the migration of elvers in the west highlands of Scotland:

'Early in May comes the recurrent miracle of the elvers' migration from the sea. . . . When the elvers reach the Camusfeàrna burn—no more than a uniform three inches long nor thicker than a meat-skewer, steel-blue when seen from above, but against the light transparent except for a red blob at the gills—they have been journeying in larval form for two whole years from their breeding grounds south-west of Bermuda, through two thousand miles of ocean and enemies. During that long, blind voyage of instinct their numbers must have been reduced not to a millionth but a billionth of those who set forth, yet it is difficult to imagine that there can have been vaster hordes than reach the Camusfeàrna burn; still more difficult

[1] The extract and the photographs are reproduced by kind permission of the author from RING OF BRIGHT WATER, by Gavin Maxwell, published by Messrs Longmans, Green & Co. Ltd., London.

Migrating elvers climbing vertical rock at the side of the fall

(*Reproduced from the* RING OF BRIGHT WATER, *by Gavin Maxwell, Longmans,* 1961, *by kind permission*)

'dip a bucket here and it comes up with a greater volume of elvers than of water'. Elvers and eel-slime, technically known as 'vomp'.

(*Reproduced from the* RING OF BRIGHT WATER, *by Gavin Maxwell, Longmans*, 1961, *by kind permission*) to realize that these are but a tiny fraction of the hosts that are simultaneously ascending a myriad other burns.

'Where the burn flows calm through the level ground their armies undulate slowly and purposefully forward towards the seemingly insurmountable barrier of the falls; on, above the bridge, into the stretch where the water rushes and stumbles over uneven stones; round the rock-twist to the foot of the falls. Here, temporarily daunted or resting before their assault upon the vertical, spray-wet rock-face, they congregate almost motionless in the rock pools, forming a steel-blue carpet inches deep; dip a bucket here, and it comes up with a greater volume of elvers than of water. Some mistake the true course of the burn, and follow steep trickles leading to *cul-de-sac* pools of spray water; to and from these (for the miraculous powers of their multitudes do not appear to include communication or deduction), there are simultaneous streams of ascending and descending elvers, while the spray-pool itself is filled to the brim with an aimlessly writhing swarm.

'It is here, during the wait at the foot of the falls, that the last heavy toll is taken of their numbers; for a week or two the rocks below the waterfall are splashed white with the droppings of herons who stand there scooping them up by the bill-full, decimating yet again, on the verge of their destination, the remnants of the great concourse that has been travelling thus perilously for two years.

'. . . it is in the elvers' final ascent of the falls that the colossal driving power of their instinct becomes most apparent to the onlooker. At first, where at the edges of the falls the water splashes into shallow stone troughs among the horizontal ledges, the way is easy—a few inches of horizontal climb and the elver has reached the next trough. But after a foot or two of this ladder-like progression they are faced either with the battering fall of white water at their left or with a smooth black stretch of rock wall in front, hit every few seconds by heavy splashes of spray. For a few feet at the bottom of this wall grows a close slimy fur of waterweed, and among its infinitesimal tendrils the elvers twine themselves and begin, very slowly, to squirm their way upwards, forming a vertical, close-packed queue perhaps two feet wide. Sometimes a big gob of spray lands right amid their ranks and knocks a hundred of them back into the trough below, but slowly, patiently, they climb back again. I have never marked an elver so that it is recognizable, and for all I know this may happen to the same elver many, many times in a day or even in an hour . . .

'Once above the water-draggled weed there is no further incidental support for the climbing elvers; there is just sheer wet rock, with whatever microscopic roughness their transparent bellies may apprehend. They hang there, apparently without gravity, with an occasional convulsive movement that seems born of despair. They climb perhaps six inches in an hour, sometimes slithering backward the same distance in a second, and there are a further twelve feet of rock above them.

'It is not possible for more than a moment or two to identify oneself with any single one of this mass, but there is a sense of relief, of emotional satisfaction, in looking upward to the lip of the falls where they spill over from the hidden pool above, and seeing the broad band of glistening elvers that have accomplished the apparently impossible and are within an inch of safety.

'Perhaps a few million out of billions top the Camusfeàrna falls; some, certainly, surmount the second and third falls too, and I have seen elvers of that size more than two thousand feet up the peak where the burn has its source. In perspective, the survival rate must be high when compared with that of spermatozoa.'

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, EDITORS
BOMBAY 6,
May 18, 1962.

20. FISH MORTALITY AT SHAHDRA FISH FARM, DELHI

Sudden and large scale mortality of fishes in inland waters is a common occurrence in India, particularly during the summer months. Since the total quantity of fish destroyed in this way is very high, it is imperative to analyse the causes of such fish wastage. A number of investigations carried out (Hornell & Naidu 1923, Sewell 1926, Chopra 1926, Aiyar 1936, Ganapati & Alikunhi 1948, Prescott 1948-49, Ganapati 1949, Alikunhi, Chaudhuri, & Ramachandran 1955, and George 1961) in this direction have revealed that the causative factors may be either biological or physico-chemical. The former includes scarcity of food and parasitic, fungal, or bacterial infections. The physico-chemical factors are temperature, turbidity, pH, dissolved oxygen, obnoxious gases produced by organic debris at the bottom of the pond, and chemical effluents. The extent of damage depends on the severity of these factors.

Topography of the pond. The Shahdra Fish Farm is situated about two miles from Delhi between the Howrah-Delhi railway line and the Grand Trunk Road. It is a rectangular pond having an average water area of five acres. The average depth of the water column during the monsoon is nine feet and in summer five and a half feet. The main source of water is from the monsoon rains, though the tank is also fed once from Jumna River during the months of May or June. It enjoys full sunshine owing to the absence of trees on the three sides of the bank. The shore line is steep on the western side and is sloping on the eastern side. The tank supports a dense growth of *Potamageton pectinatus* Linnaeus throughout the year. Carp fingerlings are stocked regularly in this tank.

Mortality. Severe fish mortality occurred in the tank on 1 August 1961. The fishes were found dying from the early hours of the morning. Many were swimming with their mouths out of the water and gasping for breath. All the fishes in the tank numbering about two hundred died, the size range being 24-360 mm. The fish population consisted of *Labeo rohita* (Ham.), *L. calbasu* (Ham.), and *L. bata* (Ham.), *Cirrhina mrigala* (Ham.) and *C. reba* (Ham.), *Catla catla* (Ham.), *Amblypharyngodon mola* (Ham.), *Chela bacaila* (Ham.), and *Botia lohachata* (Chaudhuri).

Chemical Conditions. The results of chemical analysis of the water, carried out from 1 to 8 August 1961, are presented in Table below. For comparison, the results of the analysis of two normal samples collected on 30 August and 28 September 1961 respectively are included in the Table. The data obtained show nothing abnormal except the high values of alkalinity.

Biological Conditions. The biological estimate on the qualitative and quantitative nature of plankton showed nothing abnormal. The phytoplankton population was mostly composed of *Chlamydomonas, Tetraspora, Pediastrum, Dictyosphaerium, Oocystis, Crucigenia, Scenedesmus, Euglena, Trachelomonas, Fragilaria, Navicula, Merismopedia,* and *Oscillatoria.* The zooplankton was dominated by *Filinia, Asplanchna, Brachionus, Hexarthra, Diaptomus, Cyclops,* and crustacean larvae.

Discussion. The guts of the dead fishes on examination were found gorged, indicating that they were feeding normally. As these fishes appeared normal and healthy, the cause of mortality cannot be attributed to possible fungal, bacterial, or parasitic infection. Free CO_2 was never detected at any time during the course of the investigation. The value of dissolved oxygen was comparatively low (3.2 p.p.m.). But the results obtained by Basu (1949) indicate that under experimental conditions fishes can survive over 24 hours in water with 1 p.p.m. of dissolved oxygen. George (1961) has pointed out that *Labeo rohita* and *Cirrhina mrigala* can survive for about 7

TABLE

CHEMICAL ANALYSIS

Date	Colour	Temperature in °C.	Free CO_2 p.p.m.	Turbidity p.p.m.	pH.	Dissolved oxygen p.p.m.	Carbonate alkalinity p.p.m.	Total alkalinity p.p.m.	Total hardness p.p.m.	Chlorides p.p.m.
1-8-61	Clayish green	33	Nil	70	8.8	3.2	20	570	140	93
2-8-61	Dirty green	32.6	do.	69	8.8	3.6	20	572	140	94
3-8-61	do.	33	do.	68	8.8	3.8	21	580	142	93
4-8-61	do.	32	do.	70	8.8	4.3	18	590	140	95
5-8-61	do.	33	do.	69	8.8	4.2	18	586	145	96
6-8-61	do.	33.2	do.	68	8.8	4.1	16	595	146	94
7-8-61	do.	33	do.	64	8.8	4.0	19	590	152	92
8-8-61	do.	32	do.	70	8.8	4.3	18	559	150	102
30-8-61	Light brown	32	do.	84	8.5	4.9	11	358	298	156
20-9-61	Light green	31.6	do.	23	8.5	6.3	13	320	305	147

minutes in waters containing 0.1 p.p.m. of dissolved oxygen, so that it may be inferred that the mortality was not due to lack of oxygen.

The rains supply a large amount of drainage water to catchment areas from where it ultimately reaches the tanks. It profoundly alters the physico-chemical nature of pond water as it washes down large quantities of nutrients and mineral during its transit. The annual rainfall recorded in Delhi territory during 1961 is 1115.4 mm. The first major shower of the monsoon of 88.8 mm. was recorded on 31 July 1961 which was the day prior to the mortality. The high values of alkalinity noted on 1 August 1961 might be due to the washing down of large quantities of the salts of calcium and magnesium from the catchment areas. According to Alikunhi (1957) total alkalinity over 500 p.p.m. is lethal to fish life. Thus the fish mortality in the Shahdra Fish Farm in the absence of any other adverse factor is attributed to the highly alkaline condition of water which exceeds the tolerance limit of the major carps of India.

Acknowledgements. I am grateful to Dr. M. Chandy, Reader in Zoology, University of Delhi, for critically reading the manuscript. Thanks are due to Mr. K. L. Dixit of Meteorological Department, Delhi, for providing the data on rainfall.

EXTENSION OFFICER, FISHERIES,
KHYBER PASS,
DELHI,
March 25, 1962.

R. N. CHATURVEDI

REFERENCES

Aiyar, Gopala (1936): Mortality of fish of the Madras coast. *Curr. Sci.* **5**: 488.

Alikunhi, K. H. (1957): Fish Culture in India. Indian Council of Agricultural Research Farm Bulletin, **20**.

——— Chaudhuri, H., & Ramachandran, V. (1955): On the mortality of carp fry in nursery ponds and the role of plankton in their survival and growth. *Indian J. Fish.* **2**: 257-313.

Basu, S. P. (1949): Some experimental data regarding the oxygen requirements of the Indian Fishes, *Catla catla*, *Labeo rohita*, *Labeo bata* and *Cirrhina mrigala*. *Proc. nat. Inst. Sci. India* **15**: 283-286.

Chopra, B. N. (1926): A note on fish mortality in the Indaw River in Upper Burma. *Journ. & Proc. Asiatic Soc. Bengal* **22**: 203-210.

Ganapati, S. V. (1949): The hydrology of three summer pools in the rocky stream bed at Mettur Dam with special reference to certain abnormal surface congregation of fishes. *J. zool. Soc. Inida* **1**: 44-48.

Ganapati, S. V. & Alikunhi, K. H. (1948): On an interesting case of mortality of larvicides in the Public Health Fish Nurseries at Ennur, Madras. *Proc. Ind. Sci. Cong.* **35**: 208.

George, M. G. (1961): Diurnal variations in two shallow ponds in Delhi, India. *Hydrobiologia* **18**: 265-273.

* Hornell, J., & Naidu, Ramaswami (1923): Madras Fish Bull. **17**.

Prescott, G. W. (1948-49): Objectionable algae with reference to the killing of fish and other animals **1**: 1-13.

Sewell, R. B. S. (1926): Investigations regarding an epidemic of fish mortality in the tank in the Indian Museum compound. *Journ. & Proc. Asiatic Soc. Bengal* **22**: 177-201.

* Not referred to in original.

21. MARINE BIVALVE MOLLUSC *SOLENOMYA MEDITERRANEA* LAMARCK FROM COCHIN, SOUTH INDIA: A NEW RECORD

(*With one plate*)

In April 1961, I received a specimen of a bivalve mollusc (without the soft parts, but with both valves of the shell intact) for identification from Mr. P. Dinamani, Research Officer, Oceanographic Laboratory, University of Kerala, Cochin, collected from near Cochin, on the west coast.

On careful examination, I found that the specimen belonged to a species of bivalve, *Solenomya mediterranea* Lamarck, which has not hitherto been recorded from the coasts of India. One characteristic feature of the genus *Solenomya* is that the shell possesses a strong, shiny brown periostracum which extends beyond the edges of the valves and this feature was very well marked in the specimen I examined.

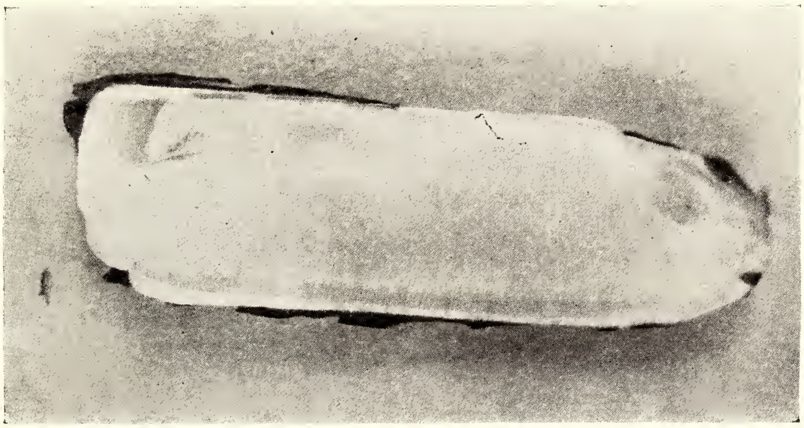
The shell is transversely elongated, somewhat rectangular, with more or less obtusely rounded front and hind margins, but the posterior side is rather narrowed and obliquely truncated. The hinge is without teeth, and the ligament partly internal. The cardinal callus is narrow, curved, and obliquely triangular, and the ligamentary area behind the callus is also triangular and linearly produced below. The shell is covered with a fairly thick, glossy, dark brown, horny periostracum extending beyond the margins of the valves. The surface of the shell bears distinct radial striations.

The specific name *mediterranea* indicates that the original specimens on which this species was based were recorded from the Mediterranean (which is the type locality mentioned by Reeve for this species, in his CONCHOLOGIA ICONICA, Vol. XX, Species 2), but this does not imply that specimens of this species are not likely to be found in other localities.

This is an interesting and unique record, for, as far as I know, this species has not been recorded from Indian waters earlier. If any of our readers happens to collect any further specimens of this species on Indian shores, we shall be glad to have a few for the Madras Museum collection in which it is not at present represented.

MADRAS GOVERNMENT MUSEUM,
MADRAS,
August 30, 1962.

S. T. SATYAMURTI
Superintendent



Solenomya mediterranea Lamarck

Above : Inner view of shell ($\times\ 1\frac{1}{2}$) ; *Below :* Outer view of shell ($\times\ 1\frac{1}{3}$)

22. TERMITE '*ODONTOTERMES OBESUS* (RAMBUR)': ROYAL CHAMBER WITH FOUR QUEENS AND TWO KINGS

(*With two plates*)

The occurrence of more than one king and one queen in the royal chamber in mounds of species of *Odontotermes* has occasionally been reported. Thus, two queens were reported in *O. obesus* (Ramb.) by Holmgren (1912) and by Roonwal & Gupta (1952), three queens in *O. wallonensis* Wasm. by Mathur & Chhotani (1960), and as many as six queens in *O. bangalorensis* Holmg. by Holmgren (1913).

Recently we came across several mounds of '*Odontotermes obesus* (Rambur)'[1] on the roadside in the Balukhand Forest Range near Puri (Orissa), which were of the type described by Holmgren (1912, Pl. A, Fig. 1).

The mounds were relatively small (*c.* 70-120 cm. high, with a slightly larger diameter), somewhat dome-shaped (Pl. I, Fig. *a*) and with several short (*c.* 10-20 cm. high), blind turrets arising all over the mound-surface. The fungus-combs (Pls. I and II) lie in small vaults distributed throughout the mound. The royal chamber (*r.c.*), lies near ground-level (in Pl. 1, Fig. *b* it seems to be situated higher up, but this is because this mound is on sloping ground, and hence the impression in the photograph), and is difficult to separate from the earthen mound-material. The royal cell is rather large, more or less spindle-shaped in cross-section, and has smooth inside walls.

In one of these mounds (Pl. I), the royal cell (maximum dimensions: length 25, width 15, and height 4 cm.) contained four large physogastric queens (de-alated females) and two kings (de-alated males) (Pl. II, Fig. *a*) and several soldiers and workers. The queens were lying in pairs—one pair lying north-south and the other pair west-southeast, with the heads of the pairs facing in opposite directions.

---

[1] The mounds of this species seem to be variable, but soldiers from different kinds of mounds are indistinguishable. Thus, in the north (Uttar Pradesh and Bihar) the mounds are of high, fluted type with buttresses (see Roonwal, 1962, for a detailed description and discussion), and elsewhere somewhat dome-shaped and low as described in the present account. Pending a suitable revision, termites from both these types of mounds may be regarded as belonging to '*Odontotermes obesus* (Rambur)'.

All the queens were large, with long, swollen abdomens, while the kings were, as usual, smaller. The dimensions were:

		Queens (4)	*Kings* (2)
		mm.	mm.
1.	Total length (excluding antennae) ..	52.2-62.8	11.3-11.5
2.	Length of abdomen	50.5-58.0	5.7-6.0
3.	Max. width of abdomen	13.2-17.2	3.5-4.0

ZOOLOGICAL SURVEY OF INDIA,
34, CHITTARANJAN AVENUE,
CALCUTTA-12,
September 28, 1962.

M. L. ROONWAL
O. B. CHHOTANI

REFERENCES

HOLMGREN, N. (1912): Termites from British India (Bombay) collected by Dr. J. Assmuth, S.J. *J. Bombay nat. Hist. Soc.* **21** (3): 774-793, 4 pls. Bombay.

——— (1913): Termites from British India (near Bombay, in Gujerat, and Bangalore), collected by Dr. J. Assmuth, S.J. ibid. **22** (1): 101-117, 3 pls.

MATHUR, R. N., & CHHOTANI, O. B. (1960): Three queens in mounds of *Odontotermes wallonensis* (Wasmann) (Termitidae, Isoptera). *Indian For.* **86** (10): 623-624.

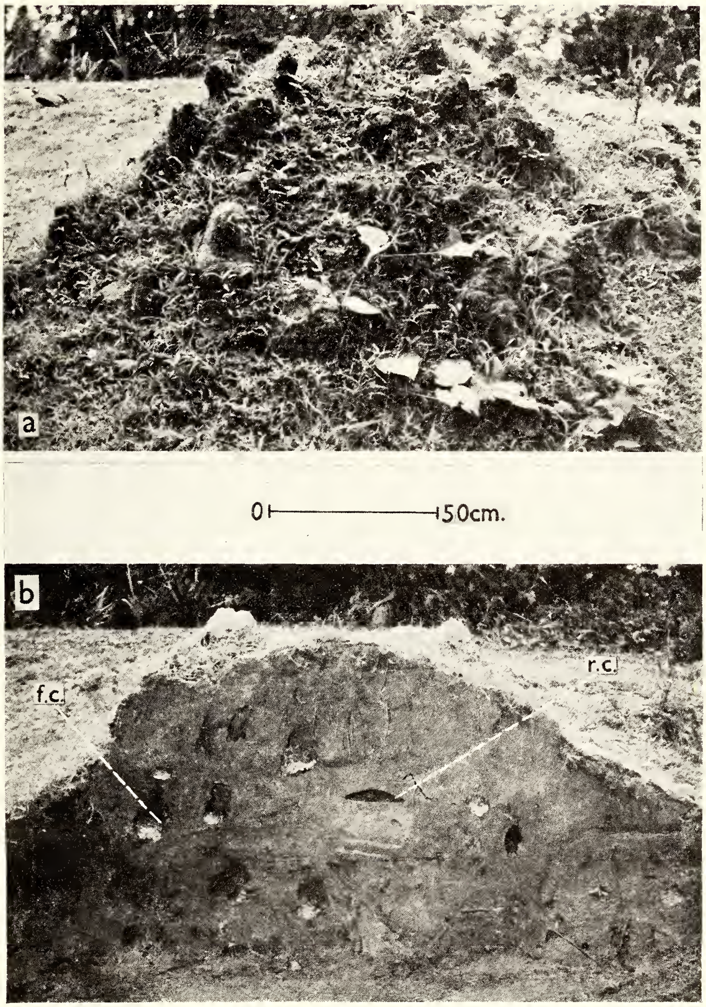
ROONWAL, M. L. (1962): Biology and ecology of Oriental Termites. No. 5. Mound-structure, nest and moisture-content of fungus-combs in *Odontotermes obesus*, with a discussion on the association of fungi with termites. *Rec. Indian Mus.* **58** (3 & 4): 131-150, 4 pls. 1960.

——— & GUPTA, S. D. (1952): An unusual royal chamber with two kings and two queens in the Indian mound building termite *Odontotermes obesus* (Rambur) (Isoptera: Family Termitidae). *J. Bombay nat. Hist. Soc.* **51** (1): 293-294, 1 pl.

23. OBSERVATIONS ON THE FLORA OF AGRA DISTRICT WITH SOME NEW RECORDS

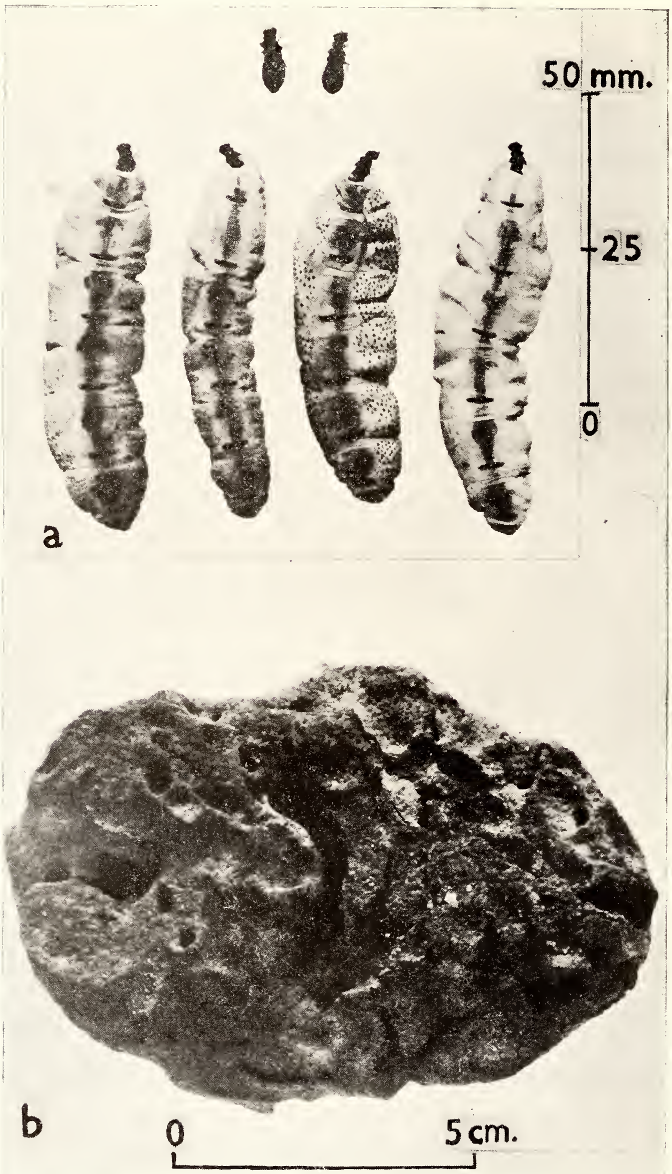
INTRODUCTION

The district of Agra lies between 26° 44′—27° 25′ N. and 77° 26′—78° 32′ E. and is situated at an altitude ranging from 160 m. to 180 m. It is the border district between the States of Rajasthan and Uttar Pradesh. The area is semi-arid with an average annual rainfall of 67.4 cm. (26.53 in.). Many times the district has received an annual rainfall below 40 cm. As regards temperature the district of Agra may probably claim to be the warmest district of Uttar Pradesh, with the temperature many times going above 47° C. in summer. The effect of 'loo' is also disastrous for green growth during the summer months.



A mound of '*Odontotermes obesus* (Rambur)'
Balukhand Forest Range, Puri (Orissa)

(*a*) The mound. Note the numerous turrets; (*b*) Same, in vertical section. *f. c.* fungus-comb; *r. c.* royal cell



' *Odontotermes obesus* (Rambur)'

Royal pairs and fungus-comb from mound in Plate I

(*a*) Four queens (*below*) and two kings (*above*) from the royal cell ; (*b*) a fungus-comb

The study of the vegetation of Agra District is important from the point of view of checking the advance of the Rajputana desert into the fertile plains of Uttar Pradesh and has, therefore, received much attention recently, particularly in respect of afforestation schemes to rehabilitate forests.

In the past Munro (1844), Duthie (1903-29), and Paliwal (1935) have made valuable contributions on the flora of Agra District. The comparatively recent work of Watts (1953) and Bharadwaja *et al.* (1956) has further enhanced our knowledge in this regard.

In January 1956 a party of botanical workers, including the author, led by Prof. K. N. Kaul, Director, National Botanic Gardens, Lucknow, visited Agra for botanizing in the interesting localities of Kitham and Kailash. Common weeds were also collected from the important parks and gardens of Agra city. The collection was subsequently examined by the author leading to the discovery of as many as 18 species which are new to N. A. Watts's FLORA.

Distributional Analysis of the Flora

As indicated by the climatic conditions, the flora of the Agra District is characteristically that of a tropical region, the tropical element comprising over 70% of the whole flora.

The element which is cosmopolitan in the tropics is represented in the Agra flora by *Boerhavia diffusa* Linn., *Caesalpinia bonduc* (Linn.) Roxb., *Cassia absus* Linn., *C. obtusifolia* Linn., *C. occidentalis* Linn., *C. pumila* Lamk., *Cassytha filiformis* Linn., *Celosia argentea* Linn., *Corchorus aestuans* Linn., *C. tridens* Linn., *Cressa cretica* Linn., *Crotalaria retusa* Linn., *Cyperus compressus* Linn., *Dactyloctenium aegyptium* (Desf.) Beauv., *Desmodium triflorum* DC., *Eclipta prostrata* Linn., *Eleusine indica* Gaertn., *Galactia villosa* W. & A., *Gynandropsis gynandra* Briq., *Lindernia crustacea* (Linn.) F. v. Mueller, *Malvastrum coromandelianum* Garcke, *Melochia corchorifolia* Linn., *Rhynchosia minima* DC., *Sesbania bispinosa* (Jacq.) Wight, *Sphenoclea zeylanica* Gaertn., *Spilanthes acmella* Linn., *Teramnus labialis* Spr., *Urena lobata* L., *Waltheria indica* Linn. and *Zornia diphylla* Pers.

Other tropical species are *Abrus precatorius* Linn., *Ageratum conyzoides* Linn., *Alysicarpus rugosus* DC., *Amaranthus spinosus* Linn., *Cardiospermum halicacabum* Linn., *Cissampelos pareira* Linn., *Heteropogon contortus* (Linn.) Beauv. ex R. & S., *Hydrolea zeylanica* Vahl, *Oldenlandia corymbosa* Linn., *Paspalidium geminatum* (Forsk.) Stapf, *Paspalum distichum* Linn., *Phyllanthus niruri* Auct., *Sida cordifolia* Linn., *Triumfetta bartramia* Linn., etc.

Acacia leucophloea Willd., *Coccinia cordifolia* (Linn.) Cogn., *Crotalaria prostrata* Roxb. *Lepidagathis incurva* Don, *Mollugo pentaphylla* Linn., *Panicum paludosum* Roxb. etc., restricted to the Asian tropics, are also found at Agra.

The flora of Agra shows affinity with the tropical African flora in having *Alysicarpus monilifer* DC., *Cocculus hirsutus* (Linn.) Diels, *Crotalaria orixensis* Rottl., *Cymbopogon schoenanthus* (Linn.) Spreng., *Dicoma tomentosa* Cass., *Dipteracanthus prostratus* (Poir.) Nees, *Hibiscus micranthus* Linn., *Lindernia parviflora* (Roxb.) Haines, *Luffa echinata* Roxb., *Oldenlandia aspera* DC., etc., occurring here commonly.

Some species of the Australian tropics also occur at Agra, e.g. *Brachiaria distachya* (L.) Stapf, *Cayratia carnosa* Gagnep., *Dentella repens* Forst., *Helicteres isora* Linn., *Hibiscus ficulneus* Linn., *Indigofera enneaphylla* Linn., *I. glandulosa* Willd., *I. trita* Linn., *Ottelia alismoides* Pers., *Pavetta indica* Linn., *Pouzolzia indica* Linn., *Sporobolus diander* Beauv., *Trichosanthes cucumerina* Linn., and *Zizyphus oenoplia* Mill.

Species of the American tropics that have become naturalized within the area are *Alternanthera echinata* Sm., *Eichhornia crassipes* Solms., *Ipomoea alba* Linn., *Sida veronicaefolia* Lamk., *Trianthema portulacastrum* Linn., *Tridax procumbens* Linn., etc.

A few Brazilian species like *Acanthospermum hispidum* DC., *Croton bonplandianum* Baill., and *Gomphrena celosioides* Mart. have also become well established.

Over 16% of the Agra flora is truly Indian. The Indian element is represented by *Acacia jacquemontii* Benth., *Ailanthus excelsa* Roxb., *Alysicarpus vaginalis* DC., *Andrographis paniculata* Nees, *Anisochilus carnosus* Wall., *Aristolochia bracteata* Retz., *Azadirachta indica* Juss., *Blepharis molluginifolia* Pers., *Cassia auriculata* Linn., *Ceropegia bulbosa* Roxb., *Cleome simplicifolia* Hk. f. & T., *Cochlearia flava* Ham., *Cyperus niveus* Retz., *Desmostachya bipinnata* (L.) Stapf, *Echinops echinatus* Roxb., *Erythrina suberosa* Roxb., *Euphorbia elegans* Spr., *Glossocardia bosvallia* (Linn. f.) DC., *Holoptelea integrifolia* Planch., *Iseilema laxum* Hack., *Kochia indica* Wt., *Lepidagathis hamiltoniana* Wall., *Leucas cephalotes* Spr., *Maerua arenaria* Hk. f. & T.[1], *Melanocenchris jacquemontii* Jaub. & Spach., *Mimosa hamata* Willd., *M. rubicaulis* Lamk., *Panicum trypheron* Schult., *Phoenix sylvestris* Roxb., *Sehima sulcatum* (Hack.) A. Camus, *Sopubia delphinifolia* G. Don, *Tetrapogon tenellus* (Roxb.) Chiov., etc.

---

[1] Duthie mentions *M. arenaria* var. *scabra* Hk. f. & T. also as occurring ' in the neighbourhood of Agra ', though it has not been included in Watts's FLORA.

Affinity with the Malayan flora is shown by species like *Anisomeles indica* (Linn.) O. Ktze., *Capparis sepiaria* Linn., *Commelina obliqua* Buch.-Ham., *Flacourtia indica* (Burm. f.) Merr., *Hibiscus hirtus* Linn., *Leucas aspera* Spr., *Lindernia ciliata* (Colsm.) Pennell, *Oldenlandia diffusa* Roxb., *Polygonum flaccidum* Meissn., and *Zizyphus mauritiana* Lamk.

Arnebia hispidissima DC., *Eragrostis ciliaris* Link., *Nerium indicum* Mill., *Prosopis spicigera* Linn., *Psammogeton biternatum* Edgew., *Pulicaria crispa* Sch.-Bip., *Sporobolus marginatus* Hochst. ex A. Rich., *Tamarix aphylla* (Linn.) Karst., *Trichodesma indicum* R. Br., *Viola cinerea* Boiss., and *Zizyphus nummularia* (Burm. f.) W. & A., occurring at Agra, are distributed widely in Arabia or/and Persia.

Orobanche aegyptiaca Pers., *Trigonella hamosa* Linn. and *T. occulta* Delile, occurring at Agra, are the Egyptian representatives.

A few European representatives, which have been long established in Indian tropics, occur at Agra also, e.g. *Lathyrus aphaca* Linn., *L. sphaericus* Retz., *Silene conoidea* Linn., *Spergula arvensis* Linn., *Trigonella corniculata* Linn., *Vicia hirsuta* Gray.

An analysis of the whole flora reveals that the families represented by more than ten species are in order of dominance: Gramineae, Leguminosae, Compositae, Acanthaceae and Malvaceae (both having the same number of species), Cyperaceae, Scrophulariaceae, Convolvulaceae and Euphorbiaceae (with equal number of species), Amaranthaceae, and Labiatae.

Appendix 1 gives the distribution pattern of the flora of Agra District. Appendix 2 gives a quantitative analysis of the various taxa of angiosperms met with in the district.

NEW RECORDS

Cruciferae

Sisymbrium irio Linn.

In gardens, R. C. Bharadwaja, 1950 and 1952 ; Hewett Park, G. S. Srivastava, N.B.G. 24827, 8.1.1956. Europe ; As. and N. Afr.

Malvaceae

Pavonia zeylanica Cav.

Kailash, R. C. Bharadwaja, 1953 ; Kailash, Kaul, and party, N.B.G. 24640, 4.1.1956. Ind. ; trop. Afr.

Tiliaceae

Grewia tenax (Forsk.) Fiori

Kailash, Kaul, and party, N.B.G. 24671, 4.1.1956. Ind.; Trop. Afr.

Leguminosae

Abrus precatorius Linn.

Kailash, Kaul, and party, N.B.G. 24669, 4.1.1956. Tropics.

Alysicarpus longifolius W. & A.

Keetham, Kaul, and party, N.B.G. 24738, 4.1.1956. India.

Indigofera tinctoria Linn.

Kailash, Kaul, and party, N.B.G. 24645, 4.1.1956. Cult. in Tropics.

Umbelliferae

Coriandrum sativum Linn.

Hewett Park, G. S. Srivastava, N.B.G. 24829, 8.1.1956. S. Europe ; the East.

Gentianaceae

Enicostemma verticillatum (Linn.) Engl.

Keetham, R. C. Bharadwaja ; Kailash, Kaul, and party, N.B.G. 24664, 4.1.1956. Tropics.

Pedaliaceae

Martynia annua Linn.

Keetham, Kaul, and party, N.B.G. 24701, 4.1.1956. N. America.

Amaranthaceae

Alternanthera echinata Sm.

Taj Gardens, G. S. Srivastava, N.B.G. 24783, 5.1.1956. Trop. Am.

A. paronychioides St. Hill.

Keetham, Kaul, and party, N.B.G. 24750, 4.1.1956. S. Am.

Euphorbiaceae

Kirganelia reticulata (Poir.) Baill.

Keetham, Kaul, and party, N.B.G. 24745, 4.1.1956. Trop. of Old World.

LILIACEAE

Asparagus racemosus Willd.

Kailash, Kaul, and party, N.B.G. 24646, 4.1.1956. Ind. ; trop. Afr. ; Austral.

TYPHACEAE

Typha elephantina Roxb.

Keetham, Kaul, and party, N.B.G. 24703, 4.1.1956. Mediterr. ; Ind.

NAIADACEAE

Zannichellia palustris Linn.

Agra, R. C. Bharadwaja, 1950. Europe ; N. Am.

CYPERACEAE

Cyperus niveus Retz.

Keetham, Kaul, and party, N.B.G. 24761, 4.1.1956. Ind.

Fimbristylis diphylla Vahl

Keetham, Kaul, and party, N.B.G. 24746, 4.1.1956. Tropics and temp. regions.

F. ferruginea Vahl

Keetham, Kaul, and party, N.B.G. 24771, 4.1.1956. Trop.

SUMMARY

Observations have been made on the distributional pattern of the flora of Agra District. The flora is characteristically that of a tropical region, the tropical element comprising over 70% of the whole flora. Over 16 % of the flora is truly Indian.

2. 18 species of angiosperms have been recorded as new to N. A. Watts's FLORA OF AGRA DISTRICT.

3. A quantitative analysis of the various taxa of angiosperms met with in the district has been given.

ACKNOWLEDGEMENT

The author is grateful to Prof. K. N. Kaul, F.L.S., Director, National Botanic Gardens, Lucknow, for facilities of work.

NATIONAL BOTANIC GARDENS,
LUCKNOW, S. L. KAPOOR
May 29, 1961.

References

Anon. (1895-1959) : Index Kewensis.

Bharadwaja, R. C., Basu, K. C., & Sinha, S. (1956) : The Grasses of Agra District. *Agra Univ. J. of Res.* (*Science*) **5** (2) : 285-320.

Duthie, J. F. (1903-29): Flora of the Upper Gangetic Plain and of the Adjacent Siwalik and Sub-Himalayan Tracts.

Hooker, J. D. (1872-97): Flora of British India.

Munro, W. (1844) : Hortus Agrensis, or a catalogue of all plants in the neighbourhood of Agra . . . Agra.

Nevill, H. R. (1921) : District Gazetteers of the United Provinces **8**. Agra.

Paliwal, B. P. (1935) : A Contribution to the Flora of Agra. M. Sc. Thesis, Agra University (unpublished).

Raizada, M.B. (1958) : Name Changes in Common Indian Plants. *Indian For.* **84** : 467-538.

——— (1959) : Name Changes in Common Indian Grasses. *Indian For.* **85** : 473-509.

Watts, N. A. (1953) : Flora of Agra District.

Appendix 1

S. No.	Native distribution	Number of species occurring at Agra	Percentage of the whole flora
1.	India ..	99	16.5
2.	Tropics of the Old World ..	64	10.7
3.	Tropical Regions ..	34	5.7
4.	Cosmopolitan in tropics ..	30	5.0
5.	Tropical Asia and Africa ..	26	4.3
6.	Round the tropics of the world..	24	4.0
7.	India ; tropical Africa ..	20	3.3
8.	Tropical Asia and Australia ..	17	2.8
9.	India ; Malaya ..	16	2.7
10.	Cosmopolitan ..	13	2.2
11.	Tropical Asia ..	11	1.8
12.	Tropical Asia ; Australia ..	9	1.5
13.	Tropical America ..	8	1.3
14.	Hot regions ..	8	1.3
15.	India ; China ..	7	1.1
16.	India ; Burma ..	6	1.0
17.	India ; Afghanistan ..	6	1.0

NOTE.—Native distributions constituting less than 1% of the whole flora have been omitted.

Appendix 2

S. No.	Family	No. of genera	No. of species	S. No.	Family	No. of genera	No. of species
1.	Ranunculaceae	1	2	41.	Gentianaceae	3	4
2.	Menispermaceae	2	2	42.	Hydrophyllaceae	1	1
3.	Nymphaeaceae	2	3	43.	Boraginaceae	5	9
4.	Papaveraceae	1	1	44.	Convolvulaceae	8	16
5.	Fumariaceae	1	1	45.	Solanaceae	5	8
6.	Cruciferae	6	7	46.	Scrophulariaceae	13	18
7.	Capparidaceae	4	7	47.	Orobanchaceae	1	2
8.	Resedaceae	1	1	48.	Lentibulariaceae	1	1
9.	Violaceae	2	2	49.	Pedaliaceae	1	1
10.	Flacourtiaceae	1	1	50.	Bignoniaceae	1	1
11.	Polygalaceae	1	3	51.	Acanthaceae	13	23
12.	Caryophyllaceae	6	7	52.	Verbenaceae	4	4
13.	Portulacaceae	1	2	53.	Labiatae	8	13
14.	Tamaricaceae	1	4	54.	Plantaginaceae	1	1
15.	Elatinaceae	1	3	55.	Nyctaginaceae	1	2
16.	Malvaceae	9	23	56.	Amaranthaceae	8	14
17.	Sterculiaceae	5	7	57.	Chenopodiaceae	4	6
18.	Tiliaceae	3	9	58.	Polygonaceae	2	7
19.	Zygophyllaceae	2	2	59.	Aristolochiaceae	1	1
20.	Oxalidaceae	3	4	60.	Piperaceae	1	1
21.	Simarubaceae	2	2	61.	Lauraceae	1	1
22.	Meliaceae	2	2	62.	Loranthaceae	1	1
23.	Rhamnaceae	1	3	63.	Euphorbiaceae	7	16
24.	Vitaceae	1	2	64.	Urticaceae	4	7
25.	Sapindaceae	1	1	65.	Salicaceae	1	1
26.	Leguminosae	37	84	66.	Ceratophyllaceae	1	1
27.	Rosaceae	1	1	67.	Hydrocharitaceae	4	4
28.	Lythraceae	1	4	68.	Lilliaceae	3	3
29.	Onagraceae	3	4	69.	Pontederiaceae	2	3
30.	Cucurbitaceae	7	9	70.	Commelinaceae	3	7
31.	Aizoaceae	3	9	71.	Juncaceae	1	1
32.	Umbelliferae	4	4	72.	Palmae	1	1
33.	Rubiaceae	4	8	73.	Typhaceae	1	2
34.	Compositae	39	50	74.	Araceae	2	2
35	Campanulaceae	3	3	75.	Lemnaceae	2	3
36.	Plumbaginaceae	1	1	76.	Alismaceae	1	1
37.	Primulaceae	1	1	77.	Naiadaceae	3	7
38.	Salvadoraceae	1	2	78.	Eriocaulaceae	1	1
39.	Apocynaceae	5	5	79.	Cyperaceae	6	22
40.	Asclepiadaceae	6	7	80.	Gramineae	53	89

Total number of genera—356

Total number of species—599

Notes and News

At the XIII world conference of the International Council for Bird Preservation held in New York in June 1962 at which India was represented along with some 30 other national sections, together with representatives of several international organisations and observers, a number of important resolutions were passed for submission to the various governments. The following are of special interest to India.

1. Having noted that pesticides will often: (*a*) have a lethal effect on birds and other animals, though this may only become apparent after one or more years, (*b*) kill insect predators of the pest so that, in spite of an initial satisfactory control, soon after application an exceptionally heavy infestation may follow,

RECOMMENDS that Governments adopt legislation by which all pesticides must only be applied at minimum effective concentration since the cumulative effects are largely unknown;

RECOMMENDS that continuing research be prosecuted on the longterm effects of pesticides with the object of elaborating control methods, both biological and chemical, which are harmless to birds and other vertebrates and to beneficial insects.

2. Having noted the critical decrease in the number of various species of birds of prey in many countries,

RECOMMENDS to Governments that they combat through educational measures the widespread but erroneous opinion that all these birds are harmful, in order to diminish or stop their persecution.

3. RECOMMENDS that Governments restrict, by all means at their disposal, the importation of wild birds to those birds whose exportation fully complies with the laws of their country of origin.

4. Having noted that the system of paying bounties for the destruction of birds has been demonstrated to be expensive, indiscriminate, and ineffective method of population control, that it tends to have extremely harmful side effects, particularly in leading to the unauthorized killing of protected species of birds of prey, that it has a lamentable psychological effect, and that its abolition will be an important step towards the adoption of a more objective attitude towards bird life and towards more rational methods of game management,

RECOMMENDS that the system of paying bounties for destruction of birds be totally abolished.

It is to be hoped that the Indian Board for Wild Life and the State Wild Life Boards will take note of these recommendations and implement them in the appropriate manner.

* * * *

The XVI International Congress of Zoology will be held at Washington on 20-27 August 1963.

The tentative programme covers six plenary sessions which will refer to: (i) genetic continuity; (ii) cell biology; (iii) development; (iv) evolution; (v) behaviour; (vi) three or four problems of general biology.

The Congress Secretariat is located at 2101 Constitution Avenue, Washington 25, D.C., U.S.A.

* * * *

M. Andre Brosset, the author of the series of papers on 'The Bats of Central and Western India', has resigned from the French Foreign Service and is now Director of the Charles Darwin Research Station, Isla Santa Cruz, Galapagos. This is maintained by the Charles Darwin Foundation for the Galapagos Islands, founded under the auspices of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the International Union for the Conservation of Nature and Natural Resources (IUCN).

In a letter to the Society he describes 'sport' in the Galapagos Islands as follows:

'For the sportsmen shooting is no problem.. The "game" can be taken with the hand. Only the goats, cows, and pigs are wild and also the dogs and chickens, They are often very shy and rifles are sometimes required. When you ask the sportsman "What is the bag today?", he usually replies, "Two cows and a chicken", or "5 goats and a donkey".'

* * * *

With this issue Mr. Humayun Abdulali, who has resigned from the Honorary Secretaryship of the Society, ceases to be an Editor of the *Journal.*

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1961-62

Executive Committee

President

Shri Sri Prakasa, *Governor, State of Maharashtra*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S. (Retd.)
Rev. Fr. H. Santapau, S.J.
Dr. Sálim Ali

Hon. Secretary

Mr. Humayun Abdulali

Hon. Treasurer

Mr. Surendr Lall

ex officio

Members

Dr. D. V. Bal, M.SC., Ph.D.
Mr. G. V. Bedekar, I.C.S.
R. S. Dharmakumarsinhji
Mr. Z. Futehally
Mr. R. E. Hawkins
Dr. C. V. Kulkarni, M.SC., Ph.D.
Mr. D. N. Marshall
Mr. D. J. Panday
Mr. D. E. Reuben, I.C.S. (Retd.)
Dr. H. Trapido, M.D.

Advisory Committee

Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Sir Chintaman Deshmukh, Kt., C.I.E., I.C.S. (Retd.) ..	*New Delhi*
Rev. Fr. J. B. Freeman, M.A., L.T., Ph.D., D.D. ..	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Shillong*
Dr. Baini Prashad, D.SC., F.N.I.	*Dehra Dun*
Mr. P. D. Stracey, I.F.S. (Retd.)	*Shillong*
Dr. M. L. Roonwal, M.SC., Ph.D., F.N.I., F.Z.S.I. ..	*Calcutta*
Lt.-Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E.	*Roorkee*
Y. S. Shivrajkumar of Jasdan	*Jasdan*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1961-62

At the last Annual General Meeting of the Society, I presented a report for the year ending 31st August 1961. The present report covers the period of 12 months thereafter.

THE SOCIETY'S JOURNAL

Three numbers of the *Journal* have been published during the year completing Vol. 58 and commencing Vol. 59. The 868 pages include three papers on national parks and sanctuaries, 10 botanical, 8 on birds, 3 on reptiles and amphibians, 7 on insects, 2 on Annelids, 3 on fish and fisheries, and one each on mammals, Crustaceans, and Molluscs. 83 Miscellaneous Notes covered many subjects and, together with the papers, included descriptions of several new species and races of different forms of animals and plants.

It is gratifying to note that the collections of the Society and the field activities with which the Society's staff is directly associated are again finding a place in the notes and papers published in the *Journal*. Attempts are being made to increase the number of pictures and illustrations to make the *Journal* of greater interest to naturalists, and it is hoped that a request to the Ministry of Scientific Research and Cultural Affairs for a more substantial grant for the *Journal* will assist us in this direction.

GENERAL

I am glad to report that the Ministry of Scientific Research and Cultural Affairs have agreed to pay Rs. 1,50,000 towards the cost of construction of a building to house the Society in the Museum compound. The plans have been approved by the Bombay Municipality and the Government of Maharashtra and it is hoped to commence work during October.

A detailed report on the working of Dr. Sálim Ali's Bird Banding Project appeared in the April number. Since December 1961 the effort has been directed to migrant forms and 8942 birds were ringed up to April 1962, bringing the total to 19,262 (61.65% migrants). Birds are now netted at their roosts and large numbers of swallows, wagtails, and other Passerine migrants were ringed in Bombay City, Kerala, and Bharatpur. Six recoveries have been recorded so far, all from the U.S.S.R., and include 2 garganey teal out of 78 duck ringed at Bharatpur.

This year saw the award of the first M.Sc. Degree in Field Ornithology in India by the Bombay University to a student of the Society. The subject of the thesis was 'The Breeding Biology of the Weaver Bird, *Ploceus philippinus*'.

Members of the Society's staff made short trips to the Shevaroy Hills, Salem District, Madras State, and the Koyna Dam, Satara District, Maharashtra, to collect reptiles and amphibians. Several interesting specimens were obtained, including topotypes of the lizard (*Hemiphyllodactylus typus aurantiacus*) from the Shevaroy Hills, and a Geckonid lizard from Ratnagiri District, and a Bufonid from Koyna, Satara District, Maharashtra, which it has not yet been possible to name and which may be undescribed forms. Short visits were also made to the Nal Bird Sanctuary in Gujarat and the Pirotan Swamp in the Gulf of Kutch mainly for waterbirds. Three members of the staff were deputed for a week each to the Japanese Primate Research Centre at Dharwar, to enable them to familiarise themselves with current methods of such field studies.

During the year, some 576 additions were made to our vertebrate collections—9 mammals, 222 birds, 178 reptiles, and 167 amphibians. Interesting additions among reptiles and amphibians include *Dinodon gammie, D. septentrionalis, Hemiphyllodactylus typus aurantiacus, Mabuya bibroni, M. beddomii*, and *Philautus beddomii*.

During the year 39 books were added to the library, some of which were presented and for which we thank the donors. 50 journals have been bound. We obtain 10 journals and/or magazines by subscription and 54 by exchange.

PUBLICATIONS

I am glad to report that arrangements have been made with the Prince of Wales Museum of Western India, whereby they have paid Rs. 25,000 towards the cost of the publication of a 2nd edition of THE BOOK OF INDIAN ANIMALS by S. H. Prater. 2000 copies will be marked as published by the Museum and handed over to them for sale. This long awaited book should be available next year.

At the instance of U Tun Yin, a member in Burma, the New York Zoological Society bore the cost of a pamphlet with a coloured picture of the Pinkheaded Duck and, for comparison with it, the Redcrested Pochard. This was distributed among forest personnel and other interested persons in north-east India and Burma in an attempt to obtain information regarding this curious duck known only from India, never very numerous and last definitely recorded in 1935. More than one person has written reporting sight records in recent years, but evidence more definite than a recollection several *years* old must be available to permit any hope of its continued existence.

Nature Education

The Nature Education Scheme for children, financed by the Government of Maharashtra, is now in its 14th year. Tours of the Natural History Section of the Prince of Wales Museum and special talks on natural history subjects with the aid of exhibits and other specimens, films, and sometimes living animals were continued. Talks on 'Plant Life' illustrated with a number of plants specially planted in the Museum Garden were started this year. Over 8000 children took advantage of these activities.

Seven field trips to different places in the island of Salsette were arranged for members of nature study clubs. The trips were followed by meetings at schools to help children to learn to collect and and preserve specimens and to discuss items and topics experienced afield.

About 150 children from 8 to 10 schools joined the field trip on each occasion.

English and Marathi editions of the 5th booklet OUR WILD ANIMALS are available, and Gujarati and Hindi editions are in the press.

Membership

The total membership on our books at the end of 1961 was 1164 including 237 life and 4 honorary members. Subscriptions were received from 749 members up to the end of July this year, leaving 174 who had either not informed us of their desire to resign or could not be traced. This compares favourably with 596 subscriptions received in 1957, when the number of life members was almost the same (231). During the 12 months 80 ordinary members and 5 life members were enrolled as against 13 resigned and 3 ordinary members, 4 life members, and 2 honorary members who died during the year.

Revenue Account

During the year under review, the income of the Society, excluding the special grant received from the Government of Maharashtra for the maintenance of the reference collections, was Rs. 42,701.84 as against Rs. 45,409.06 in the previous year.

The operations of the Society during 1961 showed a deficit of Rs. 19,955.45 as against Rs. 8,966.43 in 1960. This was principally due to larger and appropriate depreciations being provided.

Staff

The Committee wishes to record its appreciation of the willing co-operation of the entire staff in the activities of the Society.

Acknowledgements

The Committee's thanks are due to Mr. J. L. Bernard who continues to look after the Society's interests in the United Kingdom.

Registered No. F 244 (BOM)

THE BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT 1950

SCHEDULE VII [VIDE RULE 17 (1)]

BALANCE SHEET AS AT 31 DECEMBER 1961

FUNDS AND LIABILITIES		Rs. nP.	Rs. nP.
Trust Fund or Corpus:			
Life Membership Fund			
Balance as per last Balance Sheet ..		99,640.28	
Add: Amount received during the year		2,250.00	
		1,01,890.28	
Less: Transferred to Publication Fund		30,725.00	
			71,165.28
Fixed Assets Fund			71,222.61
Other Earmarked Funds:			
Field Work Fund ..			
Balance as per Last Balance Sheet	1,959.97		
Less: Spent during the year ..	458.64		
		1,501.33	
Wild Life Fund			
Balance as per last Balance Sheet ..	715.25		
Less: Spent during the year ..	240.01		
		475.24	
Expedition Fund			
Balance as per last Balance Sheet ..		1,800.00	
Carried forward ..		3,776.57	1,42,387.89

ASSETS		Rs. nP.	Rs. nP.
Immovable Properties:			—
Motor Car (At cost)			19,362.46
Purchased in previous year—			
Furniture, Fixtures, & Equipment:			
Balance as per last Balance Sheet ..		952.14	
Add: Purchased in previous years	41,366.45		
Purchased during the year	10,493.70		
		51,860.15	
		52,812.29	
Less: Depreciation during the year ..		119.02	
			52,693.27
Investments:			
Rs. 14,000 4% Bombay Port Trust Bonds ..		10,780.00	
Rs. 15,000 4% Bombay Improvement Trust Bonds ..		11,400.00	
Rs. 36,000 3% Funding Loan 1966/68		35,812.62	
Rs. 25,000 3% Conversion Loan 1946 ..		25,000.00	
Rs. 2,000 3% 1st Development Loan 1970/75 ..		1,948.75	
Rs. 92,000 (Market Value Rs. 82,309.50) ..		84,941.37	
Carried forward ..		84,941.37	72 055.73

BALANCE SHEET AS AT 31 *DECEMBER* 1961—(*continued*)

FUNDS AND LIABILITIES		Rs. nP.	Rs. nP.
Brought forward ..		3,776.57	1,42,387.89
Mammal Survey Fund			
Balance as per last Balance Sheet ..	2,327.98		
Less: Spent during the year ..	199.82		
		2,128.16	
Building Fund			
Balance as per last Balance Sheet ..		29,150.00	
Publication Fund			
Being amount transferred from Life Membership Fund ..		30,725.00	
Nature Education Trophy Fund			
Balance as per last Balance Sheet ..	500.00		
Less: Spent during the year ..	250.00		
		250.00	
Reserve for Wall Snake Chart			
Balance as per last Balance Sheet ..	3,000.00		
Less: Transferred to Income and Expenditure Account ..	3,000.00	—	
Carried forward ..		66,029.73	1,42,387.89

ASSETS			Rs. nP.	Rs. nP.
Brought forward ..			84,941.37	72,055.73
Investments—(contd.)				
£. 460 3½% Defence Bonds ..			6,133.34	
(At cost) ..			91,074.71	
Less: Provision for Depreciation ..			3,750.00	
				87,324.71
Loans: (Unsecured)	*Good*	*Doubtful*		
Loan Scholarship	nil	nil		
Other Loans (to staff)	405.00	nil		405.00
Advances:				
To Trustees			—	
,, Employees			—	
,, Contractors			—	
,, Lawyers			—	
,, Nature Education Scheme ..			3,499.53	
,, Others			1,118.85	
,, Prepaid Expenses			82.65	
				4,701.03
Stocks: (At cost or under)				
Books and Publications ..			59,913.87	
Blocks etc.			5,956.06	
(as certified by the Hon. Secretary)				65,869.93
Income Outstanding:				
Rent			—	
Interest (Accrued)			1,189.00	
Carried forward ..			1,189.00	2,30,356.40

BALANCE SHEET AS AT 31 *DECEMBER* 1961—(*continued*)

FUNDS AND LIABILITIES		Rs. nP.	Rs. nP.
Brought forward ..		66,029.73	1,42,387.89
Other Earmarked Funds: (contd.)			
Unspent Grant Government of Maharashtra			
1960-61 Unspent balance brought forward ..	12,068.86		
Less: Spent during the year (as per Income & Expenditure Account) ..	11,226.39		
		842.47	
1961-62 Grant for the year.	37,000.00		
Less: Spent during the year (as per Income & Expenditure Account) ..	27,671.68		
		9,328.32	
Unspent Grant Government of Maharashtra			
For Furniture and Equipment.			
Balance as per last Balance Sheet ..	7,000.00		
Less: Spent during year ..	7,000.00		
		—	
Carried forward ..		76,200.52	1,42,387.89

ASSETS	Rs. nP.	Rs. nP.
Brought forward ..	1,189.00	2,30,356.40
Other Income:		
Supplies and Services	13,337.39	
Government of Maharashtra Education Activity Grant 1961-62 ..	4,000.00	
Government of Maharashtra Maintenance Grant 1961-62	37,000.00	
Government of India for Journal Expenses 1961-62	8,000.00	
		63,526.39
Cash and Bank Balances:		
(*a*) In Current Account with National and Grindlays Bank Ltd., Bombay	1,284.67	
National and Grindlays Bank Ltd., London (£. 694-6-2) ..	9,257.44	
(*b*) With the Trustee	—	
(*c*) With the Cashier	5 50.00	
		11,092.11
Carried forward ..		3,04,974.90

BALANCE SHEET AS AT 31 DECEMBER 1961—(continued)

FUNDS AND LIABILITIES		Rs. nP.	Rs. nP.	ASSETS	Rs. nP.	Rs. nP.
Brought forward ..		76,200.52	1,42,387.89	Brought forward ..		3,04,974.90
Unspent Grant World Health Organisation						
Balance as per last Balance Sheet ..	30,029.93					
Add: Amount received during the year ..	23,810.00					
	53,839.93					
Less: Spent during the year.	18,272.53	35,567.40	1,11,767.92			
Liabilities:						
For Expenses		40,565.53				
,, Advance (Subscription) ..		1,382.46				
,, Sundry Credit Balances ..		1,246.72	43,194.71			
Overdraft Account with Chartered Bank, Bombay			5,961.43			
Income and Expenditure Account:						
Balance as per last Balance Sheet ..		18,618.40				
Add: Transfer from Reserve for Wall Snake charts		3,000.00				
		21,618.40				
Less: Deficit as per Income and Expenditure Account		19,955.45	1,662.95			
Total ..			3,04,974.90	Total ..		3,04,974.90

The above Balance Sheet to the best of my belief contains a true account of the Funds and Liabilities and of the Properties and Assets of the Trust.

As per our report of even date

(Sd.) A. F. Ferguson & Co.,
Chartered Accountants
Bombay, 5th July 1962

(Sd.) J. D. Kapadia
Trustee.

Bombay, 25th June, 1962

THE BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT 1950

SCHEDULE IX [VIDE RULE 17(1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER* 1961

EXPENDITURE	Rs. nP.	Rs. nP.
To Expenses in respect of properties:		
Rates, Taxes, Cesses, Repairs, and Maintenance	nil	
Salaries	nil	
Insurance	nil	
Depreciation (by way of provision or adjustments)	nil	nil
,, *Expenditure from Grants Government of Maharashtra:*		
For 1960-61 : Salaries	3,752.30	
Rent	5,250.00	
Miscellaneous ..	2,224.09	
		11,226.39
For 1961-62 : Salaries	11,921.68	
Rent	15,750.00	
		27,671.68
,, *Establishment Expenses:*		
Salaries (Including Dearness Allowance)	31,470.49	
Society's contribution to Staff Provident Fund	1,171.51	
Postage	1,255.41	
Printing and Stationery	910.46	
Carried forward ..	34,807.87	38,898.07

INCOME	Rs. nP.	Rs. nP.
By Rent:		
Accrued	nil	
Realised	nil	nil
,, *Interest* (Accrued and Realised) ..		
On Securities	3,251.41	
On Bank Account	627.29	
		3,878.70
,, *Dividends*		nil
,, *Donations*		
In cash	nil	
In kind	nil	nil
,, *Grants:*		
Government of Maharashtra		
For 1960-61 (Expended as per contra)	11,226.39	
For 1961-62 (Expended as per contra)	27,671.68	
For Educational Activity 1961-62 ..	4,000.00	
Government of India		
For Journal Expenses for 1961-62 ..	8,000.00	
		50,898.07
Carried forward ..		54,776.77

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1961—(continued)

EXPENDITURE	Rs. nP.	Rs. nP.	INCOME	Rs. nP.	Rs. nP.
Brought forward ..	34,807.87	38,898.07	Brought forward ..		54,776.77
To Establishment Expenses—(contd.)					
Advertisement	122.06		*By Income from Other Sources:*		
Telephone charges	506.97		Subscriptions	22,252.62	
Bank charges	128.14		Entrance Fees	425.00	
Electric charges	371.14				22,677.62
Meeting Expenses	202.18		,, *Publications*		
Conveyance and Travelling expenses..	420.29		Journal Sales	4,531.59	
		36,558.65			
,, Remuneration to Trustees ..	nil		*Books etc. profits*		
,, Remuneration (In the case of Math)	nil		Book of Indian Birds ..	5,634.06	
,, Legal Expenses	nil		Some Beautiful Indian Climbers and Shrubs	817.81	
,, Audit Fees (Includes Rs. 100.00 for audit of Journal Cost) ..	850.00		Game Birds of India, Burma, and Ceylon Vol. III	99.75	
		850.00	Indian Molluscs	28.80	
,, *Amounts Written off:*			Circumventing the Mahseer and Other Sporting Fish ..	24.00	
Bad Debts	59.48		Synopsis of Birds of India and Pakistan	5,749.35	
Loan Scholarships	nil		Calendars	959.24	
Irrecoverable Rents	nil		Other Publications	181.41	
Other Items	nil				
		59.48			
,, *Miscellaneous Expenses*					
General Charges	1,034.30				
Fire Insurance	110.30				
Interest on Overdraft and Loan Account	68.58				
Donation to Zoological Society of London and Nature Education Scheme	166.67				
		1,379.85			
Carried forward Rs. ..		77,746.05	Carried forward Rs. ..	18,026.01	77,454.39

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1961—(*continued*)

Expenditure	Rs. nP.	Rs. nP.
Brought forward ..		77,746.05
,, *Depreciation*		
On Investments	nil	
On Furniture	119.02	
		119.02
,, *Expenditure on objects of the Trust*		
(*a*) Religious		
(*b*) Educational—Journal Expenses ..	21,614.17	
—Library Account .. (Subscriptions to other Societies) ..	542.84	
—Purchase of Books	570.75	
—Periodical and Binding charges ..	85.75	
—Maintenance of Reference Collections ..	876.78	
		23,690.29
Total ..		1,01,555.36

Income		Rs. nP.	Rs. nP.
Brought forward ..			77,454.39
Books etc., profits, brought forward..		18,026.01	
Less: Loss--Some Beautiful Indian Trees ..	1,133.52		
Butterflies of the Indian Region ..	8,128.10		
Identification of Poisonous Snake charts ..	6,556.87	15,818.49	
			2,207.52
By Miscellaneous Receipts ..			1,938.00
,, Deficit carried to Balance Sheet ..			19,955.45
Total ..			1,01,555.36

As per our report of even date

(Sd.) A. F. FERGUSON & CO.
Chartered Accountants

BOMBAY, 25*th June* 1962

(Sd.) J. D. KAPADIA
Trustee

BOMBAY, 5*th July* 1962

THE BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the year ended 31 *December* 1961

RECEIPTS	Rs. nP.	Rs. nP.
To Balance as at 1st January 1961		
Brought forward ..		
Cash with Cashier	50.00	
Balance with Bank on Current Account	32.72	
		82.72
,, Grant Government of Maharashtra 1960-61		6,640.00
,, Sales of Booklet No. I	380.60	
,, Sales of Booklet No. II	293.40	
,, Sales of Booklet No. III ..	317.06	
,, Sales of Booklet No. IV ..	293.44	
,, Sales of Booklet No. V ..	55.18	
,, Sales of Nature Study Pamphlets and Line drawings	10.70	
		1,350.38
,, Donation from Bombay Natural History Society		100.00
,, Balance, carried forward being advance from Bombay Natural History Society		3,499.53
Total ..		11,672.63

PAYMENTS		Rs. nP.
By Balance brought forward, being advance from Bombay Natural History Society		1,963.41
,, Salary of Nature Education Organiser ..		5,640.00
,, Postage		123.84
,, Printing and Stationery		43.70
,, Cost of Booklet No. 1 (II Edition) and No. IV ..		2,971.26
,, General charges		648.60
,, Printing Line drawings		25.20
,, Field Trip Expenses		123.00
,, Balance as at 31st December 1961 :		
Cash with the Cashier	50.00	
With Bank on Current Account ..	83.62	
		133.62
Total ..		11,672.63

BOMBAY, 25*th June* 1962

(Sd.) A. F. FERGUSON & CO.
Chartered Accountants

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD IN THE B.E.S.T. CONFERENCE HALL, ORMISTON ROAD, COLABA, BOMBAY 5, ON THURSDAY, 11TH OCTOBER 1962 AT 6 P.M., WITH MR. R. E. HAWKINS IN THE CHAIR

1. The Honorary Secretary's report for the year ending 31st August 1962 having been previously circulated to members was taken as read and adopted.

2. The Balance Sheet and Statement of Accounts presented by the Honorary Treasurer were approved.

3. The following were elected as members of the Executive and Advisory Committee for the year 1962:

Executive Committee

President

Dr. P. Subbaroyan, *Governor, State of Maharashtra*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S. (Retd.)
Rev. Fr. H. Santapau, S.J.
Dr. Sálim Ali

Hon. Secretary

Mr. Humayun Abdulali

Hon. Treasurer

Mr. J. D. Kapadia, I.C.S. (Retd.)

ex officio

Members

Dr. D. V. Bal, M.SC., Ph.D.
Mr. G. V. Bedekar, I.C.S.
R. S. Dharmakumarsinhji
Mr. Z. Futehally
Mr. R. E. Hawkins
Dr. C. V. Kulkarni, M.SC., Ph.D.
Mr. D. N. Marshall
Mr. D. J. Panday
Mr. D. E. Reuben, I.C.S. (Retd.)
Dr. H. Trapido, M.D.

ADVISORY COMMITTEE

Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Sir Chintaman Deshmukh, Kt., C.I.E., I.C.S. (Retd.) ..	*New Delhi*
Rev. Fr. Dr. J. B. Freeman, M.A., L.T., Ph.D., D.D. ..	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Shillong*
Dr. Baini Prashad, D.Sc., F.N.I.	*Dehra Dun*
Mr. P. D. Stracey, I.F.S. (Retd.)	*Shillong*
Dr. M. L. Roonwal, M.Sc., Ph.D., F.N.I., F.Z.S.I. ..	*Calcutta*
Lt.-Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E.	*Roorkee*
Y. S. Shivrajkumar of Jasdan	*Jasdan*

4. The film OUR FEATHERED FRIENDS loaned by Films Division, Government of India, and kodachrome transparencies of the flowers of the Western Ghats by Mr. R. R. Bharadwaja were exhibited and greatly appreciated.

5. The meeting terminated with a vote of thanks to the Films Division, Government of India, for the loan of the film, to Mr. R. R. Bharadwaja for the transparencies shown, and to the Chairman of the meeting.

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
10 CHURCH ROAD, VEPERY, MADRAS—25-3-1963. C8623
EDITORS: H. SANTAPAU & HUMAYUN ABDULALI

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. With many coloured and monochrome plates. 2nd (revised) edition. *(In preparation)*

Birds

Game Birds of India, by E. C. Stuart Baker. Vol. III. Pheasants, 1st Edition. **Rs. 20**
(Price to Members Rs. 15)

The Book of Indian Birds, by Sálim Ali. With 64 coloured and many monochrome plates, 6th edition, revised and enlarged. **Rs. 25**
(Price to Members Rs. 20)

A Synopsis of the Birds of India and Pakistan, by S. Dillon Ripley II. An up-to-date checklist of all the birds resident and migrant, including those of Nepal, Sikkim, Bhutan, and Ceylon. **Rs. 25**
(Price to Members Rs. 20)

Snakes

Identification of Poisonous Snakes. Wall chart in English, Gujarati, and Marathi. **Rs. 10**
(Price to Members Rs. 8)

Miscellaneous

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 2nd edition. Revised by W. T. Stearn. **Rs. 20**
(Price to Members Rs. 16)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. **Rs. 22**
(Price to Members Rs. 17.50)

Butterflies of the Indian Region, by M. A. Wynter-Blyth. With 27 coloured and 45 monochrome plates. **Rs. 28**
(Price to Members Rs. 22.50)

Indian Molluscs, by James Hornell. With 2 coloured and many monochrome plates, and text-figures. **Rs. 6**
(Price to Members Rs. 4.50)

Glimpses of Nature Series Booklets:

1. Our Birds I (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.80**
   Kannada **Rs. 0.62**
2. Our Birds II (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.62**
3. Our Beautiful Trees (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.62**
4. Our Monsoon Plants (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.80**
5. Our Animals (with 8 coloured plates) in English, Gujarati, Hindi, Marathi. **Rs. 1.25**

Back numbers of the Society's Journal. Rates on application.

Correspond with :

The Honorary Secretary,
Bombay Natural History Society,
91, Walkeshwar Road, Bombay 6-WB.

Agents in England :

Messrs. Wheldon & Wesley Ltd.,
Lytton Lodge, Codicote, Nr. Hitchin,
Herts., England.

The Society will gratefully accept back numbers of the *Journal,* particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 and a life membership fee of Rs. 500.

Ordinary Members pay an entrance fee of Rs. 5 and an annual subscription of Rs. 30.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postal registration (Rs. 2.50) if required—in all Rs. 32.50—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-10-0 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 26 Bishopsgate Street, London, E.C. 2.

CONTENTS