



Journal of the Bombay Natural History Society

Vol. 57, No. 1

Editors

SÁLIM ALI, H. SANTAPAU, S.J., & HUMAYUN ABDULALI



APRIL 1960

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 blatterii*.

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 x 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).

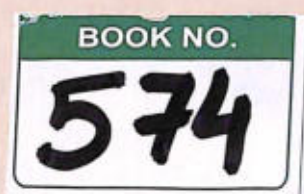
9. *Synopsis*: Each scientific paper should be accompanied by a concise, clearly written synopsis, normally not exceeding 200 words.

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,

91, Walkeshwar Road,
Bombay 6

*Journal of the Bombay Natural
History Society.*



CONTENTS OF VOLUME 57, NO. 1

	PAGE
STUDIES ON THE REPRODUCTIVE BEHAVIOUR OF THE BAYA WEAVER [<i>Ploceus philippinus</i> (L.)]. By John Hurrell Crook. (With one plate, one text-figure, and three diagrammatic schemes).. ..	1
VEGETATION OF KODAIKANAL IN SOUTH INDIA. I. SYSTEMATIC LIST OF TREES, SHRUBS, AND HERBS. By Raj Kumar Gupta	45
FISHES FROM THE KASHMIR VALLEY. By E. G. Silas. (With two plates) ..	66
THE DIATOM FLORA OF THE BOMBAY AND SALSETTE ISLANDS. By H. P. Gandhi. (With 120 figures)	78
CRITICAL NOTES ON THE ORCHIDACEAE OF BOMBAY STATE. II. <i>Platanthera</i> L.C. RICH. & <i>Peristylus</i> BL. By H. Santapau and Z. Kapadia. (With four plates)	124
CONSTANCY TO HORTICULTURAL VARIETIES SHOWN BY BUTTERFLIES, AND ITS POSSIBLE EVOLUTIONARY SIGNIFICANCE. By Krishna Rao Dronamraju and Helen Spurway	136
SYSTEMATICS AND ECOLOGY OF INDIAN PLANTS. I. ON THE RAINY SEASON WEEDS OF GORAKHPUR. By D. N. Sen. (With a sketch map).. ..	144
ON SOME NEW SPECIES OF SPIDERS (ARACHNIDA) OF THE FAMILY THOMISIDAE FROM INDIA. By B. K. Tikader. (With seven text-figures)	173
THE VEGETATION OF KANYAKUMARI DISTRICT (CAPE COMORIN). By C. A. Lawrence. (With a map)	184
SOME OBSERVATIONS ON THE BIOLOGY OF <i>Labidura riparia</i> (PALLAS) (LABIDURIDAE, DERMAPTERA) FROM POONA. By P. V. Joshi. (With two text-figures) ..	196
LEAVES AND TENDRILS AS AIDS FOR IDENTIFICATION OF CUCURBITS. By Priyadarsan Sensarma. (With six plates)	204
REVIEWS :	
1. The Waterfowl of the World (S.A.)	208
2. My year with the Woodpeckers (S.A.)	209
3. A Handbook to the collections illustrating a Survey of the Animal Kingdom (R.R.)	210
4. Crocodiles and other people (H.A.)	211
5. The Wealth of India : A Dictionary of Indian Raw Materials and Industrial Products. Raw Materials. Vol. V : H-K (D.E.R.) ..	212

MISCELLANEOUS NOTES :

1. Possible function of the tiger's whiskers. By Lt.-Col. M. M. Ismail (p. 213).
2. The present status of the Indian Lynx (*Caracal caracal*). By B. P. Srivastava (p. 214).
3. Toddy Cat (*Paradoxurus hermaphroditus*) and Russell's Viper (*Vipera russelli*). By B. Subbiah Pillai (p. 215).
4. Bats as a storm signal? By Ishwar Prakash (p. 216).
5. Occurrence of the Sea Cow, *Halicorn dugong* (Ersl.), off the Saurashtra coast. By S. B. Mani (p. 216).
6. Wild life problems. By M. A. Khan (p. 218).
7. The Forest Wagtail, *Motacilla indica* (Gmelin), in Madras, Chingleput District. By P. J. Sanjeeva Raj (p. 220).
8. The Adjutant Stork, *Leptoptilos dubius* (Gmelin), a destroyer of locusts in Rajasthan. By Gurdas Singh and Charan Singh (p. 221).
9. Additions to the birds of Coimbatore, south India. By Subbiah Pillai (p. 222).
10. Bird migration in India. Recovery of ringed birds. By Editors (p. 223).
11. Further additions to the birds of Kutch. By P. B. Shekar (p. 224).
12. Can snakes produce vocal sounds? By Humayun Abdulali (p. 225).
13. Distribution of the Skink, *Riopa lineata* (Gray). By V. K. Chari (p. 226).
14. A note on the amphibians of Kutch. By P. W. Soman (p. 226).
15. *Laelia adalia* Swinhoe (*Laelia exclamatoris* Koll.) (Lymantriidae: Lepidoptera): A new pest of Guinea Grass in south India (With a photograph). By B. Vasantharaj and K. R. Nagarajan (p. 228).
16. Correct name of the Asiatic butterfly hitherto known as *Danaus* (or *Papilio*) *plexippus*. By Editors (p. 230).
17. Occurrence of the Blue Mormon (*Papilio polymnestor* Cramer) in Bombay. By D. E. Reuben (p. 231).
18. Additions to the butterflies of Bombay and Salsette. By Editors (p. 233).
19. The submerged leaves of *Nymphaea pubescens* Willd. (With one plate). By J. J. Gaudet (p. 234).
20. *Brucea amarissima* (Lour.) Merr.—A new record for south India (With one plate). By N. C. Nair (p. 237).
21. The identity of the *Entada* plants from Bombay. By H. Santapau (p. 238).
22. The main botanical gardens of the U.S.S.R. (With a photo). By B. Kotelnikov (p. 240).
23. The Water Hyacinth—An appeal for information. By J. B. S. Haldane (p. 243).

GLEANINGS. 244



Arrival of prospecting female at helmet nest (lower). Top right : Initial "wad" stage.



Cocks advertising at pre-helmet stage nests.

Photos : Salim Ali

JOURNAL

OF THE

BOMBAY NATURAL HISTORY SOCIETY

1960 APRIL

Vol. 57

No. 1

Studies on the Reproductive Behaviour of the Baya Weaver [*Ploceus philippinus* (L.)]

BY

JOHN HURRELL CROOK

Ornithological Field Station, Madingley, Cambridge

(With one plate, one text-figure, and three diagrammatic schemes)

CONTENTS

	PAGE
I. INTRODUCTION	
1. Methods	2
2. The colony sites	3
3. Polygamy and numbers of nests per territory	5
II. TERRITORY	
1. General	7
2. Experimental compression of territories	9
III. AGONISTIC AND TERRITORIAL BEHAVIOUR	
1. Behaviour in flocks	14
2. Agonistic behaviour in territorial defence and courtship	15
3. Discussion of agonistic postures in pair formation	18
4. The occurrence of song	18
IV. NEST INVITATION, COURTSHIP, AND HAREM FORMATION	
1. The pair formation process	19
2. Nest invitation and the early courtship sequences	21
3. Nest acceptance and pair bond formation	23
4. Analysis of behaviour sequences during courtship with comparisons with other colonial weaver birds	26
V. THE MUTUAL BEHAVIOUR OF MALE AND FEMALE FOLLOWING PAIR FORMATION	32
VI. THE BEHAVIOUR OF JUVENILE BIRDS	35
VII. SUMMARY	37
ACKNOWLEDGEMENTS	39
REFERENCES	40

I. INTRODUCTION

The present paper is a continuation of studies on the biology of the Indian weavers initiated by Dr. Sálim Ali in 1930 and resumed in 1953 (Ali & Ambedkar 1956, 1957, Ambedkar 1958, in preparation). It is also part of a programme of research on the ethology and social organisation of the Ploceinae started at the Ornithological Field Station of the Department of Zoology, Madingley, Cambridge, in 1954. Observational methods used in West Africa in 1955 and 1956 have been employed in India so that accounts of the behaviour of species in both the Ethiopian and Oriental regions may be directly and precisely compared (See Crook 1958, 1959, 1960, in press : a, b).

The Baya Weaver (*Ploceus philippinus*) is a polygamous species whose life history and general behaviour have been well described (Ali 1930, Ali and Ambedkar loc. cit.). In the Bombay and Poona areas it breeds in the monsoon season siting its nest colonies typically either in tall palms, usually over water, or in vegetation hanging over deep wells. Occasionally small colonies may be found in trees without protection from water but such sites are decidedly infrequent. The male establishes and defends one or two nests, constructing them as far as the 'helmet stage'¹ (Ali 1930, Crook 1960) at which they are maintained until, following a courtship involving much 'nest advertisement display' and mutual antagonism, they are accepted by females. The male may have up to three wives whom he acquires successively in a very short period.² Details of clutch size, hatching success, mortality, growth rate of young, and fledgeling success have been studied in part (Ali & Ambedkar loc. cit., Ambedkar 1958) and the work remains in progress.

In this paper certain new observations made during the 1958 and 1959 seasons are described and, in particular, a detailed account is given of the territorial and sexual behaviour of the species together with a brief analysis of the data.

1. Methods

Detailed observations from hides, through 8×30 binoculars and a ×20 telescope, were made at several wild nesting colonies around Poona, particularly those at Hingane, Parbati Hill, and near the Agricultural College. The changes in behaviour of the weavers are most rapid and in

¹ The terms referring to stages in nest construction have been used in previous publications (Ali 1930, Ali and Ambedkar loc. cit., and Crook in press a). They are (i) Wad—the first bunch of strands woven into a nest site, (ii) the Initial Ring—the ring that develops from the wad, (iii) the Helmet Stage Nest—the roof flange projects both before and behind the initial ring from above, (iv) the Completed Egg Chamber—egg chamber complete but no tube, (v) complete nest and lengthening tube present.

² V. C. Ambedkar reports a single case of 5 females to a male in 1959 at Poona.

order to obtain a high degree of accuracy an EMI field tape recorder was used in making commentaries on the sequences of behaviour observed. Such commentaries provide the basis for the quantitative data found in the Schemes¹ and described in the text. The recorder was also used in taping the song and cries of the species which will be later analysed by sound spectrograph at Cambridge and used in a comparative study of the vocalisation of the sub-family. A number of simple experiments were made in which nest positions etc. were modified in order that certain aspects of territorial behaviour might be revealed. The results of a programme of nest mutilation experiments will be published separately.

2. The colony sites

The types of site chosen by the birds for their breeding colonies are shown in Table I. Of 35 colonies 29 (i.e. 82.8%) were situated over water and of these 23 (i.e. 65.7% of the total) were hanging either within wells or in trees over them. Only 6 active colonies and occasionally small groups of adults and colonies of juveniles with unoccupied nests were found away from water. In Kumaon several colonies in bhabar country were also located in small thorny bushes without water near them but in the terai most colonies were again hanging over pools or streams.

A fair amount of polemic has centred around the survival value of the siting of weaver colonies over water. Very similar sites are used by certain colonial species in Africa. Lack (1954) supports the argument that 'colonial nesting is possible only for species which are comparatively safe from nest predators, which otherwise would be attracted to the spot'. The sites of avian breeding colonies are normally protective, at least against crippling predation, and the case of cliff-dwelling sea birds is particularly to point here. In the colonial weavers the chosen sites normally appear to be protective either through association with tribal villages (e.g. *Ploceus cucullatus* in West Africa), through breeding in dense thorny bushes, e.g. the *Quelea* in Senegal, (Crook in press a), or through siting over water. Actual observations of predators failing to obtain their prey as a result of these factors are relatively few (Crook 1958, 1960); but the fact that there are such accounts does indicate that predators do attempt to enter the nests and that they do fail. The main dangers to a Baya colony are crows (*Corvus splendens*, Ali 1956, and also almost certainly *Corvus macrorhynchos* in the Poona area) which bore holes in the nests and feed on eggs and young, and also the nocturnal tree mouse, *Vendeluria oleracea*, which may destroy a brood and establish its nest within that of the Bayas (Ali & Ambedkar 1956). However, this species also builds nests and has young in old nests prior to the reoccupation of the colony in spring so that its breeding is not dependent upon a fresh nest. Against these dangers the Bayas have little protection,

¹ For Schemes see pp. 42-44 below.

though the crows' entry to the colony occasions great excitement and mild mobbing. The Striped Squirrel (*Funambulus palmarum* and *F. pennanti*), certainly a potential predator of eggs, which inhabits the vegetation of wells never climbs out on the dangerously fine twigs from which the Bayas suspend their nests. V. C. Ambedkar (personal communication) has a magnificent account of a snake which was observed on a Baya's nest

TABLE I

Sites of breeding colonies of *Ploceus philippinus* in the Poona area 1958 and 1959.

Site	No. of colonies observed	Percentage of total number of colonies
Tall palms over water	2	5.70
Trees overhanging streams	3	8.55
Tree projecting from cliff over stream	1	2.85
Trees over wells	5	14.28
Vegetation hanging within wells	18	51.42
Trees on steep bank away from water	1	2.85
Trees/bushes not near water	3	8.55
Small tree in garden near house	2	5.70
TOTAL	35	..

hanging over the water and attempting to find an entrance. The snake seemed to find difficulty in gripping the nest which contracted under pressure. It edged its way down and tried to get in the tube. However, at this point, it slipped and fell into the well. This provides good evidence not only for the protective value of the siting but also of the nest form itself.

The Bayas are also extremely particular about the siting of the actual nest. Fine down-hanging twigs are normally used and the resulting nest is well separated from near-by prominences upon which predators might perch while opening it. Further, all projections, such as leaves and leaf bases on the supporting twig, are meticulously plucked off leaving the whole support and the nest surface as bare as possible. This could be a factor preventing predators, such as snakes, getting a grip on the support or alternatively it may reduce the surface area thus lessening sway in

winds. This latter point is, however, hardly relevant to nests within the shelter of wells.

It thus appears that both the siting of whole colonies and of individual nests are usually appreciably protective against potential predators. Nevertheless the fact that 17.1% of all the colonies found did not appear to be in a protective site is of obvious significance. Most of these cases were found in the upland area near Karakwasla away from the river valleys and where there are no wells or deep surface streams. It appears then that, where protective sites are not available, the weavers can and do breed without them. It is not known what effect this has on survival. One may suppose that the type of site most common in any one area represents a 'tradition' of site selection in the Baya population brought about by the selection of the most successful (i.e. most protective) sites in the course of many generations.

3. Polygamy and numbers of nests per territory

The male Baya normally pairs with several females whom he establishes successively in the helmet stage nests prepared for their inspection. Assuming that the ratio of males to their nests in the colonies is taken from a representative sample of all adult birds, Ali & Ambedkar (1956, 1957) have concluded that the tertiary sex ratio is therefore 1 male : 2 to 3 females. This ratio excludes the large population of males in their first year which neither attain adult plumage nor breed successfully till their second year. Females of the first year mate and breed successfully.

During Phases II and III of the breeding season in 1958 (see p. 21) the numbers of females paired to a male were studied in relation to the number of nests the male had built and was maintaining in a fresh condition at the time. The results are given in Tables II and III. The majority of males were mated to a single female (53.6% of total territories examined), a fair number (34.1%) to two females, and very few birds (7.3%) to three females. Further, two territories were noted in Phase III in which the males still hopefully maintained helmet stage nests which no females had occupied. In no case did a male complete a nest that was not occupied by a female. In 78% cases a helmet stage nest was maintained in addition to completed nests. The mean number of both completed nests and females per territory was 1.13 (15 territories and 17 females) at Hingane, 1.5 (16 territories and 24 females) at the Parbati Hill area, and 1.8 (10 territories and 18 females) at the Agricultural College. The mean for all the territories examined is 1.44, thus giving a lower tertiary sex ratio in the breeding colonies than previously supposed. The numbers of structures maintained by males in their territories irrespective of their stage of construction are given in Table IV.

though the crows' entry to the colony occasions great excitement and mild mobbing. The Striped Squirrel (*Funambulus palmarum* and *F. pennanti*), certainly a potential predator of eggs, which inhabits the vegetation of wells never climbs out on the dangerously fine twigs from which the Bayas suspend their nests. V. C. Ambedkar (personal communication) has a magnificent account of a snake which was observed on a Baya's nest

TABLE I

Sites of breeding colonies of *Ploceus philippinus* in the Poona area 1958 and 1959.

Site	No. of colonies observed	Percentage of total number of colonies
Tall palms over water	2	5.70
Trees overhanging streams	3	8.55
Tree projecting from cliff over stream	1	2.85
Trees over wells	5	14.28
Vegetation hanging within wells	18	51.42
Trees on steep bank away from water	1	2.85
Trees/bushes not near water	3	8.55
Small tree in garden near house	2	5.70
TOTAL	35	..

hanging over the water and attempting to find an entrance. The snake seemed to find difficulty in gripping the nest which contracted under pressure. It edged its way down and tried to get in the tube. However, at this point, it slipped and fell into the well. This provides good evidence not only for the protective value of the siting but also of the nest form itself.

The Bayas are also extremely particular about the siting of the actual nest. Fine down-hanging twigs are normally used and the resulting nest is well separated from near-by prominences upon which predators might perch while opening it. Further, all projections, such as leaves and leaf bases on the supporting twig, are meticulously plucked off leaving the whole support and the nest surface as bare as possible. This could be a factor preventing predators, such as snakes, getting a grip on the support or alternatively it may reduce the surface area thus lessening sway in

winds. This latter point is, however, hardly relevant to nests within the shelter of wells.

It thus appears that both the siting of whole colonies and of individual nests are usually appreciably protective against potential predators. Nevertheless the fact that 17.1% of all the colonies found did not appear to be in a protective site is of obvious significance. Most of these cases were found in the upland area near Karakwasla away from the river valleys and where there are no wells or deep surface streams. It appears then that, where protective sites are not available, the weavers can and do breed without them. It is not known what effect this has on survival. One may suppose that the type of site most common in any one area represents a 'tradition' of site selection in the Baya population brought about by the selection of the most successful (i.e. most protective) sites in the course of many generations.

3. Polygamy and numbers of nests per territory

The male Baya normally pairs with several females whom he establishes successively in the helmet stage nests prepared for their inspection. Assuming that the ratio of males to their nests in the colonies is taken from a representative sample of all adult birds, Ali & Ambedkar (1956, 1957) have concluded that the tertiary sex ratio is therefore 1 male : 2 to 3 females. This ratio excludes the large population of males in their first year which neither attain adult plumage nor breed successfully till their second year. Females of the first year mate and breed successfully.

During Phases II and III of the breeding season in 1958 (see p. 21) the numbers of females paired to a male were studied in relation to the number of nests the male had built and was maintaining in a fresh condition at the time. The results are given in Tables II and III. The majority of males were mated to a single female (53.6% of total territories examined), a fair number (34.1%) to two females, and very few birds (7.3%) to three females. Further, two territories were noted in Phase III in which the males still hopefully maintained helmet stage nests which no females had occupied. In no case did a male complete a nest that was not occupied by a female. In 78% cases a helmet stage nest was maintained in addition to completed nests. The mean number of both completed nests and females per territory was 1.13 (15 territories and 17 females) at Hingane, 1.5 (16 territories and 24 females) at the Parbati Hill area, and 1.8 (10 territories and 18 females) at the Agricultural College. The mean for all the territories examined is 1.44, thus giving a lower tertiary sex ratio in the breeding colonies than previously supposed. The numbers of structures maintained by males in their territories irrespective of their stage of construction are given in Table IV.

TABLE II

Number of females per territory in three different colony groups in the Poona area. (Total number of territories examined : 41)

	Hingane colony (Tree over well)	Parbati Hill colonies (Bushes over wells)	Agricultural College colony (Palm tree)	Totals of territories
Territories unoccupied by females	2	..	..	2
Territories occupied by 1 female	9	10	3	22
Territories occupied by 2 females	4	4	6	14
Territories occupied by 3 females	..	2	1	3
Mean number of females per territory	1.13	1.5	1.8	1.44

TABLE III

The construction stages of nests maintained by males in territories occupied by 1, 2, or 3 females respectively. (Number of territories examined : 41. The numerals represent the number of territories of each nest composition.)

Territories of differing nest composition occupied by 1, 2, or 3 females	Hingane colony	Parbati Hill colonies	Agricultural College colony	Total of territories in each category
Unoccupied territories : 1 Helmet stage nest only	2	..	..	2
Territories occupied by a single female :				
1 Helmet stage plus 1 complete nest	8	10	1	19
0 Helmet stage, 1 complete	..	..	1	1
2 Helmet stages plus 1 complete nest	1	..	1	2
Territories occupied by two females :				
1 Helmet stage plus 2 complete nests	3	3	3	9
2 Helmet stages plus 2 complete nests	1	1	3	5
Territories occupied by three females :				
0 Helmet stage nests, but three complete ones	..	..	1	1
1 Helmet stage nest plus three complete ones	..	2	..	2

TABLE IV

The number of structures maintained by males in their territories irrespective of their stages of construction. (Phases II and III of breeding)

Number of structures in territory	Number of cases
1	3
2	24
3	12
4	2

From the above discussion we may note the following points :

- i. While the actual tertiary sex ratio in the three colony areas studied was only 1 male : 1.44 females, the males nevertheless normally maintained an additional structure at the helmet stage ready for any female that might accept it.
- ii. The numbers of females and completed nests per territory appear to differ in the three areas studied (Table II). In particular the colony high in a palm tree had a greater mean number of females per territory than those established over wells. A contingency test shows χ^2 to be 9.23 for which p lies between .1 and .2. Although the differences are not thereby shown to be significant this could be due to the numbers available for the test being small. It is thus possible that a real difference does exist. Such a difference could be due to the greater density of potential nest sites on the palm leaves and birds packing more nests into their restricted territories. Further figures from contrasting colony sites are required to test this idea.
- iii. Polygamy in the Baya is based clearly upon the greater availability of potent females compared with potent males in any one season. The disproportionate sex ratio in the breeding colonies is probably due to the failure of the males to breed in their first year. However, since the sex ratio of fledgelings has been shown to be slightly in favour of males, the question remains open.

II. TERRITORY

1. General

The male Baya establishes his ownership of a particular site by loud song and aggressive behaviour (see p. 15) to all approaching birds. He also gives the nest advertisement display there (p. 22). Careful observations mostly in the Hingane colony in 1958 revealed the following facts :

- i. At least two males may build upon established nest sites up to the helmet stage ; thus neighbours build upon each other's nests

during the earliest stage of construction. This was observed only at the onset of breeding when the first nests were being started. At this time the territorial aggressiveness of the male is least marked and territories barely established.

- ii. Defence of the site begins soon after the first stitches have been made in any selected place. The founder soon becomes intolerant of other males visiting his nest and building upon it and any attempt to do so may lead to a fight. Thereafter, males approaching nests other than their own do so in sleeked postures (strong tendency to flee) and usually make attempts to steal material for their own nests. Two nest sites may be established at once : usually they are close together, and the male may thus construct two wads at the same time. Usually one nest develops faster than the other and becomes the centre of the territory.
- iii. Two established nests of a male may be separated occasionally by a great distance. Two cases were observed at Hingane in which the two nests of a male were situated on opposite sides of the well. The territories of these birds were thus in two parts. In both cases the double territories were maintained for a few days until one of the nests was abandoned and its site no longer visited or defended.
- iv. Experiments (see below) show that the spatial extent of a Baya territory is compressible down to that of the nest (or the nests) itself. Thus when nests were brought very close together, the males would lunge at one another from them and show much threat, but in no case was a nest abandoned and rarely did ferocious fighting result. It is thus the nest itself rather than a volume of space of certain size around it which is significant. However, supplanting attacks are often made at neighbouring males during establishment of the territories and threat occurs at distances of between three and six feet approximately from the nest site. The distance from the nest at which a male refuses to retreat in the face of threat or attack is easily observed and marks the inner limits of a boundary zone. The territories are so packed that there is rarely any 'no man's land' between them.
- v. A further factor influences the size of territories. This is the frequency of suitable sites in a given area. Thus over wells, where the vegetation is sparse and the numbers of suitable twigs few and scattered, the defended areas may be large, up to several square feet. On the hanging leaves of tall palms, however, every pinna of which offers a suitable site, nests are frequently placed very close together and the territories are

much smaller as a result. It is thus partly the distribution of suitable sites that determines the number and the size of the territories within a given area. The males establish territories including as much space around their nests as their neighbours allow them.

2. Experimental compression of territories

A number of simple experiments were made to determine the extent of the defended area and changes in behaviour of the individuals concerned under modified conditions. Nests of neighbouring males were moved closer to one another and the behaviour before and after the move was recorded.

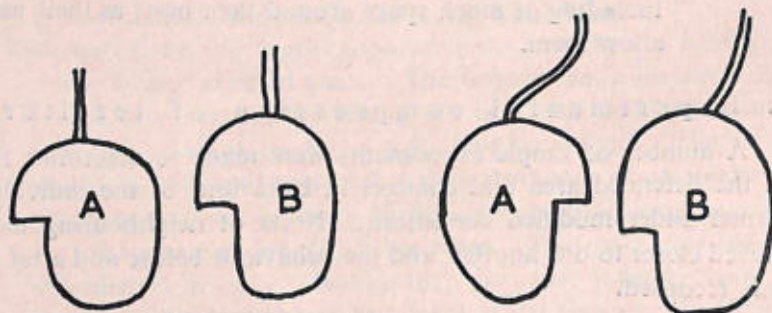
TEST I. Two neighbouring nests, A and B, originally two feet apart, were wired together with approximately one inch between them. The entrance remained in the same relative position throughout (see figure). The nests were completed egg chambers but only A was certainly accepted by a female.

For 15 minutes before the test the nests were watched closely and the two males were present on their respective nests several times. No aggressive encounter of any sort was observed between them. As soon as the change was made the two males returned to their nests and at once assumed mild threat postures (i.e. Tail depressed Threat). Bird B fixated bird A intensely but kept the body of his nest between himself and his opponent. Bird A maintained his threat posture and sat on a twig above his nest with his back to B much of the time. Whenever A hopped down to his nest, B hopped off his on to a twig, a little further from A than before, and whenever B hopped to his nest, A retreated to a twig in the same manner. Once when male A flew to his own nest, B supplanted him and twice, when female A flew to nest A, both males attempted to enter the nest (copulation attempt) after her but, after a brief supplant from male A, B retired to his own nest. Most of the time the males sat near their nests taking little note of each other. When male B was absent for a time male A made shaping movements in the beginnings of the tube on nest B and then, sitting on nest A, leaned out and pulled a small strand off nest B.

At the end of the test the nests were restored to their original positions.

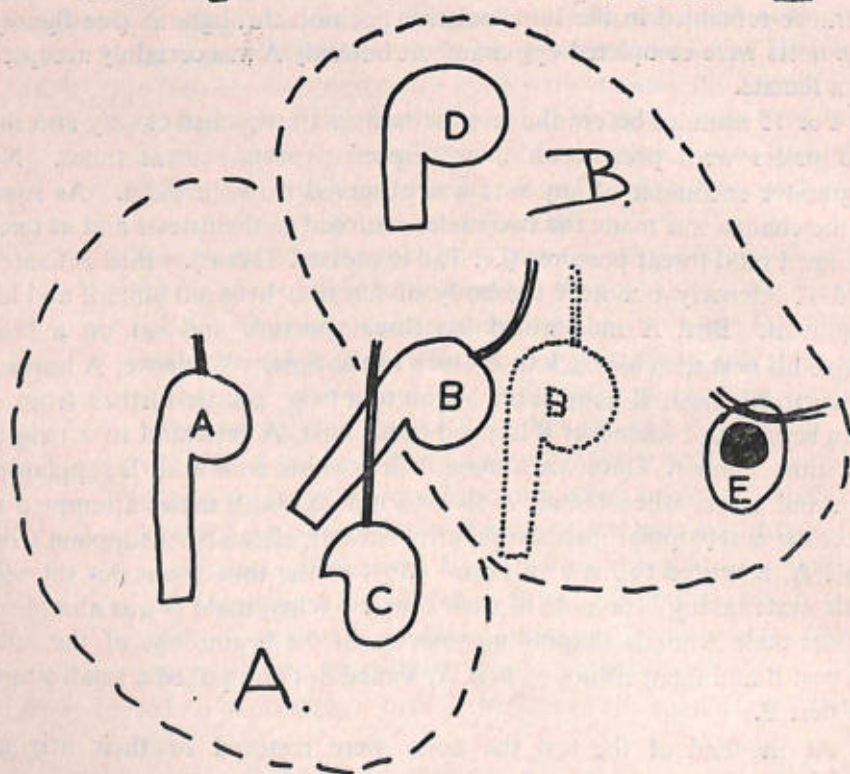
TEST II. The same two nests were wired together at the same distance but this time with their entrances close together. Male A pulled out the wire so that the nests swung apart and the experiment had to be set up again and left over night. Next morning A hopped about on both nests but mainly on A. His female entered nest A and the male displayed

there. On her emergence she entered nest B and male A thereupon sang upon it and tried to enter it in a copulation attempt. The female titivated on both nests. Later, in the absence of male A another male, very



TEST I

TEST II



TEST III

sleeked, visited both nests twice. It was perhaps B but he was not certainly present at the nests at all.

Note on Tests I and II The tests show that the territories were compressible without fighting occurring between the owners. There was, however, a very clear increase in threat, and the owners showed a strong tendency to avoid one another. Neither bird would allow the other on its nest which thus marked the limit of the compressibility of the territories. Male A appeared dominant to B, this being enhanced perhaps by his possession of a female which visited both nests in the absence of male B. In Test II, after the entrances had been apposed, it appeared that male A had taken over both nests and that, if B came at all, it was in the sleeked posture of a trespassing bird. No bird other than A showed territorial ownership at the two nests during Test II (see also Test IV).

TEST III. Two neighbouring territories, again called A and B, were chosen. Male A owned nests A (completed with tube and female) and C (uncompleted helmet stage nest with no female). Male B owned nests B (completed with tube and female), D (old completed, no female) and E (abandoned helmet stage nest). In the test the nest B was slightly tilted and wired so that its tube entrance opened into the defended area of A only two inches from the tube of nest A (figure).

Before the change no interaction (beyond one case in which male B attempted to follow female A into her nest and was supplanted by male A) between the birds of the territories was observed. Immediately after the change the following events were recorded :

1. Female B returned and hopped on to a twig, which had been previously her last perch before flying up the tube of her nest. She flicked wings and tail in obvious 'anxiety' (intention movement of flight) and repeatedly flew between the twig and the top of her nest B. She never approached the tube entrance of the nest. She then flew to old nest D and the male B followed her there and gave a full advertisement display (p. 22) upon it. Previously no female had visited this nest. Male B then approached the displaced entrance but did not enter.
2. Female B apparently located her displaced nest entrance and made two attempts to fly up into it. On both occasions male A chased her off.
3. Male A wing quivered and gave pseudo-female solicitation to female B as she hopped about anxiously on her nest (B).
4. Female A, on leaving nest A, entered nest B. Later she entered B in addition to her own nest several times. Male A greeted her with wing quivering and pseudo-female solicitation at both nest entrances.
5. Female B visited nests D and E : at D male B advertised but at E he supplanted her. Later he advertised here as well as giving further supplants.

6. Female B made further attempts to enter nest B but once more was supplanted by male A.
7. When male A was absent, female A was supplanted by male B on trying to enter nest A. Later when she flew to her nest, male B wing quivered and gave pseudo-female solicitation to her while perched on nest C. The female took no notice but flew into nest A.
8. When no other bird was present female B once arrived on the top of her nest and then flew down and entered nest A.

After forty-five minutes the nest B was restored to its original position. On returning, female B alighted on nest C and supplanted female A near it. Male B then alighted on nest B and sang; whereupon female B at once flew to nest B and entered it. From then on the original behaviour of females A and B was restored, each going to its appropriate nest. Once, however, female B supplanted female A as the latter was going to nest A.

Note on Test III. The displacement of the nest entrance at the end of a long tube into the centre of a neighbouring territory effectively prevented both the male and the female owner from entering. The male was singularly undisturbed by the change and no aggressive encounters between him and his neighbour were recorded. The female, however, was much disturbed and made several attempts to enter her nest by passing through the neighbour's territory. On each occasion she was driven out. During her anxious hopping about the neighbouring male greeted her once with wing quivering and solicitation as if she were his own female. In addition, she visited two abandoned nests of her own mate at which he resumed typical 'Advertisement' and supplanting behaviour. In the absence of male A from his territory, male B extended his into it and drove off the former's female. Female B could then enter her own nest; instead she actually entered that of the neighbouring female. On restoring the nest to its original position, female B resumed her original behaviour. The test showed that movement of the nest entrance disturbed the female only and that her anxious wanderings produced the following responses from the otherwise unconcerned males:

- i. The neighbouring male showed defensive supplanting and courtship approaches identical with those with which he greeted his own female.
- ii. Her own male resumed advertisement display and courtship at his more or less abandoned nest sites as soon as she began visiting them.
- iii. When the neighbouring male was absent the original owner expanded his territory to cover the displacement of his nest tube and in doing so supplanted the neighbouring female.

The return of the neighbouring male restored the defended area to its original size. Thus so long as neighbouring males are present, displacement of the nest entrances does not bring about a change in the spatial relations of their territories.

TEST IV. The following day a further experiment was carried out using the same nest group as in Test III. Nests A and B were wired together so that their entrance tubes hung a foot apart instead of three feet. Nest C was then moved to a position to the right of nest B thus bringing it into B's territory. The following occurred :

1. The two females both arrived on nest A on returning, and a fight occurred. B took nest C for her own nest and hopped on it several times until she found the B nest entrance tube and went in. Female A showed repeated threat postures at female B.
2. Female A arrived on nest B. At once female B attacked and a short fight followed before female A retired to her own nest.
3. Female B spent much time on nest C titivating it as if it were her own nest.
4. Male B titivated on nest C and hopped about on it. Male A took no notice.
5. Strong 'Tail depressed Threat' postures were given by male A when male B was in nest B. Otherwise only mild threat posturing as normally seen between neighbours was observed. When male B titivated on nest C male A fixated him but no encounter developed.

Note on Test IV. The change in the positions of the nests and the distance between them led to confused female behaviour when they returned to their territories. Fights occurred whenever they alighted on each other's nests apparently in mistake. Female B took interest in nest C formerly of A's territory but now placed in nest B's position relative to the other nests. This nest was adopted by male B and male A did not defend it. There was an increase in the frequency and strength of threat posturing between the neighbouring males.

TESTS V AND VI. In two other tests nests of two further territories were brought close together. The original distances between the nests were three feet ; after changing the nests they were at three inches and nine inches in the two tests respectively.

Results :

1. Males showed an increase in the frequency and strength of threatening in Test V.
2. In Test VI (during which the two males were never seen present at the same time) the female whose nest had been moved the most showed the greatest anxiety (e.g. wing flicking) calling and hopping about agitatedly.

3. The nests were not returned to their original positions after the tests. Aggression and anxious behaviour both disappeared after a few hours and thereafter normal territorial behaviour was recorded.

TEST VII. The young were removed from two nests and the behaviour of the returning females watched. Both became excessively anxious and visited all neighbouring nests. As these were empty no interactions with other birds occurred.

Summary of Tests :

The results of all these tests may be summarised as follows :

(1) If occupied nests are moved closer to one another during brooding there is an increase in threatening behaviour between the neighbouring males.

(2) If the entrance tube of an occupied nest is tilted so that it opens within a neighbouring territory, the owner female is prevented from entering it by the neighbouring male. The male owner does not attempt to defend the entrance tube of his nest when the neighbouring male hops on it or the female enters it.

(3) If unoccupied nests are moved into a neighbouring territory or placed near another male's nest they change owners (Tests II and IV).

(4) Displacement of nests confuses the females who follow regular routes and use certain landmarks in locating them. They become very anxious showing wing flicking, calling, and visiting several neighbouring nests. This results in fights between the various female nest owners. Neighbouring males respond to the wanderings of females with supplanting attacks or occasionally with sexual 'greetings' both of which the females avoid.

(5) When unoccupied nests are kept with reduced distances between them, the aggressive responses gradually fade until finally the interactions between the two pairs do not differ from those of birds in territories in which the nests have not been moved. The birds thus adapt themselves quickly to a much reduced territory size.

(6) The defended area can be reduced to little more than the nest itself. The arrival of strange or neighbouring birds on a nest is never tolerated.

III. AGONISTIC AND TERRITORIAL BEHAVIOUR

1. Behaviour in flocks

Baya weavers are 'Distance' species (Hediger 1950) and maintain an 'individual distance' when moving together in groups. Each individual prevents another coming near it by aggressive or fleeing behaviour depending upon the relative dominance of the two birds in the encounter. In caged groups stable 'peck right' hierarchies are established but in wild

flocks it is unlikely that the group composition is sufficiently constant for individuals to learn to recognise one another enough for this to occur. The dominance shown by one bird to another in a wild flock is thus not likely to be learnt in relation to the opponent. It is rather the expression of the innate relative dominance of the two birds. The actual tolerance distance around an individual within which another individual is never permitted is small, being about two inches, depending on the mood of the bird. It thus resembles distances estimated for other Weaver species in aviaries in Cambridge and in Senegal (Crook 1958).

The typical threat posture, composed of components that are intention movements of attack and escape, is the 'Head forward Threat' (Hinde 1953). Components indicating the tendency to attack are the crouched posture, the head held low, forward, and often rather pulled back into the shoulders, and sometimes a spread tail. Components showing a tendency to flee are the sleeking of the body plumage and a turning away from the opponent. The most frequent form of attack is the 'Supplant' (Hinde 1952) in which a bird fixates another, often in the Head forward Threat posture, and then flies directly at it and takes its perch as it flees. If it does not flee, a short fight occurs. 'Supplants' are frequent at food sources, at another bird when it has some nesting material, and in any competitive situation. Another aggressive movement, the 'Lunge', is a brisk reaching-out at the opponent as if to peck it, accompanied by an aggressive chatter. It occurs often during 'individual distance' encounters on perches, the birds then separating out and so increasing the distance between them. The 'lunge' may end in a peck in which the opponent's plumage is seized in the beak. This often starts a fight.

2. Agonistic behaviour in territorial defence and courtship

Once a male has established himself in a territory, his aggressive postures are used both in territorial defence and in the various encounters occurring outside the colony in flocks. The Head forward Threat and the Lunge are now frequently associated with the loud wheezy song which functions here in claiming ownership of the site and in warning other males to keep away. At wads, initial rings, and early helmet stage nests, the males threaten their neighbours primarily by supplanting those that come close (about three feet from the nest in a palm tree colony). Birds that hop near the borders of a defended area are treated to a loud song and much ocular fixation, the owner advancing towards them and eventually supplanting or relaxing depending on whether the other bird retreats or not.

When the helmet stage of the nest is reached and most neighbours know each other well, a further threat posture the 'Tail depressed

Threat' appears. The components are: (i) Body plumage slightly fluffed, (ii) head lowered, retracted into shoulders, (iii) tail very depressed and spread, and (iv) song or aggressive chatter. Interpretations of the motivation of this posture have been published previously (Crook, in press *a* and *b*). It arises in situations in which a sexually motivated bird is also tending to respond to an intruder with both attack and escape. It is most common in weaver species with small territories such as the *Quelea*. In the Baya the posture appears most commonly in courtship when the female has partially accepted the male's nest and the dominance-subordination relationship between the sexes is changing in favour of the female. The male then begins to show a tendency to flee from her as well as to attack her; this is expressed by the fluffing of the body feathers (i.e. thwarted escape found in many submissive postures also). The lowered head drawn back into the shoulders, the spread tail, and the calls are aggressive while the depression of the tail, especially frequent in aggression against the female (see Table V), appears to express attack and sex together.

The exact contexts of 228 sequences of aggressive behaviour are shown in Table V. A glance at the totals of sequences for each context shows that the highest number (32.5% of the total) occurred when the male attacked or threatened the female following nest invitation displays and the female's initial approaches to the nest. In these sequences the male mostly lunged at the female (95% of the cases in the context) and in the remaining cases he supplanted her. The greater number of lunges over supplants is due to the close proximity of the birds at the nest during the invitation sequences. In addition, the male is at the time showing alternating tendencies to approach the female, either in a mounting attempt or in an attack and to flee from her. Due to this conflict situation the male's lunge rarely develops into a full attack and few supplants are seen for the same reason. In courtship, following acceptance of the nest, the behaviour is less confined to the nest and supplants leading to sexual chases are more common than lunges. Large numbers of aggressive sequences were also seen when males passed near the territory (mostly supplants, 79% of cases in context, or a few Tail depressed Threats always given to well-established neighbours, 21%) and with females, during courtship sequences, when many Tail depressed Threats (37% of sequences in context) were seen in addition to the many supplants (58%). The numbers of sequences in other contexts are also given in Table V.

Of the different types of aggressive response 91% of the lunges occurred as the female approached an advertising male. The majority of supplanting attacks was given against approaching males (33%) or neighbouring males in display (26%) with a further high number occurring during the courtship sequences (19%). Tail depressed Threat occur-

TABLE V

The occurrence of the three main types of aggressive behaviour of male *Ploceus philippinus* in differing contexts in territorial defence and pair formation.

Contexts	Aggressive Responses			
	Lunge (i.e. Head forward Threat with attempted peck)	Supplanting attack	Tail depressed Threat	Total of sequences per context
Strange male at the nest	..	9	..	9
Neighbouring male in full display in nest advertisement ; no female present	2	25	2	29
Neighbouring male in full advertisement display ; female near attacker's nest	..	8	..	8
Another male passes close by nest	2	43	9 (to neighbouring birds)	54
Attack on female during nest invitation (i.e. following her arrival after the advertisement display)	67	7	..	74
Attack on female during courtship	2	25	16	43
Strange male attacked while at a neighbour's nest	..	8	..	8
Aggressor attempts to rob material being carried by another male	..	3	..	3
Totals of sequences	73	128	27	228

red most commonly in courtship sequences (59% of cases observed). Eight supplants were seen against strange males visiting nests belonging to the neighbours of the defender. In this case the latter sallied forth from his territory to defend a neighbour's nest in his absence. It seems that the sleeked appearance of male strangers encourages attack even from a distance beyond the territory. In this way males sometimes save the nests of their neighbours from robbers. Owners of nests at



which a female was visiting sometimes attacked neighbouring males who were advertising near by (8 cases). However, since the owners in such contexts are primarily occupied with the female the number of aggressive responses to near-by males is much less than when a group of males displays together in the absence of a female (29 cases).

3. Discussion of agonistic postures in pair formation

Supplants are shown by birds motivated by an unopposed attack tendency. Lunges, when they develop into a pecking attack, may be interpreted in the same way but in most cases the lunge does not reach the target and the bird often withdraws. Lunging thus is usually part of a posture or sequence in which attack and escape response tendencies are in conflict. We have already seen that they may be given to both males and to females. In the Tail depressed Threat attack, escape, and sex tendencies are all activated. The majority of these postures occur in response to the female in courtship sequences. Nevertheless they also play an important role in territorial defence against neighbouring males once the nests have been well established. This is presumably because the posture has acquired value as a social signal proclaiming ownership of a nest and territory during the course of its evolution and ritualisation (further discussion in Crook, in press *b*).

4. The occurrence of song

The loud wheezy song is heard in the following contexts :

- (1) Given by several males in concert while resting in a group. Often it occurs during bouts of preening or sitting drowsily and well before breeding commences. Thus loud singing may be heard in groups in day roosts in March and April. The song is not orientated at any other individual nor does the song posture reveal any component associated with attack tendency.
- (2) Males may sit in their territories and sing without orientation to other individuals and without attack tendency present.
- (3) Song may be given at males approaching or near the territory. In these cases the posture includes threat components (e.g. rump fluffing, tail spreading) and the bird faces the opponent.
- (4) After giving a supplant the male may return to his territory and sing.
- (5) The males repeatedly sing to females after their arrival at the

nest. Such songs are given during the performance of 'wings rigid' posturing (p. 22) and in the post-courtship phase after abortive threats. They are often given on the exterior of the nest, the female being within.

In (1) and (2) there is no aggressive motivation apparent and no reason to suppose its presence. Song increases as the breeding season approaches though it appears to be present to some extent throughout the dry season. Thus caged hand-reared juveniles sing when a few weeks old though the song is not yet fully formed. Song is evidently associated with sexual motivation and its repetition in choruses, in which social facilitation plays a notable role, may possibly bring about a synchronisation of the timing of maturation so that all birds are physiologically ripe when environmental stimuli elicit breeding. In (3) and (4), however, song is occurring in aggressive contexts and functions in announcing the ownership of a site and thus as a warning to neighbouring males. In (5) too the context is aggressive though sexual motivation is usually apparent at the same time. It is unlikely, therefore, that the song plays much part in attracting the female and, further, the vocalisation accompanying the advertisement display is totally different (p. 22). Song is most marked, except in (1) and (3), where there is a conflict between two or more tendencies and where the tendency to attack is especially strong.

IV. NEST INVITATION, COURTSHIP, AND HAREM FORMATION

1. The pair formation process

In common with many other Ploceine species the pairing process of the Baya falls under two headings: (i) nest invitation by 'advertisement' display, and (ii) courtship. As soon as the nest reaches the 'ring' stage, the 'advertisement' displays are given upon them, although usually not at the full intensity achieved later on helmet stage nests. The display (see below) consists in a vigorous wing beating given while hanging below the nest and clearly functions in attracting the female. Courtship posturing follows the arrival of a female at a nest with which she is already familiar following frequent previous visits. The male's initial hostility to her wanes; he begins to court her, and she shows sexual solicitation in return. Copulation eventually results. After egg laying, throughout brooding and the rearing of the young, several courtship postures are retained as part of the greeting ritual shown mutually by the birds whenever they meet at the nest. These postures may also lead to copulation even when the young of the pair are well grown. The courtship postures, in modified form, are found throughout the entire occupation of the nest by the female and her family.

Before describing the details of these behaviour patterns and sequences, the changes in the mutual behaviour of male and female in the territory at different periods in the annual life of the colony may be summarised.

A. Preliminary breeding attempts (i.e. after the first early showers of the monsoon)

- i. Nest as a wad or ring. The male's responses to the female's approach are at this stage primarily aggressive. Advertisement displays may be given as a result of social facilitation with the displaying of other males on more advanced nests near by ; they are never long sustained.
- ii. Nest at helmet stage. Prolonged and excited advertisement displays follow the arrival of a female or group of females in the colony. When the female approaches and enters a nest, the owner responds with courtship but copulation does not yet occur nor does the female solicit. The male frequently becomes very aggressive towards the female as soon as she alights on his nest, even though this may follow several minutes of ardent invitation. The nervous female flees at the slightest provocation.

During these preliminary breeding attempts activity in the colonies is only sustained for a few days. It then rapidly wanes and the place becomes once more deserted until further showers of rain are accompanied by renewed activity.

B. Definitive breeding season.

As soon as definitive breeding starts the above activities are again observed at wads, rings, and helmet stage nests. Now, however, the nests are constructed beyond the helmet stage following their acceptance by the female.

PHASE I

Nest as a completed egg chamber :

Nests of this stage have been accepted by the females and courtship occurs on and near them at maximum intensity. Whenever the females fly from the nests the males chase them for considerable distances outside the

colony and the females lead them back to their nests. At the nests the females solicit and the males copulate with them. The females also frequently refuse to copulate and attack the males instead. In such sequences the males often give the pseudo-female solicitation postures which form a marked element in courtship. As a female becomes established at a nest site advertising becomes rarer though it is maintained at the fresh nests in the territory.

PHASE II

Eggs in the nest :

Females visiting the nests for brooding are greeted by the males with much wing quivering and often pseudo-female posturing. Copulation can still occur.

PHASE III

Young in the nest :

Greeting behaviour becomes less frequent as the male remains in his territory for shorter periods. He also often assists in feeding well-grown young.

PHASE IV

Young away from colony :

Both parents feed the young after they have left the nest. No courtship or greeting postures have been seen between the sexes at this time.

2. Nest invitation and the early courtship sequences

Females are not present in the colonies at their establishment. The males busy themselves building, robbing each other's nests of material, supplanting one another and indulging in bouts of singing. The females first appear either singly or in small groups flying swiftly into the colony, hopping rapidly about the branches in very nervous sleeked postures, and occasionally flying up to a nest or two giving them apparently a brief inspection. The males with wads or rings usually react aggressively to the females' approach, threatening them and making short swift supplanting attacks. Males with helmet stage nests react strongly to the females' arrival giving intense 'Advertisement displays', hanging below their nests, and a particular call. Between displays they hop about wing quivering intensely and repeatedly fly back to their

nests for further displays. The males advertise either with the female present near the nest or when stimulated by the displaying of neighbouring birds. Thus even if only one or two females have entered the colony many of the males burst out in display immediately. Birds with wad or ring nests usually only quiver the wings or sometimes continue their building without responding to the females. The displays clearly attract the females for they rarely approach nests earlier than the helmet stage, and confine their attention especially to those upon which the males display.

The Advertisement display has two main forms, the Wings beating Display and the Wings rigid Display. Both displays are associated with much wing quivering which frequently precedes a bout of display. The Wings beating Display is given on the nest or on twigs near it. On the nest the males usually perform upside down but on twigs the body is normally upright. Wings beating Display is given during the female's approach and prior to her arrival but the Wings rigid Display is given immediately she alights on the nest. One can thus observe a transition from wing beating to the rigid posture on the arrival of the female.

The Wings beating Display has the following components :

- (1) The bird hangs from the nest, usually positioned on the developing roof of the egg chamber. Frequently the line of the back is inclined at an angle of 45° to the vertical, but often the bird is completely upside down with the back horizontal.
- (2) The wings are fully spread and hang down below the back. When the display is given in the 'upright' position the wings are of course extended and raised above the body.
- (3) In either case the wings are beaten at a speed of about 10 beats per 1.8 seconds (Table VI) through an arc between approximately 45° and 135° to the dorso-ventral plane of the bird's body.
- (4) The tail is slightly spread and either held in line with the back or slightly depressed upwards against the fabric of the nest.
- (5) The birds emit a continuous call rendered *wheetu wheetu wheetu* or *che weee che weee che weee* in the field notebooks.
- (6) The beak is often held down against the breast during display or the bird may peer around after other birds.

On the female's arrival the display changes to the Wings rigid Display through the successive development of the following components :

- (1) The bird remains hanging on the nest in the same position.
- (2) Wing beating ceases totally and the wings are held stiffly out

at the side of the body at between 45° and 90° to the dorso-ventral plane of the body.

- (3) The tail remains spread.
- (4) The feathers of the crown are raised.
- (5) The bird leans forward slightly towards the female, often peering under the edge of the nest wall and sings loudly.
- (6) As the bird leans forward with the crest raising, the wings are usually synchronously relaxed to the side of the body, a movement usually complete as the song begins.

During the initial approaches of the females the males' responses were closely observed on 154 occasions. During 50 of these the female remained near the nest but did not approach it closely, while the male merely quivered his partially extended wings. On 104 occasions the females came exceedingly close to the nests and the males gave the Wings beating Display often coupled with short flights down towards the female where they perched on twigs and gave either wing quivering or upright Wings beating Displays. In 74 cases the female alighted on the nest and the male responded with the Wings Rigid posture, a song, and often an attempt at pecking the female. A large number of these sequences were tape recorded and are shown in Schemes A, B, and C.

While visiting the colony the female is sleeked and nervous, showing a strong tendency to flee. She darts from one position to another, being frequently supplanted by the males and chased by them. Finally she alights in the nest of a displaying bird and, maintaining her very sleeked plumage, makes shaping movements in the cavity. As soon as the male threatens she flees.

3. Nest acceptance and pair bond formation

The females clearly make a choice of the nest they are to occupy for although at first they may visit several nests they soon concentrate their attention on one nest only and no longer visit others. It is difficult to gauge how far the female is affected by the male's displaying in making her choice of nests and how far it is the nest structure itself that counts. The fact that females only accept nests that have reached the helmet stage suggests that the structure itself plays the more important role though it is likely that nest structure and the male's performance taken together combine in influencing the female. However, once a female returns persistently to any given site the behaviour of the male undergoes a change and courtship rather than advertisement becomes the chief activity at the nest.

The change in behaviour occurs gradually. The original short supplanting chases whereby the male drove the female from his territory become more sustained and the male may pursue the female outside

the colony. After these long chases he may at first return alone but eventually the female, after leading the pursuing male in a long detour up to several hundred yards around the colony, flies straight back into

TABLE VI

Wing beating speeds in the Advertisement Displays of *Ploceus philippinus*
(Stopwatch accurate to 0.1 second)

Time taken for ten wing beats in seconds	Number of cases observed
1.4	1
1.5	4
	} 5
1.6	3
1.7	4
	} 7
1.8	14
1.9	4 [@]
	} 18
2.0	12
2.1	4
	} 16
2.2	2
2.3	0
	} 2

[@] This reading is due clearly to some subjective bias for reading 1.8 or 2.0 rather than 1.9 on the stopwatch dial.

it and alights in the male's nest. The chases lose their aggressive character and become interwoven with other courtship activities, the motivation of the chase becoming, at least in part, clearly sexual. The male may now make attempts at mounting the female, attempts at which the latter at first reacts aggressively, lunging or fiercely threatening the male. The chases are interpreted as prolonged attempts at mounting. During these sequences a change in the relative dominance of the two birds occurs so that the male can no longer dislodge the female from his nest so frequently. Thus whenever the male turns aggressive the female often pecks back with such effect that he desists and sits disconsolately near by until, as she flies off in her own time, he chases her. In scheme A these later sequences are marked with an asterisk.

By this time the nest is nearly finished. The usual sequence of events in the territory is summarised below :

- (1) The female alights in the nest entrance. The male, who may have given a few wing beating movements, usually sings

and then makes repeated attempts to enter his own nest. Some of these attempts are highly aggressive but the majority are attempts at copulation. The female refuses entry to him and when she departs he chases her.

- (2) Ultimately, however, the female responds to the male's constant advances with solicitation and, although in many cases this turns again to threat as the male approaches, it ultimately ends in a successful copulation.
- (3) At this time the male's sexual excitement is very evident. Apart from occasional bouts of aggressive behaviour, he is constantly wing quivering and approaching the female in short flights attempting to mount her. As the female is usually positioned in the ring entrance of the nest most of the attempted copulations occur there, but they also occur on other parts of the nest or on twigs near by. If the nest has a fully completed egg chamber and the start of a tube, then the male attempts to mount the female as she is sitting on the cross bar of the nest (the former perching position in the base of the initial ring of the nest frame) within the base of the tube. Such cases may be observed by tilting the nests so that the observer can see up the tube. Many of these attempts fail as the female repeatedly turns on the male and drives him off.
- (4) Under intense sexual frustration (i.e. following repeated rejection of his advances) the male gives pseudo-female solicitation, thereby soliciting the female in exactly the same postures as those whereby she solicits him.

In these copulation sequences the behaviour is extremely variable. The male's wing quivering advances may be met with an immediate crouching of the female and copulation may then follow immediately. Usually, however, the female resists the male's approaches with some degree of aggression alternating this with spells of wing quivering in concert with him. When the female solicits copulation normally follows at once, but when the male solicits the female usually responds only with wing quivering. She may also solicit, however, in which case again copulation is the normal consequence. The process is highly elaborate and the male by constant wooing provides the stimuli that elicit the female's sexual responses thereby suppressing her tendency to attack. The female's sexual behaviour (soliciting, etc.) elicits the male's responses and results in copulation.

Solicitation by the female has the following components :

- (1) The body is deeply crouched and the breast especially lowered,

the feathering of the breast and body being often slightly fluffed.

- (2) The wings are drooped slightly but only a little spread. The initial wing quivering that normally precedes solicitation gives way to extremely high speed tremoring most noticeable at the wing tips.
- (3) The tail is slightly raised and tremored in the vertical plane at high speed.
- (4) The head may be slightly tilted backwards and the beak thus points upwards.
- (5) Crown and nape slightly fluffed.

The components of the male's pseudo-female solicitation are closely similar to the above though the body is rarely so deeply crouched and the head is less prominently tilted. In the male's display wing quivering with fluffed body plumage changes to pseudo-female solicitation by an increase in the speed of the wing movements with a marked decrease in their amplitude. At the same time the tail is slightly raised and tremored at high speed. When giving this posture the male frequently gives a special cry, a high pitched *ti ti ti ti ti t t eeee* which also accompanies the act of copulatory mounting. Also when highly excited the male may clipper his mandibles together producing rapid little snapping sounds. This happens particularly when the male is flitting after the female in the territory, much fluffed and wing quivering and obviously highly motivated sexually.

When the male mounts the female prior to copulation she crouches in solicitation and her tail often keeps up the high speed tremoring. She then raises her beak and points it up vertically. The male then lowers his cloaca to make contact with that of the female who raises her rump and puts her tail to one side. The male utters the copulation call and flutters his wings throughout. After copulation the pair usually separate and the female is very prone to attack the male. Often, however, she flies rapidly out of the colony leaving the male hopping about often wing quivering. The female has been observed making washing movements with the wings after a copulation.

4. Analysis of behaviour sequences during courtship with comparisons with other colonial weaver birds

In Scheme A behaviour sequences recorded during nest invitation are drawn to reveal the variety of responses that occur. In Scheme B

and C sequences of male and female behaviour respectively are shown during courtship and copulation. Nest invitation and courtship do, of course, merge into one another but their separation in the Schemes is justified because there is in fact a considerable and fairly abrupt change in the behaviour of the birds as soon as the female comes repeatedly to the nest and thereby demonstrates her acceptance of it. Nest invitation displays thereafter become less frequent and intermingled with a far greater frequency of courtship sequences. In addition, acceptance of the nest marks a major change in the male's building activity. The nest is at first rapidly constructed up to the helmet stage and then maintained without further change of form until a female has accepted it. Thereupon the male resumes construction at high speed completing the nest chamber in time for the laying of the clutch. The tube is only added during the laying and early brooding. The change in behaviour was shown clearly on 12 August 1958 when a count of Wings beating Displays during a set observation period gave 44 on helmet stage nests but only 7 on nests with recently completed egg chambers.

An individual male may have several nests at one of which courtship is in full swing while at another he may give Advertisement Displays. Thus at any one time in different territories some males are advertising, others courting, and others doing the former at one nest and the latter at another. At the Hingane colony this mixture of behaviour persisted from 6 August to 10 August 1958 approximately by which time most females had commenced laying and the majority of nests had been accepted. Throughout the whole life of the colony, however, there were some males with helmet stage nests at which they continued to advertise long after fresh females had ceased prospecting and while their other nests contained well-grown young.

A. Nest Invitation

Sequences following 141 arrivals of females in the colony (Scheme A) show that 94 (66.8%) were followed by Wings beating Displays by the males at helmet stage nests, 16 (11.3%) by threat at helmet stages, 16 (11.2%) by vigorous supplants and chase by the male, and 14 (10%), in which female approached wads or rings, by threat. The male thus reacts with aggression more particularly at wads and rings. As soon as the nest reaches the helmet stage he gives Advertisement Displays. Thus from treating the female primarily as an intruder to his territory the male begins responding to her in a manner that encourages her approach (i.e. wing quivering and Wings beating Display).

The sleeked, dodging-about behaviour of the female clearly encourages the supplanting attacks of the male; yet it is clear from the start

that females are to some extent recognised as such. Thus the tremendous excitement generated in the colony by the arrival of one or two females demonstrates that the birds are in no way confused with other males. Further the large amount of wing quivering occurring between pursuits and while the male is not actually displaying is a well-known component of sexual behaviour. The initial appearances of the female near the nest thus elicit both aggressive and sexual responses from the males. The females show a strong tendency to flee (constant crouching in take-off postures, frequent wing flicking, and extreme sleeking of the body plumage) yet in spite of this the tendency to approach the nests and to examine them (undoubtedly an aspect of the sexual tendency even though courtship wing quivering and solicitation is not at this time observed) brings them repeatedly back to the colony.

The Wings beating Display is most complex. In two other colonial weavers (*Ploceus cucullatus* and *P. castaneofuscus/nigerrimus*) in West Africa homologous Advertisement Displays have been analysed and discussed at length (Crook, 1958, in press *b*). The Baya's display resembles these closely and a full analysis of its motivation will not therefore be given here. But the following points are made by way of explanation and to show the differences in the nest invitation of these three very similar species :

1. The Wings beating Display is a complex posture in which components derived in evolution from sexual chasing (wings beating) and song bowing (tail spreading and depression, beak against breast) threat postures are combined into a partially 'ritualised' static display given on or near the nest.

2. The component composition of display shows that the male is responding with attack, sex, and escape all at the same time. So long as the stimulus situation provided by the movements of the female remains relatively constant, the conflicting tendencies remain in the same effective ratio to one another. They then appear in the typical intensity, frequency, and form of display.

3. As soon as the female actually alights on the nest the male *P. philippinus* gives the Wings Rigid posture. In *P. cucullatus* the same thing occurs but it is followed immediately by 'dashing to and fro' within the territory during which he makes frequent visits to the nest where he bows to the female, sings to her, and may lunge at her. This has been interpreted as an initial freezing of the display with the tendencies to attack and to escape from the female effectively equal, followed by alternating movements of attacks and escapes or threats at the female at the nest. In *P. castaneofuscus/nigerrimus* the male usually wing quivers or droops his wings before 'dashing to and fro'. This

is interpreted as a strong sexual response in conflict with escape, there being comparatively little attack motivation apparent. Contrasted with these, the Baya's display changes firstly to the Wings Rigid posture and then passes immediately into a threatening song bow towards the female. Of the components of the display the cessation of beating and the rigidity of the wings represents the initial 'freezing' of wings beating with the attack and escape tendencies in balance and cancelling each other's manifestation; the spread tail, occurring otherwise in threat postures, indicates the presence of the tendency to attack; the raised crest, occurring otherwise in alarm, indicates the tendency to flee; the fixation of the female and the leaning forward are preparatory movements of lunging and, together with the spread tail and the song, reveal the tendency to attack; the relaxation of the wings (component 6 on p. 23) indicates the absence of intention movements of flight.

4. All this indicates that the reaction of the Baya to the arrival of the female is primarily aggressive but that the tendency to attack is *at first* partially inhibited by the opposing tendency to flee. This interpretation (for further discussion of the analysis of components in these displays see Crook, in press *b*) is supported strongly by the subsequent events in the behaviour sequences shown in Scheme A. Thus following 74 Wings Rigid postures the male actually pecked into the nest at the female 57 times and in all but 7 cases (3 in which the male relaxed on the departure of the female and 4 in which the female threatened him) he finally chased her from the nest as she fled. Only later after much chasing (an activity that is less prominent in both the West African species) do sexual responses appear at all clearly (Scheme B).

From this account we see that the differences between the displays of the Baya and those of the two West African species are due to the relatively more aggressive responses of the male to the first approaches of the female. The female Baya also is a more aggressive creature than the female of the other two species, and only after much threatening and chasing do the birds become sufficiently accustomed to one another for mutual sexual behaviour to become possible. The aggressive nature of the female also accounts for the high incidence of pseudo-female solicitations shown by the male Baya late in pair formation. The sexual chase plays an important role in courtship. It develops out of supplanting attacks through the gradual appearance of sexual responses and late in courtship the chases are inextricably part of the pairing process, the female leading the male back to his nest where she often solicits him. The Baya differs from *P. cucullatus* and *P. castaneofuscus/nigerimus* markedly in this respect and resembles other species [e.g. *P. benghalensis* and *P. manyar* in India and *P. (Xanthophilus) aurantius* in West Africa] in which sexual chasing plays a prominent role in court-

ship and nest invitation. Hinde (1953) discussing the sexual chasing of the Chaffinch (*Fringilla coelebs*) and other birds suggests that it may have a stimulating effect on the female. This is certainly so in the Baya where the female returns to the nest after a chase and solicits (Scheme C).

It has been suggested elsewhere (Crook, 1959, in press *b*) that, in the evolution of complex colonial life in certain weavers, highly motile displays in both territorial defence and nest invitation have given place to static posturings derived from the earlier movements. *P. cucullatus* and, as recent work has shown (Ali & Crook 1960), *P. megarhynchus*, in which territorial defence is conducted largely by immobile posturings and in which the sex chase is virtually absent in courtship, are the most advanced species in this respect so far observed. The Baya seems to lie between these two, together with *P. castaneofuscus/nigerrimus*, on the one hand and less colonial species on the other. The implications of these comparisons will be developed further in a later publication, by which time further species will have been studied.

B. Courtship

The behaviour sequences of the male and female during courtship are summarised in Schemes B and C respectively and the wide variety in the male's responses clearly shown (headings A-G in the Scheme). 51% (24 out of 47 cases) of the sequences in Scheme B show the male attacking or threatening (sequences passing via headings A, B and C) while the remaining sequences (23), amounting to 49%, show sexual motivation predominant. The relations between sequences under headings C and D show that initial aggressive behaviour may change easily to courtship at least for a time. Out of 23 cases in which courtship began well only 7 resulted in a successful copulation (30.5%) though a further 8 mounting attempts were made (34.7%) in which the female fled. In a further five cases (21.7%) the female reacted aggressively to the male's approaches and in one case fled in the course of courtship. In no case, where the sequence began with aggressive behaviour or included it, did a mounting attempt occur. The same situation is shown in the sequences of female behaviour, complementary to those of the males, presented in Scheme C. An attack tendency thus precludes the possibility of mating and, in a situation in which so much aggression is shown by both sexes, the frequency of sequences in which both sexes are sufficiently motivated sexually and reacting mutually without aggression is notably small.

The postures given by the birds in these sequences are mostly simple when compared with those of nest invitation. They are likewise com-

posed of components representing the tendencies to behave sexually, to attack, and to flee. Thus in the sequences under headings A to C in Scheme B the tendencies to attack and to flee are seen in conflict. The postures may later incorporate typical sexual components such as wing quivering, and with a further increase in sexual motivation, change to postures containing sexual components alone. Under the headings D to G sequences occur in which the sexual tendency is in conflict with the tendency to flee, though here again aggressive behaviour is recurrent. The significance of most of the postures shown has been discussed elsewhere (Crook, in press *b*) so that only a summary of their interpretations need be given here :

1. Wing quivering. Given by both sexes.
 - Motivation. It is normally associated with and precedes sexual behaviour in many passerine birds (Hinde 1952, 1955-56, Marler 1956, Andrew 1957, Crook, in press *a* and *b*). Some escape motivation is also present.
 - Derivation. It appears to be derived from the wing quivering of juvenile birds (Marler loc. cit.).
 - Function. It is often associated with submissive 'fluffed' postures and it appears to reduce the likelihood of attack from birds approaching or approached (e.g. as in courtship and in food solicitation by juveniles to adults). It allows partners to approach one another closely prior to mounting.
2. Solicitation. Given by the female.
 - Motivation. Largely sexual though the crouching component, an intention movement of flight, suggests the tendency to escape (Marler, loc. cit.).
 - Derivation. Movements of copulation and preparatory movements of flight.
 - Function. Invitation to the male to copulate.
3. Pseudo-female solicitation. Given by the male during copulation sequences and in the post-courtship period. It begins with the first copulation attempts following the acceptance of the nest by the female and thus coincides with the shift in relative dominance in her favour.
 - Motivation. The sexual tendency is in conflict with a strong tendency to escape. Thus it is not found early



ship and nest invitation. Hinde (1953) discussing the sexual chasing of the Chaffinch (*Fringilla coelebs*) and other birds suggests that it may have a stimulating effect on the female. This is certainly so in the Baya where the female returns to the nest after a chase and solicits (Scheme C).

It has been suggested elsewhere (Crook, 1959, in press *b*) that, in the evolution of complex colonial life in certain weavers, highly motile displays in both territorial defence and nest invitation have given place to static posturings derived from the earlier movements. *P. cucullatus* and, as recent work has shown (Ali & Crook 1960), *P. megarhynchus*, in which territorial defence is conducted largely by immobile posturings and in which the sex chase is virtually absent in courtship, are the most advanced species in this respect so far observed. The Baya seems to lie between these two, together with *P. castaneofuscus/nigerrimus*, on the one hand and less colonial species on the other. The implications of these comparisons will be developed further in a later publication, by which time further species will have been studied.

B. Courtship

The behaviour sequences of the male and female during courtship are summarised in Schemes B and C respectively and the wide variety in the male's responses clearly shown (headings A-G in the Scheme). 51% (24 out of 47 cases) of the sequences in Scheme B show the male attacking or threatening (sequences passing via headings A, B and C) while the remaining sequences (23), amounting to 49%, show sexual motivation predominant. The relations between sequences under headings C and D show that initial aggressive behaviour may change easily to courtship at least for a time. Out of 23 cases in which courtship began well only 7 resulted in a successful copulation (30.5%) though a further 8 mounting attempts were made (34.7%) in which the female fled. In a further five cases (21.7%) the female reacted aggressively to the male's approaches and in one case fled in the course of courtship. In no case, where the sequence began with aggressive behaviour or included it, did a mounting attempt occur. The same situation is shown in the sequences of female behaviour, complementary to those of the males, presented in Scheme C. An attack tendency thus precludes the possibility of mating and, in a situation in which so much aggression is shown by both sexes, the frequency of sequences in which both sexes are sufficiently motivated sexually and reacting mutually without aggression is notably small.

The postures given by the birds in these sequences are mostly simple when compared with those of nest invitation. They are likewise com-

posed of components representing the tendencies to behave sexually, to attack, and to flee. Thus in the sequences under headings A to C in Scheme B the tendencies to attack and to flee are seen in conflict. The postures may later incorporate typical sexual components such as wing quivering, and with a further increase in sexual motivation, change to postures containing sexual components alone. Under the headings D to G sequences occur in which the sexual tendency is in conflict with the tendency to flee, though here again aggressive behaviour is recurrent. The significance of most of the postures shown has been discussed elsewhere (Crook, in press *b*) so that only a summary of their interpretations need be given here :

1. Wing quivering. Given by both sexes.
 - Motivation. It is normally associated with and precedes sexual behaviour in many passerine birds (Hinde 1952, 1955-56, Marler 1956, Andrew 1957, Crook, in press *a* and *b*). Some escape motivation is also present.
 - Derivation. It appears to be derived from the wing quivering of juvenile birds (Marler loc. cit.).
 - Function. It is often associated with submissive 'fluffed' postures and it appears to reduce the likelihood of attack from birds approaching or approached (e.g. as in courtship and in food solicitation by juveniles to adults). It allows partners to approach one another closely prior to mounting.
2. Solicitation. Given by the female.
 - Motivation. Largely sexual though the crouching component, an intention movement of flight, suggests the tendency to escape (Marler, loc. cit.).
 - Derivation. Movements of copulation and preparatory movements of flight.
 - Function. Invitation to the male to copulate.
3. Pseudo-female solicitation. Given by the male during copulation sequences and in the post-courtship period. It begins with the first copulation attempts following the acceptance of the nest by the female and thus coincides with the shift in relative dominance in her favour.
 - Motivation. The sexual tendency is in conflict with a strong tendency to escape. Thus it is not found early



in courtship when the male is dominant and highly aggressive. It follows threat by the female and when the male leads the female to the nest (Scheme B, headings E and G).

Derivation. The posture consists of preparatory movements of copulation and flight and evidently shares common causal factors with female solicitation (Hinde 1955-56, p. 15).

Function. Probably the same as wing quivering. It appears also to elicit solicitation by the female. The posture has been observed in many weavers but rarely so frequently as in the Baya. The high level of aggression shown by the female which produces frequent thwarting of the male's mounting attempts is responsible.

V. THE MUTUAL BEHAVIOUR OF MALE AND FEMALE FOLLOWING PAIR FORMATION

Once the pair bond is established and courtship over, the females and males occupy themselves respectively with brooding and the courtship of further prospecting females. In addition the male is zealous in strengthening his nests, in lengthening the tubes, and in defending the territory against the depredations of robbers. The male remains most of his time in the territory, and thus established females frequently encounter him on their journey to and from their nests.

When the two birds meet, a number of alternative sequences may be observed. These are set out in Table VII where the female's behaviour on entering the nest is matched against the male's response. A glance at the totals reveals that 36.6% (i.e. 37 of 101 cases) of females arrived and flew to their nests without showing any particular posturing, 34.6% solicited their mates, 14.9% wing quivered before entering, and 9.9% solicited or wing quivered (35, 15, and 10 cases respectively) even though their mates were at the time not present in the territory. A remaining 4% solicited neighbouring males in the absence of their own. Correspondingly, of the males' responses 33.8% were pseudo-female solicitations (30 times out of 91 cases)¹, 20.1% wing quivering (19 times), and 10.9% aggression (10 cases), i.e. flying to the female at the nest and singing loudly sometimes with lunge, or supplanting. 63.3% of the

¹ On one occasion a male was observed giving pseudo-female solicitation to a male flying past, apparently a case of mistaken identity.

males' pseudo-female solicitations were given to those females that flew directly to their nests without posturing, merely perching a moment and wing flicking (intention movement of flight) before darting up the tube (19 of 30 cases in context), and 33.3% to females that were themselves soliciting (10 cases). Females that wing quivered were solicited by the male rarely and were usually met with wing quivering. Occasionally other neighbouring males also joined in the wing quivering though without approaching near enough to invite an attack from the owner (4 cases). The frequency with which wing quivering was met by the same behaviour in response, and soliciting likewise with soliciting suggests strongly that the male, if he responds, tends to show a similar behaviour pattern to that of the female. However, the male often showed no response at all (26.2% of total male responses) and especially to soliciting females (45.7% of responses in context); yet only in 5 out of 37 cases (i.e. 13.5%) did the male fail to react to a female flying directly to the nest without posturing. Here it is noteworthy that of all the male's aggressive responses 60%, including all four observed supplants, were made against females that showed neither wing quivering nor solicitation on entering the territory.

It is thus clear that, in addition to aggressive responses, courtship postures and solicitation persisted well after the period of their greatest significance during pair formation. The male solicited established females both when they solicited him and when they entered the territory in a sleeked manner. A number of such encounters led to mounting attempts and even to a few apparently fully competent copulations. Some of these took place at a time when the females concerned were actively engaged in feeding young. Both sexes are thus fully potent sexually for a long time after the initial pair formation. Often the male responds to his established female as if she were a prospecting newcomer and especially so if she enters the territory without greeting him (Table VII). Her sleeked posture and wing flicking then resembles the nervous behaviour of a prospecting bird. Sometimes an established female returning in this way is met with advertisement display on the latest helmet stage nest thus suggesting that the male is responding primarily to her posture and that her identity as an individual bird is indistinctly known by him. In a few cases the established female actually responds at once to the male's invitation and visits the nest, pokes about in it, is threatened by the male and so on, exactly in the manner of a freshly arrived bird, and often with food in her beak for the young all the time. Thus not only is the male liable to attack his female and invite her to a fresh nest but the female may also respond with appropriate behaviour, but in relation to her functional role at the time, certainly out of context. All this again is set against the background of repeated threats by the male. We have seen that females entering the territory without

TABLE VII

Tabular representation of behaviour sequences of females and males in territories during brooding and care of young in the nests. (The sequences follow the arrival of the female in the territory. The numbers of male responses recorded are placed against the behaviour of the female on her arrival.)

Behaviour of female on arrival in colony	Male						
	No of sequences observed	Male supplants female	Male gives no response	Male flies about nest, wing quivering	Male flies to or near nest; sings at female	Male gives pseudo female solicitation	Strange male wing quivers with ♀.
Female flies to nest without posturing	37	4	5	7	2	19	..
Female approaches nest, wing quivers to her mate	15	..	3	6	1	1	4
Female approaches nest soliciting her mate, often carrying food for her young at same time	35	..	16	6	3	10	..
Female approaches nest and solicits a male other than her own near her nest; own mate absent at time	4	..	..	..	..	..	4
Female in territory in absence of mate nevertheless shows wing quivering or solicitation	10 (7 are solicitations)	..	..	..	..	..	..
TOTALS	101	4	24	19	6	30	8

posturing in some way to the male are most liable to be molested, either aggressively or sexually. The wing quivering, however, functions as in courtship and reduces the likelihood of a (sexual) attack. Thus the female may usually pass quickly to the nest without the hindrance of the male's provocative solicitations. The male's wing quivering in return reveals the absence of aggression in his welcome. Thus the mutual performance of this posture is of great utility, informing the female that the male will not attack her and the male that she is neither an intruder nor a prospecting female. The strength of the female's tendency to wing quiver or solicit on arrival is indicated by the frequency with which she

performs these patterns even when the male is absent from the territory. In such cases neighbouring males may approach her in attempts at a stolen copulation.

The similarity between these postures and those of late courtship indicates that the same complex of conflicting tendencies is responsible and that the relative dominance of the pair remains unchanged. The persistence of the conflict is due to the continuing sexual potency of the male after his initial courtship and his maintenance of a helmet stage nest in readiness for a fresh mate throughout the whole breeding season. It is thus a feature of the polygamous capacity of the male. It is noteworthy here that the monogamous *Quelea quelea* does not show such intensely sexual greeting behaviour after pair formation, the normal procedure being limited to extensive mutual wing quivering. In other polygamous species [e.g. *P. cucullatus*, *P. (Xanthophilus) aurantius*, and *P. megarhynchus*] solicitation postures are similarly found in both male and female postures in mutual greeting after pair formation. This suggests that where solicitation and pseudo-solicitation are common in courtship they appear also in the greeting behaviour. Thus the relative strengths of the conflicting tendencies (attack, fear, sex) responsible for the postures remain approximately the same both during and after actual pair formation, so long as the male is sexually active in courtship and the pair bond is maintained.

VI. THE BEHAVIOUR OF JUVENILE BIRDS

1. On leaving the nest

Young Bayas are capable of full flight for some twenty to thirty yards on leaving their nest on approximately the fifteenth day (see Ambedkar, in preparation). Frequently during the examination of a nest the young will fly out and flutter off in different directions into the undergrowth. Sometimes, when disturbed, young birds fall into wells and drown. This seems due to a premature departure and does not appear to be a natural occurrence. In spite of attentive watching the natural departure of the young was not observed and very little is known of the role played by the parents at this time. However, one young was seen immediately after its flight from the nest. On the return of the female she fluttered over the young bird and then flew off calling into a near-by stand of sugarcane. The young bird followed it there landing within a few feet of it. The two birds were then lost to view in the dense foliage.

On leaving the colony the young birds scatter and go into dense vegetation. The family does not clump together closely at all and only single juveniles of this age have been seen. One young bird was seen near the Hingane colony shortly after its first flight from the nest and

both parents were seen feeding it. It begged frequently with wing quivering and gave a shrill 'location' call. At greater distances from the colony the young have also been seen sitting still for long periods (up to twenty minutes at least in some cases) and the parents then come and feed them at intervals. The young of one family can generally be located in the same general area although the young are not perched together. One family party was found in dense bushes with a distance of ten to twenty yards separating the three young birds. As the female flies in to feed the young she gives a special *tchrrrrr* which the young birds answer by the 'location' call. As the young become older they begin to flutter more frequently after the parents when they have brought food. They thus begin to show a marked 'following reaction'. One such juvenile was seen pursuing a male as it flew into a tree. The male fed it and flew off about the tree collecting insects. Every few minutes the young would turn toward the parent and flutter towards it landing as if in a supplant attack, exactly on its perch or just beside it. The adult would then usually feed it. In this way the family maintains a loose contact that becomes more effective as the young begin to fly well.

It seems that the young enter flocks when their parents gradually cease responding to their calls. They follow the parents increasingly and gradually mix with other groups. This happens sometime after the 30th day of life. Young birds were seen among adults in flocks, often wing quivering at neighbours, and also among certain other migratory finches (e.g. Blackheaded Bunting, *Emberiza melanocephala*, and Rosefinch, *Carpodacus erythrinus*) common in the Poona area in autumn. When the flock flew off, however, the juveniles often stayed behind not yet showing full social integration with it. Later several juveniles were found together in a group feeding on cereal heads. It is not therefore altogether clear how far the young first form flocks consisting of their own age group alone and how far they integrate directly with adults. Both evidently do occur.

The behaviour of the juveniles on leaving the nest may then be characterised in three stages :

(1) Nest departure and flight from the colony during which the family becomes well scattered.

(2) Sitting still for long periods with little attempt to follow parents.

(3) The following of parents soon develops and leads eventually to the formation of family groups and to joining flocks.

This sequence differs greatly from that followed by juvenile *Quelea* on leaving their nests in Africa. *Quelea* nests are situated in dense thorn bushes and when the young leave them they scramble about the twigs for several days without attempting a single flight. The dense thorns

are a perfect protection and so long as the young birds remain among them they cannot be taken by the various predators that wait beyond it (Morel & Bourlière 1956). While moving about, these youngsters show typical 'contact' behaviour cuddling together and even preening each other (Crook, in press a). Both in the *Quelea* and in the Baya the juveniles eventually join flocks in which 'individual distance' is maintained, but the behaviour prior to this differs markedly in the two species. In each case the behaviour seems to provide maximum possible security for the young. Thus for the *Quelea* the thorns are an effective protection and the young keep together. In the Baya scattering and sitting still, in an environment which is itself in no way protective, seems to be safer than any form of social grouping while the birds are incapable of sustained flight.

2. In the first year

In the first monsoon young male Bayas are busy building nests in sites quite separate from those of the adult birds. Nests of juveniles occur in small groups or in isolation but never in the large clusters typical of adult colonies. The young birds do not build very effectively for often their nests are somewhat aberrant in form. At the structures they sing and advertise but the nests are never accepted by females and never finished. Occasionally young males fly into colonies of adults and hop about the nests there in very sleeked nervous postures. They are soon chased out by the adults present. The main burst of building was seen at the onset of the monsoon, but a second outbreak occurred in October when some second broods of adult Bayas were in the nest. Thus juvenile Bayas were busy at fresh green nests in bushes projecting above sugarcane stands at a time when most adults were flocking after leaving their colonies. At this season the male juvenile weavers are a dull grey colour with blackish beaks and can be distinguished from post-breeding adults and from juveniles of the year.

VII. SUMMARY

1. The reproductive behaviour of the Baya Weaver (*Ploceus philippinus*) was studied in the Poona area of western India in the monsoon seasons of 1958 and 1959. The work continues studies by other authors on the species in India and recent comparative work on weaver bird behaviour in West Africa.

2. Of 35 colonies studied 82.8% were situated over water and of these 65.7% occurred either within wells or in trees over them. Only six active colonies were found away from water. The survival value of colony siting is discussed.

3. The tertiary sex ratio as determined in the breeding colonies was 1 male : 1.44 females. This excludes from consideration the non-breeding population of males in their first year of life.

4. Each male builds enough nests for his females and usually maintains an extra 'helmet stage nest' at which he will court any female arriving late in the colony. The numbers of females per territory are shown in Table II. In Table III the numbers of nests per territory and their stages of construction are shown together with the number of females in the territory.

5. The polygamy of the Baya appears to result from the greater availability of females over males in any one breeding season. This is partly due to the failure of males to breed in the first year. Other factors may be important however as the sex ratio of fledgelings is in favour of the males.

6. Males defend small territories around their nest sites. While at first more than one male may build on a nest, mutual hostility soon develops and trespassing is met with aggressive behaviour, the dominant bird at any one site becoming the owner. Occasionally a male may build two nests at once and sometimes these may be in different parts of the colony. In such cases one nest is eventually abandoned and the male's activity concentrated in one place. The size of the territories is influenced by the frequency of suitable nesting sites in a given area.

7. Experimental modification of territories produced the following results :

- a. When occupied nests are moved closer together during brooding an increase in threatening behaviour between neighbouring males occurs.
- b. If the entrance tube of an occupied nest is tilted so that it opens within the territory of a neighbour, the female owner of the nest cannot enter it nor does the male attempt to fight either member of the pair into whose territory the entrance has been moved. The female of the latter pair however enters it without hesitation. The original owner female is driven out when she attempts to reach her own nest entrance.
- c. Unoccupied nests when moved into a neighbouring territory or placed near another male's nest change ownership.
- d. Displacement of nests confuses the females who become very anxious, showing much wing flickering, and visit neighbouring nests. This causes fights between females. Neighbouring males respond to the wanderings of the females with supplanting attacks and occasionally with sexual 'greetings' both of which the females avoid.
- e. If occupied nests are kept with reduced distances between them the aggressive responses of the males gradually fade and

finally the interactions between the members of the two pairs do not differ from those in unchanged territories. The birds thus adapt themselves quickly to a reduced territory size. The defended area can in fact be reduced to little more than the nest itself.

8. Territories are defended by supplanting attacks, lunges, and Tail depressed Threat. Sequences of aggressive behaviour are analysed and the frequencies of different types related to the contexts in which they occur (see Table V). The occurrence of song is discussed.

9. The pairing process of the Baya occurs in two stages : nest invitation by Advertisement Display and pair bond formation during courtship which includes much sexual chasing. The details of the various displays and other behaviour patterns shown are analysed with comparative reference to the behaviour of other colonial Weavers. The observed behaviour is shown to be due to motivational conflicts between tendencies to respond to the female with sex, attack, and escape. The mutual resolution of these conflicts leads to copulation and pair formation. The detailed descriptive data are shown in Schemes A, B, and C which are further analysed and discussed in the text.

10. Following pair formation, behaviour identical with that shown in the final stages of courtship appears in the 'greeting' responses between male and established female whenever they meet in their territory. These may include actual courtship sequences and even copulations. The relative strengths of the conflicting tendencies responsible for the postures remain approximately the same after pair formation so long as the male is sexually active in the courtship of fresh females and the earlier pair bonds are maintained.

11. Juvenile birds scatter on leaving the nest and sit still for long periods during which the parents come and feed them. As their flight improves they begin to follow their parents and gradually form loose family groups. These eventually join flocks of other juveniles or mixed flocks of juveniles and adults.

12. In their first monsoon season juvenile males build nests in sites separated from those of adult birds. The colonies of juveniles are small and often isolated nests built by them are seen. Their nest building is defective and females never accept their nests although they may visit them. First year males in early autumn can be distinguished in the field both from breeding females and the young of the year.

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the assistance given me by numerous persons throughout the course of these studies. Indeed they would not have been possible without the kindly help I never failed to receive in India.

Dr. Sálím Ali, in particular, has taken a great personal interest in the work at all stages and his detailed knowledge of the species has been a great source of information and renewed initiative. The use of his extensive library whenever required was a kindness I especially appreciated. It was largely due to Dr. Ali that my visit to India became possible and without his help and advice it would have been most difficult to obtain satisfactory results. The success of this endeavour is thus primarily due to him.

Mr. Vijaykumar Ambedkar introduced me to the various colonies around Poona and took part in the investigation at various stages. His assistance in the field on many occasions and his willingness to act as an interpreter helped me greatly at all times. He is at present continuing to work on the breeding biology of the Baya in western India.

On my arrival in Poona Dr. Telford Work, Director of the Virus Research Centre, helped me greatly with certain administrative problems and allowed me to construct aviaries in his garden. Through his assistance I was able to make use of the V.R.C. facilities in numerous practical respects and to benefit greatly, at a later stage, from the help and friendship of his successor Dr. C. Anderson. Dr. Harold Trapido and Dr. Raja Varma also took an interest in the work and were always ready with suggestions and assistance. It was a pleasure to be associated with the work of the V.R.C. on several occasions during my stay.

Mr. John Goatly, regional representative of the British Council in Bombay, gave me much valuable information both before and during my visit to India and did much to help me on several occasions.

I have been in constant correspondence with Dr. W. H. Thorpe, F.R.S., and Dr. Robert Hinde, both of the Zoology Department, Cambridge University. Their continuing advice and encouragement has been of the greatest value. The work is part of a series of Weaver Bird studies financed by the Department of Scientific and Industrial Research, London.

REFERENCES

- Ali, Sálím (1930): The nesting habits of the Baya (*Ploceus philippinus*). *J. Bombay nat. Hist. Soc.* 34 : 947-964.
- (1956): Crows and Weaver Birds—Ratiocination or what? *ibid.* 53 : 470-472.
- & Ambedkar, V. C. (1956): Notes on the Baya Weaver Bird, *Ploceus philippinus*. *ibid.* 53 : 381-389.
- (1957): Further Notes on the Baya Weaver Bird, *Ploceus philippinus*. *ibid.* 54 : 491-502.
- Ali Sálím & Crook, J. H. (1960): Observations on Finn's Baya (*Ploceus megarhynchus* Hume) re-discovered in the Kumaon Terai, 1959. *ibid.* 56 : 457-483.
- Ambedkar, V. C. (1958): Notes on the Baya: Breeding season 1957. *ibid.* 55 : 100-106.
- Andrew, R. (1957): The aggressive and courtship behaviour of certain Emberizidae. *Behaviour* 10 : 255-308.
- Crook, J. H. (1958): Comparative Ethology and Social Organisation of the Weaver Birds. (Ph.D. Thesis). Cambridge University Library.

- Crook, J. H. (1959) : Behaviour Study and the classification of West African Weaver Birds. *Proc. Linn. Soc. Lond.*, 170 Session, 1957-58, pt. 2 : 147-153.
- (1960) : Nest Form and Construction in West African Weaver Birds. *Ibis* : 102 (1) : 1-25.
- a : Studies on the Social Behaviour of *Quelea q. quelea* in French West Africa. *Behaviour* (in press).
- b : Comparative studies on the reproductive behaviour of two colonial Weaver bird species (*Ploceus cucullatus* and *P. castaneofuscus/nigerrimus*; subfamily Ploceinae) in West Africa. *Ibis* (in press).
- Hediger, H. (1950) : Wild Animals in Captivity. London.
- Hinde, R. A. (1952) : The behaviour of the Great Tit (*Parus major*) and other related species. *Behaviour* supp. 2.
- (1953) : The conflict between Drives in the Courtship and Copulation of the Chaffinch. *ibid.* supp. 5: 1-31.
- (1955-56) : A comparative study of the courtship of certain Finches (Fringillidae) *Ibis* 97 : 706-754, 98 : 16-23.
- Lack, D. (1954) : The natural regulation of Animal Numbers. Oxford.
- Marler, P. (1956) : Behaviour of the Chaffinch, *Fringilla coelebs*. *Behaviour* supp. 5.
- Morel, G. & Bourlière, F. (1956) : Recherches écologiques sur les *Quelea q. quelea* (L.) de la basse vallée du Sénégal. II La reproduction. *Alauda* 25. No. 2. 6-93.

SCHEME A. BEHAVIOUR SEQUENCES DURING NEST INVITATION

COLONIES IN POONA AREA, JULY-AUGUST 1958

FEMALE BEHAVIOUR,

141.

Female flies into the colony and approaches the nests finally alighting in the initial ring of one of them.

While at the nest the female is sleeked, she often peers about, makes shaping movements, pokes about in the fabric, and either flies off when she wishes or is driven off by the male.

MALE BEHAVIOUR.

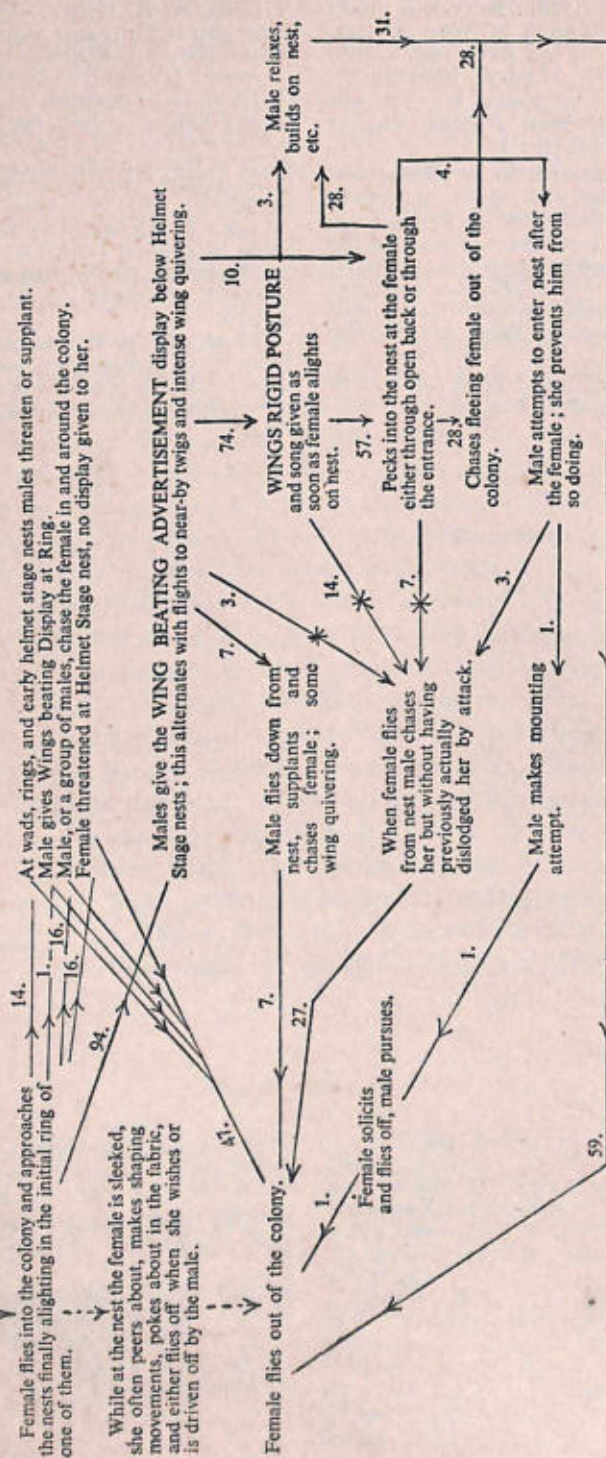
At wads, rings, and early helmet stage nests males threaten or supplant.

Male gives Wings beating Display at Ring.

Male, or a group of males, chase the female in and around the colony.

Female threatened at Helmet Stage nest, no display given to her.

Males give the **WING BEATING ADVERTISEMENT** display below Helmet Stage nests; this alternates with flights to near-by twigs and intense wing quivering.

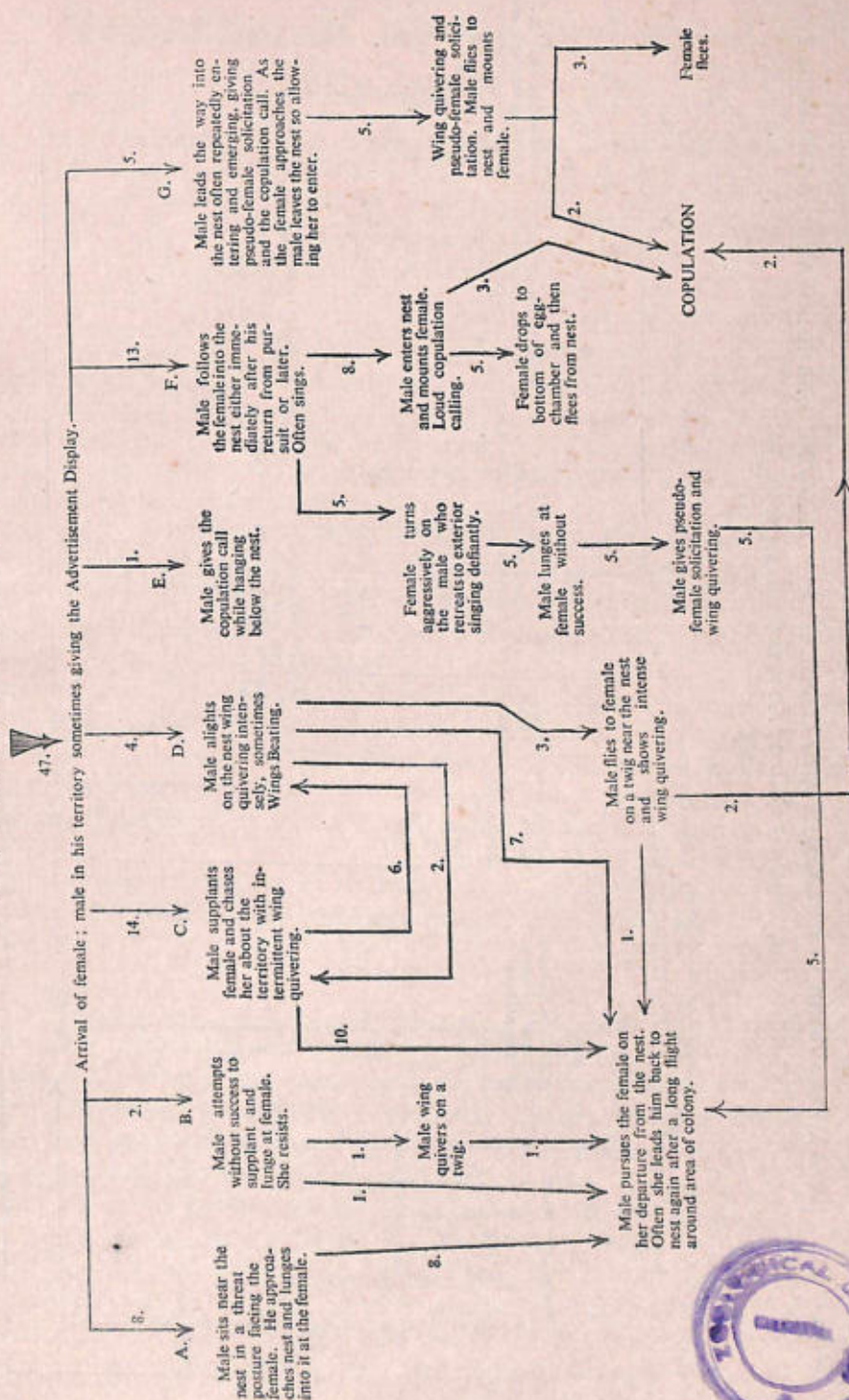


* See Text, p. 24

(NOTE.—The Scheme is read in the following way : 141 sequences of behaviour have been observed. All start with the females' arrival and then pass through various changes, dependent on the males' varying responses, until her eventual departure. Thus following the arrival of a female at a helmet stage nest the male gave the Advertisement display 94 times and this was followed 74 times by the Wings rigid posture. And so on, see further in text.)

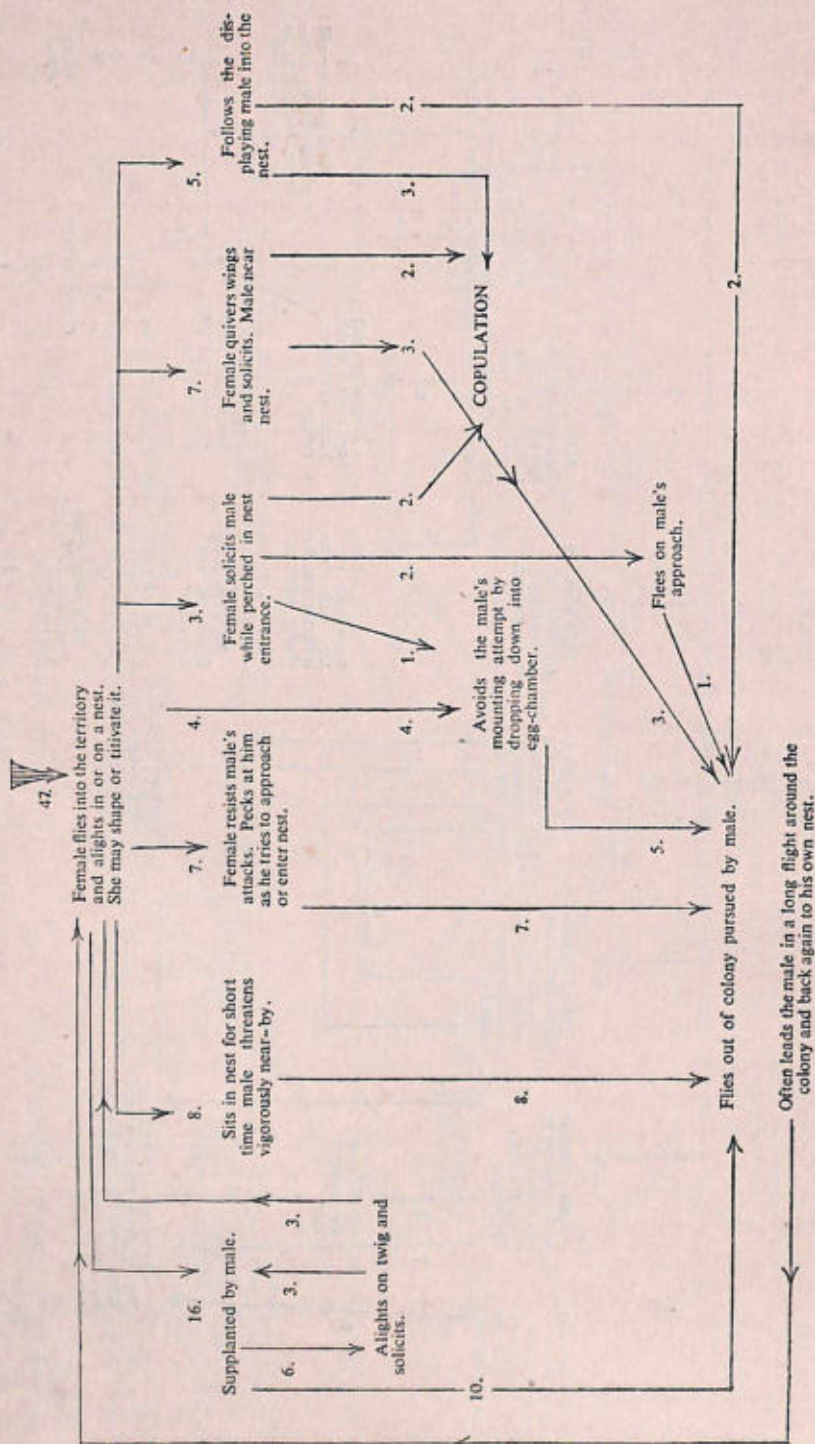
SCHEME B. MALE BEHAVIOUR DURING COURTSHIP AND COPULATION FOLLOWING THE ARRIVAL OF
A FEMALE IN HIS TERRITORY

HINGANE COLONY, AUGUST 6TH-8TH, 1958



SCHEME C. FEMALE BEHAVIOUR IN COURTSHIP AND COPULATION FOLLOWING HER ARRIVAL IN A TERRITORY

HINGANE COLONY, AUGUST 6TH-8TH, 1958



Vegetation of Kodaikanal in South India

I. Systematic list of Trees, Shrubs, and Herbs

BY

RAJ KUMAR GUPTA M.SC.
French Institute, Pondicherry

INTRODUCTION

Kodaikanal is a beautiful health resort in south India, situated on the southern crest of the Palni plateau in Madurai district, and is visited by numerous tourists, naturalists, and students every year. The height of Kodaikanal is about 6900 ft. while the surrounding hills do not rise beyond 7-8000 ft.

The name 'Kodaikanal' is derived from the hanging woods situated on the inner side of the basin, the top of which was previously a swamp but was formed into a lake by banking up the stream in 1863. The shape of the lake is like that of a starfish and is about 3 miles round when measured along the level of the road on its margins.

Earlier noteworthy collections from the Palnis have been made by Robert Wight, Lady Bourne, Sir Alfred Fyson, and Gamble. More recently Fr. Pallithanam (1957) gave an account of some of his observations on the flora of Kodaikanal. The present paper gives an account of the plants collected from the area during the author's visit to this hill station.

The floristic composition and status of the shola-grassland formation have been discussed by the author in a separate communication.¹

VEGETATION

The natural vegetation is of Southern Wet Temperate Forests (Champion 1936) commonly called the *sholas*, which have suffered at the hands of man to a great extent with the result that they are confined to the folds of the hills and have practically vanished except at places where they have been protected by the Forest Department. There are vast stretches of grassland extending all over the area.

Certain exotic species, such as *Acacia decurrens* Willd., *Acacia dealbata* Link., *Acacia melanoxylon* R. Br., *Eucalyptus citriodora* Hook. f., *Eucalyptus filicifolia* F. M. V., *Eucalyptus globulus* Labill., *Pinus insignis* Dunel., *Pinus roxburghii* Sarg., have been planted so as to make the spot attractive for tourists. As many as 35 species of *Eucalyptus* have been

¹ Ecological Notes on the Vegetation of Kodaikanal. *J. Ind. Bot. Soc.* 39 (in press).

enumerated by Pallithanam (1957). Other exotic plants that have become naturalised in the area are *Cytisus scoparius* Link, *Ulex europaeus* Linn., *Eupatorium glandulosum* H. B. & K., etc. and are found as roadside plants and in the grasslands.

The Bombay and the Tiger sholas have been preserved by the Forest Department from cutting and lopping. Common plants met with in the sholas are *Eugenia calophyllifolia* Wight, *Eugenia arnottiana* Wight, *Ternstroemia japonica* Wight, *Sideroxylon tomentosum* Roxb., *Meliosma wightii* Wall., *Elaeocarpus tuberculatus* Roxb., *Symplocos spicata* Roxb., *Rhododendron nilagiricum* Zenck. There are numerous shrubs, such as *Impatiens phoenicea* Beddome, *Mallotus albus* Muell., *Gaultheria fragrantissima* Wall., *Lobelia excelsa* Lesch., *Berberis tinctoria* Lesch., that cover the ground. There is heavy leaf litter and mould, which when compressed with the hand may measure 3 to 4 inches.

In the grasslands common species present are *Eragrostis nigra* Nees, *Cymbopogon confertiflorus* Stapf, *Andropogon micranthus* Kunth., *Chrysopogon wightianus* Nees, *Brachypodium sylvaticum* Beauv., etc. These grasslands are invaded by a number of species from the roadsides, such as *Osbeckia wightiana* Benth., *Rhododendron nilagiricum* Zenck., *Erigeron linifolius* Willd., *Rhodomyrtus tomentosa* Wight. Other roadside plants, such as *Lycopodium cernuum* Linn., *Helichrysum bracteatum* Andr., *Crotalaria scabrella* Wight & Arn., *Alysicarpus rugosus* DC., *Dipsacus leschenaultiana* Coult., *Anaphalis beddomei* Hook. f., *Ageratum conyzoides* Linn., *Artemisia nilagirica* Pamp., *Taraxacum officinale* Linn., *Wahlenbergia gracilis* DC., *Swertia corymbosa* Wight, *Cynoglossum furcatum* Wall., *Verbascum thapsus* Linn. are not uncommon in these grasslands.

LIST OF THE PLANTS COLLECTED

The plants given in the following list have been collected from the area and are preserved in the herbarium of the French Institute at Pondicherry. The nomenclature followed is the one given by Fyson except for some recent nomenclatural changes as given by Raizada (1958). After the name of each plant, whenever possible, reference is given to Fyson's FLORA. Thus *Naravelia zeylanica* DC. (Fyson 1 : 4) means that this plant is described in Fyson's FLORA OF THE SOUTH INDIAN HILL STATIONS Vol. 1, page 4. Plants marked with an asterisk have not been described by Fyson.

Ranunculaceae

Naravelia zeylanica DC. (Fyson 1 : 4)

A climbing shrub with numerous white flowers in compound panicles. Climber in sholas.

Ranunculus muricatus Linn. (Fyson 1 : 3)

A small herb with broad leaves and with conspicuous spines on achenes. Flowers yellow. From Kodaikanal near a stream.

Ranunculus subpinnatus Wight & Arn. (Fyson 1 : 7)

An erect tufted herb with large yellow flowers. Between 6000-7500 ft. Kodaikanal.

Magnoliaceae**Michelia champaca** Linn. (Fyson 1 : 11)

A tall tree with fragrant yellow flowers. Between 3000-5500 ft. near Kodaikanal, occasionally found in gardens.

Berberidaceae**Berberis tinctoria** Leschenault. (Fyson 1 : 15)

A shrub with yellow flowers in drooping racemes. The plant is not similar to *Berberis aristata* found in the western Himalayas

Mahonia leschenaultii Takeda. (Fyson 1 : 16)

A big shrub with slender or stout branches. Sometimes almost a tree. Flowers yellow in dense terminal racemes or spikes.

Nymphaeaceae**Nymphaea stellata** Willd. (Fyson 1 : 18)

An aquatic herb with blue flowers. The only species seen by me in the Kodaikanal lake.

Cruciferae***Lobularia maritima** Desv.

A cultivated herb growing in the garden of La Providence.

***Cheiranthus cheiri** Linn.

A cultivated herb grown for the flowers.

Violaceae**Viola partrinii** DC. (Fyson 1 : 26)

A small herb with stout rootstock and white flowers. Common in the open downs, in grasses in shady places ; also in the Himalayas.

Bixaceae

**Cochlospermum gossypium* DC.

A small tree with tomentose branchlets with a few golden yellow flowers. Common on the roadsides in the lower hills.

Scolopia crenata Clos. (Fyson 1 : 28)

A tree with brown young branches and yellow flowers in racemes. Common on the roadsides at lower levels.

Polygalaceae

Polygala javanica DC. (Fyson 1 : 34)

A small loosely-branched undershrub. Flowers with yellow wings and pink keel. Common on Kodaikanal hills.

Polygala sibirica Linn. (Fyson 1 : 35)

A small herb with many stems and pinkish flowers in short racemes from the axils of upper leaves. Very common on the cattle tracts in grasses at 7000 ft.

Hypericaceae

Hypericum mysorense Heyne. (Fyson 1 : 46)

A shrub with four-angled wings and yellow flowers at the end of branches solitary or in threes. Very common on the roadsides invading grasslands on poor soils.

Ternstroemiaceae

Eurya japonica Thunb. (Fyson 1 : 53)

A big tree with straight stem. Flowers pale yellow, fragrant, from the axils of fallen leaves. Common in the sholas, also found in the western Himalayas.

Sterculiaceae

**Waltheria indica* Linn.

A perennial villous herb with yellow flowers at 5000 ft. in Kodaikanal.

Elaeocarpaceae

**Elaeocarpus tuberculatus* Roxb.

A tree with leaves glabrous above and hairy along the nerves beneath. Flowers yellow, petals silky outside, in racemes. A common tree of the sholas.

Elaeocarpus ferrugineus Wight. (Fyson 1 : 65)

A tree with brownish green foliage. Leaf like an inverted boat. Flowers in racemes. Common in the sholas at high levels.

Elaeocarpus oblongus Gaertner. (Fyson 1 : 65)

A middle-sized tree with white stem, twigs with conspicuous lenticels. Flowers with white petals in racemes in the axils of fallen leaves. Very common in the sholas near Kodaikanal at 6000 ft.

Geraniaceae***Pelargonium zonale** Ait.

A herb commonly cultivated for its flowers in gardens.

***Pelargonium graveolens** L'Her.

A fragrant-leaved bushy plant, cultivated in gardens for its flowers.

Oxalis tetraphylla Cav. (Fyson 1 : 74)

Herb with four leaflets. Flowers pink or red on the upper side and white on the lower. A common weed at 7000 ft.

Biophytum candolleianum Wight. (Fyson 1 : 77)

A small woody plant with yellow flowers. Common in shady places at 6000 ft.

Impatiens phoenicea Cav. (Fyson 1 : 96)

A slender herb with dark green elliptic leaves and red flowers. Common plant in the sholas.

Impatiens tomentosa Heyne. (Fyson 1 : 88)

A branched herb with yellowish white flowers having magenta-coloured wings spotted with dark purple near the crimson base. Quite common on the downs at 7000 ft.

Rutaceae**Toddalia asiatica** Lamk. (Fyson 1 : 100)

A prickly shrub with white flowers in close axillary corymbose panicles. Very common in the sholas extending down to the plains in dry forests.

***Atalantia ceylanica** Oliv.

A shrub, armed with prickly spines. Leaflets notched. Flowers shortly racemed. Common in the lower hill near Kodaikanal.

Meliaceae

Toona ciliata Roem. Syn. *Cedrela toona* Roxb. (Fyson 1 : 105)

A handsome tree with large pinnate leaves ; flowers white in axillary branched panicles. A dominant tree of the low level sholas at 5000 ft. below Kodaikanal. Also found in the Himalayas.

Aquefoliaceae

* **Ilex malabarica** Bedd.

A large glabrous tree with narrowly elliptic oblong leaves. Male flowers in shortly paniced umbellules. In the sholas at low level.

Celastraceae

Euonymus crenulatus Wall. (Fyson 1 : 110)

A small tree with yellowish green leaves and purplish brown flowers. Quite common in the sholas.

Rhamnaceae

Zizyphus rugosa Lamk. (Fyson 1 : 117)

A large straggling shrub armed with solitary curved spines. Flowers greenish yellow in long peduncled cymes on leafless branches. On roadsides at 6500 ft.

Sapindaceae

Dodonaea viscosa Linn. (Fyson 1 : 128)

A shrub with lenticelled stem and flowers in terminal cymose branches. In open places and edges of the sholas below Kodaikanal.

* **Sapindus emarginatus** Vahl.

A moderate-sized tree with pinnate leaves. Flowers white axillary or terminal. Common near Kodaikanal in the low level sholas.

Anacardiaceae

* **Buchanania angustifolia** Roxb.

A tree with black brown bark, tesellated with deep irregular cracks. Common in the forests of lower hills.

Sabiaceae

Meliosma wightii Planch. (Fyson 1 : 130)

A tree with dark green foliage and cream-coloured flowers in branched panicles. Common tree in the sholas on Kodaikanal downs.

Meliosma microcarpa. (W. A.) Craib. Syn. *Meliosma arnottiana* Wight. (Fyson 1 : 131)

A round-topped tree with dark green foliage with broad cream-coloured bases of flowers. Common tree in the sholas at 5000 ft.

Leguminosae

Cytisus scoparius Link. (Fyson 1 : 138)

A herb with very dark green foliage and solitary yellow flowers in the axils of the leaves. A very common herb on the roadsides invading the grasslands.

Crotalaria fysonii Dunn. (Fyson 1 : 144)

A small plant with large yellow flowers at the end of branches. Common on the roadsides spreading over paths and cattle tracts.

Crotalaria scabrella Wight & Arn. (Fyson 1 : 141)

A small shrub with hard, stiff branches and yellow flowers. On roadsides in long grass on the open downs.

Crotalaria semperflorens Vent. (Fyson 1 : 149)

A shrub with large ear-shaped stipules and yellow flowers in spikes. Common on the roadsides and edges of the sholas above Kodaikanal.

***Alysicarpus rugosus** DC.

An ascending herb with glabrous stem; leaflets 3. Flowers in dense racemes. Pods 3-5 jointed.

Dumasia villosa DC. (Fyson 1 : 165)

A climber with 3-foliate leaves and yellow flowers in short racemes. On the downs in sholas.

Trifolium repens Linn. (Fyson 1 : 153)

A herb with white flowers in heads. Cultivated for animal food, here as an escape.

Mucuna hirsuta Wight & Arn. (Fyson 1 : 166)

A climbing herb with obliquely ovate leaves. Flowers reddish purple. Fruit densely covered with hairs, having irritating properties.

Ulex europaeus Linn. (Fyson 1 : 136)

A thorny shrub with bright yellow flowers. Very common on the roadsides, as an escape and spreading quickly.

Acacia melanoxylon R. Br. (Fyson 1 : 186)

A tree 50-75 ft. planted everywhere on the roadsides.

Bixaceae

**Cochlospermum gossypium* DC.

A small tree with tomentose branchlets with a few golden yellow flowers. Common on the roadsides in the lower hills.

Scolopia crenata Clos. (Fyson 1 : 28)

A tree with brown young branches and yellow flowers in racemes. Common on the roadsides at lower levels.

Polygalaceae

Polygala javanica DC. (Fyson 1 : 34)

A small loosely-branched undershrub. Flowers with yellow wings and pink keel. Common on Kodaikanal hills.

Polygala sibirica Linn. (Fyson 1 : 35)

A small herb with many stems and pinkish flowers in short racemes from the axils of upper leaves. Very common on the cattle tracts in grasses at 7000 ft.

Hypericaceae

Hypericum mysorense Heyne. (Fyson 1 : 46)

A shrub with four-angled wings and yellow flowers at the end of branches solitary or in threes. Very common on the roadsides invading grasslands on poor soils.

Ternstroemiaceae

Eurya japonica Thunb. (Fyson 1 : 53)

A big tree with straight stem. Flowers pale yellow, fragrant, from the axils of fallen leaves. Common in the sholas, also found in the western Himalayas.

Sterculiaceae

**Waltheria indica* Linn.

A perennial villous herb with yellow flowers at 5000 ft. in Kodaikanal.

Elaeocarpaceae

**Elaeocarpus tuberculatus* Roxb.

A tree with leaves glabrous above and hairy along the nerves beneath. Flowers yellow, petals silky outside, in racemes. A common tree of the sholas.

Elaeocarpus ferrugineus Wight. (Fyson 1 : 65)

A tree with brownish green foliage. Leaf like an inverted boat. Flowers in racemes. Common in the sholas at high levels.

Elaeocarpus oblongus Gaertner. (Fyson 1 : 65)

A middle-sized tree with white stem, twigs with conspicuous lenticels. Flowers with white petals in racemes in the axils of fallen leaves. Very common in the sholas near Kodaikanal at 6000 ft.

Geraniaceae***Pelargonium zonale** Ait.

A herb commonly cultivated for its flowers in gardens.

***Pelargonium graveolens** L'Her.

A fragrant-leaved bushy plant, cultivated in gardens for its flowers.

Oxalis tetraphylla Cav. (Fyson 1 : 74)

Herb with four leaflets. Flowers pink or red on the upper side and white on the lower. A common weed at 7000 ft.

Biophytum candolleianum Wight. (Fyson 1 : 77)

A small woody plant with yellow flowers. Common in shady places at 6000 ft.

Impatiens phoenicea Cav. (Fyson 1 : 96)

A slender herb with dark green elliptic leaves and red flowers. Common plant in the sholas.

Impatiens tomentosa Heyne. (Fyson 1 : 88)

A branched herb with yellowish white flowers having magenta-coloured wings spotted with dark purple near the crimson base. Quite common on the downs at 7000 ft.

Rutaceae**Toddalia asiatica** Lamk. (Fyson 1 : 100)

A prickly shrub with white flowers in close axillary corymbose panicles. Very common in the sholas extending down to the plains in dry forests.

***Atalantia ceylanica** Oliv.

A shrub, armed with prickly spines. Leaflets notched. Flowers shortly racemed. Common in the lower hill near Kodaikanal.

Meliaceae

Toona ciliata Roem. Syn. *Cedrela toona* Roxb. (Fyson 1 : 105)

A handsome tree with large pinnate leaves ; flowers white in axillary branched panicles. A dominant tree of the low level sholas at 5000 ft. below Kodaikanal. Also found in the Himalayas.

Aquefoliaceae

* **Ilex malabarica** Bedd.

A large glabrous tree with narrowly elliptic oblong leaves. Male flowers in shortly paniced umbellules. In the sholas at low level.

Celastraceae

Euonymus crenulatus Wall. (Fyson 1 : 110)

A small tree with yellowish green leaves and purplish brown flowers. Quite common in the sholas.

Rhamnaceae

Zizyphus rugosa Lamk. (Fyson 1 : 117)

A large straggling shrub armed with solitary curved spines. Flowers greenish yellow in long peduncled cymes on leafless branches. On roadsides at 6500 ft.

Sapindaceae

Dodonaea viscosa Linn. (Fyson 1 : 128)

A shrub with lenticelled stem and flowers in terminal cymose branches. In open places and edges of the sholas below Kodaikanal.

* **Sapindus emarginatus** Vahl.

A moderate-sized tree with pinnate leaves. Flowers white axillary or terminal. Common near Kodaikanal in the low level sholas.

Anacardiaceae

* **Buchanania angustifolia** Roxb.

A tree with black brown bark, tessellated with deep irregular cracks. Common in the forests of lower hills.

Sabiaceae

Meliosma wightii Planch. (Fyson 1 : 130)

A tree with dark green foliage and cream-coloured flowers in branched panicles. Common tree in the sholas on Kodaikanal downs.

Meliosma microcarpa. (W. A.) Craib. Syn. *Meliosma arnottiana* Wight. (Fyson 1 : 131)

A round-topped tree with dark green foliage with broad cream-coloured bases of flowers. Common tree in the sholas at 5000 ft.

Leguminosae

Cytisus scoparius Link. (Fyson 1 : 138)

A herb with very dark green foliage and solitary yellow flowers in the axils of the leaves. A very common herb on the roadsides invading the grasslands.

Crotalaria fysonii Dunn. (Fyson 1 : 144)

A small plant with large yellow flowers at the end of branches. Common on the roadsides spreading over paths and cattle tracts.

Crotalaria scabrella Wight & Arn. (Fyson 1 : 141)

A small shrub with hard, stiff branches and yellow flowers. On roadsides in long grass on the open downs.

Crotalaria semperflorens Vent. (Fyson 1 : 149)

A shrub with large ear-shaped stipules and yellow flowers in spikes. Common on the roadsides and edges of the sholas above Kodaikanal.

***Alysicarpus rugosus** DC.

An ascending herb with glabrous stem; leaflets 3. Flowers in dense racemes. Pods 3-5 jointed.

Dumasia villosa DC. (Fyson 1 : 165)

A climber with 3-foliate leaves and yellow flowers in short racemes. On the downs in sholas.

Trifolium repens Linn. (Fyson 1 : 153)

A herb with white flowers in heads. Cultivated for animal food, here as an escape.

Mucuna hirsuta Wight & Arn. (Fyson 1 : 166)

A climbing herb with obliquely ovate leaves. Flowers reddish purple. Fruit densely covered with hairs, having irritating properties.

Ulex europaeus Linn. (Fyson 1 : 136)

A thorny shrub with bright yellow flowers. Very common on the roadsides, as an escape and spreading quickly.

Acacia melanoxylon R. Br. (Fyson 1 : 186)

A tree 50-75 ft. planted everywhere on the roadsides.

Acacia decurrens Willd. (Fyson 1 : 186)

The plant is commonly planted everywhere near Kodaikanal.

Acacia dealbata Link. (Fyson 1 : 186)

A plant cultivated all around Kodaikanal.

Rosaceae

Rubus racemosus Roxb. (Fyson 1 : 195)

A shrub with branches and inflorescence covered with glandular hairs. Flowers white. On the downs at Kodaikanal.

Rubus ellipticus Smith. (Fyson 1 : 193)

A shrub covered with white tomentum. Flowers yellow. In open downs near Kodaikanal; also common in the Himalayas.

Fragaria indica Andr. (Fyson 1 : 197)

Herb with slender runners and yellow flowers. Common at Kodaikanal and in the Himalayas near water in shady place.

Myrtaceae

Baeckea virgata Anders. (Fyson 1 : 216)

A loosely-branched shrub with flowers in the upper axils at Kodaikanal 7000 ft.

***Syzygium cumini** (Linn.) Skeels. Syn. *Eugenia jambolana* (Fyson 1 : 222 under *Syzygium jambolanum*)

A large spreading tree with numerous flowers in cymes. Common tree of the sholas below Kodaikanal.

Eucalyptus globulus Labill. (Fyson 1 : 217)

A tree cultivated extensively near Kodaikanal.

Eucalyptus citriodora Hook. (Fyson 1 : 217)

A tree with drooping branches and slender leaves. Cultivated near Kodaikanal.

Eucalyptus filicifolia F.M.V. (Fyson 1 : 217)

A small tree with finely pointed leaves and red flowers. Cultivated near Kodaikanal.

Rhodomyrtus tomentosa Wight. (Fyson 1 : 218)

A round-topped shrub with green foliage and pink flowers in cymose axillary corymbs. Common on the roadsides and dry slopes.

Melastomaceae

Osbeckia wightiana Benth. (Fyson 1 : 226)

A shrub with hairs on the branches. Flowers purple. Common on the roadsides and downs up to 4000 ft.

Onagraceae

Fuchsia corymbiflora Ruiz & Pav. (Fyson 1 : 237)

A shrub cultivated in the gardens at Kodaikanal.

Passifloraceae

Passiflora leschenaultii DC. (Fyson 1 : 240)

A climber with semicircular leaves and white flowers. Common on the shola trees.

Umbelliferae

Bupleurum distichophyllum Wight & Arn. (Fyson 1 : 251)

A herb with grass-like leaves and yellow flowers on open downs above Kodaikanal.

Bupleurum mucronatum Wight & Arn. (Fyson 1 : 250)

A herb with linear-oblong leaves and yellow flowers at 7000 ft. The plant is different from *B. falcatum* found in the Himalayas.

Heracleum sprengelianum Wight & Arn. (Fyson : 1 : 257)

A large herb with yellow flowers and elliptic mericarps. In the grass on the downs.

Heracleum ceylanicum Gard. (Fyson 1 : 256)

Herb with longer than broad leaves and pure white flowers. In the moist valleys.

Araliaceae

Schefflera racemosa Harms. (Fyson 1 : 260)

A medium-sized tree with 7-9 leaflets spreading star-like and white flowers in axillary compound spikes. Common in the sholas.

Caprifoliaceae

Viburnum erubescens Wall. (Fyson 1 : 265)

A roadside shrub with white-barked branches and cream-coloured flowers.

Viburnum coriaceum Blume. (Fyson 1 : 263)

A small tree with lenticelled twigs and yellowish white flowers. On the downs below and above Kodaikanal.

Rubiaceae

Oldenlandia stylosa O.Kze. (Fyson 1 : 272)

A shrub with flexuous branches and white flowers. In cool and shady places near sholas.

Oldenlandia articularis Gamble (Fyson 1 : 272)

Shrub with narrow leaves and white flowers in terminal compact cymes. In shady places on the downs.

Oldenlandia swertioides O.Kze. (Fyson 1 : 273)

A shrub with stiff ovate leaves and flowers in dense pubescent cymes. Common on the downs above Kodaikanal.

***Anotis calycina** Hook.f.

A small herb covered with soft hairs. Flowers white in terminal cymes with a pair of leaves just below. In moist and shady places.

Anotis wightiana Wall. (Fyson 1 : 276)

A perennial herb clothed with soft curly hairs. Flowers white-blue, shortly pedicelled; at 6000 ft. at Kodaikanal.

Psychotria congesta Wight & Arn. (Fyson 1 : 287)

A glabrous shrub with oblanceolate leaves and white flowers in terminal panicles. Common shrub in sholas, in downs.

Rubia cordifolia Linn. (Fyson 1 : 294)

A slender climbing herb. Flowers in axillary cymes on short axillary branches. Common in thickets at Kodaikanal.

Galium asperifolium Wall. (Fyson 1 : 295)

A herb with rough and 4-angled stems climbing on bushes. Flowers small. Above Kodaikanal on the downs.

Mussaenda hirsutissima Hutch. (Fyson 1 : 279)

A hairy shrub. Sepals white leaf-like. Corolla orange-brown. Abundant on lower slopes up to 6000 ft.

Dipsaceae

Dipsacus leschenaultiana Coult. (Fyson 1 : 298)

A large herb. Stems hollow. Flowers whitish in heads. Above Kodaikanal in downs. Flowers not seen. In the Himalayas another species, *Dipsacus inermis*, is very common at the same altitude.

Compositae

Vernonia conyzoides DC. (Fyson 1 : 313)

A low herb usually unbranched till near flowering region. Heads few in spreading corymbs. Below Kodaikanal near the sholas.

Vernonia monosis Benth. (Fyson 1 : 308)

A tree with densely tomentose young parts. Flowers mauve coloured. In sholas at Kodaikanal at 7000 ft., commonly on the borders.

Vernonia saligna DC. (Fyson 1 : 312)

A herb with numerous heads in branched rounded cymes. Downs just below Kodaikanal.

Anaphalis neelgerriana DC. (Fyson 1 : 334)

A herb, leaves bluish white coated with soft white cotton. Heads in open corymbose panicles. Common on roadsides. There are several other species of *Anaphalis* in the Himalayas, but not the ones in Kodaikanal.

Anaphalis beddomei Hook. f. (Fyson 1 : 328)

A decumbent herb with branches curving upwards. Flower heads in small corymbs on peduncles. Common on the downs at Kodaikanal.

Anaphalis leptophylla DC. (Fyson 1 : 333)

A herb with linear leaves. Heads pure white with yellow centre. In damp and shady places near Kodaikanal.

Ageratum conyzoides Linn. (Fyson 1 : 315)

A hairy herb with light purple florets. Common on roadsides.

**Myriactis wallichii* DC.

A small herb with oblanceolate leaves and yellow heads. Near Kodaikanal, common.

Conyza ambigua DC. (Fyson 1 : 322)

A herb with narrow linear leaves. Heads with pale florets. A common weed.

Bidens pilosa Linn. (Fyson 1 : 339)

An erect herb with four-angled stem and three-foliate leaves. Flowering portion forked cymosely, involucre bracts with scarious margins. Ray florets yellow or white. A roadside weed.

Gnaphalium hypoleucum DC. (Fyson 1 : 334)

A herb with lanceolate leaves. Flowers golden coloured.



***Cnicus wallichii** DC.

An erect herb with spine-toothed leaves, decurrent down the stem. Florets purple, tubular, in terminal heads on short axillary, leafy branches, forming a terminal corymbose panicle. Near golf links.

Moonia heterophylla Arn. (Fyson 1 : 337)

An annual herb. Flower heads in irregular umbels. Ray florets white, inner yellow. Common in sholas.

Artemisia nilagirica Pamp. (Fyson 1 : 341) (= *A. vulgaris* Auct., non Linn.)

Herbs with leaves white tomentose on under surface. All florets fertile. Common in Kodaikanal downs in dense patches.

Artemisia parviflora Roxb. (Fyson 1 : 342)

A shrub-like herb with small heads and few florets. Common in downs.

Taraxacum officinale Linn. (Fyson 1 : 356)

A herb with strong rootstock, florets yellow in solitary heads on hollow scapes. A common weed at Kodaikanal and in the Himalayas up to 10,000 ft.

Erigeron mucronatum DC. (Fyson 1 : 320)

A herb with slender branches. Flower heads solitary, terminal, white when young, pinkish when old. Kodaikanal, on roadsides.

Siegesbeckia orientalis Linn. (Fyson 1 : 338)

Pubescent herb. Heads terminal. Florets yellow.

Galinsoga parviflora Roxb. (Fyson 1 : 339)

An annual herb with small heads on slender stalks of unequal length. Common in damp and shady places in sholas.

Campanulaceae

Wahlenbergia gracilis DC. (Fyson 1 : 361)

A perennial herb with linear lanceolate leaves and blue flowers. Common in grass in open downs near and above Kodaikanal.

Lobeliaceae

Lobelia excelsa Lesch. (Fyson 1 : 359)

A tall herb. Flowers in dense purplish brown spikes. Near sholas and roadsides, very common.

Vacciniaceae

Vaccinium nilgherense Wight. (Fyson 1 : 365)

A large shrub with narrow leaves, white flowers, and compressed fruits. Common at Kodaikanal.

Ericaceae

Gaultheria fragrantissima Wall. (Fyson 1 : 366)

A shrub with snow-white flowers in axillary racemes. Very common at edges of sholas near Kodaikanal.

Rhododendron nilagiricum Zænk. (Fyson 1 : 368)

A small tree with rough elliptical leaves erect in bud. Flowers crimson coloured. Very common, conspicuous by its red flowers like the *Rhododendron arboreum* in the Himalayas.

Myrsinaceae

Maesa perrottetiana DC. (Fyson 1 : 373)

A shrub with lenticelled twiggy branches. Flowers in slender racemes. Common plant of the sholas at low levels.

Styracaceae

Symplocos foliosa Wight. (Fyson 1 : 382)

A tree with lumpy foliage and white flowers in short axillary spikes. In sholas near Kodaikanal.

Symplocos laurina (Retz.) Wall. ex G. Don. Syn. *Symplocos spicata* Roxb. (Fyson 1 : 381)

A tree with thick glossy leaves and white yellow flowers in axillary spikes. On downs above Kodaikanal.

Oleaceae

Olea glandulifera Wall. (Fyson 1 : 389)

A tree with grey and lenticelled branches. Flowers in regular decussately-branched panicles. In the sholas.

Ligustrum roxburghii C.B. Clarke. (Fyson 1 : 391)

A small tree with large acuminate leaves and creamy-white flowers in axillary and terminal compound panicles. In low level sholas.

Apocynaceae

**Vinca major* Linn.

An erect herb with purplish flowers. On the walls on roadsides at Kodaikanal.

Loganiaceae

**Buddleia asiatica* Lour.

An erect shrub with lanceolate leaves and flowers in axillary and terminal paniced cymes.

Gentianaceae

Exacum wightianum Arn. (Fyson 1 : 407)

A tall herb with violet blue flowers. In open downs near Kodaikanal.

Swertia corymbosa Wight. (Fyson 1 : 410)

A small herb, flowers white with darker veins in umbel-like inflorescence. Very common in open downs.

Boraginaceae

Cynoglossum furcatum Wall. (Fyson 1 : 413)

A herb with lanceolate leaves and blue or pink flowers in spikes. In the open downs.

Convolvulaceae

Argyreia nellygherrya Choisy. (Fyson 1 : 415)

A climber with silvery hairs on green parts. Flowers pale purple. Kodaikanal at 5000 ft.

Solanaceae

Solanum nigrum Linn. (Fyson 1 : 419)

A small herb with white flowers and black fruits. Roadside weed in damp and shady places.

**Solanum jasminoides* Paxt.

A climbing shrub with white flowers, at 7000 ft.

Solanum laeve Dunal. (Fyson 1 : 419)

A small shrub with geniculate branches. Flowers white in axillary branches.

**Cestrum fasciculatum* Miers.

An elegant garden plant, 7000 ft.

Scrophulariaceae

Verbascum thapsus Linn. (Fyson 1 : 425)

A stout herb, with yellow flowers in densely woolly spikes. A weed of waste places.

Digitalis purpurea Linn. (Fyson 1 : 429)

A herb with pink flowers in tall terminal spikes. Common in Kodai-kanal as a garden escape.

Antirrhinum majus Linn.

Cultivated in the garden of La Providence for its flowers.

Acanthaceae

Strobilanthes kunthianus T. Anders. (Fyson 1 : 445)

A shrub with pale blue flowers in dense spikes, flowering only every 7-12 years. Common on open hillsides covering large areas.

Strobilanthes luridus Wight. (Fyson 1 : 451)

A straggling shrub with flowers in erect spikes on old branches with broad bracts. In the sholas.

Rungia laeta Clarke. (Fyson 1 : 458)

A herb with terete stem. Flowers in axillary racemes.

Andrographis neesiana Wight. (Fyson 1 : 454)

Shrub with flowers in one-sided racemes in the axils of upper and smaller bract-like leaves. On the downs.

**Blepharis maderaspatensis* (Linn.) Heyne ex Roth. Syn. *Blepharis boerhaviaefolia* Pers.

A prostrate herb with axillary spikes. Flowers pink. At Kodai-kanal, at 6000 ft.

Verbenaceae

Lantana aculeata Linn. (Fyson 1 : 459)

A strongly scented shrub, with recurved prickles on the angles of branches. Flowers orange, red, or pink. Naturalized and troublesome.

***Stachytarpheta indica** Vahl.

A herb with flowers in long spikes. Corolla tubular pink. A garden escape.

Clerodendrum serratum Moon. (Fyson 1 : 461 under *Clerodendron serratum* Spreng.)

A shrub; flowers blue with a conspicuously wide oblique mouth. Common on the slopes near Kodaikanal.

***Verbena citriodora** H. & B. & K.

A cultivated shrub. In garden of La Providence.

Labiatae

Pogostemon speciosus Benth. (Fyson 1 : 472)

An undershrub with flowers in terminal spikes. In cool and shady places on the outskirts of sholas.

Pogostemon heyneanus Benth. (Fyson 1 : 471)

An aromatic shrub with slender spike. Near Kodaikanal often cultivated.

Micromeria biflora Benth. (Fyson 1 : 474)

A small herb with pink purple flowers in small cymes in the axils of the leaves. Common all over in grass.

Scutellaria violacea Heyme. (Fyson 1 : 476)

A herb with white flowers tinged with purple in spikes. Common in moist and shady places.

***Salvia patens** Cav.

A garden plant. Cultivated often for its flowers.

***Salvia farinacea** Benth.

A garden plant. Cultivated for the flowers.

Leucas angularis Benth. (Fyson 1 : 480)

A straggling herb with few white flowers. Common on shrubs and small trees.

Leucas suffruticosa Benth. (Fyson 1 : 480)

An undershrub; under surface of the leaves white. Flowers white. Common in the grass of the downs.

Leucas hirta Spreng. (Fyson 1 : 483.)

A herb with elliptic, obscurely-toothed leaves. Flowers white.

Plantaginaceae

***Plantago major** Linn.

A perennial herb with stout rootstock. Flowers in spikes. Cultivated in gardens.

Amaranthaceae

Achyranthes bidentata Bl. (Fyson 1 : 487)

A herb similar to *Achyranthes aspera* but the bracteoles of the flowers are reduced to spines. Common herb in the sholas.

Polygonaceae

Polygonum chinense Linn. (Fyson 1 : 493)

A shrub-like herb with white or pinkish flowers. Very common in the rich cool soil.

Piperaceae

Piper brachystachyum Wall. (Fyson 1 : 499)

A small herb. Leaves elliptic, narrower than long, with 4 side-veins. Male spikes slender. Female spikes smaller than male, about $\frac{1}{4}$ ", erect in fruit. Common on the sholas near Kodaikanal.

Piper schmidtii Hook. f. (Fyson 1 : 500)

A small herb with ovate elliptic leaves. Flowers in male and female spikes. Near Kodaikanal, common in sholas. Berry red or yellow.

Piper wightii Miq. (Fyson 1 : 500)

A herb with stout branches and broad leaves with 5-7 nerves near the base. Spike stout, bracts with prominent sinuate margins. Below Kodaikanal and in Bombay shola.

Lauraceae

Cinnamomum wightii Meissn. (Fyson 1 : 503)

A large tree with light green foliage. Flowers in open panicles. Common tree of the sholas.

Litsea wightiana Wall. (Fyson 1 : 507)

A moderate tree with coriaceous leaves. Common in sholas.

Thymelaeaceae

***Lasiosiphon eriocephalus** Decne.

A shrub with slender twigs. Flowers in terminal heads, nearly globular. In sholas at 6000 ft.

Elaeagnaceae

Elaeagnus kologa Schlecht. (Fyson 1 : 511)

A straggling shrub, covered with silvery scales and with spiny branchlets at the angles of main bracts. Flowers in clusters of 4-5 in leaf axils. Common in sholas.

Santalaceae

Osyris wightiana Wall. ex Wight Syn. *Osyris arborea* Wall. (Fyson 1 : 522)

A shrub with angular and green branchlets. Fruit a yellow-orange berry. In sholas and downs.

Euphorbiaceae

Mallotus albus Muell. var. *occidentalis* Hook. f. (Fyson 1 : 535)

An evergreen tree with young parts covered densely with tomentum. Flowers in terminal panicles. Below Kodaikanal very common at 6500 ft.

***Bischoffia javanica** Blume

A round-headed, glabrous tree with green flowers in panicles. Males minute on slender pedicels, females on stout pedicels.

Euphorbia rothiana Spr. (Fyson 1 : 527)

A herb with narrow leaves, one-nerved. Flowering branches 3-5, tufted once or twice. On margins of sholas in shady places on damp soil.

Phyllanthus rheedii Wight. (Fyson 1 : 528)

An annual undershrub with slender reddish stem. Male flowers 2-3 at a node, females solitary. Common near Kodaikanal.

Urticaceae

Trema orientalis Bl. (Fyson 1 : 539)

A tree with ovate leaves, nerves joined by many cross veins, lower surface white with silvery pubescence. On slopes below Kodaikanal.

Orchidaceae

Oberonia wightiana Lindl. (Fyson 1 : 562)

An epiphyte, pale yellowish green flowers. On shola trees at Kodaikanal.

Aerides ringens Fischer. (Fyson 1 : 579)

An epiphytic orchid with strongly grooved leaves often spotted brown. Flowers in spikes. On shola trees.

Saccolabium filiforme Lindley. (Fyson 1 : 581)

An epiphytic herb with slender green stem, stick-like leaves, and yellow-brown flowers in drooping spikes. Frequent in sholas.

Spiranthes australis Lindley. (Fyson 1 : 583)

A small terrestrial orchid with flowers in dense spirals. Common in grass all over the downs.

Liliaceae**Lilium neilgherrense** Wight. (Fyson 1 : 611)

A peculiar herb with narrow lanceolate leaves and single, bell-shaped, pendulous flower. Common in open downs.

Commelinaceae**Commelina clavata** Clarke. (Fyson 1 : 615)

Herbs with slender stem. Flowers blue in small cymes sheathed in a large heart-shaped bract. On downs below Kodaikanal.

Cyanotis pilosa Schultes. (Fyson 1 : 617)

Herbs with thick rootstock. Flowers in clusters. On slopes above Kodaikanal.

Cyanotis arachnoidea Clarke. (Fyson 1 : 618)

Sprawling herbs, covered with white hairs. Flowers in terminal cymes with a leaf or bract just below. In dry places above Kodaikanal.

Araceae**Arisaema leschenaultii** Blume. (Fyson 1 : 623)

A herb with stem mottled with brownish purple marks. Spadix straight not projecting beyond the mouth. Female spadix with hair-like projections. On roadsides in cool and shady places.

Cyperaceae**Fimbristylis paupercula** Boeck. (Fyson 1 : 639)

A herb with short rhizome and tufted stem. Spikelets in an irregular umbel. Common on the dry slopes.

Fimbristylis kingii Clarke. (Fyson 1 : 638)

A herb with short rhizome at 7000 ft. in Kodaikanal.

Carex baccans Nees. (Fyson 1 : 650)

A grass-like herb with stout rhizome and tall stem. Spikes $1\frac{1}{2}$ -2", upper flower male, in large panicle. Utricle ribbed strongly. Shola at 7000 ft.

Graminaceae

Oplismenus compositus Beauv. (Fyson 1 : 659)

A weak-stemmed grass with thin flat leaves. Spikelets in short spikes. Very common in the sholas.

Ischaemum ciliare Retz. (Fyson 1 : 664)

A coarse grass with elliptic, acute leaves. Flowering stem slender and purplish upwards. Spikes two diverging. In Kodaikanal on the open downs.

***Ischaemum aristatum** Linn.

A perennial grass. At 7000 ft.

Chrysopogon wightianus Nees. (Fyson 1 : 666)

A grass with tufted stem, glumes red, anthers yellow. Awns long and bent. In and near Kodaikanal.

Chrysopogon zeylanicus Th. (Fyson 1 : 667)

A grass with a stout rootstock. Leaves narrow, pubescent with slender greenish branches. Near Kodaikanal on the downs.

Heteropogon contortus Beauv. (Fyson 1 : 668)

A grass with stem about 1 ft. densely tufted. Leaves rigid. Spikelets terminal solitary. Abundant near Kodaikanal.

Cymbopogon confertiflorus Stapf. (Fyson 1 : 669)

A grass with 3-4 ft. stem. Glume of the sessile spikelet shallow. In and around Kodaikanal.

Anthistiria ciliata Linn. (Fyson 1 : 671)

A tall annual grass. Leaf blade ciliate near the base with hairs on bulbous bases. On the downs above Kodaikanal.

Anthoxanthum odoratum Linn. (Fyson 1 : 671)

A sweet-scented grass with a rhizome. In the woods near Kodaikanal.

Sporobolus indicus Br. (Fyson 1 : 672)

A grass with narrow leaves and long spike-like panicles, branches of which are closely covered to the base with small spikelets and erect close to the stem. Very common near Kodaikanal.

Avena aspera Munro. (Fyson 1 : 674)

A grass with flat leaves, stem purplish ending in a narrow panicle of erect spikelets. Near Kodaikanal.

Bromus asper Murray. (Fyson 1 : 680)

A grass with slender stem 2-3 ft. Leaves slender. In moist places near and below Kodaikanal.

Brachypodium sylvaticum Beauv. (Fyson 1 : 681)

A perennial grass, stem 2-4 ft. Leaves narrow spike 2-6" nodding its axis flattened. In the downs of Kodaikanal.

Coniferae

***Pinus roxburghii** Sargent.

A large tree with thick and furrowed bark. Leaves triquetrous, light green. Planted rarely in Kodaikanal.

Lycopodiaceae

***Lycopodium cernuum** Linn.

A small herb, very common on the roadsides at Kodaikanal.

ACKNOWLEDGEMENTS

The author is deeply indebted to Prof. P. Legris for his valuable suggestions and for excellent facilities provided during the author's tours; to Rev. Fr. H. Santapau for his criticism and perusal of the manuscript; and to Dr. G. S. Puri, Regional Botanist, Botanical Survey of India, Poona, for his kind help and suggestions during the course of the work.

REFERENCES

- Champion, H. G. (1936) : A preliminary survey of the forest types of India and Burma. *Ind. For. Rec.* 1936 (N. S.) 1 : 1-236
- Fyson, P. F. (1915-21) : The Flora of Nilgiri and Palney Hill Tops (above 6500 ft.) and Kodaikanal. Madras. 3 vols.
- Fyson, P. F. (1932) : The Flora of South Indian Hill Stations. Madras. 2 vols.
- Pallithanam, J. (1957) : Observations on the flora of Kodaikanal. *J. Bombay nat. Hist. Soc.* 54 : 835-844.
- Raizada, M. B. (1958) : Name Changes in Common Indian Plants. *Ind. For.* 84 : 467-538.

Fishes from the Kashmir Valley¹

BY

E. G. SILAS

Central Marine Fisheries Research Station, Mandapam Camp

(With two plates)

In March-April 1954 the late Dr. Sunder Lal Hora visited the Kashmir Valley and made an extensive collection of fishes, which on his return to Calcutta he kindly passed on to me for study. As regards the topography of the Kashmir Valley and its drainage, he wrote that the Valley is 'about eighty miles long, about twenty to twenty-five miles broad, and on the average rising about 6000 ft. above sea-level. It is flanked on almost all sides by snow-capped mountains. The Jhelum River which originates in its south-eastern corner traverses its whole length and is supplied by several spring-fed and snow-fed streams as well as by its all great water reservoirs, the most important of which are the Wular, the Dal, and the Manasbal lakes.' (Hora *et al.*, 1955).

Up to now the most important treatise on the fishes of Kashmir is Heckel (1838) : *FISCHE AUS KASCHMIR*, which contains descriptions of sixteen species, all described as new to science. In 1844 Heckel published 'Fische Kaschmir's' in Von Huegel's *KASCHMIR UND DAS REICH DER SEIK* (Bd. 4, abth. 2, pp. 351-384) with a few minor changes. McClelland (1839) in the 'Supplement' to his monograph on Indian Cyprinidae commented on Heckel's species from Kashmir, which have also found mention in volumes 15 and 16 of the *HISTOIRE NATURELLE DES POISSONS* (Valenciennes, 1840 & 1842). Since then notable contributions concerning the ichthyofauna of Kashmir have been those by Steindachner (1866), Günther (1868), Day (1876, 1878*a*, 1878*b*), Chaudhuri (1909), Hora (1922*a*, 1922*b*, 1934, 1936, 1939), Mukerji (1936), Misra (1949), and Hora & Silas (1952 *a* and *b*). In addition, there are several references to sport-fishing in Kashmir, of which Ross (1916) and Mitchell (1918) deserve special mention.

The examination of the fresh material as well as that already present in the fish collection of the Zoological Survey of India has enabled me to codify the nomenclature of the species described by Heckel (*op. cit.*), as given in Table 1.

¹ Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.

Misra (op. cit.) has shown that Heckel's species *Schizothorax plagiosomus* and *S. sinuatus* were based on male and female specimens of the same species respectively, and as such the specific name *S. plagiosomus* (= *Oreinus plagiosomus*) which has priority is used. I have compared a few specimens from the Kashmir Valley referable to *Varicorhinus diplostomus* Heckel (= *Tylognathus valenciennesii* Heckel) with *Labeo dero* (Hamilton), which species also occurs in the Indo-Gangetic watersheds along the Himalayas and do not find sufficient difference between them to justify the Kashmir specimens being considered specifically distinct. Hence I consider them conspecific and have here used the older name, *Labeo dero*, to indicate them.

Hora (1939) gave an excellent account of the mahseer *Barbus* (*Tor*) *putitora* (Hamilton) in the 'Game Fishes of India' series published in the *Journal*, and indicated the distribution of the species as 'all along the Himalayas'. However, one significant omission is his non-inclusion of *Labeobarbus macrolepis* Heckel in its synonymy. I take this opportunity to rectify this and at the same time support Hora's contention that infraspecific differentiation of the different species of mahseers must await detailed scrutiny of good series of material from the different watersheds along the range of distribution of the species.

Mukerji (1935) proposed a new subspecies *Crossochilus latius punjabensis* to denote the variety of *C. latius* from the Punjab and Afghanistan. I have compared specimens of this variety of *C. latius* from the Punjab with those from the Kashmir Valley referable to *Barbus diplochilus* Heckel (= *Varicorhinus barbatulus* Heckel) and find that in all diagnostic characters including the relatively smaller size at maturity as well as the smaller size of the eyes (diameter 4.2 to 5 versus 3.6 to 3.7 in head length in the *forma typica*) they are identical. This being the case, I propose considering the older name *diplochilus* as valid to denote the subspecies of *C. latius* occurring in the Kashmir Valley and the Punjab (Indus drainage), relegating *C. l. punjabensis* Mukerji to its synonymy.

Cobitis marmorata Heckel and *C. vittata* Heckel are at present referable to the genus *Noemacheilus* van Hasselt, while Haig (1950) has shown that *Silurus lamgur* Heckel is a synonym of *Ompok bimaculatus* (Bloch).

More than any other Indian species of fishes, I feel, that inter-specific as well as inter-generic hybridization in nature takes place to a greater extent among the Schizothoracinae. The primary factors responsible for this in the Kashmir Valley are the great abundance in numbers of each species present, overlap in breeding time, and their spatial distribution in the Valley. The collection contains specimens showing intergrading characters attributable to hybrids, the easily recognisable combinations

TABLE

No.	Heckel (1838)	Valenciennes (XV, 1840 ; XVI, 1842)	Heckel (1844)
1.	<i>Schizothorax plagiotomus</i> p. 16, pl. 1.	<i>Schizothorax plagiotomus</i> XVI, p. 213.	<i>Schizothorax plagiotomus</i>
2.	<i>Schizothorax sinuatus</i> p. 21, p. 2.	<i>Schizothorax sinuatus</i> XVI, p. 214.	<i>Schizothorax sinuatus</i>
3.	<i>Schizothorax curvifrons</i> p. 25, p. 3.	<i>Schizothorax curvifrons</i> XVI, p. 216.	<i>Schizothorax curvifrons</i>
4.	<i>Schizothorax longipinnis</i> p. 27, pl. 4.	<i>Schizothorax longipinnis</i> XVI, p. 216.	<i>Schizothorax longipinnis</i>
5.	<i>Schizothorax niger</i> p. 29, pl. 5.	<i>Schizothorax niger</i> XVI, p. 217.	<i>Schizothorax niger</i>
6.	<i>Schizothorax nasus</i> p. 32, pl. 6.	<i>Schizothorax nasus</i> XVI, p. 218.	<i>Schizothorax nasus</i>
7.	<i>Schizothorax hügelii</i> p. 36, pl. 7.	<i>Schizothorax hügelii</i> XVI, p. 219.	<i>Schizothorax hügelii</i>
8.	<i>Schizothorax micropogon</i> p. 41, pl. 8, fig. 1.	<i>Schizothorax micropogon</i> XVI, p. 220.	<i>Schizothorax micropogon</i>
9.	<i>Schizothorax planifrons</i> p. 44, pl. 8, fig. 2.	<i>Schizothorax planifrons</i> XVI, p. 224.	<i>Schizothorax planifrons</i>
10.	<i>Schizothorax esocinus</i> p. 48, pl. 9.	<i>Schizothorax esocinus</i> XVI, p. 221.	<i>Schizothorax esocinus</i>
11.	<i>Labeobarbus macrolepis</i> p. 60, pl. 10, fig. 2.	<i>Labeobarbus macrolepis</i> XVI, p. 209.	<i>Labeobarbus macrolepis</i>
12.	<i>Barbus diplochilus</i> p. 63, pl. 10, fig. 1.	<i>Barbus diplochilus</i> XVI, p. 204.	<i>Tylognathus barbatulus</i> IV, p. 376.
13.	<i>Varicorhinus diplostomus</i> p. 67, pl. 11.	<i>Labeo diplostomus</i> XVI, p. 360.	<i>Tylognathus valenciennesii</i> IV, p. 378.
14.	<i>Cobitis marmorata</i> p. 76, pl. 12, figs. 1 & 2.	..	<i>Cobitis marmorata</i> IV, p. 380.
15.	<i>Cobitis vittata</i> p. 80, pl. 12, figs. 3 & 4.	..	<i>Cobitis vittata</i> IV, p. 382.
16.	<i>Silurus lamgur</i> p. 82, pl. 12, figs. 5 & 6.	<i>Silurus lamgur</i> XV, p. ix.	<i>Silurus lamgur</i>

I

Günther (V, 1864; VII, 1868)	Day (1878)	Present nomenclature
<i>Oreinus plagiostomus</i> VII, p. 160.	<i>Oreinus plagiostomus</i> p. 530.	♂ <i>Oreinus plagiostomus</i> <i>plagiostomus</i> (Heckel)
<i>Oreinus sinuatus</i> VII, p. 161.	<i>Oreinus sinuatus</i> p. 529, pl. cxxiv, fig. 4.	♀ <i>Oreinus plagiostomus</i> <i>plagiostomus</i> (Heckel)
<i>Schizothorax curvifrons</i> VII, p. 164.	(<i>species inquirendae</i>) p. 532.	<i>Schizothorax curvifrons</i> <i>curvifrons</i> Heckel
<i>Schizothorax longipinnis</i> VII, p. 166.	(<i>species inquirendae</i>) p. 532.	<i>Schizothorax longipinnis</i> Heckel
<i>Schizothorax niger</i> VII, p. 164.	(<i>species inquirendae</i>) p. 531.	<i>Schizothorax curvifrons niger</i> Heckel
<i>Schizothorax nasus</i> VII, p. 166.	(<i>species inquirendae</i>) p. 532.	<i>Schizothorax nasus</i> Heckel
<i>Schizothorax hugelii</i> VII, p. 164.	(<i>species inquirendae</i>) p. 532.	<i>Schizothorax hugelii</i> Heckel
<i>Schizothorax micropogon</i> VII, p. 163.	(<i>species inquirendae</i>) p. 532.	<i>Schizothorax micropogon</i> Heckel
<i>Schizothorax planifrons</i> VII, p. 163.	(<i>species inquirendae</i>) p. 532.	<i>Schizothorax planifrons</i> Heckel
<i>Schizothorax esocinus</i> VII, p. 166.	<i>Schizothorax esocinus</i> p. 533, pl. cxxiii, fig. 4.	<i>Schizothorax esocinus</i> <i>esocinus</i> Heckel
<i>Barbus macrolepis</i> VII, p. 131.	<i>Barbus tor</i> (Hamilton) p. 564, pl. cxxxvi, fig. 5 & pl. cxl, fig. 1.	<i>Tor putitora</i> Hamilton
<i>Crossochilus barbatulus</i> VII, p. 72.	<i>Cirrhina latia</i> (in part) p. 548.	<i>Crossochilus latius diplo-</i> <i>chilus</i> (Heckel)
<i>Labeo diplostomus</i> VII, p. 57.	<i>Labeo diplostomus</i> p. 540, pl. cxxxix, fig. 2.	<i>Labeo dero</i> (Hamilton)
<i>Nemachilus marmoratus</i> VII, p. 356.	<i>Nemachilus marmoratus</i> p. 620, pl. clv, fig. 9	<i>Noemacheilus marmora-</i> <i>tus</i> (Heckel)
<i>Nemachilus marmoratus</i> VII, p. 356.	<i>Nemachilus marmoratus</i> p. 620.	<i>Noemacheilus vittatus</i> (Heckel)
<i>Silurichthys lamgur</i> V, p. 36.	<i>Callichrous pabda</i> (Hamil- ton), p. 479, pl. cxi, figs. 2 & 3.	<i>Ompok² bimaculatus</i> (Bloch)

being *Schizothorax esocinus* x *Schizothorax* sp., and *Oreinus plagiostomus* x *Schizothorax* sp.

In the fish collection of the Zoological Survey of India there is material of three species, *Schizothorax nobilis* McClelland (Z.S.I. Reg. No. 6532, and F. 5325/1), *S. intermedius* McClelland (Day's coll. Reg. No. 791) and *Lepidocephalichthys balgara* (Hamilton) (Day's coll. Reg. No. 2584), all labelled as having been obtained from 'Kashmir' or 'Kashmir lakes'. Since the exact localities are not clearly specified and as the present collection does not indicate their occurrence in the Valley, these species are not included in the synopsis to the species known from the Valley given at the end of this paper. So also several Indian species, namely *Chela cachius* Hamilton, *Esomus danricus* (Hamilton), *Barilius vagra* Hamilton, *Barilius bendelisis* (Hamilton), *Aspidoparia morar* (Hamilton), *Puntius sophore* Hamilton, *Puntius ticto* Hamilton, *Puntius sarana* (Hamilton), *Labeo bata* (Hamilton), *Cirrhinus mrigala* (Hamilton), *Channa* sp., *Ambassis* sp., *Mastacembelus armatus* (Lacépède), etc., occurring in the Jhelum drainage below the Kashmir Valley and in the Jammu area, and species such as *Noemacheilus yarkendensis* Day, *N. ladacensis* Günther, *N. stoliczkae* (Steindachner), etc., occurring in northern Kashmir beyond the limits of the Kashmir Valley are not included in the synopsis.

The absence of any specimens of *Barbus compressus* Day in the collection also lends support to Mukerji's contention (Mukerji, 1935) that the type locality of this species is probably not Kashmir, but more likely northern Burma and that the type specimen might have been inadvertently placed in a bottle containing a specimen of *Oreinus* from Kashmir.

The two exotic or introduced species in the Valley are the American Cyprinodont *Gambusia affinis holbrooki* Girard and the Brown Trout *Salmo trutta fario* Linnaeus. The former is a recent introduction and occurs profusely in certain places thereby indicating that it is well established in the natural waters of the Valley. The Brown Trout attains very large sizes in the cool waters of the Valley and there is one on record which weighed 16 lb. 1 oz. (Mitchell 1916).

The species, both indigenous as well as exotic, at present known from the Kashmir Valley may be classified as follows :

LIST OF SPECIES

1930 = 1931

Order : SALMONIFORMES

Family : SALMONIDAE

Salmo trutta fario Linnaeus

Order : CYPRINODONTIFORMES

Family : POECILIIDAE

Gambusia affinis holbrooki Girard

Order : SILURIFORMES

Family : SISORIDAE

- Glyptothorax kashmirensis* Hora
Glyptosternum reticulatum McClelland

Family : SILURIDAE

- Ompok bimaculatus* (Bloch)

Order : CYPRINIFORMES

Family : CYPRINIDAE

Subfamily : Schizothoracinae

- Oreinus plagiostomus plagiostomus* (Heckel)
Ptychobarbus conirostris Steindachner
Diptychus maculatus Steindachner
Schizothorax progastus McClelland
Schizothorax nasus Heckel
Schizothorax planifrons Heckel
Schizothorax esocinus esocinus Heckel
Schizothorax hugelii Heckel
Schizothorax longipinnis Heckel
Schizothorax micropogon Heckel
Schizothorax curvifrons curvifrons Heckel
Schizothorax curvifrons niger Heckel

Subfamily : Garrinae

- Crossochilus latius diplochilus* (Heckel)

Subfamily : Cyprininae

- Labeo dero* (Hamilton)
Labeo dyocheilus (McClelland)
Tor putitora Hamilton

Family : COBITIDAE

Subfamily : Botiinae

- Botia birdi* Chaudhuri

Subfamily : Noemacheillinae

- Noemacheilus rupicola* (McClelland)
Noemacheilus gracilis Day
Noemacheilus vittatus (Heckel)
Noemacheilus kashmirensis Hora
Noemacheilus marmoratus (Heckel)
Noemacheilus yasinensis Alcock

From the above list it is clear that the bulk of the indigenous fish fauna of the Valley is composed of the Palaearctic element (of central

Asiatic origin) while those of Indian origin are *O. bimaculatus*, *G. kashmirensis*, *C.l. diplochilus*, *L. dero*, *L. dyocheilus*, *T. putitora*, *B. birdi*, and *N. rupicola*. Of the latter, *G. kashmirensis* is endemic in the Kashmir Valley, but its congeners are predominant in the Oriental Region. Six species and one subspecies of *Schizothorax* (except *S. progastus* and *S. esocinus*) and three species of the genus *Noemacheilus*, namely *N. vittatus*, *N. marmoratus*, and *N. kashmirensis* appear to be endemic in the Valley. On the whole, the high percentage of endemism (about 42%) of the fish fauna of the Valley is noteworthy.

The key below embraces all valid species described by Heckel (op. cit.), those recorded by various authors from Kashmir Valley since that date, and those present in the collection under study. Specimens approximating very close to *Schizothorax progastus* McClelland and *Noemacheilus rupicola* (McClelland) are present in the collection. I find that the differences between *Schizothorax curvifrons* and *S. niger* are not sufficiently distinct to justify their treatment as separate species and hence the latter is treated here as a subspecies of *S. curvifrons*.

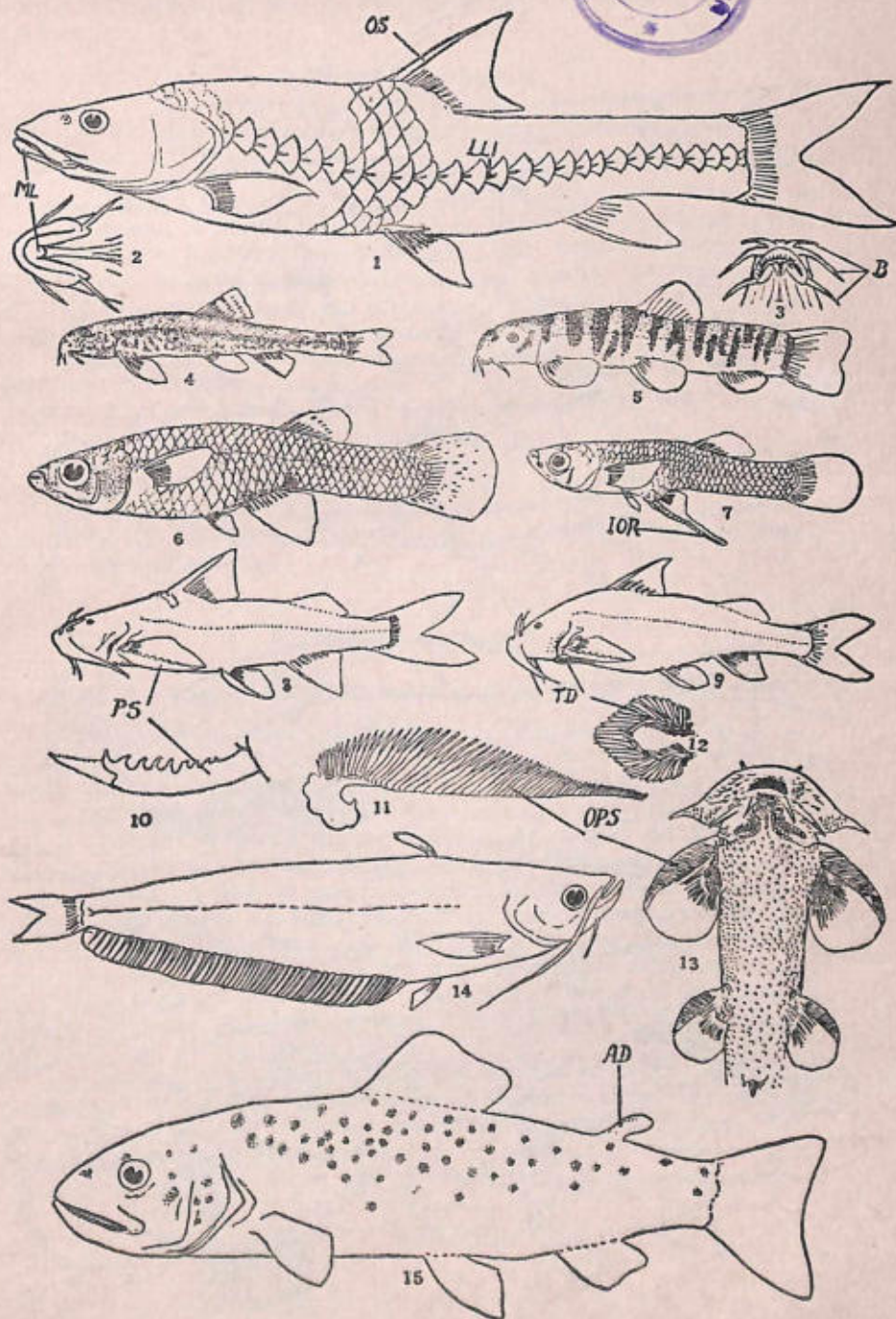
This account of the fishes of the Kashmir Valley will not be complete without a reference to the fossil fishes known from the area. Hora (1937) has described remains of Schizothoracinae (scales, one pharyngeal tooth, pectoral spine, and skeleton of caudal region) referable to *Schizothorax* or *Oreinus* [in all probability those of *S. curvifrons*, and *O. sinuatus* (= *O. plagiostomus*)] from the Karewas beds of Kashmir.

Details on the ecology of most of the species dealt with in this paper are embodied in an excellent article by G. Evelyn Hutchinson entitled 'Ecological observation on the Fishes of Kashmir and Indian Tibet' (*Ecol. Monogr.* 9 : 145-182. 1939).

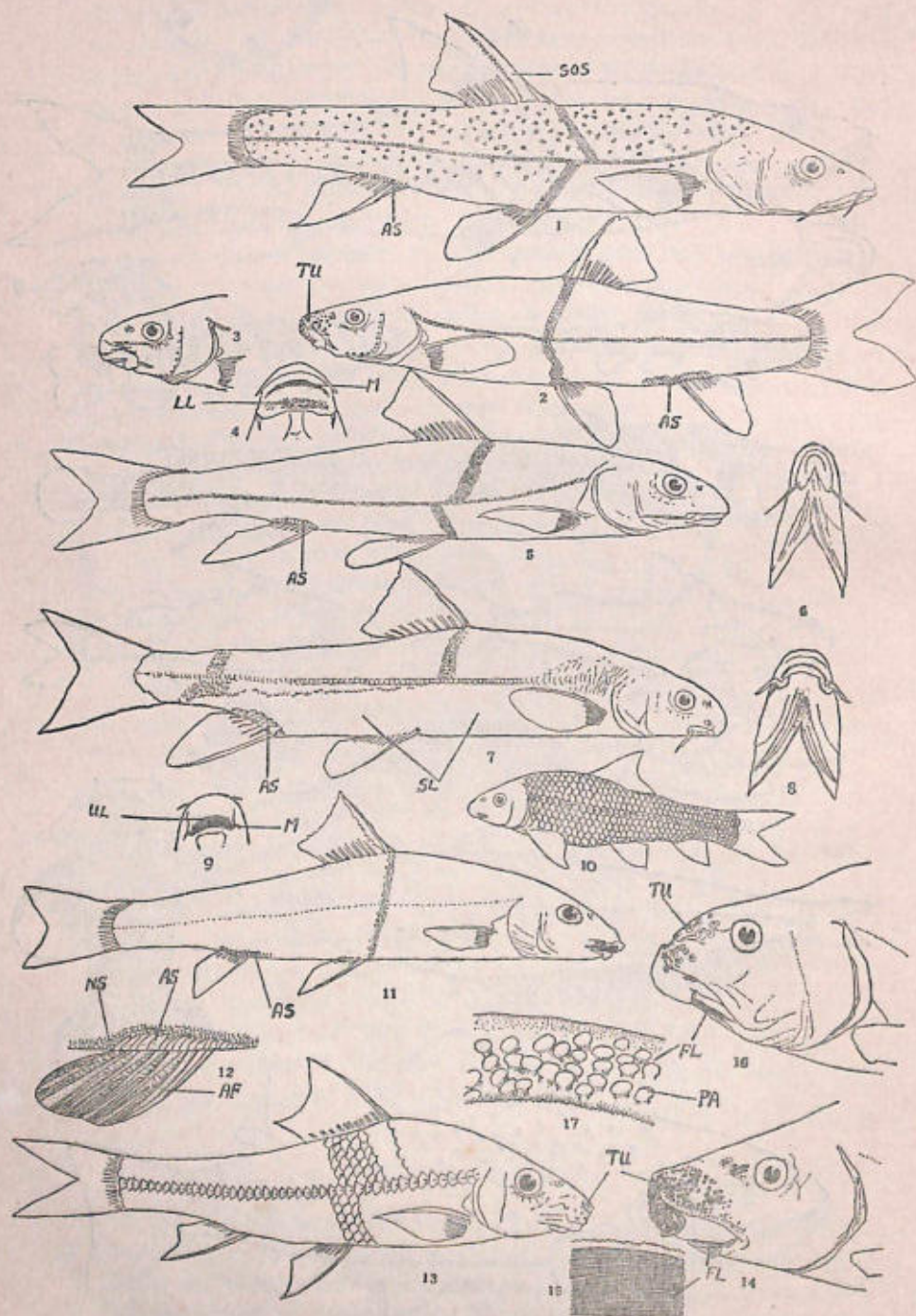
In conclusion I hope that this paper, wherein the nomenclature of Heckel's species (Heckel, op. cit.) is codified and a working 'Key' is given for the identification of all the species known from the Kashmir Valley, will stimulate greater interest in the study of the ichthyofauna of this area. Racial studies of the Schizothoracinae, especially the important species such as *S. esocinus*, *S. curvifrons*, *O. plagiostomus*, etc., are lacking. Investigations hitherto on natural hybrids between species of the Schizothoracinae have been cursory, and detailed observations on this aspect will be of interest. It is also hoped that this account will aid in the preparation of a comprehensive work on the fishes of Kashmir.

ACKNOWLEDGEMENT

My grateful thanks are due to the late Dr. Sunder Lal Hora for placing at my disposal his collection of Kashmir fishes for study and the facilities given to me for working out the collection at the Zoological Survey of India, Calcutta. I am also thankful to Dr. S. Jones, Chief Research



Outline drawings of Kashmir fishes showing diagnostic characters
For explanation see p. 73.



Outline drawings of Kashmir fishes showing diagnostic characters
For explanation see p. 73.

Officer, Central Marine Fisheries Research Station, for giving me facilities for working at this Station and completing this account.

Explanation to Plate I

Outline drawings of Kashmir fishes showing diagnostic characters

1. *Tor putitora* Hamilton; 2. Ventral view of anterior part of head of same; 3. Ventral view of anterior part of head of *Noemacheilus* showing disposition of three pairs of barbels; 4. *Noemacheilus kashmirensis* Hora; 5. *Noemacheilus rupicola* (McClelland); 6. *Gambusia affinis holbrooki* Girard, female; 7. Same, Male; 8. *Glyptothorax kashmirensis* Hora, Male; 9. Same, Female; 10. Pectoral spine of same; 11. Outer pectoral spine of *Glyptosternum reticulatum* McClelland showing pinnate condition; 12. Thoracic adhesive disc of *G. kashmirensis*; 13. Ventral view of *G. reticulatum*; 14. *Ompok bimaculatus* (Bloch); 15. The Brown Trout, *Salmo trutta fario* Linnaeus.

(Figures 1, 4, 8, 9 & 12 after Hora; 6 & 7 after Prashad & Hora; 14 after Day; 11 & 13 after Hora & Silas)

Abbreviations: AD=Adipose dorsal fin; B=three pairs of barbels; IOR=Part of anal fin modified into intromittent organ; LLI=Lateral line; ML=Median lobe of lower lip; OPS=Outermost pectoral spine which is soft and pinnate; OS=Strong osseous dorsal spine; PS=Osseous and denticulated pectoral spine; TD=Thoracic adhesive disc.

Explanation to Plate II

Outline drawings of Kashmir fishes showing diagnostic characters

1. *Schizothorax esocinus esocinus* Heckel; 2. *Oreinus plagiostomus plagiostomus* (Heckel), Male; 3. Head of female of same species; 4. Ventral view of anterior part of head of same species; 5. *Ptychobarbus conirostris* Steindachner; 6. Ventral view of head of same; 7. *Diptychus maculatus* Steindachner; 8. Ventral view of head of same; 9. Ventral view of anterior part of head of *Crossocheilus*; 10. *Crossocheilus latius diplochilus* (Heckel); 11. *Schizothorax progastus* McClelland; 12. Region of anal fin and the vent in the Schizothoracinae showing disposition of enlarged scales forming the 'Anal sheath'; 13. *Labeo dyocheilus* (McClelland); 14. Head of same showing nature and disposition of tubercles; 15. Inner fold of lower lip of same showing the transverse folds, each fold in turn being striated; 16. Head of *Labeo dero* (Hamilton); 17. Inner fold of lower lip of same showing papillae. (Figures 1, 5-8, 11 & 13 after Day; 2, 3, & 10 after Misra; 14-17 after Hora)

Abbreviations: AF=Anal fin; AS=Anal sheath of scales; FL=Inner fold of lower lip; M=Mouth; LL=Lower lip; NS=Normal scales; PA=Papilla; SL=Scaleless area; SOS=Strongly osseous and serrated dorsal spine; TU=Tubercles; UL=Upper lip joined to rostrum.

KEY TO THE IDENTIFICATION OF THE SPECIES

- 1a. Body totally scaleless 2
- 1b. Body partly or wholly scaled (exception being certain species of the family Cobitidae) 4
- 2a. Body laterally compressed ; barbels two pairs ; an adipose dorsal fin absent ; anal fin greatly elongate with 53 or more rays
Ompok bimaculatus (Bloch) (Pl. I, fig. 14)
- 2b. Body depressed and ventrally flattened ; barbels four pairs ; an adipose dorsal fin present ; anal fin short with not more than 6 branched rays .. 3
- 3a. A longitudinally striated thoracic adhesive disc present ; pectoral spine osseous and denticulated along its inner border
Glyptothorax kashmirensis Hora (Pl. I, figs. 8, 9, 10 & 12)
- 3b. A longitudinally striated thoracic adhesive disc absent ; pectoral spine weak and pinnate along its inner border
Glyptosternum reticulatum McClelland (Pl. I, figs. 11 & 13)
- 4a. Jaws with teeth 5
- 4b. Jaws edentulous 6
- 5a. Large fish with an adipose dorsal fin some distance behind rayed dorsal fin ; origin of rayed dorsal ahead of that of pelvic fin ; scales numerous with 120 or more along lateral line ; anal fin of male like that of female ; egg-layer
Salmo trutta fario Linnaeus (Pl. I, fig. 15)
- 5b. Small minnow-like fish without an adipose dorsal fin ; origin of rayed dorsal considerably behind that of pelvic fin ; scales few, not exceeding 35 along mid-lateral line ; anal fin of male unlike that of female, modified into an intromittent organ ; live-bearer
Gambusia affinis holbrooki Girard (Pl. I, figs. 6 & 7)
- 6a. Barbels absent or when present one or two pairs only (Cyprinidae) .. 7
- 6b. Barbels three or four pairs present (Cobitidae) 22
- 7a. Vent and base of anal fin ensheathed by large imbricate or tiled scales (Schizothoracinae) 8
- 7b. Vent and base of anal fin not ensheathed by imbricate or tiled scales (Cyprininae) 19
- 8a. Margin of lower jaw with an exposed horny covering ; lower lip thick, reflected from jaw, papillated and with a free margin
Oreinus plagiosomus plagiosomus (Heckel) (Pl. II, figs. 2, 3 & 4)
- 8b. Margin of lower jaw without an exposed horny covering ; lower-lip not reflected from jaw, nor papillated, nor with a free posterior margin .. 9
- 9a. One pair of maxillary barbels ; pharyngeal teeth biserial 10
- 9b. Two pairs of barbels, one pair rostral and one pair maxillary ; pharyngeal teeth triserial 11
- 10a. Body completely covered with small scales ; origin of dorsal fin almost opposite that of pelvic fin ; pectoral fin separated from pelvic origin by about half its length
Ptychobarbus conirostris Steindachner (Pl. II, figs. 5 & 6)
- 10b. Body not completely covered with scales, they being present on upper two-thirds of body, thoracic region and sides of caudal peduncle including the scaly sheath from vent to base of anal fin ; origin of dorsal fin markedly

ahead of that of pelvic fin ; pectoral fin separated from pelvic origin by a distance equal to or more than its own length

Diptychus maculatus Steindachner (Pl. II, figs. 7 & 8)

11a. Post-labial groove continuous

Schizothorax progastus McClelland (Pl. II, fig. 11)

11b. Post-labial groove interrupted in the middle 12

12a. Origin of dorsal fin distinctly nearer base of caudal than to tip of snout 13

12b. Origin of dorsal midway between or nearer to tip of snout than to base of caudal fin 15

13a. Snout pointed ; greatest height of body much more than five times in standard length (5.5 to 7.0) ; blackish brown spots on upper half of body, base of dorsal, caudal, and inner sides of pectoral fins ; attaining large size and weighing as much as 24 pounds

Schizothorax esocinus esocinus Heckel (Pl. II, fig. 1)

13b. Snout bluntly rounded ; greatest height of body five times or less in standard length ; body devoid of blackish brown spots ; moderate size, weighing not more than 7 pounds 14

14a. Barbels rudimentary ; diameter of eye 4.0 to 4.5 in head and 1.0 to 1.3 in snout length ; distance between origins of pelvic and anal fins contained more than four times (4.25) in standard length

Schizothorax micropogon Heckel

14b. Barbels well developed, atleast as long as diameter of eye ; latter 5.0 to 5.5 in head length and about 1.5 in snout length ; distance between origins of pelvic and anal fins contained less than four times (about 3.75) in standard length

Schizothorax planifrons Heckel

15a. Largest scales of anal sheath as broad as or broader than diameter of eye ; scales along lateral line about 120 *Schizothorax hugelii* Heckel

15b. Largest scale of anal sheath small, being not more than half diameter of eye ; scales along lateral line 110 or less 16

16a. Length of longest anal ray contained five times or less in standard length ; diameter of eye contained less than five (4.5) in head length

Schizothorax longipinnis Heckel

16b. Length of longest anal ray contained six or more times in standard length ; diameter of eye contained more than five times in head length .. 17

17a. Dorsal fin short, its height contained 5.5 to 6.0 in standard length

Schizothorax nasus Heckel

17b. Dorsal fin moderately high, its height contained 4.75 to 5.0 in standard length 18

18a. Diameter of eye 5.0 to 5.5 in head length ; perforated scales along lateral line 98 to 102, none larger than those on adjoining rows ; edge of front gill cover oblique *Schizothorax curvifrons curvifrons* Heckel

18b. Diameter of eye 6.0 to 7.0 in head length ; perforated scales along lateral line 91 to 95, being slightly larger and elliptical than those on adjoining rows ; edge of gill cover convex *Schizothorax curvifrons niger* Heckel

19a. Upper lip separated from rostrum by a deep groove 20

- 19b. Upper lip confluent with the skin of the rostrum
Crossocheilus latius diplochilus (Heckel) (Pl. II, figs. 9 & 10)
- 20a. Mouth terminal ; scales large, about 25 to 28 along lateral line ; lower lip produced into a median lobe and post-labial groove continuous; last undivided dorsal ray strongly ossified
Tor putitora Hamilton (Pl. I, figs. 1 & 2)
- 20b. Mouth inferior ; scales smaller, about 41 to 45 along lateral line ; lower lip not produced into a median lobe and post-labial groove interrupted in the middle ; last undivided dorsal ray not strongly ossified .. 21
- 21a. Dorsal with 9 or 10 branched rays ; inner surface of lower lip closely papillated
Labeo dero (Hamilton) (Pl. II, figs. 16 & 17)
- 21b. Dorsal with 11 branched rays ; inner surface of lower lip striated with transverse folds
Labeo dyocheilus (McClelland) (Pl. II, figs. 13, 14 & 15)
- 22a. Barbels four pairs ; body greatly compressed and deep ; bifid backwardly directed suborbital bony spine present in both sexes
Botia birdi Chaudhuri
- 22b. Barbels three pairs ; body subcylindrical ; bifid backwardly directed suborbital spine absent 23
- 23a. Body with distinct dark vertical bands descending from back to ventral side and alternating with lighter bands
Noemacheilus rupicola (McClelland) (Pl. I, fig. 5)
- 23b. Body without dark vertical bands and alternating lighter bands .. 24
- 24a. Pelvic fins fall short of vent by considerable distance
Noemacheilus gracilis Day
- 24b. Pelvic fins reaching or surpassing vent 25
- 25a. Origin of dorsal fin midway between base of caudal and tip of snout .. 26
- 25b. Origin of dorsal nearer to base of caudal than to tip of snout .. 28
- 26a. Lateral line incomplete consisting of only a few pores and not extending beyond vertical from free end of pectoral fin
Noemacheilus vittatus (Heckel)
- 26b. Lateral line complete or clearly defined up to vertical opposite posterior end of anal base, being indistinct on the caudal peduncle (exception being female *N. yasinensis* in which L.L. is clear only up to above pelvic fin) .. 27
- 27a. Pectoral as long as or slightly longer than head ; least height of caudal peduncle about as broad as diameter of eye in specimens over 55 mm. in standard length
Noemacheilus yasinensis Alcock (Male)
- 27b. Pectorals shorter than head length ; least height of caudal peduncle considerably greater than diameter of eye in specimens over 55 mm. in standard length
Noemacheilus kashmirensis Hora (Pl. I, fig. 4)
- 28a. Snout and post orbital part of head of equal length ; anal fin separated from caudal by a distance almost equal to its own length
Noemacheilus marmoratus (Heckel)
- 28b. Snout shorter than post-orbital part of head ; anal fin separated from caudal fin by a distance considerably lesser than its own length
Noemacheilus yasinensis Alcock (Female)

REFERENCES

- Chaudhuri, B. L. (1909): Description of new species of *Botia* (*B. birdi*) and *Nemachilus* (*N. macmahoni*). *Rec. Ind. Mus.* 3: 339-42.
- Day, F. (1876): On the fishes of Yarkand. *Proc. Zool. Soc. London*: 781-807.
- (1878a): Scientific results of the Second Yarkand Mission. Ichthyology. Calcutta. 1-25 with 5 pls.
- (1878b): The Fishes of India, being a Natural History of the Fishes known to inhabit the Seas and Freshwaters of India, Burma, and Ceylon.
- Günther, A. (1864 & 1868): Catalogue of Fishes of the British Museum. Vols. 5 & 7.
- Heckel, J. J. (1838): Fische aus Caschmir.
- (1844): Fische Kaschmir's in von Hugel's: Kaschmir und das Reich der Siek, Bd. 4, abth. 2: 351-384.
- Hora, S. L. (1922a): Notes on fishes in the Indian Museum III. On fishes belonging to the family Cobitidae from high altitudes in Central Asia. *Rec. Ind. Mus.* 24: 63-83.
- (1922b): Notes on fishes in the Indian Museum IV. On fishes belonging to the genus *Botia* (Cobitidae). *Ibid.* 24: 313-321.
- (1934): The fish of Chitral. *Ibid.* 36: 279-319.
- (1936): Yale North Indian Expedition, Article XVIII. Report on Fishes, Part 1, Cobitidae. *Mem. Conn. Acad. Sci.* 10: 299-321.
- (1937): On fossil fish-remains from the Karewas of Kashmir. *Rec. Geol. Surv. India* 72 (2): 178-187.
- (1939): The Game Fishes of India VIII. The Mahseers or the Large scaled barbels of India I. The Putitor Mahseer, *Barbus* (*Tor*) *putitora* (Hamilton). *J. Bombay nat. Hist. Soc.* 41: 272-285.
- (1955): Fisheries of certain tropical fishes in natural cold waters of India. *Ibid.* 53 (1): 138-140.
- Hora, S. L. & Silas, E. G. (1952a): Notes on Fishes in the Indian Museum. XLVII. Revision of the Glyptosternoid fishes of the family Sisoridae, with description of new genera and species. *Rec. Ind. Mus.* 49: 5-30.
- (1952b): Evolution and distribution of Glyptosternoid fishes of the family Sisoridae (Order: Siluroidea). *Proc. Nat. Inst. Sci. India* 18 (4): 309-322.
- Hora, S. L., Mulick, G. M., & Khajuria, H. (1955): Some interesting features of the aquatic fauna of the Kashmir Valley. *J. Bombay nat. Hist. Soc.* 53 (1): 140-3.
- McClelland, J. (1839): Indian Cyprinidae. *Asiat. Research.* 19 (2): 217-471.
- Misra, K. S. (1949): A note on the systematic position of two cyprinid fishes of the genus *Oreinus* McClelland from Kashmir. *J. Zool. Soc. India* 1 (3): 39-40.
- Mitchell, F. J. (1916): Large Kashmir Brown Trout, *Salmo fario*. *J. Bombay nat. Hist. Soc.* 24 (2): 371-372 (with one photograph).
- (1918): How trout were introduced into Kashmir. *Ibid.* 26 (1): 295-299.
- Mukerji, D. D. (1935): Report on Burmese fishes collected by Lt.-Col. R. W. Burton from the tributary streams of the Mali Hka River of the Myitkyina District, (Upper Burma). *Ibid.* 37 (1): 38-80.
- (1936): Yale North Indian Expedition, Article 18. Report on fishes, part 2. Sisoridae and Cyprinidae. *Mem. Conn. Acad. Sci.* 10: 323-359.
- Ross, E. J. (1939): Trout fishing in Kashmir. *J. Bombay nat. Hist. Soc.* 41(2): 437-442.
- Steindachner, F. (1866): Zur Fisch fauna Kaschmirs und der benachbarten Landerstriche. *Verh. Zool.-Bot. Ges. Wein* 16: 784-796.
- Valenciennes, A. (1840 & 1842): Historie Naturelle des Poissons. Vols. 15 & 16.

The Diatom Flora of the Bombay and Salsette Islands

BY

H. P. GANDHI

Bahauddin College, Junagadh, Saurashtra

(With 120 figures)

INTRODUCTION

This account deals with the diatom genera, *Pinnularia*, *Amphiprora*, *Amphora*, *Cymbella*, and *Gomphonema*, collected from the year 1945-1949 onwards up to 1958 in the form of stray samples. It continues the chain of first three papers jointly published by Mrs. E. A. Gonzalves and myself (1952-54).

Since 1954 the author's work on the diatom flora of the Bombay and Salsette Islands has been disturbed by difficulties and circumstances beyond his control. However, during this long period several other collections were made at different times from the same and other localities of the said region and were examined at different institutions on account of the frequent transfers that the author suffered. With the further observations some more diatoms were recorded, making this paper more comprehensive. In this paper the distribution of individual diatoms in the area is also indicated. Several illustrations are given of certain species to suggest the form-change or variation exhibited by them.

Further, the arrangement of diatoms is mostly done according to Cleve-Euler's (1951-55) monograph in consultation with that of Hustedt (1930) and several other publications. The diatoms already recorded in the Indian literature are merely listed here with some necessary notes or remarks; the rest are fully described and illustrated. Of diatoms that are considered to be new taxa, besides their Latin diagnoses, the slide numbers are given in accordance with the International Code of Botanical Nomenclature, Art. 35, 1956. All the material relating to this paper is with the author in his own herbarium.

Again, to validate the new taxa published by the author in his earlier paper on 'Freshwater Diatoms from Kolhapur and its immediate

Environs,' *J. Bombay nat. Hist. Soc.* 55 (3) : 493-511, 1958, the following slide numbers refer to those specific taxa, thus :

Navicula cuspidata Kütz. f. *brevirostrata* f. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 18-9-1954, et positus in herbario proprio auctoris sub numero KOP-49, (slide).

Pinnularia kolhapurensis sp. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 9-12-1954, et positus in herbario proprio auctoris sub numero KOP-61, (slide).

Gomphonema lacus-rankala sp. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 9-12-1954, et positus in herbario proprio auctoris sub numero KOP-63, (slide).

Gomphonema lacus-rankala v. *robusta* v. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 9-12-1954, et positus in herbario proprio auctoris sub numero KOP-64, (slide).

Gomphonema lacus-rankala v. *gracilis* v. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 9-12-1954, et positus in herbario proprio auctoris sub numero KOP-65, (slide).

Gomphonema spicula sp. nov. : Typus lectus a H. P. Gandhi in lacu Rankala die 18-9-1954, et positus in herbario proprio auctoris sub numero KOP-68, (slide).

Genus PINNULARIA Ehrenberg 1840

Section TENUISTRIATAE Å. Berg.

1. *Pinnularia appendiculata* (Ag.) Cl. (Fig. 1)

Schmidt, A., 1874-1944, *Atlas Diat.* t. 313, f. 10-11 ; Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : 565, t. 20, f. 13 ; 1930, *Bacil.* 317, f. 570a ; Skvortzow, B. W., 1938, *Philipp. J. Sci.* 66 : 169, pl. 2, f. 8 ; Tiffany & Britton, 1952, *Alg. Illinois* 258, pl. 69, f. 796 ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 18, f. 1004 a-d (=v. *genuina* A. Cl.).

Valves 44-56.5 μ long and 6-8.5 μ broad, linear-lanceolate with weakly constricted, produced subcuneate ends. Raphe thin and straight with central pores unilaterally bent and terminal fissures slightly curved. Axial area quite narrow, linear-lanceolate ; central area large, rhomboid, reaching the sides. Striae 12-14 in 10 μ , radial in the middle and convergent at the ends.

This species agrees well with the type described by Hustedt and others, in the outline, apices, central and axial areas and the nature of the striae. The range of dimensions recorded here closely agree with those indicated by Cleve-Euler, but appear to be larger than those given by Hustedt, Tiffany & Britton, and Skvortzow. The number of striae per 10 μ are less here than recorded by Hustedt and Tiffany & Britton but agree with

those recorded by Cleve-Euler and Skvortzow. It appears that the number of striae per 10 μ suffer reduction in larger forms as may be seen from the following table :

Author	Length	Breadth	Striae per 10 μ
Hustedt	18-36 μ	4-6 μ	16-18
Skvortzow	35 μ	5 μ	12-13
Tiffany & Britton	18-36 μ	4-6 μ	16-18
Cleve-Euler	35-58 μ	5-7 μ	(12) 13-16
Local forms	44-56.5 μ	6-8.5 μ	12-14

Again, Berg describes a similar looking form as *P. subcapitata* Greg. (Berg, *Arkiv Bot.* 1945, 32 A(1) : 17, t. 5, f. 176) and Skvortzow as *P. gibba* Ehr. (Skvortzow, 1937, *Philipp. J. Sci.* 61 : 278, pl. 5, f. 2), but I am not inclined to refer the present specimens to either *P. subcapitata* or *P. gibba*, which are obviously different species. In fact, Berg's *P. subcapitata* and Skvortzow's *P. gibba*, appear closer to *P. appendiculata* if Cleve-Euler's record is considered, as given in the above table. In any way I consider the present specimens to be *P. appendiculata* in light of the data given above.

Habitat : Fresh water. Collected from Jogeshwari, Goregaon, Andheri, and Dahisar ponds and pools, usually in a small number.

2. *Pinnularia molaris* Grun. (Fig. 2)

Schmidt, 1874-1944, *Atlas Diat.* t. 313, f. 18 ; Hustedt, 1924, *Naturw. Unters. Sarek.* t. 20, f. 8 ; 1930, *Bacil.* 316, f. 568 ; Skvortzow, B. W., 1937, *Philipp. J. Sci.* 62 : 337, pl. 11, f. 9 ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 18, 1005.

Valves 28-33 μ long and 5.6-6.2 μ broad, linear-lanceolate with sub-cuneate rounded ends. Raphe thin and straight with curved terminal fissures. Axial area quite narrow ; central area large, rhomboid, reaching the sides. Striae 14-18 in 10 μ , fine, radial in the middle and convergent at the ends.

Habitat : Fresh water. Pools and streams at Borivli and Kanheri caves and certain ponds at Andheri, Vile-Parle, Dahisar, and other places. Usually collected as a stray form.

Section SUBVIRIDES A. Cl.

3. *Pinnularia finlandica* A. Cl. (Fig. 3)

Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 22, f. 1027.

Valves 50-57.5 μ long and 10-11.2 μ broad, linear with parallel sides and rounded ends. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area fairly wide about 1/4

the width of the valve, linear ; central area slightly dilated and somewhat unilateral. Striae 10-11 in $10\ \mu$, coarse, slightly radial in the middle and convergent towards the ends.

Habitat : Fresh water. Collected from ponds at Andheri and Goregaon, and some pools at Jogeshwari and other places. Not common.

This species agrees well with the type except that it has slightly larger dimensions.

Section NODOSAE A. Cl.

4. *Pinnularia braunii* (Grun.) Cl. (Fig. 4)

Hustedt, 1930, Bacil. 319, f. 577 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 24, f. 1020 a-c (=v. *genuina* A. Cl. et etiam v. *marginata* A. Cl.) ; Schmidt, A. 1874-1944, Atlas Diat. t. 45, f. 77-78 (= *Navicula brauniana* Grun.) ; Van Heurck, 1896, Treat. Diat. 173, pl. 2, f. 95 (= *Nav. braunii* Grun.).

Valves 43-50 μ long and 8.5-9.5 μ broad, broadly lanceolate with constricted, produced capitate ends. Raphe thin and straight with central pores closely set and unilaterally bent and terminal fissures curved. Axial area very wide, lanceolate ; central area very wide, rhomboid, reaching the sides. Striae 10-12 in $10\ \mu$, very coarse, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from several pools, ponds and tanks in the area, usually in a small number or as a stray form.

5. *Pinnularia polyonca* (Bréb.) O. Müll. (Fig. 5)

Hustedt, 1930, Bacil. 319, f. 576 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 24, f. 1021 ; Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 54-55 (= *Navicula mesotyla* (Pinn.) Ehr.) ; Van Heurck, 1896, Treat. Diat. 174, pl. 2, f. 99 (= *Nav. polyonca* Bréb.).

Valves 90-100 μ long and 14-15.2 μ broad, lanceolate with strongly triundulate sides and strongly capitate-cuneate ends. Raphe thin and straight with closely set central pores unilaterally bent and terminal fissures curved. Axial area fairly wide, sublanceolate ; central area large reaching the sides. Striae 8-10-12 in $10\ \mu$, coarse, radial in the middle and strongly convergent at the ends and closer.

Habitat : Fresh water. Collected from pond at Andheri usually as a stray form. Rare in the area.

Cleve-Euler refers *Nav. mesotyla* of Schmidt's 'Atlas' to *P. polyonca* but *N. mesotyla* has rounded ends and therefore differs from *P. polyonca* in this respect.

6. *Pinnularia acrosphaeria* (Bréb.) W. Sm.

Habitat : Fresh water as well as somewhat brackish water. Widely distributed in the area, mostly in marginal slime of pools, ponds, and tanks. It was noted to be gregarious in ponds at Andheri and Goregaon.

7. *Pinnularia acrosphaeria* f. *undulata* Cl.

Habitat : Fresh water. Sometimes collected along with the species. Not common in the locality.

8. *Pinnularia acrosphaeria* v. *minor* Cl. (Figs. 6-7)

Habitat : Fresh water as well as in somewhat brackish water. Widely distributed in the area, but always recorded in a small number.

9. *Pinnularia acrosphaeria* v. *sandvicensis* A. S. (Figs. 8-9)

Schmidt, A., 1874-1944, Atlas Diat. t. 43, f. 14-15, 18 ?

Valves 70-85 μ long and 12.5-13 μ broad, linear, strongly inflated in the middle, ends broadly swollen and rounded. Raphe thin and straight with central pores closely set and unilaterally bent and terminal fissures curved. Axial area very wide, about $1/3$ the width of the valve, linear with fine scattered markings or puncta ; central area slightly formed. Striae 9-10 in 10 μ coarse, weakly radial in the middle, at length perpendicular to the middle line and weakly convergent at the ends.

Habitat : Fresh water. Streams at Borivli and Powai lake. Rare.

This diatom is distinguished on account of the strong inflations in the middle and at the ends.

10. *Pinnularia dolosa* sp. nov. (Figs. 10-11)

Schmidt, A., 1874-1944, Atlas Diat. t. 43, f. 17 (=nomen nudum).

Valvae 60-90 μ longae atque 13-15 μ latae, lineares, tumidae in medio; apicibus vix dilatatis ac late rotundatis. Raphe evoluta in zona hyalina, ornata poris centralibus proxime positis et unilateraliter inclinatis, fissuris terminalibus curvatis. Area axialis amplissima, circiter $1/3$ - $1/2$ latitudinis valvae, linearis et irregulariter subtiliter punctata ; area centralis paulum unilateraliter dilatata. Striae 9-11 in 10 μ , crassae, paululum radiales in medio, tandem perpendiculares ad lineam mediam ac paulum convergentes ad apices. Typus lectus a H. P. Gandhi ad Andheri die 1945-48, et positus in herbario proprio auctoris sub numero BOM-AND.—43-45.

Valves 60-90 μ long and 13-15 μ broad, linear, tumid in the middle ; ends scarcely dilated and broadly rounded. Raphe formed in the hyaline zone with central pores closely set and unilaterally bent and terminal fissures curved. Axial area very wide about $1/3$ - $1/2$ the width of the valve, linear with fine irregularly disposed puncta ; central area slightly

unilaterally dilated. Striae 9-11 in $10\ \mu$, thick, weakly radial in the middle, at length perpendicular to the middle line and at the ends convergent.

Habitat: Fresh water. Collected as a common form in a pond at Andheri. Seen as a constant form for a period of almost three years.

An illustration occurs in Schmidt's *ATLAS DIAT.*, without name, but it has been remarked that it is somewhere intermediate between *Navicula* (*Pinnularia*—Ehr. ?) *macilenta* and *Navicula* (*Pinn.*) *acrosphaeria* Bréb., 'ATLAS DIAT.', t. 43, f. 9 and 16 respectively. From my continued observation of this species, I find it to be related to *P. acrosphaeria* (Bréb.) W. Sm. However, it differs from *P. acrosphaeria* in having non-dilated apices, clear hyaline zone around the raphe, much wider axial area, and the puncta in the axial area being much finer. It is therefore considered to be a new species and placed near *P. acrosphaeria*, being related to it.

11. *Pinnularia dolosa* v. *chariessa* v. nov. (Fig. 12)

Valvae 117-120 μ longae atque 16-17 μ latae, sublanceolatae, tumidae in medio ac apicibus rotundatae. Raphe, zona hyalina, atque area axialis ut in typo. Area centralis ampla, ad latera perveniens. Striae 8-9 in $10\ \mu$, crassae, paulum radiales in medio, tandem perpendiculares ad lineam mediam ac paulum convergentes ad apices, ut in typo. Typus lectus a H. P. Gandhi ad Andheri die 1946-48, et positus in herbario proprio auctoris sub numero BOM-AND.—47.

Valves 117-120 μ long and 16-17 μ broad, sublanceolate, tumid in the middle with rounded ends. Raphe, hyaline zone, and the axial area as in the type. Central area large and extended to the sides. Striae 8-9 in $10\ \mu$, thick, weakly radial in the middle and at the ends slightly convergent as in the type.

Habitat: Fresh water. Collected from a pond at Andheri along with the type but in a smaller number or as a stray form.

This diatom differs from the above type in being gracefully lanceolate. Moreover, the central area is extended to the sides and the striae are more widely set; therefore they count less in number than in the type.

Section DISTANTES Cleve

12. *Pinnularia ueno* Skvortzow v. *wadalensis* v. nov. (Figs. 13-14)

Valvae 32-47.5 μ longae atque 10-11.7 μ latae, lineares, marginibus parallelis vel paululum concavis, apicibus cuneatis, late rotundato-truncatis. Raphe crassa, poris centralibus unilateraliter inclinatis ac fissuris terminalibus aliquantum curvatis. Area axialis modica, lineari-lanceolata; area centralis ampla, rhomboidea ad latera pertingens. Striae 6.5-8 in $10\ \mu$, crassae, radiales in medio ac paulum convergentes

in utroque apice. Typus lectus a H. P. Gandhi ad Wadala die 31-7-1945, et positus in herbario proprio auctoris sub numero BOM-WAD.—5-7.

Valves 32-47.5 μ long and 10-11.7 μ broad, linear with parallel or weakly concave sides and cuneate, broadly truncate-rounded ends. Raphe thick with central pores unilaterally bent and terminal fissures slightly curved. Axial area moderate, linear-lanceolate; central area large, rhomboid, reaching the sides. Striae 6.5-8 in 10 μ , thick, radial in the middle and slightly convergent at the ends.

Habitat : Fresh water. Collected from pools and ponds at Wadala as a frequent form during post-monsoon seasons. Some stray specimens also were recorded from Powai lake.

This diatom agrees very closely with *P. ueno* Skv. (Skvortzow, 1937, *Philipp. J. Sci.* 61 : 44, pl. 7, f. 1), in the outline, arrangement of striae, and other details. However, of the specimens collected here the dimensions are much smaller. Moreover, the striae are fewer in number than in *P. ueno*, hence it differs. Again, Foged has described a similar looking form as *P. microstauron* (Ehr.) Cl. (Foged, N., 1955, *Medd. om Gronland* 127 : 59, pl. 11, f. 21), which is in fact very different from *P. microstauron* (Ehr.) Cl. I am not sure if it could be the same. However, I am inclined to consider it with the present diatom, since it bears great likeness. Further, I place the present diatom under 'Distantes' group on account of the robust and distantly set striae.

Section BREVISTRIATAE Cleve em.

13. *Pinnularia brevicostata* Cl. v. *indica* v. nov. (Fig. 15)

Valvae 90-95 μ longae atque 19.8-20.5 μ latae, lineari-ellipticae ac apicibus rotundatis. Raphe tenuis vel crassa, ornata poris centralibus distinctis, unilateraliter inclinata ac fissuris terminalibus paulum curvatis. Area axialis amplissima, circiter $1/3$ - $1/2$ latitudinis valvae, sublanceolata; area centralis obscura. Striae 5.5-6 in 10 μ , crassissimae, aliquantum radiales in medio atque in utroque apice convergentes. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—18.

Valves 90-95 μ long and 19.8-20.5 μ broad, linear-elliptical with rounded ends. Raphe thin or thick with central pores distinct and unilaterally bent and terminal fissures slightly curved. Axial area very wide, about $1/3$ - $1/2$ the width of the valve, sublanceolate; central area not obvious. Striae 5.5-6 in 10 μ very coarse, slightly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Borivli streams and Powai lake as a stray form.

This diatom in its general features agrees well with *P. brevicostata* Cl. (Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 37, f. 1045 a-b) (= *v. genuina* A. Cl.) and its other varieties. However, the present specimens differ from the type in having more uniformly convex sides, somewhat smaller size, and coarser and therefore fewer striae. It is, therefore, tentatively regarded as a new variety.

14. *Pinnularia meisteri* A. Cl. v. *scandica* A. Cl. (Fig. 16)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 40, f. 1050 b.

Valves 61-68 μ long and 11-13 μ broad, broadly linear, slightly swollen in the middle with somewhat inflated rounded ends. Raphe thin and straight with terminal fissures curved. Axial area narrow, linear; central area only slightly dilated. Striae about 12 in 10 μ , coarse, slightly radial in the middle and convergent at the ends.

Habitat: Fresh water. Collected from some pools and ponds at Wadala, Goregaon, Vile-Parle, and streams at Borivli. Not common.

Section LUNULAE A. Cl.

15. *Pinnularia stomatophora* Grun. v. *triundulata* Font. (Fig. 17)

Hustedt, 1942, *Int. Rev. Hydrobiol. Hydrogr.* 42 (1/3): 88, f. 168-170; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 41, f. 1053 d (= *P. stomatophoroides* Mayer f. *triundulata* (Font.) A. Cl.).

Valves 115-118.8 μ long and 13.7-14 μ broad, sublinear, with triundulate sides and produced capitate rounded ends. Raphe slightly thick and straight with bayonet-shaped terminal fissures. Axial area somewhat narrow, linear; central area without lunulae, large, rhomboid, reaching the sides. Striae 10-12 in 10 μ , coarse, strongly radial in the middle and convergent at the ends.

Habitat: Fresh water. Collected from streams at Borivli, Powai and Tansa lakes, mostly as a stray form.

Some specimens of this diatom found in the collections, none showed lunulae in the central area, which are supposed to be the characteristic feature of the type. However, Hustedt illustrated a form (fig. 169) without lunulate markings and in the remarks stated that a good deal of variation seemed to occur in the species. Cleve-Euler has treated the same as *P. stomatophoroides* Mayer f. *triundulata* (Font.) A. Cl., without assigning any reasons as I believe. I do not favour Cleve-Euler's diagnosis, since *P. stomatophoroides* was established in 1940, much later than *P. stomatophora* Grun. v. *triundulata* Font. 1917.

Further, the present diatom also agrees with *P. gibba* f. *subundulata* Mayer (Hustedt, 1930, Bacil. 327, f. 601) in the outline, central and axial areas, and the number of striae. However, I separate the same on

the basis of thicker raphe and bayonet-shaped terminal fissures taking them as characteristic features of *P. stomatophora*. A more or less similar diatom has been described by Skvortzow as *P. platycephala* (Ehr.) Cl. v. *hattoriana* Skv. (Skvortzow, 1935, *Philipp. J. Sci.* 57 : 470, pl. 2, f. 4 ; 1937, *ibid.* 61 : 41, pl. 6, f. 2), having bayonet-shaped terminal fissures and triundulate sides. However, this diatom has not been well understood, since Skvortzow illustrated the type somewhat differently in the papers hitherto cited. Moreover, *P. platycephala* has terminal fissures bent in opposite directions, and this feature being of diagnostic importance for the type finds no appearance in the variety v. *hattoriana* Skv.

Section PARALLELAE A. Cl.

16. *Pinnularia episcopalis* Cleve (Fig. 18)

Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : 569, t. 21, f. 1 ; 1930, *Bacil.* 323, f. 592 ; Mills, F., 1932, *J. roy. microsc. Soc.* 52 : 389, pl. 3, f. 30 ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 47, f. 1063 c (= v. *elliptica* A. Cl.).

Valves 108-112 μ long and 24.6-25 μ broad, subelliptical with rounded ends. Raphe thin, slightly bent with central pores large, somewhat hook-like and terminal fissures oblique and slightly curved. Axial area linear ; central area somewhat quadrate, reaching the sides. Striae 8-9 in 10 μ , thick, closely set, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai and Tansa lakes in a smaller number. Stray specimens also were collected from some hill-streams at Borivli.

17. *Pinnularia platycephala* (Ehr.) Cl. (Fig. 19)

Schmidt, A., 1874-1944, *Atlas Diat.* t. 310, f. 6-8 ; Hustedt, 1930, *Bacil.* 324, f. 593 ; Berg, 1945, *Ark. Bot.* 32 A (1) : 15, t. 4, f. 155 ; Cleve-Euler, A. 1951-55, *Diat. Schwed. Finn.*—IV, 47, f. 1065 a-b. (= v. *genuina* A. Cl.).

Valves 81-95 μ long and 16.5-17.5 μ broad, linear or sublinear, sides distinctly triundulate, ends broadly capitate-rounded (two ends somewhat differ in appearance). Raphe thin, not quite straight, with large central pores and terminal fissures thick, sharply curved in the opposite directions. Axial area somewhat narrow, linear ; central area quadrate, somewhat narrow while reaching the sides. Striae 9-11 in 10 μ , coarse, strongly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from ponds at Andheri, Dahisar, and Goregaon, streams at Borivli, and Powai lake. It occurred in a small number. Not common.

Section DIVERGENTES Cleve em.

18. *Pinnularia legumen* Ehr. v. *florentina* (Grun.) Cl.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Tansa lakes, usually in a small number.

19. *Pinnularia scythica* (Pant.) Gandhi, comb. nov. (Fig. 20)

Navicula scythica Pantocsek, Beitr. Kenn. foss. Bacil.—III, 81, t. 23, f. 335, 1905; Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 30? (= *P. decurrens* Ehr.); t. 391, f. 9-10 (= *P. krasskei* Hust. v. *ventricosa* Hust.).

Valves 87.4-92 μ long and 16.6 μ broad, linear-lanceolate with uniformly convex sides and constricted, broadly produced rounded ends. Raphe thin or somewhat thick with central pores distinct and terminal fissures curved. Axial area about 1/5-1/4 the width of the valve, sub-linear; central area large and more or less elliptical. Striae 9-10 in 10 μ , thick, closely set, strongly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai and Tansa lakes in good number, and some stray specimens were recorded from a tank at Bandra and some other larger ponds. Not quite common.

This agrees well with Pantocsek's *Nav. scythica* Pant., which from the illustration evidently appears to be *Pinnularia* on account of the smooth costae. Here, therefore, Pantocsek's *Nav. scythica* is emended. From further survey of the literature, *P. decurrens* Ehr. (Schmidt's 'Atlas' t. 45, f. 30) more or less compares here, except that it has more evident lanceolate shape and less apparently constricted produced ends. Again, in the 'Atlas' *P. krasskei* Hust. v. *ventricosa* Hust. (t. 391, f. 9-10) is illustrated, which very closely agrees with the present specimens as well as with Pantocsek's *Nav. scythica* in the outline, apices, central and axial areas, and the number and arrangement of the striae. I, therefore, consider *P. krasskei* v. *ventricosa* Hust. identical with *Nav. scythica* Pant., the latter needing emendment of its generic name, which I here-with effect.

20. *Pinnularia divergens* W. Sm. (Fig. 21)

Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : 568, t. 22, f. 4; 1930, *Bacil.* 323, f. 589; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 51, f. 1071 a (= v. *minor* A. S.); Schmidt, A., 1874-1944, *Atlas Diat.* t. 44, f. 42, (= *Nav. divergens* (Pinn.) W. Sm. f. *minor* A. S.).

Valves 80-87.5 μ long and 14.4-15 μ broad, linear-lanceolate with constricted, broadly produced, rounded ends. Raphe thin and somewhat undulate with central pores unilaterally bent and terminal fissures thick and more or less bayonet-shaped. Axial area linear; central area large, rhomboid, reaching the sides with conical projections formed on

the sides. Striae 9-11 in $10\ \mu$, thick, congested, strongly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Borivli streams, Powai and Tansa lakes, as a less frequent form. It was usually found in brownish masses of decaying vegetable matter lying on the margins.

21. *Pinnularia divergens* v. *undulata* Hér. & Perag. (Fig. 22)

Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (5) : 568, t. 22, f. 5 ; 1930, *Bacil.* 323, f. 591 ; Skvortzow, B. W., 1938, *Philipp. J. Sci.* 66 : 171, pl. 1, f. 28 ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 52, f. 1071 d.

Valves 68-75 μ long and 13-13.5 μ broad, linear-lanceolate with distinctly triundulate sides and constricted, broadly produced rounded ends. Striae 10 in $10\ \mu$. In all other features alike the above type.

Habitat : Fresh water. Collected from Powai and Tansa lakes and ponds at Andheri, Goregaon, and Vile-Parle. Not quite common.

22. *Pinnularia divergens* v. *elliptica* Grun. (Fig. 23)

Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : t. 21, f. 1 ; 1930, *Bacil.* 323, f. 590 ; Mills, F. W., 1932, *J. roy. microsc. Soc.* 52, 389, pl. 1, f. 14 ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 52, f. 1071 e.

Valves 68-90 μ long and 15-18 μ broad, linear-elliptical with rounded ends. Striae 8-10 in $10\ \mu$. In all other details like the type described above.

Habitat : Fresh water. Collected as a common form from Andheri and Goregaon ponds. Stray specimens were also collected from some larger pools and streams at Borivli.

23. *Pinnularia divergens* v. *capitata* Mills (Fig. 24)

Mills, F. W., 1932, *J. roy. microsc. Soc.* 52 : 389, pl. 2, f. 15.

Valves 65-81 μ long and 12.8-14 μ broad, linear-lanceolate with weakly triundulate sides and constricted, broadly capitate rounded ends. Axial area somewhat narrow, linear. Striae 10-12 in $10\ \mu$. In all other details like the type described above.

Habitat : Fresh water. Collected from Powai, Vihar, and Tansa lakes, inhabiting decaying mass of vegetable matter. Fairly common. Isolated specimens also were recorded from a pond at Andheri.

This diatom agrees well with the specimen described by Mills, except that the breadth here is much less. From the measurement of the illustration given by Mills it appears that some mistake has crept in, since the breadth given in the text is 0.025 mm. whereas by measurement it comes out to be 0.01566 mm. With the measured dimensions, therefore, my specimens agree more or less quite well with those of Mills ; so I treat my speci-

mens. Moreover, some smaller specimens also have been recorded from the present region.

Again, a reference is cited by Mills, which refers to Schmidt's 'Atlas' t. 44, f. 12 (an illustration without name), to be *P. divergens* v. *capitata*. I think this to be different, since Mills's illustration clearly shows triundulate sides whereas in the 'Atlas' that is not the case.

Further, Cleve-Euler described a diatom under a similar name, i.e. *P. divergens* v. *capitata* n. v. (Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 53, f. 1071 k), which befits *P. divergens* characteristics, but greatly differs from Mills's and present specimens. According to the International Code of Botanical Nomenclature, one name for two different specimens cannot hold good and at the same time rule of priority has to be observed. Under the circumstances, therefore, Cleve-Euler's specimen needs a new name.

24. *Pinnularia brébissonii* (Kütz.) Cl. (Fig. 25)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 53, f. 1071a (= v. *genuina* O. Müll.); Schmidt, A., 1874-1944, Atlas Diat. t. 44, f. 17-19 (= *Navicula brébissonii* Kütz.); Van Heurck, 1896, Treat. Diat. 171, pl. 2, f. 82 (= *Nav. brébissonii* Kütz.); Pantocsek, J., 1905, Beitr. z. Kenn. foss. Bacil. III, 65, t. 19, f. 279 (= *Nav. brébissonii* v. *fossilis* Pant.); Hustedt, 1930, Bacil. 321, f. 584 (= *P. microstauron* (Ehr.) Cl. v. *brébissonii* (Kütz.) Hust.); Foged, N., 1949, Dansk Bot. Ark. 13 (6) : 30, II, f. 11 (= *P. microstauron* v. *brébissonii*); Jurilj, A., 1954, Jugoslav Akad. Znan. Umjet. 1954 : 141, f. 44 a-b (= *P. microstauron* v. *brébissonii*).

Valves 60 μ long and 14.8 μ broad, linear-elliptical to subelliptical with subcuneate rounded ends. Raphe thin and straight with unilaterally bent central pores and slightly curved terminal fissures. Axial area fairly wide, linear-lanceolate; central area large, rhomboid, reaching the sides. Striae 10-11 in 10 μ , coarse, radial in the middle and convergent at the ends.

Habitat: Fresh water. Collected from ponds at Andheri and Goregaon, usually in a small number. Stray specimens were also observed in some of the samples from Powai lake.

The present species conforms well with illustrations given in the 'Atlas' and by Pantocsek, Van Heurck, Foged, and Jurilj. However, Foged and Jurilj show somewhat narrower axial area. Hustedt's illustration differs much more than in the works hitherto cited in as much as that it has more linear outlines and somewhat distinctly cuneate ends. It is possible to keep Hustedt's specimen apart to be treated as variety of the present species, which is being done by Cleve-Euler (v. *acuta* A. Cl.)

25. *Pinnularia brébissonii* v. *producta* A. Cl. (Fig. 26)

Some larger specimens were recorded from the area than those found from paddy and millet fields at Mugad. Moreover, the present specimens have comparatively a fewer striae (dimensions $53-63 \times 12-14 \mu$, str. $8.5-10$ in 10μ).

Habitat: Fresh water. Collected from several ponds, large pools and tanks in the area. More frequently noted in a pond at Goregaon.

26. *Pinnularia brébissonii* v. *producta* f. *biundulata* (O. Müll.) A. Cl. (Fig. 27)

The specimens recorded from the area are comparatively smaller than those recorded from Mugad area (dimensions recorded here: $29-40 \times 6.2-8 \mu$, str. $10-12$ in 10μ).

Habitat: Fresh water. Collected from lakes, ponds, and tanks in the area. Fairly distributed.

27. *Pinnularia balatonis* (Pant.) Gandhi, comb. nov. (Fig. 34)

Navicula balatonis Pantocsek, *Res. Wiss. Erf. Balat.* 2 (2): 33, t. 3, f. 64, 1902; Skvortzow, B. W., 1928-32, *Ceylon J. Sci.* 11: 256, pl. 33, f. 4 (= *P. microstauron* β *brébissonii* (Kütz.) May. v. *ceylonica* Skv.); Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 55, f. 1072 t. (= *P. brébissonii* v. *acuta* A. Cl.).

Valves $46-51.3 \mu$ long and $10-12 \mu$ broad (in the middle $8-9 \mu$), linear with concave sides and subcuneate rounded ends. Raphe thin and more or less straight, terminal fissures curved. Axial area narrow, sublinear; central area large, rhomboid, reaching the sides. Striae $9-10$ in 10μ , coarse, radial in the middle and convergent at the ends, middle striae gradually abbreviated.

Habitat: Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Not common.

This species agrees very closely with Pantocsek's *Nav. balatonis* Pant., which is in fact a *Pinnularia* type as suggested by the illustration. Cleve-Euler also probably considers it to be a *Pinnularia* as suggested by the remark: 'a plumper form than that of Hustedt's *P. microstauron* v. *brébissonii* (Kütz.) Hust.' I, therefore, merit the remarks of Cleve-Euler and effect the emendment by recognising *Nav. balatonis* as *Pinnularia balatonis*.

Further, I consider *P. balatonis* (Pant.) Gandhi to be a distinct species, since I never found it in association of *P. brébissonii* (Kütz.) Cl. Moreover, its outline and the arrangement of striae appear to be different from *P. brébissonii*, which can be appreciated only on close comparison. However, it may be remarked that it has a close affinity with *P. brébissonii*,

Again from the literature it appears that Skvortzow described a form from Ceylon which is almost identical with the present one, except that it has slightly smaller range of dimensions (dimensions : $40-43 \times 8.5 \mu$, str. 12 in 10μ). Likewise Cleve-Euler's *P. brébissonii* v. *acuta* 'fig. 1072 t' agrees well here (dimensions : $37-43 \times 8-10 \mu$, str. 13 in 10μ). Giving little importance to these size differences, I herewith propose to refer Skvortzow's *P. microstauron* β *brébissonii* v. *ceylonica* Skv. and Cleve-Euler's *P. brébissonii* v. *acuta* 'fig. 1072 t only' to *P. balatonis* (Pant.) Gandhi, having range of dimensions : $37-51.3 \times 8-13 \mu$, striae 9-13 in 10μ .

28. *Pinnularia microstauron* (Ehr.) Cl. (Figs. 28-29)

Habitat: Fresh water. Collected from various small and large bodies of water in the region. It was usually found in rotting masses of vegetable matter spread on the edges of pools. Common but never found to be gregarious.

29. *Pinnularia divergentissima* (Grun.) Cl. (Fig. 30)

Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 59-60 ? (without name) ; t. 388, f. 23-24 ; Hustedt, 1930, Bacil. 320, 581 ; Berg, Å., 1945, Ark. Bot. 32 A (1) : 15, t. 4, f. 159 ; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 57, f. 1077 a-d (= v. *genuina* A. Cl.).

Valves $50-55.2 \mu$ long and 7.6μ broad, narrowly lanceolate with broadly rounded capitate ends. Raphe thin and straight with central pores slightly unilaterally bent and terminal fissures curved. Axial area very narrow, linear ; central area large, rhomboid, reaching the sides. Striae 11-13 in 10μ , very strongly radial in the middle and convergent at the ends, the angle formed between radial and convergent striae is about 115° .

Habitat: Fresh water. Collected from ponds at Goregaon, Andheri, Vile-Parle, and other places. Stray forms also were collected from Powai lake and streams at Borivli. Not common.

30. *Pinnularia termes* Ehr. v. *termitina* (Ehr.) A. Cl. (Fig. 31)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 60, f. 1085 c ; Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 64 (= *Navicula termitina* Ehr.).

Valves $50-55 \mu$ long and 7.2μ broad, narrowly linear with distinctly concave sides and strongly constricted, somewhat produced, broadly capitate rounded ends. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area linear ; central area wide, rhomboid, reaching the sides. Striae $10-12 \mu$ 10μ , well marked, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai and Vihar lakes quite frequently. Stray specimens also were collected from ponds at Andheri and Goregaon and a tank at Bandra. Not common.

31. *Pinnularia mesolepta* Ehr. v. *stauroneiformis* Grun. (Fig. 32)

Hustedt, 1914, *Arch. Hydrobiol.* 10 : 142, t. 1, f. 12 ; Skvortzow, B. W., 1928, *Philipp. J. Sci.* 35 : 43, pl. 2, f. 20 ; Schmidt, A., 1874-1944, *Atlas Diat.* t. 45, f. 71 (= *Navicula mesolepta* Ehr. v. *stauroneiformis* A. S. ?).

Valves 57.6-60 μ long and 9.10 μ broad, linear with strongly triundulate sides and somewhat narrowed, produced, broadly rounded capitate ends. Raphe thin and straight with central pores unilaterally bent or not ; terminal fissures curved. Axial area somewhat narrowly linear ; central area large, quadrate, reaching the sides. Striae 9-10 in 10 μ , coarse, strongly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from ponds at Goregaon, Dahisar, Vile-Parle, Jogeshwari, streams at Borivli, tank at Bandra, and Powai lake, mostly in a small number.

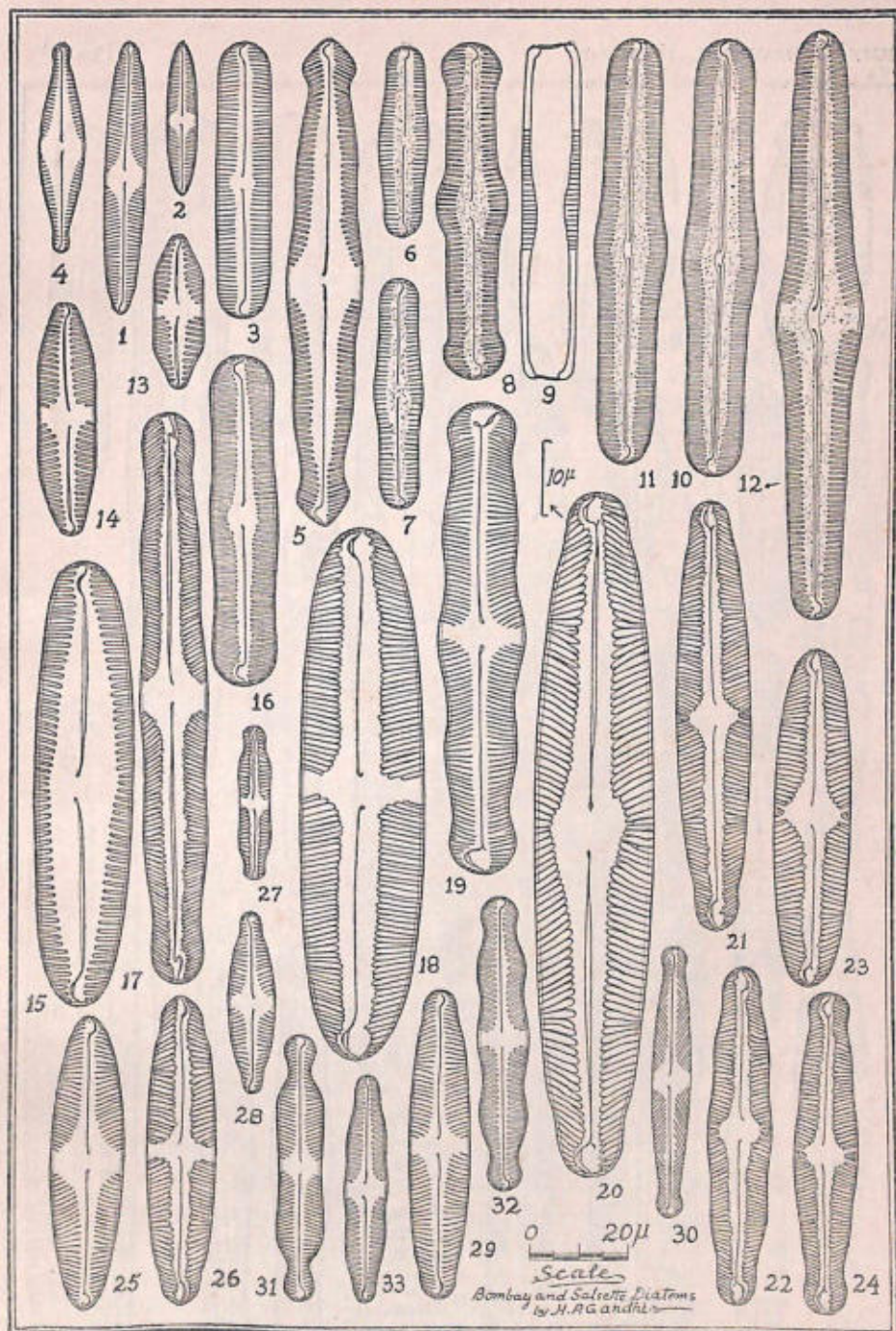
32. *Pinnularia mesolepta* v. *indica* v. nov. (Figs. 33, 35)

Valvae 38.7-50 μ longae atque 8.2-8.8 μ latae, lineari-lanceolatae, marginibus distincte triundulatis, apicibus leniter constrictis, elongato-rotundatis. Raphe tenuis et recta, fissuris terminalibus curvatis. Area axialis sublinearis ; area centralis magna, rhomboidea, ad latera perveniens. Striae circiter 9 in 10 μ , crassae, radiales in medio ac in utroque apice convergentes. Typus lectus a H. P. Gandhi ad Wadala die 31-7-1945, et positus in herbario proprio auctoris sub numero BOM-WAD.—4.

Valves 38.7-50 μ long and 8.2-8.8 μ broad linear-lanceolate with distinct triundulate sides and softly constricted, produced rounded ends. Raphe thin and straight with terminal fissures curved. Axial area, sublinear ; central area large, rhomboid, reaching the sides. Striae about 9 in 10 μ , coarse, radial in the middle and convergent at the ends.

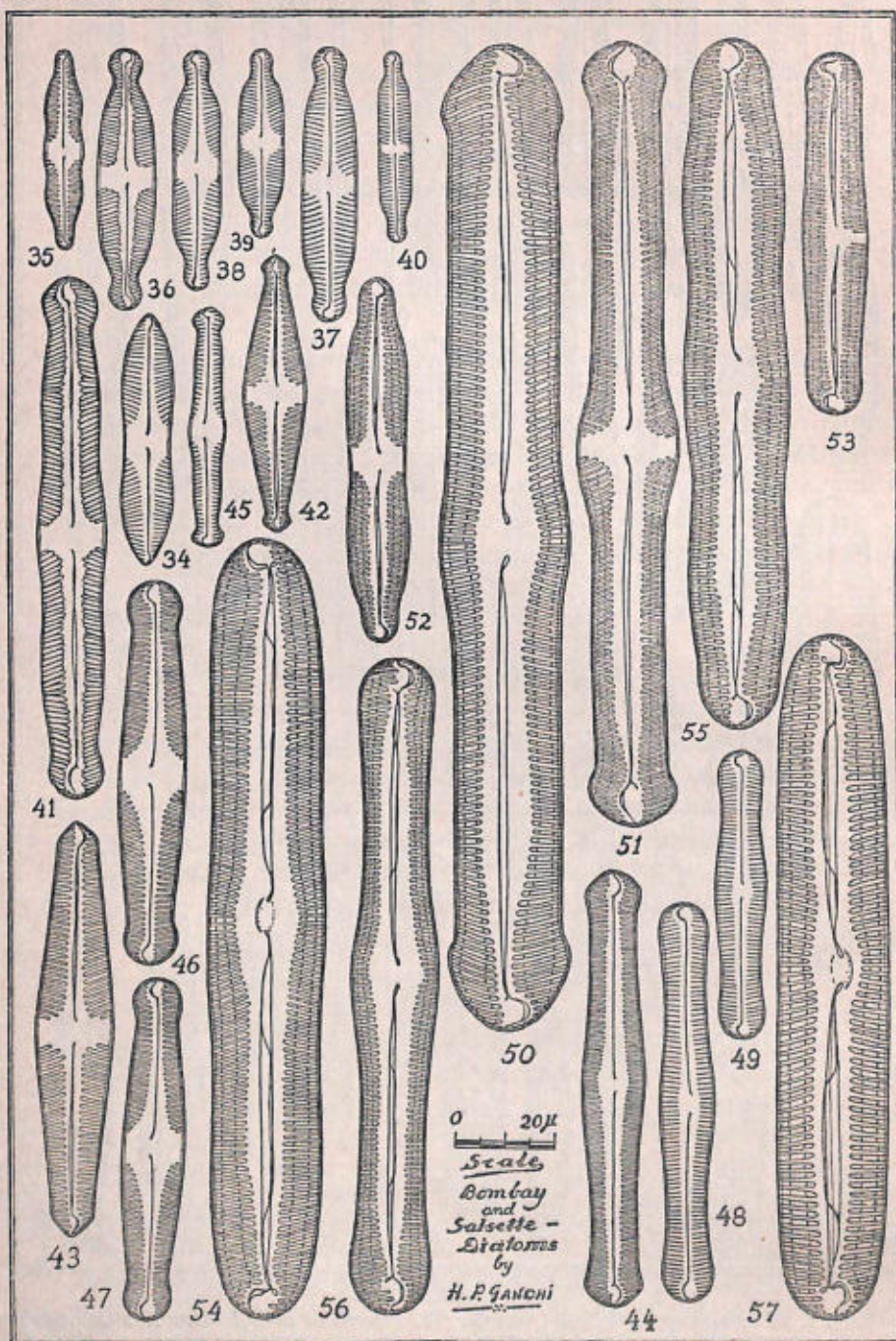
Habitat : Fresh water. Collected from pools and ponds at Wadala as a frequent form.

This diatom agrees closely with *P. mesolepta* Ehr. and its forms and varieties (Hustedt, 1930, *Bacil.* 319, f. 575 a-b ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 60-61, f. 1087), in triundulate sides, raphe, axial and central areas and the arrangement of striae. However, it differs from them in having linear-lanceolate outline with softly constricted produced ends. It is a more robust diatom than *P. mesolepta* f. *angusta* Cl. (Hustedt, *op. cit.* f. 575 b = *P. pulchra* Østr. v. *genuina* A. Cl. Cleve-Euler, *op. cit.* 27, f. 1025 d), since the length to breadth proportions here are 4.7-5.7 : 1, in contrast to 7-8 : 1 as indicated by Hustedt. With



FIGURES 1-33

Fig. 1. *Pinnularia appendiculata* (Ag.) Cl.; 2. *Pinnularia molaris* Grun.; 3. *Pinnularia finlandica* A. Cl.; 4. *Pinnularia braunii* (Grun.) Cl.; 5. *Pinnularia polyonca* (Bréb.) O. Müll.; 6-7. *Pinnularia acrosphaeria* (Bréb.) W. Sm. v. *minor* Cl.; 8-9. *Pinnularia acrosphaeria* v. *sandvicensis* A. S.; 10-11. *Pinnularia dolosa* sp. nov.; 12. *Pinnularia dolosa* v. *chariessa* v. nov.; 13-14. *Pinnularia ueno* Skv. v. *wadalensis* v. nov.; 15. *Pinnularia brevicostata* Cl. v. *indica* v. nov.; 16. *Pinnularia meisteri* A. Cl. v. *scandica* A. Cl.; 17. *Pinnularia stomatophora* Grun. v. *triundulata* Font.; 18. *Pinnularia episcopalis* Cleve; 19. *Pinnularia platycephala* (Ehr.) Cl.; 20. *Pinnularia scythica* (Pant.) Gandhi; 21. *Pinnularia divergens* W. Sm.; 22. *Pinnularia divergens* v. *undulata* Hér & Perag.; 23. *Pinnularia divergens* v. *elliptica* Grun.; 24. *Pinnularia divergens* v. *capitata* Mills; 25. *Pinnularia brébissonii* (Kütz.) Cl.; 26. *Pinnularia brébissonii* v. *producta* A. Cl.; 27. *Pinnularia brébissonii* v. *producta* f. *biundulata* (O. Müll) A. Cl.; 28-29. *Pinnularia microstauron* (Ehr.) Cl.; 30. *Pinnularia divergentissima* (Grun.) Cl.; 31. *Pinnularia termes* Ehr. v. *termitina* (Ehr.) A. Cl.; 32. *Pinnularia mesolepta* Ehr. v. *stauroneiformis* Grun.; 33. *Pinnularia mesolepta* v. *indica* v. nov.



FIGURES 34-57

Fig. 34. *Pinnularia balatonis* (Pant.) Gandhi; 35. *Pinnularia mesolepta* v. *indica* v. nov.; 36. *Pinnularia lundii* Hust.; 37-39. *Pinnularia interrupta* W. Sm.; 40. *Pinnularia subcapitata* Greg. v. *hilseana* (Jan.) O. Müll.; 41. *Pinnularia graciloides* Hust.; 42. *Pinnularia lacus-biwa* Skv. f. *minor* f. nov.; 43. *Pinnularia nakaii* Skv. v. *indica* v. nov.; 44. *Pinnularia stauroptera* (Rabh.) Cl. ? Grun.; 45. *Pinnularia stauroptera* v. *clevei* Meister f. *hyalina* (Perag. & Hér.) A. Cl.; 46-47. *Pinnularia gibba* Ehr.; 48-49. *Pinnularia simplex* sp. nov.; 50. *Pinnularia major* (Kütz.) Cl. v. *sendaiensis* Hust.; 51. *Pinnularia hartleyana* Grev. v. *pulchella* Mills.; 52. *Pinnularia nipponica* Skv.; 53. *Pinnularia kiusiuensis* Skv.; 54. *Pinnularia neglecta* (Mayer) A. Berg.; 55. *Pinnularia neglecta* v. *undulata* v. nov.; 56. *Pinnularia pseudoluculenta* sp. nov.; 57. *Pinnularia streptoraphe* Cleve.

these differing features, therefore, the present specimens are tentatively considered to be a new variety.

33. *Pinnularia lundii* Hust. (Fig. 36)

Hustedt, 1954, *Arch. Hydrobiol.* 48 (4) : 474, f. 61-63.

Valves 40-53.7 μ long and 9.5-11.5 μ broad, linear-lanceolate or linear-elliptical with constricted, broadly capitate rounded ends. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area moderate, narrowly lanceolate; central area wide, reaching the sides. Striae 11-13 in 10 μ , coarse, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Borivli streams, Powai and Vihar lakes, in good number; elsewhere seen rather as a stray form.

A form in my earlier paper described as *P. biceps* Greg. v. *amphicephala* (May.) A. Cl. (Gandhi, 1958, *J. Bombay nat. Hist. Soc.* 55 : 498, f. 23), I am not sure if it could be this species, since my Kolhapur form shows slightly a different arrangement of the middle striae as a result of which the central area appears to be much enlarged.

34. *Pinnularia interrupta* W. Sm. (Figs. 37-39)

Habitat : Fresh water. Collected from various wet situations in the region. It was found to be a variable species and the typical forms noted from the region are herewith depicted. Quite common in the area.

35. *Pinnularia subcapitata* Greg. v. *hilseana* (Jan.) O. Müll. (Fig. 40)

Hustedt, 1930, *Bacil.* 317, f. 572; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 65, 1090 n-r; Schmidt, A., 1874-1944, *Atlas Diat. t.* 45, f. 65 (= *Navicula hilseana* Janisch).

Valves 39-42 μ long and 6 μ broad, narrow, linear with or without indistinctly concave sides and constricted, produced subcapitate rounded ends. Raphe thin and straight, terminal fissures curved. Axial area very narrow; central area large, reaching the sides. Striae 11-13 in 10 μ , radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai and Vihar lakes as a common form. Isolated or stray specimens also were noted from streams at Borivli.

36. *Pinnularia graciloides* Hust. (Fig. 41)

Habitat : Fresh water. Collected from Powai and Vihar lakes as a common form and stray specimens were recorded from Borivli streams.

37. *Pinnularia conica* Gandhi

Habitat : Fresh water. Collected from various ponds, large pools and tanks. It occurred mostly in small number. Common.

38. *Pinnularia lacus-biwa* Skv. f. *minor* f. nov. (Fig. 42)

Valvae 54-56 μ longae atque 12.4 μ latae, lanceolatae, apicibus constrictis, capitato-cuneatis. Raphe crassa sed simplex, ornata poris aliquantum unilateraliter inclinatis, fissuris terminalibus curvatis. Area axialis lanceolata; area centralis ampla, rhomboidea, ad latera perveniens. Striae 8-9 in 10 μ , crassae, radiales in medio ac convergentes ad apices. Typus lectus a H. P. Gandhi in lacu Powai die 28-1-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—18.

Valves 54.56 μ long and 12.4 μ broad, lanceolate with constricted capitate-cuneate ends. Raphe thick but simple with central pores slightly unilaterally inclined and terminal fissures curved. Axial area lanceolate; central area large, rhomboid, reaching the sides. Striae 8-9 in 10 μ , thick, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Rather rare, since only a few specimens were seen.

This diatom agrees well with *P. lacus-biwa* Skv. (Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 280, pl. 6, f. 8) in the outline, raphe, axial and central areas, and the arrangement of the striae. However, the present specimens differ in being much smaller than the type. It is, therefore, provisionally considered to be a new form.

39. *Pinnularia nakaii* Skv. v. *indica* v. nov. (Fig. 43)

Valvae 80-83.6 μ longae atque 15.4 μ latae, lanceolatae, apicibus aliquantum productis late cuneatis. Raphe crassa sed simplex et recta, ornata poris centralibus unilateraliter inclinatis, fissuris terminalibus curvatis. Area axialis ampla, lineari-lanceolata; area centralis magna, ad margines perveniens. Striae 7-8 in 10 μ , crassae, radiales in medio atque in utroque apice convergentes. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—20.

Valves 80-83.6 μ long and 15.4 μ broad, lanceolate with slightly produced, broadly cuneate ends. Raphe thick but simple and straight with central pores unilaterally bent and terminal fissures curved. Axial area fairly wide, linear-lanceolate; central area large, reaching the sides. Striae 7-8 in 10 μ , thick, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai lake rather as a stray diatom.

This diatom agrees well with *P. nakaii* Skv., as described by Skvortzow (Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 280, pl. 8, f. 4), in the outline, raphe, axial and central areas, and the nature of striae and their arrangement. However, the local specimens differ in being comparatively

smaller, broader hence more lanceolate, and the ends are not marked to be capitate. With these differences observed, it is therefore considered to be a new variety.

Section TABELLARIAE Cleve

40. *Pinnularia stauroptera* (Rabh.) Cl. ? Grun. (Fig. 44)

Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 66, f. 1091 a-c (=v. *genuina* Mayer); Hustedt, 1924, *Naturw. Unters. Sarek*. 3 (6): 569, t. 19, f. 9-10 (= *P. stauroptera* Grun.); 1930, *Bacil.* 327, f. 600 a-b (= *P. gibba* Ehr.); Donkin, A. S., 1871-73, *Brit. Diat.* III, 70, pl. 12, f. 3 (= *Navicula tabellaria* Ehr.); Schmidt, A., 1874-1944, *Atlas Diat.* t. 45, f. 50-51 (= *N. gibba* (Pinn.) Ehr.); Van Heurck, 1896, *Treat. Diat.* 172, pl. 2, f. 86 (= *N. tabellaria* Ehr.).

Valves 66-88.7 μ long and 12.6-13 μ broad, linear, inflated in the middle with swollen rounded ends somewhat cuneate. Raphe thin and straight with central pores approximate and unilaterally bent and terminal fissures curved. Axial area very broad, linear-lanceolate; central area not quite defined. Striae about 10 in 10 μ , coarse, radial in the middle and convergent at the ends.

Habitat: Fresh water. Collected from Borivli streams, Powai and Vihar lakes, tank at Bandra, and as a stray form in several large bodies of water in the region. Fairly distributed.

This species I have referred to *P. stauroptera* according to Cleve-Euler, since from my some years of collections and observations I felt it to be different from *P. gibba* Ehr., which is described in the following. The references cited here all more or less point out the present species and it appears that no two opinions are the same for it.

41. *Pinnularia stauroptera* v. *clevei* Meister f. *hyalina* (Perag. & Hér.) A. Cl. (Fig. 45)

Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 57, f. 1091 f.

Valves 49-52 μ long and 7.2 μ broad, weakly silicified, linear-lanceolate with weakly triundulate sides, middle inflation rather more wide and prominent, ends very broad capitate-rounded-cuneate. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area fairly wide, linear or sublinear; central area large, rhomboid, reaching the sides. Striae about 10 in 10 μ , somewhat delicate, radial in the middle and convergent at the ends.

Habitat: Fresh water. Collected from hilly streams at Chembur, Borivli, and Powai lake, rather as a stray form.

38. *Pinnularia lacus-biwa* Skv. f. *minor* f. nov. (Fig. 42)

Valvae 54-56 μ longae atque 12.4 μ latae, lanceolatae, apicibus constrictis, capitato-cuneatis. Raphe crassa sed simplex, ornata poris aliquantum unilateraliter inclinatis, fissuris terminalibus curvatis. Area axialis lanceolata; area centralis ampla, rhomboidea, ad latera perveniens. Striae 8-9 in 10 μ , crassae, radiales in medio ac convergentes ad apices. Typus lectus a H. P. Gandhi in lacu Powai die 28-1-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—18.

Valves 54.56 μ long and 12.4 μ broad, lanceolate with constricted capitate-cuneate ends. Raphe thick but simple with central pores slightly unilaterally inclined and terminal fissures curved. Axial area lanceolate; central area large, rhomboid, reaching the sides. Striae 8-9 in 10 μ , thick, radial in the middle and convergent at the ends.

Habitat: Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Rather rare, since only a few specimens were seen.

This diatom agrees well with *P. lacus-biwa* Skv. (Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61: 280, pl. 6, f. 8) in the outline, raphe, axial and central areas, and the arrangement of the striae. However, the present specimens differ in being much smaller than the type. It is, therefore, provisionally considered to be a new form.

39. *Pinnularia nakaii* Skv. v. *indica* v. nov. (Fig. 43)

Valvae 80-83.6 μ longae atque 15.4 μ latae, lanceolatae, apicibus aliquantum productis late cuneatis. Raphe crassa sed simplex et recta, ornata poris centralibus unilateraliter inclinatis, fissuris terminalibus curvatis. Area axialis ampla, lineari-lanceolata; area centralis magna, ad margines perveniens. Striae 7-8 in 10 μ , crassae, radiales in medio atque in utroque apice convergentes. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—20.

Valves 80-83.6 μ long and 15.4 μ broad, lanceolate with slightly produced, broadly cuneate ends. Raphe thick but simple and straight with central pores unilaterally bent and terminal fissures curved. Axial area fairly wide, linear-lanceolate; central area large, reaching the sides. Striae 7-8 in 10 μ , thick, radial in the middle and convergent at the ends.

Habitat: Fresh water. Collected from Powai lake rather as a stray diatom.

This diatom agrees well with *P. nakaii* Skv., as described by Skvortzow (Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61: 280, pl. 8, f. 4), in the outline, raphe, axial and central areas, and the nature of striae and their arrangement. However, the local specimens differ in being comparatively

smaller, broader hence more lanceolate, and the ends are not marked to be capitate. With these differences observed, it is therefore considered to be a new variety.

Section TABELLARIAE Cleve

40. *Pinnularia stauroptera* (Rabh.) Cl. ? Grun. (Fig. 44)

Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 66, f. 1091 a-c (=v. *genuina* Mayer); Hustedt, 1924, *Naturw. Unters. Sarek*. 3 (6): 569, t. 19, f. 9-10 (= *P. stauroptera* Grun.); 1930, *Bacil.* 327, f. 600 a-b (= *P. gibba* Ehr.); Donkin, A. S., 1871-73, *Brit. Diat.* III, 70, pl. 12, f. 3 (= *Navicula tabellaria* Ehr.); Schmidt, A., 1874-1944, *Atlas Diat.* t. 45, f. 50-51 (= *N. gibba* (Pinn.) Ehr.); Van Heurck, 1896, *Treat. Diat.* 172, pl. 2, f. 86 (= *N. tabellaria* Ehr.).

Valves 66-88.7 μ long and 12.6-13 μ broad, linear, inflated in the middle with swollen rounded ends somewhat cuneate. Raphe thin and straight with central pores approximate and unilaterally bent and terminal fissures curved. Axial area very broad, linear-lanceolate; central area not quite defined. Striae about 10 in 10 μ , coarse, radial in the middle and convergent at the ends.

Habitat: Fresh water. Collected from Borivli streams, Powai and Vihar lakes, tank at Bandra, and as a stray form in several large bodies of water in the region. Fairly distributed.

This species I have referred to *P. stauroptera* according to Cleve-Euler, since from my some years of collections and observations I felt it to be different from *P. gibba* Ehr., which is described in the following. The references cited here all more or less point out the present species and it appears that no two opinions are the same for it.

41. *Pinnularia stauroptera* v. *clevei* Meister f. *hyalina* (Perag. & Hér.) A. Cl. (Fig. 45)

Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 57, f. 1091 f.

Valves 49-52 μ long and 7.2 μ broad, weakly silicified, linear-lanceolate with weakly triundulate sides, middle inflation rather more wide and prominent, ends very broad capitate-rounded-cuneate. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area fairly wide, linear or sublinear; central area large, rhomboid, reaching the sides. Striae about 10 in 10 μ , somewhat delicate, radial in the middle and convergent at the ends.

Habitat: Fresh water. Collected from hilly streams at Chembur, Borivli, and Powai lake, rather as a stray form.

42. *Pinnularia gibba* Ehr. (Figs. 46-47)

Schmidt, A., 1874-1944, Atlas Diat. t. 45, f. 45-47; Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 42, pl. 7, f. 2-3; Van Heurck, 1896, Treat. Diat. 172, pl. 2, f. 88 (= *Navicula gibba* Ehr.); Pantocsek, J., 1902, *Res. Wiss. Erf. Balat.* 2 (2) : 33, t. 3, f. 66 (= *Nav. stauroptera* Grun. v. *parva* Grun.); Schönfeldt, H., 1913, *Bacil.* 109, f. 235 (= *P. gibba* W. Sm. ? Ehr.); Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 57, f. 1091 bb (= *P. stauroptera* ?).

Valves 68-79 μ long and 11-12.6 μ broad, linear-lanceolate with slight but uniformly convex sides and at the extremities abruptly swollen, broadly rounded ends. Raphe thin and straight with central pores unilaterally bent and terminal fissures curved. Axial area narrowly lanceolate; central area very large, rhomboid, reaching the sides. Striae 8-9 rarely up to 10 in 10 μ , very coarse, radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from Powai, Vihar, and Tansa lakes as a frequent form but stray specimens were obtained from several large bodies of water in the region. Common.

Krishnamurthy has described a form under *P. gibba* Ehr. (Krishnamurthy, V., 1954, *J. Indian bot. Soc.* 33 : 369, f. 43). This is shown to be an arcuate type with clear longitudinal bands on the striae, which are characteristically apparent only in 'Majores, Complexae, Vitreatae' groups. Moreover, it is shown to have complex or subcomplex raphe. These features as given by Krishnamurthy for *P. gibba* appear to be strange and unknown in the literature, particularly the one he has cited. It seems that the said author has erroneously determined this as well as several other diatoms of his paper.

43. *Pinnularia simplex* sp. nov. (Figs. 48-49)

Valvae 59-80 μ longae atque 9-11.4 μ latae, lineares, marginibus concavis centrum inter et polos, apicibus late-rotundatis. Raphe tenuis et recta, ornata poris centralibus aliquantum unilateraliter inclinis ac fissuris terminalibus curvatis. Area axialis angusta, linearis; area centralis paulum dilatata. Striae 9-11 in 10 μ , aliquantum radiales in medio ac in utroque apice convergentes. Typus lectus a H.P. Gandhi ad Wadala die 31-7-1945, et positus in herbario proprio auctoris sub numero BOM-WAD.—10.

Valves 59-80 μ long and 9-11.4 μ broad, linear with margins concave in between the middle and the ends, ends broadly rounded. Raphe thin and straight with central pores slightly unilaterally bent and terminal fissures curved. Axial area narrow, linear; central area slightly widened. Striae 9-11 in 10 μ , slightly radial in the middle and convergent at the ends.

Habitat : Fresh water. Collected from pools and ponds at Wadala, Goregaon, Jogeshwari, Andheri, and some other places. It occurred usually in a small number.

This diatom does not agree well with any of the similar looking species of *Pinnularia*. It is, therefore, tentatively considered to be a new species.

Section MAJORES Cleve

44. *Pinnularia major* (Kütz.) Cl. v. *sendaiensis* Hust. (Fig. 50)

Schmidt, A., 1874-1944, Atlas Diat. t. 387, f. 3.

Valves 201-207 μ long and 26.2-27 μ broad, linear, distinctly inflated in the middle, sides parallel, ends swollen and subcuneate-rounded. Raphe thick with central pores unilaterally bent and terminal fissures somewhat obliquely curved. Axial area wide 1/4 to nearly 1/3 the width of the valve, linear; central area dilated. Striae 5-5.5 in 10 μ , thick, radial in the middle and convergent at the ends with fairly wide longitudinal bands quite evident.

Habitat : Fresh water. Collected from Powai lake rather in a small number. Rare.

This diatom agrees well with the type illustrated in the 'Atlas', in the outline, raphe, and striae. However, it appears to be somewhat smaller and has rounded cuneate ends, hence it slightly differs. Skvortzow has described a form *P. hustedtii* Meister (Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 43, pl. 8, f. 5) which is very much like the present one in the outline, apices, raphe, striae, and other details. However, *P. hustedtii* is a larger and slimmer form (221 x 17 μ , striae 9 in 10 μ) with more number of striae per 10 μ , than is the case with the present form. Again, the material of the present species is very scarce. It is therefore difficult to remark in any way. Presently, I refer my specimen to Hustedt's *P. major* v. *sendaiensis*, of course provisionally, since the striae number as also many other details approximate to it.

45. *Pinnularia hartleyana* Grev. v. *pulchella* Mills (Fig. 51)

Mills, F. W., 1932, *J. roy. microsc. Soc.* 52 : 390, pl. 2, f. 19-20.

Valves 149-160 μ long and 18-21 μ broad, linear, strongly inflated in the middle, sides almost parallel, ends swollen and subrounded. Raphe thick and straight with central pores conspicuous and unilaterally bent and terminal fissures large comma-shaped. Axial area about 1/4-1/3 the width of the valve, linear; central area large and reaching the sides. Striae 8-9 in 10 μ , thick, strongly radial in the middle and convergent at the ends with faint longitudinal bands.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Rather rare.



This diatom agrees well with the type described and illustrated by Mills except that the local forms have smaller size.

46. *Pinnularia nipponica* Skvortzow (Fig. 52)

Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 45, pl. 7, f. 12 ; 281, pl. 3, f. 8, pl. 8, f. 5.

Valves 70-75 μ long and 11.2-12 μ broad, linear, sides concave in the middle with constricted, broadly produced rounded ends. Raphe thick, subcomplex with central pores unilaterally bent and terminal fissures curved. Axial area linear or sublinear ; central area large, reaching the sides. Striae 8-10 in 10 μ , thick, radial in the middle and convergent at the ends with longitudinal bands faintly visible.

Habitat : Fresh water. Collected from ponds and pools at Wadala and Powai lake usually as a stray form. Rare.

Section COMPLEXAE Cleve

47. *Pinnularia kiusiensis* Skvortzow (Fig. 53)

Skvortzow, B. W., 1937, *Philipp. J. Sci.* 62 : 206, pl. 3, f. 4.

Valves 72-75 μ long and 13.6 μ broad, linear, slightly swollen in the middle with swollen rounded ends. Raphe thick, more or less complex with central pores unilaterally bent and terminal fissures thick and curved. Axial area linear about 1/5 the width of the valve ; central area large and unilaterally reaching the side. Striae 9-10 in 10 μ , thick, slightly radial in the middle and convergent at the ends with longitudinal bands somewhat narrow but distinct.

Habitat : Fresh water. Collected from Powai and Vihar lakes in a small number. Rare in the locality.

This species agrees well with the type described by Skvortzow, except that the ends here are somewhat more rounded.

48. *Pinnularia neglecta* (Mayer) Å. Berg (Fig. 54)

Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 80, f. 1112.

Valves 157.5-163 μ long and 23-24 μ broad, linear, slightly inflated in the middle with gradually swollen, weakly narrowed rounded ends. Raphe thick and complex with central pores unilaterally bent and terminal fissures thick, slightly obliquely large-comma-shaped. Axial area fairly wide, about 1/4-1/3 the width of the valve ; central area somewhat dilated and apparent. Striae 6-7 in 10 μ , thick radial in the middle and convergent at the ends with fairly broad, clear longitudinal bands.

Habitat : Fresh water. Collected from Powai and Vihar lakes in good numbers.

49. *Pinnularia neglecta* v. *undulata* v. nov. (Fig. 55)

Valvae 137-140.2 μ longae atque 21.6-22 μ latae, robustae, lineares, ad margines triundulatae, apicibus constrictis, late elongato-rotundatis. Raphe crassa et complexa, ornata poris centralibus unilateraliter inclinatis, fissuris terminalibus curvatis. Area axialis $1/4-1/3$ latitudinis valvae, linearis; area centralis aliquantum dilatata. Striae 6-7 in 10 μ , crassae, radiales in medio ac convergentes in utroque apice, vittis longitudinalibus distincte evolutis. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—62.

Valves 137-140.2 μ long and 21.6-22 μ broad, robust, linear with triundulate sides and constricted, broadly produced rounded ends. Raphe thick and complex with central pores unilaterally bent and terminal fissures curved. Axial area $1/4-1/3$ the width of the valve, linear; central area slightly dilated. Striae 6-7 in 10 μ , thick, radial in the middle and convergent at the ends with longitudinal bands distinct.

Habitat : Fresh water. Collected from Powai lake and streams at Borivli. Stray forms also were recorded from Vihar and Tansa lakes. Rather rare.

This diatom agrees well with *P. neglecta* (May) Å. Berg, described above, in all the features except that the valves are more robust with distinct triundulate sides and constricted, broadly produced rounded ends. It is, therefore, considered to be a new variety.

50. *Pinnularia pseudoluculenta* sp. nov. (Fig. 56)

Valvae 132-140 μ longae atque 17.6-18 μ latae, anguste lineares, marginibus concavis centrum inter et polos, apicibus gradatim tumidis ac late rotundatis. Raphe crassa et complexa, ornata poris centralibus unilateraliter inclinatis conspicuis, fissuris terminalibus oblique curvatis. Area axialis circiter $1/3$ latitudinis valvae, lineari-lanceolata; area centralis fere dilatata vel quadrata. Striae 7-8 in 10 μ , crassae, aliquantum radiales in medio atque in utroque apice convergentes, vittis tenuibus sed distinctis. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 1944, 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—35.

Valves 132-140 μ long and 17.6-18 μ broad, narrowly linear with concave sides between the middle and the ends, ends gradually swollen and broadly rounded. Raphe thick and complex with central pores conspicuous and unilaterally bent and terminal fissures obliquely curved. Axial area about $1/3$ the width of the valve, linear-lanceolate; central area almost dilated to quadrate. Striae about 7-8 in 10 μ , thick, slightly radial in the middle and convergent at the ends with bands narrow but distinct.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes, as a frequent form. Not common in the region.

This species resembles *P. conspicua* (A.S.) Cl., as illustrated by Mills (Mills, F. W., 1932, *J. roy. microsc. Soc.* 52 : 390, pl. 2, f. 22), in the outline and the arrangement of the striae. However, the present specimens are much smaller and very sleek and have comparatively much wider axial area ; hence they differ. Moreover, in the reference cited by Mills [Schmidt, A., 1874-1944, *Atlas Diat.* t. 43, f. 10-11 (= *Navicula conspicua* A. S.)] the illustrations appear to be very different from that of Mills (Mills seems to recognise the fact) and the present forms ; hence the comparison is difficult. Further, Cleve-Euler's *P. alandica* A. Cl. (Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 80, f. 1112 A) also appears to be different as it has broader valves, produced-cuneately-rounded apices, and fewer striae per 10 μ , although it has somewhat a similar shape. Again, the present forms compare well with *Navicula luculenta* A. S. which is in fact a *Pinnularia* type (Schmidt, A., *op. cit.* t. 43, f. 12) in the outline, range of dimensions, and perhaps the striae. However, the present specimens show much wider axial area, well defined quadrate central area, comparatively shorter striae with narrow longitudinal bands ; hence they differ. In the literature no other species are known with which the satisfactory comparison could be made, hence the present specimens are considered to be a new species.

Section VITREATAE Å. Berg

51. *Pinnularia streptoraphe* Cleve (Fig. 57)

Hustedt, 1924, *Naturw. Unters. Sarek.* 3 (6) : 572, t. 19, 8 ; 1930, *Bacil.* 337, f. 620 ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 85, f. 1117 a-c (= *v. genuina* A. Cl.) ; Schmidt, A., 1874-1944, *Atlas Diat.* t. 42, f. 7 (= *nomen nudum*).

Valves 140-160 μ long and 22.5-24 μ broad, linear with broadly rounded ends. Raphe thick, very strongly complex and folded with central pores prominent and unilaterally bent and terminal fissures thick and obliquely comma-shaped. Axial area about 1/4 the width of the valve, linear ; central area only slightly dilated. Striae 5-5.5, rarely 6 in 10 μ , thick, radial in the middle and convergent at the ends with fairly broad very conspicuous longitudinal bands.

Habitat : Fresh water. Borivli streams, Powai, Vihar, and Tansa lakes. Fairly common.

Genus **AMPHIPRORA** Ehrenberg 1843, emend. Cleve 1891

52. **Amphiprora alata** Kütz. (Fig. 58)

Hustedt, 1930, *Bacil.* 340, f. 625; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—V, 32, f. 1402 a-d (=v. *genuina* A. Cl.).

Frustules 48-59 μ long and 21-23 μ broad in the middle and 35-37 μ at the broadest, strongly siliceous, torsive in the longitudinal plane, oblong-elliptical, deeply constricted in the middle with rounded truncate ends in the girdle view. Connecting zone with numerous longitudinal plaits, broad and somewhat sigmoid. Keel sigmoid with undulate keel projections. Striae 16-18 in 10 μ , fine and punctuate.

Habitat: Brackish water. Collected from Mahim and Chembur creeks in good numbers and as a common form.

53. **Amphiprora lata** Grev. v. **angustior** McCall (Fig. 59)

McCall, D., 1933, *J. Linn. Soc. (Bot.)* 49 : 268, 26.

Frustules 98-116 μ long and 21.6-22 μ broad in the middle and 30-33.5 μ at the broadest, weakly siliceous, oblong, constricted in the middle with truncate rounded ends in the girdle view. Connecting zone with numerous longitudinal plaits almost straight with about 22 fine striae in 10 μ . Keel broad, sigmoid with uniformly arcuate keel projections. Striae about 13-14 in 10 μ , rather fine.

Habitat: Brackish water. Collected from Mahim creek usually in a small number. Very stray specimens also were collected from Chembur and Bhayandar creeks.

Genus **AMPHORA** Ehrenberg 1840

54. **Amphora ovalis** Kütz. v. **gracilis** (Ehr.) Cl. (Fig. 60)

Van Heurck, 1896, *Treat. Diat.* 127, pl. 1, f. 16; Hustedt, 1930, *Bacil.* 342 (=f. *gracilis* (Ehr.) Cl.); Cleve-Euler, A. 1951-55, *Diat. Schwed. Finn.*—III, 91, f. 667 b; Schmidt, A., 1874-1944, *Atlas Diat.* t. 26, f. 108 (=A. *ovalis* Kütz.).

Frustules 65-70 μ long and 27-29.5 μ broad, slender than the type, elliptical with truncate ends in girdle view. Valves lunate with convex dorsal side and concave ventral side with rounded ends. Raphe arcuate with dorsally bent conspicuous central pores. Axial area very narrow; central area large, quadrate, reaching the ventral side. Striae 12-13 in 10 μ , coarsely punctuate, radial on the dorsal side but on the ventral side radial in the middle and convergent at the ends.

Habitat: Fresh water. Collected from pools and ponds at Wadala, Vile-Parle, Goregaon, and some other places. Usually collected in a small number.

This diatom agrees well with the type described by Van Heurck and others. The maximum length given by Cleve-Euler is 40 μ , from which the present specimens differ in being much larger. It also resembles *A. libyca* Ehr. (Cleve-Euler, *op. cit.* 90 f. 666 a-b (=v. *typica* A. Cl.), but differs in not having clearly defined longitudinal hyaline bands.

55. *Amphora ovalis* Kütz. v. *pediculus* Kütz.

Habitat : Fresh water. Widely distributed in the locality and sometimes abundant.

56. *Amphora acutiuscula* Kütz. (Fig. 61)

Van Heurck, 1896, *Treat. Diat.* 134, pl. 1, f. 5 ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—III, 98, f. 686 a-b ; Schmidt, A., 1874-1944, *Atlas Diat.* t. 26, f. 59 (= *A. lineata* Greg.) ; Foged, N., 1957, *Nat. Hist. Rennell Isl.* 3 : 75, pl. 9, f. 5 ? (= *A. sp.*)

Frustules 32-38 μ long and 15-16 μ broad with abruptly constricted produced truncate ends in girdle view. Valves semi-lanceolate, 7-8 μ broad, with straight ventral side and produced, somewhat capitate ends. Raphe thin and straight rather delicate. Axial area very narrow. Striae 14-18 in 10 μ , radial, indistinctly punctuate and rudimentary on the ventral side.

Habitat : Brackish water. Collected from Mahim and Chembur creeks fairly frequently.

Genus CYMBELLA Agardh 1830

57. *Cymbella turgida* (Greg.) Cl.

Habitat : Fresh water. Widely distributed in the area but always collected in smaller numbers. Common.

58. *Cymbella ventricosa* Kütz.

Habitat : Fresh water and wet soils. Common throughout the region.

59. *Cymbella gracilis* (Rabh.) Cl. (Fig. 62)

Hustedt, 1930, *Bacil.* 359, f. 663 ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 129, f. 1184 a-b (=v. *schmidtii* A. Cl.) ; Schmidt, A., 1874-1944, *Atlas Diat.* t. 10, f. 36-37, 39-40 (= *Encyonema gracile* Rabh.)

Valves 32.4-36 μ long and 5.4 μ broad, asymmetrical, narrow semi-lanceolate with ventral side almost straight, ends acutely rounded sometimes slightly constricted and weakly bent on the ventral side. Raphe thin and straight, strongly excentric and close to the ventral side. Axial

area very narrow ; central area very small. Striae 12-14 in 10 μ , fine and slightly radial, ventral side striae marginal.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes usually in good number.

This species agrees well with the type described Cleve-Euler and others except that the ventral side sometimes noted to be slightly concave as indicated by Cleve-Euler in f. 1184 a.

60. *Cymbella yarrensii* (A. S.) Cl. (Fig. 63)

Schmidt, A., 1874-1944, Atlas Diat. t. 379, f. 21-22; t. 71, f. 16 (= *Encyonema ? yarrensii* A. S.).

Valves 75-80 μ long and 12.6-13 μ broad, asymmetrical-lanceolate with dorsal side more convex than the ventral one with acutely rounded ends. Raphe thin and straight, clearly excentric with terminal fissures dorsally directed. Axial area narrow very narrowly lanceolate ; central area slightly widened. Striae 12-14 in 10 μ , strongly radial in the middle but less so towards the ends and somewhat closer. In some cases the end striae tended to be probably perpendicular to the middle line.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Only stray specimens were recorded.

This species agrees well with the type illustrated in the 'Atlas', in the outline, length-breadth proportions, raphe and strongly radial striae in the middle. However, the end striae noted in the local forms are not necessarily perpendicular to the middle line. I have referred these specimens to the said species with some amount of hesitation, but these definitely do not agree with any other similar-looking species.

61. *Cymbella amphicephala* Naeg.

Habitat : Fresh water. Collected from streams at Borivli, pools at Kanheri caves, Powai and Vihar lakes, usually as a common form.

62. *Cymbella leptoceros* (Ehr. ?) Grun. v. *rostrata* Hust. f. *indica* f. nov. (Fig. 64)

Valvae 38-43 μ longae atque 12-12.5 μ latae, asymmetricae, sub-rhomboidae, latere dorsali valde convexo, ventrali aliquantum convexo, apicibus constrictis ac elongato-rotundatis. Raphe crassa, arcuata, leniter centrica, poris centralibus conspicuis, fissuris terminalibus ad marginem dorsalem versus flexis. Area axialis sat ampla, anguste lanceolata ; area centralis paululum dilatata. Striae 9-12 in 10 μ , crasse lineatae bis seriatae, ubique radiales ac in utroque apice proxime positae. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—48.

Valves 38-43 μ long and 12-12.5 μ broad, asymmetrical, subrhomboid, dorsal side strongly convex than the ventral side with constricted, slightly produced rounded ends. Raphe thick, arcuate, somewhat centric with central pores conspicuous and terminal fissures dorsally bent. Axial area fairly wide and narrowly lanceolate; central area very slightly dilated. Striae 9-12 in 10 μ , coarsely lineate in double rows, throughout radial and at the ends closely set.

Habitat : Fresh water. Collected from streams at Borivli and Powai lake in a small number.

This diatom agrees well with *Cymbella leptoceros* (Ehr. ?) Grun. v. *rostrata* Hust. (Hustedt. 1944, *Arch. Hydrobiol.* 39 : 132, f. 52-54) in the outline, striae and other details. However, the present forms show rather rhombic shape and less conspicuously produced rostrate ends. It is, therefore, considered to be a new form.

63. *Cymbella austriaca* Grun. v. *subrhomboidea* (Østrup) A. Cl.

Habitat : Fresh water. Collected from streams at Borivli and Kanheri caves. Fairly common.

64. *Cymbella tumida* (Bréb.) V. H. (Figs. 65-66)

Schmidt, A., 1874-1944, *Atlas Diat.* t. 376, f. 4-7; t. 10, f. 28-30 (= *C. stomatophora* Grun.); Van Heurck, 1896, *Treat. Diat.* 148, pl. 1, f. 42; Hustedt, 1930, *Bacil.* 366, f. 677; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 166, f. 1255 a [=v. *genuina* (Grun.) A. Cl.].

Valves 53-65 μ long and 18-19.5 μ broad, asymmetrical, boat-shaped, strongly convex on the dorsal side, on ventral side straight, medially gibbous, feebly concave or triundulate with strongly constricted, broadly produced rounded-truncate ends. Raphe thick, arcuate, excentric with distinct central pores and dorsally reflexed terminal fissures. Axial area rather narrow, linear; central area large roundish or subquadrate with a luna on the dorsal side and a pore or elongated marking on the ventral side. Striae 7.5-9 in the middle up to 11 in 10 μ towards the ends, clearly and coarsely punctate and radial throughout.

Habitat : Fresh water. Collected from Powai, Vihar, and Tansa lakes as a common and frequent form. A smaller number of forms also were collected from Bandra tank and some other places. Not widely distributed.

65. *Cymbella powaiana* sp. nov. (Fig. 67)

Valvae 57.6-60 μ longae atque 18-19 μ latae, asymmetricae, cymbiformes, latere dorsali valde convexo, ventrali vero recto sed paululum tumido ad medium, apicibus constrictis in dorso, distincte productis et

subtruncatis. Raphe crassa, arcuata, leniter centrica, ornata poris centralibus distinctis atque fissuris terminalibus ad marginem dorsalem versus flexis. Area axialis sat ampla, linearis; area centralis ampla subrotundata absque stigmatibus. Striae 7-8 in $10\ \mu$, crasse lineatae, punctis circiter 18-20 in $10\ \mu$, ubique radiales. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—77.

Valves 57.6-60 μ long and 18-19 μ broad, asymmetrical, boat-shaped, dorsal side strongly convex, ventral side straight with a slight inflation in the middle; ends constricted on the dorsal side, distinctly produced and subtruncate. Raphe thick, arcuate, nearly central with central pores distinct and terminal fissures reflexed towards the dorsal side. Axial area fairly wide, linear; central area large somewhat roundish without any stigmata. Striae 7-8 in $10\ \mu$, coarsely lineate with puncta about 18-20 in $10\ \mu$, throughout radial.

Habitat: Fresh water. Collected from Powai lake along with the above type in a small number. Stray specimens also were collected from streams at Borivli and Vihar lake.

This species does not satisfactorily agree with any other similar looking types in the literature, hence it is regarded as a new species.

66. *Cymbella aspera* (Ehr.) Cl.

Habitat: Fresh water. Collected from streams at Borivli, Chembur hills, Powai, Vihar and Tansa lakes, usually in good number, from among the dead vegetable matter scattered around the borders. It was also found to form slimy encrustations on stony or rocky substratum.

67. *Cymbella bengalensis* Grun.

Habitat: Fresh water. Mostly collected from the streams at Borivli and Powai lake. Not common.

Genus *GOMPHONEMA* Agardh 1824

68. *Gomphonema constrictum* Ehr. v. *capitata* (Ehr.) Cl. (Fig. 68)

Schmidt, A., 1874-1944, Atlas Diat. t. 247, f. 33; Hustedt, 1930, Bacil. 377, f. 715; Van Heurck, 1896, Treat. Diat. 270, pl. 7, f. 297 (= *G. constrictum* v. *capitatum* Ehr.); Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 173, f. 1261 e-f? [= *G.*—v. *capitatum* (Ehr.) Cl. f. *typica* May.].

Valves 47.5-50 μ long and 12.5-13 μ broad, broadly clavate with feebly constricted broadly produced subtruncate apex and attenuated rounded base. Raphe thick and straight. Axial area narrow, linear; central

area somewhat rhomboid, slightly unilateral with a stigma on the opposite side. Striae 10-12 in $10\ \mu$, fine but clearly punctate and slightly radial.

Habitat : Fresh water. Collected from streams at Borivli and Powai lake, in good number.

69. *Gomphonema constrictum* v. *indica* v. nov. (Fig. 69)

Valvae 45-47.5 μ longae atque 12.5 μ latae, clavatae, apice constricto, late elongato-rotundato. Striae circiter 11-12 in $10\ \mu$, radiales atque distincte punctatae. Caetera ut in typo. Typus lectus a H. P. Gandhi in lacu Powai die 28-1-1945, et positus in herbario proprio auctoris sub numero BOM-POW. —78.

Valves 45-47.5 μ long and 12.5 μ broad, clavate, apex constricted broadly produced and rounded. Striae about 11-12 in $10\ \mu$, radial and clearly punctate. In all other characters resembles the type.

Habitat : Fresh water. Collected from streams at Borivli and Powai lake, usually in a smaller number along with the type.

This diatom agrees well with above mentioned type in all characters except that the apical part is rather short, distinctly constricted, broadly produced and rounded. It is, therefore, considered as a new variety.

70. *Gomphonema acuminatum* Ehr. v. *turris* (Ehr.) Cl. (Figs. 70-71)

Valves 46-71.5 μ long and 11-14.4 μ broad and striae 9-10 to 12-13 in $10\ \mu$.

While going through the literature, there appears to be some difficulty regarding the present species. The figure 70 very exactly agrees with Hustedt's *G. acuminatum* v. *turris* (Hustedt, 1911, *Abh. Nat. Ver. Bremen*, 20 : 293, t. 3, f. 36) and in the said reference, Schmidt's 'Atlas Diat.' t. 239, f. 31-36, illustrations are considered to be identical. In fact, of the 'Atlas' t. 239, f. 32, 34 are rather more closely so, with the present as well as that of Hustedt (1911, *op. cit.*).

Cleve-Euler, however, considered Hustedt's (1911, *op. cit.*) specimens to be *G. montanum* Schum. v. *turriforme* A. Cl. (Cleve-Euler, A., 1951-55. *Diat. Schwed. Finn.*—IV, 182, f. 1276 a-b). The illustrations represented by her actually correspond more or less well with Hustedt's *G. lanceolatum* Ehr. v. *turris* (Ehr. e. p.) Hust. (Hustedt, 1936, *Arch. Hydrobiol.*, suppl. 14 : 166, t. 3, f. 23). Hustedt renamed his 1936 (*op. cit.*) forms as *G. lanceolatum* f. *turris* (Ehr. e.p.) Hust. in his later work (Hustedt, 1938-39, *Arch. Hydrobiol.*, suppl., 15 : 437, t. 26, f. 8-11). If the illustrations of these two papers were to be compared, they differ much among themselves. The Java (1938, *op. cit.*) forms appear to be more broadly clavate

from the middle part upwards with broadly cuneate ends and in the smaller forms therein the appearance goes as far as to suggest that *G. augur* Ehr. is getting evolved. These forms more or less come closer to *G. acuminatum* v. *turris* Ehr., 'Atlas' t. 239, particularly the figures 31, 33, 35 except that the figs. in the 'Atlas' have rather more pointed apex. But in any way all these are obviously dissimilar to present specimens as well to the one illustrated by Hustedt (1911, *op. cit.*).

Cleve-Euler's *G. montannum* v. *suecicum* Grun. (Cleve-Euler, *op. cit.*, 182, f. 1276 c) as well as of 'Atlas Diat.' t. 239, f. 32, 34 (= *G. acuminatum* v. *turris*) and t. 240, f. 4 (regarded as intermediate form between *G. acuminatum* and *G. augur* Ehr.) agree well here and with Hustedt's (1911, *op. cit.*).

Hustedt's *G. acuminatum* v. *turris* (Ehr.) Cl. (Hustedt, 1930, Bacil. 372, f. 687) befits anywhere between *G. acuminatum* v. *turris* of the 'Atlas' and *G. lanceolatum* v. *f. turris* (Ehr. e.p.) Hust., is being referred by Cleve Euler to *G. montanum* v. *turris* A. Cl. This form more or less corresponds well with my illustration (fig. 71). It also corresponds to a certain degree with 'Atlas' t. 240, f. 18-20, particularly with f. 18 which is *G. acuminatum* v. *brasiliensis* Ehr., and much more with Skvortzow's *G. acuminatum* v. *turris* (Skvortzow, B. W., 1935, *Philipp. J. Sci.*, 57: pl. 3, f. 9; 1937, 61: 51, pl. 12, f. 4; 1938, 66: 356, pl. 1, f. 5?). Skvortzow recorded denser striae for some of his forms, particularly in forms collected from Kizaki lake.

Looking at *G. acuminatum* Ehr. itself which is a highly variable species, it may be assumed that *G. acuminatum* v. *turris* Ehr. is as well variable under different climatic, topographical, and habitat conditions, and as a result of that the same or different workers have given different illustrations and sometimes the considerations.

Yet, with a good deal of uncertainty and far fetched considerations, I presume the present diatoms to be *G. acuminatum* v. *turris* (Ehr.) Cl. a poly-phasic type. The references hitherto mentioned, all probably go to represent manifestations of the indicated type as has been suggested by Geitler (1932) in the case of several Pennate diatoms, Hendey (1951) in the case of *Achnanthes longipes* Ag., Lund (1945-46), and others. I believe, nothing better than this could be thought of, at least for the present. The two illustrations depicted here show the extremes that have been recorded from among several specimens collected from different localities in the region.

Habitat : Fresh water. Collected from several places in the region usually in a small number.

71. *Gomphonema augur* Ehr. (Figs. 72-73)

Habitat : Fresh water. Collected from several pools, ponds, and other large bodies of water in the region. Quite common.

72. *Gomphonema subapicatum* Fritsch & Rich (Figs. 74-80)

Habitat : Fresh water. Collected from several wet situations in the Bombay and Salsette region. In certain ponds and tanks it was found to be gregarious. Its distribution so far known in India : Punjab, whole of South-Western Zone, and N. Gujarat.

Having collected and observed this species in varying quantity for almost fifteen years from various parts of South-Western Zone of India (an area comprised of approximately 900 miles long and 100 miles broad) reaching up to parts of N. Gujarat, I am convinced that it is a distinct species. Therefore, I appreciate the diagnosis given by Fritsch & Rich (Fritsch, F. E. & Rich, F., 1929, *Trans. roy. Soc. S. Afr.* 18 : 109, f. 6 A-D). From this long tenure of work, I have found quite an amount of structural and size variations in the species which perhaps does not appear in the literature ; hence, I set it forth in the record by giving several illustrations and a table of dimensions. The forma *curta* Frit. & Rich of the said species is included within the type since I have observed all the intergrading sizes and forms from the same and different localities during different times.

Further, Hustedt has regarded such specimens of his Sunda-Expedition material as *G. gracile* Ehr. f. *turris* Hust. (Hustedt, 1938, *Arch. Hydrobiol., Suppl.* 15 : 439, t. 28, f. 14-16), calling them as tropical deviation of *G. gracile*. However, I consider them to be *G. subapicatum*, since they are so very alike in all characters. Again, I have found this species to be rather independent of *G. gracile*, frequent and sometimes gregarious. Looking at its manifestations which I have recorded, it appears that it has probably found its expression from *G. acuminatum* Ehr. and *G. augur* Ehr. series rather than from *G. gracile*. This fact may be derived from considering the apex and apicule, organisation of striae and their punctate nature, raphe, central area, and as a rule the whole of the general plan of the valve. It is assumed that the probable line of deviation might have taken through *G. acuminatum* v. *turris*, like forms which I have described earlier and my figures 70-71 perhaps bear the testimony of the same.

I herewith give in the following table the range of dimensions recorded by previous workers and here, thus :

Author	Length	Breadth	Striae per 10 μ
Fritsch & Rich (1929)	77-55 μ 40-28 μ	14-12 μ 11-10 μ	10-12 10-12 f. <i>curta</i>
Abdul-Majeed (1935)	same range as given by Fritsch & Rich		
Hustedt (1938)	no dimensions given		(= <i>G. gracile</i> v. <i>turris</i> Hust.)
Gandhi (1956)	99-48 μ	15.6-12 μ	9-12
present forms	85.6 μ 72 μ 70 μ 67 μ 60 μ 50 μ 49.5 μ 44 μ 36 μ 30 μ 26 μ	15.5 μ 14.4 μ 14.5 μ 12.5 μ 12.6 μ 12.7 μ 13.2 μ 9.5-11 μ 9.5 μ 9 μ 8.7-9 μ	8-10 12-13 13 11-13 12-14 12 11-12 10-13 11-12 10-12 10-12
forms collected from N. Gujarat area	48-62 μ	10-12.5 μ	9-11

73. *Gomphonema subapicatum* v. *okamurae* (Skv.) emend. (Fig. 81)

Skvortzow, B. W., 1937, *Philipp. J. Sci.* 62 : 209, pl. 4, f. 13 (= *G. augur* Ehr. v. *okamurae* Skv.).

Valves 49-55 μ long and 13.7-14 μ broad, lanceolate-clavate with broad abruptly narrowed subapiculate apex and from the middle gradually attenuated base. Central area with two stigmata. Striae 9-11 in 10 μ , radial and punctate. In all other features like the above type.

Habitat : Fresh water. Collected from streams at Borivli, Andheri, Goregaon and Dahisar ponds, Powai and Vihar lakes, and other places.

It was recorded usually as a stray form with the species.

This diatom strongly agrees with *G. subapicatum* Frit. & Rich rather than with *G. augur* Ehr. ; hence it is considered to be a variety of the former, and Skvortzow's nomenclature is emended.

74. *Gomphonema sphaerophorum* Ehr.

Habitat : Fresh water. Collected from several wet situations from the region of Bombay and Salsette. A common type.

75. *Gomphonema subtile* Ehr. v. *malayensis* Hust. (Fig. 82)

Hustedt, 1942, *Int. Rev. Ges. Hydrobiol. Hydrogr.* 42 (1/3) : 119, f. 258-260.

Valves 45-50 μ long and 8.5-9 μ broad, lanceolate-clavate with only

slightly produced, narrowly capitate rounded apex and gradually attenuated base. Raphe thin and straight. Axial area narrow, linear; central area small, very slightly unilaterally expanded with an isolated stigma on the other side. Striae 9-10 in $10\ \mu$, radial and coarsely lineate.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes, ponds at Dahisar, Goregaon, and Andheri. Mostly recorded as a stray form.

76. *Gomphonema parvulum* Kütz. (Figs. 83, 120)

Habitat : Fresh water and rarely somewhat brackish water. A widely distributed diatom. Common.

The two illustrations given show much deviation among themselves in the outline. The figure 120 is typical of the type and 83 is a variant but it agrees well with Cleve-Euler's fig. 1269 a, and Berg's illustration (Berg, A., 1953, *Bot. Not.* 1 : 63, f. 4).

77. *Gomphonema parvulum* v. *subellipticum* Cl.

Habitat : Fresh water. Collected from several wet situations but usually in small numbers along with the type.

78. *Gomphonema parvulum* v. *micropus* (Kütz.) Cl.

Habitat : Fresh water. Collected from several pools, ponds, tanks, and other wet situations. Fairly common.

79. *Gomphonema parvulum* v. *lagenula* (Grun.) Hust. (Fig. 110)

Hustedt, 1930, *Bacil.* 373 ; 1949, *Expl. Parc. Nat.-Albert Miss. H. Damas* 1935-36, 8 : 119, t. 11, f. 8-10.

Valves 26-30.6 μ long and 7.2 μ broad, lanceolate-clavate with constricted subcapitate apex and slightly produced base. Raphe thin and straight. Axial area narrow, linear; central area somewhat unilateral with an isolated stigma on the opposite side. Striae about 14 in $10\ \mu$, radial.

Habitat : Fresh water. Collected from streams at Borivli and various ponds, puddles, and pools in the region. It occurred usually with the type but in small numbers. Fairly common.

80. *Gomphonema angustatum* (Kütz.) Rabh. v. *producta* Grun. f. *indica* f. nov. (Fig. 84)

Valvae 30-32 μ longae atque 6.5 μ latae, lineari-clavatae, apice constricto, breviter elongato et rotundato, basi constricta capitata. Raphe tenuis et recta. Area axisialis angusta; area centralis parva ac unilaterally dilatata, stigmatate unico in latere opposito. Striae circiter 10-11 in $10\ \mu$, aliquantum radiales atque indistincte punctate. Typus lectus a

H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR. —97.

Valves 30-32 μ long and 6.5 μ broad, linear-clavate, apex constricted, shortly produced and rounded; base constricted and capitate. Raphe thin and straight. Axial area narrow; central area small and unilaterally dilated with an isolated stigma on the opposite side. Striae about 10-11 in 10 μ , slightly radial and indistinctly punctate.

Habitat: Fresh water. Collected from streams at Borivli and Kanheri caves in a small number.

This diatom agrees with *C. angustatum* Kütz. (Schmidt, A., 1874-1944, Atlas Diat. t. 234, f. 34-36) and *G. angustatum* (Kütz.) Rabh. v. *producta* Grun. (Hustedt, 1930, Bacil. 373, f. 693) in the outline, axial and central areas, and the organisation of the striae. However, it differs in having shortly produced apex and rather capitate base; hence it is considered to be a new form.

81. **Gomphonema martini** Fricke (Fig. 85)

Schmidt, A., 1874-1944, Atlas Diat. t. 238, f. 22-25, particularly f. 24; Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 181, f. 1275 c-f (=v. *genuinum* A. Cl.).

Valves 80-97 μ long and 14-16 μ broad, narrowly lanceolate-clavate, inflated in the middle with apex acutely cuneate and base gradually attenuated. Raphe somewhat thick and straight. Axial area narrow, linear; central area fairly large, unilateral with an isolated stigma on the opposite side. Striae about 7.5-10 in 10 μ , middle 1-2 striae are abbreviated, radial and indistinctly punctate or lineolate.

Habitat: Fresh water. Collected from streams at Borivli, Kanheri caves, and Powai lake, usually in a small number.

This species agrees well with the type in all respects except that from this locality larger specimens have been recorded.

82. **Gomphonema montanum** Schum. (Fig. 86)

Cleve-Euler, A., 1951-55, Diat. Schwed. Finn.—IV, 182, f. 1276 l-n (=v. *genuinum* Mayer); Schmidt, A., 1874-1944, Atlas Diat. t. 238, f. 1-11, particularly f. 1, 2, 8 (= *G. subclavatum* Grun. v. *montana* Schum.); Hustedt, 1930, Bacil. 375, f. 708 (= *G. longiceps* Ehr. v. *montana* (Schum.) Cl. f. *suecica* Grun.).

Valves 38.7-50 μ long and 7-7.5 μ broad, linear-clavate with undulate sides, apex broadly produced-wedge-shaped and from the middle narrowed gradually attenuated at the base. Raphe thick with part in the centre slightly unilaterally inclined. Axial area narrow, linear; central area large, somewhat quadrate, unilaterally expanded with an isolated stigma

on the opposite side. Striae 8-10 in 10 μ , slightly radial and indistinctly punctate, 1-middle striae very short.

Habitat : Fresh water. Collected from streams at Borivli, Kanheri caves, and Powai lake, in a good number. Elsewhere in the locality it occurred as a stray form.

83. *Gomphonema montanum* v. *acuminatum* Mayer (Figs. 100-101)

Valves 39.6-53 μ long and 12.3-12.6 μ broad, striae about 9-10 in 10 μ .

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Stray specimens also were obtained from other larger bodies of water.

Skvortzow has described almost identical forms as *G. acuminatum* v. *sinica* Skv. (Skvortzow, B. W., 1935, *Philipp. J. Sci.* 57 : 474, pl. 3, f. 10-11) from Poyang lake material, which I include here.

84. *Gomphonema aequatoriale* Hust. (Figs. 87, 102)

Hustedt, 1949, *Expl. Parc Nat. Albert, Miss. H. Damas* (1935-36), 8 : 119, t. 10, f. 6-8.

Valves 48.6-80 μ long and 10.8-15 μ broad, sublinear-clavate with broad subtruncate-rounded apex and gradually attenuated base, may be sometimes concave. Raphe thick with central part slightly unilaterally bent. Axial area moderately linear; central area large, somewhat unilaterally expanded with an isolated stigma on the opposite side. Striae 8-10 rarely up to 12 in 10 μ , clearly lineate, radial and somewhat closely set at the ends.

Habitat : Fresh water. Collected from streams at Borivli, Kanheri caves, Powai, Vihar, and Tansa lakes, rather frequent. Stray specimens also were recorded from ponds at several places.

This species appears to be closely related to *G. subclavatum* Grun.

85. *Gomphonema clavatoides* sp. nov. (Figs. 88-89, 103)

Valvae 26.2-36 μ longae atque 7.2-8.7 μ latae, late clavatae, apice plus minus late rotundato, basi gradatim attenuata vel raro subcapitata. Raphe tenuis et recta. Area axialis angusta, sublinearis; area centralis plus minus ampla, unilateraliter dilatata, stigmatibus unico in latere opposito. Striae 6-8 in 10 μ , crasse lineatae atque aliquantum radiales. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario auctoris sub numero BOM-BOR.—99-102.

Valves 26.2-36 μ long and 7.2-8.7 μ broad, broadly clavate with more or less broadly rounded apex and gradually attenuated to rarely subcapitate base. Raphe thin and straight. Axial area narrow, sublinear; central area more or less large, unilaterally dilated with an isolated

stigma on the opposite side. Striae 6-8 in $10\ \mu$, coarsely lineate and slightly radial.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes, in good number. It is also known from Kolhapur—Rankala tank, and Katyani hills and Ahmedabad—Chandola lake.

This species does not agree with any of the similar looking forms in the literature, hence it is considered to be a new species.

86. *Gomphonema clavatoides* v. *valida* v. nov. (Fig. 104)

Valvae $37.8-40\ \mu$ longae atque $6.4-6.5\ \mu$ latae, lanceolato-clavatae, apice acute cuneato, ad basim gradatim attenuatae. Raphe aliquantum crassa et recta. Striae 7-8 in $10\ \mu$, crasse lineatae atque aliquantum radiales. Caetera ut in typo. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—102.

Valves $37.8-40\ \mu$ long and $6.4-6.5\ \mu$ broad, lanceolate-clavate with acutely cuneate apex and gradually attenuated base. Raphe somewhat thick and straight. Striae 7-8 in $10\ \mu$, coarsely lineate and slightly radial. In all other characters like the type.

Habitat : Fresh water. Collected from streams at Borivli and Powai lake along with the type, as stray specimens.

This diatom differs from the above type in having acutely cuneate apex, slimmer valves and more attenuated base. It is therefore considered to be a new variety.

87. *Gomphonema lanceolatum* Ehr. (Figs. 105-107)

Habitat : Fresh water. Collected from several wet situations in the region, as a common and frequent form.

Some of the forms recorded from Bombay and Salsette region were found to be comparatively broader than the type described in the literature.

88. *Gomphonema lanceolatum* v. *insignis* (Greg.) Cl.

Habitat : Fresh water. Collected from streams at Borivli and Powai and Vihar lakes as a common form, but elsewhere seen as scarce.

89. *Gomphonema magnifica* sp. nov. (Fig. 108)

Valvae $80-90\ \mu$ longae atque $18-19.8\ \mu$ latae, lanceolato-clavatae, apicibus acute rotundatis, basi interdum concava. Raphe crassa et recta. Area axialis angusta, linearis; area centralis parva, aliquantum unilateralis stigmate unico in latere opposito. Striae 6.5-8 in $10\ \mu$, paululum radiales, distincte punctatae, punctis circiter 13-15 in $10\ \mu$.

singulae striae mediae remote evolutae. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 1944, 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—106.

Valves 80-90 μ long and 18-19.8 μ broad, lanceolate-clavate with acutely rounded apices, the base sometimes concave. Raphe thick and straight. Axial area narrow, linear; central area small, slightly unilateral with an isolated stigma on the opposite side. Striae, 6.5-8 in 10 μ , very slightly radial, distinctly punctate, puncta about 13-15 in 10 μ , single middle striae distantly formed.

Habitat: Fresh water. Collected from streams at Borivli and Powai and Vihar lakes as a common form. From other bodies of water it is recorded to be very stray.

This species agrees with *G. lanceolatum* Ehr. in the outline, raphe, and punctate striae, but greatly differs in having much broader valves and larger size. Moreover, the striae are only slightly radial, very clearly punctate, and much fewer per 10 μ than in *G. lanceolatum*. It is therefore considered to be a different type, and as it does not agree with any other known species it is regarded as a new species.

90. *Gomphonema magnifica* v. *rhomboida* v. nov. (Fig. 109)

Valvae 79-85 μ longae atque 19.8-20 μ latae, rhomboideo-lanceolato-clavatae, apicibus acute rotundatis, basi interdum paululum concava. Striae 6.5-7 in 10 μ vel rarius 8 in 10 μ , distincte punctatae. Caetera ut in typo. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—106.

Valves 70-85 μ long and 19.8-20 μ broad, rhomboid-lanceolate-clavate with acutely rounded ends, the base sometimes slightly concave. Striae 6.5-7 to rarely 8 in 10 μ , distinctly punctate. In all other characters like the type.

Habitat: Fresh water. Collected from streams at Borivli and Powai lake along with the type, usually in a small number.

This diatom differs from the type in having rhomboid-lanceolate-clavate shape and more clearly marked punctate striae.

91. *Gomphonema gracile* Ehr. (Figs. 111-112)

Habitat: Fresh water. Collected from several pools, ponds, tanks, and other wet situations in the region. A common form.

The two illustrations given here suggest the range of variation that was recorded among the forms collected from the area. The figure 112 corresponds well with Schmidt's 'Atlas Diat.' t. 236, f. 16, whereas the other does with those given by Hustedt and Cleve-Euler.

92. *Gomphonema gracile* v. *naviculoides* (W. Sm.) Grun. (Figs. 113-114)

Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 186, f. 1281 c ; Schmidt, A., 1874-1944, *Atlas Diat.* t. 236, f. 18-19 (= *G.*—v. *naviculacea* W. Sm.).

Valves 49-70 μ long and 8.5-10.8 μ broad, almost isopolar, lanceolate-weakly-clavate, slightly bent with attenuated ends. Raphe thin and straight, feebly excentric. Axial area narrow, linear-lanceolate ; central area roundish and somewhat unilaterally expanded with an isolated stigma on the opposite side. Striae 12-16 in 10 μ , radial and indistinctly punctate.

Habitat : Fresh water. Collected from ponds at Andheri, Jogeshwari, Goregaon, streams at Borivli, and Powai lake, usually in a small number along with the type. Fairly distributed.

93. *Gomphonema gracile* v. *aurita* A. Br. (Fig. 115)

Schmidt, A., 1874-1944, *Atlas Diat.* t. 236, f. 20-24 ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 186, f. 1281 i (= *G.*—v. *auritum* A. Br.).

Valves 56-59 μ long and 9.2-9.6 μ broad, lanceolate-clavate, somewhat rhomboid with acutely rounded ends. In living cells ends are often provided with gelatinous apicules. Raphe thin and straight. Axial area very narrow ; central area slightly unilaterally formed with an isolated stigma on the opposite side. Striae 13-17 in 10 μ , strongly radial and more closely set towards the ends, one middle striae quite distant than the rest.

Habitat : Fresh water. Collected from Powai and Vihar lakes in good number but elsewhere seen as very stray specimens.

94. *Gomphonema gracile* v. *lanceolata* (Kütz.) Cl. (Fig. 116-117)

Schmidt, A., 1874-1944, *Atlas Diat.* t. 236, f. 25-28, t. 237, f. 9-10 (= *G.*—v. *lanceolata* Kütz.) ; Hustedt, 1938, *Arch. Hydrobiol., Suppl.*, 15 : 439, t. 28, f. 11-13 ; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 186, f. 1281 m-o (= *G.*—v. *lanceolatum* (Kütz.) Cl. ?).

Valves 45-49 μ long and 9-10 μ broad, distinctly lanceolate-clavate with more acutely rounded apex than the base, sometimes feebly constricted and produced. Raphe coarse and straight. Axial area very narrow ; central area small, slightly unilateral with an isolated stigma. Striae 14-16 in 10 μ , radial and indistinctly lineolate.

Habitat : Fresh water. Collected from several wet situations in the region but usually in a small number along with the type.

The present diatoms differ from Cleve-Euler's specimens in not having clearly defined apiculate apex. Moreover, the outline here is

on the opposite side. Striae 8-10 in $10\ \mu$, slightly radial and indistinctly punctate, 1-middle striae very short.

Habitat : Fresh water. Collected from streams at Borivli, Kanheri caves, and Powai lake, in a good number. Elsewhere in the locality it occurred as a stray form.

83. *Gomphonema montanum* v. *acuminatum* Mayer (Figs. 100-101)

Valves $39.6-53\ \mu$ long and $12.3-12.6\ \mu$ broad, striae about 9-10 in $10\ \mu$.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes. Stray specimens also were obtained from other larger bodies of water.

Skvortzow has described almost identical forms as *G. acuminatum* v. *sinica* Skv. (Skvortzow, B. W., 1935, *Philipp. J. Sci.* 57 : 474, pl. 3, f. 10-11) from Poyang lake material, which I include here.

84. *Gomphonema aequatoriale* Hust. (Figs. 87, 102)

Hustedt, 1949, *Expl. Parc Nat. Albert, Miss. H. Damas* (1935-36), 8 : 119, t. 10, f. 6-8.

Valves $48.6-80\ \mu$ long and $10.8-15\ \mu$ broad, sublinear-clavate with broad subtruncate-rounded apex and gradually attenuated base, may be sometimes concave. Raphe thick with central part slightly unilaterally bent. Axial area moderately linear; central area large, somewhat unilaterally expanded with an isolated stigma on the opposite side. Striae 8-10 rarely up to 12 in $10\ \mu$, clearly lineate, radial and somewhat closely set at the ends.

Habitat : Fresh water. Collected from streams at Borivli, Kanheri caves, Powai, Vihar, and Tansa lakes, rather frequent. Stray specimens also were recorded from ponds at several places.

This species appears to be closely related to *G. subclavatum* Grun.

85. *Gomphonema clavatoides* sp. nov. (Figs. 88-89, 103)

Valvae $26.2-36\ \mu$ longae atque $7.2-8.7\ \mu$ latae, late clavatae, apice plus minus late rotundato, basi gradatim attenuata vel raro subcapitata. Raphe tenuis et recta. Area axialis angusta, sublinearis; area centralis plus minus ampla, unilateraliter dilatata, stigmati unico in latere opposito. Striae 6-8 in $10\ \mu$, crasse lineatae atque aliquantum radiales. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario auctoris sub numero BOM-BOR.—99-102.

Valves $26.2-36\ \mu$ long and $7.2-8.7\ \mu$ broad, broadly clavate with more or less broadly rounded apex and gradually attenuated to rarely subcapitate base. Raphe thin and straight. Axial area narrow, sublinear; central area more or less large, unilaterally dilated with an isolated

stigma on the opposite side. Striae 6-8 in $10\ \mu$, coarsely lineate and slightly radial.

Habitat : Fresh water. Collected from streams at Borivli, Powai and Vihar lakes, in good number. It is also known from Kolhapur—Rankala tank, and Katyani hills and Ahmedabad—Chandola lake.

This species does not agree with any of the similar looking forms in the literature, hence it is considered to be a new species.

86. *Gomphonema clavatoides* v. *valida* v. nov. (Fig. 104)

Valvae $37.8-40\ \mu$ longae atque $6.4-6.5\ \mu$ latae, lanceolato-clavatae, apice acute cuneato, ad basim gradatim attenuatae. Raphe aliquantum crassa et recta. Striae 7-8 in $10\ \mu$, crasse lineatae atque aliquantum radiales. Caetera ut in typo. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—102.

Valves $37.8-40\ \mu$ long and $6.4-6.5\ \mu$ broad, lanceolate-clavate with acutely cuneate apex and gradually attenuated base. Raphe somewhat thick and straight. Striae 7-8 in $10\ \mu$, coarsely lineate and slightly radial. In all other characters like the type.

Habitat : Fresh water. Collected from streams at Borivli and Powai lake along with the type, as stray specimens.

This diatom differs from the above type in having acutely cuneate apex, slimmer valves and more attenuated base. It is therefore considered to be a new variety.

87. *Gomphonema lanceolatum* Ehr. (Figs. 105-107)

Habitat : Fresh water. Collected from several wet situations in the region, as a common and frequent form.

Some of the forms recorded from Bombay and Salsette region were found to be comparatively broader than the type described in the literature.

88. *Gomphonema lanceolatum* v. *insignis* (Greg.) Cl.

Habitat : Fresh water. Collected from streams at Borivli and Powai and Vihar lakes as a common form, but elsewhere seen as scarce.

89. *Gomphonema magnifica* sp. nov. (Fig. 108)

Valvae $80-90\ \mu$ longae atque $18-19.8\ \mu$ latae, lanceolato-clavatae, apicibus acute rotundatis, basi interdum concava. Raphe crassa et recta. Area axialis angusta, linearis; area centralis parva, aliquantum unilateralis stigmate unico in latere opposito. Striae $6.5-8$ in $10\ \mu$, paululum radiales, distincte punctatae, punctis circiter 13-15 in $10\ \mu$.

singulae striae mediae remote evolutae. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 1944, 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—106.

Valves 80-90 μ long and 18-19.8 μ broad, lanceolate-clavate with acutely rounded apices, the base sometimes concave. Raphe thick and straight. Axial area narrow, linear; central area small, slightly unilateral with an isolated stigma on the opposite side. Striae, 6.5-8 in 10 μ , very slightly radial, distinctly punctate, puncta about 13-15 in 10 μ , single middle striae distantly formed.

Habitat: Fresh water. Collected from streams at Borivli and Powai and Vihar lakes as a common form. From other bodies of water it is recorded to be very stray.

This species agrees with *G. lanceolatum* Ehr. in the outline, raphe, and punctate striae, but greatly differs in having much broader valves and larger size. Moreover, the striae are only slightly radial, very clearly punctate, and much fewer per 10 μ than in *G. lanceolatum*. It is therefore considered to be a different type, and as it does not agree with any other known species it is regarded as a new species.

90. *Gomphonema magnifica* v. *rhomboida* v. nov. (Fig. 109)

Valvae 79-85 μ longae atque 19.8-20 μ latae, rhomboideo-lanceolato-clavatae, apicibus acute rotundatis, basi interdum paululum concava. Striae 6.5-7 in 10 μ vel rarius 8 in 10 μ , distincte punctatae. Caetera ut in typo. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—106.

Valves 70-85 μ long and 19.8-20 μ broad, rhomboid-lanceolate-clavate with acutely rounded ends, the base sometimes slightly concave. Striae 6.5-7 to rarely 8 in 10 μ , distinctly punctate. In all other characters like the type.

Habitat: Fresh water. Collected from streams at Borivli and Powai lake along with the type, usually in a small number.

This diatom differs from the type in having rhomboid-lanceolate-clavate shape and more clearly marked punctate striae.

91. *Gomphonema gracile* Ehr. (Figs. 111-112)

Habitat: Fresh water. Collected from several pools, ponds, tanks, and other wet situations in the region. A common form.

The two illustrations given here suggest the range of variation that was recorded among the forms collected from the area. The figure 112 corresponds well with Schmidt's 'Atlas Diat.' t. 236, f. 16, whereas the other does with those given by Hustedt and Cleve-Euler.

92. *Gomphonema gracile* v. *naviculoides* (W. Sm.) Grun. (Figs. 113-114)

Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 186, f. 1281 c; Schmidt, A., 1874-1944, *Atlas Diat.* t. 236, f. 18-19 (= *G.*—v. *naviculacea* W. Sm.).

Valves 49-70 μ long and 8.5-10.8 μ broad, almost isopolar, lanceolate-weakly-clavate, slightly bent with attenuated ends. Raphe thin and straight, feebly excentric. Axial area narrow, linear-lanceolate; central area roundish and somewhat unilaterally expanded with an isolated stigma on the opposite side. Striae 12-16 in 10 μ , radial and indistinctly punctate.

Habitat: Fresh water. Collected from ponds at Andheri, Jogeshwari, Goregaon, streams at Borivli, and Powai lake, usually in a small number along with the type. Fairly distributed.

93. *Gomphonema gracile* v. *aurita* A. Br. (Fig. 115)

Schmidt, A., 1874-1944, *Atlas Diat.* t. 236, f. 20-24; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 186, f. 1281 i (= *G.*—v. *auritum* A. Br.).

Valves 56-59 μ long and 9.2-9.6 μ broad, lanceolate-clavate, somewhat rhomboid with acutely rounded ends. In living cells ends are often provided with gelatinous apicules. Raphe thin and straight. Axial area very narrow; central area slightly unilaterally formed with an isolated stigma on the opposite side. Striae 13-17 in 10 μ , strongly radial and more closely set towards the ends, one middle striae quite distant than the rest.

Habitat: Fresh water. Collected from Powai and Vihar lakes in good number but elsewhere seen as very stray specimens.

94. *Gomphonema gracile* v. *lanceolata* (Kütz.) Cl. (Fig. 116-117)

Schmidt, A., 1874-1944, *Atlas Diat.* t. 236, f. 25-28, t. 237, f. 9-10 (= *G.*—v. *lanceolata* Kütz.); Hustedt, 1938, *Arch. Hydrobiol., Suppl.*, 15: 439, t. 28, f. 11-13; Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 186, f. 1281 m-o (= *G.*—v. *lanceolatum* (Kütz.) Cl. ?).

Valves 45-49 μ long and 9-10 μ broad, distinctly lanceolate-clavate with more acutely rounded apex than the base, sometimes feebly constricted and produced. Raphe coarse and straight. Axial area very narrow; central area small, slightly unilateral with an isolated stigma. Striae 14-16 in 10 μ , radial and indistinctly lineolate.

Habitat: Fresh water. Collected from several wet situations in the region but usually in a small number along with the type.

The present diatoms differ from Cleve-Euler's specimens in not having clearly defined apiculate apex. Moreover, the outline here is

rather more lanceolate than clavate. Hustedt's *G. gracile* v. *lanceolata* (Kütz.) Cl. (Hustedt, 1930, Bacil. 376, f. 703) differs in having more drawnout apex. However, the present specimens very closely agree with those illustrated in the 'Atlas' and recorded by Hustedt (1938).

95. *Gomphonema gracile* v. *frickei* v. nov. (Fig. 90)

Valvae 50-52 μ longae atque 11-11.2 μ latae, clavato-lanceolatae, apice constricto, distincte apiculato, basi gradatim attenuata. Raphe tenuis et recta. Area axialis angustissima; area centralis aliquantum unilateraliter dilatata, stigmati unico in latere opposito. Striae 8-12 in 10 μ , radiales atque indistincte punctatae. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—60.

Valves 50-52 μ long and 11-11.2 μ broad, clavate-lanceolate with constricted distinctly apiculate apex and gradually attenuated base. Raphe thin and straight. Axial area very narrow, central area slightly unilaterally dilated with an isolated stigma on the opposite side. Striae 8-12 in 10 μ , radial and indistinctly punctuate.

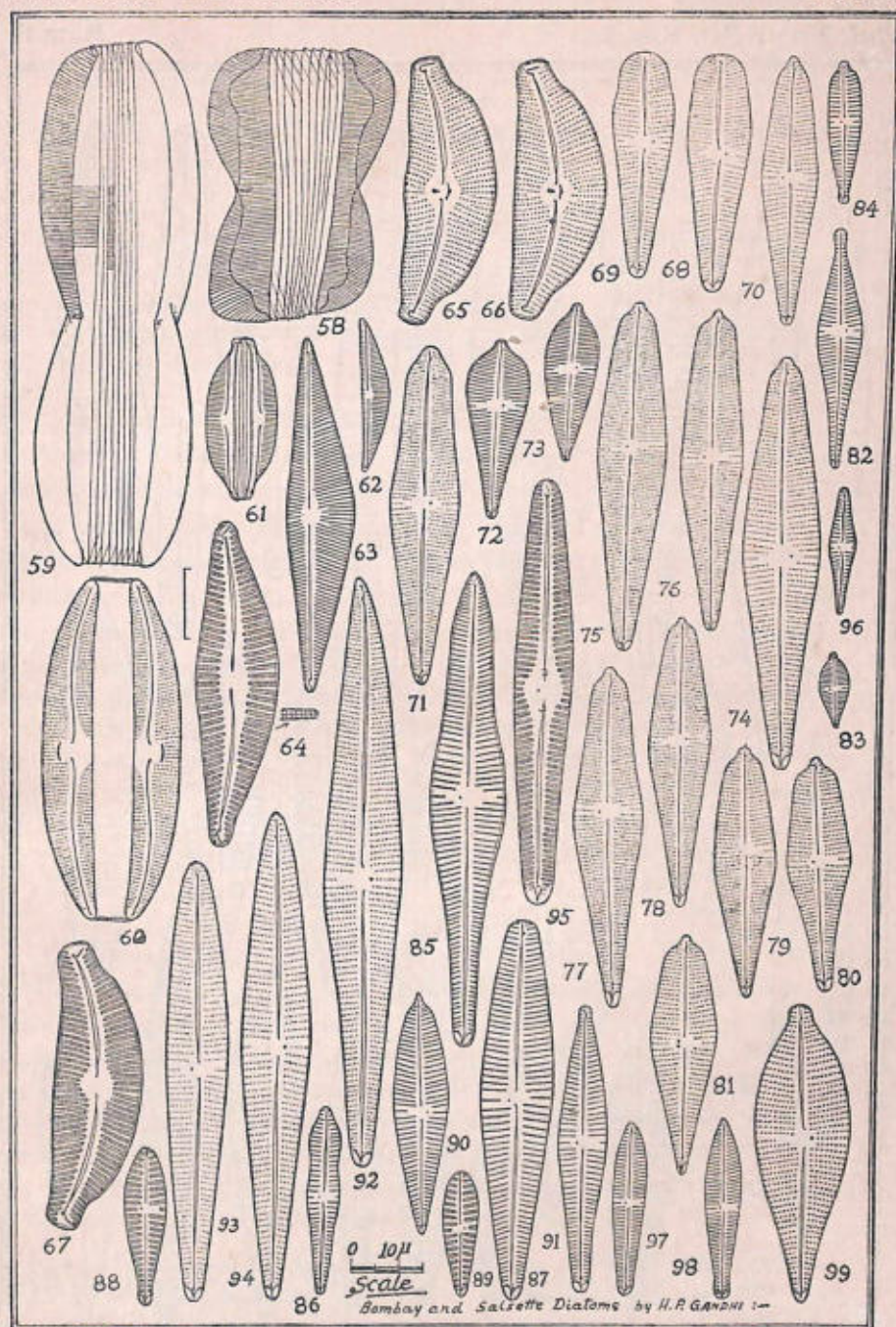
Habitat : Fresh water. Collected from Powai lake as a stray form.

This diatom more or less agrees well with "*G. gracile* v.", as given in the 'Atlas Diat.' t. 236, f. 31, in the outline and sharply pointed apiculate apex. However, the present valves are clearly clavate, i.e. the apex region is distinctly broad; thus they differ. As the figure 31 on t. 236 of the 'Atlas' has no complete name, it has been named here and the present specimens are included under the same with the noted differences.

96. *Gomphonema gracile* v. *subcapitata* v. nov. (Fig. 91)

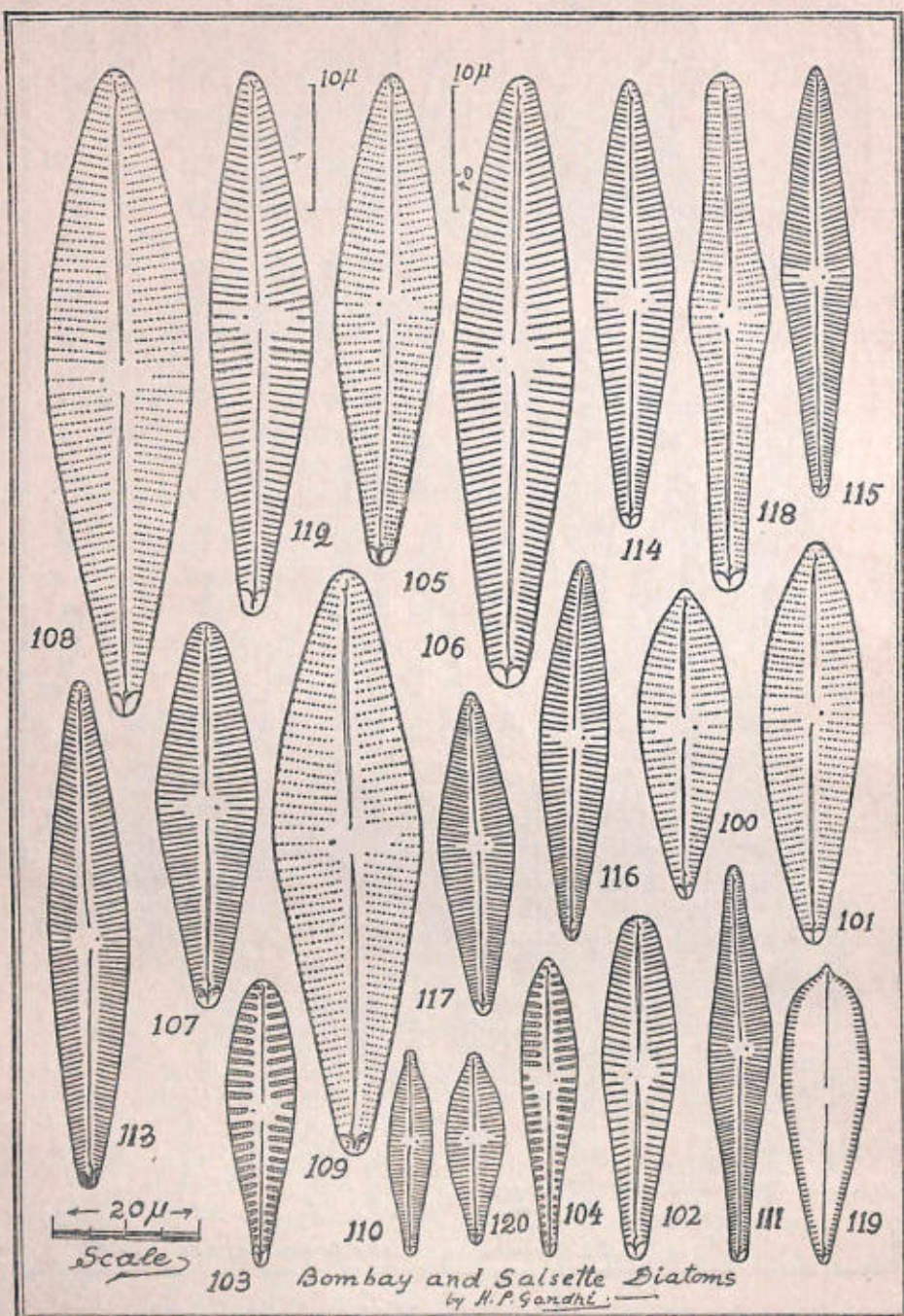
Valvae 50-60 μ longae atque 9-10 μ latae, lanceolato-clavatae, apice constricto subcapitato, basi aliquantum concava, attenuato-rotundata. Raphe tenuis et recta. Area axialis angustissima; area centralis magna, unilateraliter dilatata, stigmati unico in latere opposito. Striae 8-9 in medio ac 9-13 in 10 μ in utroque apice, radiales atque indistincte punctatae. Typus lectus a H. P. Gandhi ad Wadala die 31-7-1945, et positus in herbario proprio auctoris sub numero BOM-WAD.—16.

Valves 50-60 μ long and 9-10 μ broad, lanceolate-clavate with constricted subcapitate apex and slightly concave, gradually attenuated rounded base. Raphe thin and straight. Axial area very narrow; central area large, unilateral with an isolated stigma on the opposite side. Striae 8-9 in the middle and 9-13 in 10 μ , towards the ends, radial and indistinctly punctate.



FIGURES 58-99

Fig. 58. *Amphiprora alata* Kütz.; 59. *Amphiprora lata* Grev. v. *angustior* McCall.; 60. *Amphora ovalis* Kütz. v. *gracilis* (Ehr.) Cl.; 61. *Amphora acutiuscula* Kütz.; 62. *Cymbella gracilis* (Rabh.) Cl.; 63. *Cymbella yarrensensis* (A. S.) Cl.; 64. *Cymbella leptoceros* (Ehr.) Grun. v. *rostrata* Hust. f. *indica* f. nov.; 65-66. *Cymbella tumida* (Bréb.) V. H.; 67. *Cymbella powaiana* sp. nov.; 68. *Gomphonema constrictum* Ehr. v. *capitata* (Ehr.) Cl.; 69. *Gomphonema constrictum* v. *indica* v. nov.; 70-71. *Gomphonema acuminatum* Ehr. v. *turris* (Ehr.) Cl.; 72-73. *Gomphonema augur* Ehr.; 74-80. *Gomphonema subapicatum* Fritsch & Rich.; 81. *Gomphonema subapicatum* v. *okamurae* (Skv.) emend.; 82. *Gomphonema subtile* Ehr. v. *malayensis* Hust.; 83. *Gomphonema parvulum* Kütz.; 84. *Gomphonema angustatum* (Kütz.) Rabh. v. *producta* Grun. f. *indica* f. nov.; 85. *Gomphonema martini* Fricke; 86. *Gomphonema montanum* Schum.; 87. *Gomphonema aequatoriale* Hust.; 88-89. *Gomphonema clavatoides* sp. nov.; 90. *Gomphonema gracile* v. *frickei* v. nov.; 91. *Gomphonema gracile* v. *subcapitata* v. nov.; 92. *Gomphonema spiculoides* v. *major* v. nov.; 93. *Gomphonema balatonis* Pant.; 94. *Gomphonema balatonis* v. *lanceolata* v. nov.; 95. *Gomphonema sumatrense* Fricke; 96. *Gomphonema undulatum* Hustedt; 97-98. *Gomphonema tenuis* sp. nov.; 99. *Gomphonema moniliforme* sp. nov.



FIGURES 100-120

Fig. 100-101. *Gomphonema montanum* v. *acuminatum* Mayer; 102. *Gomphonema aequatoriale* Hust.; 103. *Gomphonema clavatoides* sp. nov.; 104. *Gomphonema clavatoides* v. *valida* v. nov.; 105-107. *Gomphonema lanceolatum* Ehr.; 108. *Gomphonema magnifica* sp. nov.; 109. *Gomphonema magnifica* v. *rhomboides* v. nov.; 110. *Gomphonema parvulum* v. *lagenula* (Grun.) Hust.; 111-112. *Gomphonema gracile* Ehr.; 113-114. *Gomphonema gracile* v. *naviculoides* (W. Sm.) Grun.; 115. *Gomphonema gracile* v. *aurita* A. Br.; 116-117. *Gomphonema gracile* v. *lanceolatum* (Kütz.) Cl.; 118. *Gomphonema intricatum* v. *vibrio* (Ehr.) Cl.; 119. *Gomphonema lingulatum* Hust.; 120. *Gomphonema parvulum* Kütz.

Habitat : Fresh water. Collected from pools and ponds at Wadala in a small number along with the type. It is also recorded from the Jog falls.

This diatom agrees well with *G. gracile* Ehr. in the general outline, range of dimensions, and the nature and arrangement of the striae. However, the forms observed during different times always showed the apex slightly constricted and subcapitate ; hence such specimens are considered to be a new variety.

97. *Gomphonema spiculoides* Gandhi, nov. nom.

G. spicula Gandhi, *J. Bombay nat. Hist. Soc.* 55 : 501, f. 28, 1958 (non *G. spicula* Manguin).

Habitat : Fresh water. Collected from pools and ponds at Wadala, ponds at Andheri, Goregaon, Vile-Parle, and streams at Borivli. Fairly common.

I have to introduce here a new nomenclature for my *G. spicula*, since my esteemed friend Dr. J. W. G. Lund informed me of the same name existing in the literature. Unfortunately, I did not have the publication in which the other *G. spicula* was described, nor could I avail the same from any other source. Naturally, I approached Dr. Manguin who so kindly furnished me with the full information regarding his *G. spicula*, and I understand that my *G. spicula* is a different species altogether. I, herewith, extend my grateful thanks to both these friends for furnishing me with the valuable information.

98. *Gomphonema spiculoides* v. *major* v. nov. (Fig. 92)

Valvae 90-123 μ longae atque 12.5-16 μ latae, anguste lanceolato-clavatae, aliquantum arcuatae, apice acutissimo, ad basim gradatim attenuatae. Raphe crassa, parte centrali unilateraliter inclinata. Area axialis angustissima ; area centralis unilateraliter dilatata, stigmati unico in latere opposito. Striae 7-8 in medio ac 8-11 in 10 μ in utroque apice, radiales atque distincte punctatae, punctis 16-18 in 10 μ . Typus lectus a H. P. Gandhi ad Wadala die 31-7-1945, et positus in herbario proprio auctoris sub numero BOM-WAD.—18.

Valves 90-123 μ long and 12.5-16 μ broad, narrowly lanceolate-clavate, slightly arcuate, apex very acute, towards the base gradually attenuated. Raphe thick with central part unilaterally bent. Axial area very narrow ; central area unilaterally dilated with an isolated stigma on the opposite side. Striae 7-8 in the middle and 8-11 in 10 μ towards the ends, radial and distinctly punctate, punctae about 16-18 in 10 μ .

Habitat : Fresh water. Collected from ponds at Wadala in good number, but stray specimens also were collected from ponds at Gore-

gaon, Andheri, Vile-Parle, and Borivli streams. Fairly distributed in the region.

This diatom agrees well with *G. spiculoides* Gandhi, collected here and from Kolhapur and Jog falls, in the shape, raphe, and the organisation of the striae. However, these forms are very large with comparatively very few striae per 10 μ . Unfortunately, I have so far not come across any such intergrading specimens which might connect these two extreme ranges of dimensions. I, therefore, regard the present specimens to be a new variety of *G. spiculoides*, till the other intergrading individuals are discovered.

99. *Gomphonema intricatum* Kütz.

Habitat : Fresh water. Collected from ponds at Goregaon, Dahisar, Sion, streams at Borivli, and Powai, Vihar, and Tansa lakes. Fairly common.

100. *Gomphonema intricatum* v. *vibrio* (Ehr.) Cl. (Fig. 118)

Habitat : Fresh water. Collected from pools, ponds, and tanks around Andheri, Goregaon, Vile-Parle, and other wet situations in the region, usually in a small number.

101. *Gomphonema balatonis* Pant. (Fig. 93)

Pantocsek, J., 1902, *Res. Wiss. Erf. Balat.* 2 (2) : 64, t. 7, f. 164.

Valves 86-90 μ long and 12-12.6 μ broad, narrowly lanceolate-clavate with rounded ends without constrictions. Raphe thick and straight, terminal fissures distinct. Axial area narrow, linear; central area slightly unilaterally enlarged with an isolated stigma on the opposite side. Striae 6-7 in 10 μ in the middle up to 8.5 towards the ends, slightly radial, fine but clearly punctate, punctae about 13-15 in 10 μ .

Habitat : Fresh water. Collected from Powai and Vihar lakes in a small number. It was also collected from Someshwar tank at Dharwar as a stray form.

This species agrees well with the type described by Pantocsek, except that the local forms were found to be somewhat of larger size. Cleve-Euler regards the same as *G. lanceolatum* Ehr. v. *affine* (Kütz.) A. Cl. (Cleve-Euler, A., 1951-55, *Diat. Schwed. Finn.*—IV, 185, f. 1280 g-p), but the illustrations given do not agree well either with Pantocsek's or the present forms. Moreover, the striae do not appear to be very closely set towards the apices as are being indicated by Cleve-Euler (striae at the ends shown to be around 11-13 in 10 μ). I, therefore, consider *G. balatonis* Pant. to be different from *G. lanceolatum* v. *affine*, of Cleve-Euler.

Further, Hustedt has described a diatom as *G. dubravicense* Pant.

(Hustedt. 1938, *Arch. Hydrobiol.*, *Suppl.* 15 : 437, t. 28, f. 1) which agrees with the present form in all respects except that it has two stigmas in the central area. While referring to Pantocsek's original paper (Pantocsek, J., 1905, *Beit. z. Kenn. foss. Bac.*—III, 54, t. 20, f. 294, 296), illustrations given in the 'Atlas Diat.' t. 238, f. 32-34, and by Cleve-Euler (Cleve-Euler, *op. cit.* IV, 190, f. 1286 a-b), it appears that *G. dubravicense* Pant. is more or less tumid in the middle with axial and central areas comparatively large and the central area has more than two stigmas in one or more rows situated on one or both sides of the central nodule. Evidently, Hustedt's *G. dubravicense* seems to be different from that of Pantocsek's. However, I am presently not quite sure if it could be referable to *G. balatonis* or otherwise, since my own material has been too little to allow more detailed study.

102. *Gomphonema balatonis* Pant. v. *lanceolata* v. nov. (Fig. 94)

Valvae 100-108 μ longae atque 14-14.4 μ latae, anguste lanceolato-clavatae, apice acute cuneato, basi gradatim attenuata. Striae 6-8 in 10 μ , aliquantum radiales atque distincte punctatae. Caetera ut in typo. Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—108.

Valves 100-108 μ long and 14-14.4 μ broad, narrowly lanceolate-clavate with acutely cuneate apex and gradually attenuated base. Striae 6-8 in 10 μ , slightly radial and distinctly punctate. In all other characters like the type.

Habitat : Fresh water. Collected from Powai lake along with the type in a small number. A few specimens also were available from streams at Borivli. A rare type.

This diatom differs from the type in having acutely cuneate apex and somewhat more distinctly punctate striae. It also bears some resemblance with *G. hungaricum* Pant. (Pantocsek, J., 1905, *Beit. z. Kenn. foss. Bac.*—III, 54, t. 2, f. 28), but the present form differs in having more narrowly cuneate apex and only a single shortened striae in the middle part. However, it may be stated that further observations are necessary regarding this diatom to draw any conclusions.

103. *Gomphonema sumatrense* Fricke (Fig. 95)

Schmidt, A., 1874-1944, *Atlas Diat.* t. 248, f. 2-3.

Valves 87.7-94 μ long and 12-12.4 μ broad, narrowly-lanceolate-clavate with broadly rounded ends. Raphe thick and straight with part in the central nodule transversely comma-shaped and terminal fissures distinct, bayonet-shaped. Axial area narrowly lanceolate, gradually widened in the middle to form a wide, more or less elliptical central area, stigma formed on one side. Striae 7-8.5 in 10 μ , coarsely lineate, radial, lineations about 18-20 in 10 μ .

Habitat : Fresh water. Collected from ponds at Goregaon, Andheri, Vile-Parle, streams at Vajreshwari, Powai and Vihar lakes. It mostly occurred as a stray form.

104. *Gomphonema undulatum* Hustedt (Fig. 96)

Hustedt, 1936, *Arch. Hydrobiol., Suppl.* 14 : 166, t. 5, f. 34 ; 1938, *ibid.*, 15 : 441, t. 28, f. 2-8.

Valves 25-35 μ long and 5.2-5.8 μ broad, lanceolate-clavate with sides between the middle and ends somewhat concave, apex more broad than the base. Raphe coarse and clearly undulate with central part unilaterally bent. Axial area very narrow ; central area quite large and unilateral with an isolated stigma on the opposite side. Striae 10-11 in 10 μ , coarse, radial, indistinctly punctate and the middle striae very much shortened.

Habitat : Fresh water. Collected from streams at Borivli, Chembur hills, Powai and Vihar lakes, usually in a small number.

105. *Gomphonema tenuis* sp. nov. (Figs. 97-98)

Valvae 30-37.5 μ longae atque 6.4-7.4 μ latae, clavato-lanceolatae, apice acuto-cuneato, basi gradatim attenuata, late rotundata, aliquando producta vel producto-subcapitata. Raphe tenuis et recta. Area axialis angustissima ; area centralis magna, unilateraliter dilatata, stigmatate unico in latere opposito. Striae 13-15 in 10 μ , radiales, subtiles, media vero striae valde abbreviata. Typus lectus a H. P. Gandhi ad Borivli in rivulis die 10-8-1946, et positus in herbario proprio auctoris sub numero BOM-BOR.—107.

Valves 30-37.5 μ long and 6.4-7.4 μ broad, clavate-lanceolate with acutely cuneate apex and gradually attenuated broadly rounded base, base sometimes produced to produced-subcapitate. Raphe thin and straight. Axial area very narrow ; central area large, unilaterally dilated with an isolated stigma on the opposite side. Striae 13-15 in 10 μ , radial, quite fine and one middle striae much abbreviated.

Habitat : Fresh water. Collected from streams at Borivli, Kanheri caves, Powai lake, in a good number mixed up in vegetable dead matter. It was also collected from Kolhapur-Katyani hill streams, and some pools along roadsides.

This species does not agree with any of the known types of similar shape ; hence it is considered to be a new species.

106. *Gomphonema moniliforme* sp. nov. (Fig. 99)

Valvae 56-52 μ longae atque 19-20 μ latae, late clavatae, apice constricto, producto-subtruncato, basi aliquantum concava ad latera ac attenuata. Raphe crassa et recta, parte centrali unilateraliter inclinata

in nodulo centrali, fissuris terminalibus distinctis. Area axialis angusta, linearis; area centralis angusta, unilateraliter dilatata, stigmatе unico in latere opposito. Striae 7.5-8 in 10 μ , aliquantum radiales, crasse punctatae, punctis circiter 11-13 in 10 μ . Typus lectus a H. P. Gandhi in lacu Powai die 6-3-1945, et positus in herbario proprio auctoris sub numero BOM-POW.—110.

Valves 56-62 μ long and 19-20 μ broad, broadly-clavate, apex constricted, produced-subtruncate; base with slightly concave sides and attenuated. Raphe thick with part in the central nodule unilaterally bent and terminal fissures distinct. Axial area narrow, linear; central area narrow unilaterally dilated with an isolated stigma on the opposite side. Striae 7.5-8 in 10 μ , slightly radial, coarsely punctate and puncta about 11-13 in 10 μ .

Habitat: Fresh water. Collected from Powai lake in a small number.

This diatom is quite distinctive and does not agree with any other type, hence it is considered to be a new species.

107. *Gomphonema olivaceum* (Lyngb.) Kütz.

Habitat: Fresh water. Collected from streams at Borivli, Powai, Vihar, and Tansa lakes, and several other large bodies of water in region. A common form.

108. *Gomphonema lingulatum* Hust. (Fig. 119)

Hustedt, 1927, *Arch. Hydrobiol.* 18 : 166, t. 5, f. 5; Skvortzow, B. W., 1937, *Philipp. J. Sci.* 61 : 52, pl. 13, f. 6-7; 1937b, *ibid.* 61 : 285, pl. 3, f. 13; Hustedt, 1938, *Arch. Hydrobiol., Suppl.* 15 : 443, t. 27, f. 1.

Valves 30-42 μ long and 10-12 μ broad, clavate with shortly apiculate apex and gradually attenuated base. Raphe thin and straight. Axial area very broad; central area not defined. Stigma absent. Striae 14-15 in 10 μ , radial, short and marginal.

Habitat: Fresh water. Collected from Powai and Vihar lakes in a small number.

SUMMARY

This paper deals with the diatom genera *Pinnularia*, *Amphiprora*, *Amphora*, *Cymbella*, and *Gomphonema*, collected from the year 1945 to 1958, from the region of Bombay and Salsette. Here, in all 108 diatoms are recorded of which 53 are new records for India and eight species, twelve varieties, and three forms are considered to be new to science.

ACKNOWLEDGEMENT

The author wishes to record his grateful thanks to Prof. (Mrs.) E. A. Gonzalves for early suggestion of the problem, to Rev. Father F. Braganza and Rev. Father H. Santapau for correcting the Latin diagnoses of the new diatoms described in this paper. He is further indebted to the latter for the information concerning valid publication of new taxa.

REFERENCES

- Berg, Å. (1945): Diatomeen von der Sophia—Expedition in Jahre 1883, *Ark. Bot.* 32A (1): 1-34.
- (1953): Diatoms from the upper Finke River, Central Australia, collected by Dr. O. H. Selling, *Bot. Not.* 1: 65-72.
- Cleve-Euler, A. (1951-55): Die Diatomeen von Schweden und Finnland—I, V, II, III, IV, K. Svenska Vetens.-Akad. Handl., Fjärde Ser. 2(1): 1-163; 3(3): 1-153; 4(1): 1-158; 4(5): 1-255; 5(4): 1-232.
- Cleve, P. T. (1894-95): Synopsis of the Naviculoid Diatoms, pt. I-II, K. Svenska Vetens.-Akad. Handl. 26(2): 1-194; 27(3): 1-219.
- Donkin, A. S. (1871-73): The Natural History of the British Diatomaceae, Pts. I-III, pp. 1-74, pls 1-12, London.
- Foged, N. (1949): Diatoms in the salt bog of Langemose in East Funen, *Dansk. bot. Ark* 13(6): 1-31.
- (1955): Diatoms from Pearyland, North Greenland, collected by Kjeld Holman, *Medd. om Grønland* 128(7): 1-90.
- (1957): I. Diatoms from Rennell Island, *Natur. Hist. Rennell Isl., Brit. Sol. Isl.* 3: 6-117.
- Fritsch, F. E. & Rich, F. (1955): Contributions to our knowledge of the fresh water Algae of Africa-8. Bacillariales (Diatoms) from Griqualand West, *Trans. roy. Soc. S. Afr.* 18: 93-123.
- Gandhi, H. P. (1955): A contribution to our knowledge of the fresh water Diatoms of Partabgarh, Rajasthan, *J. Indian bot. Soc.* 34: 307-38.
- (1956): A contribution to our knowledge of fresh water Diatomaceae of South-Western India. I. Fresh water Diatoms of Dharwar, *ibid.* 35: 194-209.
- (1957): A contribution to our knowledge of the Diatom genus *Pinnularia*, *J. Bombay nat. Hist. Soc.* 54(4): 845-52.
- Gandhi, H. P. (1958a): The fresh water. Diatom-flora of the Hirebhasgar-Dam area, Mysore State, *J. Indian bot. Soc.* 37: 249-65.
- (1958b): Fresh water Diatoms from Kolhapur and its immediate environs, *J. Bombay nat. Hist. Soc.* 55 (3): 493-511.
- Geitler, L. (1932): Der Formwechsel der penneten Diatomeen (Kieselalgen). *Arch. Protistenk.* 78: 1-226.
- Gonzalves, E. A. & Gandhi, H. P. (1952-54): A systematic account of the Diatoms of Bombay and Salsette, I-III. *J. Indian bot. Soc.* 31: 117-51; 32: 239-63; 33: 338-50.
- Hendey, N. I. (1951): I. Littoral Diatoms of Chichester Harbour with special reference to fouling, *J. roy. microsc. Soc.* 71: 1-86.
- Hustedt, F. (1911): Beiträge zur Algenflora von Bremen. IV. Bacillariaceen aus der Wumme, *Abh. naturw. Ver. Bremen* 20(2): 257-315.
- (1914): Bacillariales aus den Sudeten und einigen benachbarten Gebieten des Odertales, *Arch. Hydrobiol.* 10: 1-65, 129-192.
- (1924): Die Bacillariaceen—Vegetation des Sarekgebirges, in A. Hamberg (Herausg.) *Schwedisch-Lappland gel., Naturw. Unters. Sarekgeb. in Schwedisch-Lappland* 3(6): 525-625.
- (1927): Bacillariales aus dem Aoki-ko in Japan, *Arch. Hydrobiol.* 18: 155-73.
- (1930): Bacillariophyta Diatomaceae), in A. Pascher's *Die Süßwasser-Flora Mitteleuropas*, H. 10, Jena.
- (1936): Die fossile Diatomeen-flora in den Ablagerungen des Tobasees auf Sumatra, *Arch. Hydrobiol., suppl.*, 14: 143-92.
- (1938): Systematische und ökologische Untersuchungen über die Diatomeenflora von Java, Bali und Sumatra nach dem Material der Deutschen Limnologischen Sunda-Expedi-

- tion, *Arch. Hydrobiol.*, Suppl. 15 : 131-177, 187-295, 393-506, 638-790.
- Hustedt, F. (1942): Süßwasser-Diatomeen des indomalayischen Archipels und der Hawaii-Inseln, *Int. Rev. Hydrobiol. u. Hydrogr.* 42(1/3) : 1-252.
- (1944): Diatomeen aus der Umgebung von Abisko in Schwedisch Lappland, *Arch. Hydrobiol.* 39(1) : 82-174.
- (1949): Süßwasser-Diatomeen aus dem Albert-National park in Belgisch-Kongo, *Expl. Parc nat.-Albert, Miss. H. Damas* (1935-36) 8 : 1-199.
- (1954): Diatomeenflora der Eifelmaare, *Arch. Hydrobiol.* 48(4) : 451-96.
- Jurilj, A. (1954): Flora and vegetation of Diatom from Ochrida Lake in Jugoslavia, *Jugoslav Akad. Znan. Umjet.* 1954 : 99-190.
- Krishnamurthy, V. (1954): A contribution to the Diatom flora of South India, *J. Indian bot. Soc.* 33 : 354-81.
- Lund, J. W. G. (1946): Observation on soil Algae—I. The ecology, size and taxonomy of British soil Diatoms, pt. II, *New Phytol.* 45(1) : 56-110.
- McCall, D. (1933): Diatoms (recent and fossil) of the Tay District, *J. Linn. Soc. (Bot.)* 49 : 219-308.
- Mills, F. W. (1932): Some Diatoms from Warri, South Nigeria, *J. roy. microsc. Soc.* 52 : 383-94.
- Pantocsek, J. (1902): Die Bacillarien des Balatonsees, *Res. wissenschaft. Erf. Balat.* 2(2) : 1-112.
- (1905): Beiträge zur Kenntniss der fossilen Bacillarien-III. Süßwasser Bacillarien, Pozsony, pp. 1-118.
- Schmidt, A. (1874-1944): Atlas der Diatomaceen-Kunde, Taf. 1-460, Leipzig.
- Schönfeldt, H. (1913): Bacillariophyta (Diatomeae) in A. Pascher's Die Süßwasser-Flora von Deutschlands, Österreich und der Schweiz, H. 10, Jena.
- Skvortzow, B. W. (1930): Notes on Ceylon Diatoms—I. *Ceylon J. Sci.* 11 : 251-60.
- (1935): Diatoms from Poyang Lake, Hunan, China, *Philipp. J. Sci.* 57 : 465-78.
- (1937a): Diatoms from Kizaki Lake, Honshu Island, Nippon. *ibid.* 61 : 9-73.
- (1937b): Diatoms from Biwa Lake, Honshu Island, Nippon. *ibid.* 61 : 253-96.
- (1937c): Diatoms from Ikeda Lake, Satsuma Province, Kiusiu Island, Nippon. *ibid.* 62 : 191-218.
- (1937d): Diatoms from Olhan Gate of Baikal Lake, Siberia, *ibid.* 62 : 293-377.
- (1938a): Diatoms from a peaty bog in Lianchiho River Valley, Eastern Siberia, *ibid.*, 66 : 161-82.
- (1938b): Diatoms from Chengtu, Szechwan, Western China. *ibid.* 66 : 479-96.
- (1938c): Diatoms from a mountain bog, Kaolingtze, Pin-Chian-Sheng Province, Manchoukuo. *ibid.* 66 : 161-82.
- Tiffany, L. H. & Britton, M. E. (1952): The Algae of Illinois, Univ. Chicago Press, Chicago.
- Van Heurck, H. (1896): A Treatise on the Diatomaceae (trans. by W. E. Baxter), London.

Critical Notes on the Orchidaceae of Bombay State

II. *PLATANTHERA* L. C. RICH. & *PERISTYLUS* BL.

BY

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

(With four plates)

[Continued from Vol. 56 (2): 203]

These two genera are treated in this paper together on account of their close relationships. The genera *Platanthera* L. C. Rich. and *Peristylus* Bl. are in fact so closely allied among themselves and with the genus *Habenaria* that many of the older botanists treated the three genera as one, *Habenaria*, the other plants being merely distinguished as sections of the same genus. This is the case, for instance, in Bentham and Hooker's *GENERA PLANTARUM* and in Hooker's *FLORA OF BRITISH INDIA*. Modern authors are somewhat divided on the subject; Holttum (1953) retains the whole group under *Habenaria*; on the other hand, J. J. Smith (1905) and Summerhayes (1951) split the group into distinct genera. Cooke in his *FLORA OF THE PRESIDENCY OF BOMBAY*, and Blatter and McCann in their *REVISION OF THE FLORA OF THE BOMBAY PRESIDENCY* keep *Platanthera* and *Peristylus* independent from *Habenaria*. In the following pages we treat these two genera as closely allied to but independent from *Habenaria*.

Our Bombay genera may be distinguished by the following key:

- | | |
|--|--------------------|
| 1. Flowers about 7.5 cm. across, greenish white;
stigmatic surfaces flat, almost confluent .. | <i>Platanthera</i> |
| 1. Flowers under 3 cm. across, white or yellow;
stigmatic surfaces not flat, and separate: | |
| 2. Ovary and capsule more or less erect, and
parallel to the peduncle, not spreading at
an angle to it; stigmatic surfaces in the
form of small swellings on the edge of
the lip | <i>Peristylus</i> |
| 2. Ovary and capsule widely spreading at an
angle to the peduncle; stigmatic lobes
standing out as stalked appendages .. | <i>Habenaria</i> |

NOTE: In the following pages, under the heading 'Occurrence in Bombay State', we list plants from Bombay State as understood after



Platanthera susannæ Lindl.

Whole inflorescence of plant collected from Khandala and grown in Bombay.

Photo : H. Santapau

Independence but prior to the Reorganisation of the States, that is to say we include plants from N. Kanara districts that were formerly part of Bombay State. With but few exceptions, the specimens mentioned for the various parts of Bombay are preserved in Blatter Herbarium, St. Xavier's College, Bombay.

PLATANTHERA L. C. Rich.

PLATANTHERA L. C. Rich. in Mem. Mus. Paris 4: 48, 1818; Pfitzer in Engler & Prantl, Natürl. Pflanzenfam. 2 (6): 92, 1889 (excl. syn. *Peristylus* Bl.); J. J. Smith in Fl. Buitenz. 6: 26, 1905; Slechter, Orchid. 62, 1927. *Habenaria* Benth. & Hook. Gen. Pl. 3: 624, 1863; Hook. f. Fl. Brit. India 6: 131, 1890; Duthie in Ann. R. Bot. Gard. Calcutta 9 (2): 174, 1906; Holttum, Rev. Fl. Malaya 1: 79, 1953 (omnes pro parte). *Lysias* Salisb. in Trans. Hortic. Soc. 1: 288, 1812, nom. nud. (See Plates VII & VIII).

The generic name, *Platanthera*, is made up of two Greek words, *Platys*=flat and *Anthera*=anthers. The genus is distributed in the Northern Temperate Zone of the World, particularly in North America; a few species occur in Europe and in tropical Asia.

Pfitzer has divided the genus *Platanthera* into two sections, 1. *Filicornes*, with a thin and long spur, and 2. *Crassicornes*, with a stout and short spur. In accordance with Art. 22 of the Code, the first section (that includes the type species) should be called *Platanthera* sect. *Platanthera*. Our Bombay species belong to this first section.

Platanthera susannae (Linn.) Lindl. Gen. Sp. Orch. 295, 1835; Wight, Icon. t. 920; Dalz. & Gibs. Bombay Fl. 261, 1861; J. J. Smith 27, f. 9; Cooke 2: 713, 1907; Fischer in Gamble, Fl. Madras 1475, 1923; Blatt. & McCann in Journ. Bombay Nat. Hist. Soc. 36: 736, 1932; Santapau in Rec. Bot. Surv. India 16 (1): 305, 1953. *Orchis susannae* Linn. Sp. Pl. 939, 1753; Lour. Fl. Coch. 522, 1790. *Orchis gigantea* Smith, Exot. Bot. 2: 79, t. 100, 1805. *Habenaria gigantea* D. Don, Prodr. Fl. Nepal. 24, 1825; Graham, Cat. Bombay Pl. 201, 1839. *Habenaria susannae* (Linn.) R. Brown ex Sprengel, Syst. Veg. 3: 622, 1826; Hook. f. Fl. Brit. India 6: 137, 1890; Prain, Bengal Pl. 1030, 1903; Duthie, loc. cit. 178, t. 128, & Fl. Upp. Gang. Pl. 3: 222, 1920; Gammie in Journ. Bombay Nat. Hist. Soc. 21: t. 11, 1911; Haines, Bot. Bihar Or. 1155, 1924; Merrill in Trans. Amer. Phil. Soc. n.s. 24: 121, 1935; Holttum 81, f. 13.

Stout terrestrial herbs, 60-120 cm. high. *Tubers* 2, ellipsoid or ovoid. *Leaves* 5-18×2-7 cm., ovate-oblong or oblong-lanceolate, acute, often with a sharp black apex, entire, glabrous, deep green

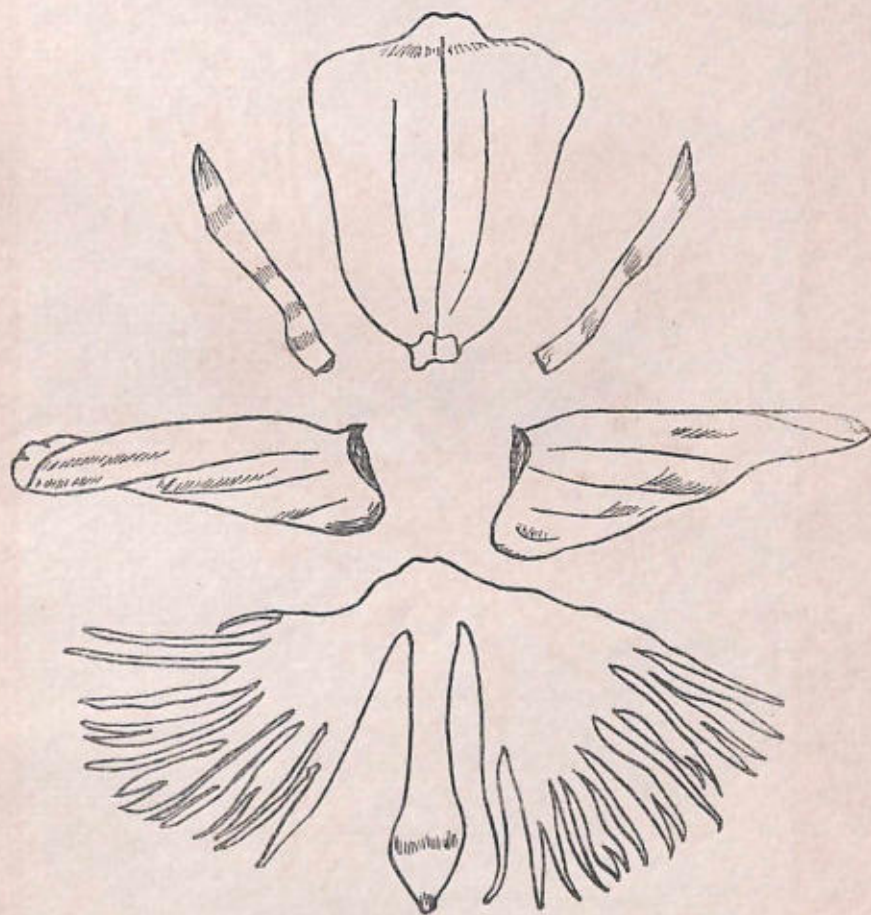
above, paler beneath; sheaths veined, the veins decurrent from the lamina; midnerve prominent beneath, with 8-10 fainter side-nerves; margins faintly yellowish. *Inflorescence* terminal, in 2-6-flowered racemes, 16-20 cm. long. *Flowers* 6×7.5 cm., white faintly tinged with green, bracteate, shortly pedicellate, strongly perfumed, especially when freshly opened. *Bracts* $6-10 \times 1.5-2$ cm., longer than and ensheathing the ovary, oblong-lanceolate, subacuminate, often sharply pointed, entire, several-nerved. *Sepals* unequal, white, faintly suffused with green, entire, 5-nerved; dorsal sepal 4.6×3.4 cm., revolute on the margins, subconcave, obovate-elliptic, obtuse; lateral sepals 4.4×1.8 cm., spreading lightly backwards, somewhat ascending, revolute on the margins, obliquely subquadrately oblong, acute. *Petals* 3.4×0.4 cm., white, narrowly linear-oblong, obliquely curving along the lower margins to an acute apex. *Lip* 4.7×9 cm., white, fan-shaped in outline, fimbriately dissected into 10-16 thin, narrow, often bipartite, $8-26 \times 0.5-1$ mm., narrowly linear-filiform segments; midlobe 3.8×0.9 cm., recurved at the margins, elliptic, slightly dilated beyond the middle, obtuse. *Spur* 8-11.5 cm. long, about 3-5 mm. in diam., pale green, obtuse; mouth broad. *Column* 7.1×1.2 mm., white, oblong, truncate-retuse above. *Anther* cells 0.4 cm. long, curved, divergent; pollinia 2, each 6×2 mm., yellow, narrowly falcate with a 6 mm. long, thin caudicle and a small, shiny, ovate-elliptic gland. *Stigmatic* surfaces 2, almost touching, 5×5 mm., just below the rostellum, white, squarely oblong with rounded ends, flat. *Ovary* 4.3×0.7 cm., strongly ribbed, green with 4 yellowish ridges. *Capsule* 4.5×1.5 cm., ellipsoid, strongly ribbed; beak 7 mm. long.

Flowering: September to October. *Fruiting:* October to December.

Occurrence in Bombay State: DANGS: Waghai, *Kapadia* s.n.; Susarda, *Kapadia* 711. KONKAN: Bombay, cultivated, *Santapau* 1578; *Kapadia* 726; Matheran, Cooke. W. GHATS: Igatpuri, *Kapadia* s.n.; Khandala, *Blatter* 25953; *Santapau* 775, 1101, 2672, 2818-2820, 5010, 11156; *Kapadia* 627-628; Lonavla, D. K. Patel. DECCAN: Lohagad, *Blatter* 27522; Dapoli, *Acland* 1173. N. KANARA: Belgaum, *Ritchie*; Yellapur, *Bell* 3121; Castle Rock, *Gammie*, *Sedgwick*.

Distribution in India: Most of the hilly parts of India from the lower Himalayan ranges to the south of the country. *World:* India, Burma, China, Java, and throughout Malaysia.

Critical Notes: In cultivated specimens the flowers have been noted to appear somewhat earlier and to be larger than in wild specimens. In the field this beautiful orchid grows usually on sloping ground at the edges of forest, usually in places rich in humus. The plant suffers much persecution from humans, who find the flowers



0 1 2 3 4 5 CM

Platant'era susanna Lindl. Dissection of the calyx and corolla.

very attractive, and from wild pigs, who uproot many plants for the sake of the apparently very tasty tubers.

In our floras the binomial *Habenaria susannae* is usually attributed to R. Brown; but according to Merrill this is not correct, for Brown did not make the actual combination as required by Art. 32, paragraph 2 of the Code; Merrill gives the combination as *H. susannae* R. Br. ex Sprengel, Syst. Veg. 3: 622, 1826.

Cultivation: This beautiful orchid does deserve a place in our gardens, and it is one of the easiest plants to grow under artificial conditions. In St. Xavier's College garden a specimen has been kept growing and flowering regularly for over 15 years. In the first instance the plant was collected from Khandala, and planted in a flower-pot; after flowering and fruiting, the plant was left in the flower-pot without watering until the following season's monsoon. Flowers are showy, the largest among our Bombay wild orchids, and about the most sweetly and strongly scented among our wild flowers. The photograph appearing at the beginning of this paper was taken from a plant grown in Bombay from a Khandala specimen.

PERISTYLUS BL.

PERISTYLUS Bl. Bijdr. 404, t. 30, 1825; Endl. Gen. Pl. 209, 1837; J. J. Smith, Fl. Buitenz. 6: 30, 1906; Cooke 710; Santapau in Rec. Bot. Surv. India 16 (1): 305, 1953. *Habenaria* sect. *Peristylus* Bth. & Hk. Gen. Pl. 3: 624, 1883; Hook. f. Fl. Brit. India 6: 131, 1890; King & Pant. in Ann. R. Bot. Gard. Calcutta 8: 305, 1898; Duthie, ibid. 9 (2): 174, 1906. *Platanthera* Pfitzer in Engl. & Prantl, Natürl. Pflanzenfam. 2 (6): 92, 1888 pro parte.

The generic name, *Peristylus*, is derived from the Greek words *Peri*=around and *Stylus*=column, probably referring to the shape of the column, which is in the form of a protuberance from the apical portion of the ovary. In Bombay State the plants belonging to this genus are among the least showy of our wild orchids; flowers are usually in compact racemes or spikes, and individually they are small and inconspicuous; the plants, however, are typical in their appearance and in their habitat, i.e. the surroundings in which they grow.

Many modern orchidologists favour including *Peristylus* under *Habenaria* Willd.; Pfitzer, loc. cit., separates it from *Habenaria* but places it under *Platanthera*. We keep it separate from both, following among others J. J. Smith, for the reason that *Peristylus* forms a natural and clearly distinct group in our native orchids. There are about 80 species of *Peristylus* distributed in the warmer regions of the Old World.

KEY TO THE SPECIES OF *PERISTYLUS* OF BOMBAY

1. Spur as long as or longer than sepals, linear, subclavate:
 2. Leaves sessile, narrowly lanceolate; lateral sepals linear; lateral lobes of lip subulate, or narrowly linear-oblong, spreading, about twice as long as the midlobe; spur scarcely clavate at apex *densus*
 2. Leaves tapered at base, broadly obovate-elliptic; lateral sepals broad; lobes of lip subequal, linear oblong, rounded; spur inflated at apex *stocksii*
1. Spur much shorter than sepals, saccate, globose:
 3. Leaves scattered or subimbricate on stem *spiralis*
 3. Leaves clustered about middle of stem:
 4. Petals white; lip shorter than the broad sepals, entire or scarcely 3-lobed, lobes very small, entire, rounded *plantagineus*
 4. Petals yellow or yellowish-green; lip about as long as sepals, distinctly 3-fid:
 5. Spikes dense; lateral sepals mucronate at the back a little below apex *goodyeroides*
 5. Spikes lax; lateral sepals not mucronate *lawii*

1. *Peristylus densus* (Lindl.) Santapau & Kapadia, comb. nov. *Coeloglossum densum* Lindl. Gen. Sp. Orch. 302, 1835. *Gymnadenia* ? *tenuis* Lindl. in Wall. Cat. n. 7057, 1832, nom. nud. *Habenaria peristylodes* Wight, Icon. t. 1702, 1851. *Platanthera stenostachya* Lindl. in Hook. J. Bot. 7: 37, 1855. *Habenaria stenostachya* Benth. Fl. Hongk. 362, 1861; Hook. f. Fl. Brit. India 6: 156. *Peristylus stenostachyus* (Lindl.) Kränz. Orchid. Gen. Spec. 1: 502, 1898; Fischer in Gamble, Fl. Pres. Madras 1474, 1928; Blatt. & McC. in Journ. Bombay Nat. Hist. Soc. 35: 734, 1932. *P. xanthochlorus* Blatt. & McC. loc. cit. 733, 1932. (See Plate IX, A-B)

Herbs 12-35 cm. tall. *Tuber* 1, small, globular. *Leaves* grouped on the basal third of the stem, green or yellowish-green, sheathing, 2-7×0.5-2 cm., lanceolate, oblong-lanceolate or linear lanceolate, acute or obtuse, mucronulate, entire, minutely papillate; midnerve prominent below with 3-5 lateral fainter nerves. *Inflorescence* in lax or dense spikes 7-21 cm. long; peduncle slender, up to 3 mm. thick, short, terete; bracts distantly or closely arranged, subopposite to imbricate, lanceolate, entire, minutely papillate, subacuminate; the margins paler. *Flowers* yellowish-white to greenish-yellow, subsecund, bracteate, sessile.

Bracts unequal, the lower equalling or slightly longer than the flowers, the upper ones shorter, 7-15×3-5 mm., acute or acuminate. *Sepals* pale greenish-yellow, obtuse; dorsal sepal 4-5×2-3 mm., ovate-oblong, concave, midnerve prominent on the back with a pair of fainter lateral ones; lateral sepals 4-5×1-1.5 mm., narrowly linear, often sub-falcate, 1-nerved, margins incurved. *Petals* 3.5×1.5-2 mm., sub-oblique, ovate-oblong, obtuse, erect, greenish-yellow. *Lip* shortly clawed, fleshy, rigid, 3-lobed; claw very short, hollowed at the base; lateral lobes 3.5×5×0.5-1 mm., linear, subulate, spreading straight or upwards and backwards, slightly narrower than the midlobe, acute or obtuse; midlobe 2-3×1-1.5 mm., narrowly oblong, straight, slightly tapering to the obtuse apex. *Spur* 5-7 mm. long, straight or slightly curved, very slightly thickened towards the acute apex, shorter than the ovary, greenish-white. *Ovary* 7 mm. long, curved, faintly ribbed. *Capsule* 10×4 mm., sessile, narrowly conical, 6-ridged.

Flowering: August to October.

Occurrence in Bombay State: W. GHATS: Panchgani Blatter & Hallberg; Sedgwick 7596; Saldanha 1521; Mahableshwar, Sedgwick 7622. N. KANARA: Castle Rock, Sedgwick 2779; Mundgod, Talbot s.n.; Tinai Ghat, Talbot 2508; Yellapur, Talbot.

Distribution in India: Sikkim Himalaya, Khasia Hills, W. Ghats, N. Kanara, Bababudden and Pulney Hills, High Wavy Mountains. *World:* India, Burma, China.

Critical Notes: We have examined Sedgwick 7596, collected from the type locality of *P. xanthochlorus* Blatt. & McC., and also Sedgwick 7622, both specimens identified by Blatter himself as *P. xanthochlorus*, and cited under this name in the REVISION. In the absence of the type, these specimens may serve to clarify the identity of the species. There does not seem to be any definite and constant character by which such specimens may be separated from *P. densus*. In our opinion this is another case of variations induced by the conditions of the habitat. Normally *P. densus* has laxer and longer spikes; but in open rocky plateaux (as in Panchgani and Mahableshwar) plants are more stunted, somewhat stouter, and shorter; the basic floral structure of *P. xanthochlorus* is identical with that of *P. densus*.

Hooker f. op. cit. p. 157 adds the remark: 'I have had difficulty in choosing a specific name, for Bentham, in adopting *stenostachya*, overlooked the older published one of *tenuis*. That of *peristylodes* may be objected to from the plant being sectionally a *Peristylus*, though Wight did not recognise it as such, and it is preoccupied by A. Richard for an Abyssinian species.' The earliest published name is, indeed, *tenuis*, but this is a *nomen nudum*. We have not been able to examine

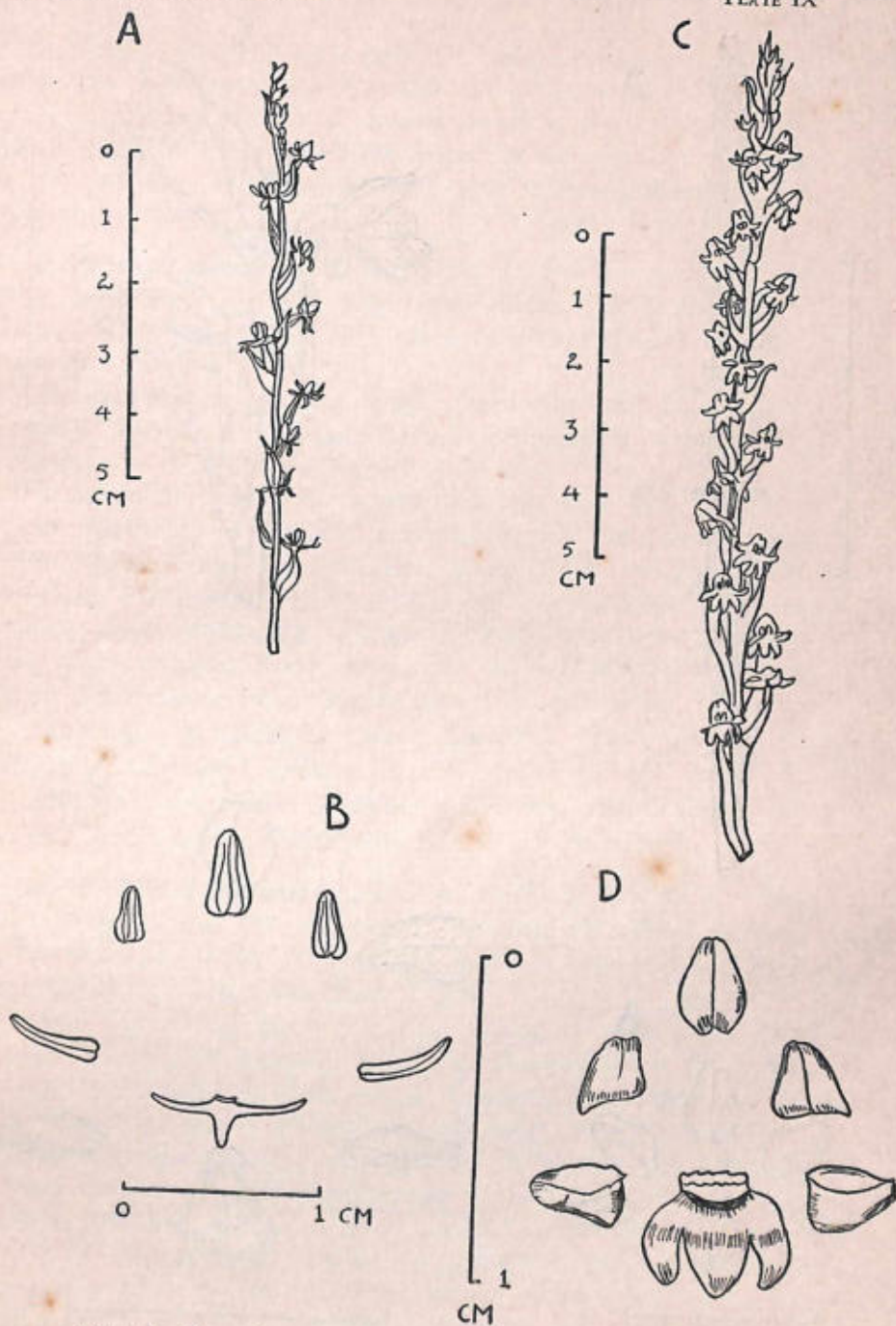
the types of *Coeloglossum densum* Lindl. and *Peristylus stenostachyus* Kränz., but from the descriptions and from Hooker's own admission they are identical; this being the case, the oldest valid name is *Coeloglossum densum* Lindl. and in consequence the correct binomial in the genus *Peristylus* for the present plant is *P. densus* Sant. & Kapad.

2. *Peristylus stocksii* (Hook. f.) Kränz. Orchid. Gen. Spec. 1: 513, 1898; Cooke 710; Gammie in Journ. Bombay Nat. Hist. Soc. 21: 172, 1911; Fischer 1475; Blatt. & McC. 735; Santapau 305. *Habenaria stocksii* Hook. f. Fl. Brit. India 6: 158, 1890; Haines, Bot. Bihar Or. 1159, 1924. (See Plate IX, C-D)

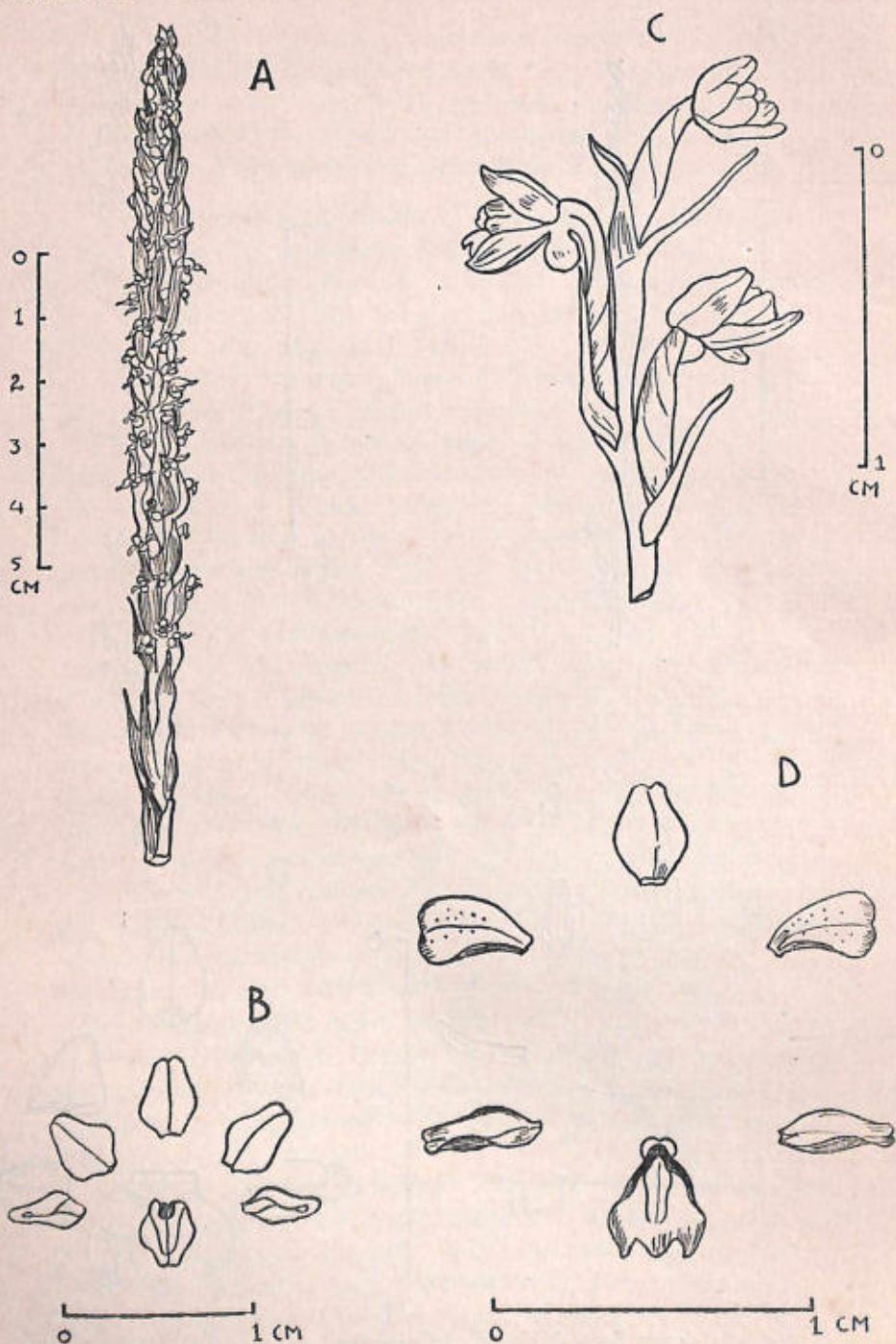
Herbs 10-50 cm. high. *Tubers* 1-2, each 1.7-3×1.2-2 cm., oblong or ellipsoidal. *Stem* slender, sheathed. *Leaves* 5-14×2-4 cm., clustered about the middle or more or less scattered on the stem, narrowed and sheathing at the base, obovate-elliptic, elliptic-lanceolate, or lanceolate to oblong, acute or subacuminate; margins wavy, yellowish, minutely papillate. *Inflorescence* lax, of many-flowered subsecund twisted spikes, 9-24 cm. long; peduncle 5-10 cm. long, slender, with a few bracts which are scaly, ovate, acute, and 1-nerved. *Flowers* small, yellowish-green, sessile, bracteate. *Bracts* 1.2×0.3 cm., more or less equalling the ovary, ovate, acuminate, glabrous, 1-nerved. *Sepals* subequal, green, glabrous, 1-nerved, sub-fleshy; dorsal sepal 3×2 mm., concave, forming a hood over the column with the petals, elliptic-oblong; lateral sepals 2.5-3×1.5-2 mm., spreading, obliquely oblong, obtuse. *Petals* 2.5×2 mm., green, sub-fleshy, sub-obliquely ovate-oblong, obtuse or sub-retuse, entire, glabrous, 1-nerved. *Lip* 3×4 mm., green, longer than the lateral sepals, 3-lobed, clawed; claw 2 mm. broad, concave; lateral lobes 1.5×1 mm., narrower than the midlobe, incurved, oblong, obtuse, entire; midlobe 1.6×1.5 mm., straight, oblong, obtuse, entire. *Spur* 6 mm. long, green, shorter than the ovary, obtuse, inflated downwards. *Column* very small, green, obtuse. *Anther* cells small, whitish-green, slightly divergent at the base; pollinia yellowish, clavate, obovate-oblong with a short caudicle and an exerted linear-elliptic gland; staminodes greenish-white, small, glandular, auriculate-oblong. *Ovary* 8 mm. long, green, slightly curved, ribbed.

Flowering: July to September. *Fruiting*: August to October.

Occurrence in Bombay State: DANGS: Waghai, Santapau 19210. W. GHATS: Igatpuri, Kapadia 1383; Khandala, Santapau 773, 805, 2491, 2579, 4575-4576, 4672, 6883-6885, 9224-9225, 9248-9249; Irani 1167; Kapadia 557-559, 561; Lonavla, Kapadia 541, 545; Mahableshwar, Santapau 13208-13209; Kapadia 617-619, 2077-2080; Bhimashankar, Kapadia 1463. N. KANARA: Yellapur, Kapadia 2240.



Peristylus densus Sant. & Kapad. Inflorescence (A) and dissection of calyx and corolla (B). *P. stocksii* Kränz. Inflorescence (C) and dissection of calyx and corolla (D).



Peristilus plantagineus Lindl. Inflorescence (A) and dissection of calyx and corolla (B).
P. lawii Wt. Inflorescence apex (C) and dissection of calyx and corolla (D).

Distribution in India: Parasnath Hill, Dangs, W. Ghats, N. Kanara southwards to Mysore. *World:* Apparently endemic in India.

Critical Notes: This is a common orchid in the undergrowth of forests; together with *P. lawii* this is one of the commonest orchids in such habitats. The structure of the spur at once distinguishes this species from *lawii*.

3. *Peristylus spiralis* A. Rich. in Ann. Sc. Nat. ser. 2, 15: 69, t. 2 B, 1844; Wight, Icon. t. 1696, 1851; Cooke 711; Gammie 172; Fischer 1474; Blatt. & McC. 735. *Habenaria torta* Hook. f. Fl. Brit. India 6: 159, 1890.

We have seen no specimen of this plant in the field; there is none in Blatter Herbarium. We give, therefore, a translation of the original description of A. Richard's, loc. cit.:

'Stem slender, leafless for a foot from the base, laxly sheathed; leaves elliptic-lanceolate, acute, sheathing at the base, passing into bracts above, which are lanceolate, acute; flowers small, spicate, bracteate; spikes subspiral; bracts lanceolate, acute, longer than the flowers; sepals oval-oblong, obtuse; lip fleshy, trifid, saccate at the base; lobes subequal, linear, obtuse . . . Stem bi-tuberculate, tubers entire, ovoid-oblong, leaves narrow; flowers greenish-white . . .'

Occurrence in Bombay State: KONKAN: Law, Stocks. N. KANARA: Tinai Ghat, Talbot.

Distribution in India: Konkan, N. Kanara, Bababudden Hills, Nilgiris up to 2100 m., Travancore. *World:* India, Ceylon.

4. *Peristylus plantagineus* Lindl. Gen. Sp. Orch. 300, 1835; Wight, Icon. t. 921; Cooke 711; Gammie 173; Fischer 1475; Blatt. & McC. 735. *Habenaria wightii* Trimen, Cat. Ceyl. Pl. 91, 1885; Hook. f. Fl. Brit. India 6: 162. (See Plate X, A-B)

Herbs 17-88 cm. tall. Tubers 2, oblong or ellipsoidal. Stem robust, generally of a pinkish-brown hue, sheathed below the leaves; sheaths broad widening at the mouth, somewhat funnel-shaped, acute, the margins entire and minutely papillose, often pale yellowish-white. Leaves 4-8, clustered about the middle of the stem, closely sheathing at the base, sessile, brownish-green above, pale pink-brown beneath; oblong, oblong-lanceolate to broadly elliptic or elliptic-ovate, acute, 7-23×2-9 cm.; margins yellowish, entire, minutely papillose; midnerve prominent beneath with 5-7 faint lateral nerves. Inflorescence in spikes 9-22 cm. long, erect, strict, densely and compactly many-flowered, pale pinkish brown; peduncle 4-10 cm. long, terete, pale brown, bracteate; bracts 1.5-2×0.4 cm., ovate-lanceolate, acuminate,

entire, minutely papillose, glabrous, dirty brownish-green with a yellowish margin. *Flowers* sessile, bracteate, pinkish-brown. *Bracts* unequal, the lower much longer than the ovary, the upper ones smaller, 9-14×2-3 mm., subulate, lanceolate-acuminate, pale brownish-green, somewhat strongly 1-nerved. *Sepals* subequal, dirty brown, very minutely denticulate, glabrous, strongly 1-nerved; dorsal sepal 2-4.5×2.3 mm., concave, oblong-ovate; lateral sepals 2.5-5×1.5-2.5 mm., spreading, oblong, the margins incurved often overlapping. *Petals* 2.5-4×2-3 mm., white, subobliquely oblong-elliptic or rarely sub-orbicular, obtuse, entire, glabrous, 1-nerved, somewhat gland-dotted. *Lip* 2-3.5×2-3.5 mm., smaller than the lateral sepals, white, faintly gland-dotted, broadly ovate-oblong in outline, shortly 3-lobed; very small, entire, obtuse; base of the lip subconcave; the lip 3-nerved, mid-nerve running straight from the base to the apex, the 2 lateral ones slightly sinuate, meeting a little below the apex to form a loop across the midnerve. *Column* very short, pale green. *Anther* cells short, sessile on the column, divergent at the base; pollinia 2, bipartite, clavate, caudicles very small with a small, orbicular gland. *Stigmatic* lobes short, stout, convex. *Ovary* 10×2 mm., stout, curved at the apex, pale brown, ribbed.

Flowering: July to August. *Fruiting:* up to December.

Occurrence in Bombay State: DANGS: Waghai, Santapau 19133, 19208-19211, 19999; Kapadia 691-693, 1429-1435; Subir, Santapau 19510. KONKAN: Nimmo Borivli, R. Fernandes 2314-2315; Herbert 2521; Malwan, Dalzell. W. GHATS: Lonavla, Kanitkar, Kapadia 544-545; Ram Ghat, Ritchie. N. KANARA: Londa, Spooner; Yellapur, Talbot; Kapadia 2042, 2214-2223; Dandeli, Kapadia; Guddehalli, Talbot; Bell 7869; Hallberg & McCann 34896; Kapadia 2131; Karwar, Hallberg & McCann 34375, 35014.

Distribution in India: Madhya Pradesh, Dangs, Konkan, W. Ghats, N. Kanara, Rampa Hills in Andhra, Annamalais, Malabar, Travancore. *World:* India, Ceylon.

Critical Notes: This species is typical of dense forests, but is usually found only in clearings in the forest, along forest paths, etc. Hooker f. has given *P. elatus* Dalz. as a synonym of this species; Alston has kept it as a distinct and valid species but in the genus *Habenaria* as *H. elata* (Dalz.) Alston in Trim. Handb. Fl. Ceyl. 6: 280, 1931. Dalzell & Gibson in their BOMBAY FLORA mention that the lateral sepals of *P. elatus* Dalz. are mucronate on the back; this is certainly not the case with *P. plantagineus* Lindl.

5. *Peristylus goodyeroides* Lindl. Gen. Sp. Orch. 299, 1835; Dalz. & Gibbs. Bombay Fl. 300, 1861; J. J. Smith 32, t. 14; Fischer 1475; Blatt. & McC. 735. *Habenaria goodyeroides* D. Don, Prodr. Fl. Nep. 25, 1825; Graham, Cat. 201, 1839; Hook. f. 161; King & Pantling 326, t. 430; Duthie 192; Prain, Bengal Pl. 1039; Holttum 86. *H. affinis* D. Don, op. cit. 25, 1825. *Peristylus goodyeroides* var. *affinis* Lindl. op. cit. 300, 1835; Cooke 712; Gammie 173. *Habenaria goodyeroides* var. *affinis* King & Pantl. op. cit. 327, t. 430 (bis), 1893.

Herbs 37 cm. tall. *Leaves* more or less clustered about the lower third of the stem, sessile, hardly narrowed to the sheathing base, broadly ovate-elliptic or elliptic, about 7-nerved, acute, 7-11×4-4.5 cm.; margins entire, yellowish, minutely papillose. *Peduncle* 10 cm. long, terete, grooved, with a single bract, which is 3×0.6 cm., oblong-lanceolate, acute, entire and minutely papillose. *Spike* erect, very lax, 14.5 cm. long. *Flowers* about 10 mm. long, sessile, bracteate. *Bracts* lanceolate, acuminate, acicular, equal to or longer than the flowers, entire, minutely papillose, 1-3-nerved, each 12-20×3-4 mm. *Sepals* unequal; dorsal ovate-oblong, obtuse, entire, 3.5×1.5-1.75 mm.; lateral ones 4×1.5 mm., obliquely obovate-oblong or oblong, concave, 1-nerved, mucronate a little below the apex, which is somewhat incurved and acute. *Petals* trapezoidal-obovate, rounded, entire, 3×1.5 mm. *Lip* longer than the petals, 3-fid to below the middle, 3-4 mm. long; lateral lobes narrowly linear-oblong, obtuse, entire; midlobe very slightly shorter than the side-lobes, obovate-oblong, tapering to a blunt, subtruncate entire apex. *Spur* long, saccate, ovate-globular, 1.5 mm. long. *Ovary* twisted, shallowly ribbed, sessile, 6-7 mm. long.

Flowering: August.

Occurrence in Bombay State: KONKAN: Nimmo, Dalzell. N. KANARA: Castle Rock, Sedgwick ex Blatt. & McC. Devimane Ghat, Sedgwick & Bell ex Blatt. & McC.

Distribution in India: Dehra Dun, Sikkim, Khasia and Naga Hills, Konkan, N. Kanara, W. Ghats of Bombay, and southwards. *World:* India, Nepal, Ceylon, China, southwards to Malaysia.

Critical Notes: We have studied a specimen from Travancore collected by Calder & Ramaswamy, very kindly loaned to us by the Curator, National Herbarium, Calcutta. Our plant differs somewhat from the typical forms described and illustrated by King & Pantling, Duthie, and others, in that the spikes are very lax, and the floral bracts are sharply acuminate and about twice as long as the entire flower.

Hooker f. op. cit. 166, considers *H. affinis* D. Don. a small state of *H. goodyeroides* D. Don. King and Pantling reduce the former to a

variety of the latter. Cooke points out that it is the var. *affinis* that has been recorded from Bombay; on the other hand Blatter and McCann do not distinguish the variety from the typical plant. After carefully examining the descriptions and illustrations of these plants, we have come to the conclusion that the so-called variety does not deserve even varietal rank, and for this reason we have merged it with the typical species.

6. *Peristylus lawii* Wight, Icon. 5: 12, t. 1695, 1851; Dalz. & Gibs. 270; Cooke 710; Gammie 174; Blatt. & McC. 735. *Habenaria lawii* Hook. f. Fl. Brit. India 6: 162, 1890; Prain, Bengal Pl. 1032; Duthie 192, t. 143 & Fl. Upp. Gang. Pl. 3: 227, 1920; Haines, Bot. Bihar Or. 1160. (See Plate X, C-D)

Herbs 15-45 cm. high. *Tubers* 1-2, oblong-obovate, somewhat flattened. *Stem* terete, brownish-white, stout, sheathed; sheaths 2-3, each 1.5-3 cm. in length, broad-mouthed, oblong. *Leaves* 3-5, clustered about the middle of the stem, not reduced to bracts above, sheathing at the base, lanceolate or oblong-lanceolate, acute, entire, minutely papillose, glabrous, grass-green above, pale dull green beneath, 3-13×2-4 cm. *Inflorescence* in somewhat lax spikes, 8-18 cm. long; peduncle ebracteate, terete, green, 4-7 cm. long. *Flowers* sessile, white tinged with greenish-yellow, bracteate. Bracts lanceolate, acuminate entire, shorter or longer than the flowers, 1-nerved, 5×2 mm. *Sepals* subequal, white; dorsal sepal ovate-oblong, obtuse or subretuse, entire, 1-nerved, concave, 3×2 mm.; lateral sepals oblong, obtuse, subconcave, conduplicate, entire, glabrous, 1-nerved, 3.5×1.5 mm. *Petals* obovate in outline, retuse. *Lip* 3-lobed about the middle, clawed, 3.5×2.5 mm.; claw slightly elongate, concave; lobes subequal, lateral ones about 1 mm. long, rounded, curved on the outer margins, subacute, slightly longer than the straight obtuse midlobe. *Spur* small, scrotiform, 1 mm. in diameter with a circular depression all round. *Column* very short, greenish-white. *Ovary* pale green, ribbed, about 5 mm. long. *Capsule* fusiform, turgid, ribbed, 1-1.5 cm. long; beak 3-5 mm. long.

Flowering: July. *Fruiting*: September.

Occurrence in Bombay State: DANGS: Waghai, Kapadia 1420. KONKAN: NW. of Bhiwandi, Santapau 233/3; Hills SE. of Tansa Lake, Santapau 15876; Badlapur, Kapadia 1291; Neral, Bhiva. N. KANARA: Belgaum, Law; Dharwar, Law ex Stocks.

Distribution in India: Dehra Dun, Garhwal, Bengal, Bihar, Madhya Pradesh, Dangs, Konkan, W. Ghats, N. Kanara, Mysore. *World*: Apparently endemic in India.

Critical Notes: This species has been found by us in fairly dense undergrowth on sloping ground, on hilly parts of Bombay State. This and *P. stocksii* are the only species that can be said to be common in Bombay; the spur of the present species is typical.

REFERENCES

- Blatter, E. & McCann, C. (1932): Revision of the Flora of the Presidency of Bombay. (Orchidaceae). *J. Bombay nat. Hist. Soc.* 35: 733-736.
- Holttum, R. E. (1953): A Revised Flora of Malaya. Vol. 1: Orchids. Singapore.
- Smith, J. J. (1905): Die Orchideen von Java. (Vol. 6 of Flora von Buitenzorg) Leiden.
- Summerhayes, V. S. (1951): Wild Orchids of Britain. London.

Constancy to horticultural varieties shown by butterflies, and its possible evolutionary significance

BY

KRISHNA RAO DRONAMRAJU AND HELEN SPURWAY

Indian Statistical Institute, Calcutta-35

Since Aristotle it has been known that bees of a particular colony showed a constancy to one species of flower until the local population of this was exhausted of its nectar. Recent discussions (e.g. Ribbands 1953, Butler 1954) are agreed that a few workers of a hive scout for adequate sources, and inform their comrades, who exploit these sources to exhaustion before turning their attention to newly discovered supplies. Mather (1947) has shown that in the genus *Antirrhinum* at least, this constancy is species specific.

While working in a small experimental garden consisting of three plants each of two colour varieties of the primarily South American species *Lantana camara* L. Dronamraju (1958) observed that the different varieties were preferentially visited by different species of butterflies. The two varieties of *Lantana* are those which are overwhelmingly preponderant among the feral population around Calcutta. In one called *pink* the newly opened florets are white except for the yellow honey guides, but the unopened buds and the ageing florets at the periphery of the inflorescence are pink. In the other variety called *orange* the buds and ageing florets are orange and the young florets yellow. Both forms set seed, and the specimens in our garden were collected as seedlings. It has so far proved impossible to cross these two varieties, and Dr. E. K. Janaki Ammal tells us that it is probable that they are of different ploidies. K.R.D. began watching the garden again next spring and has now spent 46.75 hours all told attempting to note all visits of all species of insects. Among these were 9 species of Papilionoidea. We have also casually observed other species of butterflies at other times and seasons, in other places, on the same varieties, and on other varieties, (and perhaps species), of *Lantana*.

Table 1 shows the data collected for the six most frequent visitors (Dronamraju 1960). The unit counted is the insertion of the proboscis into a floret, from now on to be called a *feed*. The movements of

TABLE I

Species	Family	Date of		Number of days observed	Number of feeds	
		1st observation	last observation		on orange	on pink
<i>Precis almana</i>	Nymphalidae	29-5-58	21-4-59	16	218	13
<i>Danaïs chrysippus</i>	Danaidae	19-3-59	22-5-59	18	142	152
<i>Papilio polytes</i>	Papilionidae	19-3-59	4-4-59	4	15	31
<i>Papilio demoleus</i>	Papilionidae	19-3-59	19-5-59	13	42	98
<i>Catopsilia pyranthe</i>	Pieridae	29-5-58	22-5-59	27	40	603
<i>Baoris mathias</i>	Hesperiidae	19-3-59	19-5-59	12	1	108

normally feeding butterflies are sufficiently slow for these feeds to be counted. Only in the counts of *Baoris mathias* is it believed that the movements were so rapid that any large number of feeds were unnoted. Such an underestimate would increase the significance of the preference for pink shown by this butterfly. Smaller data on other species showed statistically significant preferences, but because they were collected during too short a period of time they may only record individual preferences, or temporary constancies such as are known for *Apis mellifera*, and were observed during this same series of observations for *A. florea*.

On the totals it is clear that 5 species have a distinct preference for one colour variety rather than the other. The length of the periods during which the observations were made, and in some species the use of individuals which were sexually dimorphic, or marked by injury, or paint, makes it clear that several individuals of each species were observed. We cannot assume that all these individuals either had indistinguishable experiences, or alternatively were influenced by some previously unsuspected social reaction to a variety first visited by one individual. Therefore we think that these data make it most unlikely that an individual butterfly of these species emerges from its pupa indifferent to which colour of *Lantana* it feeds upon, and becomes conditioned or imprinted by its own individual experience.

Danais chrysippus judged by the totals given in Table 1 has no preference. However the data are highly heterogeneous. Statistical estimation cannot be made because so many observation periods included only one or two feeds.

Therefore we give (Table 2) the number of feeds during the two hours when most visits of this species were recorded. Both were between 8 and 9 a.m.

TABLE 2

Date	Orange	Pink
22-3-59	0	46
7-5-59	50	7

Formally such counts resemble those that are obtained by watching a colony of bees visiting a mixed crop, but before we postulate that *Danais chrysippus* has a social organisation, we will discuss our observations on the first feeding behaviour of twelve individuals of *Papilio demoleus* that emerged from their pupae in the laboratory.

This species is the only one of those observed of which we have obtained larvae to experiment upon. Professor B. Rensch in a letter

to Professor J. B. S. Haldane commenting on Dronamraju's paper of 1958 had suggested that these preferences might be due to the butterflies becoming imprinted to flowers of the colour of their first feed. Therefore, because wild *P. demoleus* showed a significant but not extreme preference for pink, we exposed ten of these twelve animals to orange flowers alone, including holding them on to the inflorescences if they did not alight voluntarily. After at least half an hour if they did not feed, or after at least 40 feeds if they accepted orange, pink was presented. The other two butterflies were offered a choice. One (σ 4) always flew away when held on inflorescences of either colour during the hour's observation period, though he inserted his proboscis once into an inflorescence. This was a pink inflorescence on which he had been placed and on which he subsequently remained unfeeding for 17 minutes, only leaving when disturbed. Next day he was not offered a choice and refused orange for half an hour but then accepted pink. The record of the other animal offered a choice (σ 7) is graphed in Fig. 2.

Any number from 4 to 40 inflorescences of one colour were offered on cut stems, and care was taken to match the specimens of the two colours in number and condition to human eyes. Also note was taken as to whether the flowers were freshly gathered, previously used that day for butterfly feeding experiments, or the present mature flore's had opened in the laboratory sheltered from any insect visits. We have only tenuous evidence that our flowers were ever exhausted enough for their interest to decrease for a butterfly.

At first the experiments were performed in a large room with windows in three walls. One butterfly fed on orange and was immediately eaten by a gecko; another refused orange for 2 hours and 40 minutes and then walked through a draining hole—and instead of flying away fell from four storeys and was recovered (she was marked) with a fractured costa! The third produced clear results and was observed on 6 consecutive days. All other animals were observed in a small wire and wood cage $2.1 \times 1.5 \times 2$ cu. m. in volume. Two people were necessary, one to observe (usually KRD) and one to write (usually HS), mainly but not exclusively from dictation, because the butterflies, being starved, fed more rapidly than free animals. No sugar water had been given before the experiments to be described.

Table 3 sums up our conclusions, and Figs. 1 and 2 graph two experiments to demonstrate the behaviour which we categorise as 'feeds on orange; prefers pink'. In both the figures the horizontal axis represents time, and there are four distinct vertical axes. The black

TABLE 3

Papilio demoleus
First feeds in captivity

	Prefers Orange	Prefers Pink	?
Feeds on Orange ..	3	3	1
Does NOT feed on Orange ..	..	4	1

histograms represent separately the number of feeds on orange and pink, and the white histograms the number of *landings*, i.e. the number

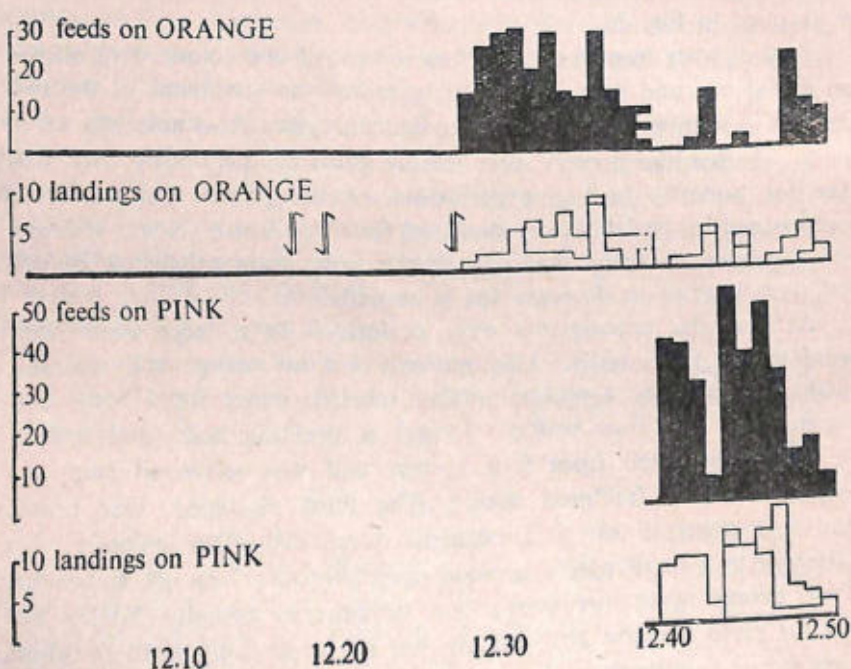


Fig. 1.

Papilio demoleus ♀ feeding on *Lantana camara* 24-8-1959.

of times the butterfly alighted and stood on an inflorescence. We have never seen a *Papilio demoleus* feed without landing, but these butterflies often land without feeding. The horizontal lines represent the period of time when flowers of that colour were present. Pink was

only presented to ♀ 3 (Fig. 1) at 12.39 hours, after the animal had fed upon orange; pink was removed from ♂ 7 (Fig. 2) at 16.14 hours, after it had been fed upon, and returned at 16.24; orange was present throughout both experiments. In the experiment with ♀ 3 two vases of both colours were presented and the histograms of landings are divided into two parts to indicate when she flew from one vase to another. When all four vases were presented they were arranged alternately in a row so that a vase of another colour had to be flown over with every change. In Fig. 1 the arrows indicate when the animal

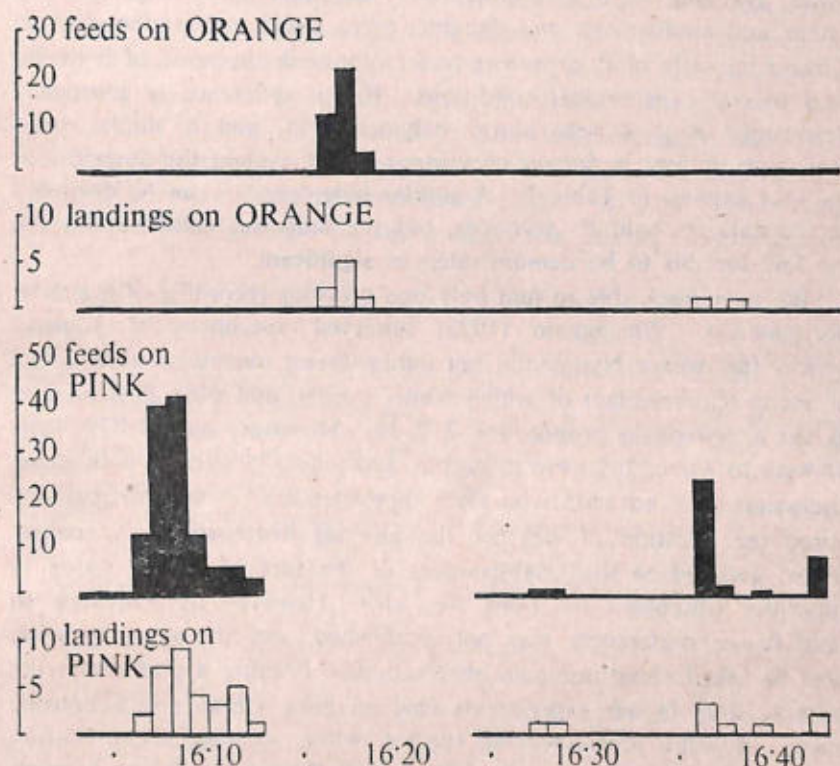


Fig. 2.

Papilio demoleus ♂7 feeding on *Lantana camara* 28-8-1959.

was forcibly held on to the flowers. She always flew away when released. The dotted histograms represent feeds and landings uncounted because the observers were occupied in introducing the vases of pink flowers. It will be seen that both these animals did feed on orange, but were reluctant to do so especially in the presence of pink. The second supply of pink offered to ♂ 7 consisted of only

four inflorescences which had been ardently fed upon (194 feeds) five hours before. Nevertheless they held his attention from the four orange to which he only had had access, and on which he had only fed 36 times.

The series of experiments summarised in table 3 support the theory that most individuals of *P. demoleus* emerge from their pupa with a preference for feeding on pink *Lantana* rather than orange and that this is not altered by receiving their first food from orange flowers. The three animals who continued to feed on orange after pink was made available were a mother, one son, and one daughter. The father and another son and daughter were tested and preferred pink. Thus a minority of *P. demoleus* prefer orange in the sense of behaving thus in our experimental conditions. If this difference is genetically determined it is a behavioural polymorphism, and a similar polymorphism present in *Danais chrysippus* would explain the observations on wild animals in Table 2. A similar heterogeneity can be discerned in the data on wild *P. demoleus*, but the individual observations are too few for this to be demonstrated as significant.

We have been able to find only one previous recording of a similar phenomenon. Eltringham (1933) observed specimens of *Vanessa urticae* (an orange Nymphalid not unlike *Precis almana*) visiting a bed of asters (Compositae) of which white, purple, and pink flowers were in the approximate proportions 7:9:12. However, out of 427 visits 47 were to white, 245 were to purple, and only 135 were to pink (from discussion by Ford 1945 who gives more details). These observations raised the question of whether the animals distinguished by colour vision, and led to the establishment of the fact of colour vision in butterflies (discussed by Ford *loc. cit.*). However its relevance to these flower preferences was not established, and the same question must be asked about our own observations. Because a pink-preferring butterfly does in our experiments feed on pink, white, and heliotrope flowers of other nectar-bearing species, while ignoring nectar-bearing orange and yellow flowers, we believe that these animals are reacting to colour and not to some other stimuli correlated with it in these *Lantana* stocks. However we do not want to stress this belief yet, as the flowers presented were very heterogeneous in structure, and not every species with pink flowers was visited.

Whatever the nature of the stimulus, such preferences will exert a selection pressure on the plant population comparable to that exerted by sexual selection in animals. A learnt preference will exert much less selection; a bee changes its behaviour to accommodate, or to adapt to, every change in the source of nectar. An instinctive preference

will either sterilize a new mutant because few or no pollinators visit it; or preserve the phenotype because it is pollinated by animals who rarely mix its pollen with that of the unchanged parental population, i.e. whose behaviour favours homogamy. So if a new mutant is recessive the butterflies' behaviour will maintain homozygosity once a few homozygotes have segregated in a population; if the mutant is a dominant so that the first unusual phenotype is a heterozygote this will be self-pollinated by the pollinators and so produce homozygotes which will be maintained by the same behaviour. The two phenotypes will be more or less isolated sexually, and thus have the possibility to become further differentiated. In short is this an insect capacity which could make possible in a plant population the initiation of sympatric speciation by a single gene mutation? Mayr (1947) considered and rejected the possibility of sexual isolation arising by a mutation producing a change in a preference. The butterflies we have described have established preferences and it is these which could exercise selection pressure on any mutants that altered relevant stimuli.

REFERENCES

- Butler, C. G. (1954): The world of the honey bee. London. Collins.
 Dronamraju, K. R. (1958): The visits of insects to different coloured flowers of *Lantana camara* L. *Curr. Sci.* 27: 452-453.
 — — — (1960): Selective visits of butterflies to flowers, a possible factor in sympatric speciation. *Nature*, Lond. 186: 178.
 Eltringham, H. (1933): The senses of insects. London, Methuen.
 Ford, E. B. (1945): Butterflies. London. Collins.
 Mather, K. (1947): Species crosses in *Antirrhinum* I. Genetic isolation of the species *majus*, *glutinosum*, and *orantium*. *Heredity* 1: 175-186.
 Mayr, E. (1947): Ecological factors in speciation. *Evolution* 1: 263-283.
 Ribbands, C. R. (1953): The behaviour and social life of honey bees. London. Bee Research Association Limited.

Systematics and Ecology of Indian Plants: I—On the Rainy Season Weeds of Gorakhpur

BY

D. N. SEN

Department of Botany, St. Andrew's College, Gorakhpur, U.P.

(With a sketch map)

INTRODUCTION

The author has tried in this paper to contribute towards the flora of Gorakhpur on the lines suggested in the address by Santapau (1956). The vegetation of many places has been commonly described in different seasons, but such a study has rarely been undertaken during the rainy season on account of inherent difficulties, and so the monsoon and cold months of the year have often been left out completely.

In this paper an attempt has been made to present the rainy season weeds of Gorakhpur. Among other difficulties during this season, as mentioned by Santapau (1956), the pressing and the preservation of plants is the main problem, because most of the plants collected during moist weather become unsuitable for preservation as herbarium materials. Excursions were made whenever possible, and features of interest connected with the phenology and ecology of these plants have been noted. Some of the plants, though quite obvious by their presence flower quite late in this season. Then there are plants which are present throughout the year, but flower profusely during this season. Some plants which do not strictly belong to this season have also been included here because of their particular character. Their density of population in certain localities has been recorded. The flowering time of plant species has been indicated as precisely as possible. The time of seed germination of those plants which could be identified at the seedling stage has also been recorded. The author was advised to include the medicinal properties of the plants recorded here. In this connection no help has been taken from published literature, but only information gathered from local inhabitants has been made use of.

Hewetson (1951 & 1952) and Santapau (1956) have stressed the necessity of a systematic plan in the study of the flora of a place, by extending the scope of such studies beyond the usual practice. The

mere enumeration of plants is not of much avail. The record of distribution, information about soils on which the plants flourish, altitude, phenology, fruit setting, relative abundance and scarcity, and the associations they form are very important, as also the various stages, namely germination, vegetative growth, and finally the formation of seeds.

It is only in recent years that attention has been drawn to such a field of study by a number of botanists. But apparently not many have dealt with this subject matter from the ecological point of view, at least in Uttar Pradesh. The earliest records in this field are those of Dudgeon (1920) and Kanji Lal (1933), which do not deal particularly with the vegetation of Gorakhpur. There are records of a systematic study by Raizada (1931, 1935, 1936, 1939) and Srivastava (1938). As to the ecological and morphological aspects, Misra (1944, 1946) has included them in a number of papers on the vegetation of Banaras. Recently Srivastava (1955), Jain (1956), Gupta (1956), and Bhargava & Gupta (1958) have contributed to the vegetation of different regions of Uttar Pradesh. The last mentioned workers emphasize mainly the phenology of plants in Naini Tal.

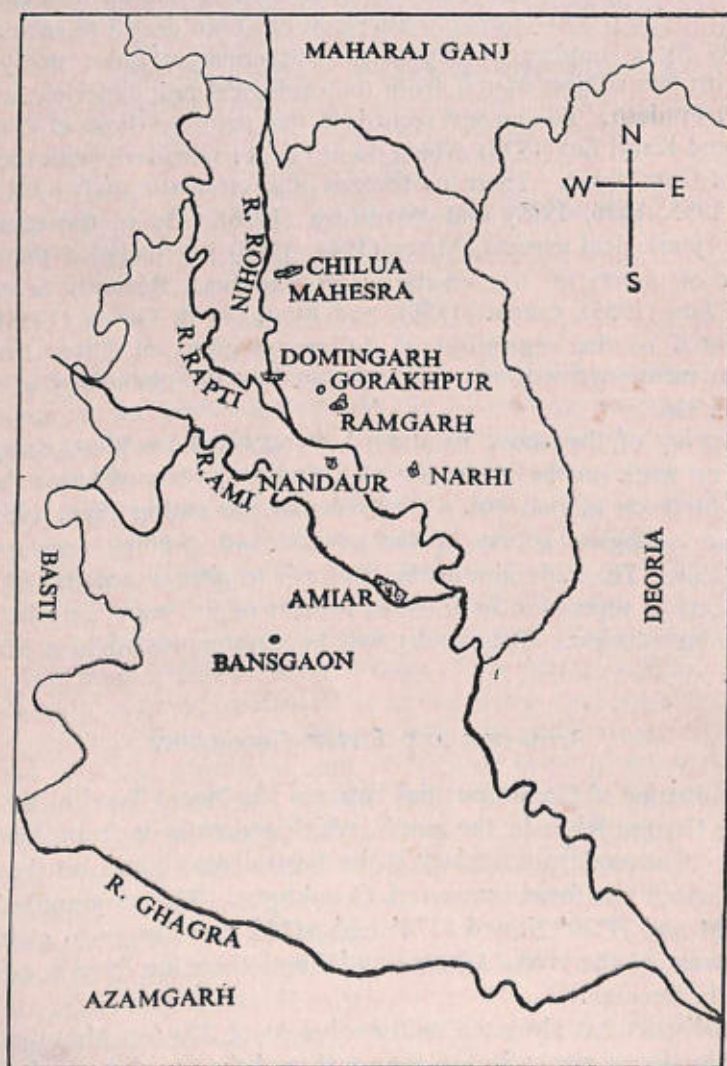
A survey of the above mentioned literature shows that, except for Misra, no work on the vegetation of the eastern parts of Uttar Pradesh has so far been carried out. Very recently the author (Sen, 1959) has made an ecological survey of the aquatic and swampy vegetation of Gorakhpur. The main aim of the author is to give an account of different aspects of vegetation in different seasons of the year from the ecological point of view. The results will be communicated in a series of papers.

SITUATION AND PHYSIO-GEOGRAPHY

The district of Gorakhpur lies between the Nepal Terai in the north and the Ghagra River in the south, which separates it from Azamgarh district. The western boundary is the Basti district; and on the east is Deoria which was formerly part of Gorakhpur. The geographical limits are $26^{\circ}5'$ and $27^{\circ}29'$ N. and $83^{\circ}4'$ and $84^{\circ}26'$ E. Owing to changes in the courses of the rivers Ghagra and Rapti there has been a continual change in the area.

The district has almost a uniform height of 270 feet above sea-level. The plain slopes gently first to the south and then to the east, indicating the general drainage of the country from NW. to NE. A remarkable feature of its landscape is the total absence of marked topographical features. The region comprises several low-lying areas irregular in shape and size, where owing to defective drainage, water accumulates during the rainy season. There are large bodies of stagnant water locally known as *tals*. These low-lying areas are depressions in the flood plains,

which the rivers by flooding are trying to bring to the general level. Many such areas are seen in the north of Gorakhpur city (see Sen, 1959). The tract is completely devoid of any hill or conspicuously marked high land.



Map of Gorakhpur showing some localities

Floods have been a regular menace in the district of Gorakhpur. The river Rapti is one of the largest Himalayan tributaries of the river Ghagra. It flows in a south-easterly direction and drains a large basin. The river Ghagra rises in Tibetan mountains; like most Himalayan rivers it first flows south and then takes an easterly turn. Gorakhpur,

being very close to the Nepal Himalayas and lying in the windward side of the monsoon, gets more rain than other more southern districts; the latter through these two important rivers, the Ghagra and the Rapti, very often suffer serious floods.

The district is part of the Gangetic plain. Its formation, therefore, is of the same geological structure and history as the plains of Uttar Pradesh. This plain has been continually filled with alluvial deposits since the first uplift of the Himalayas. Attempts have been made to ascertain the depth of the alluvial deposit, but no definite results have been achieved.

CLIMATE

In the rainy season the average temperature of Gorakhpur is 29°C., which is a little lower than the average temperature of dry summer. The difference may be due to the humidity.

TABLE
METEOROLOGICAL DATA OF GORAKHPUR—1959

Months	Temperature in °C.		Relative Humidity %		Rain-fall in mm.	Average Wind Speed Kilom. p.h.	Mean Temp. in °C.
	Mean Max.	Mean Min.	At 08.30 I.S.T.	At 17.30 I.S.T.			
Jan.	24.6	11.3	81	56	31.0	2.4	17.91
Feb.	26.5	13.0	65	42	00.0	4.4	19.75
Mar.	34.4	17.9	46	23	2.5	5.7	26.15
Apr.	39.2	23.8	44	26	34.3	6.0	31.50
May	41.3	25.4	50	23	00.0	7.7	33.35
June	42.1	27.5	62	43	39.9	7.7	34.80
July	33.8	25.7	81	75	c.197.9	7.0	29.75
Aug.	31.7	24.7	88	86	c.535.7	4.1	28.20
Sep.	33.2	25.1	81	77	c.221.8	4.7	29.15
Oct.	31.8	22.3	75	70	70.6	2.4	27.05
Nov.	29.7	15.1	60	55	00.0	1.1	22.40
Dec.	24.1	12.6	80	71	00.3	2.0	18.35

In May and June there is low pressure in the Punjab near Multan. The prevailing winds, therefore, become on-shore blowing from the sea to the land. In the beginning, while summer temperatures are rising, these sea winds move only a short distance from the Bay of Bengal. As the temperature rises these winds penetrate into the interior and are called the summer monsoon. The monsoon arrives in the month of June. The mean daily velocity varies between 7.0 and 7.7 kilometres per hour in these months.

Throughout the rainy season the monsoon winds are easterly. Their

velocity decreases as the rainy months pass on ; and then the direction of the wind changes, becoming ultimately from the east in the morning and the west in the afternoon.

The monthly relative humidity, as shown in the Table, indicates that March and April are the driest months in Gorakhpur. With the advent of the rainy season, the relative humidity increases considerably. It again goes down in October.

As a whole, Gorakhpur receives a heavier rainfall than any other part of the province excepting the hilly tracts, the average being no less than 94.5 mm. The Bay of Bengal branch of the south-west monsoon is mainly responsible for the heavy rains ; the district being on the windward side receives much rainfall. Usually the strength of the monsoon currents and the corresponding rainfall increase from June to July and remain more or less steady till about the end of August. The rain is unevenly distributed throughout the year. Nearly 78 % of the total rainfall of the year falls in the four months, July to October. Heavy downpours lead to considerable runoff, which results in soil erosion. The region north of Gorakhpur city, on account of defective drainage, the presence of forests, and the heavy rainfall in the northern tract, usually becomes marshy and moist.



Annual Temperature and Rainfall at Gorakhpur—1958

BIOTIC FACTORS

Among the biotic factors which influence the vegetation is the grazing by cattle. In places monkeys destroy the tender vegetation. Man also destroys much of the rainy season weeds, which grow quickly and, if not cleared up, give a wild look to the whole area.

GENERAL ASPECT OF VEGETATION

With the arrival of the rainy season (June to July) green herbs appear in every nook and corner. A vigorous and luxuriant growth of weeds starts with the first showers. The *ephemeral vegetation* consists mainly of herbaceous annuals, the existence of which mainly depends upon rain. After a week or two of rain, the ground is covered by plants which belong strictly to the rainy season. Among them *Cleome viscosa*, *Gynandropsis gynandra*, *Ionidium suffruticosum*, *Dentella repens*, *Indigofera* sp., *Cassia* sp., *Trienthera portulacastrum*, *Spermacoce hispida*, *Heliotropium* sp., *Ipomoea pes-tigridis*, *Bomaya* sp., *Murdannia nudiflorum*, *Peperomia pellucida*, *Phyllanthus* sp., *Cyanotis* sp., *Commelina nudiflora*, *Sesamum indicum*, *Fleurya interrupta*, *Pouzolzia indica*, *Evolvulus alsinoides*, etc. Others germinate and grow vegetatively till late in the rainy season and then come into flower, like *Urena lobata*, *Sida* sp., *Triumfetta* sp., *Oldenlandia crystallina*, *Pergularia pallida*, *Ipomoea sindica*, *Physalis minima*, *Vitis trifolia*, *Ruellia* sp., *Acalypha indica*, etc. There is a third category of weeds which germinate late in rainy season; they start flowering quite late and go on till about the middle of the winter season. Such weeds include *Oxalis corniculata*, *Tephrosia purpurea*, *Peristrophe bicalyculata*, *Andrographis paniculata*, *Ageratum conyzoides*, *Croton sparsiflorus*, *Scoparia dulcis*, *Adhatoda vasica*, *Ocimum americanum*, *Alternanthera sessilis*, *Nicotiana plumbaginifolia*, etc. There is a fourth category of plants, which are more abundant in other seasons of the year but may sprout and even flower at odd times during the rainy season; some plants in this category flower throughout the year but do so more profusely in the rainy season. Such plants are *Malvastrum coromandelianum*, *Tridax procumbens*, *Evolvulus nummularis*, *Solanum xanthocarpum*, *Achyranthes aspera*, *Tribulus terrestris*, and others.

Some of the plants complete their life-cycle in a few weeks. Plants first start drying out from the exposed habitats. Many plants in shaded places last for quite a long time. Some of the plants disappear with the departure of rain and the advent of the cold winter. Life without water and moisture is difficult for them. This will be clear from the periodicity chart at the end of this paper. The commonest and most successful weeds belong to Amaranaceae, Tiliaceae, Malvaceae, Compositae, Capparidaceae, Leguminosae, Convolvulaceae, Acanthaceae, Gramineae, and Commelinaceae.

CONCLUSION AND SUMMARY

In the present paper an attempt has been made to study the vegetation of Gorakhpur in the rainy season from the ecological point of view. Some advancement has been made in India during recent years on floristic and vegetational studies but most parts are still in need of very

thorough exploration. It would not be wise to separate systematic botany from ecological studies, and hence different observations have been included here; the phenology of each plant, its short life-cycle, relative abundance, and distribution, as has been emphasized by Santapau (1956).

Keeping all this in mind, this study has been made, which in no way claims to be complete. Even a small area may be too large for intensive exploration. The grasses have not been included in this paper, otherwise it would become very unwieldy. The author intends to make a separate communication on the subject. The present paper mainly deals with those weeds which come up soon after the first showers of the season; trees and shrubs are excluded, although many also come into flower at this time of the year. 147 species representing 107 genera from 39 families have been recorded. Plants belonging to Malvaceae, Tiliaceae, Leguminosae, Rubiaceae, Compositae, Boraginaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Labitae, Amaranthaceae, Euphorbiaceae, and Commelinaceae families are more common. Wherever possible some medicinal uses of the plants have also been given.

Ecologically, the vegetation can be divided into: (1) those plants which are strictly of the rainy season, i.e. they come up with the rains and complete their life-cycle with the departure of the rains, like *Gynandropsis gynandra* and *Ionidium suffruticosum*, etc.; (2) those which grow with the rains but complete their life-cycle after the rains are over, like *Physalis minima*, *Urena lobata*, etc.; and (3) those which germinate late in the season and flower only in winter or so, like *Peristrophe bicalyculata*, *Leonotis nepetaefolia*, etc. Taking this division strictly into account, a few plants can be excluded from this list, but as there is no strict demarcation of changing seasons, so also the plants pass from one flowering season to the other, depending mainly on the environmental factors, which definitely affect them.

ACKNOWLEDGEMENTS

Thanks are due to Prof. U. N. Chatterji of Gorakhpur University for constant encouragement and constructive criticism in the preparation of this paper; to Prof. M. O. Varkey, Principal, St. Andrew's College, Gorakhpur, who very kindly passed on his field notes to the author, and for the facilities provided; to my colleague Prof. G. C. Srivastava for many suggestions and identifications. The author is thankful to Shri M. B. Raizada, Forest Botanist, F. R. I., Dehradun, for kindly helping him in the identification of a few plants, and to the Director, Meteorological Centre, for supplying the meteorological data. He is indebted to his colleagues and many students for help given in this study. Finally, he is extremely grateful to Rev. Fr. Santapau for kindly

going through the manuscript of the paper, which is the outcome of his most inspiring address.

LIST OF SPECIES

A list of weeds collected throughout the rainy season, with a brief description, the locality where they were collected, their local names (wherever possible), the time of seed germination, flowering, and fruiting. Medicinal uses of some of the plants have also been listed. The names are arranged according to Bentham and Hooker's system, as in Duthie's FLORA. Local names are given after the scientific names or synonyms.

CAPPARIDACEAE

1. *Cleome viscosa* Linn. (Peela Hurhur)

A very common rainy season weed. It has an offensive odour. Seeds germinate by middle of July, flowers up to September. Flowers yellow. Plants remain stunted if dry spell prolongs.

2. *Gynandropsis gynandra* (Linn.) Merr. Syn. *G. pentaphylla* DC. (Safaid Hurhur)

A common weed, but not as common as *C. viscosa*. Seeds germinate with the first showers. It flowers by middle of August and is in fruit generally by the end of the same month. Flowers white.

VIOLACEAE

3. *Ionidium suffruticosum* Ging. Syn. *I. heterophyllum* Vent.

Not common, only collected from Hui Park. Seeds germinate with the early showers. It flowers from July to October. Flowers purplish pink. Fruit setting starts quite early.

PORTULACACEAE

4. *Portulaca oleracea* Linn. (Kulfa)

A common plant collected from Ramgarh Tal side. It flowers and fruits in July-August. Flowers yellow.

5. *Portulaca quadrifida* Linn.

It is a common weed in gardens and flower pots; flowers in July-August.

MALVACEAE

6. *Abutilon indicum* G. Don. (Kakahi)

A common, almost perennial, plant flowering abundantly during the rains and up to December. Flowers yellow.

7. *Malvastrum coromandelinum* Garcke ; syn. *M. tricuspidatum* A. Gray. (Baryara)

Common ; collected from SAC (St. Andrew's College) and Hui Park, germinates in the rains, flowering quite early. Flowers yellow. Roots are used as an aphrodisiac, powdered and mixed with sugar ; Hindu women worship the plant because of this property.

8. *Sida acuta* Burm. f.

Not common, collected from Ramgarh Tal side under trees. Plants quite stout, flowering in September.

9. *Sida cordifolia* Linn.

Common in Hui Park. Seeds germinate late in rainy season. Flowers abundantly in October. Used for virility in man and stomach complaints.

10. *Sida grewioides* Guill.

Not common, collected from Hui Park. Leaves are small, orbicular, and yellowish green. It flowers late in the season.

11. *Sida veronicaefolia* Lamk. Syn. *S. humilis* Willd.

Not common, trailing, sometimes very long. It flowers abundantly in early September, produces fruit in September-October.

12. *Urena lobata* Linn.

Very common in Hui Park. Seeds germinate quite early, it flowers profusely in September-October. Before flowering it looks very similar to *Triumfetta* sp. Flowers pink.

13. *Urena repanda* Roxb.

Common in SAC and Hui Park. Not so high as the previous species. It flowers in September-October. Flowers whitish pink, mostly forming clusters at the top.

TILIACEAE

14. *Corchorus aestuans* Linn. Syn. *C. acutangulus* Lamk.

Common in SAC and Hui Park. Tallest and first to appear among the species of this genus collected here. More common in moist and shady places. It flowers August-October, forming 2-3 fruits about an inch long in each axil.

15. *Corchorus antichorus* Roensch.

Not very common, collected from Hui Park. Plants small ; leaves less than an inch long ; stems often prostrate with tortuous branches. Plants grow quite late and flower in September-October. Flowers yellow.

16. *Corchorus olitorius* Linn.

Not common, collected from Hui Park. It flowers September-October. Plants sometimes not much branched; leaves $1\frac{1}{2}$ inch long.

17. *Triumfetta bartramia* Linn.; syn. *T. rhomboidea* Jacq.

Common in SAC and Hui Park. It is a large shrub-like annual with polymorphous 3-lobed leaves. Seeds germinate by middle of July, flowering starts together with fruiting by October. Fruits are hooked and round.

18. *Triumfetta rotundifolia* Lamk.

Common in Hui Park. Seeds germinate by late July, flowers and fruits in October-November. Smaller than the previous species. Fruits hooked but pointed.

ZYGOPHYLLAEAE

19. *Tribulus terrestris* Linn. (Gokhru)

A prostrate herb with yellow flowers, collected from Domingarh and Aerodrome area. Not very common. Flowers and fruits in August. Powdered seeds are used for mouth blisters.

OXALIDACEAE

20. *Oxalis corniculata* Linn. (Tinpattia)

Very common in moist and shady places, annual or perennial. It flowers throughout the year, but more in rainy season.

21. *Oxalis acetosella* Linn. (Bari Tinpattia)

Rare, collected only from SAC. Larger than the previous species. Leaves are all radical. Seeds germinate in July and plants flower in August. Flowers purplish pink. Plants not very hairy. Not seen at other times of the year like the previous species.

VITACEAE

22. *Vitis trifolia* Linn. (Imirti)

A common climber at Ramgarh Tal side on the trees and in SAC. It sprouts abundantly by middle of July, flowers and fruits in September-November. Plants seem to sprout from a stout perennial rootstock.

SAPINDACEAE

23. *Cardiospermum halicacabum* Linn.

A slender climbing plant with thin and light green leaves. Flowers small and white. Common in Hui Park in early October, fruiting starts late in winter. Fruits are characteristically triangular with bladder and wings.

PAPILIONACEAE

24. *Abrus precatorius* Linn. (Ratti)

A common hardy twiner. Abundant seedlings come up in July. It flowers in August-September, and fruits during cold season. Seeds are poisonous.

25. *Aeschynomene aspera* Linn.

A marshy tall herb, collected from Asuran. Basal part of stem swollen and pith-like. It flowers abundantly late in the season. Flowers yellow.

26. *Alysicarpus monilifer* DC.

Commonly collected from Hui Park. Stem and leaves covered with hairs. Leaves simple. Flowers late in the season.

27. *Alysicarpus rugosus* DC.

A diffuse herb, common in Hui Park. Seeds germinate in July and plants flower till September.

28. *Argyrolobium roseum* Jaub. & Spach.

Collected near University cross-roads. Plants 1-2 feet in height. Seeds germinate late in the season. It flowers and fruits in November. Flowers yellow with brown streaks on petals. Inflorescence up to 10 inches long, in racemes.

29. *Clitoria ternata* Linn.

A common twiner. Seeds germinate with the first showers. It flowers profusely from August to October. Flowers blue.

30. *Crotalaria medicaginea* Lamk.

Collected from Hui Park only. Plants 1-1½ feet in height and much branched, silky hairy. Flowers in September-October, fruits late in October. Pods round and 2-seeded.

31. *Crotalaria prostrata* Roxb.

Not common, collected from Hui Park. A late rainy season weed. It flowers and fruits in November.

32. *Desmodium gangeticum* DC.

Very common in SAC and Hui Park. Seeds germinate by late July. It flowers abundantly in September-October. Fruits set in October-November. Flowers purplish pink and white.

33. *Desmodium pulchellum* Benth.

Not common ; shrub with downy branches. Flowers yellow.

34. *Desmodium triflorum* DC.

Very common. Prostrate, especially in fields and lawns. Flowers bright bluish purple. It continues to flower till late winter or even later.

35. *Indigofera enneaphylla* Linn.

Common. It flowers late in the season.

36. *Indigofera hirsuta* Linn.

A densely hairy plant, collected from Hui Park, 1-2 feet in height. Seeds germinate in August. Flowering starts in first week of September. Pink flowers crowded on racemes 2-3 inches long. Pods deflexed, densely pubescent, 4-gonous.

37. *Indigofera linifolia* Retz.

A much branched spreading herb, with simple leaves. Collected from Hui Park, not common. It flowers late in the season. Flowers red.

38. *Tephrosia purpurea* Pers.

A perennial undershrub, collected only at Domingarh. Sprouts up with rains. Seeds may also germinate at this time. It flowers abundantly in September and onwards. Flowers rose-coloured, in leaf-apposed racemes. It sets fruit soon.

39. *Uraria neglecta* Prain.

Rare ; collected only from Kusmi Forest, 1-2 feet in height, with one trifoliate leaf and racemose inflorescence. Flowers in July. Flowers yellowish purple. Characteristic fruits in one-seeded joints folded over one another.

40. *Zornia diphylla* Pers.

Not common, collected only from Hui Park. It has sub-erect slender stem. Leaves of two leaflets. Seeds germinate in August and flowers appear in September-October. Flowers yellow.

CAESALPINIACEAE

41. *Cassia absus* Linn.

Abundant in Hui Park only. Seeds germinate by middle of August. Plants about one foot in height, start flowering by early September and continue the whole month. Flowers are beautiful rose-red and not yellow. Stamens mostly four, unequal in size, and not five as mentioned in Duthie.

42. *Cassia occidentalis* Linn. (Bara Chakwad)

One of the commonest rainy season weeds on roadsides. Seeds

germinate with the first showers, but the growth is slower than *C. tora*. Flowers in August-September. Flowers yellow.

43. *Cassia pumila* Lamk.

A common procumbent plant in Hui Park, with leaves 1-2 inches long, having 20-40 very small leaflets. Seeds germinate in August. It flowers in September-October. Flowers yellow. Stalked gland of petiole is characteristic.

44. *Cassia tora* Linn.

One of the commonest of rainy season weeds. Seeds germinate with the first rains. A number of seedlings grow close together. It starts flowering in late August and continues till September. Flowers yellow

45. *Mimosa pudica* Linn. (Lajwanti)

Cultivated and wild in Hui Park. It flowers abundantly in August.

LYTHRACEAE

46. *Ammannia baccifera* Linn.

Very common on moist margins of Ramgarh and Narhi tals and many other places. It flourishes well in swamps; dry conditions are not congenial. It flowers mostly after rains and continues for a long period.

47. *Ammannia pygmaea* Kurz.

Very similar to previous species but very small. It flowers in rainy season, grows in dry situations also.

ONAGRACEAE

48. *Jussiaea repens* Linn.

Common in Ramgarh and Narhi tals, abundant at Asuran. Grows floating in water, showing very characteristic white respiratory spongy roots. Almost perennial, it grows on mud and even in dry land when water recedes. It flowers late in the season, and continues up to January and February. Flowers yellow.

49. *Jussiaea suffruticosa* Linn.

Not so common as *J. repens* collected from south margins of Ramgarh Tal and other places. Almost a perennial herb, which flourishes in water and shows spongy roots also. It flowers late in rainy season. Flowers yellow.

50. *Ludwigia parviflora* Roxb.

Rare, collected only from Asuran. A prostrate herb which grows near water. It flowers in December. Flowers small and yellow,

51. *Trapa bispinosa* Roxb. (Singhara)

An aquatic plant of economic importance which grows in seasonal pools. Seedlings planted in July. Plants flower abundantly in August and fruit in September-October.

CUCURBITACEAE

52. *Coccinia indica* W. & A. Syn. *Cephalandra indica* Naud. (Kala Jeur, Kundru)

A common climber ; plants spread abundantly by late July, and profusely flower in August-September. They bear more male than female flowers. Flowers white, fruits red when ripe. Leaves and roots are crushed and used in diabetes.

53. *Cucumis trigonus* Roxb. (Ghurma)

A trailing plant collected from Kusmi Forest, with small yellow staminate flowers. It flowers in August-September. Fruits with green and white stripes, becoming yellow when ripe.

MOLLUGINACEAE

54. *Trianthema portulacastrum* Linn. Syn. *T. monogyna* Linn.

Very common. Seeds germinate with the first showers. It flowers abundantly from August to October, as long as conditions are wet.

55. *Glinus lotoides* Linn. Syn. *Mollugo lotoides* O. Kze. and *M. hirta* Thunb.

Plants collected from drying ponds in low-lying areas after rains. A hairy prostrate herb. Leaves opposite or whorled. It flowers late in the season.

56. *Mollugo stricta* Linn.

Not common, collected from Kusmi Forest. It flowers by middle of August till September. Fruiting starts quite early.

RUBIACEAE

57. *Dentella repens* Forst.

A prostrate slender herb, common near Ramgarh Tal and Domingarh wayside ponds. Seeds germinate quite early in June-July. The plant is so small and insignificant that it can easily be overlooked. It flowers abundantly by late July. Flowers small and white.

58. *Oldenlandia crystallina* Roxb.

Not very common ; collected from Hui Park. Seeds germinate in late July and flower by the end of August. It is smaller than *O. dichotoma*. Flowers are small in pairs on long thin pedicels in the axils of leaves.

59. *Oldenlandia dichotoma* Hook.

Very common in Hui Park and in SAC. It grows profusely in fields by September-October, and flowers soon after. A much larger species.

60. *Spermacoce hispida* Linn. (Gidni)

A procumbent annual, collected from Kusmi Forest and Hui Park. Plants are sufficiently big by late August, and flowering starts soon after. Flowers are produced in axillary clusters. Not common. Flowers purplish blue. Roots after powdering are applied on breast abscesses and ulcers.

COMPOSITAE

61. *Ageratum conyzoides* Linn.

A very common, softly hairy annual; springs up in abundance soon after rains in July-August: it is 6-16 inches in height. It flowers in September. This plant flourishes well in shady and moist ground. Flowers purplish white.

62. *Bidens pilosa* Linn.

Common, 10-20 inches in height, collected from Hui Park. It flowers in September-October.

63. *Caesulia axillaris* Roxb.

Not very common, collected by the side of a stream on way to Tilonia Forest range. It flourishes in swamps, and flowers late in the season. Flowers greyish white in the axils of long sessile leaves.

64. *Chrysanthemum indicum* DC.

A procumbent small diffuse herb. Heads are small. The plant commonly grows on roadside shady places, and flowers late in the season. Flowers yellow.

65. *Eclipta prostrata* Linn. Syn. *E. alba* Hassk., *E. erecta* Linn. (Bhangraia)

An erect or prostrate herb, common, but abundant only in moist soil. It flowers in rainy season and later. Flowers white. The leaves are used for hair dye, and are an important ingredient in medicated oils. Leaf extract is used in ear-ache and also in boils etc. Latex is used for tattooing.

66. *Tridax procumbens* Linn.

Common. Seen almost throughout the year, but more prominent in the rainy season. It flowers late in the season and continues till winter. Flowers light yellow.

67. *Xanthium strumarium* Linn. (Gokhroo)

Common all over for most of the year. Seedlings seen at Kusmi Forest in the middle of August. In other places plants were collected in flower and fruit. Not strictly a rainy season weed.

APOCYNACEAE

68. *Ichnocarpus frutescens* Br.

A large shrubby twiner, not very common. Flowering in August-September for a comparatively short time.

69. *Tabernaemontana coronaria* Willd. Syn. *Ervatamia coronaria* Stapf. (Chandni)

An ornamental shrub, become wild all over. It flowers in August to October. Leaves are shining green, flowers white.

ASCLEPIDACEAE

70. *Pergularia pallida* Wt. & Arn.

A twining shrub, collected from SAC, climbing on hedges. It grows in July and flowers abundantly with yellowish white coloured umbellate cymes. Pollinia waxy with reddish brown translator. Not seen elsewhere.

BORAGINACEAE

71. *Heliotropium indicum* Linn.

Hairy plants, common. Seeds germinate in May-June, and flower soon after. Fruits are produced abundantly in July-August. Flowers pale violet. Fruits characteristic with one-seeded pyrenes.

72. *Heliotropium ovalifolium* Forsk.

Erect, decumbent or prostrate, densely clothed with hairs; collected from Domingarh and SAC. Seeds germinate very early; fruiting abundant in July. There are invariably 4 sepals in the specimens collected, which is different from other records.

73. *Heliotropium subulatum* Hochst.

Erect, the largest in the genus: collected from Domingarh and SAC. It grows on comparatively dry soil. Plants are seen very early in the season and continue to flower after rainy season. A common plant.

74. *Heliotropium supinum* Linn.

Villous herbs, common on roadside in moist shady places. Seeds germinate very early in June-July. The plant flowers and fruits by early August. From a distance the plant looks very similar to *Salvia plebeia*.

75. *Heliotropium strigosum* Willd.

A small much-branched procumbent herb, growing abundantly in rains in playground near SAC Hostel. Seeds germinate with the first rains, the plant flowers profusely by the end of July. Flowers small and white. Not common.

CONVOLVULACEAE

76. *Evolvulus nummularis* Linn.

Very common, much-branched creeping perennial herb in fields at SAC, Domingarh, and other places, on comparatively dry and hard soil. It sprouts with the first showers after hot summer, although the plant is met with throughout the year. White small flowers are abundantly produced from July to October. Flowering is withheld for the winter months, and it appears again in April, but the plants do not look fresh.

77. *Evolvulus alsinoides* Linn.

A diffuse hairy herb, not common. It is a strict rainy season weed, collected after rains in July from SAC and Hui Park. Seeds germinate with early rains, and flower in August-September. Plants are not seen late in the season. Flowers light blue on comparatively long pedicels.

78. *Ipomoea aquatica* Forsk. Syn. *I. reptans* Poir. (Karmua)

An aquatic or semi-aquatic herb, which flourishes on swampy and moist margins of ponds etc. It flowers in late rainy season, and continues flowering till the ground is completely dry. Plants are supposed to be effective for stomach disorders.

79. *Ipomoea pes-tigridis* Linn.

Not very common. A small twining herb, collected only from Hui Park. Seeds germinate late in August. Leaves and stem fulvous hairy. It flowers in September-October and finishes soon after. Flowers purplish.

80. *Ipomoea sindica* Stapf.

A late rainy season weed, collected only from Hui Park in guava orchard twining over grasses etc. Stems many from the base, prostrate, slender and hispid. Leaves hastate, up to 2 inches long. It flowers in October-November, and finishes soon after.

81. *Porana paniculata* Roxb. (Safaid Bel)

A large climbing shrub, only recorded from Afaq Park. It does not appear to be wild. It flowers in October-November, with numerous small white flowers, arranged in large axillary, terminal drooping panicles.

SOLANACEAE

82. *Datura fastuosa* Linn. (Dhatura)

A wild form not very common, small and shrubby. It flowers late in rainy season and afterwards. Seeds are used in asthma. Seeds boiled in oil are used for gout ; they are also smoked for intoxication.

83. *Datura stramonium* Linn.

Annual. Seeds germinate in late July, collected from Domingarh. It flowers late in the season till winter. Flowers white.

84. *Nicotiana plumbaginifolia* Viv. (Jungli Tamakhu)

Common in fields and SAC. Seeds germinate in early July. Leaves radical and cauline, the latter lanceolate. Stems 6-12 inches in height. It flowers abundantly from July to October, and then again in April. Flowers purplish white. No mention of this plant in Duthie.

85. *Physalis minima* Linn. (Ban Makoi)

Common. Seeds germinate with the rains. Flowering starts by August and continues till late in the season. Flowers yellowish white.

86. *Solanum xanthocarpum* Schrad & Wendl. (Bhaktoi)

Not strictly a rainy season weed, but flourishes well in rains and starts flowering. Collected from roadside near aerodrome in middle of July. Flowers abundantly in December. Water, in which leaves are boiled, is given for fever. Seeds, after keeping on red hot earthen pot, give out fumes which are inhaled for carious teeth.

SCROPHULARIACEAE

87. *Bonnaya brachiata* Link & Otto.

Not common. Collected from moist and shaded spots near Ramgarh Tal and SAC. Seeds germinate with the early showers. Plants 3-8 inches in height, leaves spinose-serrate and glabrous. It starts flowering by the end of July and continues till the end of the season. Flowers purple and white.

88. *Bonnaya veronicaefolia* Spreng.

A common decumbent herb collected from shaded spots in Hui Park and SAC. Small plants, like the previous species. Seeds germinate in August and flower during the whole rainy season and continue till late winter in places. Leaves sub-entire or with distantly serrate margins. Flowers purplish white.

89. *Limnophila gratioloides* R. Br.

Grows in water or in swamps ; collected from Asuran. Plants

show heterophylly. Pinkish coloured flowers are produced abundantly in September-October. It continues to flower and produce fruits till late in the season.

90. *Mazus rugosus* Lour.

Very common small glabrous annual with tufted stems ; at SAC and other places. It grows late in the season, and flowers throughout winter. Flowers purplish white.

91. *Moniera cuneifolia* Mich.

From the records of Prof. M. O. Varkey, who collected it on 10-10-1946, but not recorded by the author.

92. *Scoparia dulcis* Linn.

Common. It does not seem to be a true plant of this season, possibly the rootstock sprouts in rains. Flowers white.

LENTIBULARIACEAE

93. *Utricularia flexuosa* Vahl.

A very common aquatic plant, which flourishes well in Asuran Poklhra, Bitia ponds, and others. It starts flowering in early winter and not in hot season as mentioned in Duthie. Flowers yellow.

94. *Utricularia stellaris* Linn.

Not common. Collected from a roadside pond on way to Domingarh. Inflorescence is held up above the water by a whorl of 4 floats on the peduncle, with yellow flowers. It flowers in early winter.

PEDALIACEAE

95. *Martynia diandra* Glox. (Bichhu, Kaua)

From the records of Prof. M. O. Varkey, who collected it on 27-9-1946. Fruits characteristic with 2 hard curved spines. It flowers during and after rains.

96. *Sesamum indicum* Linn. (Tilli)

An erect annual herb, common in Hui Park and many other places, 1-2 feet in height. It germinates in August and flowers in September. Flowers bilabiate and pinkish purple.

ACANTHACEAE

97. *Adhatoda vasica* Nees. Syn. *Justicia adhatoda* Linn. (Adhus)

Very common shrub. Rootstock sprouts up in rains. It starts flowering in early winter and continues onwards. Flowers large

and white. Leaves are made use of in ripening of fruits by covering the latter with them. Leaves oil-smeared and warm are kept on wounds, etc.

98. *Aechmanthera tomentosa* Nees.

From the notes of Prof. M. O. Varkey who collected it on 28-8-1945, and recorded that the plant is not hairy, as mentioned in Duthie, has no bracteoles, and also ovary is not so hairy. Not recorded by the author.

99. *Andrographis paniculata* Nees. (Kalmegh, Kalpnath)

Common; grows and flowers late in the season by October to December. Flowers pink. Leaf extract after boiling is used as blood purifier.

100. *Barleria strigosa* Willd.

An unarmed shrub, cultivated and wild, not common as a weed. Seeds germinate with late rains; it flowers for a short period in early winter. Flowers blue.

101. *Hygrophila polysperma* T. Anders.

Common near margins of ponds and ditches, collected from Domin-garh and a number of other places. It flowers abundantly in September-October and continues till winter season. Flowers pinkish white. Stamens two, and not four as mentioned in Duthie.

102. *Justicia procumbens* Linn. Syn. *J. diffusa* Willd.

A diffuse much-branched herb; not very common, collected near Rani ka Pokhra. Seeds germinate with rains, flowers in September-October. Plants are not seen after November. Flowers purplish pink.

103. *Peristrophe bicalyculata* Nees.

Very common in waste land after rains. Stem characteristically 6-angled. It flowers late in the season and early winter. Flowers pink. Crushed plants mixed with pepper are given in fever.

104. *Ruellia patula* Jacq.

A small hoary pubescent plant, collected from Hui Park and Domin-garh. Not common; flourishes during the rains only. It flowers rather sparsely in late August. Plants do not live very long.

105. *Thunbergia grandiflora* Roxb.

Not common, mostly cultivated. Plants come up with rains, flower abundantly in September-October. It is a climber with large and showy flowers. Flowers light blue.

VERBENACEAE

106. *Lippia nodiflora* Rich. (Bukkam)

Common near water and other places. It flowers throughout, but more so in July, with shining spikes of violet colour. Fruits are also formed at the same time. Plants, especially leaves, after crushing are applied on forehead for headache.

107. *Verbena officinalis* Linn.

An erect herb, collected from Ramgarh Tal side and Bitia. Spikes are 4-6 inches long. It flowers late in July till August. Flowers lilac.

LABIATAE

108. *Anisomeles indica* O. Kze. Syn. *A. ovata* R. Br.

Plants 3-6 feet in height, densely pubescent; collected from Hui Park. This is more common towards the west of Gorakhpur on the sides of railway line. It grows late in September, and flowers by October. Plants form seeds and die off by middle of November.

109. *Leucas cephalotes* Spreng. (Gom)

Plants appear by early August; they are soft and hairy, the leaves long and serrate. Inflorescence globose, about $\frac{3}{4}$ inch in diameter. It flowers by August-September. Flowers white. Crushed leaves are put in the nostrils for cold and applied on forehead for headache.

110. *Leucas lavandulaefolia* Rees. Syn. *L. linifolia* Spreng.

Not common; collected from Kusmi Forest; about 1 foot in height. Leaves linear lanceolate. It flowers in August-September. Flowers white.

111. *Leonurus sibiricus* Linn.

Not common, collected near University cross roads. About 4 feet in height, the plant flowers in early November. Flowers bluish pink.

112. *Plectranthus coetsa* Buch.-Ham.

From the records of Prof. M. O. Varkey who collected it on 27-9-1946, but not recorded by the author.

113. *Leonotis nepetaefolia* R. Br.

Not very common; collected from Hui Park. Seeds germinate by early October. It flowers in November. Flowers yellowish orange. Not recorded by Kanjilal.

114. *Ocimum americanum* Linn. Syn. *O. canum* Sims. (Tulsi)

Common, collected near University cross roads. Leaves 1 inch long,

gland-dotted on lower surface. It grows in October, flowers early November.

NYCTAGINACEAE

115. *Boerhavia diffusa* Linn. (Gajphunna)

One of the commonest perennial weeds which flourishes in rains, spreading and trailing on ground. It flowers by July to September. Plants look dull in winter, they flower again though not so profusely in March-April. Flowers pink. Roots are boiled and given in fever.

AMARANTHACEAE

116. *Achyranthes aspera* Linn. (Chitchita)

Very common ; grows in August-September, and flowers late in the season and onwards.

117. *Alternanthera sessilis* (Linn.) DC.

A prostrate herb, common near ponds and ditches. It produces white and shining axillary heads. Plants grow in July and flower late in the season.

118. *Amaranthus polygamus* Linn.

A rare plant, collected from Ramgarh Tal side. It grows with rains and flowers in September.

119. *Amaranthus spinosus* Linn. (Jungli Chaulai)

A very common spiny annual. It grows with the early rains and flowers soon after. It is bigger than *A. viridis*. A troublesome weed, whose stem is often tinged with red.

120. *Amaranthus viridis* Linn. (Chaulai)

An erect much-branched annual 1-2 feet in height. Not so common as the previous species. It grows with the rains and flowers soon after.

121. *Gomphrena globosa* Linn.

An annual herb, not common : collected only near Domigarh railway station by the side of the rails. Inflorescence globose of white silky heads. It flowers in September.

122. *Nothosaerua brachiata* Wight.

An erect slender herb, collected near Ramgarh Tal and Bitia side. It is more common in wet places. It flowers in July-August.

POLYGONACEAE

123. *Polygonum hydropiper* Linn. (Pani Mirch)

An aquatic or semi-aquatic plant, collected from Ramgarh Tal side. The stem is branched and swollen at nodes. It flowers in July. Flowers pink.

124. *Polygonum glabrum* Willd.

An aquatic or semi-aquatic plant, common in Ramgarh Tal. Inflorescence 2-4 inches long. Flowers abundantly by late July till September, opening of flowers is irregular. Flowers pink.

125. *Antigonon leptopus* Hook. et Arn.

Commonly cultivated in hedges, but becomes wild on roadsides. It flowers abundantly in late rainy season. Flowers pinkish rose. Not recorded by Duthie.

PIPERACEAE

126. *Peperomia pellucida* H.B.K.

A rare succulent annual, collected only from Hui Park. Seeds germinate in August. Stems sometimes rooting at nodes. It flowers abundantly at a young stage by August-September.

EUPHORBIACEAE

127. *Acalypha indica* Linn. (Fursh Buti)

An erect annual, common. Plants grow in July, and start flowering in early August and continue later. Leaf extract is taken in cow's milk for strength.

128. *Chrozophora rotterli* A. Juss.

Very common near Bitia side, it grows in summer and flowers abundantly in rainy season. Male flowers yellow.

129. *Croton sparsiflorus* Morong.

One of the commonest weeds on roadsides. Has a repulsive smell. It grows throughout the year, but flourishes well in rainy and cold seasons. Not recorded by Duthie.

130. *Euphorbia hirta* Linn. (Bari Dudhi)

A small prostrate herb with erect branches and opposite leaves. Common, almost throughout the year. It flowers for a considerable part of the year.

131. *Euphorbia thymifolia* Linn. (Chhoti Dudhi)

Very common on gravel paths. Seeds germinate with the rains ; plants change from a green to coppery hue, and flower for a long time in the season. Leaf extract is given in mother's milk to infants suffering from dysentery.

132. *Phyllanthus niruri* Linn.

Grows very early in the rainy season, a true rainy season weed, very common. Flowering starts by late July. Flowers are very small and axillary.

133. *Phyllanthus simplex* Retz.

A glabrous herb, common in Hui Park. Plants appear quite early in the season. Flowers are solitary on stout long pedicels, capsule rough but not echinulate. It flowers in July-August and fruits set in soon after.

134. *Phyllanthus urinaria* Linn.

A common small weed, collected from Hui Park and SAC. Plants look very similar to *P. niruri*, but they are smaller and dark green in colour. It flowers in August-September. Fruits are faintly echinulate.

URTICACEAE

135. *Cannabis sativa* Linn. (Bhang)

Very common, mostly on southern side. It sprouts up abundantly with rains, and grows till late winter. It flowers in early winter.

136. *Fleurya interrupta* Gaud. (Bichhu)

Rare ; collected only from SAC campus. It grows in August and flowers soon after. It does not live very long.

137. *Pouzolzia indica* Gaud.

It has not been recorded except from SAC ; collected together with *Fleurya interrupta*. Seeds germinate with the early rains, flower till September. A rare plant.

ORCHIDACEAE

138. *Vanda roxburghii* R. Br.

Not very common, collected from Turra Nulla. It is an epiphyte, and flowers by middle of August. Flowers yellowish cream.

SCITAMINACEAE

139. *Globba* sp.

Very common in Hui Park all along the boundary. It grows with rains and flowers profusely in August. Flowers purplish red. It looks like a canna.

DIOSCOREACEAE

140. *Dioscorea sativa* Linn.

A climbing plant, collected from Hui Park. It flowers late in August, in drooping spikes. Not common.

PONTEDERIACEAE

141. *Monochoria vaginalis* Persl.

An aquatic plant ; flowers commonly in rainy season. It is common in Ramgarh Tal.

COMMELINACEAE

142. *Murdannia nudiflorum* Linn. Syn. *Aneilema nudiflorum* R.Br.

A common slender weed, collected from Hui Park and SAC ; grows by early August. Leaves 1-2 inches long ; inflorescence is a panicle on a scape. It flowers by late August and early September for a short time.

143. *Commelina benghalensis* Linn.

Common near moist margins of ditches and in low-lying areas. It flowers abundantly during the rains.

144. *Commelina nudiflora* Linn.

Very common near bathrooms of SAC Hostel and Ramgarh Tal side ; grows by early July. Plants are bigger in size than the previous species, leaves broad and sessile. Flowering starts by early August and continues till September. Flowers blue. Leaf extract is applied in wasp stings.

145. *Cyanotis axillaris* Schult.

Rare ; collected from Hui Park in shade. Leaves 2-3 inches long and linear. Inflorescence axillary in helicoid cymes. Stamens have bearded filaments, anthers are yellow.

146. *Cyanotis cristata* Schult.

Rare ; collected only from Domingarh near old buildings on a wall ; looks very similar to *Commelina* sp. Flowers abundantly by the first week of September for a short time ; stamens six with bearded filaments.

NAIADACEAE

147. *Aponogeton monostachyon* Linn. f.

An aquatic plant collected from Domingarh in August-September, when it flowers abundantly. White flowers emerge out of the water surface.

INCIDENCE OF FREQUENCY ABUNDANCE REGARDING GROWTH AND
PHENOLOGY OF WEEDS DURING RAINY SEASON—1958

In the following chart the monthly incidence of frequency-abundance regarding growth and phenology of rainy season weeds is given. The symbols used are: R-rare (1-5); F-frequent (5-15); C-common (50-100); A-abundant (100-200); D-dominant (over 200). The numbers within brackets are the approximate numerical values of the symbols for the localities from which the plants have been collected as mentioned in the case of each plant. v and l are used as prefix for 'very' and 'local'.

Plant species	July	Aug.	Sept.	Oct.	Nov.	Dec.
1. <i>Cleome viscosa</i> Linn.	D	A	A	F	..	..
2. <i>Gynandropsis gynandra</i> (Linn.) Merr.	lA	lC	F	F	..	..
3. <i>Ionidium suffruticosum</i> Ging.	R	vF	C	F	..	..
4. <i>Portulaca oleracea</i> Linn.	vF	vF	F	..	..	..
5. <i>P. quadrifida</i> Linn.*	..	..	..	..	..	..
6. <i>Abutilon indicum</i> G. Don	lF	F	F	C	F	F
7. <i>Malvastrum coromandelinum</i> Garcke.	lF	lF	lF	lF	F	..
8. <i>Sida acuta</i> Burm. f.	..	..	lF	lA	..	..
9. <i>S. cordifolia</i> Linn.	..	F	C	lA	A	..
10. <i>S. grewoides</i> Guill.	..	F	vF	C	F	..
11. <i>S. veronicaefolia</i> Lamk.	..	..	vF	F	..	..
12. <i>Urena lobata</i> Linn.	C	C	lA	lA	C	..
13. <i>U. repanda</i> Roxb.	..	lF	lC	lA	F	..
14. <i>Corchorus aestuans</i> Linn.	F	C	C	C	F	..
15. <i>C. antichorus</i> Roensch.	..	F	F	F	..	..
16. <i>C. olitorius</i> Linn.	..	..	F	F	..	..
17. <i>Triumfetta bartramia</i> Linn.	R	F	C	C	F	..
18. <i>T. rotundifolia</i> Lamk.	..	F	F	C	vC	..
19. <i>Tribulus terrestris</i> Linn.	lR	lR	..	..	..	..
20. <i>Oxalis corniculata</i> Linn.	lF	lF	lF	lF	..	..
21. <i>O. acetosella</i> Linn.	lF	lC	lR	..	..	..
22. <i>Vitis trifolia</i> Linn.	lF	lC	lC	lC	lF	..
23. <i>Cardiospermum halicacabum</i> Linn.	..	..	lF	lF	lF	..
24. <i>Abrus precatorius</i> Linn.	..	lF	lF	..	..	..
25. <i>Aeschynomene aspera</i> Linn.	..	..	lF	lF	lF	lF
26. <i>Alysicarpus monilifer</i> DC.	..	..	..	lF	lF	..
27. <i>A. rugosus</i> Linn.	lR	lF	lC	lR	..	..
28. <i>Argyrolobium roseum</i> Jaub & Spach.	..	..	..	lR	lF	..
29. <i>Clitoria ternatea</i> Linn.	lF	lA	lA	lF	lF	..
30. <i>Crotalaria medicaginea</i> Lamk.	..	lF	lC	lA	lF	..
31. <i>C. prostrata</i> Roxb.	..	..	..	lF	lF	..
32. <i>Desmodium gangeticum</i> DC.	F	C	vA	C	..	..
33. <i>D. pulchellum</i> Benth.	..	..	lR	lR	..	..
34. <i>D. triflorum</i> DC.	..	A	A	A	A	A
35. <i>Indigofera enneaphylla</i> Linn.	..	..	..	F	F	F
36. <i>I. hirsuta</i> Linn.	..	R	C	C	..	..
37. <i>I. linifolia</i> Retz.	..	F	C	C	..	..
38. <i>Tephrosia purpurea</i> Pers.	F	F	C	C	F	F
39. <i>Uraria neglecta</i> Prain.	lR	lR	..	..	..	..
40. <i>Zornia diphylla</i> Pers.	..	lR	lF	lF	..	..
41. <i>Cassia absus</i> Linn.	..	C	vC	A	..	..
42. <i>C. occidentalis</i> Linn.	vA	D	D	vA	C	..
43. <i>C. pumila</i> Lamk.	..	lF	lC	lA	..	..
44. <i>C. tora</i> Linn.	F	vC	vC	F	..	..
45. <i>Mimosa pudica</i> Linn.	F	F	C	C	..	..
46. <i>Ammania baccifera</i> Linn.	C	A	A	A	C	..

Plant species	July	Aug.	Sept.	Oct.	Nov.	Dec.
47. <i>A. pygmaea</i> Kurz. ..	C	C	C	C	F	F
48. <i>Jussiaea repens</i> Linn. ..	F	F	F	F	F	..
49. <i>J. suffruticosa</i> Linn. ..	R	F	F	R	..	..
50. <i>Ludwigia parviflora</i> Roxb. ..	..	IR	IR	IR	..	..
51. <i>Trapa bispinosa</i> Roxb. ..	C	A	A	A	F	R
52. <i>Coccinia indica</i> W. & A. ..	F	C	C	C	..	..
53. <i>Cucumis trigonus</i> Roxb. ..	F	C	C	C	..	..
54. <i>Trianthema portulacastrum</i> Linn. ..	vC	A	A	A	vC	..
55. <i>Glinus lotoides</i> Linn. ..	IF	IF	F	F	..	..
56. <i>Mollugo stricta</i> Linn. ..	..	R	R	..	..	..
57. <i>Dentella repens</i> Forst. ..	C	A	vC	F	..	..
58. <i>Oldenlandia crystallina</i> Roxb. ..	..	F	vF	..	..	..
59. <i>O. dichotoma</i> Hook. ..	..	F	C	vC	F	..
60. <i>Spermacoce hispida</i> Linn. ..	..	F	C	F	..	..
61. <i>Ageratum conyzoides</i> Linn. ..	C	vC	IA	IA	C	C
62. <i>Bidens pilosa</i> Linn. ..	..	..	F	F	..	..
63. <i>Caesulia axillaris</i> Roxb. ..	..	..	F	F	..	..
64. <i>Chrysanthemum indicum</i> DC. ..	..	..	F	F	..	..
65. <i>Eclipta prostrata</i> Linn. ..	C	A	A	A	C	C
66. <i>Tridax procumbens</i> Linn. ..	C	C	C	C	F	F
67. <i>Xanthium strumarium</i> Linn. ..	F	F	F	F	..	..
68. <i>Ichnocarpus frutescens</i> Br. ..	..	F	C	F	..	..
69. <i>Tabernaemontana coronaria</i> Willd. ..	..	F	C	F	..	..
70. <i>Pergularia pallida</i> W. & A. ..	IR	IR	IF	IF	..	..
71. <i>Heliotropium indicum</i> Linn. ..	vF	vF	IF	IF	..	..
72. <i>H. ovalifolium</i> Forsk. ..	F	F	F	F	F	..
73. <i>H. subulatum</i> Hochst. ..	C	vC	vC	C	C	F
74. <i>H. supinum</i> Linn. ..	C	C	vC	C	C	C
75. <i>H. strigosum</i> Willd. ..	IA	IA	IA	IC	..	..
76. <i>Evolvulus nummularius</i> Linn. ..	A	vA	vA	C	F	F
77. <i>E. alsinoides</i> Linn. ..	R	F	F	R	..	..
78. <i>Ipomoea aquatica</i> Forsk. ..	F	F	F	F	F	F
79. <i>I. pes-tigridis</i> Linn. ..	..	F	vF	F	..	..
80. <i>I. indica</i> Stapf. ..	..	..	IC	F	..	..
81. <i>Porana paniculata</i> Roxb. ..	..	..	F	IA	..	..
82. <i>Datura fastuosa</i> Linn. ..	..	F	F	F	..	..
83. <i>D. stramonium</i> Linn. ..	..	F	F	F	..	..
84. <i>Nicotiana plumbaginifolia</i> Viv. ..	vF	C	C	vF	..	..
85. <i>Physalis minima</i> Linn. ..	F	C	vC	C	..	..
86. <i>Solanum xanthocarpum</i> Schr. et Wendl. ..	IF	IF	..	..	F	vC
87. <i>Bonnaya brachiata</i> Link & Otto. ..	vC	vC	vC	vF	F	..
88. <i>B. veronicaefolia</i> Spreng. ..	vC	vC	A	vC	vF	F
89. <i>Linnophila gratioloides</i> R.Br. ..	IC	IA	IA	ID	IA	..
90. <i>Mazus rugosus</i> Lour. ..	..	..	F	vC	A	C
91. <i>Moniera cuneifolia</i> Mich.* ..	..	..	..	*	..	..
92. <i>Scoparia dulcis</i> Linn. ..	F	F	F	F	F	F
93. <i>Utricularia flexuosa</i> Vahl. ..	..	..	..	IF	IF	vC
94. <i>U. stellaris</i> Linn. ..	..	..	*	..	..	..
95. <i>Martynia diandra</i> Glox.* ..	..	..	vF	C	F	..
96. <i>Sesamum indicum</i> Linn. ..	..	F	..	..	F	..
97. <i>Adhatoda vasica</i> Nees. ..	R	..	..	..	F	C
98. <i>Aechmanthera tomentosa</i> Nees.* ..	..	*	..	..	..	..
99. <i>Andrographis paniculata</i> Nees. ..	..	R	F	C	vC	F
100. <i>Barleria strigosa</i> Willd. ..	..	..	vF	C	C	..
101. <i>Hygrophila polysperma</i> T.Anders. ..	F	C	vC	C	vC	vC
102. <i>Justicia procumbens</i> Linn. ..	..	C	C	C	..	..
103. <i>Peristrophe bicalyculata</i> Nees. ..	R	F	C	vC	C	F
104. <i>Ruellia patula</i> Jacq. ..	F	F	F	F	..	..
105. <i>Thunbergia grandiflora</i> Roxb. ..	..	F	F	F	..	..

Plant species	July	Aug.	Sept.	Oct.	Nov.	Dec.
106. <i>Lippia nodiflora</i> Rich. . .	C	C	C	F	..	..
107. <i>Verbena officinalis</i> Linn. . .	C	F	F	..	C	F
108. <i>Anisomeles indica</i> O.Kze. . .	..	..	F	C	..	..
109. <i>Leucas cephalotes</i> Spreng. . .	F	vF	C	F	..	..
110. <i>L. lavandulaefolia</i> Rees. . .	R	F	F	F	..	..
111. <i>Leonurus sibiricus</i> Linn. . .	..	..	F	vF	..	..
112. <i>Plectranthus coetsa</i> Buch.-Ham.* . .	..	..	..	..	..	..
113. <i>Leonotis nepetaefolia</i> R.Br. . .	..	..	F	C	C	C
114. <i>Ocimum americanum</i> Linn. . .	..	..	F	F	F	..
115. <i>Boerhavia diffusa</i> Linn. . .	A	D	vA	C	F	..
116. <i>Achyranthes aspera</i> Linn. . .	..	R	F	vF	C	C
117. <i>Alternanthera sessilis</i> (Linn.) DC. . .	C	C	C	C	C	C
118. <i>Amaranthus polygamus</i> Linn. . .	R	R	R	..	..	..
119. <i>A. spinosus</i> Linn. . .	vC	A	D	A	C	..
120. <i>A. viridis</i> Linn. . .	C	C	vC	C	..	..
121. <i>Gomphrena globosa</i> Linn. . .	..	R	R	..	..	..
122. <i>Nothosaerua brachiata</i> Wight. . .	vF	C	C	..	..	..
123. <i>Polygonum hydropiper</i> Linn. . .	vF	vF	F	..	..	..
124. <i>P. glabrum</i> Willd. . .	vF	C	vF	F	..	..
125. <i>Antigonon leptopus</i> Hook et Arn. . .	..	R	F	C	vC	..
126. <i>Peperomia pellucida</i> H.B.K. . .	..	IF	IC	IF	..	..
127. <i>Acalypha indica</i> Linn. . .	F	F	vF	C	C	vF
128. <i>Chrozophora rottleri</i> A.Juss. . .	vF	F	..	..	..	..
129. <i>Croton sparsiflorus</i> Morong. . .	A	A	A	A	C	C
130. <i>Euphorbia hirta</i> Linn. . .	A	A	A	A	vC	F
131. <i>E. thymifolia</i> Linn. . .	A	A	A	vC	vC	..
132. <i>Phyllanthus niruri</i> Linn. . .	C	vC	vC	C	..	..
133. <i>P. simplex</i> Retz. . .	C	vC	vC	..	..	..
134. <i>P. urinaria</i> Linn. . .	..	F	C	C	..	..
135. <i>Cannabis sativa</i> Linn. . .	IF	IF	IF	IF	IF	IF
136. <i>Fleurya interrupta</i> Gaud. . .	IF	IC	IC	IF	..	..
137. <i>Pouzolzia indica</i> Gaud. . .	IF	IC	IC	IF	..	..
138. <i>Vanda roxburghii</i> R.Br. . .	F	C	C	F	..	..
139. <i>Globba</i> sp. . .	IC	IC	IF	..	..	..
140. <i>Discorea sativa</i> Linn. . .	..	F	F	F	..	..
141. <i>Monochoria vaginalis</i> Persl. . .	F	F	F	F	..	..
142. <i>Murdannia nudiflorum</i> Linn. . .	..	C	vC	F	..	..
143. <i>Commelina benghalensis</i> Linn. . .	F	vF	vF	F	..	..
144. <i>C. nudiflora</i> Linn. . .	vC	A	A	vC	C	..
145. <i>Cyanotis axillaris</i> Schult. . .	R	R	R	..	..	..
146. <i>C. cristata</i> Schult. . .	..	IF	IC	IF	..	..
147. <i>Aponogeton monostachyon</i> Linn.f. . .	IF	IC	IF	IR	..	..

REFERENCES

- Arber, A. (1920): Water Plants. Cambridge.
- Bakshi, T. S. (1954): The Vegetation of Pilani & its neighbourhood. *J. Bombay nat. Hist. Soc.* 52: 484-514.
- Bamber, C. J. (1915): Plants of the Punjab. Simla.
- Bhargava, K. S. & Gupta, R. K. (1958): Seasonal Material for a Flora of Nainital. *Agra Univ. Jour. Res. (Sc.)* 7: 1-48.
- Collet, H. (1921): Flora Simlensis. Calcutta & Simla.
- Dudgeon, W. (1920): A contribution to the ecology of Upper Gangetic Plain. *Jour. Indian bot. Soc.* 1: 296-324.
- Duthie, J.F. (1905-15): Flora of Upper Gangetic Plain. Calcutta.
- Fasset, J. F. (1940): A Manual of Aquatic Plants. New York & London.
- Gupta, R. K. (1956): Botanical Exploration in the Bhillangana Valley of the erstwhile Tenri Garhwal State. *J. Bombay nat. Hist. Soc.* 53: 581-594.
- Hewetson, C. E. (1952): Systematics and Ecology of Indian Plants or What can we demand of a Modern Flora? *J. Bombay nat. Hist. Soc.* 56: 140-144.

- Hooker, J. D. (1872-97): Flora of British India. Vol. 1-7. London.
- Jain, S. K. (1956): On a Botanical Trip to Nainital. *Indian For.* 82: 22-38.
- Kanjilal, P. C. (1933): A Forest Flora for Pilibhit, Oudh, Gorakhpur, and Bundelkhand. Allahabad.
- Kenoyer, B. L. A. (1924): Weed Manual of Gwalior State & adjacent Parts of India. Calcutta.
- Misra, R. (1944): The Vegetation of Rajghat Ravines. *Jour. Ind. bot. Soc.* 23: 113-121.
- (1946): An ecological study of the vegetation of the Benares Hindu University grounds. *Ibid.* 25: 39-59.
- (1946a): A study in the ecology of low-lying lands. *Indian Ecol.* 1: 27-46.
- Mitra, J. N. (1958): Flowering plants of Eastern India. Vol. 1 Monocot. Calcutta.
- Mukherji, S. K. (1953): Vegetation of Delhi 'Ridge'. *J. Bombay nat. Hist. Soc.* 51: 439-465.
- Pattanaik, H. (1956): Some useful weeds in and around Cuttack. *Ibid.* 54: 140-152.
- Raizada, M. B. (1931): Contribution to Duthie's Flora from the neighbourhood of Dehradun. *Jour. Indian bot. Soc.* 10: (2).
- (1935): Recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain. *Ibid.* 14: 339-348 and (1936) 15: 149-167.
- (1939): New or noteworthy plants from Upper Gangetic Plain. *Indian Forest Records* 1 (5): 223-235 and *Indian Forester* 76 (1950): 489-497.
- Santapau, H. (1947): Notes on the Convolvulaceae of Bombay. *J. Bombay nat. Hist. Soc.* 47: 337-355.
- (1954): The genus *Murdannia* in Bombay State. *Ibid.* 52: 658.
- (1956): The Botanical Exploration of India. *Jour. Indian bot. Soc.* 35: 1-6.
- (1957): *Eclipta prostrata* E. *erecta*, or *E. alba*: Which is the correct name? *J. Bombay nat. Hist. Soc.* 54: 173-174.
- (1957): The Flora of Purandhar. New Delhi.
- Sen, D. N. (1959): Ecological Studies on Aquatic and Swampy Vegetation of Gorakhpur. *Agra Univ. Jour. Res. (Sc.)* 8: 1-14.
- Singh, K. P. (1950): The Human and Economic Geography of the Gorakhpur district. (Unpublished M.A. thesis of B.H.U.).
- Srivastava, G. D. (1949): Flora of Allahabad. *University Studies Supplement. Botany Section.* 1: 1-20.
- & Tandon, R. K. (1951): A study in the Autecology of *Trapa bispinosa* Roxb. *Proc. Nat. Acad. of Sc.* 21: B: 57-66.
- Srivastava, J. G. (1955): A note on the Flora of Mirzapur (U.P.) *J. Bombay nat. Hist. Soc.* 53: 152-153.
- Tadulingam, C. & Venkatanarayana, G. (1955): A Handbook of some South Indian Weeds. Madras.
- Thakur, C. (1954): Weeds In Indian Agriculture, Patna.
- Weaver, J. E. & Clement, F. E. (1938): Plant Ecology, New York.
- Willis, J. C. (1951): A dictionary of the Flowering Plants and Ferns. Cambridge.

On some new Species of Spiders (Arachnida) of the Family Thomisidae from India

BY

B. K. TIKADER

(With seven text-figures)

INTRODUCTION

Spiders of the family Thomisidae have received scant attention in India. THE FAUNA OF BRITISH INDIA, ARACHNIDA (1900) contains no reference to this family. Only Stoliczka (1869) and Dyal (1935) described a few new species in the genus *Thomisus*.

While examining the material of spiders preserved in the Zoological Survey of India, I came across several new species of Thomisid spiders, some of which are described elsewhere. The present paper contains descriptions of seven new species. The type specimens are deposited in the Zoological Survey of India, Calcutta.

Xysticus minutus sp. nov. (Fig. 1)

General: Cephalothorax light brown; eyes black, clypeus white, legs greenish, abdomen light brown. Total length 2.20 mm.; carapace 1.00 mm. long, 1.00 mm. wide; abdomen 1.30 mm. long, 1.20 mm. wide.

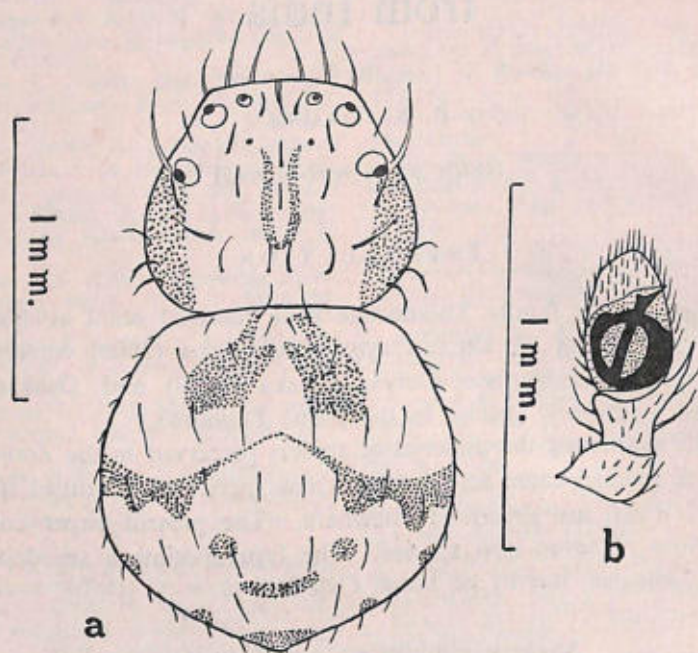
Cephalothorax as long as wide, spined, the sides with broad longitudinal dark brown patches, a pair of long paler brown irregular lines from the base of posterior median eyes, extending to the middle of the thorax. Clypeus medium, margin with seven strong spines, directed forward but the median directed upward. Eyes round, ringed with dirty-white tubercles; ocular quad slightly wider than long, space of the anterior median eyes a little wider than that of posterior; lateral eyes larger; posterior median eyes smaller than anterior medians. Legs spined, with brown transverse bands, tibiae I and II with two pairs of ventral spines. The apex of tibiae I and II with broad dark brown patches.

Abdomen oval, dorsum spined, slightly overlapping the posterior region of cephalothorax, dorsal surface with dentated bands beautifully coloured with admixture of white, dark brown, and red.

Holotype: One female in spirit.

Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 1-4-1958.

This species is closely related to *Xysticus ferox* (Hentz) but differs as follows: (i) sides of cephalothorax with longitudinal dark brown



Text-fig. 1. *Xysticus minutus* sp. nov.

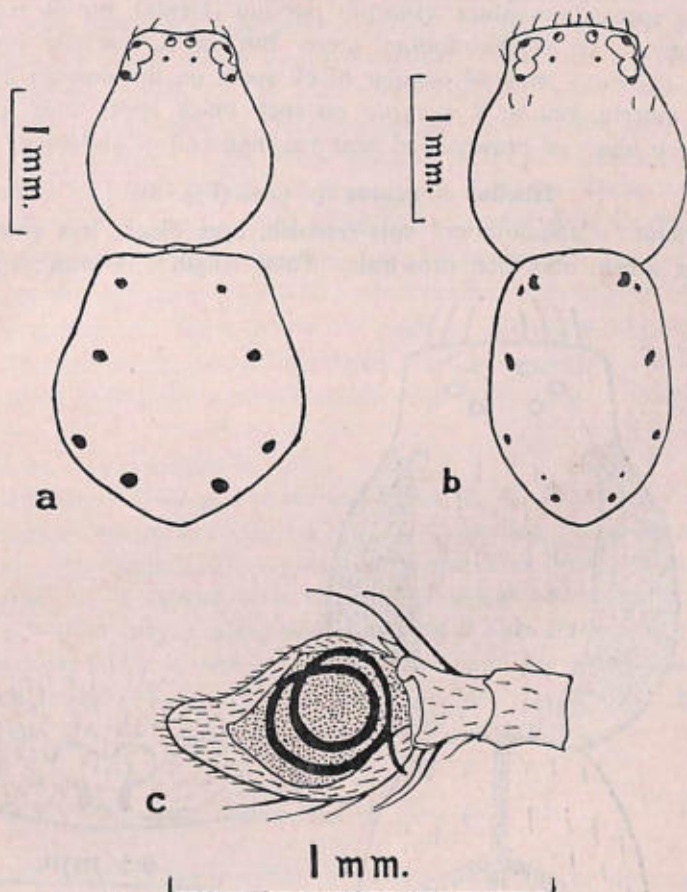
(a) Dorsal view of whole body; (b) male pedipalp.

broad patches and a pair of long pale brown irregular lines from the base of anterior median eyes to the middle of thorax, but in *X. ferox* the cephalothorax is yellowish in the middle and reddish-brown on the sides; (ii) Abdomen light brown, with dentated bands beautifully coloured with admixture of white, dark brown, and red, but in *X. ferox* abdomen brownish-grey above and smoky-white on the sides and three pairs of transverse black bars on the dorsal side of the abdomen.

Synaema decorata sp. nov. (Fig. 2)

General: Cephalothorax green, ocular tubercles chalk-white, eyes black; legs and abdomen green. Total length 3.40 mm.; carapace 1.40 mm. long, 1.40 mm. wide; abdomen 2.00 mm. long, 1.80 mm. wide.

Cephalothorax as long as wide, eyes four pairs, lateral eyes larger, posterior median eyes smaller than the anterior medians, except the

Text-fig. 2. *Synaema decorata* sp. nov.

(a) Dorsal view of whole body of female; (b) Dorsal view of whole body of male; (c) Male pedipalp.

posterior median eyes all ringed with chalk-white ocular tubercles, lateral tubercles contiguous; ocular quad slightly wider than long, space of anterior median eyes a little smaller than that of the posterior median. Clypeus narrow, margin of clypeus bearing slender spines. Legs I and II pairs longer than III and IV; tibia of I leg with four pairs of ventral spines, bases of spines black, the first pair of spines shortest.

Abdomen more or less elliptical, dorsoventrally flattened. Very slightly overlapping the cephalothorax, four pairs of circular black spots on the dorsum near the lateral margin, the posterior pair largest.

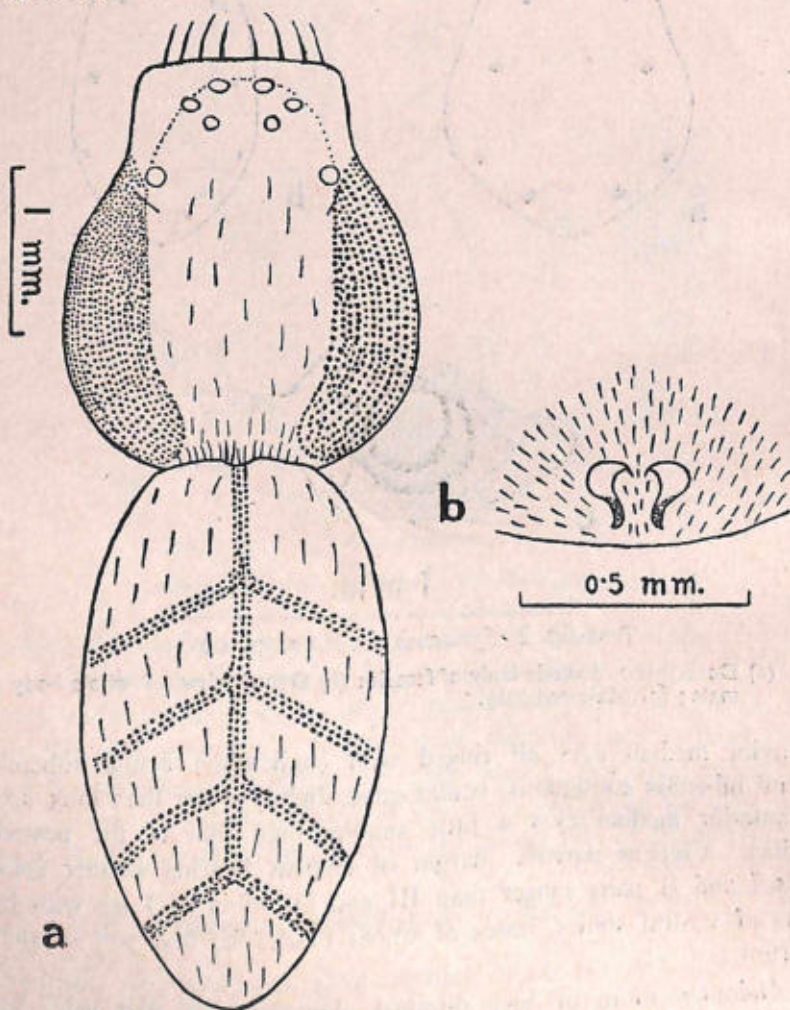
Holotype: One female in spirit.

Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 1-4-1958

This species resembles *Synaema parvula* (Hentz), but is separated as follows: (i) Cephalothorax green but in *S. parvula* brownish yellow; (ii) Four pairs of circular black spots on the dorsum near the lateral margin, but in *S. parvula* no such black spots, only a broad transverse black or brown band near the hind end of abdomen.

***Tibellus elongatus* sp. nov. (Fig. 3)**

General: Cephalothorax pale-greenish, eyes black, legs pale-green, Clypeus green, abdomen brownish. Total length 8.90 mm.; carapace



Text-fig. 3. *Tibellus elongatus* sp. nov.

(a) Dorsal view of whole body; (b) Epigynum.

4.00 mm. long, 3.50 mm. wide; abdomen 5.00 mm. long, 2.80 mm. wide.

Cephalothorax longer than wide, sparsely spined, sides about $\frac{1}{4}$ portion with dark brown pigmented patches; clypeus medium, margin of clypeus with eight spines directed forward. Anterior row of eyes closer, recurved, anterior four eyes and posterior two median eyes form a wide hexagonal area, posterior lateral eyes remote from other eyes and the largest. Legs long, spined, bearing numerous black pigmented dots, I and II pairs of legs longer than the others, tibiae I and II with three pairs of ventral spines in the apical three-fourths.

Abdomen long, cylindrical, spined, narrower behind, very slightly overlapping the posterior region of cephalothorax, with a long median black pigmented line from nearly the base of abdomen to tip, four pairs of transverse pigmented lines from the median line to the lateral margin, these four pairs almost parallel with each other. Epigyne as in Fig. 3.

Holotype: One female in spirit.

Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 1-6-1958.

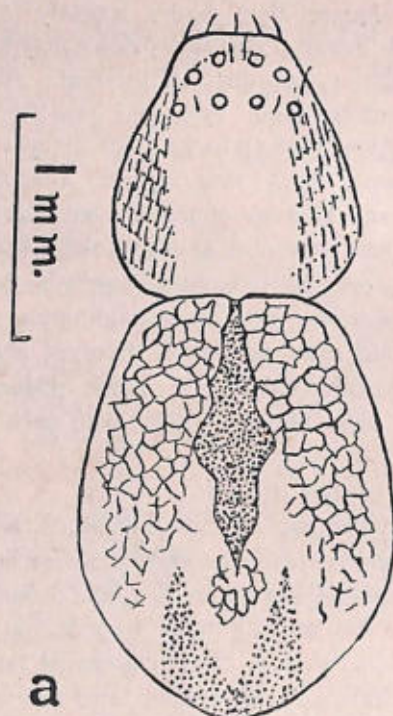
This species resembles *Tibellus duttoni* Keyserling, but is separated as follows: (i) Cephalothorax with two lateral dark brown pigmented patches, but in *T. duttoni* with three longitudinal brown stripes; (ii) Abdomen with a long median black pigmented line from base to tip and four pairs of transverse pigmented lines from the median line to the lateral margin, but in *T. duttoni* with three longitudinal brown stripes from base to tip of the abdomen.

***Thanatus dhakuricus* sp. nov. (Fig. 4)**

General: Cephalothorax pale greenish, eyes black, legs green, clypeus concolorous with cephalothorax, abdomen green, with white patches. Total length 3.20 mm.; carapace 1.20 mm. long, 1.10 mm. wide; abdomen 2.00 mm. long, 1.50 mm. wide.

Cephalothorax broadest behind, narrowing in front, maximum width slightly less than length, covered with small hairs, the sides about $\frac{1}{4}$ portion tinted with very light yellowish and ornamented by irregular dark pigmented patches, this area clothed with many small spines. Eyes black, equal, eight in two rows both recurved but the posterior row longer; both the rows form together a crescent-shaped area. Clypeus long, margin of clypeus with four spines directed forward. Legs relatively short and stout, spined and with dark brown pigmented dots.

Abdomen oval, clothed with pubescence; with white, irregular shaped, granular patches; longitudinal brown lance-shaped band anteriorly in the mid-dorsal, two longitudinal deep brown bands on either side of the posterior end.



Text-fig. 4. *Thanatus dhakuricus* sp. nov.

(a) Dorsal view of whole body.

Holotype: One female in spirit.

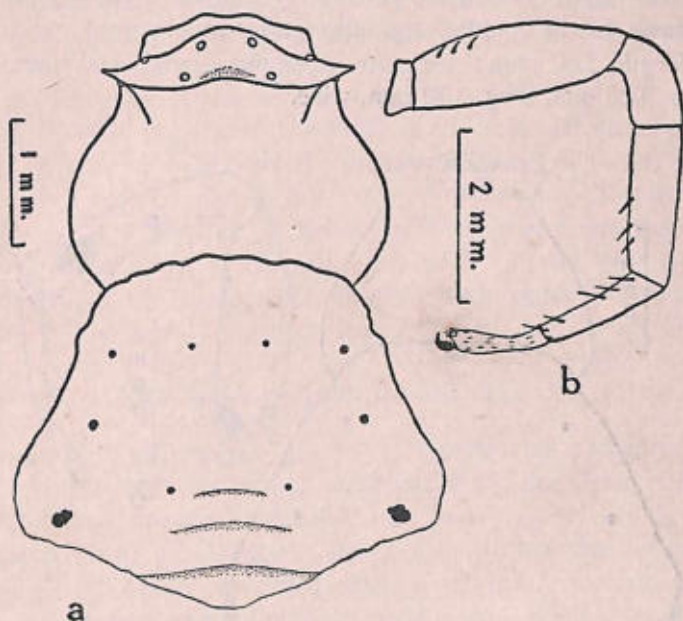
Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 1-5-1958.

This species resembles *Thanatus lycosoides* Emerton, but is separated as follows: (i) Cephalothorax pale greenish, but in *T. lycosoides* cephalothorax reddish-yellow with median longitudinal, brown band; (ii) Two longitudinal deep brown bands on either side of the posterior end of abdomen, but in *T. lycosoides* with an undulating brown band on each side of the hind part of abdomen; (iii) Eyes more or less equal in size, but in *T. lycosoides* the anterior median eyes much smaller than the anterior lateral eyes.

***Thomisus bulani* sp. nov. (Fig. 5)**

General: Cephalothorax greenish, ocular area whitish triangular, with a transverse yellow patch between the posterior median eyes; eyes black, clypeus green, legs also greenish, abdomen white. Total length 5.00 mm.; carapace 2.50 mm. long, 2.30 mm. wide; abdomen 3.40 mm. long, 3.60 mm. wide.

Cephalothorax high, as long as wide. Anterior median and anterior lateral eyes more or less equal. Clypeus moderate, sub-rectangular. Legs long and stout, I and II legs longer than others. Metatarsi of



Text-Fig. 5. *Thomisus bulani* sp. nov.

(a) Dorsal view of body; (b) 1st leg.

I and II legs with five pairs of ventral spines, posterior legs without spines; I pair of legs with three spines on each femur in front but not arising from black pigmented spots.

Abdomen pentagonal, overlapping the posterior region of cephalothorax in front, broadest just behind the middle, with three pairs of reddish-brown spots on dorsal surface near the lateral border; the spots arranged in longitudinal rows, the posterior pair of spots the largest; four very minute reddish-brown spots present on the middle and some times only two spots; posterior end with conspicuous transverse muscular corrugations.

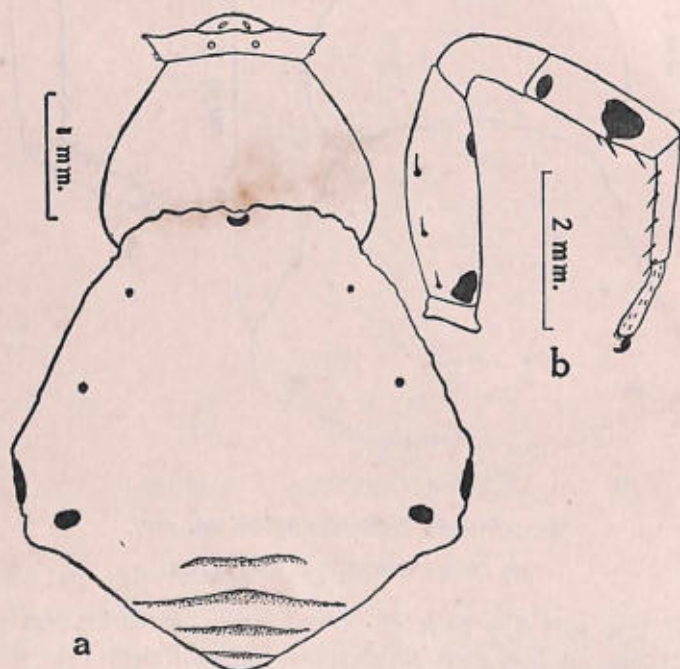
Holotype: One female in spirit.

Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 14-3-1958.

This species resembles *T. pugilis* Stoliczka but is separated as follows: (i) Black spots on the dorsal side of abdomen, no such spots in *T. pugilis*; (ii) Clypeus green, but in *T. pugilis* clypeus whitish like ocular area; (iii) Three spines on the femur of 1st legs, but no such spines in *T. pugilis*.

Thomisus dhakuriensis sp. nov. (Fig. 6)

General: Cephalothorax brownish-green; ocular area yellowish-brown, with small chalk-white patches; eyes black; clypeus green, with dark brown in the middle; legs also greenish; abdomen chalk-white. Total length 5.50 mm.; carapace 2.50 mm. long, 3.00 mm. wide; abdomen 4.00 mm. long, 3.70 mm. wide.

Text-fig. 6. *Thomisus dhakuriensis* sp. nov.

(a) Dorsal view of whole body ; (b) 1st leg.

Cephalothorax broadest posteriorly slightly narrowing in front, maximum width slightly more than length. Eyes four pairs. Anterior median eyes somewhat smaller than the anterior laterals; clypeus long, subrectangular. Legs long and stout, I and II legs longer than III and IV legs; I leg with conspicuous black spots basally below on femur, a narrow black spot subapically on tibia in front; with three spines from black pigmented spots on each femur in front; II leg with a black spot basally below on femur and a narrow black spot basally in front on tibia, metatarsi of I and II legs with five pairs of ventral spines, III and IV pairs of legs unspotted and without spines.

Abdomen pentagonal, overlapping the posterior region of cephalothorax in front, broadest just behind the middle, with four elliptical

black spots laterally, two on each side, one near the broadest region and the other near the anterior region. Three pairs of very dark brown spots sublaterally on dorsal surface, black spots arranged in longitudinal rows; posterior pair the largest; a single minute crescent-shaped black spot medially at anterior margin, posterior end with conspicuous transverse muscular corrugations.

Holotype: One female in spirit.

Type-locality: Dhakuria (Calcutta). Coll. B. K. Tikader, 30-3-1958.

This species is very near *T. pugilis* Stoliczka, with the type of which it has been compared, but differs as below: (i) Cephalothorax smaller than in *T. pugilis*; (ii) Femora and tibiae of I and II legs with conspicuous black spots; no such spots in *T. pugilis*; (iii) Abdomen longer, dorsal and lateral sides bearing black spots; no such black spots in *T. pugilis*.

***Thomisus projectus* sp. nov. (Fig. 7)**

General: Cephalothorax greenish; clypeus and abdomen chalky white. Total length 6.80 mm.; carapace 3.80 mm. long, 3.40 mm. wide; abdomen 4.00 mm. long, 4.10 mm. wide.

Cephalothorax pentagonal in shape, with a transverse yellow band on the ocular area; narrowing slightly in front, maximum width slightly less than length. Anterior median eyes slightly smaller than anterior laterals. Clypeus long, subrectangular. Legs long and stout, I and II longer than III and IV. I legs with a conspicuous incomplete transverse black mark anteriorly above on femur, a narrow black spot in front on patella, a small spot on the base, a large black spot subapically on tibia in front and a faint brown patch on the tip of metatarsus; I pair of legs with three spines above on femur; II legs with a small black spot on patella and a black spot subapically on tibia in front; metatarsi I and II with six pairs of ventral spines; III and IV pairs spotless and spineless.

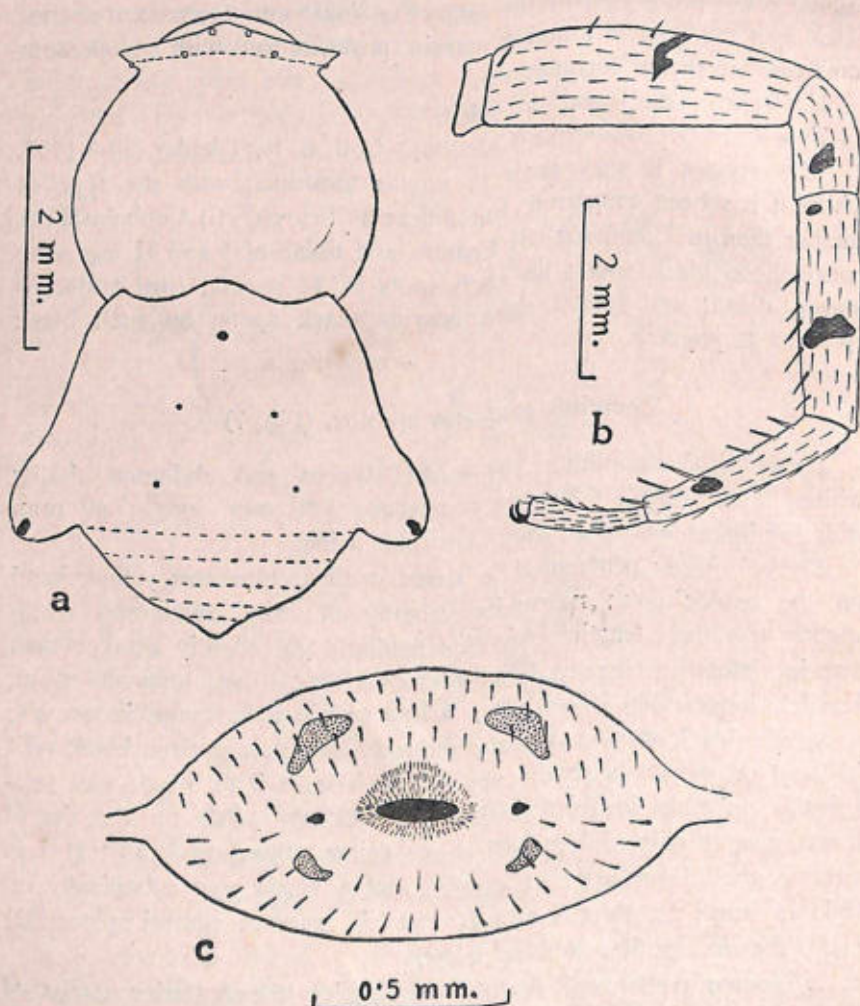
Abdomen pentagonal slightly overlapping the posterior region of cephalothorax in front, broadest at the middle, this portion tuberculating laterally and a black spot on the top of tubercle, a yellow spot just inner side of black spot; posterior half of abdomen with prominent transverse muscular corrugation. Epigyne as in Fig. 7.

Holotype: One female in spirit.

Type-locality: Habra c. 48 kilometres north-east of Calcutta. Coll. B. K. Tikader, 7-9-1958.

This species is near to *T. pugilis* Stoliczka, with the type of which it has been compared, but differs as follows: (i) I legs with conspicuous black spots, no such spots in *T. pugilis*; (ii) Abdomen

broadest at the middle, this portion tuberculating laterally and a black spot on the top and a yellow spot just inner side of black spot, but in



Text-fig. 7. *Thomisus projectus* sp. nov.

(a) Dorsal view of whole body ; (b) 1st leg ; (c) Epigynum.

T. pugilis abdomen broadest at behind the middle and no such spots and tubercle.

SUMMARY

Seven new species of spiders are described in this paper. All were collected from West Bengal, six of them from a suburb of Calcutta.

The new species belong to five genera distributed in the family Thomisidae.

ACKNOWLEDGEMENTS

I am thankful to Dr. M. L. Roonwal, Director, Zoological Survey of India, for facilities for this work and to Dr. M. S. Mani, Deputy Director, for guidance, and for going through the manuscript and offering valuable suggestions.

REFERENCES

- Comstock, J. H. (1940): The Spider Book. New York. pp. 534-563.
Dyal, Sukh, (1935): Spiders of Lahore. *Bull. Dept. Zool. Punjab Uni., Lahore* 1: 119-252.
Locket, G. H. & Millidge, A. F. (1951): British Spiders. Ray Society, London. 1: 168-205.
Petrunkovitich, A. (1911): Index Catalogue of American Spiders. *Bull. Amer. Mus. Nat. Hist., New York*. 29: 1-790.
Pocock, R. I. (1900): The Fauna of British India, Arachnida, London, pp. 153-279.
Simon, E. (1864): Histoire naturelle des araignes, Paris. 1: 949-1066.
Stoliczka, (1869): *J. Asiatic Soc. Bengal* 38: 201-299.
Thorell, T. (1895): Spiders of Burma, London, pp. 1-404.

The Vegetation of Kanyakumari District (Cape Comorin)

BY

C. A. LAWRENCE

Botany Department, Government College, Trivandrum

(With a map)

SYNOPSIS

A floristic survey of Kanyakumari district has been made to discover the ecological status of the plant communities and their succession. The present paper shows that the interaction of various factors, mainly the climatic ones, have made Kanyakumari to acquire, on the north and northwest, the same type of succession and vegetation as are typical of the west coast and, on the south, the characteristic xerophilous vegetation of the eastern districts of Madras State especially Tirunelveli. The preponderance of a rich hydrophyte flora on the Nanjinad plain, which is fundamentally an arid zone, is probably due to the biotic factor.

INTRODUCTION

The vegetation of Kanyakumari district, which was a part of the erstwhile Travancore-Cochin State, is described in Rama Rao's *FLOWERING PLANTS OF TRAVANCORE* (1914) and in *TRAVANCORE STATE MANUAL* (1940). But these descriptions are very meagre and do not tell us about the ecology of the constituents. Therefore a floristic survey of Kanyakumari district from an ecological standpoint was made by the author in the period 1954-59.

SITUATION AND TOPOGRAPHY

Kanyakumari district, situated between latitude $8^{\circ} 2'$ and $8^{\circ} 8' N.$ and longitude $70^{\circ} 1'$ and $70^{\circ} 7' E.$, has a total area of 1365 square kilometres. It forms the southernmost district of Madras State and the southern termination of the Indian peninsula. This district comprises four taluks, Thovala, Agasteeswaram, Kalkulam, and Vilavam-

code. On the north the Western Ghats form a natural boundary and the mountain passes at Aramboly and Yedamally facilitate communication with the rest of Madras State. On the northwest it is bounded by Kerala. Three sides of this district are washed by the sea—Gulf of Mannar on the southeast, the Indian Ocean on the south, and the Arabian Sea on the west.



Kanyakumari District

Topographically Kanyakumari district may be roughly divided into three natural regions:

(1) *The Coastal Region:* Kanyakumari has 68 kilometres of sea-coast. The soil is alluvial and very fertile. Many of the important townships and the Colachel port are located on this strip. There is

no bay or gulf on the western shore. The coast is rocky at Cape Comorin and Muttum. A chain of rocks locally known as Crocodile Rock projects a few furlongs into the sea at Muttum point. A lighthouse has been constructed here to give warning signals to passing ships. There is a sea cliff at Colachel. The havoc done by sea erosion is visible at several places along the coast. According to local Tamil legend, there was land beyond Cape Comorin with a hill named Kumaricode and a river known as Paruliyar. It is believed to have been swallowed by the sea thousands of years ago.

(2) *The Midland Region:* This is full of hills and dales that stretch slantingly from east to west, approximately 60 metres above sea-level. The soil of this area is gravel mixed with pebbles. The Trivandrum-Cape road runs along this strip touching Kuzhithurai, Thuckalay, and Nagercoil. The presence of a large number of perennial and ephemeral tanks and irrigation canals promotes a rich hydrophyte vegetation.

(3) *The Mountainous Region:* The Mahendragiri hill ranges extending as a continuation of the Western Ghats with two peaks, Asambu hill (1524 metres) and Mahendragiri peak (1707 metres), terminate on the south at Marundualmalai near Cape Comorin. In many places branches of the hill ranges thrust forward into the Midland Region east to west, enclosing fertile valleys. The rain-bearing monsoon winds cannot give maximum rainfall because of the low height of the Western Ghats towards the south. The sides of the hills are rugged and precipitous.

The Palayar, the southernmost river of the Indian peninsula, takes its source from Mahendragiri. While flowing through the Nanjinad plain the waters are diverted for irrigation all along its course of 37 kilometres until it falls into the Arabian Sea through Manarkudi lake, the only backwater in this district. Besides this river there are two others, the Valliyar and the Tamravarani. The Valliyar starts from the Velimalai hills and joins the Arabian Sea at Kadiapatnam estuary. It is practically dry in summer, but flooded during the monsoon season. Of all rivers only Tamravarani is wide and deep enough to be navigable for about 27 kilometres. The waters of this river have been stored by constructing two dams one at Pechippara and another at Perinjani and are diverted into irrigation canals, to be distributed among the paddy fields of Nanjinad. The Tamravarani empties itself into the Arabian Sea at Tengapattanam where it forms a small delta.

CLIMATE

Kanyakumari possesses a monsoon type of climate. The annual rainfall varies at different stations along the west coast, progressively increasing as we go from south to north, and ranges from about 89 cm. at Cape Comorin to 254 cm. at Pechippara. The Southwest Monsoon prevails over this district from June to September and the Northeast Monsoon brings rain in October and November. The total rainfall, though higher than that of Tirunelveli, is much lower than that of Kerala even though the rains last for about six months. The annual mean temperature is about 26° C. The cold season extends from December to February and in the beginning of this season a dry land breeze from Tirunelveli penetrates the Aramboly pass with great velocity and enters this district. The highest temperatures have been recorded in April. The temperature is lowest when the rainfall is maximum, in the month of October.

The wind velocity is high at Cape Comorin and at higher elevations. Even though the velocity is greater during the monsoon, cyclones are rare. A cyclone of mild strength was observed in June 1958. Minimum velocity is recorded in October during the reversal of the wind system. Summer storms occur in April and May accompanied by thunder showers. The hot wet climate favours a luxuriant vegetation.

VEGETATION

For convenience in study the district was taken up zone-wise:

1. The Mahendragiri Hill Ranges: The Mahendragiri hills are wholly forest-clad. The Southwest Monsoon being stronger than the Northeast Monsoon, the western face of the hill ranges gets more rain. This face is very steep and almost inaccessible and the vegetation is very luxuriant. But along the paths and at lower levels, the forests have been cleared. In these much-cut areas there has been lot of erosion and rocks have got exposed. In between these rocks grow trees with low gnarled trunks, smooth white bark, and coriaceous leaves, such as *Cinnamomum zeylanicum* Nees, *Hopea parviflora* Bedd., *Nyctanthes arbor-tristis* Linn., *Lagerstroemia lanceolata* Wall., *Eugenia jambolana* Lam., *Embllica officinalis* Gaertn., and many others. The rest of the hill ranges contain vigorously growing trees, at lower levels deciduous monsoon forest plants mixed with some xerophytes, and at higher levels, above 1000 metres, evergreen rain-forest species mixed with deciduous ones.

In the deciduous forest region, the trees are tall, straight, and close together, and the undergrowth is scanty. Huge lianes extend from tree to tree. Mistletoes and epiphytic orchids and ferns grow on the tree trunks. During the monsoon many bulbous and rhizomatous plants are very common on the forest floor. All along the montane region, up to an elevation of about 900 metres, *Bambusa arundinacea* Willd. and *Ochlandra travancorica* Gamb. are abundant.

The tops of hills and the rugged precipitous slopes are covered with deciduous trees especially *Bombax malabaricum* DC., *Tectona grandis* Linn. f., *Dalbergia latifolia* Roxb., *Schleichera trijuga* Willd., *Pterocarpus marsupium* Roxb., *Terminalia crenulata* Roth., *Hiptage madablota* Gaertn., and *Ficus glomerata* Roxb. The shrubs forming the undergrowth are *Ixora coccinea* L., *Streblus asper* Lour., *Alangium salvifolium* (Linn. f.) Wang., *Strychnos nuxvomica* Linn., *Helicteres isora* Linn., *Hibiscus micranthus* (Linn. f.), *Calycopteris floribunda* Lamk., and *Mussaenda frondosa* L. *Ichnocarpus frutescens* R. Br., *Abrus precatorius* Linn., *Smilax macrophylla* Roxb., *Cissampelos pareira* Linn., *Gloriosa superba* L., *Zizyphus oenoplia* Mill., and *Lantana camara* L. var. *aculeata* L. are the chief climbers and scramblers. The annually cleared areas near the dak bungalows and along the paths are occupied by tall grasses, e.g. *Heteropogon contortus* Roem., *Pennisetum polystachyon* Schltz., *Sehima nervosum* Stapf., and *Cynodon dactylon* Pers. Among these grow *Anisomeles malabarica* (Linn.) O. Kt., *Pseudarthria viscida* W. & A., *Tragia involucrata* Linn., and other erect annual dicots. Several species of crustose, foliose, and fruticose lichens, and mosses occur as epiphytes and lithophytes. *Selaginella rupestris* (L.) Spreng., *Lycopodium* spp., *Adiantum caudatum* Linn., *Cheilanthes mysorensis* Wall., *Actinopteris dichotoma* Forsk., *Lygodium flexuosum* Sw., *Nephrolepis* spp., and many other plants grow under the shade of trees and near the springs, ponds, and streams. A large number of shrubs grow as chasmophytes in the crevices of rocks filled with debris, such as *Pavetta indica* Linn., *Indigofera enneaphylla* Linn., *Holarrhena antidysentrica* (Linn.) Wall., *Triumfetta rhomboidea* Jacq., *Bryophyllum pinnatum* Kurz., and *Sansevieria zeylanica* Willd., mixed with *Cymbopogon flexuosus* (Nees) Wats., and *Phoenix humilis* Royle. The herbs are *Desmodium pulchellum* (Linn.) Benth., *Polygala chinensis* Linn., *Blumea wightiana* DC., *Aerva lanata* (Linn.) Juss., *Waltheria indica* Linn., and some grasses. There are also scramblers such as *Calamus rotang* L., *Combretum decandrum* Roxb., and *Entada scandens* Benth. At higher elevations cashew and rubber plantations have been established in

several places especially at the Balamore, Vaikundam, and Palazhi estates.

Just a small bit of land is kept under cultivation by the hill tribe, Kanikkars.

2. The Rivers and Canals: In the Anandan Canal Thovala Channel and Puthanar Channel and its branches the water is always turbid; as a consequence thereof very few plants can grow. The same is the case with rivers during the monsoon. But in summer there is very little water in Valliyar and Palayar so that pools and puddles are formed here and there. Such spots harbour masses of *Spirogyra*, and *Oscillatoria*. In shallow water, there also grow *Eichornia crassipes* Solms., *Pistia stratioides* Linn., and *Vallisneria spiralis* Linn. Sometimes masses of these are uprooted and are carried to sheltered spots, where the growth continues.

3. The Banks of the rivers Tamravarni, Valliyar, and Palayar: The banks of these rivers are comparatively low and in several places bunds have been constructed to prevent breaches during the monsoon floods. Along the bunds grow several plants such as *Pandanus odoratissimus* Roxb., *Saccharum arundinaceum* Retz., *Melastoma malabathricum* L., and sandbinding sedges such as *Cyperus arenarius* Retz., *Fimbristylis meliacea* Vahl., and *Bulbostylis barbata* Kunth.

During the monsoon these banks are partially submerged, but they are exposed by the middle of November when the flood water starts receding. They remain damp for several months thereafter. Soon after the water has receded, *Justicia procumbens* Linn., *Lippia nodiflora* Mich., *Polygonum plebejum* R. Br., *Eclipta alba* Hassk., *Elephantopus scaber* L., *Commelina benghalensis* L., various sedges, and other amphibious and wet meadow plants begin growing. By early summer these plants are dead and are replaced by dry meadow plants like *Argemone mexicana* L., *Ionidium suffruticosum* Ging., *Asteracantha longifolia* Nees., *Clerodendron inerme* Gaertn., and *Croton sparsiflorus* Morr.

On the silty banks of Tamravarni River, several trees flourish such as *Holigarna arnottiana* Hk. f., *Spondias mangifera* Willd., *Barringtonia racemosa* Roxb., *Sterculia foetida* L., and *Alstonia scholaris* R. Br., and they support many lianes, parasites, and epiphytes.

4. The Low-lying Lands: The annually inundated low lands of Vilavancode and Kalkulam show a rich amphibious vegetation during the rains consisting of various sedges and grasses like *Ageratum conyzoides* L., *Fimbristylis miliacea* Vahl., *Panicum repens* Linn., and

Aneilema nudiflorum R. Br. In summer most of the land is kept fallow when amphibious annuals perish followed by a succession of dry meadow plants, such as *Sphaeranthus indicus* L., *Scoparia dulcis* L., *Euphorbia hirta* Linn., *Phyllanthus niruri* Linn., and *Merremia emarginata* (Burm. f.) Hall. The small ditches along the roads hold water during the rainy season and show *Spirogyra*, *Nostoc*, and other algae, followed by ricefield flora later. Grasses such as *Cynodon dactylon* (Linn.) Pers., *Eragrostis coarctata* Stapf., *Iseilema laxum* Hack., and *Cenchrus setigerus* Vahl. are seen in early summer on the sides of these ditches.

5. The Ruins of the Houses, Dust Heaps, and Building Sites at Kuzhithurai and Thuckalay: The ruins of houses show a luxuriant growth of *Chloris montana* Roxb., *Trianthema portulacastrum* L., *Portulaca oleracea* Linn., *Tridax procumbens* Linn. and *Datura stramonium* Linn. On the dilapidated walls of the *mandapams* constructed long ago for the use of travellers along the Cape Road grow *Lantana camara* Linn., *Ficus benghalensis* Linn., *Stachytarpheta indica* Vahl., *Pilea microphylla* Liebm., and *Barleria prionitis* L., and occasionally *Lochnera rosea* Reichb. and *Jasminum pubescens* Willd.

The dust heaps and garbage dumps show a variety and luxuriance which is unique. Most of the common weeds of the district are found here, particularly *Amaranthus spinosus* Linn., *Cleome viscosa* Linn., *Gynandropsis gynandra* (Linn.) Briq., *Argemone mexicana* Linn., *Achyranthes aspera* Linn., *Anisomeles ovata* R. Br. and *Euphorbia heterophylla* L. Mixed with these weeds occur stray plants of household use such as *Brassica nigra* Koch., *Cucumis sativus* L., *Coriandrum sativum* L., and *Capsicum frutescens* L., that reach there along with sweepage. Ultimately *Croton sparsiflorus* Morr. dominates.

6. The *Purambokku* Fallow Lands along the Roads and Canals: These are dry meadows covered with fodder grasses such as *Vetiveria zizanioides* Nash., *Eleusine aegyptiaca* Desf., *Cenchrus ciliaris* Linn., and *Chloris barbata* Sw. Soon after the rains many other plants appear among these, such as *Ocimum basilicum* L., *Crotalaria prostrata* Roxb., *Desmodium trifolium* DC., *Ruellia tuberosa* L., *Tephrosia purpurea* Pers., *Cassia siamea* Lam., and *Cassia occidentalis* Linn. Soon invasions of *Eupatorium heterophyllum* DC. take place in such localities. In areas which are protected from grazing there grow many perennial grasses such as *Heteropogon contortus* Beauv., *Chrysopogon montanus* Trin., and

Panicum prostratum Lamk., along with many others listed above. Among these grow *Physalis minima* L., *Leucas aspera* Linn., *Acanthospermum hispidum* DC., and other erect annual dicot herbs, giving a characteristic grassland population. A longer period of protection results in the formation of a scrub jungle consisting of species like *Zizyphus jujuba* Lamk., *Morinda tinctoria* Roxb., *Pithecolobium dulce* (Roxb.) Benth., and *Jatropha gossypifolia* Linn. Climbers like *Cardiospermum halicacabum* L., *Melothria maderaspatana* (Linn.) Cogn., *Clitoria terneata* L., and *Pergularia doemia* (Forsk.) Blatt, grow on these trees during the rains and early summer. The hedges of this area are composed of plants such as *Euphorbia antiquorum* Linn., *Euphorbia nivulia* B.-Ham., *Jatropha curcas* Linn., *Erythrina indica* Lam., *Moringa oleifera* Lamk., *Plumeria acutifolia* Poir., *Thevetia nerifolia* Juss., and *Adhatoda vasica* Nees, which are propagated vegetatively during the monsoon season.

7. Nagercoil town, the Mango Orchards, and the Maidans: The building sites in Nagercoil present a different flora. There are many plants of the scrub jungle, such as *Gmelina arborea* Roxb., *Aegle marmelos* Correa, *Feronia elephantum* Correa, *Canthium angustifolium* Roxb., and *Cassia auriculata* Linn., mixed with herbs such as *Sida carpinifolia* L. f., *Polycarpea corymbosa* Lamk., *Zornia diphylla* Pers., *Mimosa pudica* L., *Alysicarpus monilifer* DC., and climbers like *Tylophora asthmatica* W. & A., *Asystasia coromandeliana* Nees, and *Coccinia indica* Wt. & Arn.

Due to severe soil erosion deep gulleys have been formed in many parts of the town. Vegetation here is very sparse with only a few drought resistant succulents such as *Cissus quadrangularis* Linn. and *Opuntia dillenii* Haw., dotted here and there. But during the monsoon, these are filled with water and then appear plants such as *Borreria hispida* (Linn.) Schum., *Aerva tomentosa* Forsk., *Digera alternifolia* Aschers., and *Mollugo cerviana* Ser. On the banks of the gulleys are seen shrubs like *Anona squamosa* Linn., *Bauhinia purpurea* L., *Vitex negundo* Linn., *Calotropis gigantea* Ait., and *Psidium guajava* L.

The orchards show a mixed vegetation generally comprising *Mangifera indica* L., *Anacardium occidentale* L., and *Calophyllum inophyllum* L. intermingled with trees which supply green manure such as *Thespesia populnea* Corr., *Cassia fistula* L., *Azadirachta indica* A. Juss., and *Poinciana elata* L. Sometimes *Tamarindus indica* Linn., *Ficus benghalensis* L., and *Borassus flabellifer* L. grow among them. The weeds growing sheltered under these trees consist chiefly of *Barleria noctiflora* Linn., *Acalypha indica* (Linn.) Bedd., *Tribulus terrestris* Linn., and *Gomphrena decumbens* Jacq.

Aneilema nudiflorum R. Br. In summer most of the land is kept fallow when amphibious annuals perish followed by a succession of dry meadow plants, such as *Sphaeranthus indicus* L., *Scoparia dulcis* L., *Euphorbia hirta* Linn., *Phyllanthus niruri* Linn., and *Merremia emarginata* (Burm. f.) Hall. The small ditches along the roads hold water during the rainy season and show *Spirogyra*, *Nostoc*, and other algae, followed by ricefield flora later. Grasses such as *Cynodon dactylon* (Linn.) Pers., *Eragrostis coarctata* Stapf., *Iseilema laxum* Hack., and *Cenchrus setigerus* Vahl. are seen in early summer on the sides of these ditches.

5. The Ruins of the Houses, Dust Heaps, and Building Sites at Kuzhithurai and Thuckalay: The ruins of houses show a luxuriant growth of *Chloris montana* Roxb., *Trianthema portulacastrum* L., *Portulaca oleracea* Linn., *Tridax procumbens* Linn. and *Datura stramonium* Linn. On the dilapidated walls of the *mandapams* constructed long ago for the use of travellers along the Cape Road grow *Lantana camara* Linn., *Ficus benghalensis* Linn., *Stachytarpheta indica* Vahl., *Pilea microphylla* Liebm., and *Barleria prionitis* L., and occasionally *Lochnera rosea* Reichb. and *Jasminum pubescens* Willd.

The dust heaps and garbage dumps show a variety and luxuriance which is unique. Most of the common weeds of the district are found here, particularly *Amaranthus spinosus* Linn., *Cleome viscosa* Linn., *Gynandropsis gynandra* (Linn.) Briq., *Argemone mexicana* Linn., *Achyranthes aspera* Linn., *Anisomeles ovata* R. Br. and *Euphorbia heterophylla* L. Mixed with these weeds occur stray plants of household use such as *Brassica nigra* Koch., *Cucumis sativus* L., *Coriandrum sativum* L., and *Capsicum frutescens* L., that reach there along with sweepage. Ultimately *Croton sparsiflorus* Morr. dominates.

6. The *Purambokku* Fallow Lands along the Roads and Canals: These are dry meadows covered with fodder grasses such as *Vetiveria zizanioides* Nash., *Eleusine aegyptiaca* Desf., *Cenchrus ciliaris* Linn., and *Chloris barbata* Sw. Soon after the rains many other plants appear among these, such as *Ocimum basilicum* L., *Crotalaria prostrata* Roxb., *Desmodium trifolium* DC., *Ruellia tuberosa* L., *Tephrosia purpurea* Pers., *Cassia siamea* Lam., and *Cassia occidentalis* Linn. Soon invasions of *Eupatorium heterophyllum* DC. take place in such localities. In areas which are protected from grazing there grow many perennial grasses such as *Heteropogon contortus* Beauv., *Chrysopogon montanus* Trin., and

Panicum prostratum Lamk., along with many others listed above. Among these grow *Physalis minima* L., *Leucas aspera* Linn., *Acanthospermum hispidum* DC., and other erect annual dicot herbs, giving a characteristic grassland population. A longer period of protection results in the formation of a scrub jungle consisting of species like *Zizyphus jujuba* Lamk., *Morinda tinctoria* Roxb., *Pithecolobium dulce* (Roxb.) Benth., and *Jatropha gossypifolia* Linn. Climbers like *Cardiospermum halicacabum* L., *Melothria maderaspatana* (Linn.) Cogn., *Clitoria terneata* L., and *Pergularia doemia* (Forsk.) Blatt. grow on these trees during the rains and early summer. The hedges of this area are composed of plants such as *Euphorbia antiquorum* Linn., *Euphorbia nivulia* B.-Ham., *Jatropha curcas* Linn., *Erythrina indica* Lam., *Moringa oleifera* Lamk., *Plumeria acutifolia* Poir., *Thevetia neriifolia* Juss., and *Adhatoda vasica* Nees, which are propagated vegetatively during the monsoon season.

7. Nagercoil town, the Mango Orchards, and the Maidans: The building sites in Nagercoil present a different flora. There are many plants of the scrub jungle, such as *Gmelina arborea* Roxb., *Aegle marmelos* Correa, *Feronia elephantum* Correa, *Canthium angustifolium* Roxb., and *Cassia auriculata* Linn., mixed with herbs such as *Sida carpinifolia* L. f., *Polycarpea corymbosa* Lamk., *Zornia diphylla* Pers., *Mimosa pudica* L., *Alysicarpus monilifer* DC., and climbers like *Tylophora asthmatica* W. & A., *Asystasia coromandeliana* Nees, and *Coccinia indica* Wt. & Arn.

Due to severe soil erosion deep gulleys have been formed in many parts of the town. Vegetation here is very sparse with only a few drought resistant succulents such as *Cissus quadrangularis* Linn. and *Opuntia dillenii* Haw., dotted here and there. But during the monsoon, these are filled with water and then appear plants such as *Borreria hispida* (Linn.) Schum., *Aerva tomentosa* Forsk., *Digera alternifolia* Aschers., and *Mollugo cerviana* Ser. On the banks of the gulleys are seen shrubs like *Anona squamosa* Linn., *Bauhinia purpurea* L., *Vitex negundo* Linn., *Caloiropis gigantea* Ait., and *Psidium guajava* L.

The orchards show a mixed vegetation generally comprising *Mangifera indica* L., *Anacardium occidentale* L., and *Calophyllum inophyllum* L. intermingled with trees which supply green manure such as *Thespesia populnea* Corr., *Cassia fistula* L., *Azadirachta indica* A. Juss., and *Poinciana elata* L. Sometimes *Tamarindus indica* Linn., *Ficus benghalensis* L., and *Borassus flabellifer* L. grow among them. The weeds growing sheltered under these trees consist chiefly of *Barleria noctiflora* Linn., *Acalypha indica* (Linn.) Bedd., *Tribulus terrestris* Linn., and *Gomphrena decumbens* Jacq.

The Municipal Maidan, S.L.B. Maidan, and other open grounds in and around Nagercoil seem to be completely denuded and barren, with stray plants of *Aristida adscensionis* Linn., *Boerhavia diffusa* Linn., *Cassia auriculata* Linn., and *Calotropis gigantea* Ait. exhibiting remarkable capacity for drought resistance.

8. Plants on the bunds of Nanjinad Paddy Fields: There are sand-binders such as *Cyperus arenarius* Retz., *Kyllingia cylindrica* Nees., *Panicum crus-galli* L., *Paspalum scrobiculatum* Linn., and others which persist as perennials. But during the irrigated periods and the rains many weeds grow on the bunds, like *Centella asiatica* (Linn.) Urban, *Monochoria vaginalis* Presl., *Marsilea quadrifolia* L., *Biophytum sensitivum* DC., and *Saccharum spontaneum* L., with clumps of *Pandanus odoratissimus* Roxb. here and there. On bigger bunds grow *Cocos nucifera* Linn., *Sesbania grandiflora* Pers., and some annuals such as *Phaseolus trilobatus* Ait., *Heliotropium indicum* L., *Eriocaulon sieboldianum* Seib. & Zucc., and *Ilysanthes serratus* Urb. Most of these annuals perish in summer.

9. Vattakottai, Mudforts, and Cape Comorin: This is a dry zone showing arid vegetation with the isolated Marunduvalmalai hill rising above the plains. Vegetation on this hill represents a typical scrub jungle (Lawrence, 1959). The gigantic hedge of xerophytes stretching from Vattakottai to Anjugramam comprises plants such as *Acacia aribica* Willd., and *Acacia planifrons* W. & A. as co-dominants, associated with *Dodonaea viscosa* L., *Phoenix humilis* Royle., *Casuarina equisetifolia* Linn., *Aloe vera* L., *Agave americana* L., *Alangium salvifolium* Wang., *Flacourtia sepiaria* Roxb., and *Euphorbia antiquorum* Linn., and climbers like *Asparagus racemosus* Willd., *Cocculus hirsutus* (Linn.) Diels., and *Coccinia indica* Wt. & Arn. The scramblers are *Capparis aphylla* Roxb., *Todalia asiatica* Lamk., and *Acacia intsia* Lamk.

Inside the dilapidated mudforts of the late Rama Varma Maharaja flourish many plants like *Parkinsonia aculeata* L., *Carissa congesta* Wight, *Clerodendron infortunatum* Gaertn., *Evolvulus alsinoides* Linn., and *Nerium odorum* Soland.

At Cape Comorin *Acacia arabica* Willd. forms pure consociations on several acres of sandy soil.

10. Reservoirs and Irrigation Tanks: True aquatics such as *Nymphaea stellata* Willd., *Nelumbium speciosum* Willd., *Limnanthemum indicum* (Linn.) Griseb., *Jussiaea repens* L., *Ottelia alismoides* (Linn.) Per., *Neptunia oleracea* Lour., and *Ipomoea*

aquatica Forsk. occur in most of the irrigated tanks. Kallarkulam, Samanjankulam, and Putherikulam tanks show a luxuriant growth of *Trapa bispinosa* Roxb. as dominant, and in reservoirs with rich humus content *Eichhornia crassipes* Solms. abounds, choking the other aquatic vegetation. Free floating forms such as *Hydrilla verticillata* Presl., *Azolla pinnata* R. Br., *Pistia stratiotes* Linn., and *Chara* spp. are very abundant in the huge reservoirs Vetkaikulam, Sundaikulam, and Parakkaikulam, mixed with the other hydrophytes mentioned above.

Halophytes of this area include such plants as *Alternanthera sessilis* (Linn.) R. Br., *Limnophila heterophylla* Benth., *Centella asiatica* (Linn.) Urban, *Aeschynomene aspera* L., *Polygonum glabrum* Willd., and *Cyperus* spp. During the unirrigated periods and in summer these are succeeded by dry meadow plants such as *Asteracantha longifolia* (Linn.) Nees, *Biophytum sensitivum* (Linn.) DC., *Eclipta alba* Hassk., and *Ludwigia parviflora* Roxb.

Insectivorous plants such as *Drosera burmannii* Vahl., *Drosera indica* L., and *Utricularia* spp. are very common on the brink of water in Anandankulam tank near the Nagercoil T.B. Sanatorium, but are submerged during the monsoon, when the water level rises.

11. Plants on the Sea Coast: Between land and sea there is about 150 metres of shore. This strip shows sand dune vegetation. On the windward side of embryonic and adult sand dunes grow *Spinifex squarrosus* L. and *Ipomoea pes-caprae* Roth. as co-dominants. Also dotted on the sea-shore are deep-rooted herbs like *Launea pinnatifida* Cass., *Hydrophyllax maritima* L., *Scaevola koenigii* Vahl, and sand-binding grasses.

The Kanyakumari sea-coast does not afford facilities for the development of mangrove flora.

The rocks on the waterfront at Muttum and Cape Comorin sea-shore harbour various marine algae such as *Sargassum*, *Ulva*, *Enteromorpha*, *Gracillaria*, *Dictyota*, *Corallina*, and *Chorenemorpha*, which are submerged during high tide.

12. Cultivated Lands: About 75 per cent of land in this district is under cultivation. In the *nanjai* fields of Nanjinad, paddy is cultivated twice a year, one crop being harvested in September and the other in February. During summer, vegetables such as *Abelmoschus esculentus* L., *Solanum xanthocarpum* Schrad. & Wendl., *Solanum melongena* L., *Trichosanthes anguina* L., *Momordica charantia* L., *Cucurbita maxima* Duch., and *Cucumis sativus* Linn. are grown in some paddy fields and irrigated by constructing temporary wells close by. Near the rivers and canals, plants such as *Musa paradisiaca* L.,

Piper betel L., *Colocasia antiquorum* Schott, *Amorphophallus campanulatus* Bl., and *Maranta arundinacea* L. are grown. At higher elevations and on hill slopes *Manihot utilissima* Pohl. is cultivated, and in some areas it is replaced by other tuber crops like *Dioscorea alata* L. and *Ipomoea batatas* Lam. Many drought-resistant weeds grow in such localities, e.g. *Blainvillea latifolia* DC., *Sida humilis* Willd., *Abutilon indicum* Sweet, *Oldenlandia paniculata* L., *Mollugo oppositifolia* Linn., and *Curculigo orchioidea* Gaertn., mixed with *Lochnera pusilla* K. Schum., *Aerva lanata* Juss., and *Vernonia cinerea* Less., which spring up suddenly during the rainy season.

Near the villages and in house compounds are present mesophytes such as *Artocarpus integrifolia* L., *Artocarpus incisa* L., *Punica granatum* L., *Terminalia catappa* L., and also *Averrhoa carambola* L., *Citrus medica* L., *Achras sapota* L., *Lawsonia inermis* L., and *Murraya koenigii* Spreng. Coconut and Palmyra palms form a prominent part of the landscape all over the district.

CONCLUSION

The vegetation of Kanyakumari district stands in sharp contrast to the other areas of Madras State. The northern half of the district is characterised by different rock formations, so that the number of species is definitely higher. The herbaceous vegetation is also richer. The abundance of the flora is due to greater precipitation and humidity. On the other hand, the southern part is primarily an arid zone of sandy soil with trees having several xerophytic adaptations. Umbrella top is exhibited by *Acacia arabica* Willd. Reduction of leaf surface in *Casuarina equisetifolia* Forst., *Euphorbia tirucalli* L., and *Capparis aphylla* Roth., and succulent habit of *Aloe vera* L., *Sansevieria zeylanica* Willd., and *Euphorbia antiquorum* Linn. serve as very effective measures for drought resistance. The physical geography of this district presents variations that are vividly reflected on its flora, so that two small ecological areas could be recognised, a region of high rainfall on the north with luxuriant vegetation, and one of low rainfall with scanty vegetation on the south, the tropophytic type and the xerophytic type of vegetation respectively.

ACKNOWLEDGEMENTS

The author is deeply indebted to Dr. T. C. N. Singh, D.Sc., F.B.S., Professor and Head of the Department of Botany, Annamalai University, for his valuable guidance and constant encouragement. He is

grateful to the Systematic Botanist and Professor of Botany, Agricultural College and Research Institute, Coimbatore, for the identification of a number of specimens. The author also wishes to express his thanks to the Principal, Scott Christian College, Nagercoil, for various facilities provided, and to Dr. A. Abraham, M.A., M.Sc., Ph.D., Head of the Department of Botany, University College, Trivandrum, for his keen interest in this work.

REFERENCES

- Beddome, R. H. (1869-74): *The Flora Sylvatica for Southern India*. Madras.
- Biswas, K. & Calder, C. C. (1936): *Handbook of common Water and Marsh Plants of India and Burma*. New Delhi.
- Bourdillon, T. F. (1903): *The Forest Trees of Travancore*. Trivandrum.
- Fyson, P. F. (1932): *The Flora of the South Indian Hill Stations*. Madras.
- Gamble, J. S. & Fischer, C. E. C. (1915-36): *Flora of the Presidency of Madras*. London.
- Lawrence, C. A. (1959): Observations on the Flora of Marunduvalmalai, Cape Comorin. *J. Bombay nat. Hist. Soc.* 56: 95-100.
- Rama Rao, M. (1914): *Flowering Plants of Travancore*. Trivandrum.
- Ramaswami, M. S. (1914): A Botanical Tour to the Tinnevely Hills. *Rec. Bot. Surv. India* 6: 105-171.
- Rangachari, K. (1921): *A Handbook of South Indian grasses*. Madras.
- Santapau, H. (1956): The Botanical Exploration of India. *J. Indian Bot. Soc.* 35: 1-6.
- Srivastava, J. G. (1956): The Vegetation of Patna District, Bihar. *J. Indian Bot. Soc.* 35: 391-401.
- Tadulingam, C. & Venkatanarayana, G. (1932): *A Handbook of some South Indian Weeds*. Madras.
- Velu Pillai, T. K. (1940): *Travancore State Manual*. Government Press, Trivandrum.
- Warming, E. (1925): *Oecology of Plants*. London.
- Weaver, J. E. & Clements, F. E. (1938): *Plant Ecology*. McGraw-Hill, New York.

Some Observations on the Biology of *Labidura riparia* (Pallas) (Labiduridae, Dermaptera) from Poona

BY

P. V. JOSHI

Department of Zoology, Nowrosjee Wadia College, Poona

(With two text-figures)

ABSTRACT

The earwigs were collected under mercury-vapour lamps on a river-side road (Fig. 1). They were reared in wooden cages as well as in

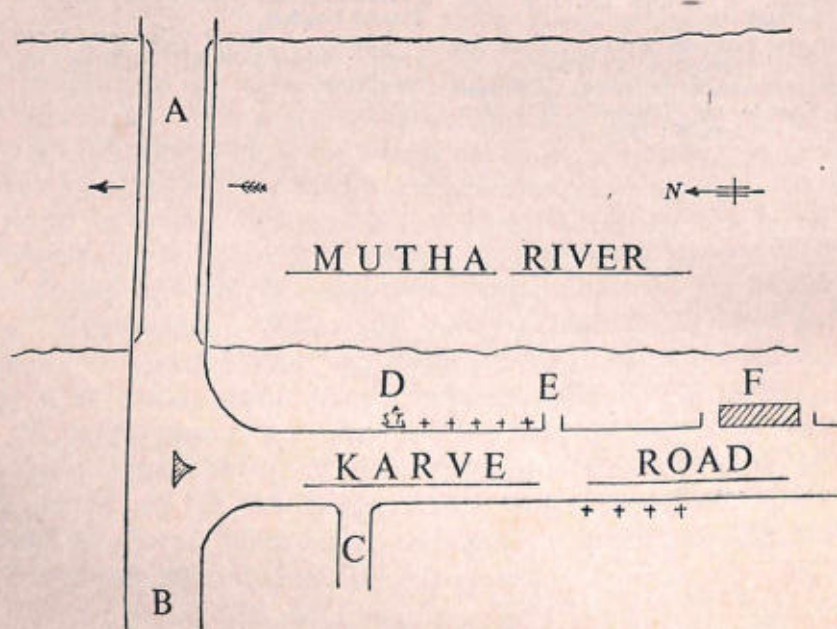


FIG. 1. Place of Collection

A. Sambhaji Bridge; B. Ferguson College Road; C. Prabhat Road; D. State Transport Bus Stop; E. Karve Road Market; F. M. E. S. College;
+. Mercury Vapour Lamp.

glass jars to study their habits in nest building, feeding, mating, oviposition, maternal care, etc.

Various interesting observations are recorded and discussed.

INTRODUCTION

Little work seems to have been done on Dermaptera in India. De Bormans (1888) gave an account of a collection made by Leonardo Fea in Burma. Boliver (1897) described an extensive collection of Orthoptera from Trichinopoly in which several species of earwigs were recorded. Burr (1905, 1906, 1907) described some specimens from the Indian Museum.

Ramamurthy (1955) studied wing venation of *L. riparia* (Pall.) and *Forficula quadrispinosa* (Dohrn). Behura (1950) worked on the life-history of *Forficula auricularia* and wrote a note on the earwig as food of the little owl, *Athene noctua vidalii* Brehm, in Great Britain. Cherian and Basheer (1950) found *Eubrellia stali* (family Forficulidae) to be a pest of stored groundnuts.

An attempt was made to study the biology of earwigs under captivity in Poona. Similar studies have been made by Pesotskaia (1927). Weidner (1940), Schlinger *et al.* (1959) in other countries.

PLACE OF COLLECTION

The collection was made at Poona on a riverside road in a heavily populated area. In the immediate vicinity of the river it is, however, mostly open, and even in the residential areas there is plenty of vegetation, consisting mainly of: (1) *Acacia arabica* Willd., (2) *Ricinus communis* L., (3) *Lantana camara* L., (4) *Musa paradisiaca* L., (5) *Clerodendron siphonanthus* R. Br.

The collection was made under nine mercury-vapour lamps. Each lamp is of 125 watts at a mean distance of 46 metres (150 ft.).

METHOD OF COLLECTION

The earwigs were collected between 6.45 p.m. and 10.45 p.m. They were mostly found resting on the cement bases of the lamps. The specimens were collected by hand picking during November-December 1958 and in June 1959. Large numbers of specimens were obtained when the atmosphere was warm and humid. Earwigs were however scarce after heavy showers and/or when the atmosphere was comparatively cooler.

While collecting the earwigs the following important observations were made:

1. The earwigs were always resting quietly at the base of the lamp pole on its cement support.
2. When disturbed, they tried to run away but never took to wing.
3. It was observed that instead of going towards the light source they remained at the base. The distance between the light source and the base was about 6 metres (20 ft.).
4. In addition to *L. riparia* (Pall.) a few specimens of *L. bengalensis* (Dohrn) were collected.

METHOD OF REARING

Specimens were reared in wooden cages, with wiremesh and having moist soil at the bottom. Some specimens were isolated in glass jars, containing moist soil at the bottom. This was done to observe their nest building habits.

NEST BUILDING

Soon after confinement, the earwigs moved about in captivity and set to work nest building. They worked hour after hour, without caring either for their food or for their mate. The nest was nothing but a gallery, carved in the moist soil. The general shape of the gallery is tubular, (Fig. 2 A & B) but sometimes it varies in its pattern. In a few cases the main galleries have lateral branches (Fig. 2 C). Measurements of excavated galleries (Table I) were taken from actual casts of galleries prepared by pouring freshly prepared paste of plaster of Paris into them.

TABLE I
MEASUREMENTS OF GALLERIES (AVERAGE OF SIX OBSERVATIONS)

Height of soil column.	Length of gallery before bend	Length of gallery after bend	Breadth of gallery	Angle at entrance	Angle at bend
2.6 cm.	2.0 cm.	1.2 cm.	0.7 cm.	37°	131°

The earwigs mainly employed their mouthparts for nest building. While digging the nest, the earwig frequently backed out of the gallery.

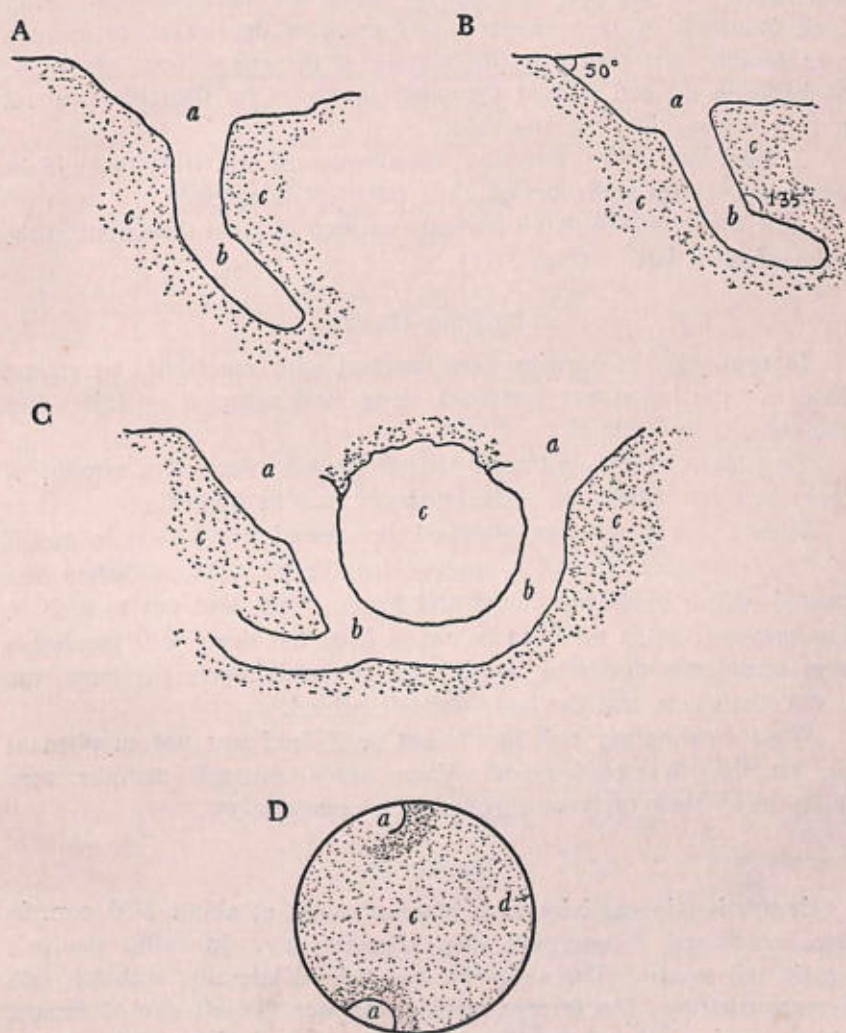


FIG. 2. Nests of Earwig

A, B, C. Longitudinal sections. D. Surface view. *a*. Opening of gallery; *b*. Lodging of earwig; *c*. Soil particles; *d*. Side of glass jar.

pushing the excavated soil particles against the sides of glass jars or to one side of the opening. In some cases it was observed that the earwig pressed the wet soil particles against the side of the glass jar so as to

cover it as completely as possible. Fore-legs were also used during this process.

1. The attempt at nest building was only successful when the soil was moist. In dry soil the earwigs failed to build the nest. After such failures they took shelter under green or dry leaves, or spent a considerable time resting on the surface of the soil without any work. Moisture in the soil seemed absolutely necessary for their life; without it they became inactive and died.

2. Each and every individual, irrespective of sex, tried to build its own nest. They never helped each other in doing so.

3. It was observed that a few earwigs tried to build their nests at the sides of glass jars. (Fig. 2 D.)

FEEDING HABITS

In captivity, the earwigs were supplied with vegetable and animal food but the latter was preferred. The food accepted or rejected is summarised in Table II.

They were strongly attracted to soft bodied insects like nymphs of cockroach, houseflies, and some arachnids such as spiders.

When living insects were supplied the earwigs seized them by means of their strong forceps. On approaching the prey, the abdomen was twisted with a quick movement and forceps were shot out to grab it. The prey was eaten up from below or from the side. Soft specimens were completely devoured but in case of hard insects the terga, the sterna, the wings, and the legs were left behind.

When food supply was insufficient or if food was not supplied at all, cannibalism was frequent. Even newly emerged nymphs were eaten up by their mothers under similar circumstances.

COPULATION

Copulation in captivity took place at night at about 8-30 p.m. in three cases and in one case soon after midday. In coitus the pair remain tail to tail. The abdomen was twisted laterally, with left side turned upwards. The forceps of the male face the left side of female, which remains in her natural position. At the end of coitus the torsion of the abdomen of male was gradually reduced.

The act of copulation lasts about $2\frac{1}{2}$ hours.

OVIPOSITION

The eggs were generally laid in the morning, at the bottom of the gallery. When the nest is destroyed the eggs are laid on the surface of the soil. At times the eggs are laid on the surface, the female briskly

moving from one place to another depositing the eggs in groups at various places. Afterwards, all the eggs are collected at one place into a heap.

TABLE II
FOOD OF EARWIGS

Vegetable Food			Animal Food		
Type of food offered	Accepted food	Rejected food	Type of food offered	Accepted food	Rejected food
Coriander (leaves and stems)	..	Coriander (leaves and stems)	Moths (<i>Euproctis lunata</i>)	Moths (<i>Euproctis lunata</i>)	..
Tomato (fruit) pieces	..	Tomato (fruit) pieces	Small cock-roaches (whole)	Small cock-roaches (whole)	..
Knolkohl (leaves)	..	Knolkohl (leaves)	Earwigs (whole)	Earwigs (whole)	..
Bread	..	Bread	Houseflies (whole)	Houseflies (whole)	..
..	..	..	Spiders (whole)	Spiders (whole)	..
..	..	..	Small grasshoppers (whole)	Small grasshoppers (whole)	..
..	..	..	Field crickets (whole)	Field crickets (whole)	..
..	..	..	Pentatomid bugs (whole)	..	Pentatomid bugs (whole)
..	..	..	Earth-worm pieces	..	Earth-worm pieces
..	..	..	Snail pieces	..	Snail pieces

The number of eggs laid varied; on the average each female laid 47 eggs. The above observations are summarised in Table III.

MATERNAL CARE

Both the eggs and the nymphs are carefully guarded by the mother. At intervals the female takes the eggs in her mouth one after the other and licks them clean. This keeps the eggs clean and shiny.

It was observed that if the eggs are displaced and kept at different places, the female again carries the eggs to one place and forms a heap. When the eggs are not guarded by the female they cling together, shrivel up, and perish. When the eggs were disturbed more than once, they were neglected and in some cases devoured by the female.

TABLE III

NUMBER OF EGGS LAID BY ONE FEMALE COLLECTED ON 23-11-1958

Date of egg laying	Days between two successive egg laying periods	Number of eggs laid	Date of emergence of nymphs	Incubation period of egg
3.12.1958	..	45	..	..
14.12.1958	11	50	22.12.1958	8
1. 1.1959	18	45	11. 1.1959	10
21. 1.1959	20	50	31. 1.1959	10
3. 3.1959	13	1	..	..
26. 3.1959	23	1	..	..

After emergence, the nymphs in the beginning were always with their mother, but after two to three days they begin to wander here and there, within close range of the mother. When they were disturbed they ran to their mother and tried to hide underneath her body. If the female noticed that the danger was beyond her capacity she tried to take shelter in her nest with her young ones.

Another interesting thing about her vigilance was observed. While watching her through glass jars it was noticed that the female was trying to close up a gap through which one could see the eggs that had been laid by her in the gallery. In a short time she filled up the gap with the moist soil.

DISCUSSION

As stated above, Pesotskaia (1927), Weidner (1940), Schlinger *et al.* (1959) have studied the biology of *Labidura riparia* (Pall.). The present observations are in conformity with the observations of the above authors in respect of feeding habits, mating, oviposition, etc., except in certain respects mentioned below:

Pesotskaia (1927) states that the female takes each egg in her mouth parts and covers it completely with liquid from glands, which protects the egg from mould. I did not observe such a secretion. If the eggs are not licked by the female or if they are neglected they shrivel and disintegrate, showing thereby that the attendance of female is necessary.

Attempts were made to determine whether the galleries are made at a fixed angle to the soil as stated by Pesotskaia (1927) and Weidner (1940). It was found that this species of earwig constructs the galleries at an angle to the surface which may vary between 44° to 55° . A similar investigation was made with regard to the angle at the bent. According to Pesotskaia it is between 115° to 130° . Present studies have shown that it is between 125° to 136° or even more.

ACKNOWLEDGEMENTS

Thanks are due to Prof. P. R. Damle, Principal, Nowrosjee Wadia College, and Prof. S. G. Nadkarni, Zoology Department, Nowrosjee Wadia College, for encouragement and facilities, and to Shri D. R. Ranade, Lecturer in Zoology and Entomology, Poona University, for his valuable guidance, and for going through the manuscript.

REFERENCES

- Behura, B. K. (1950): Note on common European earwig *Forficula auricularia* Linn. (Dermaptera) as food of little owl *Athene noctua vidalii* Brehm. *Ann. Mag. Nat. Hist.*, (12), 3, (33): 775-76.
- — — (1950): Life history of European earwig *Forficula auricularia* Linn. *Nature*, London 166 (4410): 74.
- Boliver, I. (1897): Les Orthoptere's de St. Joseph's College 'a Trichinopoly, sud de l' Inde. *Ann. Soc. Ent. Fr.* 66: 282.
- Bormans, A. De (1888): Viaggio di Leonardo Fea in Birmania e regioni vicine, vii Dermaptere's. *Ann. Mus. Civ. Gen.* (2) 6: 431.
- Burr, M. (1905): Earwigs of the Indian Museum with Descriptions of New species. *J. Proc. Asiat. Soc. Bengal* (N. S.) 1 (2): 27.
- — — (1906): A further note on Earwigs (Dermaptera) in the Indian Museum with the Description of New species. *J. Proc. Asiat. Soc. Bengal* (N. S.) 2: 387.
- Burr, M. (1907): A Third note on Earwigs (Dermaptera) in the Indian Museum with the Description of New species. *Rec. Ind. Mus.* 1, 3, no. 15.
- Cherian, M. C. & Basheer, M. (1940): Bionomics of *Eubrellia stali* (Fam. Forficulidae) a pest of ground nuts. *Indian J. Ent.* 2 (2): 155-160.
- Pesotskaia, E. (1927): Biology of Earwig *Forficula tomis* and *Labidura riparia*. *Bull. Inst. Sci. Lesshaft.* 12, 2: 51-62.
- Ramamurthy, B. N. (1955): The wing venation of *Labidura riparia* Pall. and *Forficula quadrispinosa* Dohrn (Dermaptera). *Ind. J. Ent.* 17 (3): 343.
- Schlinger, E. J., Bosch van den, R., Dietric, E. J. (1959): Biological notes on the Predaceous Earwig *Labidura riparia* Pall. a Recent Immigrant to California (Dermaptera: Labiduridae). *J. econ. Ent.* 52 (2): 247-249.
- Weidner, R. (1940): Vorkommen und Lebensweise des Sandonwurms *Labidura riparia* Pall. *Zool. Anz.* 133 (9/10): 185-202.

Leaves and Tendrils as aids for Identification of Cucurbits

BY

PRIYADARSAN SENSARMA

G. C. Bose Biological Research Unit, Bangabasi College, Calcutta.

(With six plates)

INTRODUCTION

Usually plants are identified with the aid of floral characters. Some attempts have been made to identify the cucurbits by the anatomical characters of the stem (Ghosh, 1932) and of the petioles and midribs (Yasuda, 1901, 1903 ; Chakrabarty, 1937). But the present author is not aware of any attempt to identify the cucurbits with the aid of the morphological characters of the leaves and tendrils though they exhibit some interesting features with conspicuous differences ; this attempt has been made from that point of view.

MATERIALS AND METHODS

Materials of the following twenty-four species were collected from different parts of Bengal and herbarium sheets were prepared in the usual way :

SPECIES	VERNACULAR NAME	HABITAT
1. <i>Benincasa hispida</i> Cogn.	Chalkumra	Cultivated & wild
2. <i>Bryonopsis laciniosa</i> Naud.	Mala	Wild
3. <i>Citrullus colocynthis</i> (Linn.) Schrad.	Makal	Wild
4. <i>Citrullus vulgaris</i> Schrad.	Tarmuj	Cultivated
5. <i>Coccinia indica</i> (Naud.) Wight & Arn.	Telakucha	Wild
6. <i>Cucumis sativus</i> Linn.	Sasha	Cultivated
7. <i>Cucumis melo</i> Linn.	Futi	Cultivated
8. <i>Cucumis</i> sp.	x	Wild
9. <i>Cucurbita maxima</i> Duchesne	Mithakumra	Cultivated
10. <i>Gymnopetalum cochinchinense</i> Kurz.	x	Wild
11. <i>Lagenaria vulgaris</i> Seringe.	Lau	Cultivated
12. <i>Luffa cylindrica</i> (Lour.) Roem.	Dhoondol	Cultivated & wild
13. <i>Luffa acutangula</i> Roxb.	Jhinga	Cultivated
14. <i>Luffa graveolens</i> Roxb.	x	Wild

SPECIES	VERNACULAR NAME	HABITAT
15. <i>Momordica charantia</i> Linn.	Uchchhe	Cultivated
16. <i>Momordica cochinchinensis</i> Spreng.	Kakrol	Cultivated
17. <i>Momordica dioica</i> Roxb.	Bankakrol	Wild
18. <i>Momordica</i> sp.	x	Wild
19. <i>Mukia maderaspatana</i> Kurz.	x	Wild
20. <i>Thladiantha calcarata</i> Clarke	x	Wild
21. <i>Trichosanthes anguina</i> Linn.	Chichinga	Cultivated
22. <i>Trichosanthes cucumerina</i> Linn.	Banchichinga	Wild
23. <i>Trichosanthes dioica</i> Roxb.	Patol	Cultivated
24. <i>Zanonia indica</i> Linn.	x	Wild

Out of the eighteen genera available in Bengal (Prain, 1903) fourteen have been collected. Some of these species are wild, some semi-wild i.e. wild and cultivated at the same time, or cultivated but may grow uncared for near human habitation, and some others are strictly cultivated. The majority of the species grow during the rainy season, but some grow in winter, or in spring, and two or three are perennial.

A close study of the materials collected from various places reveal that a workable key for the identification of the species can be formulated from the morphological features of the leaves and tendrils. The descriptions of the leaves and tendrils have been omitted for the sake of brevity as also because they are available in BENGAL PLANTS (vol. i, Prain, 1903) and in THE FLORA OF BRITISH INDIA (vol. ii, Hooker, 1879).

KEY FOR IDENTIFICATION OF CUCURBITS¹

A. Tendril simple

a. Leaf entire

- b. Leaf ovate, deeply cordate at the base, denticulate, softly pubescent..... *Thladiantha*

bb. Leaf slightly or deeply 5-angled

- c. Angles of the leaf not very prominent, stem soft, hairy..... *Cucumis*

- (i) Leaf somewhat orbicular, ovoid, dentate, softly hairy, petiole small..... *C. melo*

- (ii) Leaf slightly lobed, lobes acute hispidulous; petiole long..... *C. sativus*

- (iii) Leaf slightly angled, almost circular.... *C. sp.*

- cc. Angles of the leaf prominent, stem hard, hairless..... *Coccinia*

- ccc. Stiff hairs present on the leaf, petiole and stem..... *Mukia*

¹ This key, prepared on the basis of the morphological characters of tendrils and leaves, is of practical value as an aid only.

Leaves and Tendrils as aids for Identification of Cucurbits

BY

PRIYADARSAN SENSARMA

G. C. Bose Biological Research Unit, Bangabasi College, Calcutta.

(With six plates)

INTRODUCTION

Usually plants are identified with the aid of floral characters. Some attempts have been made to identify the cucurbits by the anatomical characters of the stem (Ghosh, 1932) and of the petioles and midribs (Yasuda, 1901, 1903 ; Chakrabarty, 1937). But the present author is not aware of any attempt to identify the cucurbits with the aid of the morphological characters of the leaves and tendrils though they exhibit some interesting features with conspicuous differences ; this attempt has been made from that point of view.

MATERIALS AND METHODS

Materials of the following twenty-four species were collected from different parts of Bengal and herbarium sheets were prepared in the usual way :

SPECIES	VERNACULAR NAME	HABITAT
1. <i>Benincasa hispida</i> Cogn.	Chalkumra	Cultivated & wild
2. <i>Bryonopsis laciniosa</i> Naud.	Mala	Wild
3. <i>Citrullus colocynthis</i> (Linn.) Schrad.	Makal	Wild
4. <i>Citrullus vulgaris</i> Schrad.	Tarmuj	Cultivated
5. <i>Coccinia indica</i> (Naud.) Wight & Arn.	Telakucha	Wild
6. <i>Cucumis sativus</i> Linn.	Sasha	Cultivated
7. <i>Cucumis melo</i> Linn.	Futi	Cultivated
8. <i>Cucumis</i> sp.	x	Wild
9. <i>Cucurbita maxima</i> Duchesne	Mithakumra	Cultivated
10. <i>Gynopetalum cochinchinense</i> Kurz.	x	Wild
11. <i>Lagenaria vulgaris</i> Seringe.	Lau	Cultivated
12. <i>Luffa cylindrica</i> (Lour.) Roem.	Dhoondol	Cultivated & wild
13. <i>Luffa acutangula</i> Roxb.	Jhinga	Cultivated
14. <i>Luffa graveolens</i> Roxb.	x	Wild

SPECIES	VERNACULAR NAME	HABITAT
15. <i>Momordica charantia</i> Linn.	Uchchhe	Cultivated
16. <i>Momordica cochinchinensis</i> Spreng.	Kakrol	Cultivated
17. <i>Momordica dioica</i> Roxb.	Bankakrol	Wild
18. <i>Momordica</i> sp.	x	Wild
19. <i>Mukia maderaspatana</i> Kurz.	x	Wild
20. <i>Thladiantha calcarata</i> Clarke	x	Wild
21. <i>Trichosanthes anguina</i> Linn.	Chichinga	Cultivated
22. <i>Trichosanthes cucumerina</i> Linn.	Banchichinga	Wild
23. <i>Trichosanthes dioica</i> Roxb.	Patol	Cultivated
24. <i>Zanonia indica</i> Linn.	x	Wild

Out of the eighteen genera available in Bengal (Prain, 1903) fourteen have been collected. Some of these species are wild, some semi-wild i.e. wild and cultivated at the same time, or cultivated but may grow uncared for near human habitation, and some others are strictly cultivated. The majority of the species grow during the rainy season, but some grow in winter, or in spring, and two or three are perennial.

A close study of the materials collected from various places reveal that a workable key for the identification of the species can be formulated from the morphological features of the leaves and tendrils. The descriptions of the leaves and tendrils have been omitted for the sake of brevity as also because they are available in BENGAL PLANTS (vol. i, Prain, 1903) and in THE FLORA OF BRITISH INDIA (vol. ii, Hooker, 1879).

KEY FOR IDENTIFICATION OF CUCURBITS¹

A. Tendril simple

a. Leaf entire

- b. Leaf ovate, deeply cordate at the base, denticulate, softly pubescent..... *Thladiantha*

bb. Leaf slightly or deeply 5-angled

- c. Angles of the leaf not very prominent, stem soft, hairy..... *Cucumis*

- (i) Leaf somewhat orbicular, ovoid, dentate, softly hairy, petiole small..... *C. melo*

- (ii) Leaf slightly lobed, lobes acute hispidulous; petiole long..... *C. sativus*

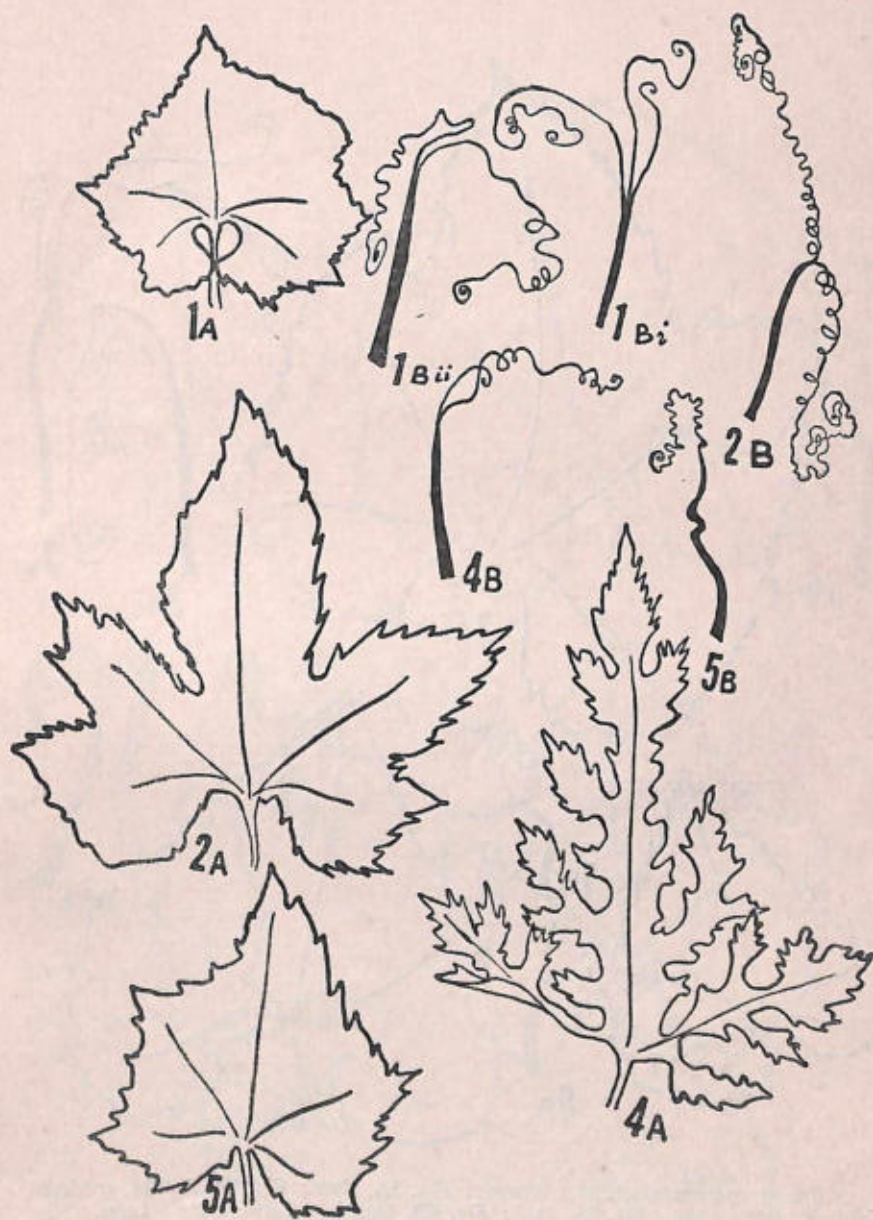
- (iii) Leaf slightly angled, almost circular.... *C. sp.*

- cc. Angles of the leaf prominent, stem hard, hairless..... *Coccinia*

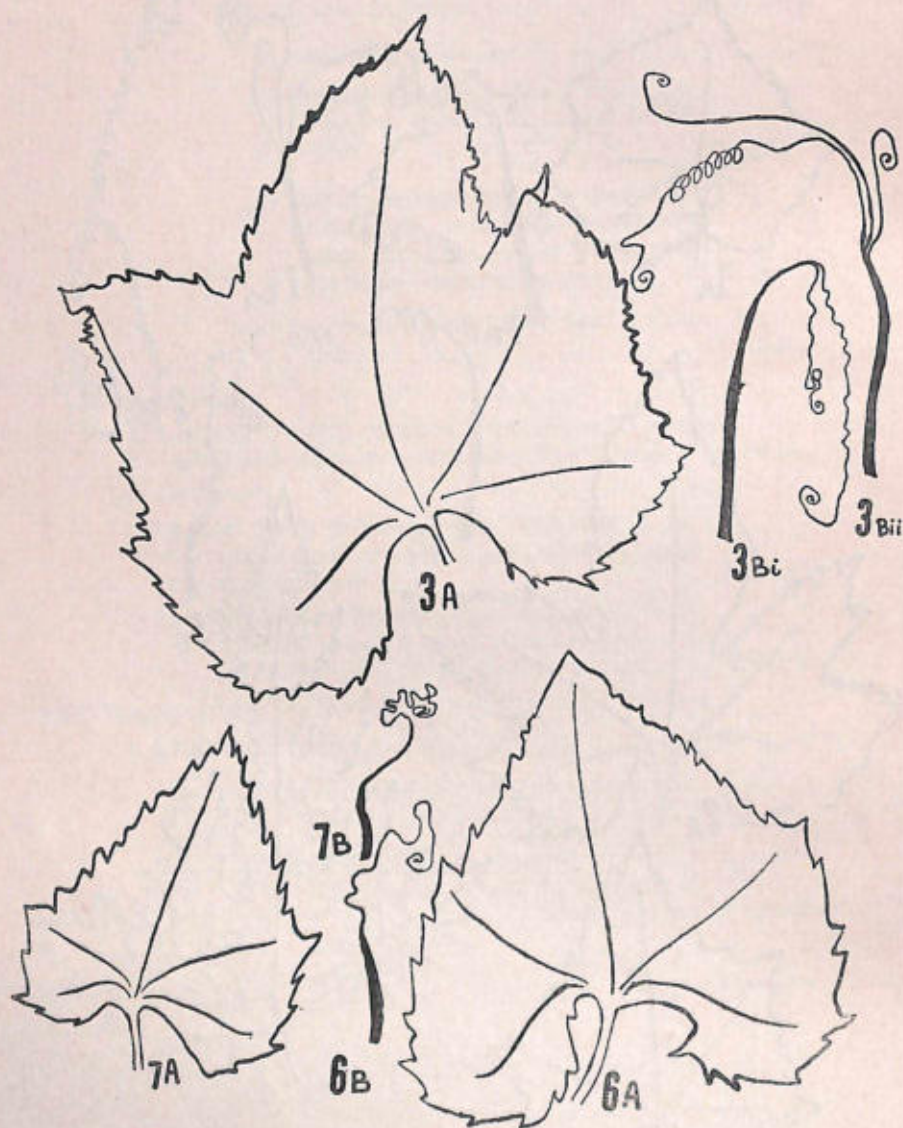
- ccc. Stiff hairs present on the leaf, petiole and stem..... *Mukia*

¹ This key, prepared on the basis of the morphological characters of tendrils and leaves, is of practical value as an aid only.

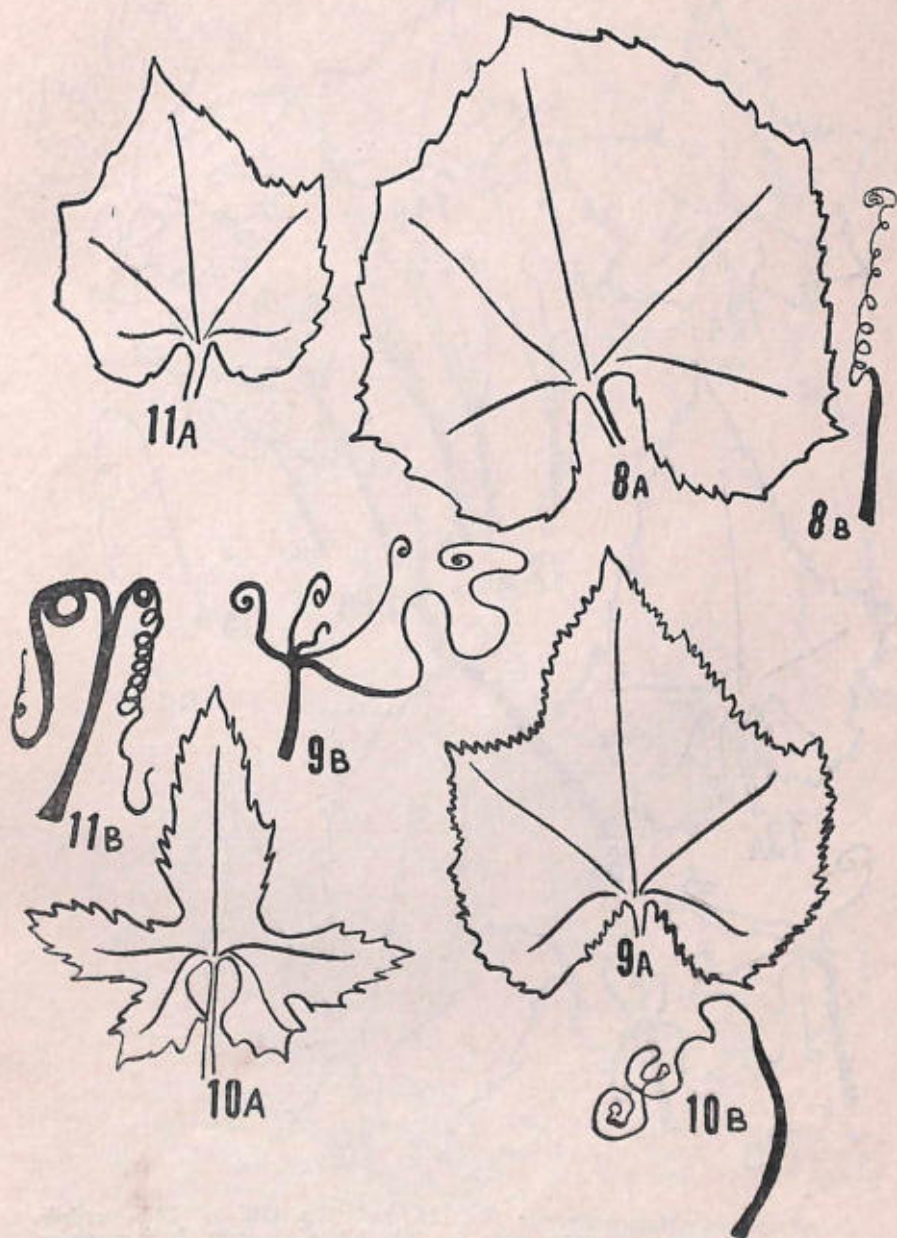
- aa. Leaf lobed or entire
 - b. Leaf 5-lobed, no hairs or very small hairs on the leaf blade..... *Gymnopetalum*
 - bb. Leaf lobed or entire, margin dentate, hairless or with soft hair, stem angular..... *Momordica*
 - (i) Leaf deeply divided into 5-7 lobes..... *M. charantia*
 - (ii) Leaf divided to the middle or deep to the base into 3 (rarely 5) ovate or oblong lobes *M. cochinchinensis*
 - (iii) Leaf divided to the middle or deep to the base into 3 (rarely 5) lobes, lobe-apices acute, petiole channelled, glands present on the lamellated outgrowth..... *M. sp.*
 - (iv) Leaf more or less entire with shallow dentation *M. dioica*
- AA. Tendril bifid
 - a. Leaf entire ; tendril elongated, branching occurs at the apical part, segments much smaller than the stalk.. *Zanonia*
 - aa. Leaf-lobed
 - b. Leaf deeply palmately lobed ; branching of the tendril occurs at the basal part, segments larger than the stalk *Bryonopsis*
 - bb. Leaf slightly 5-lobed, toothed, very hairy ; branching of the tendril occurs at the mid-point and the segments are almost equal to the stalk.... *Lagenaria*
- AAA. Tendril variable
 - a. Simple to three-fid *Trichosanthes*
 - (i) Leaf margin dentate, base cordate, leaf ovate or oblong in shape..... *T. dioica*
 - (ii) Leaf margin entire or nearly so
 - * Leaf smaller, 5-angled ; generally 3-fid tendril..... *T. cucumerina*
 - ** Leaf larger, more or less 5-lobed (faintly) *T. anguina*
 - aa. Tendril 2-3 fid
 - b. Tendril 3-fid at the younger part, bifid at the older region ; leaf reniform, cordate at the base, slightly 5-angled..... *Benincasa*
 - bb. Tendril segments equal or unequal, very small ; leaf deeply 3-7 lobed *Citrullus*
 - (i) Leaf hoarsely scabrid, deltoid in outline *C. colocynthis*
 - (ii) Leaf glabrous, deeply segmented, segments pinnatifid..... *C. vulgaris*



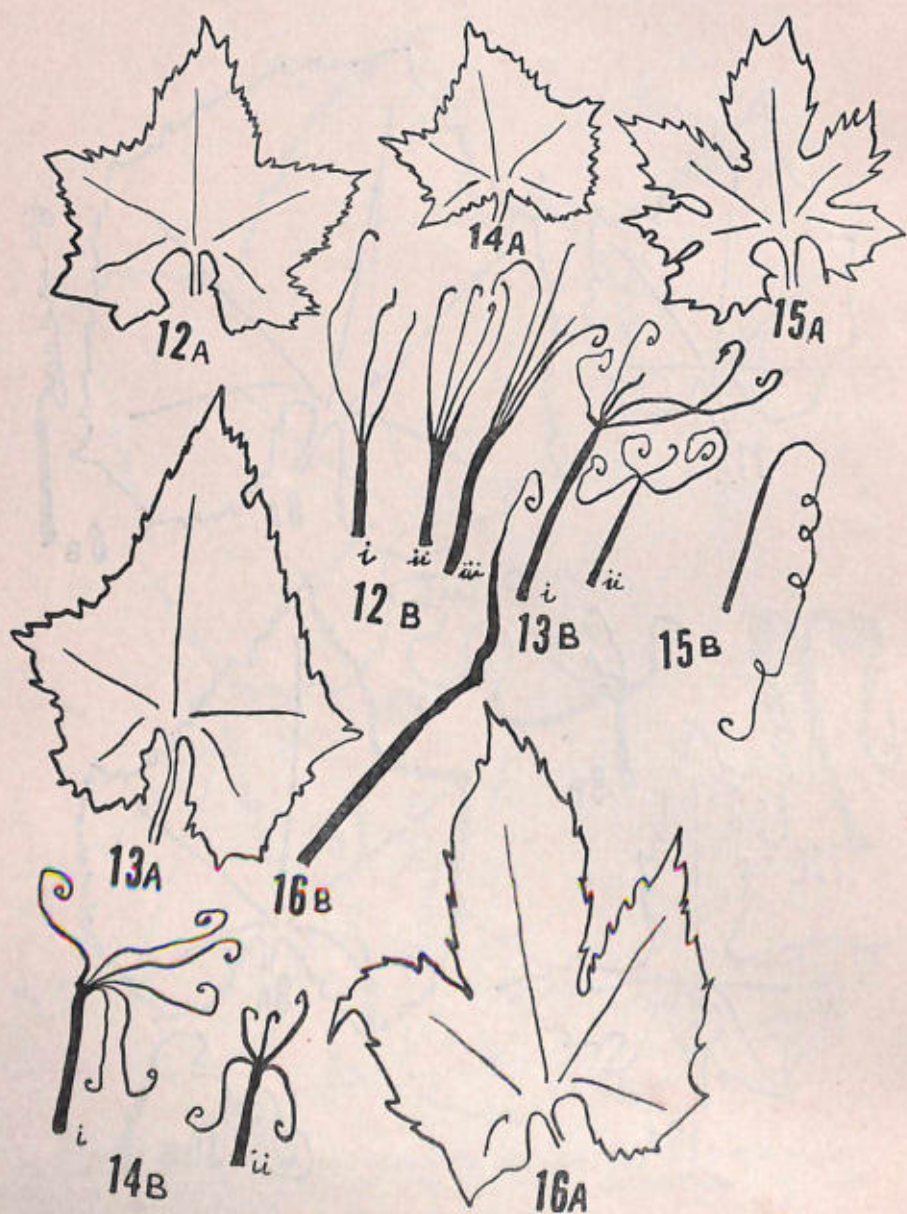
Benincasa hispida Cogn.: Fig. 1A, leaf; Fig. 1Bi & 1Bii, tendrils. *Bryonopsis laciniosa* Naud.: Fig. 2A, leaf; Fig. 2B, tendril. *Citrullus vulgaris* Schrad.: Fig. 4A, leaf; Fig. 4B, tendril. *Coccinia indica* (Naud.) Wight & Arn.: Fig. 5A, leaf; Fig. 5B, tendril.



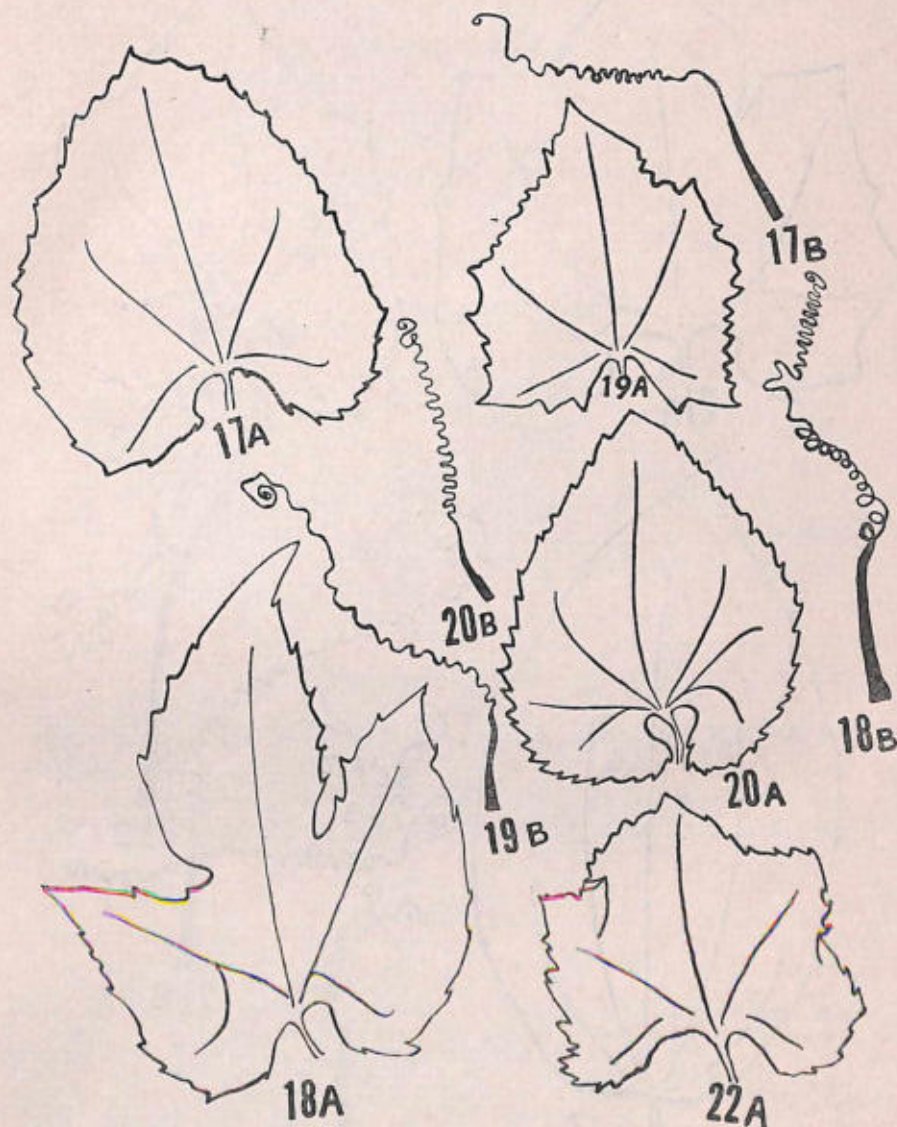
Citrullus colocynthis (Linn.) Schrad.: Fig. 3A, leaf; Fig. 3Bi & 3Bii, tendrils.
Cucumis sativus Linn.: Fig. 6A, leaf; Fig. 6B, tendril. *Cucumis melo* Linn.: Fig.
 7A, leaf; Fig. 7B, tendril.



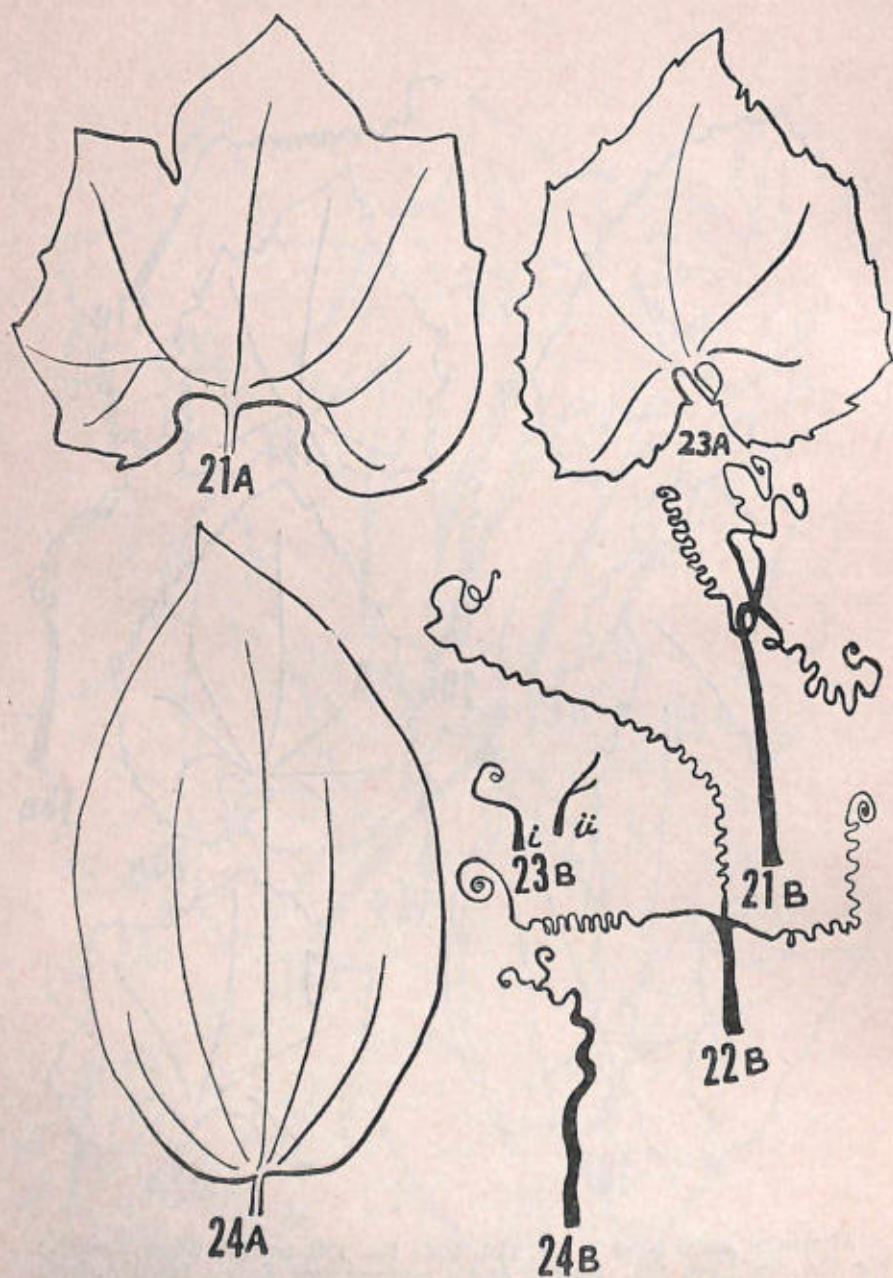
Cucumis sp.: Fig. 8A, leaf; Fig. 8B, Tendril. *Cucurbita maxima* Duchesne: Fig. 9A, leaf; Fig. 9B, tendril. *Gymnopetalum cochinchinense* Kurz.: Fig. 10A, af; Fig. 10B, tendril. *Lagenaria vulgaris* Seringe: Fig. 11A, leaf; Fig. 11B, tendril.



Luffa cylindrica (Lour.) Roem.: Fig. 12A, leaf; Fig. 12Bi to 12Biii, tendrils.
Luffa acutangula Roxb.: Fig. 13A, leaf; Fig. 13Bi & 13Bii, tendrils. *Luffa graveolens*
 Roxb.: Fig. 14A, leaf; Fig. 14Bi & 14Bii, tendrils. *Momordica charantia* Linn.:
 Fig. 15A, leaf; Fig. 15B, tendril. *Momordica cochinchinensis* Spreng.: Fig. 16A,
 leaf; Fig. 16B, tendril.



Momordica dioica Roxb.: Fig. 17A, leaf; Fig. 17B, tendril. *Momordica* sp.: Fig. 18A, leaf; Fig. 18B, tendril. *Mukia maderaspatana* Kurz.: Fig. 19A, leaf; Fig. 19B, tendril. *Thladiantha calcarata* Clarke: Fig. 20A, leaf; Fig. 20B, tendril. *Trichosanthes cucumerina* Linn.: Fig. 22A, leaf.



Trichosanthes anguina Linn.: FIG. 21A, leaf; FIG. 21B, tendril. *Trichosanthes cucumerina* Linn.: FIG. 22B, tendrils. *Trichosanthes dioica* Roxb.: FIG. 23A, leaf; FIG. 23Bi & 23Bii, tendrils. *Zanonina indica* Linn.: FIG. 24A, leaf; FIG. 24B, tendril.

- aaa. Tendril 3-6 fid *Luffa*
- (i) Tendril generally unequally 6-fid; leaf orbicular in outline, palmately 5-7 angled, scabrid on both surfaces..... *L. acutangula*
 - (ii) Tendril generally unequally 3-5-fid; leaf orbicular or reniform in outline, palmately 5 (rarely 7) lobed..... *L. cylindrica*
 - (iii) Tendril generally unequally 3-6-fid; leaf reniform somewhat lobed, and always toothed, scabrous above *L. graveolens*
- AAAA. Tendril 5-fid, segments all unequal..... *Cucurbita*

DISCUSSION AND CONCLUSION

The author submits that, though most of the species available in Bengal have been considered, the present attempt is by no means complete. Of course, from this study it becomes evident that it may be possible to build up a key for identification on the basis of the morphological characters of the leaves and tendrils of cucurbits. It must be clearly mentioned here that this key is important from the practical point of view and only as an aid, and does not indicate any phylogenetic relationship of the species.

ACKNOWLEDGEMENT

The author acknowledges his gratefulness to the late Prof. G. P. Majumdar, Ph.D. (Leeds), F.A.Sc., F.N.I., under whose guidance this piece of work was being carried out. The author is also thankful to the authorities of Bangabasi College who kindly allowed the facilities for his work.

REFERENCES

1. Chakrabarty, H. L. (1937): Physiological anatomy of the leaves of Cucurbitaceae. *Philippine J. Sc.* 63: 409-431.
2. Ghosh, E. N. (1932): On the micro-structure of the stems of Bengal Cucurbitaceae with reference to its value in Taxonomy. *J. Ind. Bot. Soc.* 11: 259-270.
3. Hooker, J. (1879): The Flora of British India. Vol. 2.
4. Prain, D. (1903): Bengal Plants. Vol. 1.
- *5. Yasuda, A. (1901): Comparative anatomy of Cucurbitaceae. (in Japanese), *Bot. Mag. Tokyo* 15: 88-91.
- *6. ——— (1903): Comparative anatomy of Cucurbitaceae. *J. Coll. Sc. Imp. Uni. Tokyo* 18: 56.

* Not seen in original by author.

Reviews

1. THE WATERFOWL OF THE WORLD. By Jean Delacour. Vol. III. Pp. 270 (24.50×18.50 cm.). Twenty plates in colour by Peter Scott; 46 distribution maps in text. London, 1959 (Country Life Ltd.). £6-6-0 net.

This volume completes the survey of all the known species of swans, geese and ducks found throughout the world, and brings to conclusion a monumental achievement. The collaboration of two such internationally recognised specialists in this group of birds has proved completely fruitful from every point of view. Both Jean Delacour and Peter Scott possess long and intimate experience of practically all the species dealt with in these three volumes in captivity, and with many in the wild state as well. They have successfully bred in their aviaries some of the rarest members of the tribe, and been able thereby to rescue—and even rehabilitate—several species from the imminent extinction with which they were faced. Peter Scott's fame as a portrayer of the duck tribe is world-wide, and his illustrations in colour of every member of it of both sexes, often in breeding as well as eclipse plumage, and of their downy young, not only lend charm and attractiveness to the volumes but are of the greatest scientific usefulness. Many of the downy young, which in various species often differ only in superficially insignificant colour patterns were quite unknown until bred in the pens of the Wildfowl Trust at Slimbridge. The plates, in effect, hall-mark the excellence of Mr. Delacour's erudite text.

The present volume deals with the five 'tribes' left over from the previous two, namely the Eiders (Somateriini), Pochards (Aythyini), Perching Ducks (Cairinini), the Scoters, Golden-eyes, and Mergansers (Mergini) and the Stiff-tailed Ducks (Oxyurini). The classification is mainly, as in previous volumes, that proposed by Delacour and Mayr in 1945 for the family Anatidae which, with minor modifications, is now widely accepted and adopted in scientific writings. The general order of description remains as before: first Key to the Species with a fairly full general description of each, then overall Distribution, General Habits covering ecology, breeding behaviour, courtship display, food, etc., and finally observations on the species in Captivity. This is followed by basic information in brief concerning each of its subspecies individually, treated under the same general heads as for

the species. The maps in the text for each species together with its geographic races are of great help in giving a clear overall picture of the distributions, but too much accuracy should perhaps not be looked for from their small scale. On p. 47 the wintering range in India of the Redcrested Pochard (*Netta rufina*) is shown as down to about the 20th parallel. Actually this duck is a regular visitor as far south as Madras though less common than in N. India.

In spite of the somewhat deterrent cost of the volumes, the intelligent sportsman, whose interest in his kills projects a little beyond the dining table, will welcome this up-to-date authentic and well-illustrated survey of a very popular group of game birds—the duck tribe; so will the serious bird watcher and the scientific ornithologist. For every good working library of natural history of course, THE WATERFOWL OF THE WORLD is quite indispensable.

S.A.

2. MY YEAR WITH THE WOODPECKERS. By Heinz Sielmann. Translated from the German by Sidney Lightman. Foreword by James Fisher. Pp. 139 (23×16 cm.). 4 coloured and 28 black and white plates. London, 1959. Barrie & Rockliff. Price 21s.

Heinz Sielmann's fame as an investigator and photographer of woodpeckers rocketed into world prominence after the exhibition of his classic documentary film at one of the recent International Ornithological Congresses. Since then the film, specially edited for the *Look* television programme of the B.B.C., has been seen and admired by millions of nature lovers. The book, based on this film, was originally published in the German in 1958. It describes not only the hidden home life of several species of woodpeckers including the shy Black Woodpecker, but also the ingenious techniques devised and employed by Herr Sielmann which made the photography possible. Woodpeckers nest in holes in tree trunks and boughs, often quite deep down, and no one had as yet been able to observe what goes on within an occupied nest, let alone filming the activities. Sielmann's admirers in English-speaking countries will welcome the eagerly awaited realization of their wish to see an English translation, and a word of praise is due to the translator for the facile manner in which he has discharged his task.

Photographing inside the ill-lit interior of a woodpecker nest-hole was accomplished by means of infra-red rays, using special infra-red

film. This permitted exposures to be made in complete darkness without causing any disturbance to the birds, but posed certain serious disadvantages, particularly in close-up work, which the author's ingenuity had to overcome. The photography was actually done through a pane of glass fitted in a window cut into the side of the tree trunk opposite the entrance hole. To avoid frightening the birds this had to be done bit by bit and with great circumspection during the foraging absences of the parent birds. The pictures obtained are unique, and reveal for the first time the internal economy of a woodpecker hole and the behaviour of the parents and young. Drumming and other noises and calls were sound-recorded, timed, and analysed. To supplement his photography at natural nests, the author hand-reared a number of nestling woodpeckers and later released them in a spacious aviary simulating as closely as possible the natural conditions under which the birds lived. The almost magical sequences in the film showing the exact manner in which the woodpecker employs its wormlike extensile tongue ('5 times as long as the beak' in the Green Woodpecker) to skewer out grubs of wood-boring beetles from the winding pupal galleries, were filmed under these controlled conditions. But they are in no way unnatural or 'made-up', and are without doubt some of the most superb documentary cine-shots of a bird ever made.

All in all this is a remarkable and beautifully illustrated book both for the bird lover and scientific ornithologist, as well as for the nature photographer. It lays bare in word and picture many of the hidden secrets of a woodpecker's family life and domestic economy, and demonstrates how the seemingly impossible in nature photography can be achieved by patience, perseverance, and ingenuity of technique, backed by enthusiasm and a proper understanding of the ways and habits of the subjects.

S.A.

3. A HANDBOOK TO THE COLLECTIONS ILLUSTRATING A SURVEY OF THE ANIMAL KINGDOM. London County Council, Horniman Museum and Library. Pp. 92 (18.5×12.0 cm.). 4 photo plates and two line drawings. Third Edition, London, 1959. Price 2s. 6d.

This is a handbook to one of the sections of the Horniman Museum, in Dulwich, London S.E., but it could as well stand on its own as an introduction to the classification of the animal kingdom, or as a summary of this to a student. In spite of having under 100 pages it

combines completeness with clarity admirably. Very occasionally there are statements like this: 'In development the mollusc egg gives rise typically to a *trochosphere* larva which turns into a *veliger* larva before assuming the adult form.' Without further explanation this can hardly be very informative to the uninitiated. On the whole, however, the reader's attention is held and there is no temptation to skip paragraphs as containing only non-essential detail. Very good value at 2s. 6d. One would like to see the Museum—it must be as well planned as the handbook.

R.R.

4. CROCODILES AND OTHER PEOPLE. By Douglas Lockwood. Pp. x+222 (21.5×14.5 cm.). Cassell, London, 1959. Price 18s.

The author was for 10 years a newspaper correspondent in the tropical northern territory of Australia and the book is an account of some of his experiences. Though most of them are not of natural history interest, the chapters on crocodiles and buffaloes contain some interesting items.

The crocodile is *Crocodilus porosus* which is found in the Sunderbans and other parts of eastern India. Some of the areas in north Australia still hold, or at least did a few years ago, sufficient numbers to warrant their being slaughtered for their skins. The native attendants on the shikaris fed on crocodile flesh and it is said that after a week on this diet they smelt worse than alcoholic.

The domestic buffalo was first introduced into Melville Island in northern Australia and subsequently to the mainland, and it appears to have multiplied in the manner in which several introduced species have done in Australia. Their further spread has been prevented by the boundaries of desert conditions about 400 miles east, west, and south of Port Darwin, but within these limits their number is now estimated at a million. Licences to kill 2000 animals per season were issued and there are references to episodes which can only be termed 'slaughter'. The author also refers in another place to 100 kangaroos shot by spotlight in one night.

The reference to a 5 ft. crocodile jaw (which would make the animal 35 ft. long) leaves one uncertain of some of the figures, but it is interesting to read of animals familiar to us.

H.A.

5. THE WEALTH OF INDIA: A DICTIONARY OF INDIAN RAW MATERIALS AND INDUSTRIAL PRODUCTS. RAW MATERIALS. Vol. V. H.-K. Pp. xxv+332+xii (27.7×21.5 cm.). 16 plates and 169 text-figures. New Delhi, 1959. Council of Scientific & Industrial Research. Price Rs. 30.

This volume of THE WEALTH OF INDIA series carries the list of Indian raw materials from the letter H to the letter K. The list is very comprehensive and particulars of the items described are given in great detail; at the same time references are given to the authorities where fuller information may be sought. An instance in point is the section on *Hevea brasiliensis* (H.B.K.) Muell. Arg., the Caoutchouc Tree, a native of South America which has been introduced on a commercial scale into Kerala State for the production of rubber. Information is given about the climate and other conditions suitable for its cultivation, the preparation of the land for it, the alternative modes of propagation and their respective merits and demerits, various cultural operations, diseases and pests affecting the plant, methods of tapping it, processes leading up to the manufacture of raw rubber, the grading, packing, and marketing of the product, and so on. This volume includes an article on insects commencing with a general description of their structure and development from the egg to the perfect insect, their classification and distribution, their nuisance value as pests or vectors of disease, methods of control, and in order to make the picture complete a description of the insects which are beneficial as pollinators or as predators or as pests of noxious weeds, animals, and other insects. The book is illustrated with well-chosen and well-reproduced pictures and drawings. With the subject matter treated so elaborately the publication, which has already reached its fifth volume, promises to be beyond the purse of the ordinary reader. It is a valuable book of reference which should be in every library. Having so much to interest the general reader, it is to be hoped that the libraries will keep it where it will catch the eyes of such readers and excite their curiosity.

There are in the book passages which I would like to see omitted. For instance, the authors tell us about a certain animal that, in the Punjab, 'the flesh is said to be pounded with ghee into an ointment for application to chronic ulcers' and that 'exposure to fumes from the burnt spines is believed to relieve pain due to haemorrhoids'. Is it necessary to condemn these creatures to death by such statements unless these remedies have been tried and found to be efficacious?

D.E.R.

Miscellaneous Notes

1. POSSIBLE FUNCTION OF THE TIGER'S WHISKERS*

It is a well known fact that the sense of smell of both the tiger and the leopard is very poorly developed. I have seen plenty of evidence for this in my own experience, and I do not think that any experienced big game hunter or naturalist will dispute this. And yet both these animals live by stalking and killing those animals (herbivores) whose sense of smell is very strongly developed. The tiger and the leopard therefore have learned over the course of centuries that if they are to succeed in killing the animals they eat, they must make due allowance for the latter's sense of smell, i.e. before the final fatal assault they must approach their quarry from a down-wind direction. Strangely enough a man-eating tiger or leopard will take the same precaution when stalking a human being! Old habits and instincts die hard. Now every hunter who has hunted bison and buffalo on foot, or even tried to stalk chital or sambar, knows how difficult it is very often inside the jungle to know or find out the direction of the wind. How does a tiger or a leopard find this out in a similar situation? They have the added difficulty of being much lower on the ground while stalking.

It is my belief that they do it with the aid of their very long whiskers. These long filaments, which are as thin as human hair at their tips—gradually thickening inwards till they become quite thick and stiff at the roots—act like so many delicate antennae which together constitute a very effective wind gauge. The slightest movement of the fine tips is carried to the stiff roots and thence to the sensory nerves of the upper lip. Could one think of any other biological reason or use for these very peculiar and prominent whiskers in the 'great cats'? I suppose the final test of the theory could be carried out if one could cut off the whiskers of a tiger and then see if he could make use of the wind in his hunting—but I have not been able to do that!

56 A.P.O.,
January 12, 1960.

M. M. ISMAIL,
Lt.-Col., I.A.

2. THE PRESENT STATUS OF THE INDIAN LYNX (CARACAL CARACAL)

I have read with interest Sri N. N. Sen's note on the Caracal or the Indian lynx (*Caracal caracal*) published in the August 1959 issue of your journal (56: 317). I saw and shot a caracal in the Saharanpur Forest Division, Uttar Pradesh, in May 1955 under somewhat interesting circumstances. I was staying in the Beribara Forest Rest House and had gone out for an early morning *ghoom* on an elephant. While we were going through scrub forest I saw a male partridge scuttling some fifty yards ahead of the elephant across an open bit of grassland. The partridge disappeared into a tuft of high grass. Immediately afterwards I saw a lithe fawn-coloured body spring into the air in a graceful arc. It looked too light-coloured and elongated for a jackal and I took the elephant near the tuft of grass to investigate what it was. On reaching there I found that the animal had caught the hapless partridge and had already plucked almost all the feathers from its breast. As the animal was neither a jackal nor a wild cat I shot it in order to identify it. One shot with a .22 long rifle cartridge at the base of the skull despatched it.

When we collected the animal I could see that it looked very much like a lynx, pictures of which I had seen in various books. I brought the carcase to the rest house and was able to identify it with the help of a book on Indian animals. I also enquired from the local people who said the animal was called *siyah gosh*, which means 'black ears'. This corresponded with the Hindustani name given for the Caracal in the book of words, as also with the fact that the animal had a pair of black and very pointed ears. The face and body were cat-like but the tail was proportionately shorter and ended in a little pom-pom. The colour of the body was light fawn and the undersides white. The ears were much longer than in the felines and were pointed at the tips which ended in thin plumes of one inch-long black hair. The size of the body was about the same as a jackal's, but it was lower and therefore looked slightly more elongated.

There is an interesting postscript to the tale. After collecting the caracal I asked my orderly to collect the partridge, as I was not averse to eating a partridge freshly killed by the caracal even though it was the close season. To our surprise, when the orderly went to pick it up the partridge got up and ran into the nearest bush, looking for all the world like a young lady who is surprised without any clothes on, and rushes headlong into the nearest cover! That is

the last we saw of that partridge. I still wonder if he grew a new set of breast feathers.

CONSERVATOR OF FORESTS,
TEHRI-GARHWAL CIRCLE, UTTAR PRADESH, B. P. SRIVASTAVA
DEHRADUN, U.P.
November 24, 1959.

3. TODDY CAT (*PARADOXURUS HERMAPHRODITUS*) AND RUSSELL'S VIPER (*VIPERA RUSSELLI*)

On the morning of 30-11-1959 while motoring through the forest on the Mysore frontier road, I found on the roadside a toddy cat and a large Russell's viper lying dead just opposite each other. The deaths were recent as rigor had not yet set in. The snake had been bitten on the head, the neck, and the tail below the vent; the rest of the body bore no teeth marks. The toddy cat had been bitten on the head near the ear. Obviously they had been fighting with fatal results to both. What is the reason for this jungle tragedy? Will the Editors or any of my readers make a suggestion?

I know small birds and mammals are included in the menu of these palm civets, but why did it tackle this stout, five-foot long Russell's viper, a most venomous antagonist? Vice versa could the snake have taken the aggressive role? This appears improbable in view of the fact that the palm civet was 3 feet 4 inches long and weighed 6 lb., rather too big for the snake to swallow.

Probably they met suddenly and a fight ensued. The snake's venom acted quickly resulting in the death of its opponent on the spot and the snake itself died there from the several bites on its head and neck. Or the toddy cat having formerly successfully tackled smaller and harmless snakes attacked and killed the Russell's viper and carried it to the roadside where it died in its turn.

15 PERUMALKOIL STREET,
FORT, COIMBATORE,
December 15, 1959.

B. SUBBIAH PILLAI

4. BATS AS A STORM SIGNAL ?

The writer had a novel experience on the evening of 27 May 1959. Eight Indian Pigmy Pipistrelles, *Pipistrellus mimus* Wroughton, were being observed in the Chandpole area in Jaipur City. At about 7.35 p.m. all the pipistrelles which were flying their characteristic flight with quick jerks and descents disappeared; evidently they took shelter in their roost, a small hole in the wall of a near-by house. I waited for 10 minutes wondering about the reason for their disappearance. At about 7.55 or 8.00 p.m. Jaipur was struck by a high speed storm which lasted for two hours and uprooted many trees.

On the evening of 28 May 1959 there was no sign of any storm but the pipistrelles again disappeared at 7.40 p.m. It struck me now: is the disappearance of the pipistrelles forecasting a storm? Immediately I cautioned my family members against the possibility of a storm and exactly at 8.05 p.m. Jaipur was struck by a devastating storm which uprooted thousands of trees, blew away hundreds of tin sheds, and killed many cattle.

On 30 May 1959 I got another opportunity of verifying that the disappearance of the pipistrelles is an indication of storm. When the pipistrelles disappeared this evening, I announced with confidence a coming storm; at 8.10 p.m. we had a very fast-moving storm which took many lives in addition to causing other destruction.

Can we not make use of the pipistrelle as an indicator of coming storms?

DEPARTMENT OF ZOOLOGY,
MAHARAJA'S COLLEGE,
JAIPUR,
July 24, 1959.

ISHWAR PRAKASH

5. OCCURRENCE OF THE SEA COW, *HALICORE DUGONG* (ERXL.), OFF THE SAURASHTRA COAST

The landing of two sea cows at Bedi Bunder recently caused considerable interest among the members of the public, leading to a report in the press.

The first of these was sighted dead and floating in the sea near the Kalyan lighthouse on the 17th July 1959 by a fisherman who cut it up into four pieces and towed it to Bedi village, intending to market its flesh. As it had no sale, it was thrown away. Only the

head with the fore-limbs and a piece of the abdomen were found two days later.

A second specimen, a female 13'-4" in length and weighing a ton, was landed on the 30th July by the same fisherman. This time, however, it was retrieved intact by the staff of the Fisheries Department. Attempts to preserve it were unsuccessful and only the skull was ultimately recovered.

The head of the animal was truncate and covered with thick bristly hair. The mouth was ventral with very thick upper and bilobed lower lips, both covered with hair. No teeth were visible, but hard calcareous protrusions could be felt inside the lips. The eyes were small and laterally placed. There were a pair of axial mammae about 3" in diameter. The stomach contained some filamentous algae.

The underside of the animal was whitish grey, becoming darker dorsally.

The skull of one of the above specimens is preserved at the Bombay Natural History Society.

Ellerman & Scott, in CHECKLIST OF PALAEARCTIC AND INDIAN MAMMALS, record the distribution of the dugong as 'seas of Portuguese East Africa, Madagascar, Mafia Island (off Tanganyika), Kenya, the Red Sea, coasts of Malabar, India, Ceylon, the Andaman Islands and Mergui Archipelago, Riukiu Is., Formosa, Malaysian Seas, Philippine Is., and Northern Australia.'

Blanford, in the FAUNA OF BRITISH INDIAN—MAMMALIA (p. 594), records its occurrence on the coasts of the Indian Ocean in Africa and India up to the 15th degree latitude.

This relation of the sea lions and seals is reputed to use its fore-limbs as hands for conveying food to the mouth, and is said to carry the young pressed to the breast with the flippers. This, together with the pectoral position of the mammae, is said to account for the mermaid legend.

A live dugong of 160 cm. length is reported to have been kept in the aquarium of the Central Marine Fisheries Research Station at Mandapam Camp.

DEPARTMENT OF FISHERIES,
TARAPOREVALA AQUARIUM,
BOMBAY 2,
December 23, 1959.

S. B. MANI

[These Saurashtra specimens extend the recorded distribution of the Dugong in India to north of the 15th parallel. Bedi (Jamnagar) is c. 22° 30' N.—Eds.]

6. WILD LIFE PROBLEMS

Mr. Humayun Abdulali's notes on Wild Life in the *Journal of the Bombay Natural History Society* (Vol. 56 (2): August 1959) make sad reading. The disillusioning thing is that it is not only in Madhya Pradesh that these conditions prevail. They seem to be common all over the sub-continent.

I often wonder whether we are not fighting an almost impossible battle in trying to protect the wild life of our country. I am a tea planter and I live in the High Ranges of Kerala and I have had the opportunity of studying this protection problem at close quarters. I have come to certain conclusions and quote them for your perusal.

1. The vast majority of our people have never heard of the Indian Board of Wild Life, do not know what it stands for, and have no idea about the work it is doing.

2. The vast majority of our people have yet to develop a genuine interest in wild life. I mean sufficient interest to worry about its welfare.

It is highly idealistic to expect a man to treat the Great Indian Bustard with respect when he does not know what the bird looks like, has no appreciation of how it is being rapidly wiped out, and does not understand why we wish to prevent its extermination. To the miscreant his bustard is a goodly bird that will do well for the evening's pot. Similarly, I know of numerous cases of Junglefowl, Spurfowl and Painted Bush Quail snared in traps in the tea and jungle in these hills nearly all the year round. I have watched shot guns go after these birds with the same degree of indiscrimination. I have seen Rainbow Trout floating on our waters after being poisoned. I have seen how a species of mountain goat has been nearly exterminated in these hills. I have known of health-crazy parties going out to slaughter our Black Monkeys for medicinal purposes. I have heard that a flourishing trade in bison meat exists in the foothills of the High Ranges. I was not surprised to read that Mr. and Mrs. T. H. Basset were 'horrified to see two figures carrying rifles' in the Periyar Sanctuary. This is typical of what goes on all the time.

3. It does not matter how many big names are associated with our Wild Life Board. What is important is the influence it has in successfully getting the State Governments to adopt and enforce its resolutions.

4. One Wild Life Week a year is totally insufficient for our needs. What we need is a Wild Life Century in our country.

5. The Wild Life Board and a Society like ours must make concerted attempts to educate our people about natural history. How

we can do this is best left to a subcommittee and to interested educationists. Personally, I think it calls for more emphasis on nature study in our school curricula from the earliest stages.

6. Steps must be taken to see that poachers are really severely punished. There is no point in passing resolutions and making laws if they cannot be enforced.

In the final analysis it all depends on whether we, as a people, want to save our wild life or not. If we do not there is very little that Societies and individuals can do in the matter.

PERIAVURRAI ESTATE,
MUNNAR P.O.,
KERALA STATE,
S. INDIA,

M. A. KHAN

November 22, 1959.

[We fully agree with our correspondent that so far the Indian Board for Wild Life has not been conspicuously effective in the purpose for which it was constituted. Reports from all over the country continue to confirm the fact that the wild life position is steadily deteriorating; poaching and illicit misuse of crop protection guns, and illegal practices of every kind are on the increase. The members of the Board have stressed again and again, at each successive meeting, that perhaps our most pressing need at the present time is publicity and educating the public to realize that our wild life is a national asset.

As our correspondent points out, it is quite true that the vast majority of people are unaware of the very existence of the Wild Life Board and of the work it is intended to be doing. In a country where literacy is as low as in ours, the only effective way of educating the public on the problems of wild life and the need for its protection would seem to be the movie film. Every successive meeting of the Board has reiterated the urgent need for film documentaries on Indian wild life for countrywide 'plugging' in cinemas in an earnest attempt to awaken interest in the problem. Yet, today, eight years after the formation of the Wild Life Board, we are not aware that any such film has been produced by the Films Division. If such a film has been produced the secret has been well kept. We have not heard of any one having seen it. The Society has certainly never been consulted about its making as one would reasonably have expected. It is obvious that the high ups both in the Central and State governments are not seriously interested in the problem. Otherwise it is inconceivable that so little would be done about it.

It is a disheartening state of affairs and we can sympathize with the pessimistic note struck in the last para above.—EDS.]

7. THE FOREST WAGTAIL, *MOTACILLA INDICA* (GMELIN),
IN MADRAS, CHINGLEPUT DISTRICT

The Forest Wagtail is an interesting winter visitor to Ceylon and the Western Ghats, arriving by about October and leaving by about March for its summer quarters in eastern Siberia, the hills of northern China and Assam where it is supposed to breed. But since its records on the eastern side of peninsular India are comparatively rare, it was earlier conjectured that like many other east-Asiatic migrants, this also reaches its winter quarters in western India, by way of the Andamans rather than through the Eastern Ghats.

On the eastern side of the Peninsula, it is recorded by Ball (*Stray Feathers* 7: 219) in the Godavari Valley; Jerdon saw it (*Birds of India* 2: 227) at Nellore, and Dewar (*J. Bombay nat. Hist. Soc.* 16: 490) noticed it twice at Madras. However, it was not procured by the Vernay Scientific Survey of the Eastern Ghats, though Sálím Ali noted (*ibid.* 36: 909) a pair at Munanur on the 12th October and one at Farahabad on the 17th October 1931, both localities rather in the interior of Andhra Pradesh (Hyderabad State). Fuller observed it at Poondy near Madras on the 29th September 1956.

Recently for about 20 days, from the 19th September till the 7th October 1959, I saw almost every day, about 7 or 8 of these Forest Wagtails feeding singly scattered throughout the estate of the Madras Christian College, Tambaram. This is about 16 miles south of Madras, but only about 7 miles across to the east coast. The college estate is about 300 acres of scrub jungle, continuous with the Vandalur reserve forest, with clearings here and there only, for the college buildings, playing fields and a number of forest footpaths.

These wagtails were usually seen in the cooler part of the evenings or at cloudy parts of the day, always singly, busily running about in shade, feeding across the footpaths, or sometimes in the wayside grass, or even getting into the adjacent bushes pursuing their food. They walk about a lot with a slight forward swing of the head, stopping now and then to swing their tail and the whole hinder part of the body sideways in a very characteristic manner. It is difficult to identify them readily, but they are extremely unmindful of the passer-by, so that one can safely approach them even to about ten feet and observe them at leisure without much difficulty. When disturbed, they fly off with a loud *spink spink* note to the nearest tree, coming down almost at once and alighting elsewhere on the ground.

The Forest Wagtail was recorded for the first time at Tambaram by Shri Gift Siromoney (*J. Bombay nat. Hist. Soc.* 56: 637). His

record doubtless refers to the same birds as mine which sojourned in the locality for about 20 days. 19th September is probably the earliest record of this east-Asiatic migrant in peninsular India. Moreover, it may suggest that the Forest Wagtail regularly passes down the eastern side of the Peninsula before reaching its winter quarters on the west. More observations at the appropriate season are called for.

DEPARTMENT OF ZOOLOGY,
MADRAS CHRISTIAN COLLEGE,
TAMBARAM,
December 20, 1959.

P. J. SANJEEVA RAJ

8. THE ADJUTANT STORK, *LEPTOPTILOS DUBIUS*
(GMELIN), A DESTROYER OF LOCUSTS IN RAJASTHAN

The Adjutant Stork [*Leptoptilos dubius* (Gmelin)] appeared singly as well as in large groups of about 2000 (*sic*) in the villages Rayanwali, Thukrana, Freedsar, and Kardoo of Suratgarh tehsil of Sri Ganganagar district on or about 14 August 1956. It was learnt from villagers over 60 years old that the visit of the Adjutant Stork (local name *Nalia*) to this area was an uncommon feature. About four decades back some birds of this species had appeared but not to the extent seen during August 1956. The unusual appearance of the bird and in such vast numbers was presumably due to large patches of concentrated breeding of solitaires of the Desert Locust in a gross area of about 50 square miles during July-August 1956, on which the birds were found preying. During the same season concentrations of a number of grasshoppers of various species also occurred at several places in the desert area of Rajasthan. The birds were observed preying in the early morning on the hoppers and fledglings of the Desert Locust, the Migratory Locust, and the grasshoppers, which were inactive at that time. Peculiar methods were adopted by this bird in preying on hoppers and adults. It would run a few steps flapping its wings briskly to beat the bushes of phog, *Calligonum polygonoides* Linn., and bauwli, *Acacia jacquemontii* Benth., on which large congregations of the hoppers and fledglings of the Desert Locust were noted to be resting in the morning. Disturbed by the heavy and noisy flaps of the wings the insects jumped down from their roosting places, when they were immediately attacked with the wedge-shaped bill, picked up, and devoured. After taking a heavy toll of various species of locusts and grasshoppers, the birds

were observed to rest during the afternoon, squatting on the ground with the shanks extended well in front and the head drawn in between the shoulders. In the evenings they became active again and resumed feeding. Their food in this area appeared to be restricted mostly to the various species of Acrididae. It was further observed that the birds selected roosting places high up on the sand dunes which were devoid of vegetation, but as these places were very near to the infested area they usually remained localized here for three to four days. The flocks disappeared on or about 21 August 1956.

LOCUST OUTPOST,
CHURU,
RAJASTHAN,
February 17, 1959.

GURDAS SINGH
CHARAN SINGH

9. ADDITIONS TO THE BIRDS OF COIMBATORE, SOUTH INDIA

I have recently obtained some birds around Coimbatore which are relatively rare in southern India and which may be worth recording.

Limosa limosa limosa (Linnaeus): The Blacktailed Godwit

On 18-10-59, my son shot a solitary bird which was in the company of 5 or 6 Greenshanks, *Glottis nebularia* (Günnerus) on the edge of a tank about 18 miles from Coimbatore. He noted that though often driven away by the Greenshanks it was reluctant to leave and kept with them. This is the first time I have seen the bird here in my experience extending over 40 years.

Demiegretta asha (Sykes): The Indian Reef Heron

One was shot on 19 November 1958.

Both the above birds have been examined and identified at the Bombay Natural History Society.

15, PERUMALKOIL STREET,
FORT, COIMBATORE, S. INDIA,
November 6, 1959.

B. SUBBIAH PILLAI

10. BIRD MIGRATION IN INDIA
Recovery of Ringed Birds

No.	Date and place of ringing	Species	Ringed by	Date and place of recovery	Reported by
Moskwa 37558 B	22-6-1956. Zapovednik of Astrakhan, Volga delta, 46° 14' N., 49° 2' E.	<i>Platalea leucorodia</i>	Bird-ringing Bureau, Moscow	16-7-58. Balkhandia tank, Piplu village near Tonk. ca. 26° 9' N., 75° 58' E.	Sahibzada Abdul Munim Khan
Moskwa E 556085	17-7-1959. Kurgaldzhin Lake (ca. 50° 30' N., 69° 35' E.), ca. 150 km. SW. from Akmolinsk, Kazakh S.S.R.	<i>Anas crecca</i> ♂ ad.	Bird-ringing Bureau Moscow	30-12-1959. Bandha Lake, 38 miles west of Partapgarh, Faizabad Division, Uttar Pradesh. ca. 26° N.; 82° E.	S.I. Moosa Qasim

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
February 26, 1960.

EDITORS

11. FURTHER ADDITIONS TO THE BIRDS OF KUTCH

The Bombay Natural History Society's Bird Migration Study project conducted by Dr. Sálim Ali in the spring this year has added one more species to the existing list of the birds of Kutch, and two more specimens of a rare migrant to the bird collections of the Society. This rare migrant is

***Hypocolius ampelinus* Bonaparte**

♀ collected on 22 March 1960

♂ collected on 23 March 1960

both at Kuar Bet, c. three miles from camp.

The diminishing daily catches prompted Dr. Sálim Ali to issue instructions to the field party on the night of the 20th to put up the nets farther afield than was being done till then. One such operational wing was put in charge of Dr. R. M. Naik of the Faculty of Science, Baroda, (one of the participants in the field team) and myself, and was located about 3 miles from the headquarters.

A beginning was made at this location on the 21st, but the day ended with the commoner birds being caught. On the 22nd at about 3.45 p.m. I found a bird, which I had neither seen earlier in the field nor at the time could recall having seen a specimen of in the Society's collections, entangled in one of the nets. It was carefully taken out and brought to camp where Dr. Sálim Ali revealed its identity to us as the female of *Hypocolius ampelinus*. The skin of this rare migrant was prepared for the Society's collection. While doing so its crop was examined and found to contain about 20 berries of *Salvadora persica*.

Enthused by the previous day's catch of a rare migrant we fixed the nets at the same spot on the 23rd. At about 3.30 p.m. another unrecognizable bird was seen by me perching on a *Salvadora* bush-top about 10 feet from one of the nets. It was busily feeding on its berries. Dr. R. M. Naik and myself now took upon ourselves the seemingly risky job of driving it into the nets, and getting it entangled. Rounding the bush it had perched on we placed the bird between ourselves on one side and the nets on the other. Scared by our presence it flew in the direction opposite to us and got entangled in one of the nets. When back at the headquarters with this specimen Dr. Sálim Ali told us that it was the male of *Hypocolius ampelinus*. Our difficulty in placing this second bird either in the field or when in hand was due to the fact that the female (a specimen of which we had seen the previous day) differs from the male in the absence of the black stripe from the lores, through the eye which widens to a broad band on the nape.

Solitary vagrants of this migrant are recorded from West Pakistan, Makran Coast, Khalat, Sind, Madhya Pradesh, and Bombay. In the Society's collections there are in all 15 specimens (10 ♂♂ and 5 ♀♀) of which only one has been taken in India. This is the one collected by Dr. Sálím Ali at Kihim, Kolaba District, Bombay on November 14, 1930, and reported in Vol. 34: 1061 of the *Journal*. The rest come from the Middle East. The above two skins, now preserved in the bird collections of the Society, bring the total of specimens of this rare migrant collected on Indian soil to three.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
April 12, 1960.

P. B. SHEKAR,
Field Collector.

[Another species added by the migration study field work to the Kutch list is the Whitefronted Finch-Lark, *Eremopterix nigriceps affinis* (Blyth). Two examples of this were taken in the nets, a third collected and preserved, and several others observed. On Kuar Bet this lark seemed to replace the commoner blackbellied species (e.g. *grisea*) of the less desert portions of Kutch.—Eds.]

12 CAN SNAKES PRODUCE VOCAL SOUNDS?

In the *Journal* (55: 578) I referred to vocal noises made by the Dhaman (*Ptyas mucosus*). Yesterday morning while shooting grey quail not far from Bombay we put up a large Dhaman in a dry paddy field.

As it rapidly glided away I had to tread on its tail and touch it with my gun barrels several times before it stopped and turned to attack. Till then we were mostly on and along a 3-foot high bund which perhaps prevented the snake from raising itself high enough to strike. When at bay several inches of neck and body behind the head were noticeably dilated and the snake uttered a very audible *aonh* which at a few feet sounded like a low growl. Others in the party who were 12 to 15 yards away also heard the noise, but Mr. Krishna Talcherkar told me afterwards that it sounded mournful to him.

The snake was captured without any physical injury having been inflicted upon it and there can now be little doubt that this species when angry (?) can emit a noise.

Clifford H. Pope in THE REPTILE WORLD (1957): 138 writes: 'Many snakes produce an alarming effect as in the cobra by inflating as well

as flattening the body. Hissing is usually combined with these processes. The bull snakes (*Pituophis*) of North America blow air against a fleshy flap that rises just in front of the windpipe and thus make a surprisingly loud sound.'

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
December 7, 1959.

HUMAYUN ABDULALI

13. DISTRIBUTION OF THE SKINK, *RIOPA LINEATA* (GRAY)

I recently received from Prof. R. V. Seshaiya, Director, Marine Biological Station, Porto Novo, south India, three specimens of the Fourtoed Skink, *Riopa lineata* (Gray), obtained at Annamalai Nagar, Chidambaram District, Madras State, during 1955 when phenomenal rains inundated the University buildings.

This species appears to have been recorded only from the Bombay State between Poona and North Kanara (Smith, FAUNA, 1935), but in the Society's collection there are also some specimens obtained on Salsette Island, Bombay. The Zoological Survey of India inform me that they have specimen (?) from Madhya Pradesh.

Anyhow the above specimens appear to extend the known range of this species very considerably.

NATURAL HISTORY SECTION,
PRINCE OF WALES MUSEUM,
BOMBAY 1,
November 1, 1959.

V. K. CHARI,
Curator.

14. A NOTE ON THE AMPHIBIANS OF KUTCH

All that is known of the meagre amphibian fauna of Kutch is from specimens in the collection of the Bombay Natural History Society and from the records given in FAUNA OF BRITISH INDIA, by Boulenger (1890), VERTEBRATE ZOOLOGY OF SIND, by J. A. Murray (1884), and C. McCann's list of amphibians of Kutch (1939, *J. Bombay nat. Hist. Soc.* 40:425-427).

During a recent field trip (late September and early October 1959) the following were collected by me:

ORDER BATRACHIA

Family RANIDAE

***Rana cyanophlyctis* Schneid.**

Locality: Bhuj, in small pools of water and 3 in the residential quarters at night. [A well of brackish water c. 5' across at Kuar Bet on the borders of the Rann visited in March 1960 held large numbers which covered the entire surface and crept into the crevices when disturbed. The water was about 6 ft. below ground level.]

***Rana tigrina* Daud.**

Locality: Bhuj and environments.

***Rana limnocharis* Wieg.**

Locality: Bhuj, in small pools of water and 2 in the residential quarters at night.

***Rana breviceps* Schneid.**

Locality: Bhuj and environments. The specimen collected did not have the tubercle at the tibiotarsal articulation found in some specimens from south India [See J. L. Bhaduri & Mira Kripalani (1954): *J. Bombay nat. Hist. Soc.* 52 (2 & 3): 620-623].

***Microhyla ornata* Dum. & Bibr.**

Locality: Bhuj, in small pools of water calling at night.

Family BUFONIDAE

***Bufo andersonii* Boulenger**

Locality: Bhuj, all over the town on roads and in the residential quarters at night.

Of these species three (*Rana limnocharis*, *Rana breviceps*, and *Microhyla ornata*) are additions to the comprehensive list published by Mr. McCann.

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6.
March 30, 1960.

P. W. SOMAN,
Junior Research Assistant.

15. *LAELIA ADALIA* SWINHAE (*LAELIA EXCLAMATIONIS* KOLL.) (LYMANTRIIDAE: LEPIDOPTERA): A NEW PEST OF GUINEA GRASS IN SOUTH INDIA

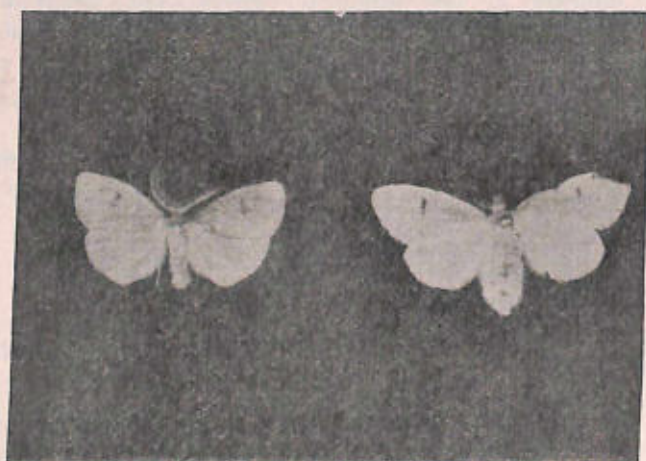
(With a photograph)

INTRODUCTION

Guinea grass (*Panicum maximum*) is a perennial grass, which has of late become extremely popular as a succulent and nutritious green fodder, particularly for milch cattle. A few municipalities have ventured to cultivate this grass, among which Madurai deserves special mention. A small beginning appears to have been made during 1927 and the area has been gradually extended up to 128 acres at present, ensuring a steady and uniform supply of this excellent fodder.

Recently, a hairy caterpillar *Laelia adalia* Swinhoe (*Laelia exclamationis* Koll.) was found to occur in large numbers and devastate the crop. Hampson (1892) mentions of this species as occurring in NW. Himalaya, Sikkim, and throughout India and Ceylon, without details of either the actual distribution in the South or the host plants.

As this is the first record of the species occurring in a serious form in south India, a short account on its incidence, life-history, etc., may be of some interest.



Laelia adalia Swinhoe (*Laelia exclamationis* Koll.)
Left: Male moth; Right: Female moth. (About actual size)

THE PEST AND ITS SEASON OF INCIDENCE

The caterpillars appeared first in pest form at the Municipal Sewage Farm, Madurai, during May 1950 and continued with unabated

virulence till July. A recrudescence of the pest was noted during December 1952 and the incidence was protracted till February 1953. The next outbreak was noted during November 1958, after a lapse of five years. The severity of the damage was heavier than before and continued till February 1959, there being three distinct and successive waves of the caterpillars.

NATURE AND EXTENT OF DAMAGE

The caterpillar is a leaf feeder. It hides between the tillers in the lower portion of the clump during the day and comes out late in the evening or early in the morning to feed on the leaves. The damage inflicted is terrific since the entire crop is defoliated.

The estimated loss of the crop in money value due to this pest during 1952-53 has been computed to be about Rs. 12,000, and during 1958-59 about Rs. 15,000.

LIFE-HISTORY

The moth lays its whitish spherical eggs on the plants in groups of 3 to 6. The caterpillar is fleshy and stout, with hairs all over its body. The first five and the last abdominal segments are dark-coloured and provided with dark tufts of hair on the dorsal side. Other segments are yellowish, with brownish hairs. The head is small and light brown. The full-grown caterpillar measures about 3 cm. in length. Pupation takes place between the interspaces of the tillers in the lower portions of the clumps, inside a dark brown oval cocoon of silk. The moth is stout with plumose antennae. The wings are brown in colour, with four spots in a line in the middle of the forewing (Photograph). The life-cycle is completed in about a month.

ALTERNATIVE HOSTS

The pest was observed to feed only on guinea grass, though extensive areas of cereal crops like paddy, ragi, etc., were available near by. It has been recorded as affecting *Casuarina* in Andhra State by Perrajy *et al.* (1959).

CONTROL MEASURES

The onslaught of the insect during 1950 was so sudden that no control measures could be contemplated. During 1952-53, B.H.C. and toxaphene were applied as 0.1% sprays, but the results were not satisfactory. As an alternative, the stubble was burnt in small blocks and the crop was replanted in fresh areas.

During 1958-59, B.H.C. 10% dust was tried, but only the earlier

instars of the caterpillars were found susceptible. The grown-up caterpillars were not affected and they pupated normally. Such pupae were parasitised by the hymenopterous parasites, viz. *Tetrasticus* sp. and *Hockeria* sp. to an appreciable degree.

The treatment of the pest with B.H.C. during earlier instars does not seem to have affected the parasitation and development of these endoparasites.

Guinea grass being a fodder crop, the insecticides had to be used with due precautions and their application was meticulously stopped four weeks before the cutting. By feeding the grass after this period no deleterious effect was noticed on the cattle.

ACKNOWLEDGEMENTS

Our thanks are due to Sri E. V. Abraham, B.Sc., Assistant Entomologist, Agricultural College and Research Institute, Coimbatore, and Mr. E. O. Pearson, M.A., Director, Commonwealth Institute of Entomology, London, for having identified the pest and parasites respectively. The generous help extended by Sri Kondaswamy Naidu, Superintendent, Sewage Farm, Madurai, in conducting the observations is also acknowledged. Our thanks are also due to Sri M. Basheer, B.Sc. (Alig.), M.A. (Stan.), F.E.S.I., Government Entomologist and Associate Professor, Agricultural College, Coimbatore, for his valuable guidance in preparing this note.

AGRICULTURAL DEPARTMENT,
MADRAS,

B. VASANTHARAJ, B.Sc. (Ag.)
K. R. NAGARAJAN, B.Sc. (Ag.)

REFERENCES

- Hampson, G.F. (1892): Fauna of British India, Moths 1: 442. Perraju, A. et al. (1959): *Andhra Agri. Jour.* 6 (4): 190-1.

16. CORRECT NAME OF THE ASIATIC BUTTERFLY HITHERTO KNOWN AS *DANAUS* (OR *PAPILIO*) *PLEXIPPUS*

There has been prolonged controversy as to whether the American Monarch Butterfly or the Asiatic species known as the Common Tiger had prior claim to the name *Danaus plexippus* (Linnaeus). Both these species have passed under the same name for many years. Rev. E. M. Shull recently sent us a copy of the letter received by him from Dr. Charles L. Remington of the Department of Zoology, Yale University, in which the latter points out that, on the basis of full evidence, the International Commission on Zoological Nomenclature has ruled (Opinion No. 282 published 1 October 1954) that the name hitherto used for the Asiatic butterfly is in fact correctly applicable

only to the North American insect while the Asiatic species should now stand as *Danaus genutia* (Cramer). Opinion 282 which gives this ruling is a lengthy document and would be of little interest to most readers, but the above summary of its conclusion deserves note for future guidance. Corbet & Pendlebury (1956, BUTTERFLIES OF THE MALAY PENINSULA: 141-142) have already followed this ruling and called the Asiatic species *Danaus genutia* (Cramer).

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
February 18, 1960.

EDITORS

17. OCCURRENCE OF THE BLUE MORMON (*PAPILIO POLYMNESTOR* CRAMER) IN BOMBAY

Having recently seen the Blue Mormon (*Papilio polymnestor*) in my garden on Pali Hill, I have searched old issues of the Society's journal for references to its occurrence in Bombay and its neighbourhood.

Writing at a time when Bombay had many more trees than it has now and a much smaller human population Aitken (1887) confessed that he was unable to understand the distribution of this butterfly. He observed: 'It is absolutely unknown in Bombay and I imagine throughout the Konkan, but becomes one of the most familiar objects as soon as we reach a level of 2000 feet. I do not think it occurs in the Deccan generally, but in Poona it frequents the old gardens in the city. Again it abounds all along the Malabar Coast at the level of the sea. Its chief season appears to be the latter half of the monsoon, but a good many come out in March and some may be met with all through the hot months.' Commenting on this Bentham (1889) stated that the butterfly was frequently seen at Dapoli, 70 miles distant from Bombay. Aitken himself seems to have changed his opinion about the non-occurrence of this butterfly in Bombay and wrote in 1903 (Aitken & Comber, 1903): 'occasionally found even in Bombay'. The next reference is by Best (Best, 1951, with notes by Alfrey): 'One seen on the 6th November near Tulsi. A very difficult butterfly to catch', on which Alfrey comments: 'I record having seen a fine female in the garden of "Silver End", Strand Road, obviously travelling from across the harbour'. In a supplementary note Best (1955) wrote: 'Two more seen on the path between Tulsi Lake and Kanheri Caves. This species must be very scarce on the island.'

In view of this last observation of Best and the fact that there is only one definite record of its occurrence in Bombay it may be of interest that I have seen this butterfly twice in the last two months;

18 February 1960. 12.25 p.m. Flew across my garden in a southerly direction at a height of about 15 feet above the ground. Steady unhurried flight. In good condition as far as I could see.

25 March 1960. 11.45 a.m. Flew across my garden in a northerly direction at a height of about 11 feet above the ground. Just before passing out of the garden turned back in its track for a distance of 20 to 25 feet, and then turned again and proceeded in its original direction. Steady unhurried pace. In good condition.

There is a further record from Mr. Basil W. Wirth, whose observations form the basis of a Miscellaneous Note at page 358 of Volume 56 of the *Journal*. In answer to an inquiry he very kindly sent me a note dated 24 February 1960 which deserves to be reproduced in full:

'First and foremost I must say that I have never seen *Papilio polymnestor* flying in any direction other than south—always north to south! They were observed in the following order:

September 1956. Three, all within two to three days of each other starting in the third week. All seen in 'Wadia House' garden (in Cuffe Parade Extension) and all slightly ragged.

25 September 1957. Colaba Road (near Pasta Lane). A perfect insect.

9 October 1957. One seen in 'Wadia House' garden.

16 October 1957. Two seen in 'Wadia House' garden. Both ragged.

26 October 1957. Seen at Tulsi Lake one single specimen hovering around, apparently not intending to go in any particular direction.

15 October 1958. One seen flying high over 'Wadia House' garden on Cuffe Parade side.

1959. None seen.

17 February 1960. Saw one at height of first floor in 'Wadia House' garden. A very ragged specimen.

Most of these were seen at heights between 20 and 30 feet from the ground. All were seen after 11 a.m. but before 3.30 p.m.'

It would appear from these observations that *P. polymnestor* is not as scarce in Bombay as was formerly thought.

Wynter-Blyth (1957) says that *Papilio polymnestor* is commonest in evergreen areas [see also Yates (1931, p. 1005) and Wynter-Blyth (1944, p. 537)], and is not much found in the plains or in areas of low rainfall. It is probable therefore that the butterflies observed were merely

flying through, a conclusion supported by Mr. Alfrey's observation of the *P. polymnestor* flying across the harbour. The uniformity of direction noticed by Mr. Wirth and the annual appearance of these butterflies in September and October suggest the possibility of a local migration.

49, PALI HILL,
BANDRA, BOMBAY 50,
April 13, 1960.

D. E. REUBEN

REFERENCES

- Aitken, E. H. (1887): A list of the Butterflies of the Bombay Presidency in the Society's Collection. With notes by Mr. E. H. Aitken. *J. Bombay nat. Hist. Soc.* 2: 35-44.
- — — & Comber, E. (1903): A list of the Butterflies of the Konkan. *Ibid.* 15: 42-55.
- Bentham, J. A. (1889): *Papilio polymnestor*, *P. dissimilis*, and *P. panope*. *Ibid.* 4: 315-316.
- Best, A. E. G. (and notes by Alfrey, J. I.) (1951): The Butterflies of Bombay and Salsette. *Ibid.* 50: 331-339.
- Best, A. E. G. (1955): Butterflies of Bombay and Salsette—Additions. *Ibid.* 53: 282-284.
- Editors (1959): Butterflies of Bombay and Salsette—Further Additions. *Ibid.* 56: 358-359.
- Wynter-Blyth, M. A. (1944): The Butterflies of the Nilgiris. *Ibid.* 44: 536-549.
- — — (1957): Butterflies of the Indian Region. Bombay.
- Yates, J. A. (1931): The Butterflies of Coorg. *J. Bombay nat. Hist. Soc.* 34: 1003-1014.

18. ADDITIONS TO THE BUTTERFLIES OF BOMBAY AND SALSETTE

Since 4th September 1959 a record is being maintained of the butterflies entering the Society's rooms at 91, Walkeshwar Road, Malabar Hill, which overlook Chowpati Bay and face south and east. Up to the middle of January 1960, the list extended to thirty different species including two which are an addition to the lists of the butterflies of Bombay and Salsette published in *J. Bombay nat. Hist. Soc.* 50: 331-9, 53: 282-4, 54: 215-6, and 56: 358-9. They are:

HESPERIIDAE

Baoris conjuncta (Herrick-Schaffer): The Conjoined Swift.

LYCAENIDAE

Nacaduba nora (Felder): The Common Lineblue.

Nacaduba nora is also reported by our correspondent, Mr. Basil W. Wirth of 21 Colaba Chambers, Bombay 5, along with two other

Lycaenid additions, all taken by him at Colaba on 12 October 1959, namely:

Nacaduba dubiosa (Semper): The Tailless Lineblue.

Nacaduba beröe (Felder): The Opaque 6-Lineblue.

Bombay Natural History Society,
91, Walkeshwar Road,
BOMBAY 6,
February 11, 1960.

EDITORS

19. THE SUBMERGED LEAVES OF *NYMPHAEA PUBESCENS* WILLD.

(With one plate)

Conard (1905) in his monograph on the genus *Nymphaea* has described the germinating tuber of *N. lotus* (L.) Willd. He states: '... about three submerged leaves are first formed, varying greatly in size according to the supply of nourishment.' A summary of the three leaves he describes could be given thus: first leaf—petiole 3.8 cm. long, a filiform midrib 1.3 cm. long with minute protuberances on either side at the base representing the lamina; second leaf—deltoid, with rounded angles and broad, shallow, rounded sinus; third leaf—broadly deltoid, with deeper sinus. In a diagram accompanying this description (fig. 74, p. 195) the lamina of the first and second submerged leaves of *N. devoniensis* Hort. are shown, but they resemble the second and third leaves of his description of the previous species; possibly Conard also meant these 2 leaves are the last and next to last submerged leaves of this plant. He does not mention the leaves of *N. pubescens*, but assumes that leaf development is the same for the whole of his 'Lotos group'.

d'Almeida and Mullan (1925) describe the sprouting of the tuber of *N. pubescens* in this way: 'The first leaves are linear or acicular; then come the lanceolate, hastate and sagittate types successively . . . also: 'The sagittate leaf is succeeded by the cordate and finally by the mature, floating, orbicular leaf'. This description of the first submerged leaves of this species is accompanied by a diagram (fig. 30, p. 68) of a sprouting tuber (d'Almeida gives the exact size of the tuber and its leaves in a later paper, see below). These authors also offer a diagram of a seedling of the same species (fig. 35, p. 76) showing a rosette of 12 apparently submerged leaves, but the exact size of the leaves is not given.

d'Almeida (1926) describes the 'tubers' of this species, which form after November and December as the dry season approaches. They are usually 6 cm. long and 3.5 cm. in diam., but they get smaller on drying; also, they are 'only the upper part of the rhizome', and the only leaves present are the scales which are left after the preceding leaves have become reduced in size and form. Sprouting of these 'tubers' takes place at the beginning of the rainy season.

McCann (1935), in contrast, describes the 'tubers' for the same species as ovoid and roundish and about 1-4 cm. long on short or long stolons. These 'tubers' are produced by the rhizome amid the roots of young plants.

It is apparent that the mature form and size of the submerged leaves of *N. pubescens* have received some attention, but information is still lacking on the exact size and form of these leaves, particularly those preceding the first formed floating leaves. In an attempt to supply some of this information, young plants of *N. pubescens* were collected from the village tank at Khandala. In this tank regeneration of this species (locally called 'kamal') takes place in the shallow areas where the small, spherical 'tubers' (c. 1 cm. in diam. with a piece of stolon attached, cf. authors mentioned above) and their young delicate leaves are protected by the matted layers of grass, which occur in these areas. Most of the young plants collected had between 2 and 4 submerged leaves and between 2 and 3 floating leaves.

Three typical plants were selected and the last 2 submerged leaves and the first 2 floating leaves were recorded to show the exact size and form (A, B and C of Plate and Table). These submerged leaves

TABLE
Petiole length (in cm.) of some leaves of *N. pubescens*

	Submerged leaves		Floating leaves	
	1	2	3	4
Plant A ..	14.5	10.0	22.0	22.0
Plant B ..	9.5	6.0	9.0	18.5
Plant C ..	12.5	12.5	24.0	18.7

are similar to some depicted in the sketch of the seedling by d'Almeida and Mullan (see above). Another young plant was selected and 4 of its 5 submerged leaves (laminae only) are shown here (D 1-4 of Plate) simply to show some of the subtle changes in leaf form. This

particular plant had no floating leaves, as yet, and the youngest submerged leaf, though not shown, was similar to B2 although it was much smaller.

Some variation exists here even among the 3 plants (A, B, and C) growing under the same environmental conditions, still it is evident that the mature form is quite stable for the last 2 submerged leaves and also for the first 2 floating leaves of this species. In any case, these submerged leaves are much larger than any reported by Conard (1905) for any species in or out of the 'Lotos group'. The only submerged leaf recorded by him which approaches the size of the largest leaf depicted here is a leaf of *N. tuberosa* Paine (not in the 'Lotos group'), which is the third submerged leaf from one tuber (fig. 71, p. 190) and represents either the last or the next to last submerged leaf of this tuber. The lamina measures at its maximum length 6.5 cm. and at its maximum width 5.0 cm., in contrast to my A1 (next to last submerged leaf) the lamina of which measures at its maximum length its maximum width 5.0 cm., in contrast to my A1 next to last submerged leaf) which measures at its maximum length 9.0 cm. and at its maximum width 5.5 cm.

Only 2 examples of the stipules (found in pairs at the base of each leaf) are recorded in the Plate, since they vary little from leaf to leaf.

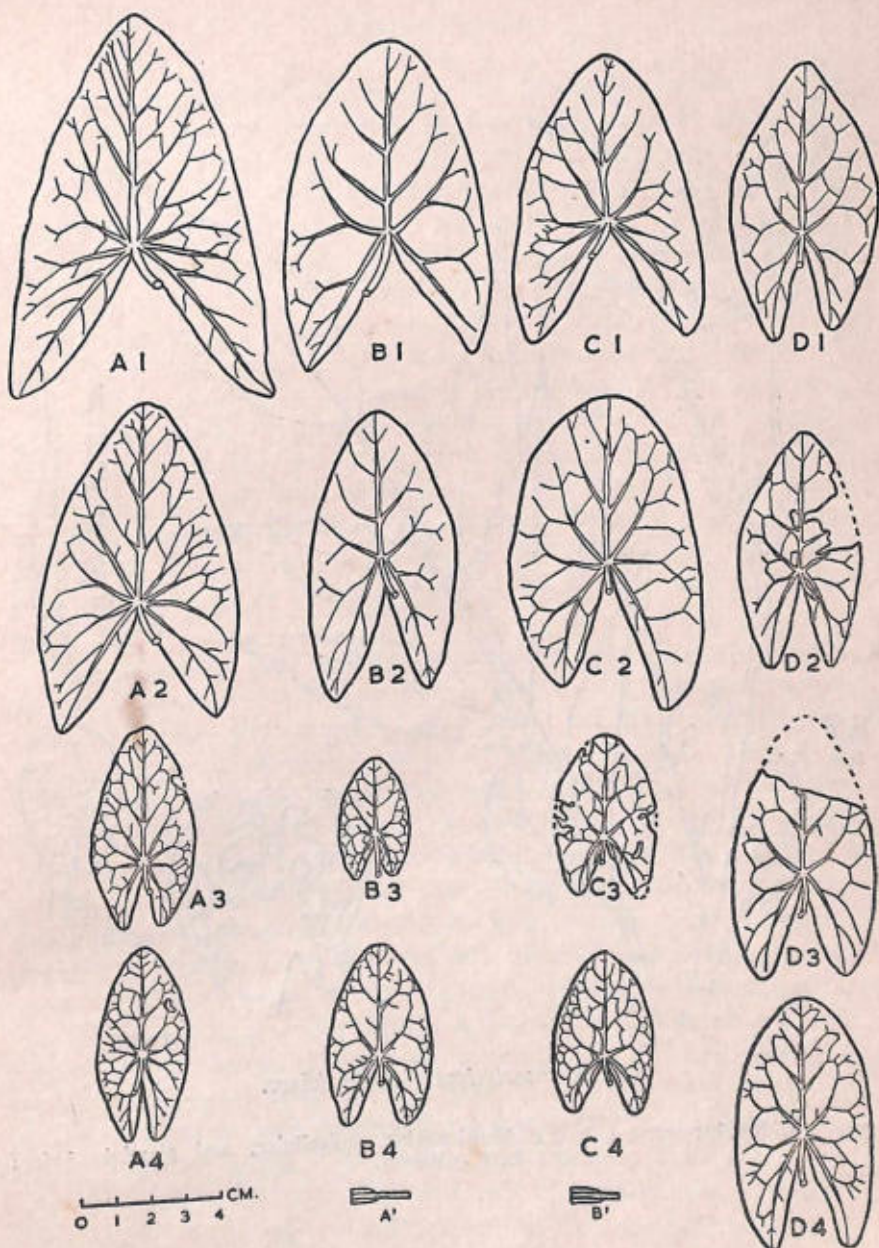
It may not be simply a coincidence that the largest submerged leaves reported so far for any *Nymphaea* species are found on two tuber-producing plants, but some points about the exact mode of tuber production in *N. pubescens*, as indicated, are in doubt.

ST. XAVIER'S COLLEGE,
BOMBAY,
February 1, 1960.

J. J. GAUDET

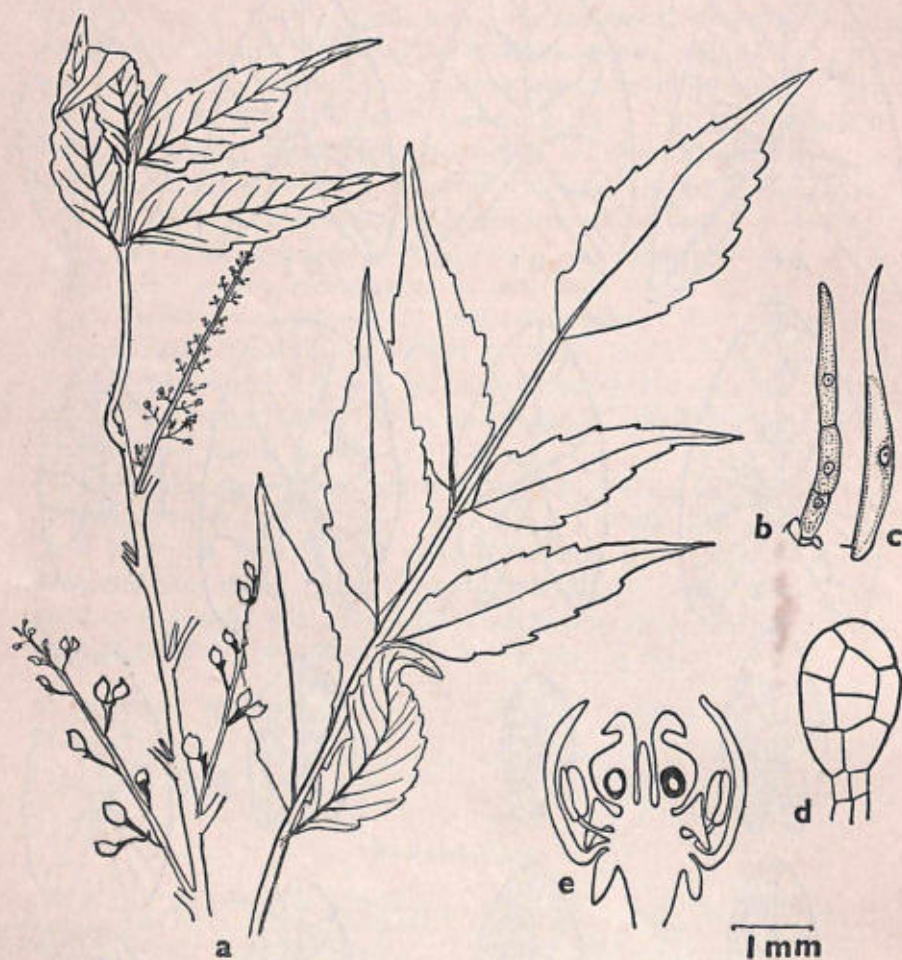
REFERENCES

- Conard, H. S. (1905): The waterlilies. A monograph of the genus *Nymphaea*. Pub. 4. Carnegie Instit., Washington.
- d'Almeida, J. F. R., & Mullan, D. P. (1925): *Nephrrolepis* and *Nymphaea*. The Popular Book Depot, Bombay. (3rd Ed., 1937).
- d'Almeida, J. F. R. (1925): Some notes on the structure and life-history of *Nymphaea pubescens* Willd. *Journ. Ind. Bot. Soc.* 5: 62-71.
- McCann, C. (1935): Some observations on *Nymphaea pubescens* Willd. *J. Bombay nat. Hist. Soc.* 37: 895-901.



Leaves of *Nymphaea pubescens* Willd.

A1-4, B1-4, C1-4 Laminae from 3 different plants (1 & 2 Laminae of last 2 submerged leaves, 3 & 4 Laminae of first 2 floating leaves); D1-4 Laminae of the submerged leaves of a single plant; A' Stipules of leaf B2; B' Stipules of leaf B3.



Brucea amarissima (Lour.) Merr.

a. Branch with inflorescence ; b, c, d. Multicellular, unicellular, and glandular hairs ;
e. L. S. of flower.

20. *BRUCEA AMARISSIMA* (LOUR.) MERR.—A NEW
RECORD FOR SOUTH INDIA

(With one plate)

Brucea is a pantropical genus of the family Simaroubaceae with about six species, of which two, *B. amarissima* and *B. mollis*, are reported from various parts of India; they are said to be common in Assam, Tenneserim, Andaman Islands, Singapore, Borneo, Sumatra, Java, Philippine Islands, S. China, and Australia.

While on holiday in my native Perunnai, Changanacherri, Kerala State, during the summer vacation of 1952, I observed a plant of *Brucea amarissima* in flower in waste lands near the town club. Subsequently I came across several plants in other places. These plants were said to be wild or spontaneous, not cultivated. The bark and seeds of the species are used in medicine, particularly in the treatment of dysentery; for this reason the plant is well known in those parts of Kerala. On the other hand none of the floras of south India consulted mentioned the plant for the area. Cameron (1894), Rama Rao (1914), Gamble (1915), Fyson (1915, 1932), Bourdillon (1937) have been studied; none of them has reported the genus *Brucea* for south India.

This absence of data on the plant prompted me to make an intense search in various parts of Kerala; this note is based on my observations of the last seven years. I have found the plant growing wild in a number of localities, such as Changanacherri, Thiruvalla, Kanjirapally, Kottayam, etc., in hilly areas; it may be found in other places. The plant does not seem to grow in the coastal areas; my specimens have been examined or collected from the hills.

Brucea amarissima is a small tree, 5-8 m. high. Leaves alternate, imparipinnately compound, 30-45 cm. long; leaflets 7-13, lanceolate, acuminate, serrate, 7.9×2-2.3 cm., the terminal one usually larger; veins 10-12, more prominent and covered with yellow pubescence on the lower surface. Inflorescence axillary, paniculate, of variable length (7.5-35 cm.), densely yellow-pubescent. Flowers bisexual, minute, in alternate distant cymes; pedicels 4-5 mm. long, thickened in fruit, pubescent with unicellular, multicellular, or glandular hairs. Calyx 4-partite, minute, 0.5-0.7 mm. long, valvate (I have not been able to confirm Hooker's statement that the sepals are imbricate), rarely persisting in fruit. Corolla 4-partite, valvate, spathulate, 1.5-2 mm. long. Stamens 4, shorter than and alternating with the petals, inserted beneath a very prominent disc. The lower portion of the disc is four-lobed, the lobes opposite the petals, the upper portion is

cup-like and four-celled, each cell enclosing a carpel. Gynecium of four free carpels; style very short, stigma reflexed. Drupes fleshy, purplish black, ovoid, one-seeded; generally out of the four carpels, only one or at most two develop into fruit. Seeds smooth, slightly albuminous; seed coat thin, membranous. Embryo of two cotyledons, which are fleshy. The floral axis continues above the level of the carpels.

Flowers and Fruits: May-August.

The fruits are eaten by birds, and the latter thus help in the distribution of the species.

I am grateful to Messrs. O. J. Kuruvilla and M. D. Joseph of St. Berckman's College, Changanacherri, for the help rendered in the preparation of this note.

BIRLA COLLEGE,
PILANI,
October 15, 1959.

N. C. NAIR

REFERENCES

- | | |
|--|---|
| Bourdillon, T. F. (1837): The Forest Trees of Travancore. 2nd ed., Trivandrum. | Fyson, P. F. (1932): The Flora of South Indian Hill Stations. Madras. |
| Cameron, J. (1894): The Forest Trees of Mysore and Coorg. Bangalore. | Gamble, J. S. (1915): Flora of the Presidency of Madras. London. |
| Fyson, P. F. (1915): The Flora of the Nilgiri and Pulney Hilltops. Madras. | Hooker, J. D. (1875): Flora of British India. London. |
| | Rama Rao, M. (1914): Flowering Plants of Travancore. Trivandrum. |

21. THE IDENTITY OF THE *ENTADA* PLANTS FROM BOMBAY

Th. Cooke, in his FLORA OF THE PRESIDENCY OF BOMBAY 1: 437, 1903, has listed a plant under the name *Entada scandens* Benth., locally known in various parts of Bombay under the name of *Garbi* in Marathi. The nomenclature and synonymy of the plant is more than ordinarily complicated. In my 'Flora of Khandala on the Western Ghats of India (in *Rec. Bot. Surv.* 16 (1): 94, 1953, I listed the plant under the name *Entada phaseoloides* (Linn.) Merrill. A recent paper by J. P. M. Brenan in *Kew Bulletin* (1955: 161 et seq.) has caused me to re-examine all the sheets of the genus in Blatter Herbarium, after which revision I came to the conclusion that all the specimens from Khandala and other parts of the W. Ghats should be called *Entada pursaetha* DC.

To check this conclusion I had several specimens sent to the Royal Botanic Garden, Kew, for examination by Mr. Brenan. The results of this second examination were communicated to me by Mr. Brenan in a private letter, in which among other things, he writes: 'The specimens of *Entada* which you mentioned in your letter of the 6th March have arrived safely. I have now examined them and, as I think we both expected, there seems no evidence at all against all of them being *Entada pursaetha* DC.'

To help other Bombay botanists in the identification of their specimens this note is being written.

Entada scandens Benth. was based on *Mimosa scandens* Linn. (1763), which as Johnston has shown in Sargentia (1949) was an aggregate species, of which the most typical plant was that mentioned by Rumphius in Herb. Amboin. 5: 5-8, t. 4, 1750, under the name of *Faba marina*. The correct name for this plant is *Entada phaseoloides* (Linn.) Merrill, 1914, based on *Lens phaseoloides* Linn., 1754. *Mimosa scandens* Roxb. Fl. Ind. 2: 554, 1832, from Sylhet seems to be a different plant from *M. scandens* Linn., but its identity is not yet clear.

Entada pursaetha DC. is given in the literature as being a plant from Africa; however, Alston has listed it as the name of the species to be found in Ceylon; it is also the name of our plant in Bombay State. The nomenclature of these two plants is the following:

(a) *Entada phaseoloides* (Linn.) Merr. in Philipp. Journ. Sci. 9: 86, 1914; Brenan in Kew Bull. 1955: 164; (non Santapau, 1953). *Lens phaseoloides* Linn. Herb. Amboin. 18, 1754. *Mimosa scandens* Linn. Sp. Pl., ed. 2, 1501, 1763. *Entada scandens* (Linn.) Benth. in Hook. Journ. Bot. 4: 332, 1841 (non Baker in Hook. f. Fl. Brit. Ind. 1: 287, nec Cooke).

The real *E. phaseoloides* Merr. comes from Amboina in the Moluccas, and does not extend to India. *E. scandens* Benth. is identical with *phaseoloides*, and does not extend to India, in spite of the fact that the name has been used in most of our provincial floras. This plant has 1-2, occasionally up to 3, pairs of leaflets; the pod is straight or curved but not twisted; the inner layer of the pod has the consistency of tough parchment.

(b) *Entada pursaetha* DC. Prodr. 2: 425, 1825 (excl. syn. nonnullis) & Mem. Leg. 421, 1826; Brenan in Kew Bull. 1955: 164. *Mimosa entada* Linn. Sp. Pl. 518, 1753. *Entada rheedii* Spreng. Syst. 2: 325, 1825. *E. monostachya* DC. Prodr. 2: 425, 1825. *E. scandens* Cooke, Fl. Pres. Bombay 1: 437, 1903, (non Benth. 1841).

Three of these names, viz. *pursaetha*, *rheedii*, and *monostachya*, all date from 1825, and there is no evidence to show that *rheedii* is prior to the others; for this reason Brenan has selected *E. pursaetha* DC. which in addition 'can be well typified and which has been adopted as the name of the common Ceylon plant by Alston, Fl. Ceylon, 6, 95 (1931) . . . The distribution of *E. pursaetha* is very wide, from West and East Africa eastwards to China, Guam, New Guinea and northern Australia.' (Brenan, loc. cit. 164.)

This plant is described as having 3-4, occasionally up to 5, pairs of leaflets; the pods are straight or curved but not twisted; the inner layer of the pod is thick, rigid, woody; the axis of the inflorescence is subglabrous to somewhat pubescent; the calyx is glabrous.

The identity of the Assam-Nepal plant remains doubtful; Brenan states *in litt.*: 'it may be an extreme variant of *E. pursaetha* itself, but it would be unwise to come to a final verdict without more evidence.'

From the foregoing notes, it is clear that the plant which is common in Khandala and other parts of the Western Ghats is not *Entada scandens* Benth. nor *E. phaseoloides* Merr., but it is *Entada pursaetha* DC. It is now too late for me to take up this name for the 2nd edition of my *Flora of Khandala*, which is expected to be out in the near future; this is why this correction is published in this *Journal*.

It is with a deep sense of gratitude that I wish to acknowledge the help received from Messrs. C. E. Hubbard and J. P. M. Brenan of the Royal Botanic Gardens, Kew, in the identification of my specimens of *Entada* from Bombay.

ST. XAVIER'S COLLEGE,
BOMBAY 1,
November 24, 1959.

H. SANTAPAU, S.J., F.I.N.

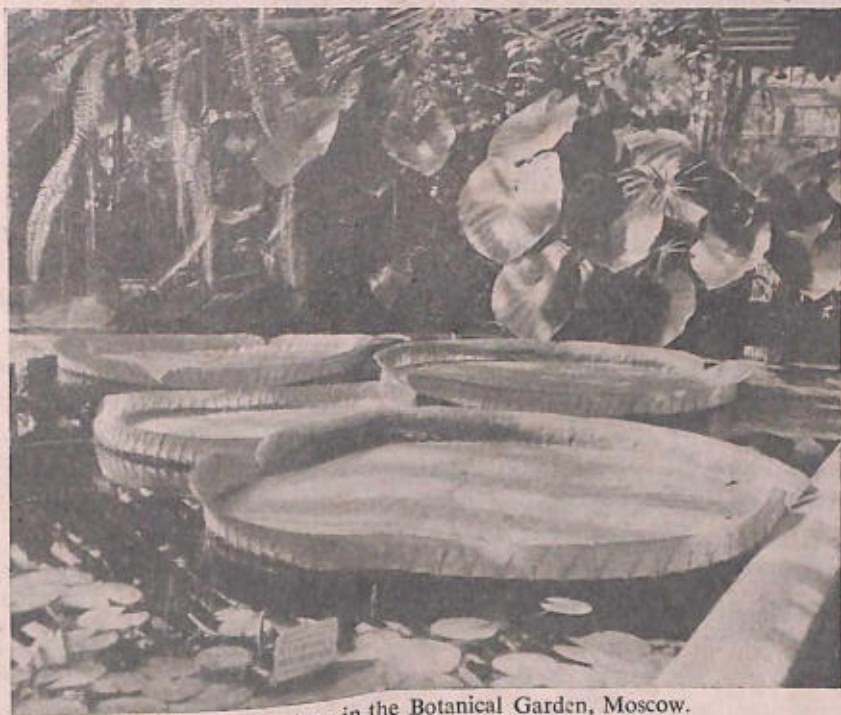
22. THE MAIN BOTANICAL GARDENS OF THE U.S.S.R.

(With a photo)

Moscow acquired a new and important scientific centre and at the same time a splendid place where people can rest when the main botanical gardens of the U.S.S.R. Academy of Sciences were opened. They occupy 360 hectares¹ of land in a picturesque suburb of the capital, in the natural conditions typical for the central zone of the

¹ One hectare = 2.471 acres.—Eps.

U.S.S.R. Two-thirds of the territory are woodland: oak forest, birch grove, pine wood, and mixed forest. Most of the trees are in their prime, being from 70 to 80 years old, some of the oaks are 200 years old.



Victoria cruziana in the Botanical Garden, Moscow.

The staff of the botanical gardens are doing important research work and solving many problems of plant acclimatization. Scientists select the most promising wild plants for cultivation and breed new varieties useful to the national economy or suitable for planting in cities, villages, and health resorts.

Special care is devoted to the development of I. Michurin's theories. The great scientist's work in distant hybridization is continued with successful results, both theoretical and practical. Crossing cultivated plants with wild varieties has produced hybrids with greater biological resistance and higher yields.

The scientists who work in the gardens also conduct research in biochemistry, the use of stimulants of plant growth, and other subjects.

The new botanical gardens are rapidly becoming popular with Muscovites. Many visitors to the capital also come here, for the gardens are included in the plan of excursions for tourists from all

parts of the Soviet Union and foreign countries. The big collection of plants from different parts of the U.S.S.R. and many other countries is of great interest. It includes about 400,000 specimens of 11,000 different plants—a really tremendous collection.

The exposition of U.S.S.R. flora occupies 25 hectares, showing about 3000 plant species, or more than one-tenth of the plants growing in the U.S.S.R. and the most typical at that. Visitors to this section can see plants from the Carpathians, the Ukrainian steppes, the Crimea, the Caucasus, central Asia, Siberia and the Far East. The Far Eastern flora is represented by 800 different plants, including the Amur cork oak, the white walnut tree whose wood is used for veneer, and the Korean cedar. Lianas hang from the branches of trees and enormous ferns grow at their foot. Grass varieties are very numerous, especially those that come from Sakhalin, including angelica, wild rye, and many other species.

A garden where flowers bloom from the beginning of May until late autumn grows at the edge of the oak wood. The first to blossom are lilies-of-the-valley, growing among the roots of the oaks. They are followed by narcissus, tulips, lilac, and peonies. Phlox of the most varied colours are now in bloom and dahlias are beginning to open up—autumn is approaching.

The botanical gardens have the biggest collection in the U.S.S.R. of trees and shrubs growing in open ground. They come from different parts of the world. Nine hundred species are distributed according to systematic features and are supposed to form one-third of the trees and shrubs that can grow in the conditions of the Moscow district.

In the section of cultivated plants visitors can observe plant evolution and see how, under man's influence, plants were transformed from wild species to the modern varieties of vegetables, fruit, and industrial plants. Varieties bred by Michurin and his numerous followers can be seen here.

The huge glass building standing in one of the glades is a conservatory housing a big collection of tropical and subtropical plants. There are more than 10,000 specimens of plants from evergreen forests, warm lakes and rivers, savannas and deserts. A temperature and humidity similar to those of the natural environment of the plants collected in the conservatory are maintained in every section.

The rich collections of the main botanical gardens of the U.S.S.R. are open for everybody to see.

C/O U.S.S.R. EMBASSY IN INDIA,
NEW DELHI.

B. KOTELNIKOV

23. THE WATER HYACINTH—AN APPEAL FOR INFORMATION

May I enlist your help in the following matter? When I settled down in West Bengal in 1957, I noted that the flowers of *Eichhornia crassipes*, the water hyacinth, had one set of stamens longer than the style, another set shorter. This suggested that the flowers are trimorphically heterostylic, like those of *Lythrum salicaria*. That is to say, we would expect also to find long-styled flowers, in which there were two sets of stamens shorter than the style, and short-styled flowers, in which there were two sets of stamens longer than the style, as well as the common mid-styled form.

I found a long-styled plant in a swamp near Madras, and my colleague Shri S. K. Roy has found another in a tank at Bangalore, but the condition is clearly rare in India and is not represented in herbaria which we have seen.

On the other hand the long-styled form is quite common both in Singapore and on the mainland of Malaya, as Shri Roy observed in 1958.

I suggest that readers of the *Journal* might care to report to the Bombay Natural History Society on the form of this plant in their neighbourhood, the reports to be collated by the Society when enough accumulate. I should personally be glad to hear of long-styled or short-styled flowers, since it may be possible to investigate their genetics.

INDIAN STATISTICAL INSTITUTE,
BARRACKPORE TRUNK ROAD,
CALCUTTA,
January 9, 1960.

J. B. S. HALDANE

Gleanings

HYDEL WATER AND PLANT LIFE

Speaking of the Owen Falls Hydro-Electric Scheme in East Uganda, Richard St. Barbe Baker (1954) says in SAHARA CHALLENGE [Lutterworth Press, London]: 'As an ecologist I could not share this enthusiasm. In what they are doing I saw certain disaster. Water that comes through a turbine is physically different from when it went in. In the process, electro-magnetic force, which keeps the trace elements in motion in each molecule or electron, is given off, with the result that those essential elements drop out; the water goes on its way deprived of them and they are needed to promote fertility and the growth of wholesome food. Also the vitality of the water is beaten out of it and it becomes flat and sick and affects the whole course of the river or valley through which it passes. I have witnessed this phenomenon for myself in the U.S.A. where the much-vaunted Tennessee Valley Project has reduced the stamina of vegetation, exposing plant life to pests, nature's method of eliminating sick plants and animals.'

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
18 CHURCH ROAD, VEPERY, MADRAS—6-7-1960. C3575
EDITORS: SÁLIM ALI, AND H. SANTAPAU
91 WALKESHWAR ROAD, BOMBAY 6

CONTENTS

	PAGE
STUDIES ON THE REPRODUCTIVE BEHAVIOUR OF THE BAYA WEAVER [<i>Ploceus philippinus</i> (L.)]. By John Hurrell Crook	1
VEGETATION OF KODAIKANAL IN SOUTH INDIA. I. SYSTEMATIC LIST OF TREES, SHRUBS, AND HERBS. By Raj Kumar Gupta	45
FISHES FROM THE KASHMIR VALLEY. By E. G. Silas	66
THE DIATOM FLORA OF THE BOMBAY AND SALSETTE ISLANDS. By H. P. Gandhi..	78
CRITICAL NOTES ON THE ORCHIDACEAE OF BOMBAY STATE. II. <i>Platanthera</i> L. C. RICH. & <i>Peristylus</i> BL. By H. Santapau and Z. Kapadia	124
CONSTANCY TO HORTICULTURAL VARIETIES SHOWN BY BUTTERFLIES, AND ITS POSSIBLE EVOLUTIONARY SIGNIFICANCE. By Krishna Rao Dronamraju and Helen Spurway	136
SYSTEMATICS AND ECOLOGY OF INDIAN PLANTS. I. ON THE RAINY SEASON WEEDS OF GORAKHPUR. By D. N. Sen	144
ON SOME NEW SPECIES OF SPIDERS (ARACHNIDA) OF THE FAMILY THOMISIDAE FROM INDIA. By B. K. Tikader	173
THE VEGETATION OF KANYAKUMARI DISTRICT (CAPE COMORIN). By C. A. Lawrence	184
SOME OBSERVATIONS ON THE BIOLOGY OF <i>Labidura riparia</i> (PALLAS) (LABIDURIDAE, DERMAPTERA) FROM POONA. By P. V. Joshi	196
LEAVES AND TENDRILS AS AIDS FOR IDENTIFICATION OF CUCURBITS. By Priyadarsan Sensarma	204
REVIEWS	208
MISCELLANEOUS NOTES	213
GLEANINGS.. .. .	244