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Breeding habits and associated phenomena in some Indian bats

Part I—*Rousettus leschenaulti* (Desmarest)—Megachiroptera[1]

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(*With a plate and two text-figures*)

The following report is based on the examination of 1367 specimens of the Indian fruit bat, *Rousettus leschenaulti* (Desmarest) collected at frequent intervals at and near Aurangabad, Maharashtra during a period of about two years and a half. There is no segregation of the specimens on the basis of sex, age or season. The uterine cornua open independently through separate cervical canals into the vagina. Each female experiences two pregnancies in quick succession in the year. The first pregnancy starts in the second week of November and terminates in the middle of March. The second pregnancy starts soon after parturition and goes until the last week of July. Gestation lasts for about 125 days. The early part of the second pregnancy overlaps the lactation period of the first pregnancy cycle. The animals are sexually quiescent from August to November. While most of the females in the colony become pregnant in November, a few become pregnant in the third week of December and deliver their young during the last week of April or early in May. After December all the females in the colony are pregnant. During each pregnancy only one uterine cornu bears a single embryo, and the two uterine cornua function alternately in successive cycles in bearing pregnancy. Whereas the females reach sexual maturity within five months of age, the males do not attain sexual maturity until they are at least 15 months old. There is a balanced sex ratio at birth, but in the adult stage the females out-number the males.

Introduction

Most of the early record on the reproduction of Megachiroptera are in the nature of casual references to the occurrence of pregnant specimens during certain seasons of the year while reporting on some other aspect of the biology of bats. An excellent review of the previous work on the reproduction of fruit bats was given by Baker & Baker (1936), and more recently by Asdell (1964), who compiled a valuable bibliography of the earlier work on

[1] Accepted September 1975.

the reproduction of fruit bats. From these reviews it is evident that most of the fruit bats, both in northern and southern hemispheres, tend to copulate in the respective "Autumn" and give birth to the young in the following "Spring".

Baker & Baker (1936), who were the first to make a detailed study of the breeding habits of fruit bats, *Pteropus geddiei* and *Pteropus eotinus* from Hog Harbour, New Hebrides (15° 15′ S), noted that these species have a sharply defined breeding season although living in an almost unvarying tropical climate, and that they copulate in February-March (Southern Autumn) and deliver the young during August-September (Southern Spring) bringing forth a single young each time.

Marshall (1947) reported that *Pteropus giganteus* from Sri Lanka has a sharply defined annual breeding season despite the climatic stability of its habitat. According to the author, this species conceives from early December until early January, and the young ones are delivered late in May or early in June. Pregnancy lasts for about six months and a single young is born to each female. Ramakrishna (1947) noticed that *Cynopterus sphinx sphinx* at Bangalore (South India) experiences post-partum oestrus and that at least two pregnancies occur in quick succession in the year. He also noted that gestation lasts for about five months in this bat.

Moghe (1951) noted that *Pteropus giganteus* in Central India copulates late in August or early in September and that a single young is delivered by each female towards the end of January or February, the gestation being of 140 to 150 days. Moghe's (1951) observations differ from the observations of Marshall (1947) on the same species, but in Sri Lanka, thereby indicating that this species differs in its reproductive habits in different regions with different climatic conditions. Brosset (1962a), while studying the ecology of *Rousettus leschenaulti,* mentioned, "from the data available, this species appears to have two periods of parturition every year, the first in March and the second in August, the latter concerning a small number". Each time a single young is born. With respect to *Pteropus giganteus* he reported that "the periodicity of the reproductive cycle is very regular, and that only a single parturition takes place every year at least in Western India". In a preliminary note Gopalakrishna (1964) reported that *Rousettus leschenaulti* breeds more than once in the year, that the females undergo copulation within a short time after the young are delivered in April, and that a single young is born each time. Pregnancy alternates between the two uterine cornua in successive cycles.

Mutere (1965 & 1967) noted the occurrence of delayed implantation in the tropical African fruit bat, *Eidolon helvum,* which has a strict periodicity of reproduction although inhabiting a region almost squarely on the equator (latitude 0° 20′ N). Copulation in this species is immediately followed by fertilization during April-June, but the implantation of the embryo does not take place until about October. Unimplanted embryos were present in the uterus between June and October. Progressively advanced stages of the embryo were noticed from October to February and deliveries occurred during February and March. Although the uterus is bicornuate and perfectly symmetrical, ovulation and pregnancy occur only on one side, either right or left, with about equal frequency, but never on both sides at the same time.

The foregoing review of earlier literature reveals that not only is there no detailed study of the breeding habits of any Indian fruit bat,

Date	Immature Attached to mother	♂♂ Free	♂♂ Adult	Total of ♂♂	Immature Attached to mother	Free	Adult: Non-pregnant Non-lactating	Adult: Non-pregnant Lactating	Adult: Pregnant Non-lactating Right horn	Adult: Pregnant Non-lactating Left horn	Adult: Pregnant Lactating Right horn	Adult: Pregnant Lactating Left horn	Total of ♀♀	Grand Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7-i-65	—	2	3	5	—	—	—	—	11	6	—	—	17	22
8-i-65	—	2	6	8	—	—	—	—	3	2	—	—	5	13
11-i-65	—	2	13	15	—	—	—	—	6	15	—	—	21	36
16-i-65	—	2	8	10	—	—	—	—	9	3	—	—	12	22
25-i-65	—	3	10	13	—	—	—	—	13	3	—	—	16	29
27-i-65	—	1	21	22	—	—	—	—	7	17	—	—	24	46
8-ii-64	—	5	17	22	—	—	—	—	9	21	—	—	30	52
9-ii-65	—	7	6	13	—	—	—	—	6	11	—	—	17	30
26-ii-65	—	4	7	11	—	—	—	—	3	3	—	—	6	17
28-ii-64	—	3	13	16	—	—	—	—	4	13	—	—	17	33
12-iii-64	—	1	7	8	—	—	—	—	8	16	—	—	24	32
13-iii-65	1	9	14	24	—	—	—	1	5	4	—	—	10	34
18-iii-65	4	4	8	16	2	—	—	1	2	1	2	3	11	27
22-iii-64	1	—	10	11	—	—	—	—	6	9	—	1	16	27
27-iii-66	1	—	1	2	3	—	—	—	1	3	1	3	11	13
29-iii-65	—	4	3	7	2	—	—	—	1	—	1	1	5	12
3-iv-64	7	2	8	17	8	—	—	—	8	4	7	8	35	52
5-iv-64	12	2	7	21	9	—	—	—	3	8	14	7	41	62
5-iv-65	2	3	3	8	2	—	—	—	—	4	—	4	10	18
8-iv-64	3	3	5	11	2	—	—	—	3	2	1	5	13	24
13-iv-64	3	4	13	20	—	—	—	—	1	7	3	2	13	33
13-iv-65	1	3	3	7	—	—	—	—	—	1	—	—	1	8
15-iv-66	2	1	1	4	5	—	—	—	1	5	—	2	13	17
19-iv-65	3	2	9	14	4	1	—	—	2	4	2	7	20	34
24-iv-65	3	1	3	7	6	—	—	—	—	4	1	5	16	23
1-v-65	1	1	13	15	2	2	—	—	—	2	3	—	9	24
7-v-66	—	—	2	2	3	—	—	3	—	—	1	5	12	14
10-v-65	1	2	2	5	—	—	—	—	—	—	1	—	1	6
13-v-65	1	1	6	8	—	2	—	—	—	1	1	—	4	12
19-v-65	—	5	1	6	—	9	—	—	—	4	—	—	13	19
22-v-65	—	—	5	5	—	—	—	—	1	—	—	—	1	6
23-v-65	—	4	1	5	1	2	—	—	—	1	—	—	4	9

TABLE 1 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-vi-65	—	8	1	9	—	5	1	—	—	5	—	—	11	20
3-vi-64	—	1	4	5	—	—	—	—	1	2	—	—	3	8
9-vi-65	—	5	6	11	—	3	1	—	5	11	—	—	20	31
26-vi-64	—	1	1	2	—	—	—	—	1	1	—	—	2	4
27-vi-65	—	8	3	11	—	13	3	—	1	2	—	—	19	30
10-vii-65	—	6	—	6	—	8	—	—	—	2	—	—	10	16
16-vii-64	—	—	3	3	—	6	4	—	—	—	—	—	10	13
24-vii-65	2	2	6	10	2	2	6	10	—	—	—	—	20	30
17-viii-65	1	1	11	13	—	—	6	1	—	—	—	—	7	20
18-viii-64	—	—	1	1	—	—	—	—	—	—	—	—	—	1
26-viii-64	—	2	1	3	—	1	3	—	—	—	—	—	4	7
1-ix-64	—	1	1	2	—	1	3	—	—	—	—	—	4	6
5-ix-65	—	—	6	6	—	1	5	—	—	—	—	—	6	12
14-ix-65	—	2	4	6	—	2	9	—	—	—	—	—	11	17
19-ix-64	—	1	6	7	—	3	4	—	—	—	—	—	7	14
21-ix-64	—	3	5	8	—	3	3	—	—	—	—	—	6	14
7-x-65	—	—	5	5	—	2	8	—	—	—	—	—	10	15
17-x-65	—	1	3	4	—	1	8	—	—	—	—	—	9	13
2-xi-64	—	3	3	6	—	—	2	—	—	—	—	—	2	8
2-xi-65	—	4	7	11	—	3	8	—	—	—	—	—	11	22
6-xi-65	—	8	3	11	—	4	7	—	—	—	—	—	11	22
9-xi-65	—	2	6	8	—	—	—	—	2	10	—	—	12	20
17-xi-64	—	1	4	5	—	1	—	—	1	—	—	—	2	7
20-xi-65	—	1	3	4	—	—	—	—	9	3	—	—	12	16
22-xi-64	—	2	3	5	—	—	—	—	5	—	—	—	5	10
27-xi-64	—	2	16	18	—	—	—	—	10	2	—	—	12	30
2-xii-64	—	6	13	19	—	1	—	—	13	4	—	—	18	37
7-xii-64	—	6	5	11	—	1	—	—	11	1	—	—	13	24
10-xii-65	—	—	4	4	—	—	—	—	8	3	—	—	11	15
19-xii-64	—	3	10	13	—	—	—	—	11	—	—	—	11	24
22-xii-65	—	4	2	6	—	—	—	—	9	2	—	—	11	17
30-xii-64	—	5	12	17	—	—	—	—	18	3	—	—	21	38

but the little information which is available, indicates that there are considerable differences in the breeding habits of the different species. Hence, it was felt that a detailed study of the reproductive biology of the Indian fruit bat, *Rousettus leschenaulti* would be of interest and value.

Material and methods

The specimens of *Rousettus leschenaulti* were collected at random at frequent intervals from an underground tunnel near Bibika-Mukbara at Aurangabad, Maharashtra State. A few collections were also made from the dungeons of a dilapidated fort near Kandar about 200 air kilometres from Aurangabad. No segregation of the specimens on the basis of sex, age or season was noticed in either of the localities.

Collection of specimens was started on 11th January 1964 and continued until 7th May 1966 in such a manner that every calendar month of the year is represented by one collection or more. A collection diary mentioning the details of the description of each specimen was maintained. Table 1 gives the summary of the collection diary, and table 2 gives the month-wise distribution of the collections.

The specimens were killed by chloroform and, after recording their body weights, they were dissected and the reproductive organs and the accessory reproductive structures were removed and fixed in various fixatives. The tissues were sectioned at 8 to 10 μ thickness after following the usual procedure of dehydration by passing through graded series of ethanol and embedding in paraffin. The sections were stained in Ehrlich's haematoxylin and counterstained with eosin and mounted in DPX after clearing in xylol.

Altogether 1367 specimens were studied for the present work. The group of specimens collected on a given date exhibited almost the same characteristics during the three years the observations were made. Hence, in the following descriptions only the date and the month are mentioned where pertinent except where the mentioning of the year has a special significance.

Table 2

Monthwise collection of specimens

Month	♂♂	♀♀	Total
Jan.	73	95	168
Feb.	62	70	132
Mar.	68	77	145
Apr.	109	162	271
May	46	44	90
June	38	55	93
July	19	40	59
Aug.	17	11	28
Sept.	29	34	63
Oct.	9	19	28
Nov.	68	67	135
Dec.	70	85	155
Total	608	759	1367

Observations and discussion

1. *Morphology of the female reproductive organs*

As in most other species of bats so far described, excepting the members of the family Phyllostomatidae, the uterus is bicornuate and the uterine cornua are morphologically symmetrical. The ovaries, which are ellipsoidal in shape, are slightly flattened dorsoventrally. The ovarian bursa has an oblique slit-like opening on its median side so that the periovarial space is in communication with the peritonial cavity. The Fallopian tube on each side arises on the mesial aspect of the ovarian bursa adjacent to the slit in the bursa, curves towards the lateral sides after passing across the ventral aspect of the ovary, and opens near the cranial end of the uterus. Although the two uterine cornua meet externally their lumina remain separate, and open into the vagina through independent cervical canals. The cranial half of the vaginal canal is broad, and the cervix protrudes as a hemispherical bulb into this cavity. The lumen of the vagina is narrow in the caudal half. A distinct, but flattened, clitoris is present abutting against the ventral surface of the vaginal wall near the vaginal orifice.

A pair of mammary glands are present, one on each of the ventrolateral sides of the thorax, and the nipples, which are prominent in the parous forms, are directed laterally.

2. *Breeding habits*

The examination of table 1 reveals some interesting features. Pregnant females occur in all the months of the year except August to October. Secondly, two deliveries occur in the year, once during March-April, and a second time during July. Thirdly, within a short period after delivering the young in March-April, every female becomes pregnant again, but after the second delivery in July, the next pregnancy does not commence until the following year. Thus, the period from August-November may be considered as the period of sexual quiescence for this species.

The females collected on 2nd November had not copulated, but all the parous and the mature non-parous females collected on 6th November had undergone copulation as evidenced by the fact that the vaginal canal was full of secretion from the seminal vesicle of the male and the uterine lumen contained sperms. Evidently all mature females copulate in a very sharply defined period in the first week of November. Ovulation takes place after copulation in this species as revealed by the fact that the ovary had not released the ovum in most of the females collected on 6th November, although the females had undergone copulation. Tubal ova and early free blastocysts were present in females collected on 9th and 17th November respectively. Unmistakable early pregnancy as indicated by the swelling of one of the uterine cornua was noticed in several females collected on 20th November (Pl. I—fig. A).

Table 1 and Pl. I fig. A reveal that not all the females become pregnant in November, and during the period from 9th November to 19th December there were many pregnant and a few non-pregnant females in each collection. Whereas all the parous females collected during this period were pregnant, among the non-parous females only some were pregnant. The parous females can be distinguished from the non-parous ones on the basis of the nature of the mammary nipples, which are large in the former and insignificant in the latter. The stage of pregnancy was more or less the same in all pregnant females collected on a given date during this period (Pl. I—Fig. A). This indicates that pregnancy must have started at about the same time in all these females.

Every female collected between 22nd December and 13th of the following March was pregnant. The absence of non-pregnant females in the collections during this period cannot be an accident because several collections were made during these months. Moreover, mention has already been made that there is no segregation of the specimens on the basis of sex, age or season. Hence, the data lead to the inevitable conclusion that all females are pregnant during the period from 22nd December to the middle of the following March. Evidently, the few non-parous females, which do not copulate until 19th December, undergo copulation about this time and become pregnant. Thus, in each collection during the months from January to the middle of March the females could be recognized into two distinct categories on the basis of the size of the gravid uterine cornu. Some were distinctly in more advanced stages of pregnancy than the others, pregnancy having commenced in the beginning of November in the former and in the third week of December in the latter (Pl. I—Figs. B & C). The young ones were delivered also in two batches—the first during the middle of March and the second during the last week of April or early in May.

A very early stage of the development of the embryo (cleaving egg) was noticed in a female collected on 9th November, and a female with an young at the breast was captured on the 13th of the following March. This must have delivered the young just a few hours before capture as borne out by the facts that the umbilical cord was still having a blood clot, the eyes of the young one were not yet open and there was a large clot of blood in the vagina of the mother. Therefore, one can conclude that the gestation period is about 125 days allowing a margin of a couple of days on either side from the date of which the cleaving egg was noticed (9th November) to the date of parturition (13th March).

Within a short time after the young are delivered in March-May, the females undergo copulation, and a second pregnancy commences within a few days after parturition. Every adult female experiences post-partum pregnancy during this period. This is revealed by the fact that every female in lactation collected during March, April and May was also pregnant. In each of these cases the second pregnancy was borne in the uterine cornu contralateral to the one in which the previous pregnancy was carried. Hence, the adult females collected during March, April and early May are either in advanced stages of pregnancy or they have delivered the young and have again become pregnant (Pl. I—Fig. D). Since parturitions of the first cycle occur in two batches, the pregnancies of the second cycle also commence in two batches. The first batch of pregnancies of the second cycle begins about the third week of March and the second batch about the end of April or the beginning of May.

A few young ones, free from their mothers, were collected on 19th April. Assuming that these were delivered in the first batch (about 13th March), it is evident that the lactation period lasts for about 35-40 days. During this time the females carry an young each at the breast and an embryo in one of the uterine cornua. Thus, the lactation period of the first cycle overlaps the gestation period of the second.

Although every adult female becomes pregnant after parturition in March-May, it appears as if the second pregnancy does not go to completion in all the females. From about the beginning of June progressively more and more females appear to lose their embryos as revealed by the fact that, amongst the adult females collected during June and early part of July, there were some which were non-pregnant. (The exact manner in which the embryos are lost is not known). Consequently, the number of females, which deliver the young in the second cycle, is much less than the number that becomes pregnant in March-May. Females in very advanced stages of pregnancy were collected on 10th July 1965. Many females, each carrying an young one at the breast, were collected on 24th July 1965. From the size of the attached young ones, whose body weights ranged from 14 to 15 gm, one can conclude that these might have been delivered 2 to 4 days before. Since the gestation period has been shown to be of about 125 days, it is evident that such of the females which deliver the young around the 20th July must have conceived some time in the third week of March.

No female was found to be pregnant after the 24th of July. This suggests that all the females, which experience post-partum pregnancy late in April must have lost their embryos, because, if these females had carried the conceptus to full term, they should have delivered the young some time during the end of August or the beginning of September, since the gestation period is about 125 days. Obviously, these must have been the few females, which had not copulated until the 19th December in the previous year, but underwent copulation and became pregnant about this time in the previous year.

There is perhaps a considerable loss of the new born young during July and the following weeks, as revealed by the fact that during July and August, although several females in full lactation were collected, many of these were not carrying the young at the breast.

The pregnancy cycles of *Rousettus leschenaulti* can be summarised as follows:

First Cycle: From November to the end of the following April. This includes two waves of pregnancy as follows—(1) Copulation during the early part of November and parturition about the middle of the following March. This refers to all the parous females and to a few non-parous females. (2) Copulation about the third week of December and parturition at about the end of the following April or early in May. This applies to the few non-parous females, which had not copulated in November.

Second Cycle: Post-partum pregnancy from March-May to about the third week of July. In this are included two waves of pregnancy as follows—

(1) *Copulation in about the third week of March followed by pregnancy.*

This refers to all the females which deliver the young ones during about the middle of March. It is not certain if all these females carry the pregnancy to full term and deliver the young. There may be some loss of embryos. Those females, which do carry the foetuses to full term, deliver the young by the end of the third week of July.

(2) *Copulation during the last week of April or early in May.*

These invariably lose their embryos and hence they never carry the pregnancy to full term.

From the foregoing account of the breeding habits of *Rousettus leschenaulti* it is evident that this species, with two quick pregnancies in a year, incorporates both the Autumn breeding pattern as in most other Pteropidae so far described (Baker & Baker 1936; Marshall 1947) and *Megaderma lyra lyra* (Gopalakrishna 1950; Ramakrishna 1951; Ramaswamy 1962) and *Hipposideros fulvus fulvus* (Patil 1968) among the Microchiroptera, and the spring breeding pattern as in several tropical and sub-tropical Microchiroptera (Baker & Bird 1936; Gopalakrishna 1947, 1958; Brosset 1962a,b,c, 1963; Anand Kumar 1965). In experiencing a quick post-partum oestrus, *Rousettus leschenaulti* resembles *Cynopterus sphinx sphinx* (Ramakrishna 1947) amongst Megachiroptera and *Nycteris luteola* (Matthews 1942), *Desmodus rotundus* (Wimsatt & Trapido 1952) and *Taphozous longimanus* (Gopalakrishna 1954, 1955) amongst the Microchiroptera.

3. *Number of young and the symmetry of the female genitalia.*

In each pregnancy *Rousettus leschenaulti* bears a single young, either in the right or in the left cornu of the uterus. Evidently, there is no physiological dominance of one side of the genitalia over the other. Further, pregnancy alternates between the two sides of the genitalia in successive cycles (Gopalakrishna 1964, 1969). Thus, after delivery in March-April, the next pregnancy (which follows within a few days after delivery) is carried in the cornu contralateral to the one in which the earlier pregnancy was borne. This is evidenced by the following facts. In most of the females, in which early pregnancy was noticed in the second cycle, the contralateral uterine cornu had not come back to normality. The corpus luteum of the previous pregnancy could be detected in the ovary of the contralateral side for quite some time after the second pregnancy had started. This was conclusively demonstrated for this animal by Gopalakrishna (1964). In those females, which carry the pregnancy to parturition in July in the second cycle, the corpus luteum of this pregnancy remains until even after the next pregnancy commences in the following November, so that, in these animals, the pregnancy in the second year occurs in the cornu opposite to the one in which pregnancy occurred during the previous summer. Apparently, the protracted persistence of the corpus luteum until about mid-pregnancy of the next cycle is an important factor which brings about a regular alternation in ovulation between the two ovaries. It is not possible to state as to whether this would be the case with regard to those females from which the embryos were lost during the summer pregnancy. There does not appear to be any physiological dominance of one side over the other in the females experiencing their first pregnancy.

Except some members of the family Vespertilionidae (Lyon 1903; Ramaswami 1933; Gopalakrishna 1947; Uchida 1950; Madhavan 1971), which normally bear more than one young in each litter, most other bats, which have been so far studied, carry a single young in each litter. In such monotocous bats there is a tendency for the physiological dominance of the right side over the left side (Robin 1881; Jones 1917; Matthews 1937, 1942) except in *Megaderma lyra lyra* (Gopalakrishna 1950; Ramakrishna 1951; Ramaswamy 1962) and *Hipposideros fulvus fulvus* (Patil 1968) where the left side shows dominance. In *Rhinolophus hipposideros minutus* (Matthews 1937) the left ovary does not even produce mature ova. Pregnancy alternates between the two sides of the genitalia in successive cycles in *Desmodus rotundus* (Wimsatt & Trapido 1952) and *Taphozous longimanus* (Gopalakrishna 1954, 1955), where a single young one is brought forth each time. The condition in *Rousettus leschenaulti* is, therefore, similar to that in *Desmodus rotundus* (Wimsatt & Trapido 1952) and *Taphozous logimanus* (Gopalakrishna 1954, 1955).

4. *Growth and maturity.*

There seems to be a considerable difference between the males and the females with respect to the age at which sexual maturity is attained in *Rousettus leschenaulti*. Table 1 reveals that during the breeding season, whereas all the females become pregnant, many males have immature gonads. This indicates that the females attain sexual maturity in the very first breeding season after their birth, but the males do not attain sexual maturity until at least the second breeding season. Further, the lowest body weight of the female showing unmistakably pregnancy is 55 gm, but in the case of the males their gonads are immature until they reach a body weight of 73 gm. Hence, the weight at which the sexual maturity is reached is about 55 gm in the females and about 73 gm in males.

(a) **Female**

The new born young weighs about 12 gm as is evidenced by the fact that the lowest body weight of the young one attached to the breast of the mother was 12 gm, and the highest weight of the foetus at full term was also 12 gm. The first wave of delivery pertaining to the first cycle occurred in the middle of March, and the first batch of young ones free from the mothers' breasts were collected on 19th April. The lowest body weight of the free young one was 37 gm. Evidently, the mothers carry their young for about 35 to 40 days during which period the young grow very rapidly and increase by nearly three times in their weight before they are weaned. The second batch of young ones are delivered during about the last week of April so that young ones of two distinct sizes are noticed from May onwards, and these correspond to the two batches of young ones delivered in the two waves of the first cycle, the first batch about the middle of March, and the second by the last week of April. One could, therefore, easily identify the young ones delivered in the first wave because they have significantly higher body weights than those delivered in the second week. It is, therefore, possible to trace separately, up to a certain stage, the growth of the animals born in the two waves. If it is assumed that in each collection after the pregnancy cycle the highest body weight recorded amongst the young ones relates to the young born in the first wave of delivery, then the females born on the 13th of March would reach a body weight of 37 gm on the 19th of April, 44 gm on 13th May, 50 gm on 27th June and 52 gm on 10th July. These are the highest body weights of young ones collected on the respective dates. These young should reach a body weight of 55 gm (weight at maturity) by the middle of August. The pattern of growth of the young ones, as indicated by their body weights, is given in text-fig. 1, which is a scatter diagram of the body weight of the females collected during the different months of the year. The curves indicate the pattern of increase in the body weight of the young during growth. The female born in the second wave of delivery, that is, during the latter part of April, have a similar pattern of growth, and these should attain 55 gm of body weight by about the end of September. Thus, by the beginning of November, that is, at the onset of the breeding season, the young ones born in the middle of March as well as those born during the latter part of April would be sexually mature. Further, since on the 6th November every female with a body weight of over 55 gm had copulated, it clearly shows that the females born during March-April copulate in the beginning of November, that is, at the age of about 7 to 8 months.

According to the pattern of growth as mentioned above, the females born during the third week of July in the second cycle should be reaching a body weight of 55 gm only by the third week of December, and hence they could not copulate in November. These are evidently the few non-parous non-pregnant females occurring in the collections between 6th November and 22nd December. After these animals reach the weight of 55 gm (by the third week of December) they also undergo copulation so that every female is pregnant after the 22nd of December. Therefore, the females born in the third week of July copulate when they are about 5 months of age.

From the foregoing it is evident that in the month of November the females can be assigned to one of the following categories—

(1) Parous females which are at last 16 months old. These are the ones born latest in

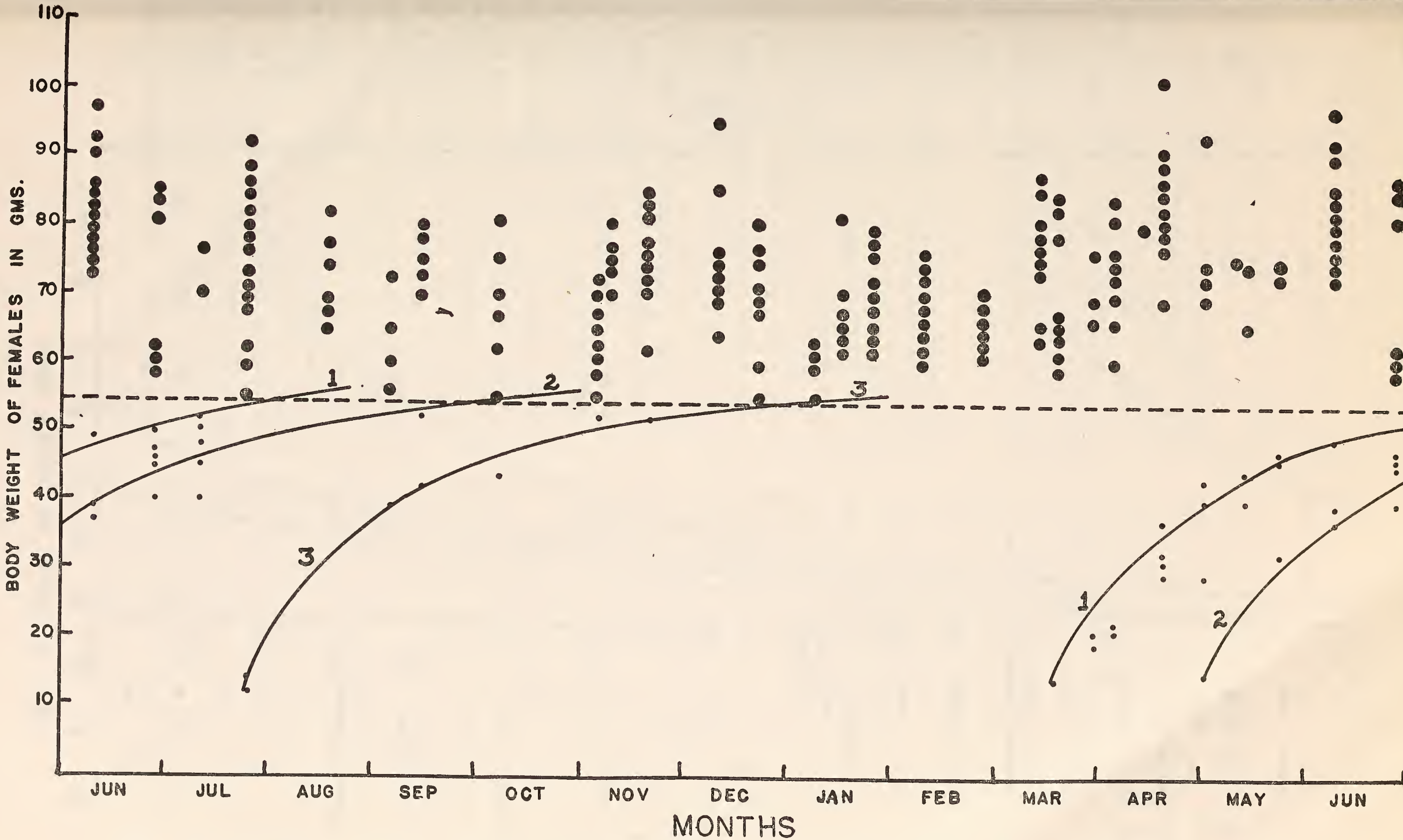

Fig. 1. Scatter diagram of the body weight of the females collected during the different months of the year. The curves numbered 1, 2 and 3 indicate the pattern of increase in the body weight of the young born in the three waves of delivery in a year. The dotted line indicates the weight at sexual maturity. Please seee text for details.

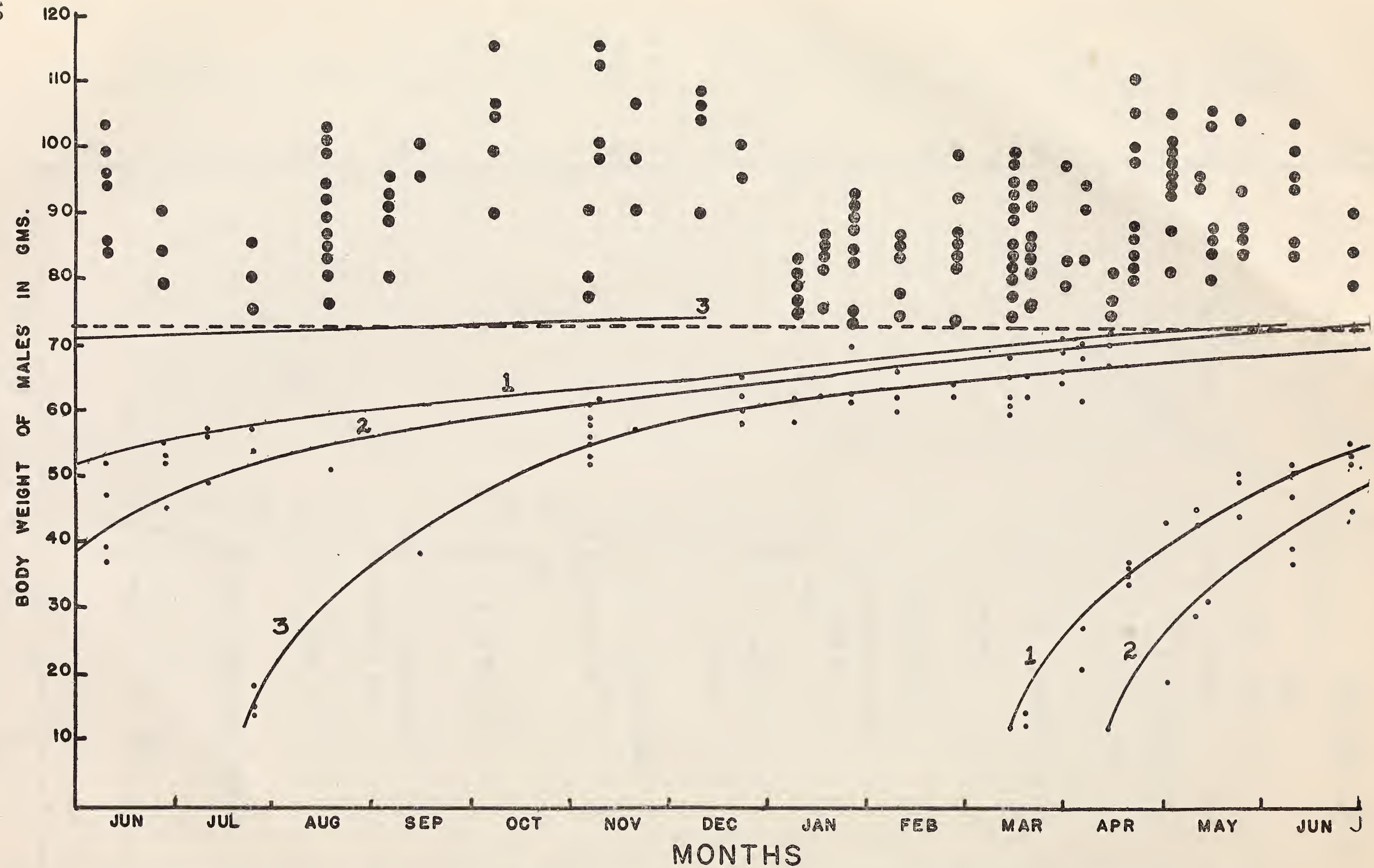

Fig. 2. Scatter diagram of the body weights of the males collected during the different months of the year. The curves numbered 1, 2 and 3 indicate the pattern of increase in the body weight of the young born in the three waves of delivery in a year. The dotted line in the graph indicates the body weight at sexual maturity. Please see text for details.

July of the previous calendar year. All these copulate early in November.

(2) Non-parous females which were born either in March or in April of the year. These are 7 to 8 months old. These also copulate early in November.

(3) Non-parous females which were born in July of the year. These do not copulate in November, but copulate sometime during the third week of December when they are about 5 months old.

(b) **Male**

The pattern of growth of the young males is similar to that of the females except that the males do not reach sexual maturity until they attain a body weight of at least 73 gm, this being the lowest body weight of a male showing spermatogenesis in the testis. Text-figure 2 is a scatter diagram of the body weights of the males collected during the different months of the year, and the curves indicate the pattern of growth of the young males. From the growth pattern indicated by the graph it is evident that the males take about 14 months to attain a body weight of 73 gm. Hence, the males born in March-April would be reaching this weight by May-June of the following year. Since the breeding season does not set in until the following November these males can participate in successful copulation only when they are about 19 to 20 months of age. The males born in July would also be reaching a body weight of 73 gm by the end of October of the following year, and hence they should also be able to copulate in November of the following year when they would be about 15 to 16 months of age. Males born in March-April as well as those born in July can take part in their first copulation only in November of the following calendar year earliest. Thus, they should be at least 16 months old before taking part in copulation in the case of those born in July, and 20 months old in the case of those born in March.

The work on other species of bats has revealed that the age at which sexual maturity is attained varies in different species. Baker & Baker (1936) working on *Pteropus geddiei* and Baker & Bird (1936) working on *Miniopterus australis* have not made a specific mention about the growth and maturity of the respective species which they studied, but from Table 2 on page 128 (Baker & Baker 1936) and Table 1 on page 153 (Baker & Bird 1936) it is apparent that during the breeding season many non-pregnant females were also collected along with the pregnant ones. Apparently, in these species the females do not experience their first oestrus in the year of their birth, and are, therefore, over 16 months of age, when they experience their first oestrus. Matthews (1937) working on two species of British horseshoe bats, has shown that in these species the females do not reach the first oestrus until their second Autumn when they are at least 15 months old. Miller (1939) states that "young males of *Myotis lucifugus lucifugus* and *Myotis greisescens* do not enter into reproductive activity until their second spring". Working on *Megaderma lyra lyra* Ramaswamy (1962) mentioned that the animals in this species "do not reach sexual maturity within the year of their birth, and very likely not until at least the Autumn of the next year. Since the males seem to be a little ahead of the females in the onset of sexual activity, the males probably do not become mature until they are at least 15 months old, and the females at least 18 months old". Anand Kumar (1965), remarked that in *Rhinopoma kinneari*, "both the young male and female bats do not reach sexual maturity at least until their second year". Patil (1968) recorded that *Hipposideros fulvus fulvus* does not reach sexual maturity in the first breeding season and the specimens should be at least 18 months of age when they attain sexual maturity.

Whereas the literature cited above shows that many species of bats do not attain sexual maturity until at least the second year of their birth, there are a few species which attain puberty within the year of their birth. Gopalakrishna (1947, 1948) has shown that in *Scotophilus wroughtoni* sexual maturity is reached in both the sexes before the specimens are one year old. Pearson *et al.* (1952) showed that in *Corynorhinus rafinesquei* "the young females only four months old mate as early as do the adults", but young males do not copulate in their first year. In *Myotis lucifugus lucifugus*, whereas the females born in June undergo copulation in the following September (Wimsatt & Kallen 1957), the males do not attain sexual maturity until their second Spring (Miller 1939).

Rousettus leschenaulti is a fairly large bat with the males reaching a maximum weight of 115 gm and the females 101 gm. It is interesting that such a large bat reaches sexual maturity within a few months whereas many bats much smaller in size take a longer time. As an example one can cite the case of *Hipposideros fulvus fulvus* (Patil 1968), whose adult maximum body weight (about 10 gm) is less than the weight of the full term foetus of *Rousettus leschenaulti*, but which reaches puberty in its second season, that is, at the age of about 18 months. Apart from the genetic factors, which determine the growth and maturity, perhaps the very rapid growth of the young during the sucking stage and during the following few weeks, coupled with the fact that there are two cycles of pregnancy occurring in quick succession, may help in accelerating maturity in *Rousettus leschenaulti*.

(c) Mortality

Since every female becomes pregnant twice in the year, each female should theoretically produce two young in a year. If all the young survive the number of young at the start of the breeding season should be more than the number of the adult specimens because the adult females out-number the males in the total population, and, further, it is normally expected that a certain number of very old adults should die due to natural old age. But in actuality, at the beginning of the breeding season the number of the first year young animals (including the non-parous females which are only a few months old) is much smaller than the number of adults. Out of 118 females there were only 34 young ones, and out of 104 males there were only 35 immature ones during the beginning of the first cycle of the breeding season, that is, between 6th November and 22nd December. This small number of immature ones can only be due to the loss of the embryos and/or the delivered young ones. It has already been stated that many pregnant females lose their embryos in the second cycle, and that there is a considerable loss of the new born young delivered in July as indicated by the fact that during July and Aug. many females in full lactation were collected but without the attached young. The period when there appears to be the greatest loss of the young is when the young are between 20 to 35 gm in weight, that is when they are between 15 to 30 days of age. The small young whose weight is less than 20 gm adhere very fast to the nipples of the mothers. The sharp teeth of these young appear to be sunk deep into the skin of the nipples, and the young can be removed from the mothers' nipples only by applying considerable force. Up to this age, therefore, there does not appear to be much loss of the young. But the young ones over the weight of about 20 gm get easily detached from the mothers, and in fact they were often found to have crawled away from their mothers in cages in which they had been kept overnight. Thus, either due to adventurism on the part of the young or due to accidents they get detached from their mothers, and once detached, the mothers do not try to bring the young back to their breasts. Since these young are very helpless and are not big enough to lead an independent life, they are lost.

5. *Sex ratio*

Among the 1367 specimens collected 759 (55.26%) were females and 608 (44.74%) were males. Since the collections were made at random, and since there is no segregation of the two sexes on the basis of age or reproductive activity, the sex ratio as is evident from the collection can safely be taken as the natural sex ratio in this species. Amongst the young ones collected from the breasts of the mothers the number of males and females was nearly the same (49 and 51 respectively). Evidently, the males and the females are born in equal numbers, but during the growth period there appears to be a higher mortality among the males. Hence, in the total population the females outnumber the males.

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Fishes of Khasi Hills, Meghalaya (India), with observations on their distributional pattern[1]

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Introduction

The fish-fauna of Khasi Hills is very poorly known. Perusal of literature shows that altogether 15 species are on record from these hills (*see* McClelland 1842; Day 1889; Sehegal 1959, Yazdani & Chanda 1971 and Yazdani 1972). Menon (1962) reported 161 species from Brahmaputra drainage which also include the drainages of the Khasi Hills. This indicates that the species known so far from Khasi Hills constitute a very small percentage of its fish-fauna.

Khasi Hills is one of the three districts namely, Khasi, Jaintia and Garo Hills of the newly formed state of Meghalaya of the Indian Union. The greater part of this hill district is like a plateau which consists of blocks of flat or gently undulating land separated by narrow ravines and deep valleys. This plateau is remarkably abrupt on its southern face but on its northern edge it gradually slopes towards the Brahmaputra valley. Its height varies from around 3,000 ft (914 metres) to 6,000 ft (1828 metres). The vegetation of this hill is luxuriant due to heavy rainfall, bamboo and pine forests covering a large tract. The upper and more level parts of the hill are however thickly carpeted with grass. The beds of streams and rivers are generally rocky and full of gravel. The water current is swift and after a heavy rainfall most of the streams become torrential.

The material on which this paper is based had accumulated at the Eastern Regional Station, Zoological Survey of India, Shillong during the past twelve years (1960 to 1971). It had been brought by field parties in all seasons of the year as a result of routine faunistic surveys of streams, tanks and lakes in the Khasi Hills. For collecting this material, bag nets were used for small fishes and cast nets for larger forms.

The material contained 29 species which are dealt with in this paper. Only 8 species, out of 15 species reported earlier from Khasi Hills, have not been found. They are: *Puntius ticto* (Ham.), *Puntius sophore* (Ham.) (Cyprinidae), *Balitora brucei* Gray (Homalopteridae), *Botia almorhae* Day, *Somileptes gongta* (Ham.) (Cobitidae), *Pseudoecheneis sulcatus* (McClelland) (Sisoridae), *Olyra longicauda* McClelland, *Olyra laticeps* (McClelland) (Olyridae).

Some observations on the distributional pattern of fishes in the Khasi Hills have also been given in the paper. An attempt is made to explain differences in the fish-fauna between dif-

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ferent streams and lakes on the basis of differences in the habitats and habits of species. The term habitat refers to only field observations like topography, flow of water and nature of bottom of the streams and lake.

Collection Localities

A total of 35 collecting localities are listed below. They have been arranged according to their altitude in two groups namely, group I representing localities between altitudes 3,000 and 4,000 ft and group II covering localities between altitudes 4,500 and 5,500 ft. This grouping is based on the fact that the number of species in the Khasi Hills shows a marked decline at elevations over 4,000 ft.

Group I:

1. Umshing stream. 2. Sumer stream. 3. Umiuh stream. 4. Umran stream. 5. Umtham stream. 6. Umsning stream. 7. Nongpoh stream. 8. Lailad stream. 9. Barapani lake. 10. Mawroh stream. 11. Decam stream. 12. Weiloi stream. 13. Sohiong stream. 14. Synrangmowrah stream. 15. Mairang stream. 16. Cherrapunjee stream. 17. Mawblang stream. 18. Mawsomai stream.

Group II:

19. Mawlai stream. 20. Pologround stream. 21. Mawpat stream. 22. Botanical garden stream. 23. Golf ling stream. 24. Lawsohtun stream. 25. Bishnupur stream. 26. Fruit-garden stream. 27. Motinagar stream. 28. Satifalls stream. 29. Lalchand basti stream. 30. Upper Shillong stream. 31. Lady Hyderi Park tank. 32. Mylliem stream. 33. Lailynkut stream. 34. Mawphlang stream. 35. Umtyngar stream.

Systematic Account

A systematic account of 29 species from Khasi Hills is given below. The numbers for localities referred under each species correspond to those of the 'collecting localities'. The relevant information about the identity and geographical distribution of species have been obtained from published literature namely, Day (1889), Shaw & Shebbeare (1938), Misra (1962) and Menon (1964) and that of habits is based solely on my own observations in the field. The general classification adopted here is that of Greenwood, Rosen, Weitzman & Myers (1966).

Order Cypriniformes
Family Cyprinidae

1. **Accrossocheilus hexagonolepis** (McClelland)

1839. *Barbus hexagonolepis* McClelland, *Asiat. Res.*, 19, pp. 270, pl. 41, fig. 3.

Material: 218 examples, 15 to 120 mm in total length, from two different localities namely, nos. 2 and 9 were examined.

Distribution: Khasi Hills: first record. Elsewhere: India: Assam, W. Bengal and Eastern Himalayas; Nepal, Bangladesh, Malaya, Malay Archipelago, Burma and Thailand.

Habits: *A. hexagonolepis* is more common in the lake than in streams. It takes bait and is commonly caught by angling.

Remarks: Only juveniles of this species are present in the collection.

2. **Cyprinus carpio** Linnaeus

1758. *Cyprinus carpio* Linnaeus, *Syst. Nat.*, ed. 10, Vol. 1.

Material: 1 example, 125 mm in total length, from one locality (no. 3) was examined.

Distribution: Khasi Hills: first record. Introduced in ponds in India. Original home is China and Japan.

Remarks: This species is being cultured in artificial ponds in Shillong by the Fisheries Dept., Govt. of Meghalaya.

3. **Danio (Danio) aequipinnatus** (McClelland)

1839. *Perilampus aequipinnatus* McClelland, *Asiat. Res.*, 19, p. 393, pl. 60, fig. 1.

Material: 87 examples, 15 to 77 mm in total length, from six different localities (nos. 4, 5, 6, 8, 16 and 17) were examined.

Distribution: Khasi Hills: first record. Elsewhere: India; Sri Lanka, Burma, Thailand and Bangladesh.

Habits: Compared to other species of *Danio*, *D. aequipinnatus* is rather uncommon in the Khasi Hills. Generally, it occurs with *D. dangila* and lives near the edges of streams. It does not occur at altitudes over 3,500 ft.

Remarks: In the Khasi Hills, the specimens of *D. aequipinnatus* show a marked tendency towards reduction in number of dorsal and anal rays and decrease in proportion of body depth. The dorsal rays vary from 12-13 (*vs* 12-16) and anal 13-15 (*vs* 14-18). The body depth in total length varies from $4\frac{1}{2}$ to 5 (*vs* $3\frac{3}{4}$ to $4\frac{1}{2}$). The longest specimen recorded in this hill is 77 mm against 152 mm the maximum length known for this species (*see* Misra 1962).

4. **Danio (Danio) dangila** (Hamilton)

1822. *Cyprinus dangila* Hamilton, *Fish Ganges*, pp. 321, 390.

Material: 630 examples, 13 to 82 mm in total length, from eighteen localities (nos. 1, 2, 4, 6, 9, 10, 11, 13, 20, 21, 23, 26, 27, 29, 31, 32, 34 and 35) were examined.

Distribution: Khasi Hills, and Shillong (Sehegal 1959). Elsewhere: India: Manipur, Nagaland, Assam, West Bengal and Bihar; Burma.

Habits: *D. dangila* is the most common species in the streams and lake of Khasi Hills and unlike *D. aequipinnatus* it occurs upto 5,000 ft (1524 metres) altitude. It is more commonly found with *D. rerio* (Ham.) than with *D. aequipinnatus* and prefers to live near the edges of streams. Its members swim in shoals near the surface of water.

Remarks: The specimens of *D. dangila* from the Khasi Hills show a tendency towards reduction of total size of the fish and in the number of dorsal and anal rays and in overall decrease in the proportion of body depth. The dorsal rays vary from 10-12 (*vs* 11-13), anal 12-14 (*vs* 17-18) and the body depth in the total length $4\frac{1}{2}$ to 5 (*vs* $3\frac{1}{2}$ to 4). The longest specimen found is 82 mm against 152 mm the maximum length known for this species (*see* Day 1889).

5. **Danio (Brachydanio) rerio** (Hamilton)

1822. *Cyprinus rerio* Hamilton, *Fish Ganges.*, pp. 323, 390.

Material: 2,506 examples, 10 to 41 mm in total length, from fourteen different localitites (nos. 1, 4, 5, 6, 7, 9, 10, 20, 21, 23, 26, 27, 29 and 32) were examined.

Distribution: Khasi Hills: first record. Elsewhere: India: throughout, Sikkim; Burma.

Habits: *D. rerio* is rather uncommon in the Khasi Hills but it occurs upto an altitude of 5,000 ft. It is generally found with *D. dangila.*

Remarks: The specimens of *D. rerio* also exhibit certain variations in the Khasi Hills. The number of dorsal rays is 8-9 (*vs* 9) and anal 12-15 (*vs* 15-16).

6. **Garra lamta** (Hamilton)

1822. *Cyprinus* (*Garra*) *lamta* Hamilton (in part). *Fish Ganges,* Edingburgh, pp. 344, 393.

Material: 1 example, 27 mm. in total length, from one locality namely, no. 8 was examined.

Distribution: Khasi Hills: first record. Elsewhere: India: Darjeeling and Kumaon Himalayas and Sikkim; Eastern Nepal.

Habits: A typical hill-stream fish found adhering to rocky bottom of the river.

7. **Garra lissorhynchus** (McClelland)

1842. *Platycara lissorhynchus* McClelland, *Calcutta Jour. Nat. Hist.* 2, pp. 587, pl. 16 fig. 2.

Material: 17 examples, 25 to 90 mm in total length from two different localities namely, nos. 9 and 14 were examined.

Distribution: Khasi Hills. Elsewhere: India:

Brahmaputra system, Assam Himalayas.

Habits: A typical hill-stream fish commonly found adhering to rocks under water.

8. **Garra naganensis** Hora

1921. *Garra naganensis* Hora, *Rec. Indian Mus.*, Calcutta, 22, p. 667, pl. 25, figs. 2, 2a.

Material: 7 examples, 29 to 105 mm in total length, from two different localities namely, nos. 4 and 9 were examined.

Distribution: Khasi Hills; first record. Elsewhere: India: Nagaland.

Habits: A typical hill-stream fish commonly found adhering to rocks under water, both in streams and the lake.

Remarks: The occurrence of *G. naganensis* in Khasi Hills extends the range of distribution of this species considerably westward.

9. **Puntius chola** (Hamilton)

1822. *Cyprinus chola* Hamilton, *Fish Ganges*, pp. 312, 389.

Material: 5 examples, 21 to 64 mm in total length, from one locality (no. 4) were examined.

Distribution: Khasi Hills; first record. Elsewhere: India: throughout; Bangladesh and Pakistan.

Remarks: *P. chola* is rare in the Khasi Hills. It is known to grow to 5 inches (128.0 mm) in length (Day 1889) but the longest specimen collected is only 64 mm.

10. **Puntius shalynius** Yazdani & Talukdar

1975. *Puntius shalynius* Yazdani & Talukdar, *J. Bombay nat. Hist. Soc.* *72*(1):218-221.

Material: 1,739 examples, 9 to 62 mm in total length, from twenty localities (nos. 1, 4, 5, 6, 9, 10, 11, 12, 13, 19, 20, 21, 22, 23, 26, 27, 29, 30, 32 and 35) were examined.

Distribution: Khasi Hills (Meghalaya).

11. **Tor putitora** (Hamilton)

1822. *Cyprinus putitora* Hamilton, *Fish Ganges*, pp. 303, 388.

Material: 107 examples, 13 to 135 mm in total length, from three localities (nos. 8, 9 and 33) were examined.

Distribution: Khasi Hills; first record. Elsewhere: India: Punjab, U.P., Western Himalayas, W. Bengal, Assam, Eastern Himalayas; Pakistan and Bangladesh.

Habits: The habits of *T. putitora* are like those of *Acrossocheilus hexagonolepis*.

12. **Tor tor** (Hamilton)

1822. *Cyprinus tor* Hamilton, *Fish Ganges*, pp. 305, 388.

Material: 2 examples, 100 to 150 mm in total length, from locality no. 9 were examined.

Distribution: Khasi Hills; first record. Elsewhere: India: Garo Hills (Meghalaya), Kashmir, throughout the Himalayas, Assam and Sikkim.

Habits: The habits of *T. putitora* resemble those of *T. tor*.

Family Psilorhynchidae

13. **Psilorhynchus balitora** (Hamilton)

1822. *Cyprinus balitora* Hamilton, *Fish Ganges*, pp. 348, 394.

Material: 1 example, 31 mm in total length, from one locality (no. 9) was examined.

Distribution: Khasi Hills; first record. Elsewhere: India: Bengal (N.E.) and Assam (Day 1889) and Burma (Shaw & Shebbeare 1938).

Remarks: This is a rare species in the Khasi Hills.

14. **Psilorhynchus homaloptera** Hora & Mukerji

1935. *Psilorhynchus homaloptera* Hora & Mukerji, *Rec. Indians Mus.*, Calcutta, 37, pp. 391, pl. 7, fig. 1-6.

Material: 11 examples, 23 to 40 mm in total length, from one locality (no. 9) were examined.

Distribution: Khasi Hills; first record. Elsewhere: India: Nagaland and Assam.

Family Cobitidae

15. **Lepidocephalus berdmorie** (Blyth)

1860. *Acanthopsis berdmorie* Blyth, *J. Asiat. Soc. Beng.*, 29, pp. 168.

Material: 1 example, 59 mm in total length, from one locality namely, no. 21 was examined.

Distribution: Khasi Hills, and Shillong (Sehegal 1959). Elsewhere: Moulmein in Burma.

Remarks: This species is extremely rare in the Khasi Hills.

16. **Lepidocephalus guntea** (Hamilton)

1822. *Cobitis guntea* Hamilton, *Fish Ganges*, pp. 353, 394.

Material: 222 examples, 13 to 64 mm in total length, from twelve different localities namely, nos. 1, 9, 11, 13, 20, 21, 23, 26, 28, 29, 32 and 35 were examined.

Distribution: Khasi Hills; first record. Elsewhere: throughout northern India, Bangladesh and Pakistan.

Habits: *Lepidocephalus guntea* is found in gravelly or muddy streams and lives on the bottom.

Remarks: This species is one of the commonest loach in the Khasi Hills.

17. **Noemacheilus dayi** Hora

1878. *Nemachilus savona* Day, nec Hamilton *Fish. India* pp. 619, pl. CLV, fig. 8.

1937. *Nemachilus dayi*, Hora, *Rec. Indian Mus.*, 37, p. 57.

Material: 10 examples, 24 to 58 mm in total length, from one locality (no. 9) were examined.

Distribution: Khasi Hills; first record. Elsewhere: India: Day (1889) gives "Bengal and N.W. Province". Subsequently this species has been recorded from Madhya Pradesh and Western ghats (Hora 1938) and from Bihar (Das 1939).

Remarks: *N. dayi* is a rare species in the Khasi Hills and its occurrence here extends the range of distribution further eastward.

18. **Noemacheilus multifasciatus** Day

1878. *Nemacheilus multifasciatus* Day, *Fish India*, pp. 617.

Material: 26 examples, 15 to 115 mm in total length, from one locality namely, no. 9 were examined.

Distribution: Khasi Hills; first record. Elsewhere: India: Assam and W. Bengal.

19. **Noemacheilus rupecola inglisi** Hora

1935. *Nemachilus rupecola* var. *inglisi* Hora, *Rec. Indian Mus.*, 37, pp. 58, pl. 3, fig. 9, 10.

Material: 56 examples, 19 to 52 mm in total length from seven different localities (nos. 1, 2, 4, 8, 9, 14 and 16) were examined.

Distribution: Khasi Hills; first record. Elsewhere: India: Assam, West Bengal, Bihar & U.P. (near Himalayan foot-hills).

Habits: This species is a typical hill-stream loach which adheres to rocks submerged under water in rapid streams.

Remarks: This is one of the commonest loach of the genus *Noemacheilus* in the Khasi Hills. The largest specimen found in this hill is 52 mm long but that recorded elsewhere is about 76 mm.

20. **Noemacheilus sikmaiensis** Hora

1921. *Nemachilus sikmaiensis* Hora, *Rec. Indian Mus.*, 22, pp. 201-202.

Material: 12 examples, 20 to 50 mm in total length, from two different localities (nos. 4 & 9) were examined.

Distribution: Khasi Hills; first record. Elsewhere: India: Manipur; Burma.

Remarks: The occurrence of *N. sikmaiensis* in the Khasi Hills extends the known range of distribution of this species considerably westward.

Order Siluriformes
Family Siluridae

21. **Ompok bimaculatus** (Bloch)

1797. *Silurus bimaculatus* Bloch, *Syst. Ichth.*, 11, pp. 17, pl. 369.

Material: 1 example, 16 mm in total length, from only one locality (no. 6) was examined.

Distribution: Khasi Hills; first record. Elsewhere: India: throughout; Sri Lanka, Pakistan, Burma, Malaya, Malay Archipelago, Thailand, Chusan and Yunan.

Family Sisoridae

22. **Glyptothorax striatus** (McClelland)

1842. *Glyptosternon striatus* McClelland, *Cal. Jour. Nat. Hist.*, 2, pp. 587, pl. vi, fig. 1, 2.

Material: 1 example, 145 mm in total length, from one locality (no. 9) was examined.

Distribution: Khasi Hills, and Cherrapunjee (Menon 1954). Elsewhere: Sikkim.

Family Heteropneustidae

23. **Heteropneustes fossilis** (Bloch)

1794. *Silurus fossilis* Bloch, *Naturg Ausland, Fische*, 8, pp. 46, pl. 370, fig. 2.

Material: 75 examples, 34 to 160 mm in total length, from four different localities (nos. 4, 6, 9 & 20) were examined.

Distribution: Khasi Hills; first record. Elsewhere: throughout India; Bangladesh, Burma, Pakistan, Sri Lanka, Thailand and Indo-China.

Remarks: The largest specimen of this species is known to be of 304 mm (a foot) in length or more (Misra 1962). In the Khasi Hills, however, the longest specimen collected was only 160 mm.

Family Clariidae

24. **Clarias batrachus** (Lin.)

1758. *Silurus batrachus* Linnaeus, *Syst. Nat.*, 1, ed. 10, pp. 305.

1889. *Clarias magur* Day, *Fauna Brit. India*, Fish., 1, pp. 115, figs. 48 and 49.

Material: 3 examples, 25 to 45 mm in total length, from one locality (no. 20) were examined.

Distribution: Khasi Hills; first record. Elsewhere: Fresh and brackish waters of the plains of India; Bangladesh, Pakistan, Burma; Sri Lanka, Malaya, Malay Archipelago, Thailand, Indo-China, Philippines, Hong Kong and China.

Order Channiformes
Family Channidae

25. **Channa orientalis** (Bl. & Schn.)

1801. *Channa orientalis* Bloch & Schneider, *Syst. Ichth.*, pp. 496.

1889. *Ophiocephalus gachua* Day, *Fauna Brit. India*, Fish., pp. 304.

Material: 295 examples, 18 to 115 mm in total length, from twenty-one different localities (nos. 1, 2, 4, 5, 9, 10, 13, 16, 17, 20, 21, 23, 24, 25, 26, 27, 28, 29, 31, 32 & 35) were examined.

Distribution: Khasi Hills. Elsewhere: India: throughout; Bangladesh, Sri Lanka, Pakistan, Burma, Afghanistan, Malaya, Malay Archipelago, Thailand, Indo-China and China.

Habits: *C. orientalis* is one of the commonest species of fish in Khasi hill-streams. It co-exists with *C. stewartii* (Playfair) and lives along the edges of streams having overhanging vegetation.

Remarks: *C. orientalis* is known to grow to 203 mm (8 inches) in length (Misra 1962) but the longest specimen collected in the Khasi hill is only 115 mm.

26. **Channa punctata** (Bloch)

1793. *Ophiocephalus punctatus* Bloch, *Naturg. Ausland, Fische*, 7, pp. 139, pl. 358.

Material: 2 examples, 84 to 123 mm in

total length, from one locality (no. 6) were examined.

Distribution: Khasi Hills; first record. Elsewhere: throughout India; Bangladesh, Pakistan, Burma, Sri Lanka, Malaya, China, Tahiti, Polynesia.

Habits: This species resembles *C. orientalis* in habit but unlike the latter it has been found only in one stream which had a muddy bottom.

27. **Channa stewartii** (Playfair)

1867. *Ophiocephalus stewartii* Playfair, *Proc. Zool. Soc. Lond.*, pp. 14.

Material: 152 examples, 13 to 111 mm in total length, from twenty-one different localities (nos. 1, 2, 4, 6, 8, 9, 10, 12, 13, 15, 16, 17, 18, 20, 21, 22, 26, 27, 30, 34 and 35) were examined.

Distribution: Khasi Hills. Elsewhere: Bihar, W. Bengal, Assam, Meghalaya (Jaintia Hills).

Habits: *C. stewartii* is one of the most common species of fish in Khasi hill-streams. In habits it very much resembles *C. orientalis*.

Remarks: *C. stewartii* is known to grow upto 10 inches (Day 1889) and 18 inches (Shaw & Shebbeare 1938) in length but the longest specimen found in Khasi Hills is only 111 mm (4½ inches).

Order Perciformes
Family Nandidae

28. **Badis badis** (Hamilton)

1822. *Labrus badis* Hamilton, *Fish* Ganges, pp. 70, 368.

Material: 10 examples, 14 to 27 mm in total length, from three different localities (nos. 5, 8 & 32) were examined.

Distribution: Khasi Hills; first record. Elsewhere: Assam, Nagaland, W. Bengal, Bihar, U.P.; Burma.

Remarks: *B. badis* is rather uncommon species in the Khasi Hills. It lives near the edges of streams and hides under vegetation.

Suborder Mastacembeloidei
Family Pillaiidae

29. **Pillaia indica** Yazdani

1972. *Pillaia indica* Yazdani, *J. Bombay nat. Hist. Soc.*, 69(1), pp. 134-135.

Material: 5 examples, 30 to 60 mm in total length from three different localities namely nos. 2, 5 and 6 were examined.

Distribution: Khasi Hills (Meghalaya).

Habits: The habits of this newly discovered eel of India have been observed both in its natural habitat as well as in an aquarium where three specimens were kept alive for about a month. It is very inactive and mostly spends its time lying on the bottom either buried in mud or clinging to submerged vegetation. While entangling itself to any branch of aquatic plants, it keeps itself suspended under water with its head facing downward. Its swimming and crawling movements resemble those of the anguilliform fishes.

Distributional Pattern

The distributional pattern of fishes in the Khasi Hills is given in Table 1. Groups I and II localities correspond to locality groupings mentioned earlier under 'collecting localities'. Selected localities correspond to streams and lake where field observations are recorded.

The distributional pattern of the fish fauna of Khasi Hills shows that it is influenced by differences in altitude as well as in habitat. The effect of altitude on distribution of species is shown in column II of the table. It shows that species follow some pattern with regard to their occurrence and their number suddenly falls to nearly 1/3rd at elsevations over 4,000 ft. Out of 29 species, 18

TABLE 1

SHOWING DISTRIBUTIONAL PATTERNS OF FISHES IN THE KHASI HILLS. GROUP I AND GROUP II RESPECTIVELY REPRESENT 18 LOCALITIES BETWEEN 3,000 AND 4,000 FT ALTITUDES AND 17 LOCALITIES BETWEEN 4,500 AND 5,000 FT ALTITUDES.

I	II		III							
	Total number of localities, where found		Distribution of species in selected localities							
			Group I						Group II	
Name of species	Group I	Group II	A	B	C	D	E	F	G	H
1. *Accrossocheilus hexagonolepis* (McClell.)	2	–	–	–	–	+	+	–	–	–
2. *Cyprinus carpio* Lin.	1	–	–	–	–	–	–	–	–	–
3. *Danio aequipinnatus* (McClell.)	6	–	+	+	+	–	–	–	–	–
4. *Danio dangila* (Ham.)	8	10	+	+	–	+	+	+	+	+
5. *Danio (Brachydanio) rerio* (Ham.)	7	7	+	+	+	–	+	+	+	+
6. *Garra lamta* (Ham.)	1	–	–	–	–	–	–	–	–	–
7. *Garra lissorhynchus* (McClell.)	2	–	–	–	–	–	+	–	–	–
8. *Garra naganensis* Hora	2	–	–	+	–	–	+	–	–	–
9. *Puntius chola* (Ham.)	1	–	–	+	–	–	–	–	–	–
10. *Puntius shalynius* Yazdani & Talukdar	9	11	+	+	+	–	+	+	+	+
11. *Tor putitora* (Ham.)	2	1	–	–	–	–	+	–	–	–
12. *Tor tor* (Ham.)	1	–	–	–	–	–	+	–	–	–
13. *Psilorhynchus balitora* (Ham.)	1	–	–	–	–	–	+	–	–	–
14. *Psilorhynchus homaloptera* Hora	1	–	–	–	–	–	+	–	–	–
15. *Lepidocephalus berdmorei* Blyth	–	1	–	–	–	–	–	–	+	–
16. *Lepidocephalus guntea* (Ham.)	4	8	–	–	–	–	+	+	+	+
17. *Noemacheilus dayi* Hora	1	–	–	–	–	–	+	–	–	–
18. *Noemacheilus multifasciatus* Day	1	–	–	–	–	–	+	–	–	–
19. *Noemacheilus rupicola inglisi* Hora	7	–	–	+	–	+	+	+	–	–
20. *Noemacheilus sikmaiensis* Hora	2	–	–	+	–	–	+	–	–	–
21. *Ompok bimaculatus* (Bloch)	1	–	+	–	–	–	–	–	–	–
22. *Glyptothorax striatus* (McClell.)	1	–	–	–	–	–	+	–	–	–
23. *Heteropneustes fossilis* (Bloch)	3	1	+	+	–	–	+	–	–	–
24. *Clarias batrachus* (L.)	–	1	–	–	–	–	–	–	–	–
25. *Channa orientalis* (Bl. & Schn.)	9	12	–	+	+	+	+	+	+	+
26. *Channa punctata* (Bloch)	1	–	+	–	–	–	–	–	–	–
27. *Channa stewartii* (Playfair)	13	8	+	+	–	+	+	+	+	–
28. *Badis badis* (Ham.)	2	1	–	–	+	–	–	–	–	+
29. *Pillaia indica* Yazdani	3	–	+	–	+	+	–	–	–	–

Abbreviations: A = Umsning stream, B = Umran stream, C = Umtham stream, D = Sumer stream, E = Barapani lake, F = Umshing stream, G = Mawpat stream, H = Mylliem stream.

namely, nos. 1, 2, 3, 6, 7, 8, 9, 12, 13, 14, 17, 18, 19, 20, 21, 22, 26 and 29 are restricted in distribution to group I localities and two nos. 15 and 24 to group II localities. Altogether 11 species occur in group II localities; of these 9 species (nos. 4, 5, 10, 11 16, 23, 25, 27 & 28) are also found equally commonly in group I localities. Species nos. 15 and 24 which also occur fairly commonly in the plains indicate the possibility of discontinuous altitudinal distribution. Some ecological factors such as temperature, pressure, oxygen and food may be effective in controlling the altitudinal distribution of species. Investigation of these factors is not attempted, for, it is beyond the scope of the present study.

The effect of habitat on distribution of species in certain localities is shown in column III of the Table. It shows that number and composition of species differs considerably between streams and lake. We shall examine below how these differences are correlated with habitats and habits of species.

Umsning stream:

The stream at Umsning is nearly 2 metres wide and about 1 metre deep. It has submerged weeds at various places and overhanging vegetation along the edges. The bottom is mostly muddy and the current is slow.

Nine species, nos. 3, 4, 5, 10, 21, 23, 26, 27 and 29, are found in this stream.

This stream provides quite a suitable habitat for species living on the bottom or living near the edges of stream. *H. fossilis, O. bimaculatus* and *P. indica* which by habit prefer a muddy bottom are well suited for this type of habitat. *Danio* spp. and *Puntius shalynius* prefer to live near the surface along the edges amongst overhanging vegetation and *Channa* spp. spend most of the time near the edges of stream under dense vegetation.

Umran stream:

The stream at Umran is about 6 metres wide and 2-3 metres deep with overhanging vegetation along the edges. The bottom is mostly rocky but at various places the bed is sandy/muddy with big boulders scattered all over. The water is clear and fast running.

Eleven species, nos. 3, 4, 5, 8, 9, 10, 19, 20, 23, 25 and 27, are found in this stream.

The composition of species here differs from that of Umsning stream mainly by the occurrence of species of *Garra* and *Noemacheilus*. This is expected because in Umran stream the current is fast and the bottom is largely rocky. Species of *Garra* and *Noemacheilus* which possess organs of adhesion to rocks are very well adapted to life in such a habitat.

Umtham stream:

A tributary of Umtru river, hardly half a metre deep with sandy bottom with pebbles scattered all over. Tall trees present on its banks cast shadows over the stream. The water is clear and slow running. In some parts of the stream, fallen leaves from trees decay in the water.

Six species nos. 3, 5, 10, 25, 28 and 29, are found in this stream.

A very shallow stream it offers limited scope and the number of species is rather poor. Species of *Channa* and *Pillaia* which by habit hide under vegetation or mud occur and other species which have a rather wide range of habitat preference manage to live near the water surface along the edges.

Sumer stream:

Sumer stream is about 5 metres wide and 1-2 metres deep, the water clear and running, and bottom sandy/muddy near the edges and sandy and gravelly elsewhere. It has overhanging vegetation along the edges.

Six species (nos. 1, 4, 19, 25, 27 and 29) occur in this stream.

Although the number of species here is the same as that in Umtham stream, the composition of species is different. The shallowness of this stream and limited scope for life accounts for its poor fish-fauna, other factors such as running water and sandy and gravelly bottom provide suitable habitat to species of *Noemacheilus* and the young ones of *Accrossocheilus*. Near the edges, muddy bottom and overhanging vegetation provide fairly suitable habitat to species of *Channa* and *Pillaia* as well as to *Danio dangila* which lives near the water surface.

Barapani lake:

The Barapani lake is one of the largest perennial water reservoirs in the Khasi Hills, situated at 3,500 ft altitude with an area of *c.* 5 sq km. It is connected with Umiam river and various other streams. Near the junctions of streams and lake there are strong currents and the bottom is mostly gravelly. In other parts of the lake water is still and the bottom is generally sandy. The maximum depth of the lake is about 20 metres.

Nineteen species, nos. 1, 4, 5, 7, 8, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 22, 23, 25 and 27, have been found in the lake. Of these only six, nos. 12, 13, 14, 17, 18 and 22, are restricted to the lake and have not been found in any of the streams.

Unlike the streams which show a great deal of seasonal variation in respect of ecological conditions, the lake provides a more or less constant environment and this factor and variety of habitats accounts for a fairly rich and diversified fish fauna.

Umshing stream:

There is a dam across this stream at Umshing. The section of the stream before the dam is 3-4 metres deep, with muddy bottom and more or less still water. The part after the dam is hardly 1 metre deep with gravelly bed having boulders scattered all over and fast running water. Overhanging vegetation is present along the edges in both parts.

Seven species, nos. 4, 5, 10, 16, 19, 25 and 27, are found in this stream, which provides habitat suitable for species living on muddy bottom (e.g. *Lepidocephalus guntea*), on gravelly bottom in running stream (*N. rupicola inglisi*), and along the edges of the stream with overhanging vegetation (e.g. *Danio* spp., *Puntius shalynius* and *Channa* spp.).

Mawpat stream:

The stream is hardly 2 metres wide and half a metre deep with clear and running water. Its bottom is muddy with pebbles scattered all over. Dense overhanging vegetation is present along the edges.

Seven species, nos. 4, 5, 10, 15, 16, 25 and 27 occur in this stream which belongs to group II localities.

Except for the lack of rocky bottom or rock boulders in its bed, the stream provides habitat more or less similar to that of Umshing and explains why excepting the species of *Noemacheilus* which is restricted to group I localities in the Khasi Hills, the fish-fauna here resembles so much that of Umshing stream.

Mylliem stream:

The Mylliem stream is about 5 metres wide and nearly $1\frac{1}{2}$ metres deep with dirty and slow running water. Its bottom is generally muddy with decaying organic matter. In some parts of this stream the bed is gravelly and water clear. Overhanging vegetation is present along the edges.

Six species, nos. 4, 5, 10, 16, 25, 28, are found in this stream of group II localities. Amongst these three was an abundant population of *Lepidocephalus guntea*.

Except for the presence of *Badis badis* and absence of *Lepidocephalus berdmorei*, the composition of fish-fauna here is similar to that of Mawpat stream, which also has a rather similar habitat. However, the presence of *B. badis* and absence of *L. berdmorei* cannot be explained. An unusual abundance of *L. guntea* appears to be related to presence of decaying organic matter which forms the food of this species.

Conclusion

Altogether 37 species belonging to 12 different families are hitherto known from Khasi Hills. Of these, 8 species reported earlier from this hill have not been found in any of the 35 localities surveyed. Out of 29 species dealt with in this paper, 21 spp. are first distributional records for Khasi Hills. Nearly one third of the fish-fauna of this hill comprises of Cyprinidae and one fifth of Cobitidae.

The drainages of the Khasi Hills form a part of the Brahmaputra drainage system of the Himalayas. Out of 37 spp., 33 spp. are commonly found in the Brahmaputra drainage. Of the remaining 4 spp., 2 spp., namely, *Pillaia indica* and *Puntius shalynius* are endemic and one species, *Cyprinus carpio* is introduced. The fourth species namely, *Botia almorhae*, which is reported to occur in this hill, is found in the drainages of Western Himalayas.

The fishes of Khasi Hills show a pattern of distribution related to the altitude and habitat of the species. Out of 29 species that have been found to occur in 35 different localities, only 11 species occur at elevations over 4,000 ft. The absence of remaining 18 species at altitudes over 4,000 ft may be due to some bio-physical factors which act as a barrier.

The streams in Khasi Hills provide a fairly good range of habitat preferred by various species. The differences in the composition of species between streams above and below 4,000 ft altitude appear largely correlated with differences in habitat and habits of species. However, differences in distributional pattern of some species appear to be correlated with factors other than habitat which is beyond the scope of the present study.

Species with wide range of habitat preference have wider distribution and those with strict choice of habitat are restricted to a few localities only. The bottom-living species of *Garra, Psilorhynchus, Lepidoecphalus, Noemacheilus, Glyptothorax, Ompok* and *Pillaia* are much affected by the condition of the bed of the stream in comparison with species which mostly live near the water surface e.g. species of *Danio, Puntius* or species which live partly near the water surface and partly on the bottom amongst dense vegetation e.g. species of *Channa* and *Badis*. This observation is supported by the fact that most common and widely distributed species in the Khasi Hills are *Danio dangila* and *Puntius shalynius, Channa orientalis* and *Channa stewartii;* other species which may be called fairly common are *Danio rerio* and *Lepidocephalus guntea*.

It is observed that in the Khasi Hills some species such as *Danio aequipinnatus, D. dangila, D. rerio, Lepidocephalus guntea, Noemacheilus rupicola inglisi, Heteropneustes fossilis, Channa orientalis* and *C. stewartii* do not grow to their usual size. The longest mature specimens of most of these species have been found to be much shorter than those normally seen in the plains. This factor appears to be of some adaptive value, for, the large size would be a handicap in hills-streams which are generally very shallow.

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Additions to the list of aphids (Homoptera: Aphididae) from India and adjacent countries[1]

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This paper presents an additional list of 311 species under 123 genera of aphids known from India and adjacent countries namely Pakistan, Nepal, Sikkim and Bhutan and provides notes on their host plants, first reference, and distribution in the region. The genera (22) and species (208) of aphids originally described from the region are also indicated. Relevant references are provided. Total number of genera and species so far known from the area now stand at 198 and 653 respectively.

Introduction

Ghosh (1974c) recorded 344 species under 142 genera of aphids, known till 1968, from Indian subcontinent. Since then 311 more species have either been described or recorded from the region under 123 genera, of which 57 genera were already known. Considering two synonyms from the earlier list (79 & 312) the total number of species so far known, comes to 653 under 198 genera. In the present list, no species has been recorded from Sri Lanka. However a number of species have been recorded from Nepal, Sikkim, Bhutan and Pakistan and a list for each of these being given below. Out of these, some are known only from one of the above areas and are denoted by abbreviations namely Bh—Bhutan, N—Nepal, P—Pakistan, S—Sikkim; the ones which are known in one or more adjacent countries in addition to India are denoted by the same abbreviations prefixed by (+); if there is no such abbreviation, the species is then known only from India. References in the parentheses relate to the first record. The genera (22) and the species (208) described as new from this geographical area have been marked (**) and (*) respectively.

Taxonomic status of some of the species recorded earlier (Ghosh, op cit.) have now been changed. Following the serial numbers of the first list, these are:

No. 16. *Aphidura* sp., now described as *Aphidura bharatia,* David, Sekhon, Bindra.

No. 57. *Betacallis odaiensis* Takahashi, should be *Betacallis querciphaga* Basu, Ghosh Raychaudhuri.

No. 79. *Capitophorus vernoniae* Ghosh is now considered as a synonym of *Subovatomyzus leucosceptri* Basu (No. 324).

No. 114. *Cinara* sp. near *schimitscheki* Borner, has now been described as *Cinara atrotibialis* David and Rajasingh.

No. 247. *Myzocallis bambusifoliae* Takah-

[1] Accepted July 1975.

ashi, is now considered as a synonym of *Takecallis arundinariae* Essig.

No. 276. *Pemphigus lichtensteni* Tull. is now considered as a synonym of *P. immunis* Buckton.

No. 312. *Schoutedenia bougaivillae* (Theo.) is now considered as a synonym of *S. lutea* (v.d. Goot) (No. 313).

No. 326. *Tetraneura heterohirsuta* Carver & Basu is now considered as a synonym of *T. radicicola* Strand.

No. 336. *Tricaudatas polygoni tuberculatus* H.R.L. & Basu is now considered as a synonym of *Tricaudatas polygoni* Nariz.

No. 341. *Unipterus* sp. has now been described as *Unipterus* (*Paoliella*) *nirmalae* David.

Further records from Nepal:

Since publication of last list (Ghosh 1974), Sharma (1968), Chakrabarti & Raychaudhuri (1971) and Ghosh, Basu & Raychaudhuri (1973) recorded 52 species from Nepal, of which 47 are also known from India; following the serial *nos.* of the earlier list and also the present list these are:

3, 19, 22, 24, 30, 31, 34, 36, 53, 58, 63, 90, 120, 124, 141, 149, 150, 161, 169, 171, 191, 194, 201, 204, 213, 220, 222, 223, 228, 231, 255, 256, 266, 279, 281, 299, 301, 303, 307, 313, 316, 328, 333, 335, 389, 468, 506, and the rest denoted by serial nos. 369, 375, 395, 571, 618, are known only from Nepal.

Further records from Sikkim:

Since publication of last list (Ghosh, op. cit.), Ghosh M. R., Ghosh A. K., Raychaudhuri (1971, 1971a), Ghosh, Banerjee, Raychaudhuhi (1971), Raychaudhuri & Chatterjee (1974) recorded 65 species from Sikkim of which 56 species are also known from India and or other areas; following the serial numbers of the earlier list and the present list, these are:

9, 10, 19, 27, 30, 51, 62, 73, 78, 124, 141, 149, 160, 171, 187, 203, 210, 222, 230, 240, 243, 247, 279, 291, 292, 300, 312, 324, 336, 354, 366, 367, 374, 376, 377, 379, 408, 430, 436, 467, 471, 475, 476, 480, 481, 488, 506, 507, 546, 577, 580, 593, 617, 636, 648, 651 and the rest denoted by serial numbers 361, 385, 388, 479, 481, 547, 584, 589, 616 are known only from Sikkim.

Records of aphid-species from Bhutan:

In the earlier list, which covers the period upto 1968, (Ghosh, op. cit.) no aphid species was listed from Bhutan. Since then Ghosh *et al.* (1971) and Ghosh, L. K. (1972) recorded 24 species from the region, of which 15 are known from other regions of the subcontinent; following the serial numbers of the earlier and the present lists these are:

2, 3, 58, 74, 119, 191, 200, 201, 212, 227, 247, 256, 333, 529, 643, and the rest denoted by serial numbers 346, 361, 400, 511, 517, 570, 603, 615, 652 are known only from Bhutan.

Further records from Pakistan:

Three species namely 594, 604, 619 have been listed in the present list from Pakistan of which two namely 594, 604 are known only from Pakistan.

Part III

(The serial numbers of the present list has been continued from earlier list; since 79, 312 have now been synonymised with nos. 324, & 313, the present list starts from 343 instead of 345).

343** *Acutosiphon obliquoris* Basu, Ghosh, Raychaudhuri, *Carex* spp., (Basu *et al.* 1970).

344 *Acyrthosiphon gossypii* Mordv., *Sophora tomentosa* (Verma & Singh 1975).

345 *A. kondoi* Shinji & Kondo, *Medicago sativa* (David & Ghorpade 1974).

346 *A. pelargonii* (Kltb.), Host plant unidentified (Ghosh *et al.* 1971b).

347 *A. phaseoli* Chakrabarti, Ghosh, Raychaudhuri, *Phaseolus* sp. (Chakrabarti *et al.* 1971a).

348 *A. soldatovi*? Mordv., Host plant unidentified (David *et al.* 1969).

349* *A. spiraeae canescentis* Chakrabarti & Raychaudhuri, *Sipraea canescens* (Ghosh *et al.* 1969a, as *A. spiraeae* n. sp., Chakrabarti & Raychaudhuri 1974).

350* *A. (Metopolophium) chandrani* David & Narayanan, *Bromus uniloides, Poa annua* (David & Narayanan 1968).

351* *A. (Metopolophium) darjeelingensis* L. K. Ghosh, *Hypericum* sp., (Ghosh, L. K. 1970b).

352 *A. (Metopolophium) euryae* (Takahashi), *Eurya japonica* (Ghosh 1974a).

353* *A. (Metopolophium) simaensis* Chakrabarti & Raychaudhuri, Host plant unidentified (Chakrabarti *et al.* 1974).

354 *A. (Micropophium) rubiformosanus* (Takahashi), *Rubus ellipticus, Rubus rosaefolia* (Ghosh *et al.* 1971d).

355* *Aiceona longisetosa* Ghosh & Raychaudhuri, Host Plant unidentified (Ghosh M. R. & Raychaudhuri 1973).

356* *A. pallida* Ghosh & Raychoudhuri, Host plant unidentified (Ghosh & Raychaudhuri 1972a).

357* *A. paraosugii* Ghosh, Ghosh, Raychaudhuri, Host plant unidentified (Ghosh *et al.* 1971d).

358* *A. pseudosugii* David, Sekhon, Bindra, *Machilus odoratissima* (David *et al.* 1970c).

359* *A. retipennis* David, Narayanan, Rajasingh, Host plant unidentified (David *et al.* 1970).

360* *A. robustisetosa* Ghosh & Raychaudhuri, *Litsaea polyantha* (Ghosh M. R. & Raychaudhuri 1973).

361* *Akkaia bhutanica* L. K. Ghosh, Host plant unidentified, (L. K. Ghosh 1972b).

362* *A. neopolygoni* Ghosh, Ghosh, Raychaudhuri, *Polygonum* sp. (Ghosh, M. R. *et al.* 1970).

363* *Allotrichosiphum assamense* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Quercus dealbata* (Ghosh *et al.* 1971 as *A. kashicola;* Raychaudhuri *et al.* 1973).

364* *Amphicercidus tuberculatus* David, Narayanan, Rajasingh, Host plant unidentified (David *et al.* 1970).

365** *Anocaudus taxus* Ghosh, Chakrabarti, Chowdhuri, Raychaudhuri, *Taxus baccata* (Ghosh *et al.* 1969a).

366 *Anomalosiphum indigoferae* Ghosh, Ghosh, Raychaudhuri, *Indigofera* sp., (Ghosh M. R. *et al.* 1970 as *A. pithecolobi* Ghosh *et al.* 1971a).

367** *Anthracosiphoniella maculatum* Basu, *Asplenium esculantum, Dryopteris mollis, Athyrium* sp., (Basu 1969a).

368 *Aphis affinis* del Guercio, *Mentha viridis, Mentha slyvestris* (David & Ghorpade 1974).

369 *A. euphorbiae* Thomas, *Euphorbia hercta* (Chakrabarti & Raychaudhuri 1972).

370* *A. leptorhynchus* David, Sekhon, Bindra, *Cyathula tomentosa* (David *et al.* 1970a).

371 *A. polygonaceae* Matsumura, *Rumex acetosella* (Chowdhuri *et al.* 1969).

372* *A. rhamniphila* David, Narayanan, Rajasingh, *Urtica* sp. (David *et al.* 1971a).

373 *A. rhoicola* Hille Ris Lambers, *Rumex* sp., (David *et al.* 1971).

374* *A. ruborum longisetosus* Basu, *Rubus ellipticus, Rubus lineatus* (Basu 1969).

375 *Astegopteryx* sp., *Bambusa* sp., (Sharma 1968). N

376* *Aulacorthum dasi* Ghosh, Basu, Raychaudhuri, plant of compositae (Ghosh *et al.* 1970). +S

377 *A. magnoliae* (Essig & Kuwana), *Cucurbita moschata, cucurbita pepo, Luffa acutangula* (Basu 1969). +S

378 *A. nipponicum* (Essig & Kuwana), *Paederia foetida* (Basu 1969).

379* *A. rhamni* Ghosh, Ghosh, Raychaudhuri, *Callistemon linearis, Eurya* sp., *Rhamnus nepalensis* (Ghosh, M. R. *et al.* 1970) +S

380 *A. scripi* v.d. Goot., *Scleria cochinensis, Scleria alata,* (David *et al.* 1969).

381* *A. sensoriatus* David, Narayanan, Rajasingh, Host plant unidentified creeper (David *et al.* 1970).

382** *A.* (*Anaulacorthum*) *fagopyri* Ghosh & Raychaudhuri, *Fagopyram cymosum* (Ghosh & Raychaudhuri 1972a).

383 *A.* (*Neomyzus*) *anthraxoni* (Takahashi), unidentified grass (Basu 1969).

384* *A.* (*Neomyzus*) *dendrobii* Basu, *Dendrobium* sp., (Basu 1969a).

385 *A.* (*Neomyzus*) *primulum* Ghosh, Banerjee, Raychaudhuri, *Primula* sp., (Ghosh *et al.* 1971a). S

386 *A.* (*Perillaphis*) *perillae* (Shinji), *Perilla frutescens, Perilla oscimoides* (Basu 1969).

387* *Betcallis prunicola* Basu, Ghosh, Raychaudhuri, *Prunus cerasus* (Basu *et al.*, In press).

388* *B. sikkimensis* Basu, Ghosh, Raychaudhuri, *Quercus* sp., (Basu *et al.* 1974) S

389 *Brachycaudus persicicola* (Bois.), *Ageratum conyzoides, Crataeja religiosa* and unidentified host. (Sharma 1968). +N

390 *B.* (*Thuleaphis*)? *amygdalis* (Schoutedon), *Fagopyrum cymosum* (Chakrabarti *et al.* 1972).

391** *Brevitrichosiphon mukerjii* Raychaudhuri, Ghosh, Banerjee, Ghosh, Host plant unidentified (Raychaudhuri *et al.* 1973).

392* *Calaphis hetulaphoides* Quednau, *Betula* sp., (S. Chakrabarti, in litt.)

393 *Calaphis* sp., *Alnus nepalensis* (Basu 1969).

394 *C. juglandis* (Goetze), *Juglans regia* (Chakrabarti *et al.* 1972).

395* *C. nepalensis* Quednau, *Juglans regia* (Quednau 1973). N

396 *Capitophorus archangelskii* Nevsky, *Artemisia vulgaris* (Ghosh *et al.* 1970d).

397* *C. himalayensis* Ghosh, Ghosh, Raychaudhuri, Host plant unidentified (Ghosh *et al.* 1971d).

398* *C. indicus* Ghosh, Ghosh, Raychaudhuri, *Litsaea* sp., (Ghosh *et al.* 1970d).

399* *C. polygoni* Ghosh, Ghosh, Raychaudhuri, *Polygonum* sp., (Ghosh *et al.* 1971d).

400* *Casimira bhutanensis* Ghosh, Basu, Raychaudhuri, Host plant unidentified (Ghosh *et al.* 1971d). Bh

401* *Cavariella biswasi* Ghosh, Basu, Raychaudhuri, *Salix* sp., (Ghosh *et al.* 1969).

402* *C. simlaensis* Chaudhuri, Basu, Raychaudhuri, *Sanicula europea* (Chowdhuri *et al.* 1969a).

403 *Cerataphis orchidearum* (Westwood), *Aerides feildeingii* (Basu 1969).

404* *Ceratoglyphina bambusae bengalensis* L. K. Ghosh, *Bambusa* sp., (L. K. Ghosh 1972c).

405* *Ceratovacuna indica* Ghosh, Pal, Raychaudhuri, *Bambusa* sp., (Ghosh, M. R. *et al.*, In press).

406 *C. graminum* v.d. Goot., Grass (Ghosh *et al.* 1970 as *Ceratovacuna* sp. B.).
407* *C. perglandulosa* Basu, Ghosh, Raychaudhuri *Gressum prothama, Saccharum officinarium* (Basu *et al.* in press).
408* *C. silvestrii* (Takahashi), *Bambusa* sp., (Hille Ris Lambers & Basu 1966 as *Oregma subglandulosa* sp., Ghosh 1973). +S
409* *C. spinulosa* Ghosh & Raychaudhuri, *Ischemum albens* (Ghosh & Raychaudhuri 1972a).
410 *Cervaphis cambodiensis* Takahashi, *Amoora* sp., *Mixacos penniculata, Pterospermum* sp., (Ghosh, Banerjee, Raychaudhuri 1971).
411 *C. quercus* Takahashi, *Quercus griffithi* (Raychaudhuri PL. 480 Tech. Rept. 1974).
412* *Chaetosiphon chaetosiphon indica* Chakrabarti & Ghosh, *Rosa* sp., (Chakrabarti & Ghosh 1970; David *et al.* 1970 recorded the nominate species *Chaetosiphon chaetosiphon* but perhaps that record would refer to the present subspecies).
413* *C. glaber* David, Rajasingh, Narayanan, *Rosa macrophylla* (David *et al.* 1970a).
414* *C. gracilicornis* David, Rajasingh, Narayanan, *Rosa macrophylla* (David *et al.* 1970a).
415 *C. tetrahoda* (Walker), *Rosa* sp., (David *et al.* 1970a).
416 *C.* (*Pentatrichopus*) *heterotrichus,* Chakrabarti, Ghosh, Raychaudhuri, *Salvia* sp., (Chakrabarti *et al.* 1971a).
417 *Chaitophorus dorocola* Mats., *Populus* sp., (Chakrabarti, S., in litt.).
418 *C.? populialbae* (Bayer), vagrant on *Solanum* sp., (David *et al.* 1971).
419 *C. popyleti* Panzer, *Populus alba* (Verma 1969).
420* *C. simlaensis* Chakrabarti, Host plant unidentified, (Chakrabarti, S., in litt.).
421* *Chromaphis hirsutustibis* Kumar & Lavinge, *Juglans regia* (Kumar & Lavinge 1970; Sharma 1968 as *Chromaphis* sp., from Nepal). +N
422 *Chuansicallis chengtuensis* Tao, *Phyllanthus* sp., (A. K. Ghosh Coll.).
423 *Cinara* sp., *Picea morinda* (Chowdhuri *et al.* 1969).
424* *C. abieticola tenuipes* Chakrabarti & Ghosh, ? *Abies* sp., (Chakrabarti *et al.* 1974).
425* *C.* (*Lachniella*) *atroalbipes* David, Narayan, Rajasingh, *Pinus* sp., (David *et al.* 1970).
426* *Clethrobius dryobius* Chakrabarti & Raychaudhuri, *Prunus cerasus,* (Ghosh, Basu, Raychaudhuri 1970 as *comes;* Chakrabarti, S., in lit.).
427* *Cranaphis indica* Chakrabarti & Raychaudhuri, *Arundinaria* sp., (Chakrabarti, S., in litt.).
428* *Cryptaphis rostrata* Chakrabarti & Ghosh, plant of Labiatae (Chakrabarti *et al.* 1974).
429 *Cryptomyzus taoi indica* Ghosh & Raychaudhuri, *Leoneuras sibricus, Leucas aspera* (Ghosh & Raychaudhuri 1972).
430* *Cryptosiphum artemisae,* Buckton, *Artemisia vulgaris* (Basu 1969) +S
431* *Dactynotus brachysiphon* Verma, *Prenanthes* sp., (Verma 1969).
432* *D. fagopyri* Chowdhuri, Basu, Chakrabarti, Raychaudhuri, *Fagopyrum cymosum* (Chowdhuri *et al.* 1969).
433* *D. formosanus crepidis* Ghosh, Ghosh, Raychaudhuri, *Crepis japonica* (Ghosh *et al.* 1971b).
434* *D. kumaoni* Banerjee, Ghosh, Raychaudhuri, *Cnicus argyracanthus, Tri-*

cholepis furcata (Banerjee *et al.* 1969).

435* *D. simlaensis* Chakrabarti, Ghosh, Raychaudhuri, *Erigeron* sp., (Chakrabarti *et al.* 1974d).

436* *D. tanaceti indica* L. K. Ghosh, plant of compositae. (L. K. Ghosh 1971, earlier Ghosh *et al.* 1970, recorded as *D. tanceti*). +S

437 *Doraphis*? *populi* Maskell, *Populus* sp., (David *et al.* 1971).

438* *Dysaphis atinus* Ghosh, Basu, Raychaudhuri, *Cnicus wallichi* (Ghosh *et al.* 1969).

439 *D. longipilosa?* (Mordv.), Host plant unidentified (David *et al.* 1969).

440* *D. multisetosa* Basu, *Pyrus communis* (Basu 1969a).

441** *Eoessigia indica* David, Rajasingh, Narayanan, Host plant unidentified (David *et al.* 1972).

442* *Eomyzus levipes* Basu & Raychaudhuri, *Eupatorium odoratum* (Basu & Raychaudhuri 1974).

443 *Eulachnus cembrae* Borner, *Pinus* sp., (L. K. Ghosh 1970a).

444 *E.? rielyi* (Williams), *Pinus* sp., (David & Rajasingh 1969).

445* *Eumyzus darjeelingensis* Basu & Raychaudhuri, *Hydrangea paniculata* (Basu & Raychaudhuri 1974).

446* *Euthoracaphis heterohirsuta* Ghosh & Raychaudhuri, Host plant unidentified (Ghosh & Raychaudhuri 1973).

447* *E. longisetosa* Ghosh & Raychaudhuri, *Senecio* sp., (Ghosh & Raychaudhuri 1973).

448* *Eutrichosiphum arunachalii* Basu, Ghosh, Raychaudhuri, *Quercus* sp., (Basu *et al.* 1972b).

449* *E. assamense* Ghosh, Basu, Raychaudhuri *Quercus fenestrata* (Ghosh *et al.* 1969).

450 *E. lithocarpi* Maki, *Quercus montana, Quercus coccinea, Quercus serrata* (David 1956).

451* *E. makii* Raychaudhuri & Chatterjee, *Glochidion* sp., (Raychaudhuri & Chatterjee 1974).

452 *E. pseudopasaniae* Szel. *Ficus* sp., *Glochidion* sp., *Quercus dealbata, Quercus* sp., (Ghosh, Banerjee, Raychaudhuri 1971).

453* *E. pyri* Chakrabarti, Ghosh, Raychaudhuri, *Pyrus communis* (Chakrabarti *et al.* 1972).

454* *E. pasaniae sankarii* Raychaudhuri, Ghosh, Banerjee, Ghosh, Host plant unidentified (Raychaudhuri *et al.* 1973).

455 *E. quercifoliae* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Quercus* sp., (Raychaudhuri *et al.* 1973).

456 *E. sinense* Raychaudhuri, *Pterospermum* sp., *Randia* sp., (Raychaudhuri, PL 480 Tech. Rept., 1974).

457* *E. takahashii* Basu, Ghosh, Raychaudhuri, *Glochidion* sp., (Basu *et al.*, in press).

458 *Eutrichosiphum* (*Neotrichosiphum*) sp., A. *Glochidion* sp. (Raychaudhuri & Chatterjee 1974).

459* *E.* (*Neotrichosiphum*) *subinoyi* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Pterospermum* sp., (Raychaudhuri *et al.* 1973 as under *Eutrichosiphum*; Raychaudhuri & Chatterjee 1974).

460 *Geoica* sp., Grass (Raychaudhuri, PL 480 Tech. Rept., 1974).

461 *Glyphina onigurumi* (Shinji), *Atriplex* sp., (Raychaudhuri PL 480 Tech. Rept., 1974).

462* *Greenidea aborensis* Ghosh, Plant of Meliaceae (Ghosh 1974a).

463 *G. decaspermi* Takahashi, *Psidium*

guajava (David *et al.* 1969).

464 *G. euginae* Takahashi, *Eugenia tetrago* (Ghosh *et al.* 1970).

466* *G. himansui* Raychaudhuri, Ghosh, dhuri, Host plant unidentified (Ghosh *et al.* 1970d).

466* *G. humansui* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Randia* sp., (Raychaudhuri *et al.* 1973).

467* *G. longicornis* Ghosh, Ghosh, Raychaudhuri, *Engelhardtia* sp., *Senecio scandens* (Ghosh M. R. *et al.* 1970). +S

468* *G. longirostris* Basu, *Schima wallichi, Quercus* sp., (Basu 1969). +N

469* *G. photiniphaga* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Photinia* sp., (Raychaudhuri *et al.* 1973).

470 *G. sinensis* Raychaudhuri, *Litchi sinensis* (Raychaudhuri, PL 480 Tech. Rept., 1974).

471* *G. symplocosis* Ghosh, Basu, Raychaudhuri, *Symplocos lauriana* (Ghosh *et al.* 1969).

472** *G.* (*Neogreenidea*) *ayyari* Raychaudhuri, Ghosh, Banerjee, Ghosh, Host plant unidentified (Raychaudhuri *et al.* 1973).

473* *G.* (*Neogreenidea*) *longisetosa* Raychaudhuri, Ghosh, Banerjee, Ghosh, Host plant unidentified (Raychaudhuri *et al.* 1973).

474* *G.* (*Neogreenidea*) *querciphaga* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Quercus* sp., (Raychaudhuri *et al.* 1973).

475* *G.* (*Trichosiphum*) *bucktonis,* Ghosh, Basu, Raychaudhuri, *Duabanga sonnarotoides, Villebrunia integrifolia,* (Ghosh *et al.* 1970) +S

476* *G.* (*Trichosiphum*) *formosana heeri* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Duabanga sonnarotoides, Engelhardtia jambolina, Engelhardtia spicata* (Raychaudhuri *et al.* 1973 as *G.*(*T.*) *heeri*). +S

477* *G.* (*Trichosiphum*) *gigantea* Ghosh & Raychaudhuri, Host plant unidentified (Ghosh & Raychaudhuri 1972a).

478* *G.* (*Trichosiphum*) *manii* Ghosh, Basu, Raychaudhuri, Host plant unidentified (Ghosh *et al.* 1970).

479* *G.* (*Trichosiphum*) *prunicola* Ghosh, Banerjee, Raychaudhuri, *Prunus* sp., (Ghosh *et al.* 1971a). S

480* *G.* (*Trichosiphum*) *schoutedeni* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Duabanga sonnarotoides* (Raychaudhuri *et al.* 1973). +S

481* *G.* (*Trichosiphum*) *sikkimensis* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Quercus* sp., (Raychaudhuri *et al.* 1973). S

482* *Greenideoida* (*Paragreenideoida*) *ceyloniae bhalukpongensis* Ghosh, Banerjee, Raychaudhuri, *Uvaria* sp., (Ghosh *et al.* 1971).

483 *G. noonadanae* Heie, *Premora* sp., (Raychaudhuri PL 480 Tech. Rept., 1974).

484** *Hemipodaphis monstrata* David, Narayanan, Rajasingh, ? Plant of Liliaceae (David *et al.* 1971a).

485** *Himalayaphis anemones* Ghosh & Verma, *Anemone* sp., (Ghosh & Verma 1973).

486* *Holotrichosiphon russellae* Ghosh, Ghosh, Raychaudhuri, *Quercus dealbata, Quercus* sp., (Ghosh *et al.* 1971c).

487* *Hoplocallis microsetosus* Quednau & Chakrabarti, *Quercus incana* (Chakrabarti, S., in litt.).

488* *Hyalomyzus raoi* Hille Ris Lambers, *Rubus* sp., (Basu 1969 as *Hyalomyzus* sp., Hille Ris Lambers 1973). +S

489* *H. scrabipes* David & Narayanan, plant of compositae (David & Narayanan 1969).

490 *H. sensoriatus* (Masen), Host plant unidentified (Ghosh *et al.* 1971d).

491 *Impatientinum ? asiaticum* Nevskii, Host plant unidentified (David *et al.* 1971).

492 *I. impatiensae dalhousiensis* Verma, *Smilax parviflora* (Verma 1969a).

493** *Indiaphis crassicornis* Basu, *Rhododendron* sp., (Basu 1969a).

494* *I. rostrata* Ghosh & Raychaudhuri, *Rhododendron* sp., (Ghosh & Raychaudhuri 1972a).

495** *Indocinara hottesis* Ghosh, Basu, Raychaudhuri, *Plectranthus coetsa* (Ghosh *et al.* 1969).

496** *Indoidiopterus geranii* (Chowdhuri, Basu, Chakrabarti, Raychaudhuri), *Geranium* sp., (Chowdhuri *et al.* 1969a as *Capitophorus geranii;* Chakrabarti *et al.* 1972).

497** *Indomyzus sensoriatus* Ghosh, Ghosh, Raychaudhuri, Host plant unidentified (Ghosh *et al.* 1971d).

498** *Indonipponaphis tuberculata* Ghosh & Raychaudhuri, *Quercus dealbata* (Ghosh & Raychaudhuri 1973).

499 *Jacksonia papillata* Theobald, Grass (L. K. Ghosh 1972).

500* *Kaburagia ailanthi* Chowdhuri, Basu, Chakrabarti, Raychaudhuri, *Ailanthus* sp., (Chowdhuri *et al.* 1969).

501* *Lachnus acutihirsutus* Kumar & Burkhardt, *Quercus incana* (Kumar & Burkhardt 1970).

502** *Longirostris raji* Kumar & Burkhardt, *Salvia* sp., (Kumar & Burkhardt 1970).

503 *Machilaphis machili* Takahashi, *Machilus odoratissima* (Ghosh *et al.* 1970).

504* *Macromyzus indicus* David & Narayanan, unidentified weed (David & Narayanan 1969).

505 *M. polypodicola* (Takahashi), *Asplenium esculantum* (Ghosh *et al.* 1970d).

506 *M. woodwardiae* (Takahashi), *Asplenium esculentum, Athyrium* sp., (Ghosh *et al.* 1970d). +S +N

507* *Macrosiphoniella hikosanensis matsumurana* Ghosh, Basu, Raychaudhuri, *Artemisia vulgaris* (Ghosh *et al.* 1970 as *M. matsumurana*). +S

508* *M. lambersi* Verma, *Artemisia scoparia* (Verma 1969).

509* *M. spinipes rhododendri,* Ghosh, Basu, Raychaudhuri, *Rhododendron arboreum* (Ghosh *et al.* 1969).

510* *M. sudhakaris* Banerjee, Ghosh, Raychaudhuri, *Achellia millefolium* (Banerjee *et al.* 1969).

511 *Macrosiphoniella* sp., Host plant unidentified, (Ghosh, L. K. 1972b). Bh

512* *Macrosiphum aulacorthoides* David, Narayanan, Rajasingh, Host plant unidentified (David *et al.* 1970).

513* *M. fagopyri* Ghosh & Raychaudhuri, *Fagopyrum* sp., (Ghosh & Raychaudhuri 1972).

514* *M. pseudogeranii* (Chowdhuri, Basu, Chakrabarti, Raychaudhuri), *Geranium lucidum* (Chowdhuri *et al.* 1969 as *M. geranii*).

515 *M. smilacifoliae* Takashashi, *Smilax ferox, Photinia* sp., (Basu *et al.* 1974).

516* *M. spinotibium* Ghosh, Ghosh, Raychaudhuri, Host plant unidentified (Ghosh M. R. *et al.* 1970).

517 *Macrosiphum* sp., Host plant unidentified (Ghosh, L. K. 1972b). Bh

518* *Macrosiphum* (*Sitobion*) *microspinulatum* David, Rajasingh, Narayanan, *Arthraxon lancifolius* (David *et al.* 1972).

519* *M.* (*Sitobion*) *plectranthi* Ghosh, Raychaudhuri, *Plectranthus coetsa* (Ghosh, M. R. *et al.* 1970).

520* *M.* (*Sitobion*) *pseudoluteum* Ghosh, *Mandenvillia* sp., *Cymbidium eburnum* (Ghosh 1969).

521* *M.* (*Sitobion*) *scrabipes* L. K. Ghosh, *Triticum* sp., (Ghosh, L. K. 1972a).

522* *Maculolachnus rubi* Ghosh & Raychaudhuri, *Rubus* sp., (Ghosh & Raychaudhuri 1972a).

523 *Maculolachnus submaculata* (Walker), *Rosa* sp., (David *et al.* 1969).

524* *M.* (*Neomasonaphis*) *inulae* Ghosh & Raychaudhuri, *Inula cappa, Rhododendron* sp., (Ghosh & Raychaudhuri 1972).

525* *Matsumuraja indica* Ghosh, Ghosh, Raychaudhuri, *Rubus* sp., (Ghosh *et al.* 1971c).

526 *M. nuditerga* Hille Ris Lambers, Host plant unidentified (Ghosh & Raychaudhuri 1972a).

527 *M. rubifoliae* Takashashi, Host plant unidentified (Ghosh *et al.* 1971c).

528* *M. urticae* Ghosh, Ghosh, Raychaudhuri, plant of urticaceae (Ghosh *et al.* 1971c).

529* *Megoura cajanae* Ghosh, Ghosh, Raychaudhuri, *Cajanas cajan* (Ghosh M. R. *et al.* 1970, Syn. *M. abnormis* L. K. Ghosh 1970). +Bh

530* *M. pallipes* Basu. *Indigofera teysmanni* (Basu 1969).

531* *Megouroparsus dooarsis* Ghosh & Raychaudhuri, plant of leguminosae (Ghosh & Raychaudhuri 1969a).

532 *Melanaphis arundinariae* (Takahashi), Bamboo (Ghosh *et al.* 1970).

533* *M. meghalayensis* Raychaudhuri & Banerjee, Bamboo (Raychaudhuri & Banerjee 1974).

534* *M. meghalayensis bengalensis* Raychaudhuri & Banerjee, Grass (Raychaudhuri & Banerjee 1974).

535* *M. vandergooti* Raychaudhuri & Banerjee, *Oryza sativa* (Raychaudhuri & Banerjee 1974).

536* *Mesocallis alnicola* Ghosh, *Alnus nepalensis* (Ghosh 1974b).

537* *M. obtusirostris* Ghosh, *Alnus nepalensis* (Ghosh 1974b).

538* *Metanipponaphis assamensis* Ghosh & Raychaudhuri, *Castanopsis tribuloides* (Ghosh & Raychaudhuri, 1973; Ghosh *et al.* 1970 as *Metanipponaphis* sp.)

539* *M. echinata* Ghosh, *Castanopsis histrix* (Ghosh 1974).

540 *M. silvestrii* (Takahashi), *Lindera* sp., (Ghosh 1974b).

541* *Micromyzus granotiae* Ghosh, Ghosh, Raychaudhuri, *Granotia* sp., (Ghosh *et al.* 1970d).

542* *M. mawphlongensis* Ghosh, *Polypodium* sp., (Ghosh 1974a).

543 *M. montanus* (Takahashi), *Astilbe rivularis* David *et al.* 1969 as *Taiwanomyzus*, (Ghosh M. R. *et al.* 1970).

544* *Micromyzodium strobilanthi* L. K. Ghosh, *Strobilanthus dalhousiensis* (L. K. Ghosh 1970).

545 *Mindarus abietinus* Koch, *Abies* sp., (Ghosh 1974b).

546* *Mollitrichosiphum* (*Metatrichosiphon*) *alni* Ghosh, Ghosh, Raychaudhuri, *Alnus nepalensis* (Ghosh *et al.* 1970d).

547* *M.* (*Metatrichosiphon*) *buddleiae* Ghosh, Banerjee, Raychaudhuri, *Buddleia* sp., (Ghosh *et al.* 1971a).

548* *M.* (*Metatrichosiphon*) *kazirangi* Ghosh, Host plant unidentified (Ghosh 1974a).

549* *M.* (*Metatrichosiphon*) *rhusae* Ghosh, *Rhus* sp., (Ghosh 1974a).

550* *M.* (*Metrichosiphon*) *shinjii* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Quercus* sp., (Raychaudhuri *et al.* 1973).

551 *M.* (*Metatrichosiphon*) *taiwanus* (Tak.), *Rhus* sp., (Raychaudhuri, PL 480 Tech. Rept. 1974).

552* *Myzaphis avriliosa* David, Rajasingh, Narayanan, *Rosa macrophylla* (David *et al.* 1970a).

553 *M. turanica* Nevskii; *Rosa* sp., (L. K. Ghosh 1969).

554* *Myzocallis* (*Dryomyzus*) *polychaetus* David, *Quercus semicarpifolia* (David 1969).

555 *Myzocallis* sp., *Prunus* sp., (Sharma 1968, may be *Tinocalloides montanus* Basu). N

556* *Myzus brevisiphon* Basu, *Polygonum capitatum* (Basu 1969a).

557* *M. corylopsis* n. sp., *Corylopsis* sp., (Raychaudhuri PL 480 Tech. Rept. 1974).

558* *M. fiilicis* Basu, Fern (Basu 1969a).

559* *M. indicus* Basu & Raychaudhuri, *Boehmeria* sp., (Basu & Raychaudhuri 1976).

560* *M. lefroyi* Basu & Raychaudhuri, Fern (Basu & Raychaudhuri 1976).

561* *M. leptotrichus* David, Narayanan, Rajasingh, *Polygonum runcinatum* (David *et al.* 1972).

562* *M. maculocorpus* Basu & Raychaudhuri, Grass (Basu & Raychaudhuri 1976).

563* *M. manoji* Basu & Raychaudhuri, Host plant unidentified (Basu & Raychaudhuri 1976).

564* *M. meghalayensis* Basu & Raychaudhuri, Host plant unidentified (Basu & Raychaudhuri 1976).

565* *M. mumecola* (Mats). *Prunus cornuta* (Chakrabarti *et al.* 1970).

566* *M. obtusirostris* David, Narayanan, Rajasingh, Grass, Bamboo, *Lindera* sp., (David *et al.* 1971a).

567 *M. ranunculinus* (Walker), Host plant unidentified (Ghosh *et al.* 1971c).

568 *M. sigesbeckicola* Strand, *Sigesbeckia orientalis, Eupatorium odoratum*; *Montana bippinnefifida, Perilla* sp., (Raychaudhuri, PL 480 Tech. Rept., 1974).

569 *M. umefoliae* (Shinji) *Galium aparine, Rubia cordifolia* (Raychaudhuri, PL 480 Tech. Rept., 1974).

570 *Myzus* sp., Host plant unidentified (Ghosh *et al.* 1971d). Bh

571 *Myzus* sp., *Malus* sp., (Ghosh *et al.* 1973). N

572* *Nasonovia* (*Kakimia*) *rostrata* David &

572* *Nasonovia* (*Kakimia*) *rostrata* David & Hameed 1974).

573* *Neoacyrthosiphon rhododendri* Ghosh, Ghosh, Raychaudhuri, *Rhododendron arboreum* (Ghosh, M. R. *et al.* 1970).

574* *N. setosum* Hille Ris Lambers & Basu, *Pentapgeryum* sp., (H. R. L. & Basu 1966 as *Ericolophium*).

575 *N. taiheisanum* (Takahashi), *Rhododendron* sp., (David & Rajasingh 1969 as *Ericolophium taiheisanum*).

576* *N. taihensanum ovalifolii* Ghosh, Ghosh, Raychaudhuri, *Pieris ovalifolia* (Ghosh, M. R. *et al.* 1970).

577 *N.* (*Pseudoacyrthosiphon*) *holstii* (Takahashi), *Rhododendron arboreum* (Ghosh & Raychaudhuri 1969).

578* *N.* (*Pseudoacyrthosiphon*) *nepalensis,* Ghosh, Basu, Raychaudhuri, *Rhododendron* sp., (Ghosh *et al.* 1973).

579* *N.* (*Pseudoacyrthosiphon*) *takahashii* Ghosh, *Anemone rivularis, Rhododendron* sp., (Ghosh 1969).

580* *Neobetulaphis trichosiphon* Quednau, *Alnus* sp., *Betula* sp., (Chakrabarti, S., in litt.). +S

581* *Nipponaphis holboelliae* Ghosh & Raychaudhuri, *Holboellia latifolia* (Ghosh & Raychaudhuri 1973; Ghosh *et al.* 1971b as *Nipponaphis* sp.)

582* *N. manoji*, Ghosh & Raychaudhuri, *Litsaea corymbosa, Litsaea polyanthi* (Ghosh & Raychaudhuri 1973; Ghosh *et al.* 1971b as *N. machilicola* Tak.).

583** *N.* (*Pseudonipponaphis*) *himalayensis* Ghosh & Raychaudhuri, *Litsaea polynatha, Machilus* sp., (Ghosh & Raychaudhuri 1973; Ghosh, Banerjee, Raychaudhuri 1971 as *machiliphaga*).

584* *N.* (*Pseudonipponaphis*) *querciphaga* Ghosh & Raychaudhuri, *Quercus* sp., (Ghosh & Raychaudhuri 1973; Ghosh, Banerjee & Raychaudhuri 1973 as *Nipponaphis* sp.). S

585 *Ovatus minutus* (v.d. Goot) *Leoneurus sibricus* (Ghosh & Raychaudhuri 1972).

586* *Paczoskia budhium* Banerjee, Ghosh, Raychaudhuri, *Echinops cornigerus, Inula cappa, Anaphilis* sp., *Blumea* sp., (Banerjee *et al.* 1969).

587 *Paratrichosiphum javanicum* Raychaudhuri, *Alnus nepalensis* (Basu 1969).

588* *P. sensoriatum* Ghosh, Host plant unidentified (Ghosh 1974a).

589* *P. sikkimensis* Raychaudhuri, Ghosh, Banerjee, Ghosh, *Duabanga sonnarotoides* (Raychaudhuri *et al.* 1973).

590 *Paratrichosiphum* sp., *Lindera* sp., (David & Rajasingh 1969).

591 *Paratrichosiphum* sp., *Styrax* sp., (Raychaudhuri, PL 480 Tech. Rept. 1974).

592 *Paratrichosiphum* (*Neoparatrichosiphum*) *flavum* (Takahashi), *Ficus* sp., *Glochidion* sp., *Quercus dealbata, Quercus* sp., (Raychaudhuri, PL 480 Tech. Rept., 1974).

593* *P.* (*Neoparatrichosiphum*) *raychaudhurii* Ghosh, *Alnus nepalensis, Buddleia* sp., *Quercus* sp., (Ghosh 1969).

594* *Pemphigus siphunculatus* Hille Ris Lambers, *Populus ciliata* (H.R.L. 1973). P

595** *Pentatrichosiphum luteum* Basu, *Litsaea polyantha, Buddleia* sp., *Lindera* sp., *Quercus* sp., (Basu 1969a).

596* *Periphyllus bengalensis* Ghosh & Raychaudhuri, *Acer* sp., (Ghosh & Raychaudhuri 1972a).

597* *P. californiensis darjeelingensis* David, Host plant unidentified (Hille Ris Lambers, in litt.).

598* *P. himalayensis* Chakrabarti, *Acer* sp., (Chakrabarti, S., in litt.).

599* *P. pusillus* Quednau & Chakrabarti, *Acer villosus* (Chakrabarti, in litt.).

600 *P. testudinacea* (Fernie), *Acer oblongum* (David *et al.* 1971).

601 *P. viridis* (Matsumura), *Acer villosus* (Chakrabarti, S., in litt.).

602 *Periphyllus* sp., Host plant unidentified (Ghosh *et al.* 1971b).

603 *Pleotrichophorus glandulosus* (Kalt.), *Artemisia* sp., (Ghosh *et al.* 1971b). Bh

604* *Prociphilus* (*Neoparacletus*) *ghanii* H.R.L., *Salix wallichiana* (Hille Ris Lambers 1973). P

605 *Prociphilus* sp., A. *Fraxinus floribunda* Ghosh *et al.* 1970).

606 *Prociphilus* sp., B. *Photinia notoniana* (Ghosh *et al.* 1970).

607 *Prociphilus* sp., Host plant unidentified (Chowdhuri *et al.* 1969).

608 *Pseudaphis abyssinica* Hille Ris Lambers, *Carex filicina* (Ghosh *et al.* 1971b).

609* *Pseudoastegopteryx himalayensis* Ghosh, Pal, Raychaudhuri, Bamboo (Ghosh, M.R. *et al.*, in press).

610 *Pseudoregma alexandri* (Takahashi),

Bamboo (Basu 1969).

611 *Pseudotinocallis nigropunctata* (Tao), *Phyllanthus* sp., (A. K. Ghosh Coll.).

612 *Pterocomma? populifoliae* (Fitch), *Populus* sp., (Ghosh M. R. *et al.* 1970).

613* *Pyrolachnus imbricatus* David, Narayanan, Rajasingh, *Prunus cornuta* (David *et al.* 1971a).

614* *Rhopalosiphonius longisetosus* Chakrabarti & Ghosh, Host plant unidentified (Chakrabarti *et al.* 1974).

615 *Rhopalosiphonicus* sp., Host plant unidentified (L. K. Ghosh 1972b). Bh

616* *Rhopalosiphum yoksumi* Ghosh, Banerjee, Raychaudhuri, *Poa* sp., (Ghosh *et al.* 1971a). S

617* *Schizaphis hypersiphonata* Basu, *Cyperus exhaltatus, Poa* sp., (Baus 1969). +S

618 *Schizaphis* sp., *Pyrus communis* (Sharma 1968). N

619** *Schizoneurella indica* Hille Ris Lambers, *Ulmus villosa, Ulmus* sp., (Hille Ris Lambers 1973). +P

620 *Semiaphis heraclei* (Takahashi), plant of Umbelliferae (Raychaudhuri, PL 480 Tech. Rept., 1974).

621 *Semiaphis* sp., Host plant unidentified (Chowdhuri *et al.* 1969).

622** *Seratocallis takahashi* Quednau & Chakrabarti, *Quercus* sp., (Chakrabarti, S., in litt.).

623* *Shivaphis bambusicola* (David, Rajasingh, Narayanan), *Bambusa* sp., (David *et al.* 1970b, as *Cranaphis bambusicola*).

624* *Sinomegoura photinae* Takahashi, *Photinia integrifolia* (Basu 1969).

625** *Subtakecallis brevisetosus* Raychaudhuri & Pal, Bamboo (Raychaudhuri & Pal 1974).

626* *S. pilosa* (David, Narayanan, Rajasingh), Bamboo (David, *et al.* 1970b, as *Cranaphis pilosa;* Raychaudhuri & Pal 1974).

627* *Taiwanaphis randiae* Ghosh, Banerjee, Raychaudhuri, *Randia* sp., (Ghosh *et al.* 1971).

628** *Taoia indica* (Ghosh & Raychaudhuri), *Alnus nepalensis, Betula alnoides* (Ghosh & Raychaudhuri 1972; David & Rajasingh 1969 as *Eucraphis chuansinensis*).

629* *Tetraneura* (*Tetraneurella*) *basui* Hille Ris Lambers, Grass (Hille Ris Lambers 1968-69).

630 *Thecabius* sp., Host plant unidentified (David *et al.* 1971).

631 *Thoracaphis* sp., *Quercus dealbata* (Ghosh & Raychaudhuri 1973).

632* *Tinocallis distincta* Ghosh, Ghosh, Raychaudhuri, *Duabanga* sp., (Ghosh, M.R. *et al.* 1970).

633* *Tinocallis himalayensis* Ghosh, Ghosh, Raychaudhuri, plant of Leguminosae (Ghosh *et al.* 1971c).

634* *T. indica* Chakrabarti, ? *Ulmus* sp., (Chakrabarti, S., in litt.).

635* *T. magnoliae* Ghosh & Raychaudhuri, *Magnolia* sp., (Ghosh & Raychaudhuri 1972).

636** *Tinocalloides montanus* Basu, *Prunus cerasus, Prunus persica, Prunus puddum* (Basu 1969; Kumar & Lavigne 1970 as *Tuberdefectus eastopi* nov. gen. et. sp.). +S

637 *Toxoptera schlingeri* Tao, *Ficus heterophylla, Ficus* sp., (Basu *et al.* 1974).

638* *Tricaudatus indicus* Ghosh, Basu, Raychaudhuri, *Prinsepia utilis* (Ghosh *et al.* 1969).

639* *Trichosiphonaphis gerberae* Ghosh & Raychaudhuri, *Gerbera macrophylla, Gerbera* sp., (Ghosh & Raychaudhuri

1972).

640 *T. lonicerae* (Uye), *Hedyotis scandens, Lonicera macrantha* (Basu *et al.* 1974).

641 *T. polygoniformosanus* (Takahashi), *Polygonum perfoliatum, Polygonum* sp., (Basu 1969).

642* *Tuberaphis indica* Ghosh, Ghosh, Raychaudhuri, Host plant unidentified (Ghosh M. R., *et al.* 1970 as *coreanus;* Ghosh *et al.* 1971b).

643 *Tubercephalus sasaki* (Matsumara), *Artemisia* sp., [Basu 1969, as *Trichosiphoniella* sasaki (Mats)]. +Bh

644* *Tuberculatus indicus* L. K. Ghosh, *Quercus* sp., (L. K. Ghosh 1972c).

645* *T. nervatus* Chakrabarti & Raychaudhuri, *Quercus* sp., (Chakrabarti, S., in litt.).

646 *T. paiki* Hille Ris Lambers., *Quercus* sp., (Chakrabarti, S., in litt.).

647** *Tuberolachnus* (*Tuberolachinella*) *scelerata* Hille Ris Lambers & Basu, *Eriobotrya petiolata* (Hille Ris Lambers & Basu 1966).

648* *Vesiculaphis kuwani* Ghosh, Basu, Raychaudhuri, *Lyonia ovalifolia* (Ghosh *et al.* 1970). +S

649* *V. polygonicola* (Basu), *Polygonum runciatum* (Basu 1969a, as *Myzakkia polygonicola*).

650* *V. rhododendri* Ghosh & Raychaudhuri, *Rhododendron* sp., (Ghosh & Raychaudhuri 1972).

651* *V. verbasci* Chowdhuri, Basu, Chakrabarti, Raychaudhuri; *Polygonum alatum; Polygonum chinense, Polygonum runcinatum, Polygonum serrulatum, Verbascum thapsus* (Chowdhuri *et al.* 1969; Basu 1969 as *Myzakkia himalayensis* n. sp.) +S

652* *Wahlgreniella neoempetri* Ghosh, Basu, Raychaudhuri Host plant unidentified (Ghosh *et al.* 1971b). Bh

653* *Yamatocallis obscura* (Ghosh, Ghosh, Raychaudhuri), Host plant unidentified (Ghosh *et al.* 1970b as *Megalophyllaphis obscura*).

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Additions to the flora of Rajasthan[1]

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In this paper 64 species belonging to 49 genera and 25 families are recorded for the first time from Rajasthan. About 12 species new records for "Upper Gangetic Plain" have also been mentioned for the first time from this area and *Ipomoea triloba* Linn. has been recorded for the second time from India.

A perusal of up-to-date literature on the vegetation of Rajasthan reveals that the north-east, north-west and western parts of the state have been intensively investigated so far. Recently, Jain & Kotwal (1960), Vyas & Ramdeo (1964-65), Ramdeo (1965, 66), Gupta (1965a & b, 66), Vyas (1965a & b, 67) and Singh (1970) have added to our knowledge of the flora of eastern part of Rajasthan.

During botanical exploration of south-eastern plateau of Rajasthan (Kotah, Bundi and Jhalawarh districts), I noted that about 64 species have not been recorded from any locality in Rajasthan. These species are enumerated below and each specific name is accompanied by its field numbers, frequency and abundance in the area, habitat with exact locality of occurrence and flowering and fruiting times.

The herbarium specimens are deposited in the Herbarium of National Botanic Gardens, Lucknow.

CRUCIFERAE

Cardamine impatiens Linn. (74007): Rare; found in moist and shady localities near Kotah Dam. *Fl.* & *Fr.*: October-December.

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MALVACEAE

Althaea ludwigii Linn. (91023): Rare; found in dry sandy soils near Atru. *Fl.* & *Fr.*: December-April.

PAPILIONACEAE

Crotalaria hirta Willd. (90396, 83677): Common; found in waste rocky grounds near Atru and as a weed of cultivation near Bhawanimandi. *Fl.* & *Fr.*: August-October.

C. prostrata Rottl. ex Willd. (83904): Occasional; found in waste rocky lands near Jhalawarh. *Fl.* & *Fr.*: August-November.

Trigonella incisa Benth. (90927): Common weed of cultivated fields and wastelands near Kotah. *Fl.* & *Fr.*: January-March.

Trifolium resupinatum Linn. (91062): Rare; found as a weed of winter season crops near Kelwara. *Fl.* & *Fr.*: January-March.

CAESALPINIACEAE

Phanera integrifolia (Roxb.) Benth. (83711): Rare; found in the forests near Jhalawarh. *Fl.* & *Fr.*: March-June.

MIMOSACEAE

Neptunia triquetra (Vahl) Benth. (90577): Rare; found in marshlands near Kotah. *Fl.* & *Fr.*: August-October.

Cucurbitaceae

Trichosanthes bracteata (Lamk.) Voigt (74679, 74808, 91064): Common in wastelands; collected from Bundi, Darah and Kelwara. *Fl.* & *Fr.*: June-October.

Umbelliferae

Seseli diffusum (Roxb. ex Sm.) Sant. & Wagh (91024): Rare; found in drying ponds near Atru. *Fl.* & *Fr.*: April-May.

Rubiaceae

Hedyotis hispida Retz. (74801): Common; found in rocky grounds and on the hills near Darah. *Fl.* & *Fr.*: August-October.

Neanotis montholoni (Hook. f.) Lewis (83675): Rare; weed of cultivation in the vicinity of Bhawanimandi. *Fl.* & *Fr.*: August-October.

Ixora arborea Roxb. ex Sm. (91066): Rare; abundant near streams in the evergreen forest of Sitabari (Kelwara). *Fl.* & *Fr.*: January-April.

Compositae

Lactuca polycephala Benth. (74750): Rare; weed of cultivated fields near Kelwara. *Fl.* & *Fr.*: February-May.

Elephantopus scaber Linn. (90842): Occasional; found in shady localities in the forests near Kelwara. *Fl.* & *Fr.*: August-November.

Adenostemma lavenia (Linn.) Kuntze (90835): Rare; found near Kelwara in still or slow running streams. *Fl.* & *Fr.*: August-November.

Spilanthes paniculatus Wall. ex DC. (83823): Rare; found in marshy habitats near Jhalarapatan. *Fl.* & *Fr.*: December-April.

Erigeron multicaulis Wall. ex DC. (90695): Rare; found in wastelands near Shahabad. *Fl.* & *Fr.*: August-October.

Campanulaceae

Wahlenbergia marginata (Thunb.) DC. (91027): Occasional; found in grasslands near Atru. *Fl.* & *Fr.*: February-April.

Primulaceae

Androsace umbellata (Lour.) Merr. (90958): Occasional found in wet and shady places in the forests near Atru. *Fl.* & *Fr.*: December-March.

Convolvulaceae

Ipomoea triloba Linn. (74692): Rare; found in garden hedges at Bundi. *Fl.* & *Fr.*: August-November.

I. sepiaria var. *stipulacea* Cl. (83775): Rare; found in wastelands among bushes near Atru. *Fl.* & *Fr.*: August-October.

I. violacea Linn. (83699): Rare; found among bushes near Eklera. *Fl.* & *Fr.*: October-January.

Evolvulus nummularius Linn. (74021): Occasional; found in dry, undisturbed grounds near Bundi and Jhalawarh. *Fl.* & *Fr.*: January-April.

Scrophulariaceae

Bacopa floribunda (R. Br.) Wettst. (83707a): Rare; found in open wetlands near Atru. *Fl.* & *Fr.*: September-December.

B. hamiltoniana (Benth.) Wettst. (83707b): Rare; found in moist places near Atru village in association with *B. floribunda*. The species can be distinguished from the latter by its sessile flowers. *Fl.* & *Fr.*: September-December.

Lindernia multiflora (Roxb.) Mukerji (74774, 83726): Occasional; found on the marshy banks of streams and in the rice-fields near Bhonra and Jhalawarh. *Fl.* & *Fr.*: August-October.

L. verbenaefolia (Colsm.) Pennell (74477): Rare; found in wet localities near Bundi. *Fl.* & *Fr.*: December-March.

L. anagallis (Burm. f.) Pennell (83742): Rare; found in open wet-lands near Atru. *Fl.* & *Fr.*: August-November.

Gesneriaceae

Didymocarpus pygmaea Cl. (74719): Rare; collected from Kotah Dam, growing on exposed rocks and in the crevices of rocks. *Fl.* & *Fr.*: February-April.

Acanthaceae

Nelsonia canescens (Lamk.) Spreng. (90846): Rare; found in wet shady places in the forests near Kelwara. *Fl.* & *Fr.*: November-March.

Eranthemum purpurascens Wt. ex Nees (83935): Rare; forming an undergrowth in the forests near Darah, Kelwara and Shahabad. *Fl.* & *Fr.*: January-June.

Hygrophila serpyllum var. *hookeriana* Cl. (90305): Rare; forming dense patches on the sides of Parbati river near Atru. *Fl.* & *Fr.*: September-December.

Polygonaceae

Rumex nepalensis Spreng. (74870): Rare; found along railway-lines near Darah. *Fl.* & *Fr.*: March-June.

Polygonum limbatum Meissn. (74775): Occasional; found on the marshy banks of rivers; collected from Kotah Dam. *Fl.* & *Fr.*: May-October.

Euphorbiaceae

Tragia cannabina Linn. f. (90806): Occasional; found in wastelands near Chhipabaraut. *Fl.* & *Fr.*: May-October.

Phyllanthus deblis Klein ex Willd. (90147): Rare; found in cultivated fields and wastelands near Kotah Dam. *Fl.* & *Fr.*: September-December.

Orchidaceae

Vanda tessallata (Roxb.) Hook. ex G. Don (90840): Rare; found on mango trees in evergreen forests of Sitabari (Kelwara). *Fl.* & *Fr.*: March-October.

Hypoxidaceae

Curculigo orchioides Gaertn. (83717): Common; found in deciduous forests, especially near Jhalawarh. *Fl.* & *Fr.*: August-October.

Liliaceae

Chlorophytum laxum R. Br. (74871): Occasional; found in the crevices of rocks on the hills near Darah. *Fl.* & *Fr.*: May-August.

Commelinaceae

Commelina kurzii Cl. (74601, 90425): Abundant throughout the area on lateritic soils rich in humus. *Fl.* & *Fr.*: August-October.

C. attenuata Koen. & Vahl (74844): Rare; found on the hill-slopes near Darah. *Fl.* & *Fr.*: October-November.

C. suffruticosa Bl. (74848): Common on sandy-loam soils throughout the area; abundant near Darah. *Fl.* & *Fr.*: August-November.

Najadaceae

Najas marina Linn. (74497): Rare: found in Telera river near Talera village. *Fl.* & *Fr.*: September-December.

Cyperaceae

Cyperus platystylis R. Br. (90843): Rare; found in marshy or aquatic habitats near Kelwara. *Fl.* & *Fr.*: April-December.

C. diaphanus Schrad. ex R. & S. (83764): Restricted to the sandy beds of Kali Sindh river near Jhalarapatan. *Fl.* & *Fr.*: August-November.

C. compactus Retz. (90612): Occasional; found in the rice-fields near Kotah. *Fl.* & *Fr.*: August-November.

Furiena ciliaris (Linn.) Roxb. (83672, 90964): Common; found in aquatic habitats and in the rice-fields; abundant near Atru and Jhalawarh. *Fl.* & *Fr.*: October-February.

Eleocharis capitata (Linn.) R. Br. (83642): Rare; found in temporary ponds along the roads near Bundi. *Fl.* & *Fr.*: August-December.

E. palustris (Linn.) R. Br. (74785): Occasional; found in marshy habitats near Atru. *Fl.* & *Fr.*: December-April.

Fimbristylis falcata (Vahl) Kunth (74764): Rare; found in marshy or aquatic habitats near Kelwara. *Fl.* & *Fr.*: July-September.

F. ovata (Burm.) Kern (83930): Common in marshlands. *Fl.* & *Fr.*: August-October.

F. tetragona R. Br. (83706): Frequently found in wet sandy places near Atru. *Fl.* & *Fr.*: September-January.

Carex cruciata Wahlenb. (74091): Occasional; found in marshy habitats near Hindoli. *Fl.* & *Fr.*: September-January.

C. heterostachya Bunge (91075): Occasional; found along the banks of ponds near Sitabari (Kelwara). *Fl.* & *Fr.*: October-April.

Gramineae

Brachiaria decumbens Stapf (74035): Rare; found in moist sandy localities near Bundi. *Fl.* & *Fr.*: August-May.

B. villosa (Lamk.) A. Camus (74831): Occasional; found in wastelands from plains to the hills; abundant near Darah. *Fl.* & *Fr.*: August-November.

Digitaria cruciata (Nees ex Steud.) A. Camus (90700): Occasional; found in the shady habitats in the gardens and forests near Kelwara. *Fl.* & *Fr.*: December-April.

Oryza rufipogon Griff. (83724): Rare; found in a pond near Forest Nursery, Jhalawarh. *Fl.* & *Fr.*: August-November.

Elytrophorus spicatus (Willd.) A. Camus (83772): Frequently found in sandy, wet soils; abundant near Atru. *Fl.* & *Fr.*: October-January.

Panicum paludosum Roxb. (83606): Occasional; found in the ponds near Hindoli and Kelwara. *Fl.* & *Fr.*: October-May.

Oryzopsis aequiglumis Duthie (90520): Rare; found in the ponds and ditches near Kotah. *Fl.* & *Fr.*: October-February.

Bothriochloa kuntzeana (Hack.) Henr. (74671): Rare; found in sandy soils in the campus of Soil Conservation Demonstration, Research and Training Centre, Kotah. *Fl.* & *Fr.*: August-December.

Duthie (1903-29) included the present area in his "Flora of Upper Gangetic Plain", but has not recorded the occurrence of plants from these districts. A perusal of literature on the vegetation of Gangetic Plain reveals that following 11 species have not been previously added to the Flora of Upper Gangetic Plain from this locality; these are: *Bacopa floribunda,* *Hygrophila serphyllum* var. *hookeriana, Phyllanthus deblis, Chlorophytum laxum, Bothriochloa kuntzeana, Oryzopsis aequiglumis, Cyperus platystylis, C. diaphanus, Neanotis montholoni, Ipomoea sepiaria* var. *stipulacea* and *Plantago pumila* Willd.

Further, *Ipomoea triloba* has been recorded for the second time from India. Earlier it was collected from Borivli, Bombay by Fernandes *et al.* (*see JBNHS 52*:661, 1954).

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Further studies on the identification of hairs of some Indian Mammals[1]

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Observations on structural hair characteristics of some mammals are undertaken in this paper. A series of camera lucida diagrams depicting the structure of hairs of 13 species of mammals is presented.

INTRODUCTION

The Project Tiger in Maharashtra was initiated in the Melghat Tiger Reserve on 22nd February, 1974, with the main object of giving protection and conserving the tiger. The present observations are undertaken under Project Tiger with the main aim of studying food and feeding habits on the basis of faeces mainly of the carnivores. McMurtrie (1886) was probably the first to study structural patterns of hairs.

The practical applications of hair identification in the biological and forensic sciences have been enumerated by several workers (Mathik 1938, Williams 1938, Mayer 1952) and Adorjan and Kolenosky (1969). However, except for studies reported by Koppiker & Sabnis (1976) on structural identification of hairs of some mammals of Maharashtra, no detailed investigations have been reported on patterns of hair structure in Indian Mammals in general and that of Maharashtra in particular. The present paper embodies further information on hair structure of some remaining mammals of Maharashtra. The hair studies undertaken so far under Project Tiger cover in all 34 mammalian species.

MATERIAL AND METHODS

All hair specimens were directly washed in hot water. They were air dried thoroughly and passed through ether and xylol. Hair slides were prepared in Canada-balsam. The camera lucida drawings were prepared of each hair showing cuticular, and medullar pattern. The three basic regions of each hair fibre namely, proximal, medial and distal were studied. The diagrams on the left hand side in the figures show the structure of hairs of the proximal end (except in Figure 9 which shows the structure of entire hair when seen visually), in the middle the medial and on the right the distal end.

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In cases where the structure of proximal and medial portions of hair was identical, only one diagram has been drawn representing both. The measurements given are averages. Magnification of the figures is × 740.

Observations

The structural parts of a hair are the cuticle, cortex, medulla, pigment and hair cells. In the system of hair identification to be outlined

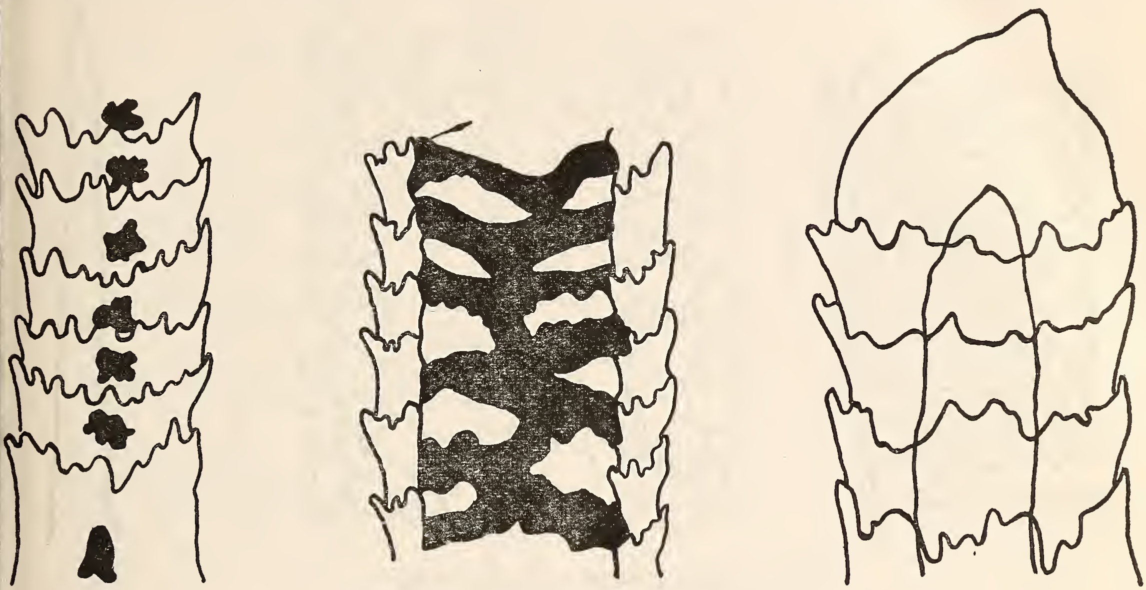

Fig. 1. Giant Squirrel (*Ratufa indica*)

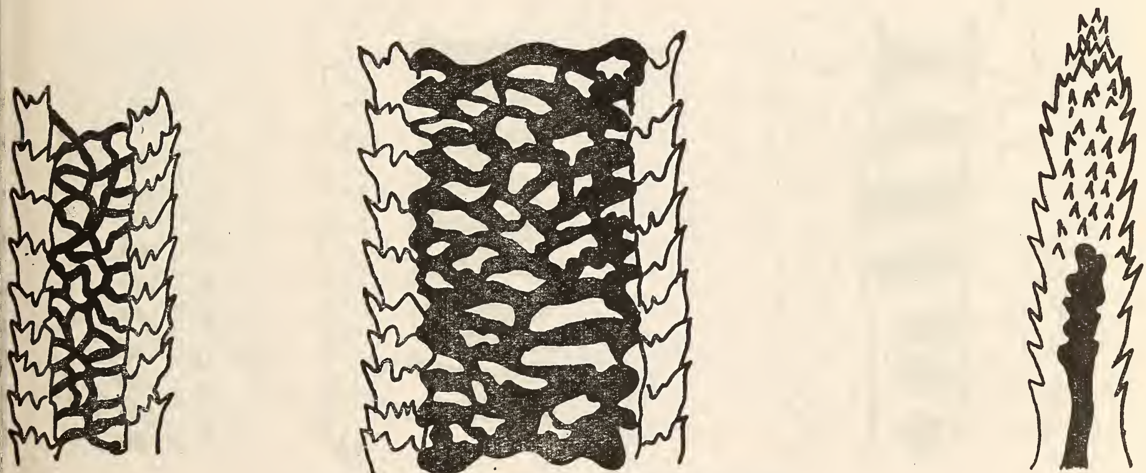

Fig. 2. Flying Squirrel (*Petaurista petaurista*)

only cuticle and medulla are important. The structure of these patterns which form the basis of hair identification under study are given below according to order and family of the specimens.

GIANT SQUIRREL *Ratufa indica*

Fig. 1

Gross Appearance:

Length 3.2 cm. The hairs differ in colour. Some are chocolate brown in colour and others

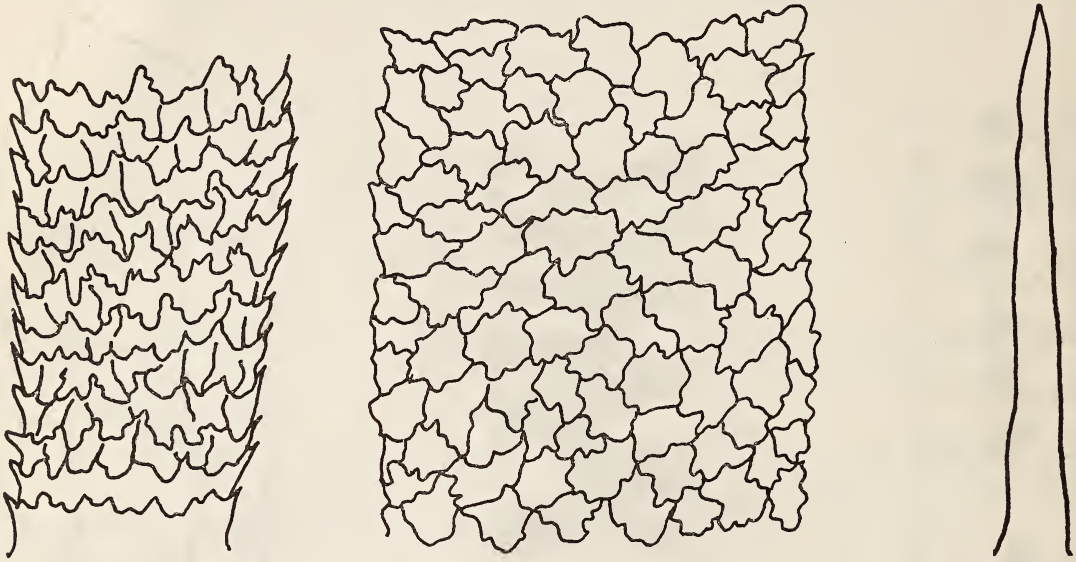

Fig. 3. Indian Porcupine (*Hystrix indica*)

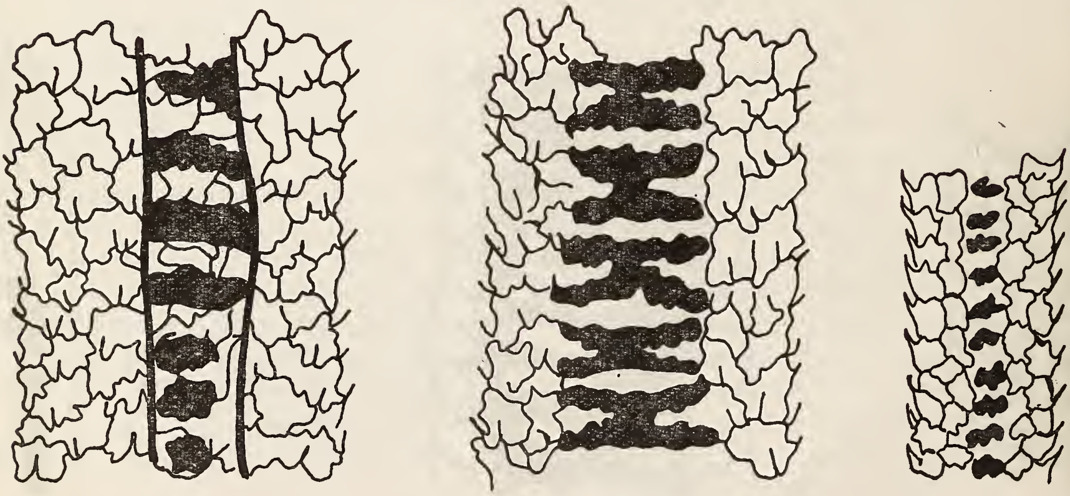

Fig. 4. Wild Dog (*Cuon alpinus*)

are half yellow and half black. They measure 60 μ in diameter in the proximal region.

Microscopic Appearance:

Scales coronal with serrate edges in proximal region. In the medial region border appears serrate, while it is coronal with serrate margins at the distal end. In the proximal region medulla is discoidal type, in the medial fragmented with criss-cross arrangements. In the distal region the medulla is continuous.

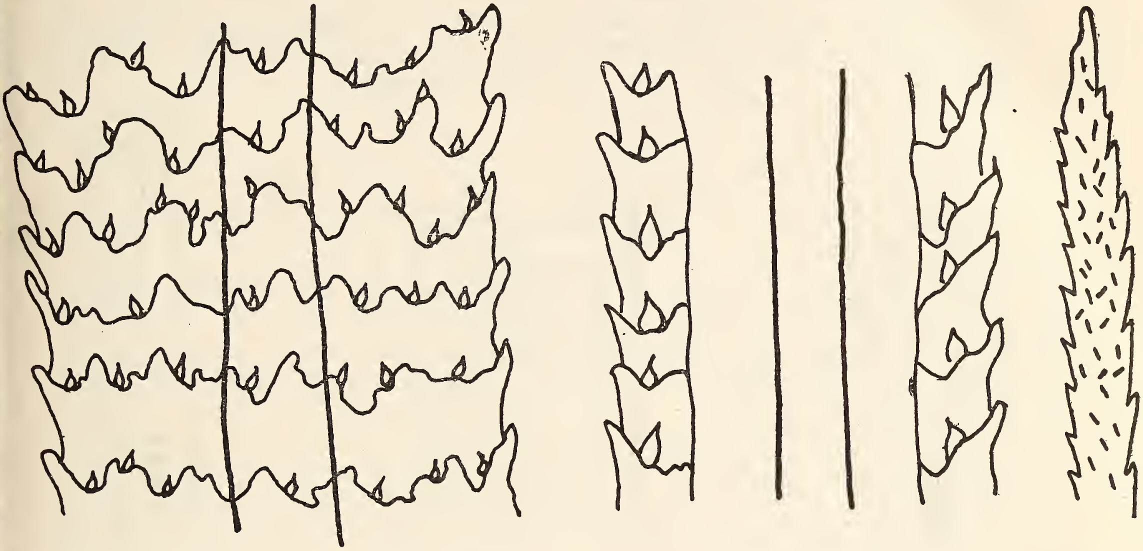

Fig. 5. Sloth Bear (*Melursus ursinus*)

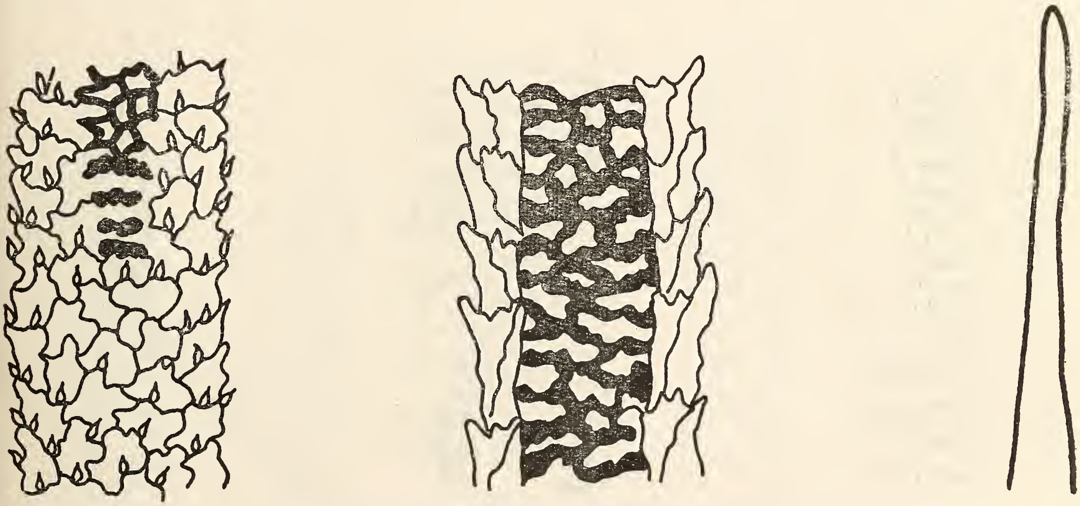

Fig. 6. Leopard Cat (*Felis bengalensis*)

FLYING SQUIRREL *Petaurista petaurista*
Fig. 2

Gross Appearance:

Length 1.8 cm. The colour of the hair in the proximal region is black, in the medial region brownish yellow while in the distal region it is black, giving it a banded appearance. The hair measures 51 μ in diameter in the proximal region.

Microscopic Appearance:

The scales are coronal with serrate edges in the proximal and medial region. The border of the distal region appears spiny and the tip of the hair also has spiny appearance. In the proximal and medial region medulla appears fragmented with arrangement like that of lattice work. In the distal region the medulla is of continuous type.

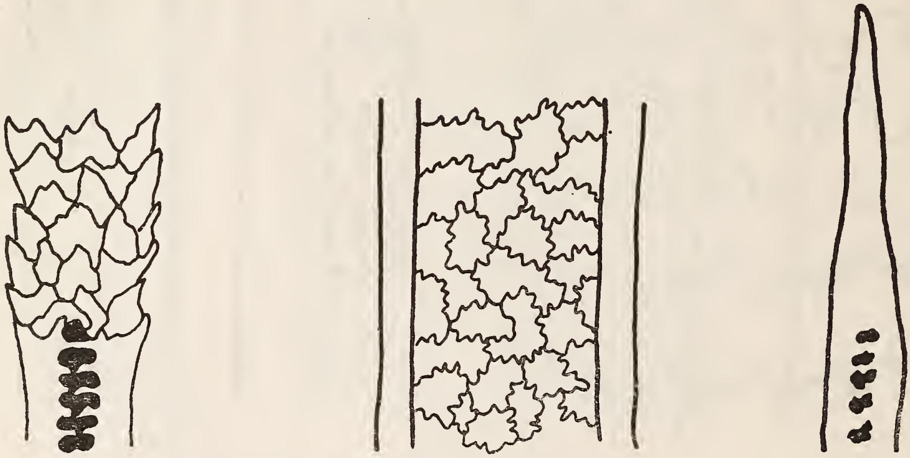

Fig. 7. Rusty-spotted Cat (*Felis rubiginosa*)

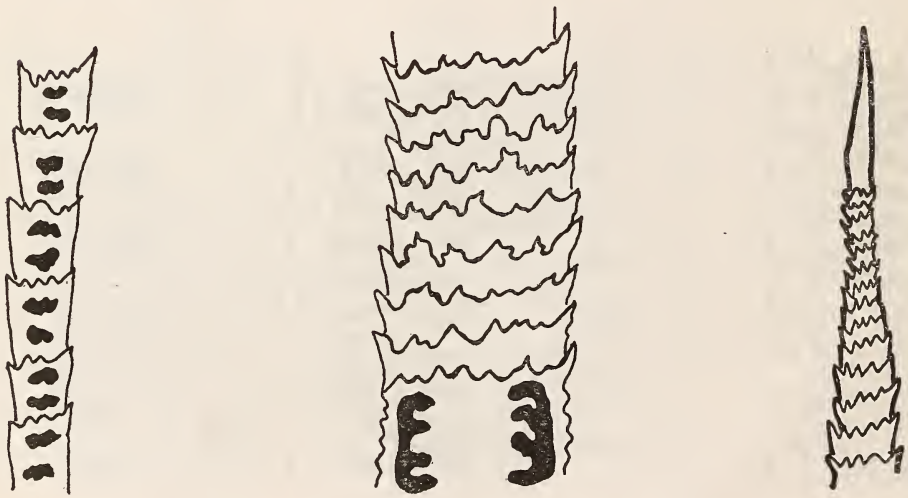

Fig. 8. Desert Cat (*Felis libyca*)

INDIAN PORCUPINE *Hystrix indica*
Fig. 3

Gross Appearance:

Length 2.1 to 3.5 cm. The hairs appear spiny and are very stiff. The hair measures 102 μ in diameter. The hair is narrow at the proximal end, becoming broader in the medial region and tapers in the distal region. They are

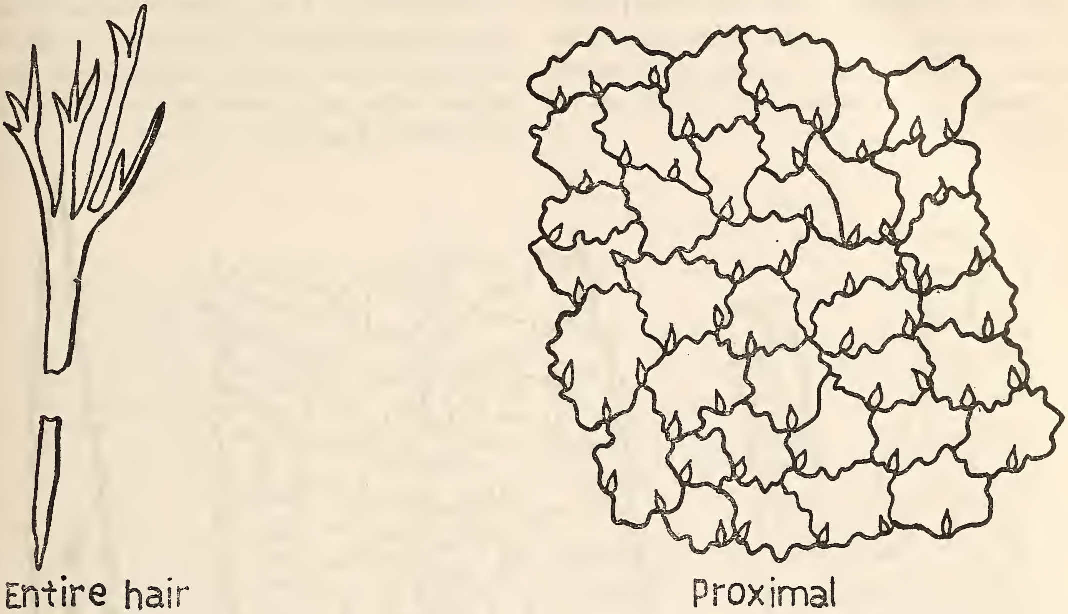

Fig. 9. Indian Wild Boar (*Sus scrofa*)

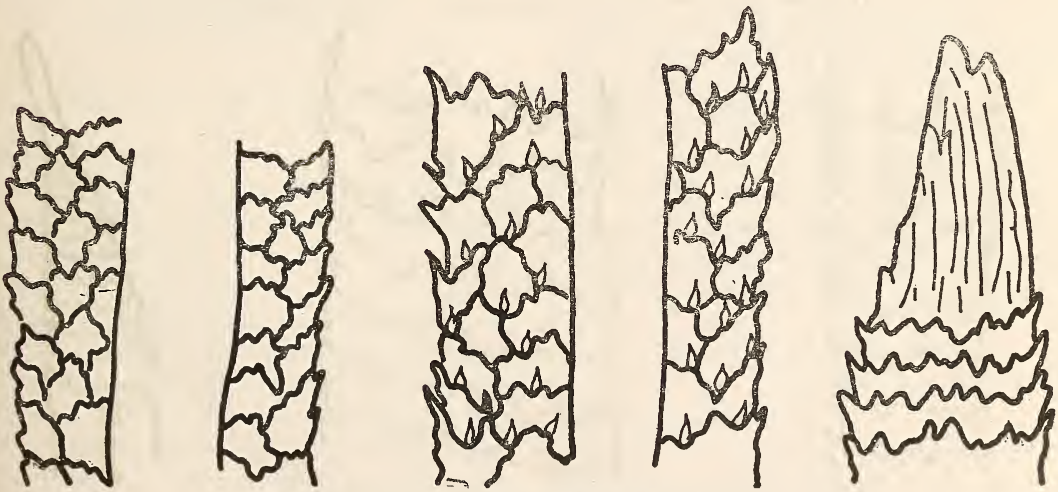

Fig. 10. Gaur or Indian Bison (*Bos gaurus*)

grayish in colour with black tip.

Microscopic Appearance:

The scales are coronal with serrate edges in the proximal region which gradually become imbricate with serrate edges in the medial region. In the distal region the border appears plain with pointed tip. The medulla is continuous throughout the length of the hair.

WILD DOG *Cuon alpinus*

Fig. 4

Gross Appearance:

Length 3 to 5 cm. They measure 48 μ in the proximal region. The colour of the hair in the proximal region is white, in the middle yellow white, in the distal half it is brown ending with a black tip.

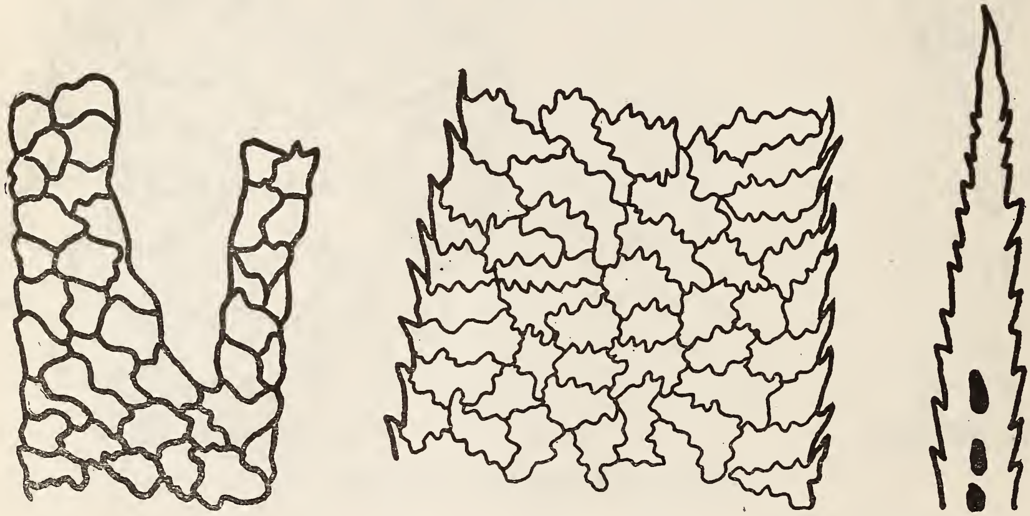

Fig. 11. Fourhorned Antelope or Chowsingha (*Tetracerus quadricornis*)

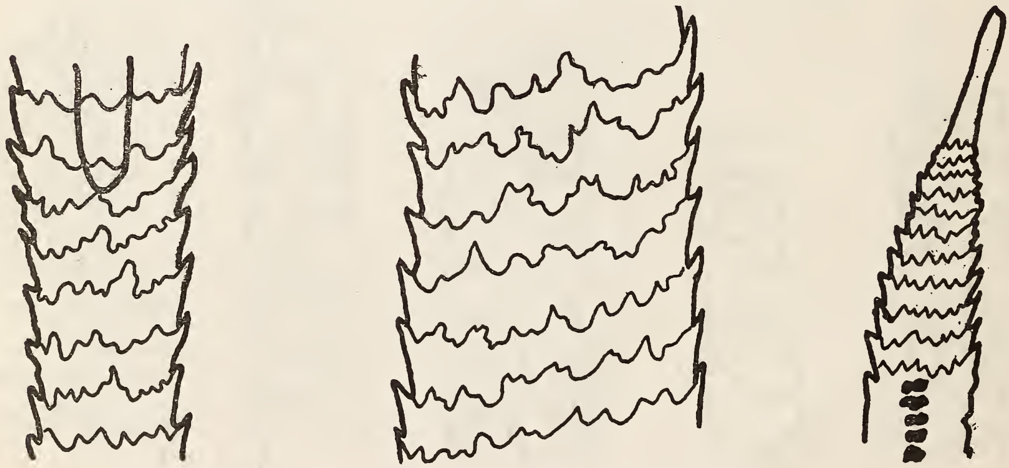

Fig. 12. Indian Chevrotain or Mouse Deer (*Tragulus meminna*)

Microscopic Appearance:

Though scales are imbricate with crenate edges in the proximal and medial region, the border of the scales give out spines intermittently. In the distal region the border of the hair appears spiny with imbricate flattened scales. The medulla is fragmented in the proximal and distal end while in the medial region it is discoidal having an appearance similar to that of capital H.

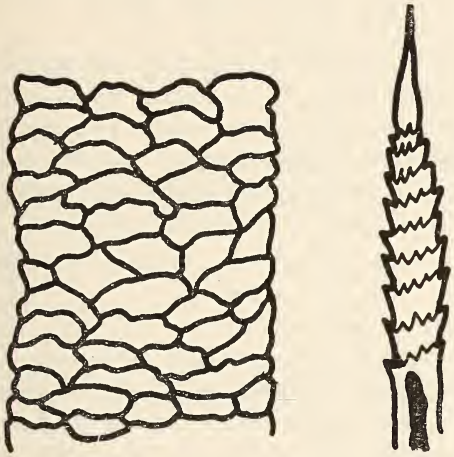

Fig. 13. Indian Gazelle or Chinkara (*Gazella gazella*)

SLOTH BEAR *Melursus ursinus*

Fig. 5

Gross Appearance:

Length 17.4 to 19.5 cm. The hairs are black in colour. They measure 96 μ in diameter in the proximal region.

Microscopic Appearance:

Scales are coronal with dentate edges in the proximal region. In the medial region the border of the hair has spines with dentate margins, while the distal region has spiny border. The medulla is continuous in the proximal and medial region. In the distal region medulla is not visible.

LEOPARD CAT *Felis bengalensis*

Fig. 6

Gross Appearance:

Length 2.2 to 2.8 cm. The hair has banded appearance. The basal region is greyish in colour, medial region black while distal half is yellow gradually turning black in the 1/3 portion of the distal region of the hair. They measure 39 μ in diameter in the proximal region.

Microscopic Appearance:

In the proximal region the scales are imbricate with serrate edges giving it a spiny appearance. In the medial region border appears dentate while in the distal region it appears plain. In the proximal region medulla appears fragmented but in the medial region it is fragmented giving lattice appearance. In the distal region medulla is not visible.

RUSTY SPOTTED CAT *Felis rubiginosa*

Fig. 7

Gross Appearance:

Length 2.3 cm. The colour of the hair is grayish in the proximal region, black in the middle and brown in the distal region. In some hairs the proximal region is grayish followed by white band and distal third region is black. They measure 30 μ in the proximal region.

Microscopic Appearance:

Scales are coronal with serrate edges in the proximal region. In the medial region the scales appear imbricate with serrate borders while in the distal region the borders appear plain. The medulla is discoidal in proximal and distal region and continuous in the medial region.

DESERT CAT *Felis libyca*

Fig. 8

Gross Appearance:

Length 1.6 cm. Hair stems are soft. The diameter at proximal region is 18 μ. The colour of the hair is white and black in proximal region, gradually becoming yellowish brown in the medial region, and in the distal region it is black.

Microscopic Appearance:

Scales are coronal with serrate margin in the proximal and distal region of the hair. They are coronal dentate in the medial region. Medulla is discoidal in the proximal region, in the medial region fragmented and arranged in two rows. Medulla is not visible in the distal region.

INDIAN WILD BOAR *Sus scrofa*

Fig. 9

Gross Appearance:

Length 7.5 to 9 cm. The colour of the hair is black, with grayish tip which is frayed. Hair stems are harsh and rigid with a diameter of 144 μ at the proximal region.

Microscopic Appearance:

Scales are imbricate with crenate margin with intermittent spines in the proximal region gradually becoming flattened compressed type in the medial and distal region. The medulla is continuous all throughout.

GAUR *Bos gaurus*

Fig. 10

Gross Appearance:

Length 5 to 6.3 cm. Hair stems are slightly curved measuring 93 μ in diameter in the proximal region. The colour of the hair is brown except for the terminal 1/3 portion which is black.

Microscopic Appearance:

Scales are imbricate with serrate edges in the proximal region, in the medial region imbricate dentate with intermittent spines and coronal serrate in the distal region. The medulla is continuous throughout.

FOUR HORNED ANTELOPE

Tetracerus quadricornis

Fig. 11

Gross Appearance:

Length 1,2 to 2.5 cm. Narrow in the proximal region beacoming broader in the medial and tapering off in the distal region. They measure 72 μ in diameter in the proximal region. The colour of the hair is white upto the proximal region, gradually changing to light brown in the apical region.

Microscopic Appearance:

Scales imbricate with plain borders in the proximal region. In the medial region scales are imbricate with serrate edges. The tip of the distal region appears spiny. Medulla is continuous in the proximal and medial region and is fragmented in the distal region.

INDIAN CHEVROTAIN *Tragulus meminna*

Fig. 12

Gross Appearance:

Length 3 to 4 cm. Hair stems are slightly wavy. The diameter at proximal region is 45 μ. The colour of the hair is white in the proximal region, brown in the medial region and the distal tip is black, with a short 1 mm white band preceding it.

Microscopic Appearance:

Scales are coronal with serrate edges throughout. Medulla appears continuous in the proximal and medial region and is fragmented in the distal region.

INDIAN GAZELLE OR CHINKARA *Gazella gazella*

Fig. 13

Gross Appearance:

Length 0.8 to 1.2 cm. The hairs look slightly curved and are more or less equal in diameter throughout except for the gradual taper at the apex. The diameter at the proximal region measures 60 μ. The colour of the hair is white in the lower half region and brown in the upper half.

Microscopic Appearance:

Scales are imbricate and flattened ovate type in the proximal and medial region. In the distal region the scales are coronal serrate type. Medulla is continuous all throughout.

ACKNOWLEDGEMENTS

We express our thanks; to Shri S. S. Buit, Chief Conservator of Forests, Maharashtra State, Poona, for his keen interest shown during the progress of this investigation; to Mr. J. C. Daniel, Curator, Bombay Natural History Society for providing hair specimens for the present study. We are also grateful to Dr. V. R. Murthy for providing necessary facilities in the laboratory.

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Status and ecology of the Barasingha (*Cervus duvauceli branderi*) in Kanha National Park (India)

CLAUDE MARTIN

(*With twenty-four text-figures*)

CONTENTS

I INTRODUCTION

Despite the recent increase in literature it seems that the Asian deer species have been practically neglected. This is unfortunate, as many of these species are on the verge of extinction and a detailed knowledge of their ecology is required for long term conservation measures.

Descriptions on the barasingha (*Cervus duvauceli* Cuvier 1823) have appeared sporadically in hunting literature of the last century. Blanford (1888-91) was however the first to give an account of the distribution of the species. Brander (1923) presented more information on the barasingha and made a distinction between the barasingha in northern India and those in Central India. Ellermann & Morrison-Scott (1951) subsequently distinguished two subspecies: *Cervus duvauceli duvauceli* Cuvier 1823 (Range: northern and northeastern India) and *Cervus duvauceli branderi* Pocock, 1943 (Range: Central India). The barasingha populations dwindled rapidly under heavy hunting pressure and the continuous habitat destruction effected by the increasing human population.

THE DEER AND THE TIGER by George B. Schaller (1967) based on a 14 month's pilot study on the tiger and its main prey species at Kanha gives the first systematic account of the barasingha's way of life. Schaller's study documented the precarious state of the barasingha in Central India, which incidentally led to considerations of this problem at the International Union for Conservation of Nature (IUCN) conference in Delhi in 1969. The Central Indian barasingha was practically confined to the Kanha National Park at that time. Yet Schaller's data had suggested that even this isolated population was threatened. Considerably less than 100 animals were left in 1964-65, and a mere 7 per cent fawns was obviously not sufficient to even maintain the population level. This and several other facts ultimately led to the formulation of this study. The essential goal was the determination of factors influencing the population size with subsequent reference to the ecological data collected by Schaller (1967).

Owing to the critical state of the population it was quite evident that no data from culled animals were to be obtained and considering possible disturbance or losses I could not mark the deer. These limitations were no doubt hindrances but on the other hand the barasingha of Kanha N.P. were an isolated population. It could thus be assumed that the population was a discrete unit, which facilitated the work. The study lasted from April 1971 until April 1973.

1. Aims

An important question that was left unanswered by Schaller (1967) was the range of the population during the second half of the year. One objective of the study was therefore to determine the annual range of the barasingha. A second objective was to record activity patterns and relate those patterns to habitat structure and use in different seasons. A third objective was to identify factors limiting the population.

In order to pursue these objectives the population size and structure had to be determined. Owing to the drastic increase of the chital (*Axis axis*)[1] population in the past decade, the possibility of interspecific competition had to be tested. A habitat analysis was designed to indicate possible habitat alterations affecting the range conditions.

2. The Species

a) *Past and Present Distribution*

The barasingha[2] is indigenous to India. There is reason to believe that since historical times its distribution was confined to the northern part of the Indian subcontinent. Blanford (1888-91), Forsyth (1889) and Lydekker (1915) reported that the distribution during the last century extended along the foot of the Himalayas from upper Assam to Bahawalpur and Rohri on the Indus and parts of

[1] Scientific names of mammals occurring in the park will from this point on be omitted. They are listed in Appendix III.

[2] "Barasingha" is a Hindi-expression that names the species according to the general antler pattern of the stags: "twelve-pointer" (bara = twelve; singha = points). English: Swamp deer. In northern India the species is locally called "Gond" or "Gonda". The Kashmir stag or Hangul *Cervus elaphus hanglu* is also occasionally called "Kashmir barasingha" and may be confused with the species.

the area between the Ganges and the Godavari River, as far east as Mandla and as well as into the Sunderbans. The species could be found in marshy areas all over the Brahmaputra—Ganges—and Indus Basin, but not in the Himalayan valleys. However, it occupied the highlands of Central India. The southern most places that the barasingha was to be found were in the Bastar District in the State of Madhya Pradesh about 18°N. Essentially the barasingha inhabited moist deciduous, semi-evergreen and wet-evergreen forests and the swampy planes of northern and Central India. It did not occupy drier areas (Fig. 1).

By the beginning of this century, the barasingha had completely disappeared from the western part of its range, i.e. the plains of the Indus River. Yet, no precise information on its distribution was obtained until 1967. According to the information collected by Schal-

Fig. 1. Past and present distribution of barasingha. Shaded area: Distribution at the end of the 19th century. Numbers: Occurrences mentioned in Table 1.

ler (1967) in 1964-65, the range of distribution had dwindled down to a few limited places in Nepal, Uttar Pradesh, West Bengal, Assam and Madhya Pradesh. Schaller estimated that approximately 3-4000 animals of *C. d. duvauceli* survived in 1965, plus 150 or more of *C. d. branderi* in Central India. Table 1 shows an account of the present situation.

barasingha herds were living in Uttar Pradesh only in the four divisions of Pilibhit, North Kheri, South Kheri and Bahraich.

The present situation of the barasingha in Nepal is not clear and needs further investigation. Schaller (1967) reported that about 400-1200 survive in 4 divisions of southwestern Nepal. At present it is said, that a larger herd (about 1000 animals) is in the Sukla Phanta Reserve of southwestern Nepal. The number of survivors in West Bengal is not known. However, the small population of the Kaziranga Sanctuary in Assam was increasing in 1959, due to better protection (Burnett 1959).

TABLE 1

PRESENT STATUS OF THE BARASINGHA

	Place	Location in Fig. 1	Approx. Numbers
Northern subspecies	Uttar Pradesh:		
(*C.d. duvauceli*)	— Pilibhit Div.	1	
	— North Kheri Div.	2	1800-2000
	— South Kheri Div.	3	(Holloway 1973)
	— Bahraich Div.	4	
	Bihar:		
	— Champaran Div.	5	perhaps a few
	Assam:		
	— Manas Sanctuary	6	a few (1974)
	— Kaziranga Sanctuary	7	approx. 520 (Forest Dep. census 1972)
	Nepal:		
	— 3 Divisions in south-western Nepal (incl. Sukla Phanta Sanctuary)	8	400-1200 (Schaller 1967) recent status not available
Southern subspecies	Madhya Pradesh:		130-140 (1973, this study)
(*C.d. branderi*)	— Kanha National Park	9	

(1) Status of the North Indian barasingha:

Of the eleven localities mentioned by Schaller (1967) where barasingha were known or believed to survive in Uttar Pradesh, Holloway (1973) says, that eight of them "need to be struck for all practical purposes". The relatively small areas which contained suitable barasingha habitat only seven years ago, had either been turned into *Eucalyptus* spp. plantations or were lost to cultivation. In 1972

(2) Status of the Central Indian barasingha:

Brander (1923) reported the presence of *C.d. branderi* in the Chindwara-, Mandla-, Raipur-, Balaghat-, Bilaspur- and Bastar Districts of Madhya Pradesh and in the Chanda District of Maharashtra. But the distribution of the subspecies must also have extended into the States of Bihar and Orissa.

As far as one can tell from past records, its distribution was confined to the sal forests (*Shorea robusta*). Forsyth (1889) and Lydekker (1915) reported about the coincident occurrence of sal forest and the three species barasingha, wild buffalo (*Bubalus bubalis*) and red jungle fowl (*Gallus gallus*). A clear example of this is the former presence of both the barasingha and the red jungle fowl in an isolated patch of sal forest in the Denwa Valley near Pachmarhi (Fig. 1). Barasingha survived there until 1920, being isolated 250 kilometres from the western limit of sal, which runs through the Mandla District. Forsyth (1889) reported seeing "countless herds" near Mandla. Particularly the Banjar Valley had large numbers of barasingha. The beginning of the century then brought a crucial turning point in the distribution pattern of the barasingha in Central India. The wide valleys of the Narmada-, Mahanadi- and Godavari River and their tributaries were being cultivated. Herds were separated. Under the continuous pressure of hunters and local Gond- and Baiga-tribes isolated populations disappeared rapidly.

Records of the southern subspecies are scarce for the period between Brander (1923) and Schaller (1967). Although the latter obtained a piece of information saying that about 100 barasingha were surviving at the Madhya Pradesh-Orissa border between 1960 and 1965, it is doubtful whether by 1965 any larger herd existed outside the Kanha National Park.[3] Since then no barasingha were recorded in Central India except in Kanha National Park (Panwar 1973). However, Krishnan (1973) found a barasingha antler in Bastar District in 1970. Yet today it is very unlikely, that barasingha survive outside the Kanha N.P. in Central India. If they do they have very little chances of survival.

The distribution pattern of the species was very similar to that of the wild buffalo (*Bubalus bubalis*) in India. Daniel & Grubh (1966) state that both species depend on the same habitat. Both species suffered due to deforestation, but particularly due to cultivation of grassland and marshes.

b) *Description*

Schaller (1967) gave a fair description of the appearance of the species in different seasons and localities. As I later refer to the development of the antlers, I shall here restrict the description to the general pattern of the antlers and the seasonality of shedding.

The typical barasingha antler has a crown with 5 tines about halfway up the beam. Together with the brow tines, which often branch at almost a right angle, a total of 12 tines is achieved.[4] Fig. 15 shows characteristic stages of antler development at different ages.

Record antler length was reported by Ward (1972) which measured 104 cm round the curve. Burke (1928) writes that a total of three record heads were obtained in Central India, all with 104 cm. In 1970 a pair of royal antlers was collected near Kanha. Its length round the curve was 92 cm. It numbered 17 tines plus 5 smaller buds, and the weight of

[3] When searching for records one may often get confusing information about the presence of barasingha, which usually turn out to be either sambar or chital. Local people often consider all deer with antlers as barasingha.

[4] Pocock (1933) was of the opinion that the pattern of tines among the antlers of different deer species is homologous. This was based on the theory of dichotomous branching: first of the base, which separates the brow tine from the beam and second

both antlers was 5.65 kg (Fig. 2).

The first stags which shed their antlers were recorded on May 17, 1971 and May 13, 1972. By the beginning of June, roughly half a month after shedding had started, about half of all stags seen in the Kanha Meadow area had shed. But it took another month for all adult stags to shed i.e. by the beginning of July. Stags with heavy antlers generally shed earlier than those with lighter antlers. The yearling stags were the last to shed their spikes. Some of them still had their spikes on as late as July 11. In the meanwhile, the heaviest stags had already grown antlers in velvet up to approximately 40 cm in length (Fig. 9). Occasionally, yearling stags were observed that still had their antlers in velvet in January and February. One case of a yearling stag was recorded that was in velvet until mid-May (i.e. at the assumptive age of 20 months).

The period of antler growth coincides almost exactly with the monsoon season that starts around mid-June. Both antler growth and monsoon cease in September. Thus, the period of antler growth falls into the period that is from the point of view of nutritive value of fodder plants, the most eutrophic. The velvet is rubbed off the antlers at the end of October and November.

3. The Habitat

a) *Location and History*

The Kanha National Park is situated between latitude 22°08′ and 22°24′ N and longitude 80°32′ and 80°45′ E in the Central Indian highlands which stretch from west to east through the State of Madhya Pradesh. It lies in the western spurs of the Maikal Hills which form the eastern branch of the Satpura Range. The present park area falls into the southern part of the Mandla District and the north-eastern part of the Balaghat District at altitudes between 502 and 802 metres. The park area drains into the Banjar River and its tributaries. The Banjar flows into the Narmada near the district town Mandla, 40 kilometres northwest of the park's centre.

The Maikal Hill Range was inhabited by two tribes, the Gonds and the Baigas. The practice of shifting-cultivation was widely used by them until it was prohibited in 1868. Many of the clearings in the park were caused by this. They served more or less permanently as sites for villages until the famine of 1874, when many of them were abandoned.

In 1935, 232 square kilometres were declared as an absolute sanctuary (excluding wild boar and birds), but in 1943 the western part of the sanctuary was again declared an officers shooting block, since it was feared that the pressure of browsing ungulates would hinder the regeneration of sal trees. In the remaining eastern part of the sanctuary (134 sq kilometres), the government permitted (1945) the destruction of 250 chital per year

of the beam. This sequence of dichotomous branching, which according to Pocock, follows the same law in different species, then results in antler patterns with detectable homologue elements. According to him, the brow antlered deer (*Cervus eldi*), Schomburgk's deer (*Cervus schomburgki*) and the barasingha have a more specialized type of antler than the chital and sambar by an additional ramification of the beam, but are "clearly derivable from it." Those of the barasingha are more generalized on the average, but subject to greater variation (Pocock). Beninde (1937), on the other hand, supposed separate growth- and ramification potentials of the front and back part of the antler pole, which if unequal, may lead to a dominance of front directed tines, as in the red deer (*Cervus elaphus*) or backward directed tines, as in the barasingha. According to him, tines in different species would thus only be convergent structures.

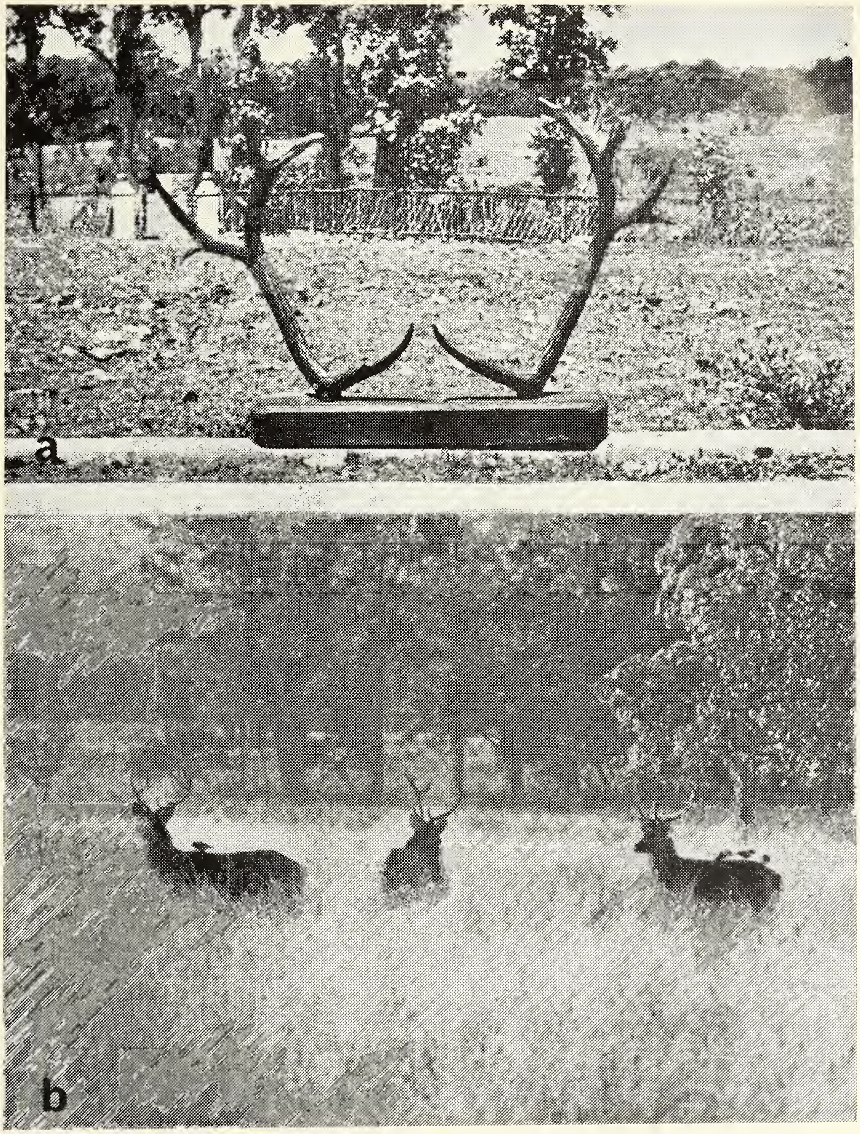

Fig. 2. (a) Royal barasingha antlers collected in Kanha in 1970. Number of tines 22. Weight of both antlers: 5.65 kg. Length round the curve: 92 cm. (b) Rutting barasingha stags on a misty January morning in the Kanha Meadow. Note: Common Mynas (*Acridotheres tristis*) on back.

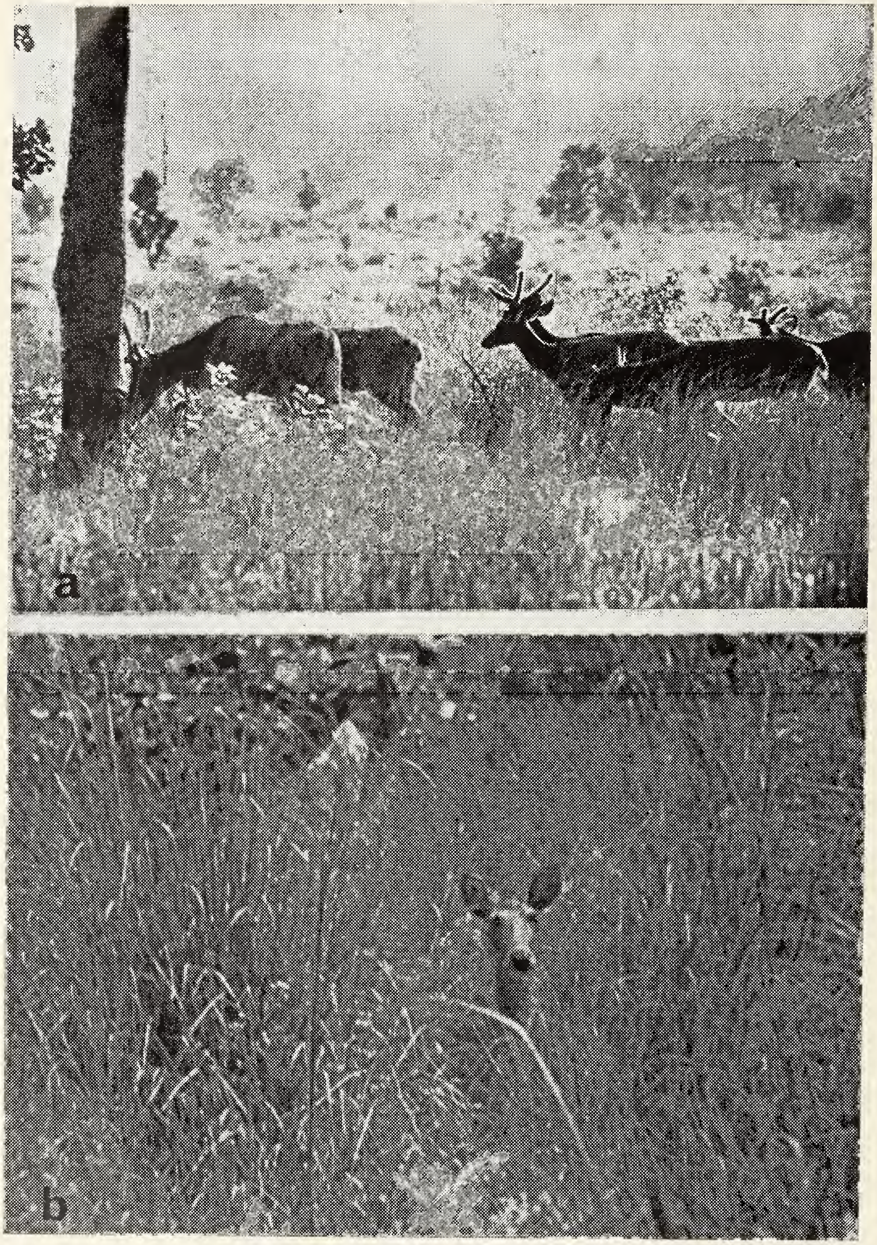

Fig. 9. (a) Stag group in the Sonph Meadow in July. Note: Summer coat and antlers in velvet. (b) Bedded barasingha hind in a swampy depression of a rivulet. September 1972.

to help sal regeneration. Between 1947 and 1951 the Maharajkumar of Vijayanagaram was permitted to shoot in and outside of the sanctuary. During that period he shot 30 tigers within a part of the present park area. In 1952 the sanctuary was again enlarged to 252 sq kilometres and shooting of any type was prohibited. In 1955 this area was declared a national park. In 1964 more land was added to the park enlarging it to 318 sq kilometres. In 1970 the part of the Balaghat District north of the Banjar River was joined to the southern part of the park, bringing it to the present size of 446.6 sq kilometres.

b) *Tectonics and Geology*

The principal formation is archaean which is also found in the rest of the peninsula. Gneisses, granites and schists (mainly mica-schists) and alluvial loamy soil, derived from decomposition of these rocks, form the undulating terrain on either side of the Mandla-Balaghat District border. This is the characteristic terrain of the wide valleys favouring sal forest. The most important meadows in the park, which retain most of the perennial watering places, are situated along these valleys. An underlying basalt formation, the deccan trap, however, appears along the inter-district boundary of Mandla-Balaghat and encircles the park's centre i.e. the Kanha Meadow, with a ridge on three sides reaching altitudes up to 890 metres. It is frequently capped by the typical red laterite, forming flat ridge tops, locally called 'dadars'. These dadars are often free of tree-growth. As a result of weathering on the basalt, black cotton soil collects in pockets on both sides of the ridge.

c) *Vegetation*

The park falls into the distribution zones of the moist deciduous forest type. Rainfall is usually between 125 - 200 cm/year and there is a distinct dry season in contrast to the wet evergreen forest type. Sal forest is considered to be the climatic climax for the main areas within the moist deciduous type (Champion 1948). Two principal forms may be found in the park:

(1) Sal forest:

Distinguished by the predominance of the sal tree *Shorea robusta*. It occurs on the undulating terrain, valleys and the lower slopes, principally on all low-lying alluvial soils of the park up to an altitude of 610 m. Sal was in great demand for the production of railway sleepers. The exploitation of sal trees in this area began in 1860 and it intermittently continued until 1959. A drought in 1942 caused the death of many sal trees and the sal borer *Hoplocerambyx spinicornis* also caused great damage. Champion (1938) classified the sal in Kanha as "peninsular moist low level sal."

(2) Mixed forest:

It covers the higher levels and slopes of the trap formations above 610 metres elevation. It is composed of about 50, mainly deciduous tree species. According to Champion's (1938) classification, the mixed forest in Kanha National Park belongs to the type: "Southern tropical moist deciduous mixed forest."

About 15-20% of the park's area are open meadows. Part of these are situated on the flat top of the ridge. A few smaller meadows occur on the hill slopes' terraces. The largest meadows however lie within the sal forest area. These are the meadows which were caused by the shifting cultivation of the Baiga tribe prior to 1868, as mentioned above. They lie in basins of the undulating terrain. The Kanha Meadow with its 6 sq kilometres, is the largest among them. A detailed description of the vegetation is given under intensive study in Chapter VII.

d) *Desiccation and Water Conditions*

After all the grasses go to seed in November, the grass cover in open areas dries fast. It remains partly green in shady locations and along rivulets. Fires occur in the winter months and induce early sprouts in the remaining tufts of perennial grasses. But even in unburnt areas green sprouts start growing slowly in the months of February and March. In early March the sal trees bloom. They shed their leaves which are simultaneously replaced by new ones. The other deciduous trees have also shed their leaves by then, but do not grow new ones immediately. Thus whereas the sal forest in the hills is bare. The great amount of water required to grow new sal leaves causes a sudden drop of the water table in sal areas and hence all the streams cease to flow. From March onwards water becomes gradually scarcer. Two types of pools that persist into the dry season may be distinguished:

(1) Shallow tubs in the rocky or sandy bed of the larger streams (Sulcum-R., Surwahi-R., Desi-Nala), from where the water could not run off. Most of these pools dry up during the hot season. In the Surwahi-River e.g. there remains then only about one small pool per 500 m stream bed. Tribals used to catch fish by poisoning these pools with the bark of *Ougeinia cojeniensis.* They moreover become badly polluted by leaf litter and dead fish.

(2) Pools that persist in small rivulets that transect the open areas. As the meadows often lie in flat basin that are surrounded by wooded hillocks, seepage water collects here even in the dry season. These pools contain clear water and rich aquatic flora and fauna, which indicate their perennial existence. On the slopes and banks of these rivulets green grass grows throughout the year. The Kanha Meadow harbours, apart from others, around 65 pools of this type ranging in size from 3 to over 100 square metres. The majority of them is found in two rivulets, the Churi-Nala and the Menar-Nala. Sectionwise seepage water keeps running through these rivulets. Within the intensive study area such pools are found apart from the Kanha Meadow only in Sonph, where they are, however, few in number. These rivulets are of major importance as watering places and grazing ground for all kinds of wildlife during the dry season. In Chapter III-2 I shall describe the barasingha's movement pattern to these localities.

The water conditions have further been improved by damming up the Desi-Nala at the north western edge of the Kanha Meadow and a dam in Sonph. Further dams were constructed at the Menar-Nala as well as at the northern edge of the Kanha Meadow during the period of this study. A small perennial pond called "Shrawantal" is located to the east of the Kanha Meadow.

e) *Climate*

The park has the typical Central Indian monsoon climate with an average annual rainfall of about 1600 mm. A Forest Department record for Kanha reported 1602 mm in 1964. Mean monthly precipitation records for 1951-64 are available for Supkhar west of the park and Baihar south of the park (Fig. 3). About 95% of the total annual precipitation falls from mid-June to mid-October. The first monsoon rains in Kanha are expected around June 18. Pre-monsoon rains may occur irregularly in the first or second week of June. The heaviest precipitation falls in the months of July and August, and ceases in the month of

September. Winter showers occur sporadically and scantily from December through March. In 1971 heavy pre-monsoon showers fell which were followed by heavy monsoon showers. In 1972, however, the monsoon was late: There were no pre-monsoon showers whatsoever and until August 10, relatively little rain fell. In Maharashtra, Uttar Pradesh and in part in other Indian states, the irregular monsoon of 1972 caused a heavy crop loss.

The minimum and maximum weekly temperatures were recorded in the centre of the Kanha Meadow (Fig. 3). Minimum temperatures measured in the forest were 1 - 3°C higher than those in the open during the cool season. From November through February, mist may accumulate during the night in the meadows. Heavy dew lies on the meadows in the morning regularly during this season (Fig. 2). In December and January night temperatures in the open occasionally drop to 0°C or even a few degrees below and ground frost may occur. Maximum day temperatures, however, remain above 25°C.

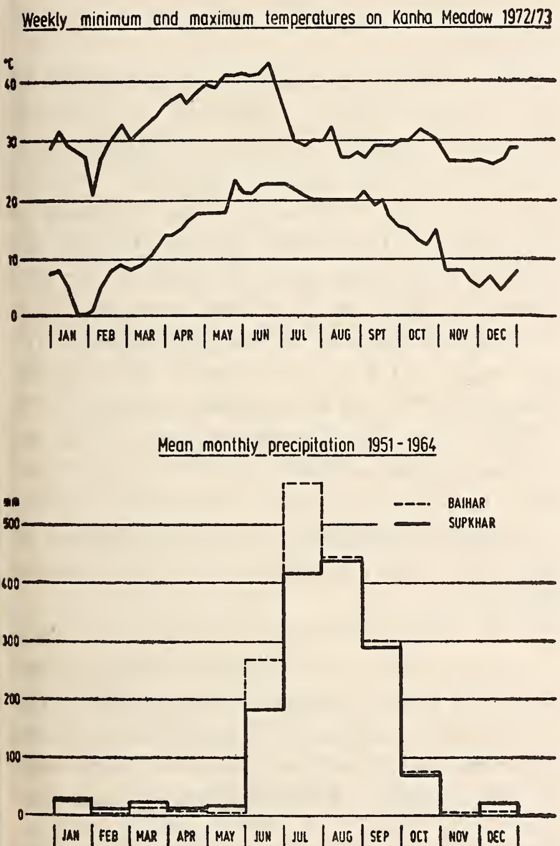

Fig. 3. Weather data, Kanha National Park. Temperatures were recorded 1.5 metres above ground in total shade. For the precipitation records I am indebted to the Forest Department.

The hottest period of the year is from the end of April until the beginning of June, when the pre-monsoon showers arrive. Temperatures may reach 41°C and night temperatures often do not drop below 23°C. Due to late monsoon arrival, an unusually high temperature of 43°C was recorded in the third week of June 1972.

There are three distinct seasons in Kanha: The cool season (winter) from November to March; the hot season from April to June and the monsoon or rainy season from June to October.

f) *Human Interference*

Today only four of the clearings in the northern part of the park, i.e. in the Mandla District, are still occupied by forest villages: Kisli, Ronda, Silpura and Kanha. One village, Bahmnidadar, is located on the basaltic ridge. All of them are situated near the park boundary, except Kanha which occupies only a small part of the Kanha Meadow. In the recently added southern part of the park, i.e. in the Balaghat District, all of the clearings are at present still occupied by forest villages: Bishanpura, Sondhar, Aurai, Ghorela, Mukki and two small settlements.

Each of the clearings with a village contains grazing land for cattle and rice fields, from which one crop is harvested in November. Until 1915 grazing was unrestricted in the forests and other clearings. During the dry season, villagers from outside the park area also used to bring their cattle to these areas. Today grazing is allowed on a limited area around the villages and no foreign cattle are allowed to graze within the park area. In 1969 the forest village Sonph was relocated outside the park. The Sonph Meadow and the meadows east and south of Sonph, i.e. Ornakhera, Parsatola etc., where cattle used to graze during the period of Schaller's study in 1964/65, are now left entirely undisturbed by either human or cattle activities. Today it is under consideration to remove three additional villages from the northern part of the National Park together with 5 villages situated in the southern part. Due to a relatively dense road net in the Kanha Meadow, the disturbance by tourists and villagers in that area has increased substantially over the last years.

(1) Poaching:

Occasionally tribesmen, mainly belonging to the Baiga tribe, enter the park from the south and roam about in the forests collecting fruit, mushrooms and roots, fishing and collecting fresh tiger kills and shed deer antlers. Active poaching, however is very rare. The effect of these tribal activities is insignificant as far as the direct influence on the wildlife is concerned. However, they often cause uncontrolled fires which may spread over large areas. Although during the study period special attention was paid to possible poaching with firearms, neither the Forest Department nor I could detect any activities within the park, however, there were some cases of poaching and trapping outside. Within the last years, the Forest Department Staff has gained a very firm control over illegal grazing and poaching; whereas in the nineteen sixties, poaching must still have been an important factor.

(2) Burning:

Probably since the beginning of this century at least the Kanha Meadow was subject to annual burning during the cool season. Extensive—and annual firing of grasslands was practiced by the Forest Department until these methods were revised in 1972. Burning will again be considered in chapter VII.

g) *Wildlife*

The fauna of the park is representative of the Central Indian Highlands of previous centuries. However, elephants (*Elephas maximus*) and wild buffalo (*Bubalus bubalis*) were last seen in the area at the beginning of this century. The Indian gazelle (*Gazella gazella*) was also seen near the park in the past (Brander 1923). A list of the larger mammals occurring in the park is given in Appendix III. For mice and bats see Claude, 1973; birds: Guntert, 1973; and drosophilidae: Bächli, 1973.

Since 1953 the Forest Department carries out an annual wild-life census.[5] Since I later refer to the interspecific relationship between chital and barasingha, the past development of the park's chital population shall be regarded here:

> In 1935 about 2800 chital were tallied in the area. As mentioned earlier, chital were culled between 1945 and 1952. The reduced population remained more or less constant throughout the 1950's and until about 1965. Schaller (1967) found two

[5] The census is taken in mid-June. About 50 forest guards with aids are distributed in delineated sections of the park, where they have to count the wildlife between fixed hours on two consecutive days. The mean of the two counts is taken as the population for each species. In general, we may assume, that the Forest Department's census gives a fair idea of the population size of the large gregarious herbivores.

concentrations of chital in the park; one near Kanha, the other in Kisli. All together there were about 1000 chital in the park. Since 1965, the population has increased rapidly, and spread into the younger parts of the park. In 1972 there were 6-7000 chital which, most probably by now, have further increased. At present the chital is thus by far the most abundant ungulate in the park.

h) *Decline of the Barasingha Population*

The country-wide decrease of barasingha did not come to a halt at the boundaries of the park. In 1938 a Forest Department census yielded 3023 animals for the area of the present park. Since then the population has decreased steadily. The census of 1953 recorded 551 barasingha, and in 1970 there were merely 66 left. In 1964 Schaller (1967) counted 82 barasingha, and 55 in 1965. Even if considerable counting errors are taken into consideration, the low number of yearlings and fawns[6] found by Schaller point to a population that was below 100.

In previous years poaching must have been intensive. The antlers—apart from their trophy value for sportsmen—were wanted by tribesmen for their supposed curative effect. Barasingha antlers were ground into powder and mixed with the extract of a Euphorbia-species. This mixture is said to have healing power against rheumatism, asthma, as well as other diseases (Panwar 1973).

In 1925/26 the park was beset by rinderpest. However, Brander (1923) writes that "the barasinghas are far more immune and suffer less casualties from rinderpest and foot and mouth disease than do sambar or bison." Schaller (1967) suggested that brucellosis might have an effect on the population dynamics of the barasingha. Brucellosis causes early abortion of the foetus and would thus give a possible explanation for the low fawn rates found by him.

II Field methods

The primary techniques used throughout the study, that lasted 24 months, was direct observation. Barasingha were observed from a jeep which allowed approaching the deer to within less than 50 metres. Impassable areas were reached by foot. Due to the bias caused by the observer, I usually abstained from longitudinal observation. Records of dispersion, group composition and activity were made in time intervals of at least 4 hours along standardized routes through the Sulcum Valley. Other areas were regularly checked for barasingha also, and local people occasionally reported sightings. When possible, all observed barasingha were recorded as to sex and age, exact location, and activity, along with the time of observation.

Five sex—and age classes were distinguished: Adult males and females, yearling males and females, and fawns. Due to a limited fawning period, age classes were temporally separate by one year's periods, the above age classes hence being easiest to distinguish. According to the peak of the fawning period age classes were considered changing into the next older class on 15th September. Since groups were incoherent in time and space, the term "group" here refers to any temporary aggregation of individuals which at the time of observation were together and spatially separate from other barasingha. Regular census were carried out for the Kanha Meadow and the Sonph Meadow in intervals of 10 days throughout the year 1972. During and after the monsoon rains part of the areas had to be scan-

[6] Yearling and fawn classes may be estimated relatively easily (see chapter VI—1).

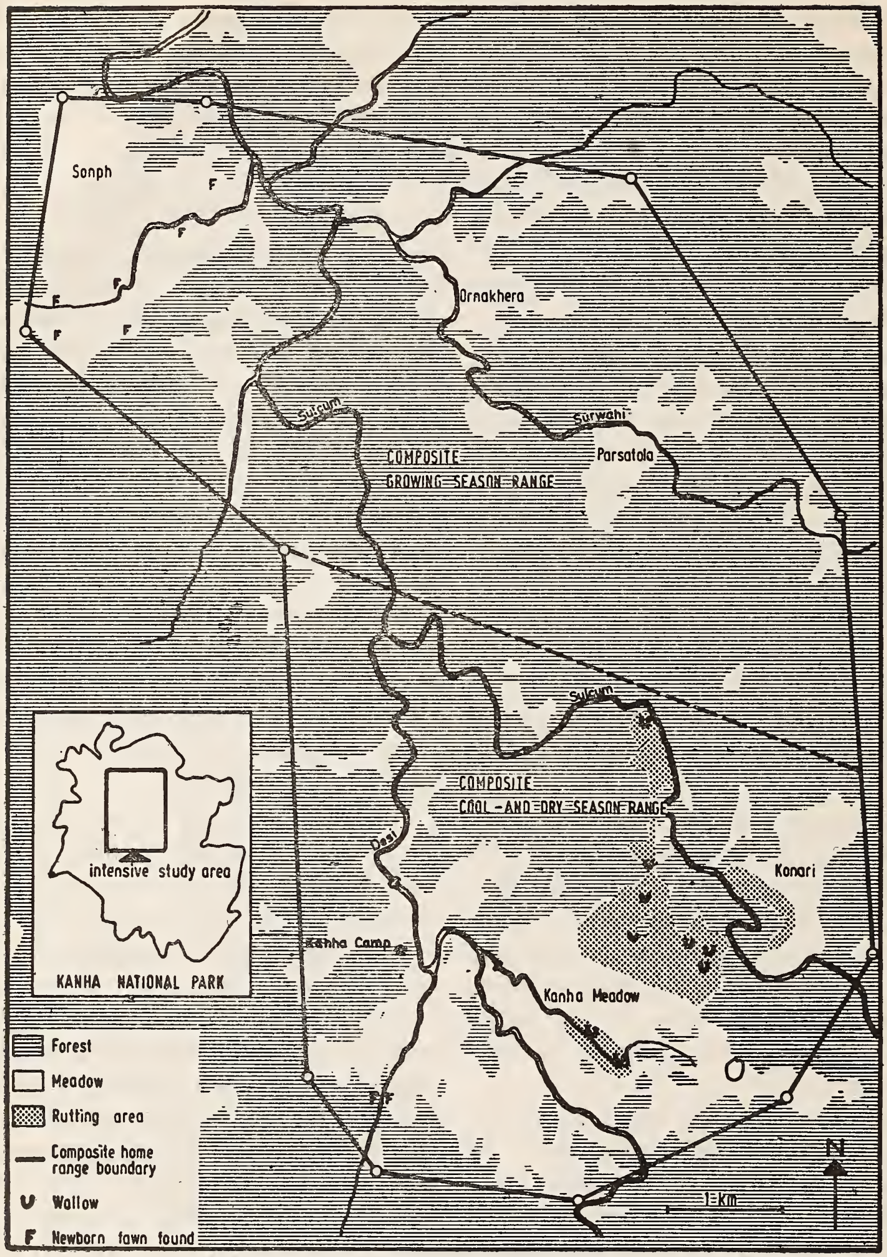

Fig. 4. Intensive study area with seasonal home range aspects of the barasingha population 1971-73.

ned on foot due to poor visibility and impassable roads. Annual total census were carried out with the help of the Forest Department Staff. They are described in Chapter VI-1.

Information on forage preferences was received by examination of feeding sites (Knowlton 1960). After a barasingha or a group of barasingha was observed feeding, I went to the feeding site and recorded instances of recent use. Each plant grazed upon was considered a single instance of use.

A rectangular area of 82 square kilometres that embraced the annual range of the population was chosen as the "intensive study area" (Fig. 4). Within this area the vegetation of the meadows was sampled using a grid system of sample plots. To test the hypothesis of common utilization of grassland habitat by different deer species, I used a modified pellet count technique which followed the principles stated by Neff (1968). To space out sample plots, distances were measured along compass lines in steps (Mean investigator's step = 0.816 metres).

Prior to the study, a 28 hectare-enclosure with carnivore safe wire mesh had been constructed in the western corner of the Kanha Meadow. It was designed for breeding barasingha in captivity, and was occasionally used for comparative observations in this study.

To describes seasonal aspects, the year was subdivided into 4 periods:

- cool season (December 15—March 14)
- dry season (March 15—May 31)
- early monsoon season (June 1—July 31)
- growing season (August 1—December 14).

All indications of time refer to the local time at Kanha (80°30′ E). As base for the indication of locations maps on a scale of 4 inch = 1 mile were kindly provided by the Forest Department. They were supplemented by own ground-surveys of the vegetational cover. The technical equipment consisted of 10 × 50 binoculars, a 15 to 60 × telescope and 35 mm cameras with a 200 mm telescopic lens.

More information on the techniques used are given in the respective chapters.

III Range of the population

1. The Composite Home Range

Initially it was planned to define the home ranges or seasonal ranges of individual barasingha. But the sparse sightings of individually known deer and the difficulty of their residence identification over longer periods excluded this. The efforts were then confined to locating the entire population's range:

Schaller (1967) recorded the barasingha in and around the park centre's Kanha Meadow during the rut and the following dry season. Their movement, however, remained unclear for the period from the beginning of the monsoon up until December. It was unknown even whether the barasingha remained within the park boundary during these seasons or not. Though for years the barasingha of the Kanha National Park were known to be the last in Central India.

I hypothesized that all of them belonged to the same herd and that this herd utilized a well defined area determined by environment and all biological requirements of the deer. This area will subsequently be referred to as "composite home range", or in the case of seasonal dispersion as "composite seasonal range". These terms were utilized also by Craighead *et al.* (1973) for elk (*Cervus canadensis*) groups in Yellowstone National Park.

The composite home range which encloses the points of all 689 sightings of groups and solitary individuals recorded between April 1971 and March 1973 is shown in Fig. 4. The range boundaries were secured by joining the outermost points of locations (Mohr 1947). All other locations fell into meadows near the surrounding hills. There were no indications that barasingha enter deep into higher forest areas. It seems thus justified to connect these outermost points of locations with straight lines. According to the seasonal dispersion of the majority of the population, the composite home range was subdivided into a northern and a southern part of nearly equal area. Each of the two parts delimits a composite seasonal range. The composite home range embraces approximately 47 square kilometres and contains the major part of the parks' Sulcum River Basin. This range is practically coincident with the distribution of sal forest in the centre of the park (see Fig. 20). All of the larger meadows on the northern side of the basaltic ridge lie within the composite home range boundaries.

The peninsular distribution of the barasingha, as shown earlier, was largely confined to the moist deciduous forest climax. It appears that the predilection for a forest type persists even on the level of group dispersion: The mixed forest type occurring in the park above 610 metres elevation seems to lack the qualifications for utilization by barasingha in any one season. The same is true for continuous sal forest areas, as they are found in other parts of the park. Even in the past, unbroken sal forest areas were less frequented by barasingha than the park centre's sal area with its meadows. Thus there is reason to believe that it is not the forest type per se, that delimits the dispersal. Rather it is the rich type of meadow that may occur in sal forest areas. This indicates that the distribution of meadows within the sal area of the Sulcum River Basin defines the composite home range of the present population.

a) *Dispersal*

Barasingha that obviously had left the composite home range were: one adult female reported from Bahmni Dadar (13 kilometres from Kanha village) in October 1972 and January 8, 1973; one adult male reported near Ronda (10 kilometres from Kanha village) on October 11, 1972; and one adult male reported near Mukki (16 kilometres from Kanha village) on March 15, 1973. The latter had crossed the park boundary, the two others had moved to within one or two kilometres of the boundary. Although these were rare reports, they suggest that emigrations from the composite home range occur in the period of monsoon movements (chapter III-4). Stragglers may leave the park and not return for the rutting period.

2. **The Cool- and Dry Season Range**

During the cool- and dry seasons (15th December to 31st May) the barasingha population congregated in the southern part of the composite home range. The range occupied included the Kanha Meadow and the neighbouring forest tracts north of the Kanha Meadow along the Sulcum River and the Desinala. From the 346 sighting points of groups and solitary individuals recorded during these seasons, merely 3 fell into the northern part.

The first congregations observed in the composite cool- and dry season range in December seemed to be related to the rut. Rutting behaviour was restricted to the cool season and occurred in well-defined areas of the cool- and dry season range in both the second half of the rutting period: on 28th January 1972, 70 animals; on 4th February 1972, 54 animals; and on 4th February 1973, 63 animals. Herds of this size contained approximately half the total population (see Table 8).

Breeding herd consolidations of the Kanha Meadow broke up into smaller units after the rut in March and April. Smaller groups and single barasingha dispersed from the Kanha Meadow and were occasionally observed in the forest tracts along the river courses, 1-3 kilometres north of this meadow. Individually known animals indicated that the barasingha moved about the southern range throughout the dry season. They occasionally appeared on the Kanha Meadow for varying amounts of time and left again for smaller clearings in the forest north of the Kanha Meadow. The occurrence of different sex-and age classes in two vegetational types during the cool- and dry season shall be shown in chapter V-2.

The occupation by barasingha of the largest meadow in each of the two seasonal ranges was checked upon by regular censuses carried out in 1972. This, firstly, gave an idea of the seasonal utilization of the two meadows, and secondly, the census figures were a fair indicator for the seasonal occupation of the two parts of the composite home range. Censuses were taken in intervals of 10 days in the Kanha Meadow of the southern range and the Sonph Meadow of the northern range. Census were carried out in standardized tours through these open areas in the morning and evening of each census day. The maximum number of barasingha recorded on each day and in the two meadows is shown in Fig. 5.

Census figures point to peak aggregation of barasingha in the Kanha Meadow during rut

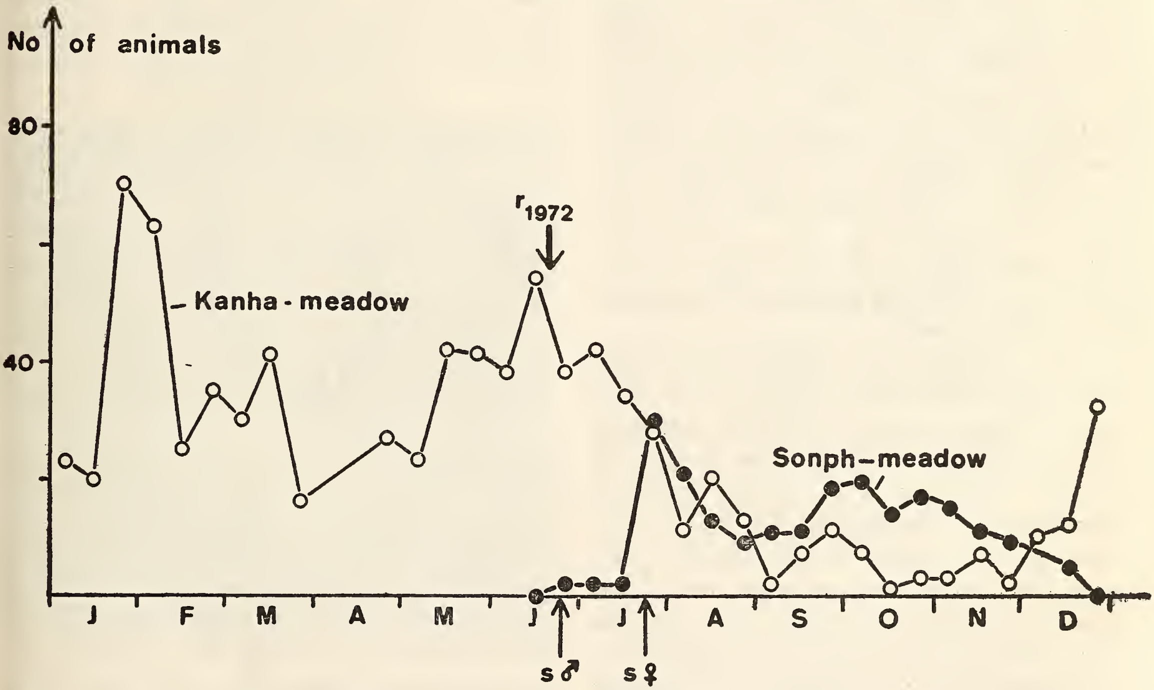

Fig. 5. Numbers of barasingha recorded on Kanha Meadow and Sonph Meadow in intervals of 10 days throughout 1972. s ♂ resp. s ♀: First occurrence of males resp. females in the Sonph Meadow. r ⟶ onset of monsoon rains.

in January and February. Utilization of this meadow tends to decrease after the rut. It increases again with progressing drought until the onset of monsoon rains in June, when barasingha start moving to their growing season range in the north. This is indicated in Fig. 5 by decreasing numbers of barasingha occurring in the Kanha Meadow in July.

a) *Activity during the Cool- and Dry Season*

The most obvious factors governing activity patterns in deer are determined by the environment. Responses to environmental factors, however, depend upon the level of perceptibility or tolerance of the species towards these factors. However, constant environment is more likely to promote individual variability in activity patterns, whereas fluctuating environmental factors should produce more uniform activity peaks. Temperate climates were found to cause widely individual activity patterns in deer. For example, Craighead *et al.* (1973) found that elk (*Cervus canadensis*) in Yellowstone National Park are individualistic in such basic activities as feeding, bedding and moving.

Here, the patterns of these three activities shall be shown for the barasingha in its cool- and dry season range:

The conditions of observation did not often allow longitudinal recording of the activity of single animals. Another sampling method was thus used, recording in time intervals the activity of all animals visible on standardized tours through the Kanha Meadow and its vicinity. Activity records, thus, stem from observations of a number of unidentified animals seen during the cool- and dry seasons 1971-73. The total number of individual activity records for these seasons was 2862.

Fig. 6 shows the diurnal activity pattern into one hour periods. Pronounced peaks are discernible for all three activities.

The main feeding activity peaks occur around sunrise and sunset. Already before sunrise barasingha start moving towards the

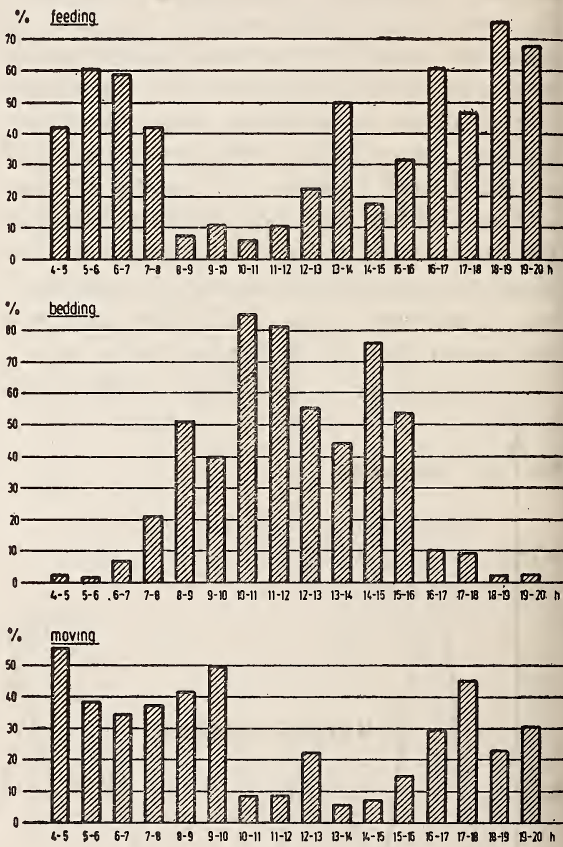

Fig. 6. Diurnal activity profiles of barasingha during the cool- and dry season (December 15 to May 31). Pooled classifications 1971-73 of three main activities. Sunrise between 0516 and 0643 hr local time at Kanha. Sunset between 1720 and 1840 hr local time at Kanha.

forest edges, or to feeding grounds along the rivulets of the open area, until movements come to an end around 10 a.m. Feeding activity is at minimum between 8 a.m. and 12 a.m., when most of the barasingha rest in the shade of forest edges. Other animals stay in the meadow, where they bed in the shade of single trees of tree groves, often crowded together on the limited patches of shade. Occasional grazing activity starts again around noon, mostly in the shady resting areas. Other barasingha may move to the forest at this time. After resting in the hot hour between 2 p.m. and 3 p.m. feeding activity increases in the late afternoon. Between 4 p.m. and 6 p.m. groups enter the Kanha Meadow again from the forest and move to grazing grounds and watering places. The daily feeding maximum occurs then around sunset. Barasingha subsequently move to other grazing areas within the meadow. Sporadic observations and indications from Schaller (1967) suggest that the barasingha are sedentary around the major grazing areas within the meadow during night. Feeding activity may be continued from sunset until about 10 p.m. and fade to resting with intermittent grazing until morning.

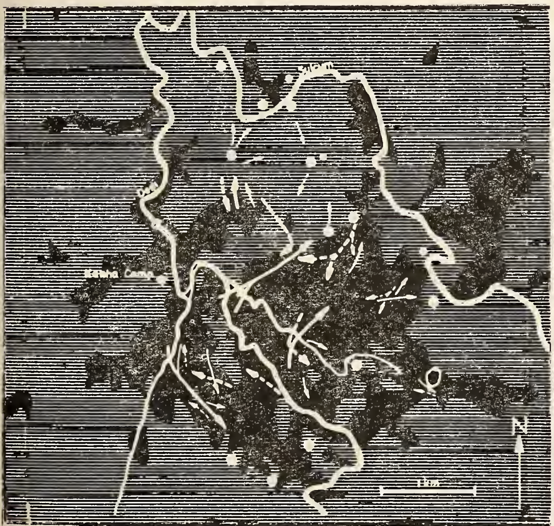

Fig. 7. Daily movement pattern of barasingha in the Kanha Meadow area, during the cool- and dry seasons 1971-73. Dots: Main day resting areas. Arrows: morning routes. Dashed arrows: evening routes.

On their movements between forest and meadow, the barasingha were found to cross the same areas daily, although they did not follow trails. Generally, barasingha moved towards the forest north of the Kanha Meadow in the morning and entered the meadow by the same areas again in the evening (Fig. 7).

As cloudy days during the cool- and dry season are few, the diurnal activity presented here may reflect the general pattern for clear days with hot hours around midday. The time when barasingha stopped, respectively started grazing in the open seemed to be determined by the heat or direct sunlight, whereas the time spent moving was largely given by the distance between suitable grazing grounds or watering places, and shady resting locations. The view, that climatic factors influence the timing of diurnal activity in these seasons, was supported by observations on the cloudy and rainy days, when activity peaks were less distinct and movements at minimum, due to bedding in open areas. The influence of the temperature regime on the timing of the daily feeding activity of deer was suspected even in temperate climates by Cowan (1945), Leopold *et al.* (1951), Swank (1958), Taber & Dasmann (1958) and Loveless (1957). Linsdale & Tomich (1953) stated also that deer may make adjustments in form of short distance movements within their principal habitat to meet with requirements for shade.

b) *Factors influencing Utilization Pattern*

Many habitat types may occur within a home range, yet, an animal may utilize only a few of these. Preferences for certain types of habitat can be due to food preferences, cover, or other factors. Berg & Phillips (1973) found such "habitat preferences" in moose (*Alces alces*) of northwestern Minnesota.

The regularity with which the barasingha moved to feeding areas of the Kanha Meadow during the cool- and dry season intimated such preferences for certain types of habitat. A possible reason for this could have been the widely different grassland structure in different parts of the Kanha Meadow. It will later be demonstrated that high ungulate grazing pressure is correlated with the occurrence of certain grassland communities during the growing season.

However, in May 1971 it appeared that water and burning were such powerful factors that preference for certain types of grassland during the cool- and dry season were eliminated. Grazing activity in the Kanha Meadow seemed to be largely restricted to rivulet zones and patches of unburnt grassland. Thus, in the cool- and dry season of 1972 an attempt was made to check upon the influence of rivulet zones and unburnt patches on the selection of grazing areas.

The data used for this investigation was based on interval records of unidentified animals seen on standardized tours through the Kanha Meadow. Records originate from the period between January 22, 1972 (one week after burning) and June 21, 1972 (first monsoon rains).

A grid system (400 × 400 steps) was superimposed on the map of the Kanha Meadow prior to the investigations. It divided the area into 61 squares. It was noted whether each square contained perennial water or unburnt grassland or both, Subsequently the frequency of grazing barasingha groups seen in each square was recorded. While recording groups instead of individual barasingha, bias caused by group size was avoided. Group size could at least partly be stipulated by social factors. Grazing groups were marked by grazing activity of all group members and hence absence of movements. The total number of such records for the period concerned was 102.

TABLE 2

MEAN FREQUENCIES OF GRAZING BARASINGHA GROUPS IN 4 TYPES OF SQUARES OF A GRID SYSTEM 400 × 400 STEPS SUPERIMPOSED TO THE KANHA MEADOW. ONE WEEK AFTER BURNING UP UNTIL ONSET OF MONSOON 1972

Kruskal-Wallis Test:
$H = 19.71 > 16.27 = x^2$ 3; 0.001 ($p < 0.001$)

Squares containing: Perennial water	Unburnt grassland	Number of squares	Number of groups	Mean per square
–	–	34	13	0.38
+	–	22	37	1.68
–	+	19	37	1.95
+	+	6	15	2.50

Table 2 shows that the mean number of grazing groups per square is lowest for those squares that contained neither perennial water nor unburnt grassland. It is medium for those squares that had one out of the two qualities and highest for the squares that had both qualities. A Kruskal-Wallis-Test proved significant differences among the four samples. Thus, during the cool-and dry season, grazing activity centres in the Kanha Meadow are primarily distinguished by these gross physiographic features of the grassland. They consequently influence the direction of the daily movements. Whereas the principal movement pattern is out of the meadow in the morning and into it in the evening, the movement within the meadow is determined by the location of perennial water and unburnt grass zones.

The preference for areas that harbour perennial water does not necessarily mean, that the site is selected for grazing due to the possibility for drinking. There may still be a preference for certain forage species, which occur near perennial water. This is undoubtedly the case with *Saccharum spontaneum,* a preferred forage species during the cool-and dry season. It forms dense stands along rivulets and produces green sprouts continuously in these locations even in the driest period of the year.

Extensive burns may cause starvation among barasingha. Green sprouts that occur after burning wither soon or are grazed upon by the large herds of chital, and cause only a shortlived attraction to barasingha.

Acute food shortage became evident when an accidental fire swept the grass cover and sal forest undergrowth of the entire 28 hectare-enclosure on March 25, 1972:

To lessen the critical situation to the enclosed deer, cut grass was deposited in the enclosure and trees were lopped. Young sal leaves that were killed off by the heat of the ground fire and subsequently fell from the trees supplied further forage. The enclosed chital turned to browsing from loppings and withered sal leaves readily and seemed not to be affected by the food shortage. Yet the barasingha made no attempt to seek forage. Most of the time they simply stood in a serried group or moved up and down along the enclosure fence. One week after the fire all 7 barasingha enclosed at that time, showed severe signs of malnutrition.

3. The Growing Season Range

Schaller (1967) stated that the barasingha disperse from the Kanha Meadow during monsoon and remain concealed until the beginning of the rut in December. Fig. 5 shows that the numbers of barasingha that were counted in the Kanha Meadow in 1972 decreased after the onset of the first monsoon rains. Throughout August and until mid December (growing season) the numbers of barasingha staying in the Kanha Meadow never exceeded 21 animals, whereas higher numbers were recorded in Sonph, which is the largest meadow of the northern part of the composite home range. This suggested (1) that a majority of the barasingha leave their cool-and dry season range in the south during the early monsoon season and (2) that not the entire population confines its activities to the same part of the composite home range. However, in spite of the wider dispersion during the second half of the year, distinct concentrations occurred in the northern part. A mere 22 per cent of all 229 locations of groups recorded during the growing seasons 1971 and 1972 fell into the southern part. Fig. 8 shows the distribution of groups during those periods of the population's most distinctive polarization in one of the two parts of the composite home range. They are coincident with the peak of the rut in January and the late fawning period in October.

a) *Importance of the Sonph Meadow*

The Sonph Meadow (Fig. 9) had been occupied by a forest village, its rice fields and grazing grounds for cattle until the village was relocated outside the park in 1969. Today merely the collapsed dikes of former rice fields and local predominance of *Ischaemum indicum*—a grass species indicative of heavy use by cattle—still point to the former presence of a village. In its present condition the Sonph Meadow had a more heterogenous grass cover than other meadows in the park (Fig. 20). It is distinguished by a patchy distribution of grass species and grassland "facies", induced by the patterns of former rice fields.

Sonph was referred to as being one of the best areas to see barasingha at the beginning of this century (Nath, not dated). However in 1964-65 Schaller (1967) recorded no barasingha in Sonph and the Forest Department had not recorded them in this area for many years (Panwar 1973). This was prior to the relocation of the village in 1969.

Yet during my study period barasingha were sedentary in the Sonph Meadow throughout

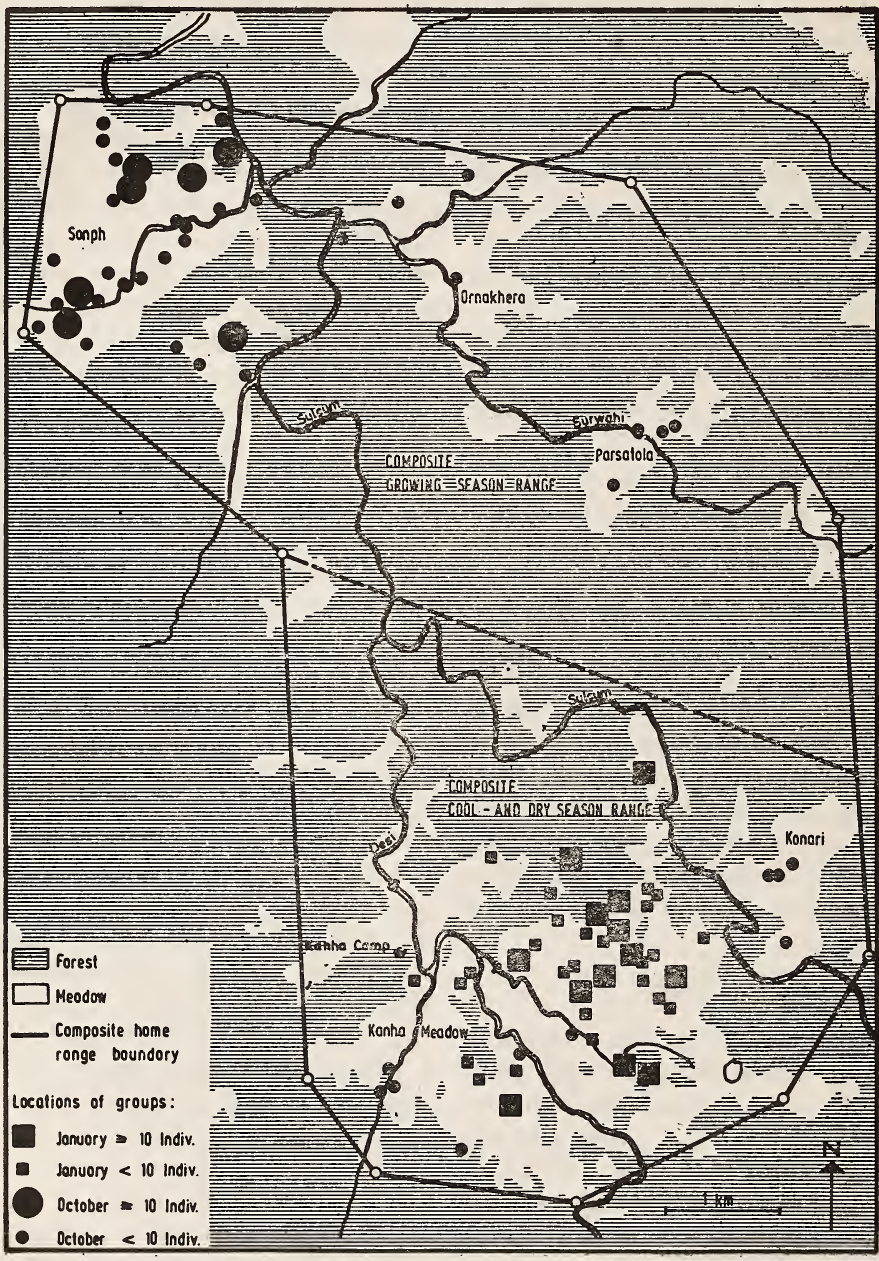

Fig. 8. Sighting points of barasingha groups during the periods of the utmost polarization within the composite seasonal ranges. From pooled classifications January 1972 plus 73, and October 1971 plus 72.

the second half of the year. The largest groups ever observed in the northern part of the composite home range, were recorded in this meadow. It has been suggested that the grassland structure that evolved in Sonph after human influence was banned, probably meets in ideal ways with the requirements of the barasingha during the growing season (Martin 1973).

Sonph was moreover the major fawning area. Six out of eight newborn fawns found during the study period were found in this meadow (Fig. 4).

b) *Activity during the Growing Season*

With the onset of monsoon rains and the subsequent appearance of new sprouts, the daily activity pattern of the barasingha changed markedly. Cloudy days, abundance of green forage and water permitted them to be more sedentary within open areas. This became even more evident during the growing season, after the majority of the barasingha had travelled to the northern part of the composite home range. Although the population had attained a wide dispersion, the activity of groups and solitary individuals seemed to be restricted to rivulet zones within the various meadows throughout the growing season. Periodic daily movements, as they were observed during the first half of the year, did not occur and barasingha very rarely entered the forests. Feeding- and bedding areas coincided along the tall grass of rivulets. Diurnal activity was restricted to short bouts of grazing. Most of the day was spent lying down in tall grass areas and grazing occurred in the direct vicinity of the bedding site. On cloudy days grazing intervals of up to 10 minutes length occurred throughout the day with a slight peak of grazing activity around sunset. The sunny days following the end of the monsoon rains then caused a polarization of several grazing intervals around the period of sunrise and sunset.

The tendency to remain in tall grass zones seemed related to (1) the need for shelter, and (2) the abundance of highly palatable food and water in the direct vicinity of the bedding sites. All sex- and age classes were found to behave in the same way. Thus sedentariness was not merely related to separation for parturition.

c) *Distribution of Bedding Sites*

Bedding sites of barasingha were found to have a typical appearance: The grass cover, while in its growing stage, was crushed into the soft ground by the bedding animal. This hindered the grass coming up again, which was also augmented by the repeated use of the same beds. The sites where barasingha had bedded ultimately were distinguishable from other species' beds by an oval patch of more or less bare to muddy ground which always had hoof impressions. Most of these beds persisted into the cool season.[7] As bedding and feeding areas were coincident, locations of such beds helped to check upon the principal habitat of growing season activity centres (Fig. 9). The 28 hectare enclosure was used to this purpose, as it contained all major components of the barasingha habitat, i.e. sal forest, open grassland, loose stands of tree and rivulet zones. Seven barasingha were living in the enclosure in 1972. The number and distribution of their growing season beds was recorded on November 10, 1972 (Fig. 10). The total number of beds was 112. 95 per cent of them were within 35 metres of the rivulet, and 21 per cent of all beds were less than 5 metres away, or on banks within the rivulet.

[7] The flight distance of bedded barasingha was unusually short during the growing season. It was not uncommon, that barasingha were approached to within less than 10 metres before the animal rushed out of the grass and bedded again some distance away.

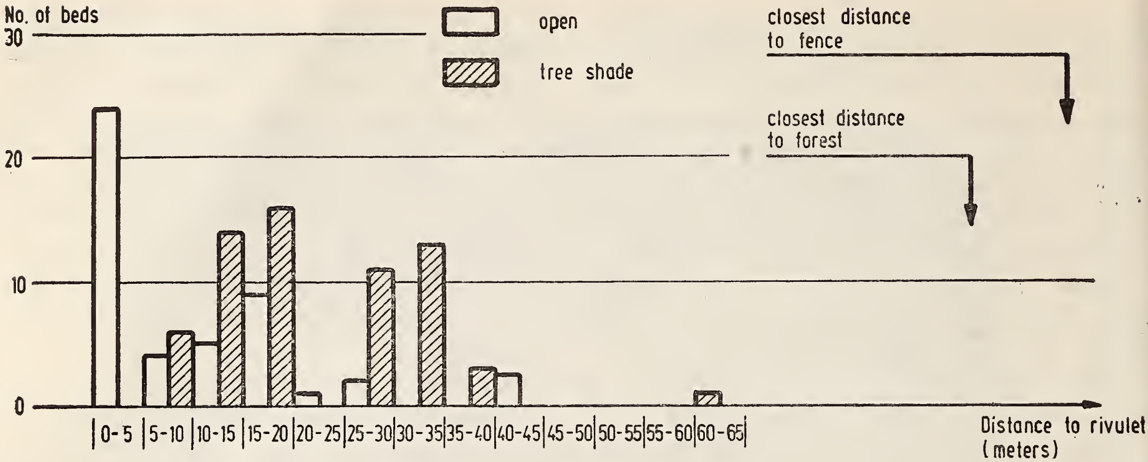

Fig. 10. Distribution of barasingha beds in relation to rivulet of the enclosure. Records from growing season 1972. The representation assumes equal distribution of shade giving trees with the distance from the rivulet (see text).

More distant ones were predominantly located under trees, but practically no beds were situated outside the rivulet zone. The distribution of shady bedding sites in Fig. 10 is of course dependant also upon the availability of shade giving trees. The distribution is therefore not merely a variable of the distance to the rivulet. Trees also occur in zones more distant from the rivulet where no or few bedding sites were found. The tree density was hence assumed to remain equal with the distance from the rivulet.

Some beds may have occurred also in the forest. Due to the absence of a continuous grass cover, beds could not always be distinguished here. However, direct observations in the enclosure showed that barasingha avoided forest tracts during the growing season. The low number of beds caused by 7 barasingha during a period of approximately 3 months further indicates the repeated use of single beds. Some of them must have been frequented 30 or more times.

4. **Migration between Ranges**

Barasingha were relatively sedentary within their seasonal ranges. Movements rarely exceeded 1-2 kilometres in a 24 hour period. A different type of movement, however, occurred between the two composite seasonal ranges: barasingha moved to their growing season range after the onset of the monsoon in June and July and returned to the cool- and dry season range in November and December. Adult stages were the first to leave their seasonal ranges. Their movements away from the southern part coincided with the onset of the first monsoon rains. In 1972 two individually known adult stags were last seen at the northern edge of the Kanha Meadow on June 22, 2 days after the onset of heavy monsoon rains. On June 24 they were recorded in the Sonph Meadow, 7 airline kilometres north of that location. More stags followed before the first females were recorded in Sonph on July 23. A relatively coherent female-young group of 33 individuals even remained around the Kanha Meadow until July 27. The month of July was thus marked by a discrete dispersion of sexes among the two ranges. In this transitional stage, up to 16 adult males temporarily aggregated in one group in the northern part,

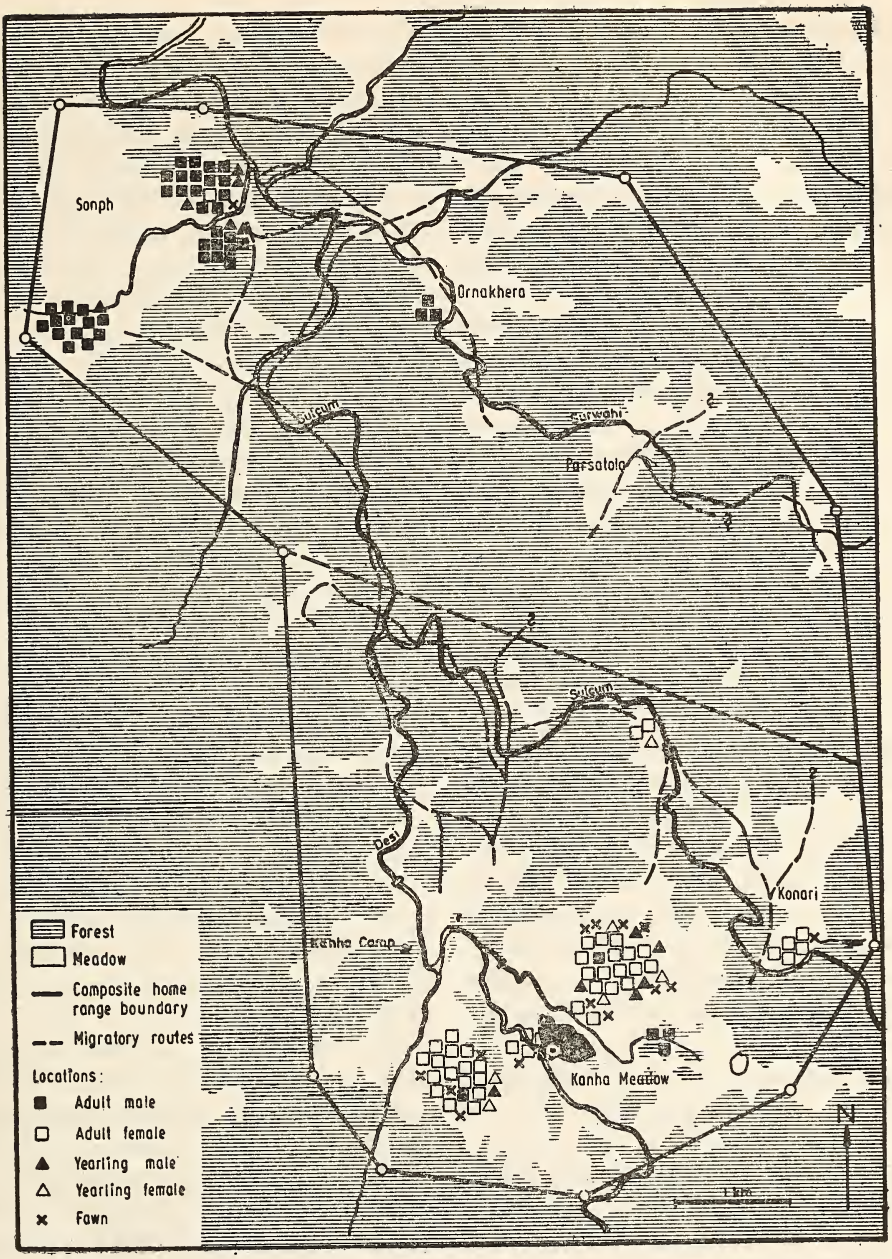

Fig. 11. Discrete dispersion of sexes in the composite home range during the period of monsoon migrations. From classifications July 1972. Travelling routes inferred from direct observations and tracks.

whereas the majority of the females and young animals were still in the southern part of the composite home range (Figs. 5 and 11). Females and young animals then left the southern part at the end of July, roughly one month after the first males were recorded in the northern part. Adult males were again the first appearing on the rutting grounds of the Kanha Meadow in early December.

Fig. 11 shows migrational routes between ranges inferred from direct observations and tracks. They indicate that barasingha head directly towards meadows of the other seasonal range. River courses connecting the meadows from preferred travelling routes. Barasingha moving between ranges appeared to be merely in small groups or solitary.

Migrations between seasonal ranges in deer were suspected to be adaptations to satisfy nutritional requirements. Such movement are well documented for elk (*Cervus canadensis*) (Schwarz & Mitchell 1945; Altman 1952; Picton 1960; Dalke 1965; Knight 1970; and Craighead *et al.*, 1973) and moose (*Alces alces*) (Edwards & Ritcey 1956; Phillips *et al.*, 1973; and others). These species often have distinctly different ranges during summer and winter. Decreased snow depths permit them to leave their spatially limited winter ranges in spring. Wanderings can be understood as adaptation to seasonally different food conditions in different areas.

The adaptations of the barasingha in Central India may altogether be paralleled with the above findings:

Whereas it is snow depth that effects spatial limitation during winter in colder climates, it is the scarcity of water that effects it in barasingha during the cool—and dry season in Central India. However, water also has a direct influence on the structure of the grass flora, in so far as the grass cover is more eutrophic where water conditions are good. The influence of water and food on the seasonal migrations, therefore, remain indistinguishable.

Though adaptation to seasonally different water—and food conditions may sufficiently explain migrations, another question remains: What is the mechanism that permits the barasingha to head for distant meadows by direct movements? This question shall be dealt with in the next section.

5. Traditions

Deer are known to have a strong tendency to return to their seasonal ranges over the years, as has been shown by Dasman & Taber (1956), Robinette (1966), Geist (1966), Knight (1970), Craighead *et al.* (1972) and Verme (1973). Ueckermann (1968) mentioned that in old fallow deer areas, the same rutting grounds were frequented over 50 and more years.

A comparison with Schaller's (1967) observations indicates that the composite cool—and dry season range of the barasingha in Kanha remained located in the same area around the Kanha Meadow. Previous reports had mentioned the importance of this meadow with respect to the barasingha during the dry season (Brander 1923). The recurring use of the same area alone, however, does not necessarily imply traditions.

Yet the following observations undoubtedly point to homing tendency. In both the rutting periods that were witnessed during this study, barasingha were found to restrict their rutting activity to the same limited areas of the Kanha Meadow (Fig. 4). No obvious ecological factors appeared to be responsible for the delineation of these areas. Even more conspicuous was the use of the same wallows in both the years, in spite of the abundance of muddy places in—and around the rutting ground. Barasingha were already shown to be loyal to their wallows by Schaller (1967). Although the number of wallows had increased from 4 in 1964/65 to 9 in 1972, it was quite striking to see that at least one of the wallows of 1964/65 was still frequented during the rut of 1972 and 1973 (compare plate 11 in Schaller, 1967). This suggests an existence of traditional bonds at least to the rutting ground. The loyalty of the barasingha to its rutting ground in the Kanha Meadow may have evolved as a consequence of the localized abundance of water and green forage in this area during the cool—and dry season. The barasingha moreover were under legal protection in this area, ever since protection measures were introduced in 1935. Since there are traditional bonds to the rutting ground, the movements to these areas may also be directed by tradition.

There is little information about the loyalty of the population to its growing season range. In chapter III-3 I mentioned, that barasingha started repopulating the Sonph Meadow only after its village was translocated in 1969. Schaller (1967) showed that even prior to this the majority of the barasingha used to move away from the vicinity of the Kanha Meadow during monsoon. As the barasingha's activity is largely confined to the open grassland of the sal area during the growing season, it may be assumed that the northern meadows were always frequented. Yet, due to man—and cattle activities until 1969, barasingha were probably forced to disperse into marginal land. The dispersion of the population during the growing season, therefore, was probably wider before 1969 than during the period of this study. Congregations in the northern part of the composite home range, as they were found in 1972, obviously did not occur. It is likely, however, that this had negative influences on the coherence and the population dynamics of the herd, even more so, because the fawning period comes in that season.

IV Habitat utilization

We have come to the conclusion that the barasingha's activity is largely confined to open grassland throughout the seasons. Grazing grounds during the cool—and dry seasons are distinguished by the presence of water and unburnt grassland. In the growing season range concentrated around open rivulet zones. This prompts the question as to what the food habits of the barasingha are.

The following section is an attempt to answer this question. Then the utilization patterns of possible competitors among the herbivores of the park will be considered. On the basis of habitat preference and food habits I shall then make a few remarks on the evolution of the barasingha.

1. Seasonal Food Habits

I suspected that almost every grass species would be eaten by barasingha on certain occasions. However, the dominance of a species and its distribution pattern in a certain locality has a great deal to do with its preference rating. The quantity fed from a certain species may therefore have only local application. Standardized observations in a heterogeneous grassland habitat are almost impossible. Smith (1952) has reported on this central problem of food habit studies. Therefore I will only describe more qualitative differences of barasingha-forage in different seasons:

Table 3 shows an appraisal of those 26 grass species which were found to be the most common in the Kanha Meadow (see chapter VII).

Indications are based on a large number of unsystematic observations. Identifications of grazed plants were made on the spot, immediately after the grazing animal(s) had been

TABLE 3

SEASONAL BARASINGHA DIET OF COMMON GRASSES IN KANHA N.P.

Species	cool- and dry season 15.12.-31.5.	early monsoon and growing season 1.6.-14.12.
Apluda mutica	+	++
Arthraxon quartinianus	–	+
Bothriochloa odorata	+++	+++
Chionachne koenigii	++ (g)	?
Diandrochloa japonica	+	+
Digitaria stricta	+	+
Dimeria connivens	+	+
Eragrostiella bifaria	–	–
Eragrostis unioloides	–	+
Eulalia trispicata	++	++
Heteropogon contortus	++	++
Ischaemum indicum	–	+
Ischaemum rugosum	–	+
Iseilema prostratum	+	+++
Mnesithea laevis	+	++
Narenga porphyrocoma	+ (g)	+
Panicum austroasiaticum	–	+
Phragmites karka	+ (g)	++
Pseudopogonatherum contortum	+	+
Saccharum spontaneum	+++	+
Schizachyrium brevifolium	+ (g)	?
Setaria glauca	++	+
Sorghum halepense	+ (g)	++
Themeda quadrivalvis	+ (g)	+++
Themeda triandra	++ (g)	+++
Vetiveria zizanioides	++	+

intake: high +++ medium ++ low +
very low or none – (g): fed upon only when green underlined signs: fed upon regularly

watched through binoculars. Identification of grasses was critical during their growing period. Grazed specimens were thus marked with aluminium tags and identified later on, when flowering. When dry, however, all 26 grass species concerned may be identified.

(1) Cool-and dry season (15th December—31st May):

Most conspicuous forage was *Saccharum spontaneum*. Monotypic, dense stands along water courses were regularly and extensively grazed upon throughout these seasons. Riverine *Saccharum spontaneum* was by far the most important barasingha forage also in forest tracts (Fig. 12). *Bothriochloa odorata* formed the bulk of the barasingha's diet in dry open- and dry shady locations, but green leaves of *Themeda triandra* were also heavily grazed upon. Except for the coarsest, which were only fed when green, grasses were eaten whether green or dry. Where available, however, green plants or parts of them were favoured.

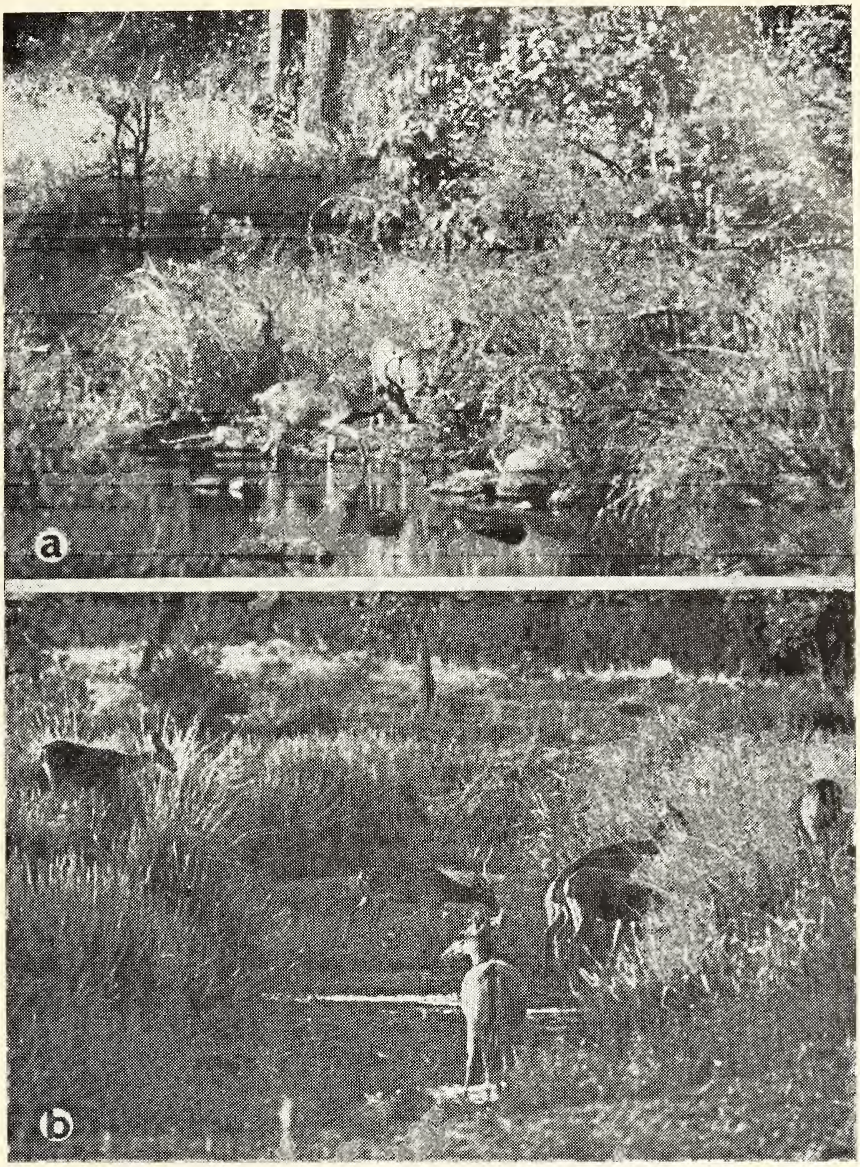

Fig. 12. (a) Group of barasingha stags feeding upon stands of *Saccharum spontaneum* in a stream bed north of the Kanha Meadow. June 1972 before the onset of monsoon rains. (b) Barasingha and chital collecting on riverine *Saccharum spontaneum* in the Kanha Meadow during the dry season.

Fig. 18. Pole used to measure grass height. The lowest figure visible on the board from a horizontal distance of 10 m was taken as grass height. Note: Difference of grass height in *Bothriochloa odorata* association at boundary where the fire was put out 11 months ago. Photo taken in November.

(2) Early monsoon-and growing seasons (1st June—14th December):
A large variety of new sprouts was fed upon during the early monsoon season. Preferences for certain species seemed less conspicuous then during the cool- and dry seasons. Though, barasingha subsisted often on locally limited "facies" of *Themeda triandra* and *T. quadrivalvis*. *Bothriochloa odorata* was still important food. *Saccharum spontaneum*, much in contrast to the dry season, was scarcely eaten. During the flowering time in October and November, leafy perennials like *Sorghum halepense* and *Phragmites karka* were heavily grazed upon. Inflorescences of *Themeda triandra, Sorghum nitidum, Bothriochloa odorata* and others supplied further forage.

The diet included the coarsest of species such as *Narenga porphyrocoma*. Even barbed species such as *Chionachne koenigii* were fed upon occasionally. Meagre annuals like *Dimeria connivens* were regularly taken, even when dry. But intensive grazing activity was generally confined to stout perennials.

Schaller (1967) has already reported an almost exclusive grass diet. He recorded merely six woody plant species fed upon by barasingha. Throughout this study much attention was paid to forage plant identification. The observations of barasingha eating browse were so few that they may be mentioned here separately. Of the six woody plants listed by Schaller, barasingha were seen feeding during this study upon: *Ziziphus jujuba* and *Moghania congesta* at one instance each, by one animal, and *Embelia tseriamcottam*[8] twice, by one animal at each instance. The other three species were not recorded as barasingha forage during this study, in spite of their abundance. In one instance, however, two barasingha were found eating the fruit of *Cordia myxa*. Even in forested areas, where browse was in lavish supply, barasingha concentrated on the grasses of the undergrowth and of small openings; but particularly on the stands of coarse grasses bordering river courses. Bamboos *(Dendrocalamus strictus)*, although gramineous and locally abundant, were chiefly avoided. *Cyperacea* species were occasionally taken, but did not make up a conspicuous part of the diet at anyone season. On several occasions during the dry season, however, barasingha were seen submerged in the water of perennial rivulets and pools. Standing in water up to their belly, they fed from water weeds *(Najas* sp., *Vallisneria* sp., and others) below the surface. Much in contrast to the other ungulates of the park, natural and artificial saltlicks were practically disregarded. These observations demonstrate an almost complete avoidance of browse at anyone season. Barasingha are thus rather unique in their diet. They subsist on grasses to such an extent, that it is difficult to compare these findings with the food habits of any other of the deer species.

2. Interspecific Competition

Apart from the barasingha the meadows of the intensive study area are regularly frequented by the herbivores chital, sambar and blackbuck, of which the latter however is restricted to the dry open ground of the Kanha Meadow. Gaur come down from the hills to the sal area only during the dry season, yet here their activity is largely confined to the forest and

[8] *Embelia tseriamcottam* is a relatively rare shrub, which is heavily browsed upon by all ungulates in the park, including the graminivorous black buck (*Antilope cervicapra*).

riverbeds. Muntjac and fourhorned antelope hardly ever leave the forests of these areas. Nilgai are rare and occur only sporadically in the northern part of the intensive study area. As in the rest of the park, the chital is by far the most numerous ungulate. Approximately 4000 chital lived in the intensive study area in 1972.

Particularly during the cool- and dry season barasingha and chital were often found to form mixed herds when grazing. The grass species fed upon by barasingha were, however, favoured also by chital. This was particularly true for *Bothriochloa odorata, Themeda triandra* and *Saccharum spontaneum*. During the dry season mixed barasingha-chital herds concentrated regularly on monotypic stands of riverine *Saccharum spontaneum*. These species, but particularly *Saccharum spontaneum*, subsequently showed severe signs of grazing impact at the end of the dry season. Heavy grazing impact was, however, largely confined to the area of the Kanha Meadow. This implied that competitive exploitation may occur between barasingha and chital.

In order to collect information on the utilization patterns of the major grassland users in the intensive study area, the distribution patterns of chital-, barasingha- and sambar fecal pellets were checked. A comparison of utilization patterns by recording pellet frequencies was preferred to direct observation of deer, because results remain unaffected by different time-space patterns of different species.

a) *Deer Pellet Count*

A pellet count was originally designed to give information on the seasonal dispersion of chital, barasingha and sambar among the intensive study area meadows.[9] Yet, the sampling intensity required to obtain a representative sample of a given area depends upon the density and distribution of pellet groups. Grieb (1958) gives a formula to determine the required sampling intensity. A preliminary survey, however revealed that high variance among samples would have required a very large number of plots to show seasonal and regional differences.

A modified pellet count technique was thus used to answer a slightly different kind of question: Is the amount of barasingha pellets in a certain locality correlated with the number of chital and/or sambar pellets? In other words: If we do not distinguish between areas, are those plots with relatively high, respectively low rates of barasingha pellets, the same as those that have high, respectively low rates of pellets of other species, or not?

We may interpret the areas with high pellet frequencies to be those of heavy use. Thus, correlation of pellet frequencies from different species will give indications on common and/or discrete utilization patterns of these sympatric species. Seasonal aspects enable distinguishing between pellets that accumulate during the dry season and during the rest of one year.

[9] Many attempts have been made to estimate the relative and actual number of deer of their days of use in a given area by counting fecal pellet-groups. Neff (1968) gives a review of the various methods used and their suitability under different conditions. Practically all methods use some stratified random distribution of sample plots. Among all the problems that arise if an estimation of the actual number of deer is to be computed, the figuring of daily defecation rates is one of the most difficult. Defecation rates are subject to seasonal and regional changes. Sampling accuracy may be influenced by different deterioration rates under various cover conditions, e.g. forest vis-a-vis meadow. Rainfall can also cause the disappearance of pellet groups (Wallmo *et al.* 1962). Interpretational difficulties as in the case of peripheral or scattered groups in the sample plots may cause further bias.

(1) Sampling:

A total of 84 plots were distributed in the intensive study area meadows. Plot sites were located according to a stratified random design and permanently marked with wooden pegs. Plots were 50 sq metres and circular. High pellet densities impeded the identification of pellet groups. Therefore single pellets were counted in divergence to other methods described. This way the problem of interpretation of peripheral or scattered groups was excluded.

The first count was carried out from March 12 - 16, 1972. Consecutive counts were carried out on July 5 - 12, 1972 and March 8 - 13, 1973. Each time pellets were classified, counted and removed from the plot. Due to extensive fires that destroyed the grass cover in most of the meadows before the first count, the pellets could be collected easily. The second count, which took place before the next growing period, also went smoothly. For the last count the grass on the plots had to be cut prior to the count.

— Thus, the first count comprised all pellets from before the count period, the second count those of the four months of the past dry season, and the third count those pellets that accumulated from July to the following February.

(2) Durability of pellets:

Whereas pellets in the forest may be lost by concealment in litter as well as other reasons within less than one year's time, pellets in the meadows lasted for at least a year. The total amount of pellets from the two count periods (1 year) is comparable to the total amount from the initial count (Tab. 4). Considering the general increase of deer and accordingly, pellet frequencies, we may assume that the pellets collected in the initial count date back from a period of a little more than one year. Generally pellets dry up quickly and remain unaffected until the next monsoon. However, they did not weather the second monsoon. Those pellets dropped during a period of heavy rain may get lost within the same monsoon season. Occasionally pellets were lost due to termite attack. Nevertheless, neither type of loss seems to affect the results of semiannual or annual counts seriously.

TABLE 4

MEAN FECAL PELLET FREQUENCIES PER 50 SQUARE-METRE PLOT; FROM 84 PLOTS IN THE INTENSIVE STUDY AREA MEADOWS

Fecal pellet type	Initial count	March 14 to July 8	rest of 1 year	Total (1 year)
Chital	709.4	133.9	573.4	707.3
Barasingha	74.0	18.0	87.5	105.5
Sambar	46.9	6.7	23.5	30.2
Total	830.3	158.6	684.4	843.0

(3) Species identification of pellets:

The year before the first count was carried out, pellets of observed animals of the three species were collected and compared. The diameter of chital pellets vary from 6.5 - 9.0 mm, whereas barasingha- and sambar pellets are always wider. Barasingha pellets are cylindrical in contrast to the pileate and wider sambar pellets. Chital- and sambar pellets are usually dark brown to black when dry, whereas barasingha pellets are light brown. The shape of pellets were fairly constant, except during the monsoon when deformed pellets also occured. Soil-containing pellets occur in chital and sambar only, as barasingha do not frequent natural or established salt licks. Because of the barasingha's exclusive grass diet, fragments of browse in pellets point to either chital or sambar. Occasionally pellets had to be disregarded due to the difficulties involved in identifying them.

b) *Correlation of Species Pellet Frequencies*

Spearman Rank Correlation tests revealed that barasingha and chital pellets commonly occur together. Rank correlation co-efficients (Tab. 5) show a significant positive correla-

TABLE 5

CORRELATION OF BARASINGHA PELLET FREQUENCIES WITH PELLET FREQUENCIES OF CHITAL AND SAMBAR; FROM 84 PLOTS IN THE INTENSIVE STUDY AREA MEADOWS

SPEARMAN Rank Correlation Tests Coefficients $|r_s| > 0.2151$ ($2a = 0.05$; $n = 84$) are significantly different from 0. ($p < 0.05$).

Correlation of barasingha pellet frequencies with pellet frequencies of:	Dry season	All other seasons
Chital	$r_s = 0.4690$	$r_s = 0.2323$
Sambar	$r_s = -0.3300$	$r_s = 0.1810$

tion between the occurrence of barasingha and chital pellets for the dry season, but even the positive coefficient for the remaining period of the year has statistical significance. Yet, there is a significant negative correlation between the occurrence of barasingha and sambar pellets for the dry season. The occurrence of pellets of these two species during the rest of the year is positively correlated, though not significantly. The fact that the occurrence of barasingha and chital pellets are correlated suggests two things:

(1) The dispersion of barasingha and chital among the intensive study area meadows tends to be proportional.

(2) Within meadows the same areas are subject to heavy use by both species.

Sambar though appear to use the meadows of the intensive study area according to a different pattern.

These findings are supported by direct observations of deer. The dispersal of chital as well as barasingha seems to be governed by the availability of water during the dry season. Hence they congregate around the Kanha Meadow. As expected, barasingha pellets occurred only in the southern part of the intensive study area during the dry season. Chital pellets occurred in all the meadows, though they were in highest density in the south. During the rest of the year barasingha pellets occured also in the northern part of the intensive study area, and chital pellets were in about equal density in both the parts.

On the other hand, sambar pellets were always more frequent in the northern meadows. This species seems not to be affected by water scarcity in these areas during the dry season. As shown in Tab. 4, the number of samber pellets was low compared to the other species' pellets, particularly chital pellets. This points to insignificant use of the meadows. The park's sambar are predominantly browsers and enter the meadow only during the night. As mentioned before, sampling intensity was insufficient to give regional differences of statistical significance.

Common utilization of grassland by chital and barasingha does not mean a priori that the chital has the same utilization pattern as the barasingha. The chital has a wider range of food preferences; also browse plays an important role in the ecology of this species (Schaller 1967). But wherever chital pass over to meadows, the same grounds are also favoured by the barasingha. The overlap of the utilization patterns of these two species is promoted by the lack of interspecific avoidance (mixed herds). Various authors have reported an overlap in food habits of sympatric deer species. Krämer (1973) suspected competitive exploitation to be the only mechanism of competition in sympatric whitetailed deer *(Odo-*

coileus virginianus) and mule deer *(Odocoileus hemionus)* populations with densities below the maximum. Martinka (1968) and Kamps (1969) expected competition to occur between these species in the case of scarcity of certain forage plants in winter, when other forage is short.

This situation, however, is comparable to the food shortage in the Kanha Meadow after extensive burns have taken place (Chapter VII-4). The assumption, that competitive exploitation of certain grass species by chital and barasingha arises here during the cool- and dry season appears therefore to be consistent.

3. Evolutionary Aspect

The outstanding importance of eutrophic moist grasslands for the barasingha suggests that it is one of the most stenoecious among the deer. This is even more conspicuous in northern and north-eastern India, where the barasingha hardly ever enter the forest due to extensive grasslands and marshes which seem to cover all their requirements. Habitat selection to cover nutritional requirements may, however, be considered a phylogenetic adaptation that evolved in the corresponding habitat. Hence the question arises as to which was the area of differentiation of the species:

Except perhaps the more arid parts of the Thar desert, the natural vegetation of the Indian Subcontinent was essentially arboreal. Tropical grassland and marshes occurred only in riparian flats inundated by flood water of the Brahmaputra River and in the alluvial flood areas of the middle and lower Gangetic Plain. From the point of view of habitat preference, it seems therefore reasonable to assume that the differentiation of the species took place in its present northern and north-eastern range, and was dominated by the alluvial flood plains deposited after the tertiary uplift of the Himalaya. The colonization of the archaean and densely forested peninsula would consequently have occurred during a later period.

Indeed, Mani (1974) in his comprehensive biogeography of India pointed out that the present-day mammalian fauna of the peninsula is largely constituted by intrusive elements of the tertiary humid tropical Indo-Chinese and Malayan subregions. The fauna that differentiated in these eastern "amphitheatres" is unlike the Peninsular faunas composed of phylogenetically much younger groups, such as the cervids. They are characterized by a high degree of plasticity, and often diversified to local subspecies after the inflow into the Peninsula in the Pleistocene times. This may also be valid for the diversification into subspecies of the barasingha. Kurup (1974) showed that the mammalian faunal flow in the Post Tertiaries from the Indo-Chinese sub-region entered India through Assam and bifurcated, one branch spreading to the Peninsular India and the other across the Sub-Himalayan belt further west. The barasingha's distribution last century had similar pattern (see Fig. 1).

This would mean, that the differentiation of the barasingha occurred in Assam or even further in the east of the Indo-Chinese subregion. A remnant of speciation, the closely related brow antlered deer *(C. eldi)*[10], was in present times still being found in these areas. Yet the details of the evolutionary processes that happened here are unknown; all the more,

[10] Although little is known on the ecology of *C. eldi*, in Manipur it is an inhabitant of floating swamps with tall reeds (Ranjitsinh, personal comm.) which may suggest similar habitat requirements as in barasingha.

there is a lack of paleontological evidence on the species level. Still there is little doubt that the peninsular occurrence of barasingha dates back to a relatively recent, i.e. post tertiary, colonization.

V Group characteristics

Deer were generally assumed to have reached firm group sociality. This idea apparently originated from the descriptions given by Darling (1937) for red deer in Scotland. More recent studies however revealed, that grouping is largely dependant upon environment and changes in physiological functions.

Schaller (1967) stated that barasingha groups tend to break up and reassemble in different groups. It was observed at the beginning of this study, that barasingha groups occasionally changed their composition several times a day. Individuals of a group often scattered while grazing, which incidentally led to the breakup of the group. Single animals or small parties later met with different animals on grazing grounds or shady resting locations to form again larger groups.

Frequent changes of group compositions were particularly conspicuous during the dry season. This was the period, when the daily movement pattern was lively and strongly influenced by the avialability of food, water and shade (chapter III-2).

The size and composition of barasingha groups were analyzed for seasonal changes.

An analysis for changes of vegetational type was done for the cool- and dry seasons, when barasingha were relatively mobile and also frequented sal forest areas.

Characteristics of barasingha groups were based on 689 records of groups totalling 5200 observations of individual barasingha. 613 groups were classified as to sex and age. Three types of groups were distinguished:

All male groups, female- young groups and mixed groups. Single animals were considered as groups consisting of one animal. The above terms were defined as follows:

— All male group: Any combination of

Table 6

Monthly size of barasingha group types. Pooled classifications 1971-73

	Total sample		All groups		All male groups		Female-young groups		Mixed groups	
	No. groups	No. baras.	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Jan	50	468	9.4	1-70	1.3	1- 3	3.1	1- 6	12.0	3-70
Feb	62	628	10.1	1-63	1.9	1- 5	3.4	1- 9	18.0	2-63
Mar	103	1047	10.2	1-61	3.9	1- 8	6.0	1-28	13.7	2-61
Apr	8	72	9.0	1-27	—	—	—	—	—	—
May	85	666	7.8	1-28	4.3	1- 8	6.0	1-15	10.1	3-23
Jun	83	725	8.7	1-36	2.7	1-10	6.2	1-21	12.5	4-38
Jul	31	405	13.1	1-33	3.3	3- 4	5.5	1-11	17.1	10-33
Aug	40	147	3.7	1-21	2.4	1- 7	2.4	1-11	7.8	5-21
Sep	80	370	4.6	1-19	1.4	1- 3	1.6	1- 3	6.3	2-19
Oct	48	218	4.5	1-19	1.0	1- 0	1.8	1- 4	6.2	2-19
Nov	36	180	5.0	1-15	1.5	1- 2	2.5	1- 5	6.3	2-11
Dec	63	274	4.3	1-32	1.2	1- 3	2.8	1- 7	6.9	2-30
Whole year	689	5200	7.5	1-70	2.3	1-10	4.2	1-28	10.3	2-70

males older than one year.

— Female-young group: Any combination of females, yearlings and fawns, except all yearling male groups. Solitary females with fawns at foot were classed as single females.

— Mixed group: Any combination of adult males with animals from other classes, except yearling males.

1. Seasonal Grouping Pattern

The mean group size for the whole study period was 7.5 animals/group. This is in accordance with the mean of the mean monthly group sizes of 7.5 animals/group.

Tab. 6 shows the monthly size of the three group types, and Fig. 13 the segregation of sexes. The April sample was too small to give representative values on the group type level.

All male groups were constantly smaller than female-young groups. Highest mean group sizes were attained by mixed groups. The peak of rutting activity in January was marked by a maximum of animals conforming to mixed breeding herds. Temporally limited peak aggregations of up to 70 animals occurred on the Kanha Meadow during the late rut consolidation of breeding herds, stag groups and female-young groups. The months thereafter, from February onwards, brought a progressive segregation of barasingha into groups of their own sex, accordingly with an increase of the mean size of the all male and the female-young groups. Segregation between sexes reached a peak during the driest period of the year in May. The maximum for the year, of females living in female-young groups was reached in this period. After the onset of the monsoon, barasingha gathered on large meadows new sprouts of which brought about the highest mean group size (without regard to composition) of 13.1 animals. The situation

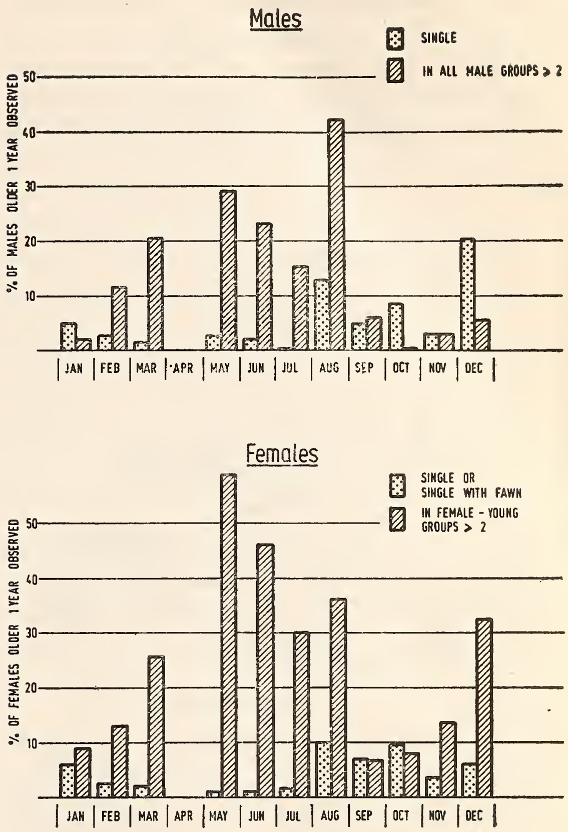

Fig. 13. Monthly segregation of barasingha into monosexual groups. From classifications 1971-73.

drastically changed by the beginning of the fawning period in August. Early monsoon aggregations had split into small groups and a high percentage of singles. Segregation of sexes reached the second peak of the year. Single females were at maximum, indicating separation for parturition. In the months thereafter, mean group sizes and segreration of sexes were at maximum. This situation remain relatively stable until November. The onset of rutting behaviour in December was again marked by segregation of sexes and the highest percentage for the year of single males.

Single individuals were observed throughout the year. The relationship between the percentage of single animals and the mean group sizes, without regard to composition, was used to analyse grouping mechanisms (Fig. 14): In-

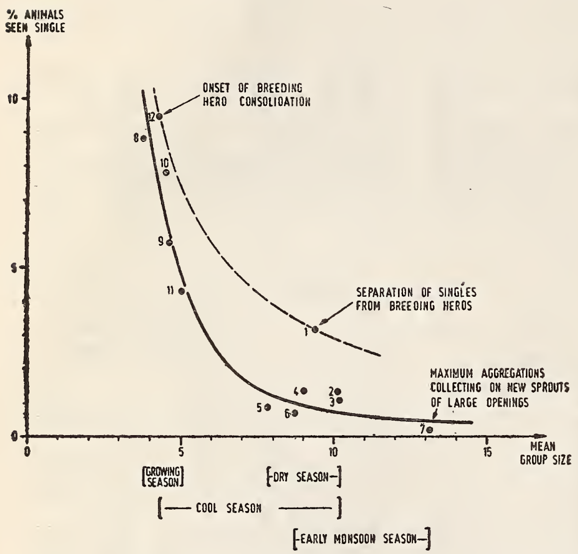

Fig. 14. Seasonal relationship between mean group size and percentage of singles. From classifications 1971-73. Note: Solitary females with fawn were classed as single animals. Numbers along the curve indicate months. Dotted line: hypothetical run for grouping during the rut.

creasing mean group size effects an exponential decrease of the probability to see single animals. Such a curve was to be expected. Yet, the positions within the coordinates and the flexure of the curve must be considered to be typical for this particular population. A sharply bent curve could signify that with increasing mean group size, single animals get readily absorbed in groups; a more linear curve would imply many animals remaining single or even actively avoiding association with other individuals. Deviation from the general relationship, finally, may be interpreted as being caused by factors different from those responsible for the general relationship. The dotted line in Fig. 14 indicates a more linear run of the curve based on the deviation of the January value. It shows the hypothetical development of grouping during the rut: December is characterized by a low mean group size of 4.3 and the highest percentage for the year of single animals. This marks the beginning of breeding herd formations. 77% of the singles are adult stags appearing on the rutting ground. By January breeding herds account for a higher mean group size of 9.4 animals/group. The percentage of animals seen single has decreased accordingly, yet remains relatively high. The deviation of the January value is caused to equal degrees by solitary low ranking stags not being tolerated in breeding herds, and solitary hinds with fawn avoiding association with rutting stags.

These singles however join the post rut aggregations in February and March. The values for these months subsequently fit again into the general relationship.

We may presume thus, that during the rut grouping is determined by different factors. The deviation may be attributed to social interactions, or more precisely—separation or exclusion of certain animal classes from the rutting procedure during the peak of the rut. I will later show that lactating females avoid association with rutting stags.

The fitting into the curve of the other monthly values, on the other hand, points to absence of this social mechanism. The conjecture is prompted that grouping is determined by environmental factors during the rest of the year.

2. Grouping in Relation to Vegetational Type

Changes of group size and composition coincided with changes in vegetational type during the cool- and dry season. The occasions where barasingha were observed within the forest areas were relatively rare. This could partially be ascribed to better visibility on open ground. Yet it appeared also that forest tracts were merely crossed to reach feeding grounds and watering places in other openings, which contributed further to the low chance of observing barasingha within the forest. Those few cases, however, where barasingha groups were located in the interior of the forest suggested, that these groups had a composition that differed as to sex and age from the usual pattern. Tab. 7 shows that groups in the forest had a higher proportion of adult males and adult nonlactating hinds, whereas hinds with fawns and yearlings were less represented. A lower percentage of female-young groups was observed in the forest, whereas the other group types were represented with higher values.

This indicates that the preference for one of the two vegetational types is not simply related to sex, but rather to age. Both sexes may leave the open areas. Females with fawns at foot and yearlings, however, tend to conform to groups remaining on open ground.

Absence of cover on open ground lowers the risk of predation by tiger. It is likely that this yields the motive for avoidance of timbered areas by female-young groups.

The mean group size was comparatively higher at 7.8 animals/group in the open type than the mean group size of 5.8 animals/group observed in the forest. The sample of barasingha seen in the forest was however too small to give this difference statistical significance. Knight (1970) found maximum group sizes of elk *(Cervus canadensis)* cow-calf groups on open grass types, suggesting similar mechanisms. According to Halder (1973) the social organisation of a species represents a phylogenetic adaptation to various factors of the habitat in which the respective species customarily lives.

TABLE 7

SEX AND AGE DISTRIBUTION AND GROUP TYPES OF BARASINGHA IN TWO VEGETATIONAL TYPES (Pooled classifications cool- plus dry season 1971-73). The distributions of sex and age classes differ significantly between open areas resp. forested areas (x^2 = 14.00; d.f. = 3; $p < 0.01$)

	Animal classes					Group types			
Observed in	Adult males	Adult females	Lactat. females	Yearling ♂ + ♁	Animals in sample	All male Groups	Feamale young groups	Mixed groups	Groups in sample
					1788				280
Open areas	31.8%	21.7%	22.6%	23.9%	100%	20.4%	35.7%	43.9%	100%
					146				30
Forest areas	38.3%	30.1%	18.5%	13.0%	100%	30.0%	20.0%	50.0%	100%
Difference of % in forest	+6.5%	+8.4%	–4.1%	–10.9%	—	+9.6%	–15.7%	+6.1%	—

3. Group Constancy

The frequent changes of group size and composition and the adaptation to different habitat types lead me to conclude, that barasingha groups have no real constancy in the social sense. This was further supported by the repeated observation of individually known barasingha in groups of different composition or as single individuals. Although a number of stags were recorded throughout the cool- and dry seasons, none was seen twice within a group of the same composition. Even breeding groups were subject to constant exchange of individuals.

The highest degree of stability in this respect was noted during monsoon when food was abundant and daily movements at minimum; 33 females and young animals that remained in the Kanha Meadow during the early monsoon season 1972 were repeatedly seen in one group but also in various sub-groups over a period of 16 days. Congregation in one group, however, appeared to be accidental and caused by coincident grazing ground, rather than by social factors. Two adult stags were known to have moved together to the northern range between June 22 and 24, 1972, where they were seen associated over a period of 28 days. Yet no larger group was known to have remained intact over such a period of time. The only stable relationship between two animals seemed to occur between a hind and her fawn, until the latter was approximately 1 year old.

Related deer species of the temperate and cold climates were found to have analogous grouping patterns: Lowe (1966) reported, that marked red deer *(Cervus elaphus)* on Rhum in Scotland may sometimes be found with one group, sometimes with another. Schloeth (1961) doubted, that red deer in the Swiss National Park would form lasting associations of any size. American elk *(Cervus canadensis)* were found to form no strong or enduring association by Craighead *et al.* (1973), Moran (1973), Knight (1970) and others. The latter proposed, that groups which tend to break up and reassemble with different combinations should more properly be called "aggregations." He further stated, that: "such aggregations owe their existence to environmental factors rather than social responses ... which however does not preclude the existence of a wide range of social responses including dominance hierarchy."

According to this, grouping in barasingha is most probably a function of environment, except perhaps for the deviation in grouping habits that was found during the rutting period.

VI Population structure and regulation

1. Population Size

A population living in a habitat with dense cover and undulating terrain may not be accurately censused to the last individual by any known method. Whereas the visibility in the Kanha Meadow is sufficient to give very accurate census results of the animals staying in the meadow at the time of censusing, forest areas cannot be scanned completely. Methods of estimation such as the "Lincoln Index" have been found to give unsatisfactory results due to different probability of observation among sex and age classes in different habitat types (Krämer 1967). Andersen (1961, 1962) checked many of the traditional methods and concluded that they normally resulted in under- rather than over estimates of the real population. The census figures presented here must therefore be taken as minimum, where there was no mean for adjustments.

a) *Method of Count*

Total census were carried out on June 10, 1971; June 27, 1972 and March 26, 1973. The selection of dates for the censuses coincided with periods when a maximum number of barasingha congregated on the Kanha Meadow, either due to grazing from green grass shoots that sprouted after the first monsoon rains in June, or due to the forming of large herds at the end of the rutting period in March. In other seasons the population is more dispersed and less visible.

Censuses were carried out from a vehicle between 0600 and 0800 hours and repeated at 1600 to 1800 hours on two consecutive days. The Kanha Meadow was covered first, leaving more isolated herds for later. A separate census was done by the Forest Department in 1971. The censuses of 1972 and 1973 were carried out in cooperation with the Forest Department Staff. In order to avoid double counting and to receive reliable information on the sex and age structure, all counting and classifying was done by the same team consisting of myself and the Divisional Forest Officer. Patrolling Forest Staff were sent out before the counting period to search all the areas in the basin of the Sulcum River. Sightings by the Forest Staff were confirmed after covering the Kanha Meadow.

The number of barasingha staying in the enclosure each year, namely 5 in June 1971, 7 in June 1972 and 8 in March 1973 were included in the census figures.

b) *Census Results* (Tab. 8).

The repetition of counts on each occasion showed that the method gave consistent results as to the number of females, yearlings and fawns.

The number of yearlings probably has the highest accuracy. Yearling classes are the most easy to locate and count due to their tendency to stay in the open areas (Tab. 7). The number of yearlings was moreover confirmed by separate counts. These were in accordance with the census results, except for the yearling male class in 1973. 11 yearling males were counted on January 27, 1973 in one herd and on February 4, 1973 in two herds instead of the 8 yearling males tallied during the census. Although I cannot exclude that the 3 missing yearling males had died between February 4, 1973 and the census of March 26, 1973, it is more likely that they were not included in the census.

From the known number of yearlings, however, conclusions can be made on the minimum number of fawns that must have been living during the census of the previous year: 12 yearlings in 1972 and 21 in 1973, indicate that in 1971 at least 12 fawns and in 1972 at least 21 fawns were present.

A similar conclusion can be made for the determination of the adult females and males: Due to mortality, the number of adults, in one sex should be less than the sum of adults and yearlings of the same sex in the previous year. If the census yields a greater number, we may conclude that the number of adults had been underestimated in the previous year. This, however, assumes that the number of yearlings was accurate. In this way, 51 counted adult females in 1973 and the known number of 6 yearling females in 1972 suggest that at least 45 adult females were present at the time of census in 1972. An analogous conclusion can be made for the minimum number of 40 adult females in 1971. Thus, even though repetitions of censuses gave consistent results for female, yearling and fawn classes, the reconstructions suggest that in all repetitions of the counts in 1971 and 1972 a part of the female and fawn classes was missed entirely.

Further adjustments had to be made for the

Table 8

Census results and estimation of real populations 1971-73

		Adult Males	Yearl. Males	Adult Females	Yearl. Females	Fawns	Total
1971	Census June 10	20	6	29	5	11	71
	Concl. from 12 yearl. 1972					+ 1	
	Concl. from 45 ad. fem. 1972			+11			
	Minimum pop. June 1971	20	6	40	5	12	83
	Forest Dept. Census 6/1971						88
	Assumptive real pop. 6/1971	30	6	40	5	12	93
1972	Census June 27	22	6	36	6	13	83
	Reports June 27						(+ 13)
	Observed July 2	+3					
	Concl. from 21 yearl. 1973					+ 8	
	Concl. from 51 ad. fem. 1973			+ 9			
	Minimum pop. June 1972	25	6	45	6	21	103
	Assumptive real pop. 6/1972	34	6	45	6	21	112
1973	Census March 26	27	8	51	10	22	118
	Observed February 4		+ 3				
	Minimum pop. March 1973	27	11	51	10	22	121
	Assumptive real pop. 3/1973	39	11	51	10	22	133

adult male class. Adult males often roam solitarily in forest areas, making this class the most difficult to comprehend from a census. Repetition of counts yielded fluctuating numbers of stags. Even maximum census figures were known not to include individually known stags that were seen again only after the census. The assumptive number of stags was thus computed from the census figures of adult sex ratio determined in Chapter VI-2. This yields the assumptive real population size and structure for the years 1971-73 shown in Table 8.

2. Sex Ratio

All of the censuses indicate a sex ratio of 1:1 among yearling classes, which points to parity among sexes at birth. 1:1 distribution among yearling sex classes is also indicated in classifications of larger groups throughout the year.

The determination of sex ratio among adults is more difficult. Substantial parts of the adult population were known to have been missed in the censuses.

The monthly totals of classifications in the southern range resulted in a fluctuating sex ratio, indicating unequal probability of observation of adults in different seasons.

Considering only the months of February and March, when large herd forming occurs at the end of the rut and the entire population congregates in the immediate vicinity of the Kanha Meadow, a sex ratio of 75.4 adult males to 100 adult females, results which give the approximate real sex ratio. No major change of the sex ratios in young animals and adults has thus occurred since 1964/65.

3. Age distribution and Antler development

Under the conditions in question an attempt of aging the adult class could only be made by judging the antler development of males.

The first indications of antlers appear in the fawn of 7 to 10 months, in the form of small bumps. Yearling stags carry spikes between approximately 7 and 20 cm length. The first set of adult antlers is acquired at the age of 2 years. Very old stags may carry set back antlers with as few as 7 tines.

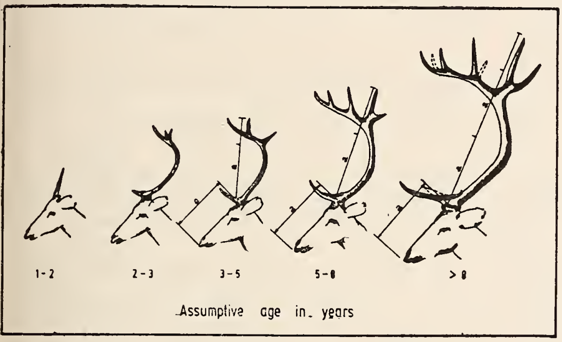

Fig. 15. Development of the barasingha antler. a—length of skull used to estimate antler length. Secondary tines dashed.

The age of stags older than 3 years is difficult to judge by antler development. The observation of both free and a few enclosed stags of known age permitted following the general development of antler stages. Data from red deer (Raesfeld 1964) supplied further information on the indication of the age (Fig. 15).

It is common knowledge that antler development is an unsatisfactory criterion for aging. Results using this criterion should thus be interpreted with care:

To class free ranging stags older than three years, I used the estimated length of the antler. This may give a somewhat more reliable indication of age than the number of antler tines. The distance from the pedicel to the most distant tip of the antler was compared with the distance between muzzle and pedicel to estimate the length of the antler (Fig. 15). This rate is indicated in Tab. 9 and allied with the assumptive age of stags.

The age structure in the male population was determined by observing and classifying stags at times during which all age classes were equally present in and around the Kanha Meadow, i.e. during and at the end of the

TABLE 9

ANTLER DEVELOPMENT AND DISTRIBUTION OF AGE CLASSES IN THE MALE POPULATION OF BARASINGHA, 1973

Age	0-1	1-2	2-3	3-5 (?)	5-8 (?)	>8	Number in sample
Estimated length of antler in muzzle-pedicel lengths	–	(spike)	(brow tine short)	1-1½	1½-2	>2	
Usual number of tines	–	(spike)	6-8	8-10	11-12	⩾12	
Adult males classified Jan. - March 1973			42	75	97	47	261
Distribution according to assumptive real population 1973	18.0%	18.0%	10.3%	18.4%	23.8%	11.5%	100%

rutting period.

Tab. 9 gives the proportion of adult male classes derived from classifications of groups made from January till March 1973. It has been adapted according to the structure of the assumptive real population of 1973 shown in Tab. 8 to give the age distribution in the total male class. Since we may presume that the sex distribution among fawns is equal 1:1, the rate of fawns recorded was halved to obtain the rate of male fawns.

The distribution is marked by a high number of young animals. 36% of all males were less than 2 years old and 46.3% were less than 3 years of age. Only 11.5% were older than approximately 8 years. The high rate of yearling stags (18.0%) points to a massive increase in the reproductive success over the year 1971. The 1973 male population was remarkably young and characteristic of an increasing population.

a) *Changes of Age Structure in the Male Class*

A comparison with the conditions in 1964/65 is informative: Schaller (1967) determined the percentage of adult stags with antlers having 6-9, 10-11, 12 and 13-15 tines from 42 adult stags tallied in the standing population of barasingha in Kanha in 1964/65. Considering the mean from 1964 and 1965 of the rates of fawns and then yearling stags, a distribution of male classes was constructed. This is compared with the distribution among the same male classes of the 1973-population, determined from 90 adult stags tallied between January and March 1973 and the assumptive real population in 1973 (Fig. 16). Even though these antler classes may not be placed in year classes, the number of antler tines is correlated with age. The 1973 population of males shows a distinctive shift towards stag classes with fewer tines i.e. younger males. The majority of males had antlers numbering 6-9 tines. The male population of 1964/65 on the other hand was marked by a majority of stags having antlers with 10-11 tines and an extremely low rate of fawns. This low rate of fawns was due to a very low reproductive success in the year 1963 and 1964 and a decrease of the population from 82 animals in 1964 to 55 animals in 1965 where, however, all fawns recorded by Schaller in 1964 became yearlings in 1965. Thus, the yearling rate of the 1964/65 population became higher than the rate of fawns. The distribution of male classes in 1964/65 was characteristic of a decreasing population, whereas the 1973 population was younger and increasing.

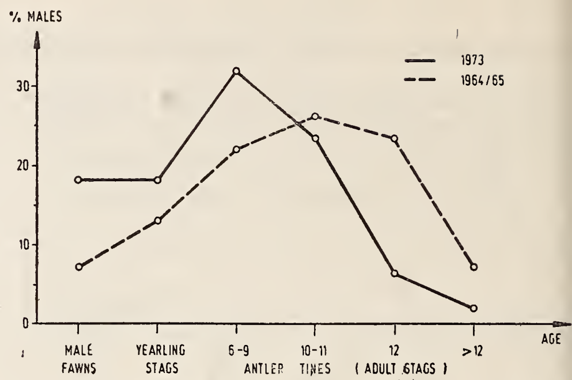

Fig. 16. Distribution of male classes in the barasingha populations of 1964-65 (adapted from Schaller 1967) and 1973 (the present study).

4. Reproduction

a) *The Breeding Period*

Rutting activity occurred between mid December and mid March. Earliest bugling by stags was heard on November 29, latest on March 29. Bugling reached highest frequencies in the second half of January, coinciding with the peak of rutting activity. Although barasingha groups were roaming over larger areas and bugling was heard all over the Kanha Meadow and its vicinity, rutting activity in groups was confined to limited areas within the Kanha Meadow in both the seasons 1971/72 and 1972/73 (see Fig. 4). A few large stags dominated the rutting area at the northern edge of the Kanha Meadow up until January 15, 1972, February 3, 1973 respectively. With the fading rutting activity of the largest stags, lower ranking stags appeared and rutting activity continued in large aggregations. Rutting of these stags continued until end of February around the Menar-Nala in the centre of the Kanha Meadow, and subsequently faded.

Schaller (1967) has already commented on the differences in the time of onset of the rut in different areas in northern India, compared to the park's population. The daily peaks of rutting activity occurred in the cool morning hours from 0630 to 0900 and between 1630 and 1830, coinciding with the peaks of grazing activity (see Fig. 6). During these hours, stags were repeatedly observed using the same 9 wallows within the rutting areas. Several copulations were witnessed in these areas between December 29 and January 29. Rutting stags seemed not to retain constant harems but confined their activity to estrus hinds. It was common to have several other stags within a breeding herd who challenged rutting stags around the periphery of the area.

Observations of rutting behaviour are in accordance with those described by Schaller (1967). Bugling, wallowing and foreplay appeared also to be in close accordance with that described for *Cervus canadensis* by Harper *et al.* (1967).

The time of peak rutting as well as the locality of the rutting areas obviously remained the same since 1964. However, the period during which rutting activity was recorded started earlier by 17 days and lasted more than a month longer. The duration of rutting activity thus seems to be related to the size of the population as suggested by Schaller (1967). Indications from Forsyth (1889) who found a longer rutting period at times when barasingha were common in Central India, support this view.

The fact that the whole population's rutting activity was confined to the same area is not consistent with Schaller's (1967) suggestion that the maximum size of a coherent breeding herd could be around 60. However, Panwar (personal comm.) noted that some rutting activity occurred in the northern meadows during the rut of 1974/75, when the population reached approximately 150 individuals.

b) *Gestation Period and Fawning*

Asdell (1964) and Kenneth (1953) reported the barasingha to be a monoestrous deer with a gestation period of 240-250 days. The peak of rutting activity in the second half of January would thus suggest that the majority of fawns would be born in the second half of September.

A total of 8 new fawns were found during the study period. The earliest of them was recorded on August 6, suggesting conception in early December, and the latest on November 4, suggesting conception in early March. A pregnant hind that lived in the enclosure in 1971 delivered shortly before September 19, when the fawn was found. All of these new fawns hid in tall grass areas and were distinctly separated from other barasingha.

There was no evidence of twins during the study period. Indications that occasionally yearlings became pregnant were lacking; this possibility may not be excluded with certainty.

c) *Reproductive Success*

One characteristic of the barasingha population described by Schaller (1967) for the years 1964/65 was the extremely low reproductive success of the population, i.e. 15 fawns/100 hinds (adult + yearling) in 1964, and 16 fawns/100 hinds in 1965 respectively. This resulted in a rate of 7% fawns of the total population for both the years 1964 and 1965.

From the censuses carried out during this study, the fawning success was calculated as 26.7 fawns/100 hinds for 1971 respectively 41.2 for 1972 and 36.1 for 1973, concerning fawns that were born the year preceeding the respective census. The census thus included the fawns that had outlasted early fawn mortality. The data suggest a great increase in reproductive success since 1965. The fawning period of 1971 appears to have been particularly productive. Similar fawn crop was indicated by Schaller (1967) for the barasingha populations of West Kheri Forest and Kaziranga, i.e. 15-19% of the total population.

Considering other monoestrous deer, these rates suggest normal production (Knight, 1970; Craighead *et al.*, 1973; and others).

d) *Breeding Potential*

During the rut it was noticed that hinds with fawn at heel tended to stay away from breeding herds, and no conceptions of lactating hinds were recorded. In one case it was observed that a fawn intervened when a rutting stag attempted to check the hind quarters of its mother.

Non lactating hinds were found to be more frequently associated with stags than lactating hinds during the rutting period. However, this tendency was noticeable also in other seasons. Tab. 10 shows the proportion of lactating and non lactating hinds in two types of groups during the rutting period. One group type was marked by intensive rutting behaviour of at least one stag and following of estrous hinds by those. The other group type had no rutting activity. Hinds with fawn at foot were significantly less frequent in groups with rutting activity. This indicates that in general only non lactating hinds conceive. Hinds with fawn at foot join the breeding groups at hours when rutting has ceased and leave them again with the onset of rutting behaviour. They may then roam along the edges of the rutting areas or join other female-young groups. This accounts for the higher proportion of adult stags in groups with rutting activity (40.6%) compared to groups without rutting activity (28.7%).

TABLE 10

FREQUENCY OF LACTATING AND NONLACTATING FEMALE BARASINGHA IN TWO TYPES OF GROUPS, DURING THE RUTTING PERIOD (DECEMBER 15 TO MARCH 14) 1971-73

Contingency table, $x^2 = 5.12$; $p < 0.05$

	Classified in groups: With rutting activity	Without rutting activity	Total
Hinds with fawn	24	198	222
Hinds without fawn	41	182	223

Trainer (1969) found the same phenomenon for Roosevelt elk *(Cervus canadensis roosevelti)* on poor range in Oregon. Phillips *et al.* (1973) noticed the use of heavy cover by moose cows with calves throughout the rut, indicating avoidance of bulls. Mitchell and Brown (1973) reported that the possession of a calf at foot at least reduced the probability of breeding in Scottish red deer living on poor quality hill land. Generally lower proportions of breeding with lactating hinds was also found for red deer on Rhum in Scotland by Lowe (1969).

Whether biennial conception in female barasingha is merely related to poor range conditions, as suggested for the above mentioned deer, could not be determined. Fecundity in monoestrous tropical deer may be lower in general, and still result in a similar fawn crop due to the absence of winter losses and generally low early fawn mortality, effected by more favourable environmental conditions.

e) *Rates of Population Increase*

As mentioned in the previous section, we must presume that only non-lactating hinds conceive. Thus, approximately half of the hinds breed each year. Under this assumption and the unlikely case that all yearling hinds would conceive, the theoretical maximum rates of increase for 1971-73 would range between 25.4% - 26.9%. Although these rates of increase estimated from sex and age data are rough calculations, they may give an estimate of increase potential as of the time the field data were collected (Kelker 1947). However, they do not account for mortality.

The actual rates of population increase calculated from Tab. 8 were: 20.4% (1971-72) and 18.8% (1972-73). The proximity of these rates to the theoretical maximum rates indicate generally low mortality during the study period. Rates of increase on this order have been obtained in the initial growth phase for *Cervus canadensis* (Murie 1951).

5. Predation

The barasingha population in Kanha is being regulated in number entirely by natural mortality. Other than for predation, no other causes of death were evident during the study period. Hence, the question arises to what extent predation may influence the abundance of the barasingha population.

Errington (1946) indicated that under certain conditions predators may cause an effective decimation of ungulate populations; and Lack (1966) suspected that cervids in particular may be reduced by predators to a level that is below the maximum density allowed, considering nutritional factors. In general, canids have been found to be effective predators of ungulates. It was stated by Pimlott *et al.* (1969) that the wolf may be determinative for the abundance of ungulate populations. The wolves on Isle Royal, Michigan were also found to limit the population of moose (*Alces alces*) to a level of about 600, which is below the carrying capacity determined by the vegetation on this island (Mech 1966). Little information on predator-prey relationships is available where cats may limit ungulate populations. Authors generally agree that the maximum density of cats is determined by intraspecific mechanisms, such as territoriality, rather than by the abundance of prey species (Lion: Schaller 1969; Mountain lion: Hornocker 1970; Cheetah: Eaton 1970).

In Kanha National Park the tiger is by far the most important cause of mortality in barasingha. There were no indications of predation by other carnivores or man during the study period. Schaller (1967) reported a massive loss of barasingha due to predation by tiger: In the year 1964 at least 16, out of the total population of 82 barasingha, were killed in the area of the Kanha Meadow alone. Such a rate of predation contrasts strongly with my observations: Not a single barasingha was killed in this area during my two-year study, in spite of the larger barasingha population that lived here. It must be concluded from Forest Department records and statements made by H. S. Panwar that the park's tiger population remained constant in numbers since 1964.[11] What then could be the cause for a lower rate of predation on barasingha in the centre of the park?

[11] The fact that the number of tigers in the area remained constant in spite of the massive increase of chital since 1964, suggests that the tiger has reached its maximum density, which according to the above mentioned authors, is determined by intraspecific mechanisms.

a) *Influence of Tiger Baiting*

Between 1964 and 1969 tigers were lured by buffalo bait in the Kanha Meadow, which is the centre of the barasingha's cool- and dry season range. Intensive baiting caused temporal aggregations of 5 and more tigers, though, tigers are normally solitary. It was quite common that a tigress with cubs remained sedentary near the baiting site over weeks. These tigers, however, frequently preyed upon free ranging animals including barasingha, which no doubt contributed to the high predation rate in the Kanha Meadow. During the period of this study, tigers lured by buffalo bait killed 3 barasingha, although the baiting site was relocated in a forest area about 1 kilometre distant from the Kanha Meadow after 1969. All the three kills were made in the direct vicinity of the baiting site.

This indicates that artificially caused aggregation or sedentariness of predators within the activity centre of a prey population may effect an increased rate of predation. From the example of 1964 it is plausible that such influences not only cause a decimation, but on the long run, eventually lead to the extermination of a strongly localized prey population.

b) *Relative availability of prey Species*

In the case of the barasingha population a decrease of the rate of predation since 1964 is, however, not totally explained by the relocation of the tiger baiting site outside the barasingha's activity centre. In chapter 1 - 3 I have commented on the massive increase of the park's chital population between 1964 and 1973. It must be expected that the proportion of chital kills increased accordingly, which possibly had an effect on the rate of predation on barasingha: Tab. 11 shows the proportion of kills of different ungulate species collected in the park area falling into Mandla District by Schaller in 1964/65 and myself in 1971-73. In most cases it was unknown when these kills were made. They may have also partly been caused by other predators than the tiger. The kills found in the two study periods were moreover not likely to be strict random samples of the total park area.

TABLE 11

NUMBER AND SPECIES OF PREDATOR KILLS COLLECTED IN THE PART OF KANHA NATIONAL PARK FALLING INTO MANDLA DISTT.; IN 1964-65 (FROM SCHALLER, 1967) AND 1971-73 (THIS STUDY)

Species killed	Period 1964-65		Period 1971-73	
	No.	%	No.	%
Chital	98	43.0	133	81.6
Barasingha	39	17.1	7	4.3
Sambar	56	24.6	9	5.5
Barking deer	1	0.4	–	0
Gaur	14	6.1	6	3.7
Black buck	2	0.9	–	0
Fourhorned antelope	–	0	2	1.2
Wild boar	10	4.4	3	1.8
Langur	6	2.6	3	1.8
Porcupine	2	0.9	–	0
Total	228	100.0	163	100.0

Nevertheless they may be used to indicate the general trend of a change in the prey ratio since 1964. Two tentative conclusions are suggested:

1) The proportion of chital kills increased, which reflects the increase of the chital population from approximately 1000 animals in 1964 (Schaller 1967) to more than 5000 in the same area in 1972.
2) The decrease of the proportion of barasingha kills is paralleled with the decrease of other species kills, particularly sambar. This suggests that the decrease of predation on barasingha is mainly due to the increased availability of chital, hence not pronouncedly due to the relocation of the tiger baiting place outside the activity centre of the barasingha.

Somewhat more reliable data on the proportion of tiger prey and its change since 1964 is found in the analysis of tiger feces collected in the central part of the Kanha Park by Schaller (1967) in 1964 and myself in 1972:

Tigers on their nightly prowl often go along roads where their feces may frequently be found. In 1972, a total of 307 tiger feces were collected on the roads of the intensive study area. Tiger feces may be distinguished from other predator feces by their large bore. The only other species which possibly could cause confusion is leopard, which were rare in this area. Practically all tiger feces had a major content of hair, apart from remains of soil, plant material, bones etc. The feces generally contained hair originating from only one prey species. Joslin (1972) elaborated a key for the identification of hair originating from a large number of domestic and wild prey animals living in Gir Forest (Gujarat). It was based on the external appearance and the cross-section of hair. This key and a reference collection of hair from different body parts of killed animals was used to distinguish between the hair of the main prey species of tiger in Kanha.

Tab. 12 lists species that may even be identified from external appearance of their hair. Unfortunately, I found no way to tell sambar and barasingha hair from each other with certainty, although Schaller (1967) made the distinction. Both species have hair of the same length and oval outline with complete but varying dull brown to reddish brown pigmentation; cross-sections are much alike. Thus, sambar and barasingha had to be classed together. Schaller's data were adapted accordingly. Tab. 12 shows a significant difference of the frequency of occurrence of different hair between the data from 1964 and those from 1972. It is marked by an increase of feces containing chital hair, and a consequent decrease of feces containing other species' hair. These results support the above conclusions made on the basis of kills found.

TABLE 12

NUMBER OF TIGER FECES CONTAINING HAIR OF DIFFERENT PREY SPECIES COLLECTED IN THE INTENSIVE STUDY AREA OF KANHA NATIONAL PARK IN 1964 (FROM SCHALLER 1967) AND 1972 (THIS STUDY). The distributions in the two samples are significantly different.

(x^2 = 50.120; d.f. = 4; $p < 0.001$)

Hair type	Period 1964		1972	
	No.	%	No.	%
Chital	175	52.2	241	78.5
Barasingha/Sambar	64	19.1	22	7.2
Langur	21	6.3	10	3.3
Wild boar	3	0.9	6	2.0
Other content	72	21.5	28	9.1
Total number of feces	335	100.0	307	100.0

Since the number of tigers in the area is likely to have remained constant, it may be concluded that the fast growing chital population has effected a reduction of the absolute number of barasingha kills. The rates of predation found in 1972 also suggest that the tiger, when naturally dispersed, preys upon the three species, chital, sambar and barasingha according to their relative abundance. Under these circumstances the tiger seems not likely to be determinative for the abundance of any one of these deer species.

VII HABITAT STRUCTURE AND ALTERATION

Although all the meadows of the intensive study area lie within the sal forest area below 610 metres a.s.l., there is an obvious difference between the grassland structures of the different meadows. All of the meadows are distinguished by a closed ground vegetation composed of grass species. A low grass cover composed mainly of short annual species abounds in the Kanha Meadow, whereas the meadows in the northern part are covered mainly with tall grass thickets interspersed with loose stands of trees and shrubs.

Some Cyperaceae species occur in moist depressions. Forbs are infrequent. As the annual precipitation of the Central Indian monsoon climate is practically confined to the months of June to September, there is a distinct growing period of all grass-like plants starting with the first heavy rains. The first species start flowering in August and by the month of October virtually all grasses are either in flower or seed. In this month identification of species poses no major problem. During the cool season and the following dry season the grasses increasingly dry up, first those in the open plain, later the more shade resistent species. Dried up grasses can not always be properly identified.

During the flowering periods of 1971 and 1972, specimens of all grass- and grass-like plant species occurring in the sal area were collected and identified.[12] Excepting some of the rarer species, a total of 81 grass- and grass-like plant species were found in the intensive study area (Appendix I).

In the intensive study area five principal kinds of grassland could be distinguished. They differed considerably in appearance, i.e. height and composition of species. Each of them was marked by the predominance of one or more characteristic species. These kinds of grassland will subsequently be referred to as "associations" and be labelled by their main character species:

Association 1 — *Dimeria connivens*
2 — *Bothriochloa odorata*
3 — *Themeda triandra*
4 — *Ischaemum indicum*
5 — *Vetiveria zizanioides*

I am aware that this is a quite arbitrary subdivision, although practically every spot in the intensive study area meadows could easily be assigned to one of these associations. I will thus first describe the appearance, identity and distribution of the five associations.

It was suspected that the difference of the vegetation structure between different parts of the intensive study area was largely determined by the impact of grazing and burning (Schaller 1967; Martin 1973). Rapid alteration of the grass cover, mainly in the Kanha Meadow, was believed to influence the food potential for herbivores. In a second step I shall therefore define the impact of grazing during the growing season, and the pattern of burning. An analysis of the distribution and diversity of trees gives some further information. This leads finally to a discussion of the habitat factors that influence the barasingha's range conditions.

1. Plot Method

In October 1972, a plot method was used to sample the larger meadows within the intensive study area. Plots were 10 square metres and circular. The plot centres were marked by pacing off compass lines in north-south and east-west direction at intervals of 200 steps (Fig. 17). The plot sites received were usually within 20 steps of the location received by

[12] Identification of the specimens was made by the Indian Forest Research Institute in Dehra Dun U.P. A preliminary survey of the grassland structure in the intensive study area has earlier been described (Martin & Huber 1973).

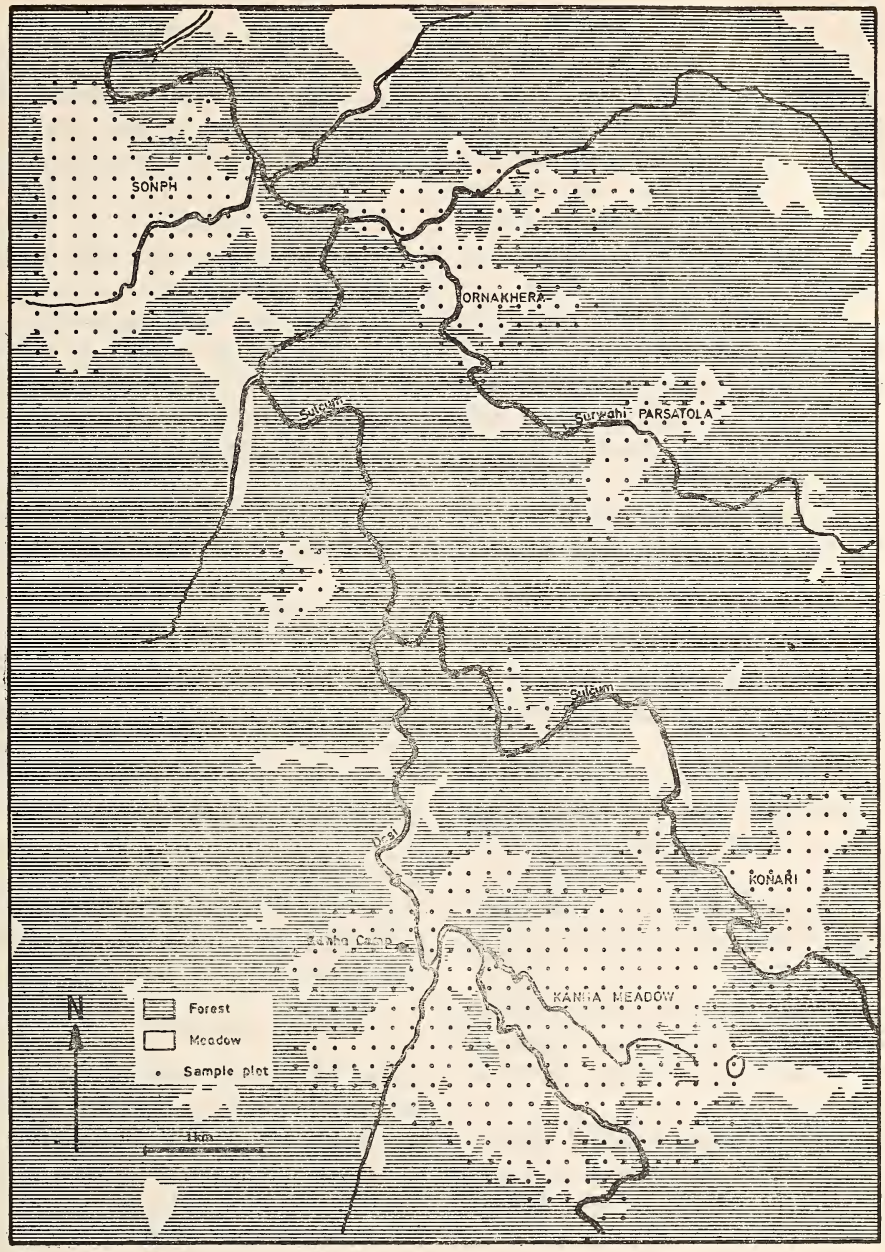

Fig. 17. Intensive study area showing distribution of sample plots for the habitat analysis.

control-pacing off from other directions. The sampling was extended into the surrounding forests by one plot on every north-south respectively east-west line. If the latter was less than 50 steps within the forest, a further plot on the line was recorded. The total number of plots was 791, of which 456 fell into meadows and 335 into forest. The number of plots that could be surveyed per hour with two helpers varied from 5 to 10, depending upon the accessibility of the terrain.

For all the plots, the plot centre was considered the centre of four quarters, with orientation given by the compass line of traverse. The species of the closest woody plant species (taller than 2 metres) to the plot centre in each of the four quarters around the centre was recorded, as well as its diameter in 5 cm intervals and its distance to the plot centre (Quarter method, see Cottam & Curtis 1956).

In the plots falling into meadow the following items were recorded:

(1) The five predominant grass- or grass-like plant species (if five present) and the degree of their abundance (rank order).

(2) The grassland association determined according to the occurrence of Key species.

(3) The principal grassland biotope, distinguished by the presence or absence of shade, respectively by "high" or "low" ground moisture:
- Dry-open—(open grassland plains)
- Moist-open—(depressions, ravines)
- Dry-shady—(forest edges, beneath loose tree stands)
- Stream-bed—(often sandy, or with rocky outcrops)

Locations were valued as "moist" if the ground still had swampy character in October i.e. roughly one month after the end of the monsoon rains, later even these may dry out. Locations were considered "shady" if the plot was found to have more than 50% shade at noon.

(4) The grass height was measured with a pole that was segmented every 5 cm. The board was put in the plot centre and read from a distance of 10 metres (Fig. 18).

(5) Grazing incidence:
low — none or one plant grazed
medium — two to ten plants grazed
high — more than 10 to all plants grazed

For plots falling in the forest, the type of undergrowth (species) was recorded.

The data collected in the 228 plots of the Kanha Meadow were used to compute a correlation matrix[13] with 35 variables. It included the correlation among the occurrence of the 24 grass species with the highest mean abundance in the Kanha Meadow; the five grassland associations; the four biotope types; the grass height and the grazing incidence. Partly, these variables were a priori interdependent. Not all correlations will thus be referred to.

2. Grassland Structure

The correlations among the occurrence of grass species helped to check and specify the distinction of the five grassland associations. Significant negative correlation ($p < 0.05$) between two species indicated that they were discretely dispersed, whereas significant positive correlation indicated that they commonly occur together. Agnew (1961) used analogous methods to show species constellation in which *Juncus effusus* ocurred in North Wales.

[13] Program BMD 02 D of the Health Science Computing Facility, UCLA.

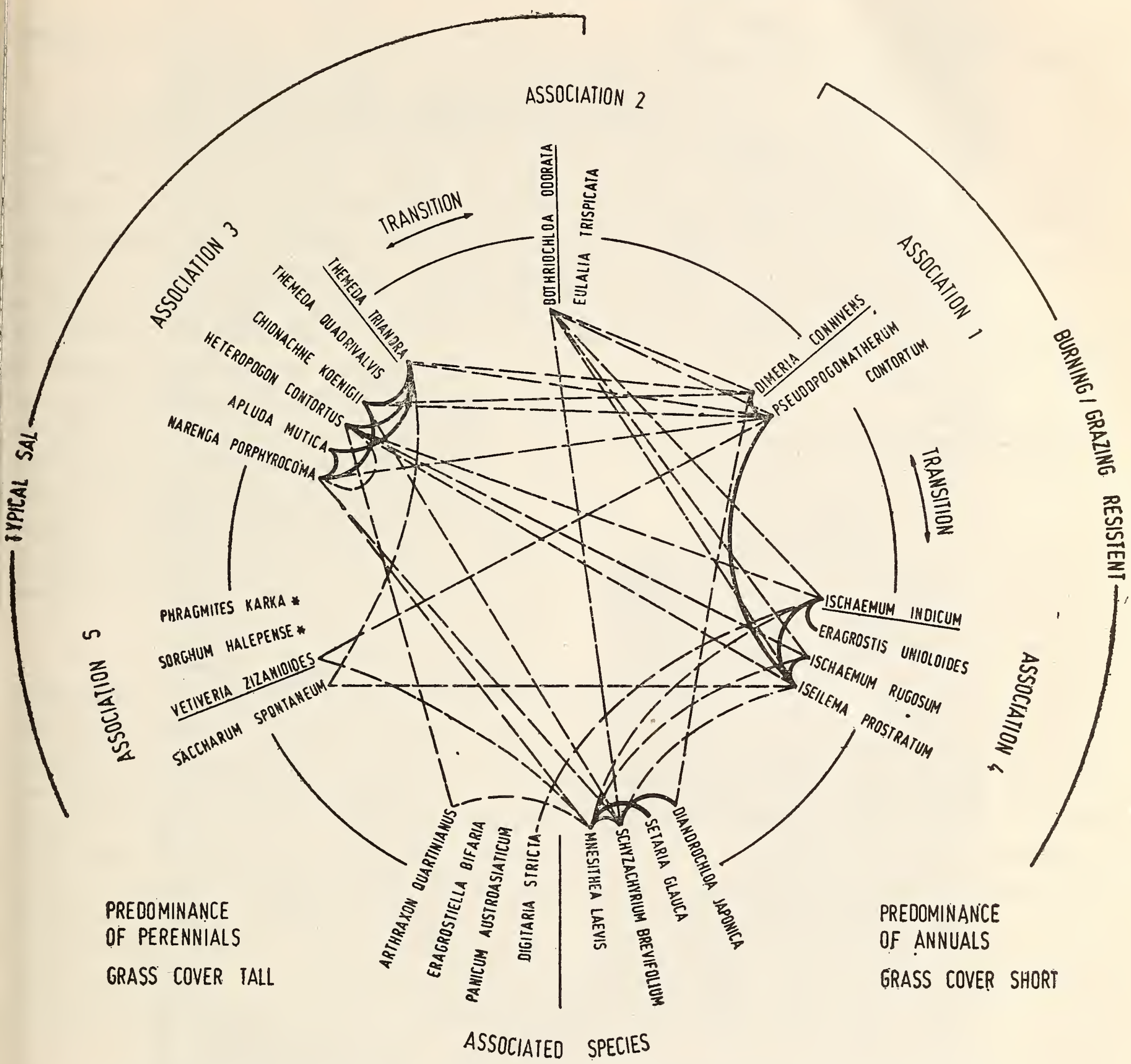

Fig. 19. Species constellation showing positive and negative correlation between the occurrence of the most common Gramineae species in the Kanha Meadow. Double line: pos. correlation ($p < 0.05$). Dashed line: neg. correlation ($p < 0.05$). Underlined species: Main character species of associations. Asterisk (*): Species not included in correlation matrix.

The correlation matrix largely confirmed the discreteness of the five associations that were distinguished initially by more subjective criteria. Fig. 19 shows the significant positive and negative correlations of the occurrence of the most common grass species.

The adaptability of different species towards different environmental conditions varies greatly. Practically every species favours one out of the four biotope types: Dry-open, moist-open, dry-shady and stream-bed. The number of species, however, that are confined exclusively to one of them are few. The associations, marked by the occurrence of character species, have themselves different forms of adaptability to the biotope types. Yet, no association is so adaptable as to occur in all the biotope types (Tab. 13).

TABLE 13

OCCURRENCE OF GRASSLAND ASSOCIATIONS IN DIFFERENT BIOTOPE TYPES OF THE GRASSLAND IN THE INTENSIVE STUDY AREA

× = main occurrence: (×) = secondary occurrence

Association	Biotope types			
	Dry open	Moist open	Dry shady	Stream bed
1 *Dimeria connivens*	x	(x)		
2 *Bothriochloa odorata*	(x)	(x)	x	
3 *Themeda triandra*	x	(x)	x	
4 *Ischaemum indicum*		x		
5 *Vetiveria zizanioides*				x

Figs. 20 and 21 show the distribution and appearance of the grassland associations.

Association 1 *(Dimeria connivens)*:

It is most common in the Kanha Meadow where it occurs in the dry-open and moist-open biotope types. It is rarely found in other meadows. *Dimeria connivens* is a short, annual species that forms typical lawns. Its wide distribution in the Kanha Meadow gives this meadow the appearance of an English park. A very typical associate is *Pseudopogonatherum contortum*, a slightly taller annual often mixed to equal abundance with *Dimeria connivens*. Both species wither relatively soon after flowering by the end of December. The terrain belonging to this association appears very bare after burning, as these annuals completely burn up. Associated species are *Digitaria stricta*, *Iseilema prostratum*, and on moist ground *Fimbristylis* spp.

Association 2 *(Bothriochloa odorata)*:

It is common in the Kanha Meadow where it predominates in the dry-shady and more rarely in the open biotope types. The character species is often associated with *Eulalia trispicata*, *Diandrochloa japonica* and numerous other species. The association is very variable in its height and composition. No significant positive correlation between the occurrence of the character species and associated species was detected. However, most of the more typical associated species are perennials that reach heights of 1.5 metres or more, which clearly demark this association from association 1. Locally the character species is lacking and the association shows a transition to association 3.

Association 3 *(Themeda triandra)*:

This association is infrequent in the Kanha Meadow but extremely common in other meadows, particularly Ornakhera and Parsatola, where it occurs mainly in the dry-open and dry-shady biotope type. *Themeda triandra* locally forms almost single species stands. The grass cover reaches heights of up to 2 metres. Some common associated species are *Apluda mutica*, *Heteropogon contortus*, and *Sorghum nitidum*. Particularly in Sonph *Themeda triandra* is replaced locally on open ground by the shorter *Themeda quadrivalvis*.

Association 4 *(Ischaemum indicum)*:

This association favours the moist open biotope type. It appears in terrain heavily utilized by cattle, or scattered on former rice cultivations as they are found in the Sonph Meadow. The association is poor. Further character species are *Eragrostis unioloides* and *Ischaemum rugosum*. In the former ricefields of Sonph, *Manisuris clarkei* is character-

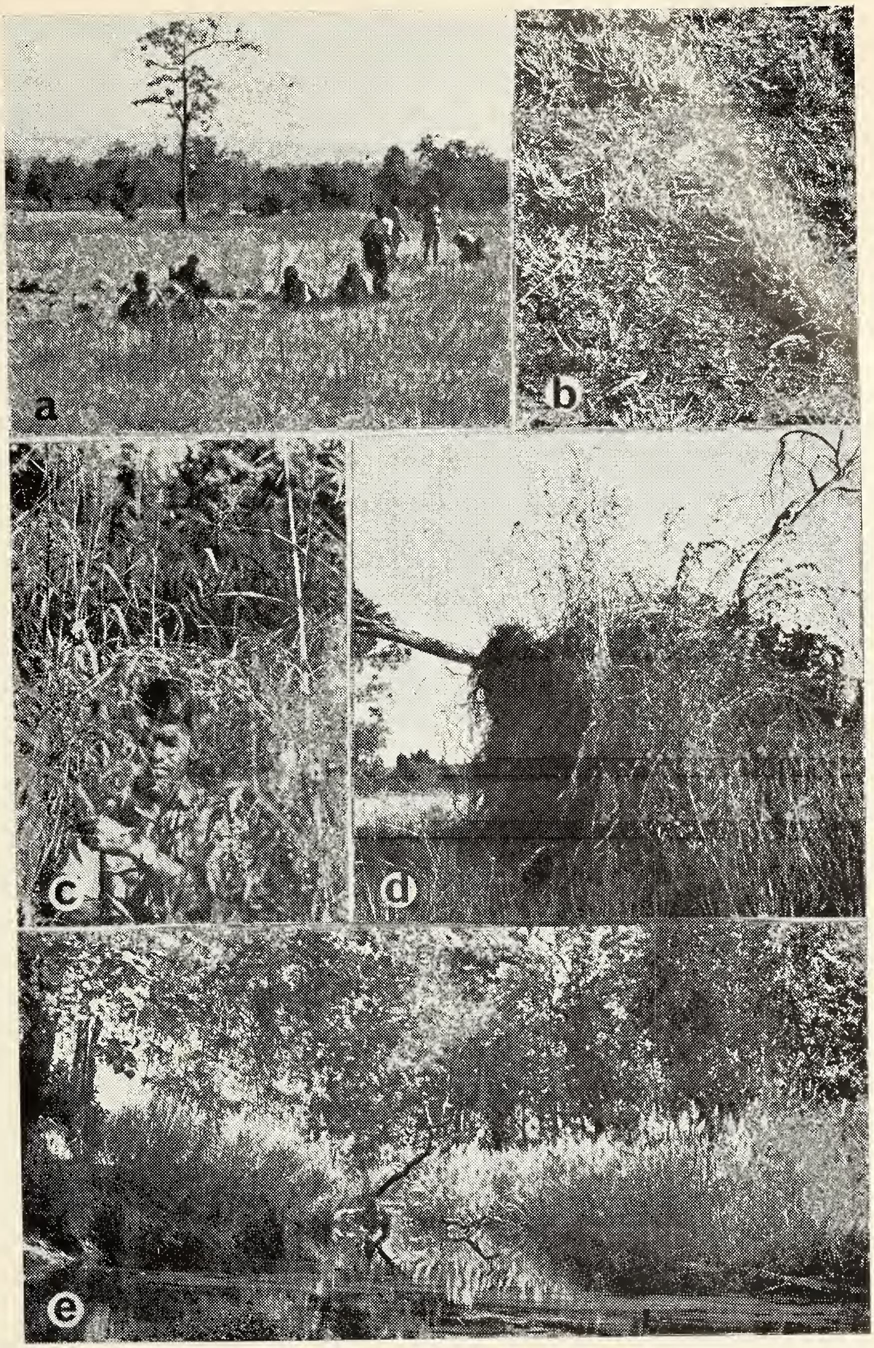

Fig. 21. Appearance of grassland in the sal forest area of Kanha N.P. (a) Short *Dimeria connivens* association in the Kanha Meadow. (b) Heavily grazed perennials in burnt area of the Kanha Meadow in May. (c) Tall *Themeda triandra* association in the Konari Meadow. (d) *Themeda triandra* persisting on a root-stock in the Kanha Meadow, where it remains unaffected by fire and grazing. (e) Stands of *Saccharum spontaneum* in a sandy stream bed belonging to the *Vetiveria zizanioides* association. The appearance of *Bothriochloa odorata* grassland is shown in Fig. 18.

Fig. 23. (a) *Moghania congesta* undergrowth in a loose patch of sal forest. (b) Mixed forest area with bamboos (*Dendrocalamus strictus*).

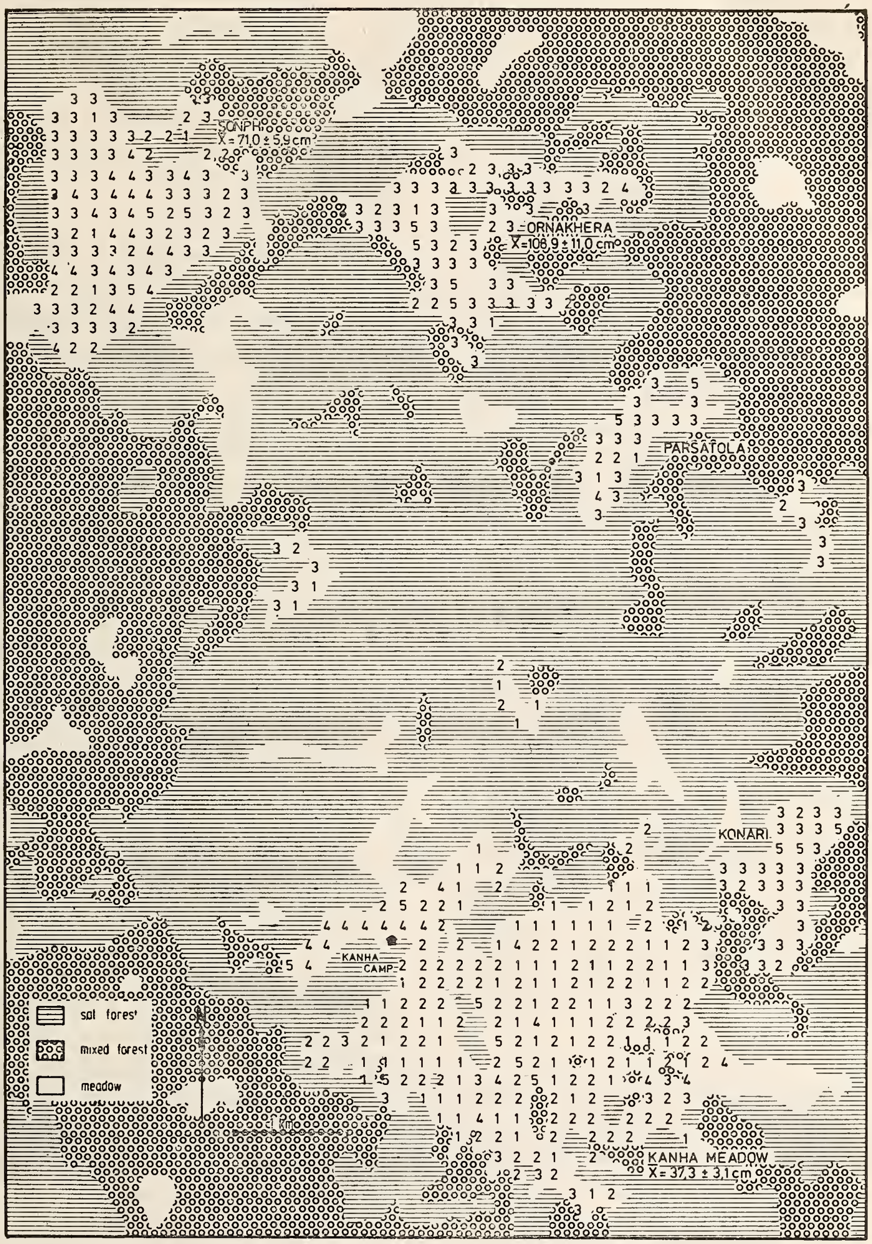

Fig. 20. Vegetation of the intensive study area. Numbers indicate grassland associations in the sample plots: 1—*Dimeria connivens;* 2—*Bothriochloa odorata;* 3—*Themeda triandra;* 4— *Ischaemum indicum;* 5—*Vetiveria zizanioides.* × = means grass height of respective meadows with 95% confidence intervals for the mean.

istically found in the association. It is possibly derived from other associations, as it is composed of species that are otherwise not very common but resistent to heavy grazing. The association shows transition to association 1.

Association 5 *(Vetiveria zizanioides)*:

This association is characteristic for the terrain along sandy and rocky river beds (Biotope type: stream-bed). It forms a belt from 5 to 15 metres wide along rivers, the width depending upon the slopes of the bed. It can, however, occur with more extensive, extremely tall grass thickets in locations that are partly flooded during monsoon. *Sorghum halepense* and *Phragmites karka* two very tall species, as well as *Bothriochloa kuntzeana* are characteristic. *Saccharum spontaneum* forms dense thickets, which remains green even in the dry season. *Phragmites karka* and *Sorghum halepense,* the tallest species, have in the past years disappeared from the Kanha Meadow, where the association remains recognisable by the dense stands of *Saccharum spontaneum*.

The fidelity of different character species to the respective association can vary greatly. Whereas the character species belonging to association 5 have a very strict fidelity, that is, they are confined exclusively to that particular association, the character species of the association 1 and 2 have a lower fidelity to their association.

Some species are very tolerant, such as *Saccharum spontaneum*. This species may occur in every association or biotope type. Yet, it abounds only along stream beds, where it forms monotypic stands. Other species are confined to one of the biotope types rather than to any particular association: Cyperaceae species occur only on moist ground. *Mnesithea laevis* occurs practically everywhere in the dry open biotope type of the Kanha Meadow. This species is often the only medium sized perennial species that grows in the short *Dimeria connivens* association.

Narenga prophyrocoma, a very tall species, was considered to be indicative for sal-forest ground by Bor (1958).

Grass height:

The unequal distribution of the grassland associations among the meadows of the intensive study area cause drastic differences in the mean grass cover height of these meadows (Fig. 20). The predominance of the short *Dimeria connivens* association in the Kanha Meadow is reproduced in the low mean grass height of 37.3 ± 3.1 cm.[14] In Sonph, where this association is practically absent, the grass reaches a mean height of 71.0 ± 5.9 cm, whereas in Ornakhera the mean height is 108.9 ± 11.0 cm. This is caused by the predominance of the tall *Themeda triandra* association.

3. Grazing Impact during the Growing Season

Grazing incidence is clearly recognizable as long as the grasses or parts of them are green. The plot method gave information on the pattern of utilization by herbivores during the growing season.

Due to grazing incidence that arose during the sampling period (October 5 to November 7), the grazing impact on the plots checked first is only to a limited extent comparable to that in the plots checked last. However, the main intention was to compare the grazing impact on the Kanha Meadow with the remaining areas. Parts of the Kanha Meadow were therefore sampled alternating with other areas.

Fig. 22 shows the distribution of grazing incidence in the intensive study area. It is

[14] 95% confidence intervals for the mean throughout. Intervals are given by $x \pm t \frac{s}{\sqrt{n}}$; at a = 5%

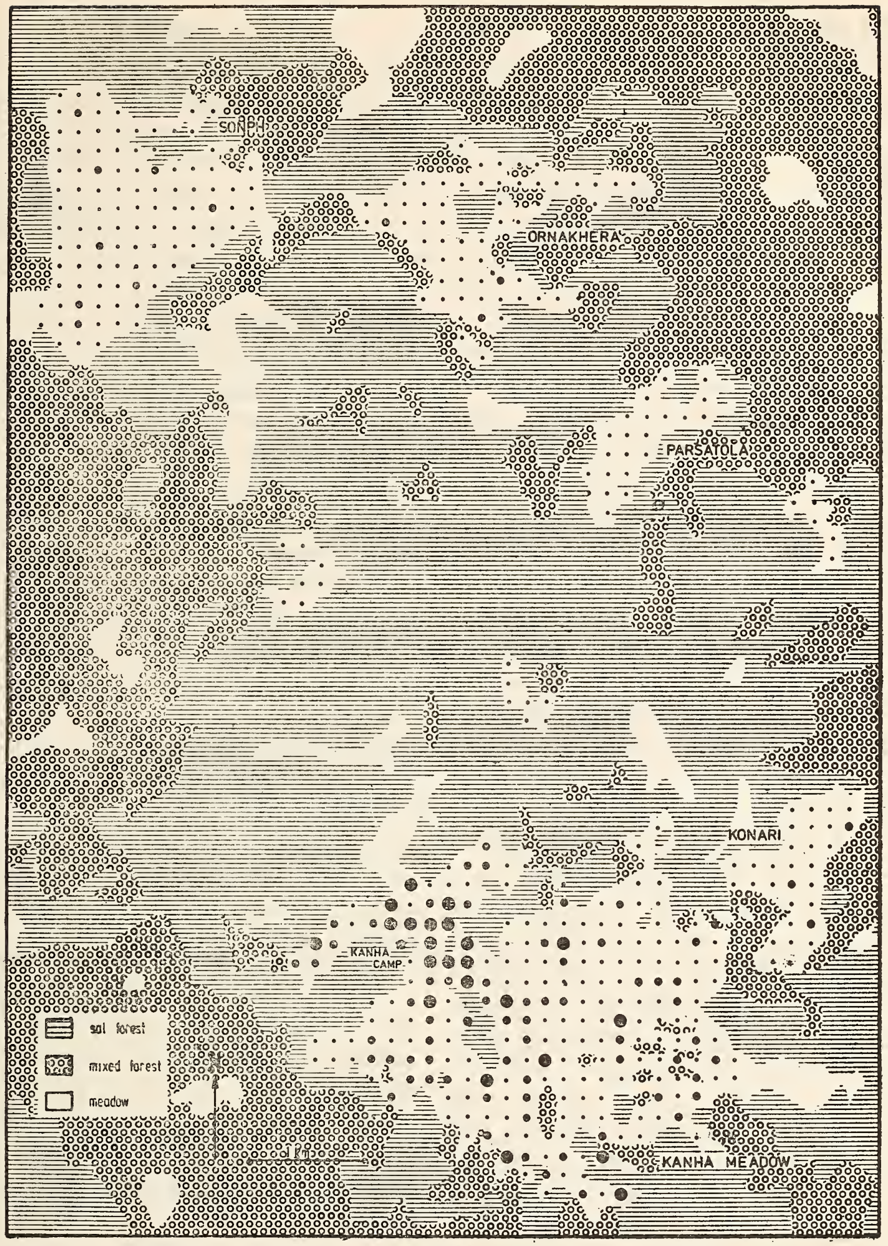

Fig. 22. Distribution of grazing incidence arising during the growing season in the intensive study area. Small dot: 0—1 plant of 10m²—plot grazed; Medium dot: 2—10 plants of 10m²—plot grazed; Large dot: 11—all plants of 10m²—plot grazed.

concentrated on the Kanha Meadow. Of the 228 plots in this meadow 38.2% had distinct signs of grazing (2 - 10 plants grazed), and 10.1% of the plots were heavily grazed (more than 10 to all plants grazed) by the end of the growing season. The grazing impact on all other meadows was relatively low and the infrequent occurrence of grazed plots did not allow correlation of grazing incidence with features of the grass cover.

In the Kanha Meadow, on the other hand, two species, *Bothriochloa odorata* and *Themeda triandra* seemed to be subject to constantly heavier grazing than other species. The correlation between grazing incidence and the occurrence of single species revealed that the pattern of grazing and avoidance is widely determined by the presence of certain species. The selective grazing pressure on *Bothriochloa odorata* was confirmed by a highly significant positive correlation coefficient (Tab. 14). Positive, but lower than subjectively expected correlation between grazing and the occurrence of *Themeda* spp. Yet the sampling intensity of the *Themeda triandra* association in the Kanha Meadow was low (only 14 plots). The correlation for these species might have resulted in higher coefficients if sampled more intensely. Significant positive correlation was however found for *Setaria glauca*. This annual occurs in various associations, often forming small "facies". Its positive correlation with grazing incidence did not correspond with the investigator's subjective impression, it may hence be an artefact. A significant negative correlation, which means avoidance, could be shown for *Pseudopogonatherum contortum* and *Schizachyrium brevifolium*. Both species, but particularly the former are common in the *Dimeria connivens* association. The species *Dimeria connivens* itself is negatively correlated, however, with a non-significant coefficient.

TABLE 14

CORRELATION OF GRAZING INCIDENCE WITH THE OCCURRENCE OF GRASS SPECIES. GRAZING INCIDENCE CAUSED BY UNIDENTIFIED HERBIVORES DURING THE GROWING SEASON

Coefficients $|r| \geqslant 0.130$ are significantly different from 0. ($p \leqslant 0.05$; d.f. = 226)

	r
Apluda mutica	0.0422
Arthraxon quartinianus	0.0734
Bothriochloa odorata	0.3241
Chionachne koenigii	0.0273
Diandrochloa japonica	–0.0489
Digitaria stricta	0.0398
Dimeria connivens	–0.1141
Eragrostiella bifaria	–0.0489
Eragrostis unioloides	0.0791
Eulalia trispicata	–0.0527
Heteropogon contortus	0.0482
Ischaemum indicum	0.0882
Ischaemum rugosum	–0.1143
Iseilema prostratum	–0.0515
Mnesithea laevis	0.0757
Narenga prophyrocoma	–0.1055
Panicum austroasiaticum	0.0096
Pseudepogonatherum contortum	–0.3026
Saccharum spontaneum	0.0253
Schizachyrium brevifolium	–0.2280
Setaria glauca	0.1611
Themeda quadrivalvis	0.0995
Themeda triandra	0.0774
Vetiveria zizanioides	–0.0489

Associations are named after single species. The correlation of associations with grazing incidence is thus a prior dependant upon the grazing incidence on single species. Hence the *Bothriochloa odorata* association showed significant positive correlation, whereas the *Dimeria connivens* association showed significant negative correlation.

4. **Burning**

As in other tropical grasslands, fires must have occurred in the park's meadows since their existence. According to Walter (1964) it is beyond all doubt that even in unpopulated tropical areas lightning can set withered vegetation afire. Natural fires, however, occur sporadically and do not necessarily frequent the same areas annually.

Brander (1923) mentioned that he had burnt the Kanha Meadow in the cool season of 1902-03 for the first time. Since then the Kanha Meadow has probably been subject to annual burning. The Forest Department used to set patches of the meadow afire from December to January until practically the entire meadow was burnt. Fires sweep the dry grass cover quickly but do not enter the forest as the vegetation in shady locations is still green in the cool season. Later during dry season occasional fires caused by villagers may also sweep the undergrowth of wide forest tracts. Living trees, however, are not affected, even when fires occur in the driest period of the year.

Fires destroy annual grasses completely, perennials survive with blackened stubble. Extensive burning practices were justified with the argument that the new sprouts, which come up sooner in the burnt areas than in unburnt ones, are for the benefit of the grazing ungulates. This shall be given consideration below.

(1) Burnt areas:

In the cool season of 1971-72 parts of the Kanha Meadow were burnt on the 19th and 23rd December, 1971. The remaining areas of the Kanha Meadow were then set afire on the 15th January 1972. Thereafter, only a few patches totalling not more than one tenth of the meadow remained unburnt. Sprouts shot up in the remaining stocks of perennials, benefitted by the short winter showers of February 2nd and 23rd. Masses of chital came to graze on the sprouts during that period. A survey made on 7th March 1972, 50 days after burning, revealed that from 145 perennial grass stocks selected at random, 40% had been grazed upon. In May grazing incidence in the stocks could not be identified anymore. Most of the sprouts had been grazed down completely, the others had again dried up (Fig. 21).

(2) Unburnt areas:

In unburnt areas green sprouts started growing later than in burnt areas. Yet, being less exposed to grazing due to the availability of dry material, they reached heights up to 40 cm by the end of May.

In 10 plots of 5 sq metres selected at random in unburnt areas of the Kanha Meadow the grass was cut 5 cm above the ground and collected on May 27, 1972. In every sample the green sprouts were separated from the dry material. Both parts of the samples were dryweighed (air dried). The mean total dryweight per sq metres surface amounted to 129.5 g (55-240 g), of which 9% (3.9-21.5%) were recently grown sprouts. Although new sprouts were inferior in number they gave the unburnt zones a flush of green even during the driest period of the year.

Thus, whereas in burnt areas the green sprouts have a short life, due either to grazing or their drying up, unburnt areas not only keep a permanent stock of dry fodder, but produce an increasing amount of green material. The situation in burnt zones turns worse during the course of the hot season until practically no fodder may be found.

A difference in the grass height between burnt and unburnt areas remains visible in the Kanha Meadow even after the growing season following the fires. Fig. 18 shows a distinctly higher grass cover on the unburnt side of a boundary where the fire was put out eleven months ago. Such differences remain visible mainly in those grassland associations that are predominantly composed of taller perennial species: namely the *Bothriochloa odorata* and *Themeda triandra* association. In the *Dimeria connivens* association, where small annuals reach high abundance, differences between burnt and unburnt areas are indistinct after the next growing season. In homogeneous areas, however, difference could be detected by the lower density of inflorescences of perennials in previously burnt areas.

In other meadows of the intensive study area the difference between burnt and unburnt areas did not persist over the next growing season. This could be ascribed to the lower grazing pressure in these areas. Perennials after burning suffer less damage from grazing, hence recover better.

5. Tree density and succession

In the intensive study area 60 woody plant species were recorded. Appendix II lists their frequency in different habitat types. A relatively small number of tree species is found regularly in the meadows, where they occur singly or in loose stands. The most important species on open ground are *Butea monosperma* and *Ziziphus jujuba,* two small trees. *Bauhinia racemosa, Cordia mixa, Cassia fistula, Diospyros melanoxylon, Bombax malabaricum* and *Ficus* spp. occur scattered in all the meadows. Along sal forest edges abound *Lagerstroemia parviflora*: tall specimens of *Shorea robusta* (sal) and *Terminalia tomentosa.* They are typical forest species and are scattered, thus point to the former occupation of these meadows by woodland.

The "Quarter method" applied in sampling the meadows allowed the comparison of the density of tree stands in different meadows (Tab. 15). The Kanha Meadow is distinguished by a low tree density. Trees are mostly more than 15 cm in stem diameter and are not typical forest species. The more northerly meadows have higher tree densities. However, the majority of trees are small or young. Typical forest species are more abundant than in the Kanha Meadow.

TABLE 15

ESTIMATION OF TREE DENSITY IN MEADOWS OF THE INTENSIVE STUDY AREA (AFTER COTTAM & CURTIS 1956). TREES AND SHRUBS TALLER 2 METRES

Meadow	Individuals per ha	Percentage of trees with less than 15 cm stem diameter	Percentage of typical forest trees (*Shorea robusta* and *Terminalia tomentosa)*
Kanha Meadow	17	44	5
Konari	36	28	12
Sonph	42	78	16
Ornakhera	90	69	30
Parsatola	76	73	3

The forest tracts adjacent to the meadows were classed into sal forest or mixed forest according to the occurrence of the *Shorea robusta* (sal). The transition between the two types is generally abrupt.

(1) In sal forest areas, the sal tree makes up 52-55% of all trees above 2 metres in height. Sal trees grow about 30 metres high and up to 1 metre in trunk diameter. The main associates of the sal tree are *Terminalia tomentosa, Syzygium cumini, Mallotus philippinensis* and *Ougeinia cojeniensis.* The predominant undergrowth is formed by a shrub- *Moghania congesta.* Bamboo (*Dendrocalamus strictus*) occurs in pockets or on slopes (Fig. 23). Around the Kanha Meadow and Konari, in the southern part of the

intensive study area, the sal forest is older than in the northern part. There appears to be no widespread regeneration. This accounts for the lower density of 181 trees above 2 metres height per ha in the southern part, compared to the surrounding areas of Parsatola (255 trees per ha), Sonph (524) and Ornakhera (613).

(2) Mixed forest occurs at the edges of the Sulcum Basin above 610 metres altitude and on hillocks in the basin. The main tree species are *Terminalia tomentosa*, two other *Terminalia* spp., *Anogeissus latifolia* and *Bauhinia* spp. The tree species occurring in mixed forest areas are largely the same as in sal areas, there is, however, no distinct predominance of one species. Bamboo (*Dendrocalamus strictus*) is found in great abundance and forms thickets up to seven metres high (Fig. 23). As in sal forest areas, the mixed forest in the southern part of the intensive study area is less dense (251 trees taller 2 meters per ha) compared to the surrounding areas of Parsatola (273), Sonph (613) and Ornakhera (524).

6. Hypothesis

In this chapter I have tried to discover factors that influence the range conditions in the barasingha habitat. The habitat analysis disclosed that the northern part of the intensive study area, which was subject to lower impact by herbivores and less rigid burning practices than the southern part, has more sal regeneration, taller grass cover, younger and denser tree stands in the meadows including more typical forest trees. Some clearings at the edges of the sal area in the north, i.e. Jamuntola or Ornakhera have been so densely overgrown with trees that locally it is difficult to draw a line between forest and meadow. There are signs of reoccupation of meadows by forest.

The Kanha Meadow, being the exponent of the southern intensive study area, is different from the other open areas by a remarkably lower grass cover, brought about by the predominance of the meagre *Dimeria connivens* association. Yet the Kanha Meadow harbours more and better perennial watering places than any other area.

It has been conjectured that the exceptional shape of this meadow is a stage of a rapid alteration of the vegetation. The influence of herbivores over the structure of vegetation was suspected earlier: In 1943 a part of the then sanctuary had been opened to shooting again, as it was feared that the heavy browsing pressure could hinder the sal regeneration. Puri (1960) states that even if sal seedlings are present, their establishment is problematic. According to him the establishment period takes 10 to 30 years. The sal seedling is evidently more threatened in a densely populated wildlife area, where there are heavy browsers. The fact that most clearings within the intensive study area have not been overrun by the sal forest again was, however, also attributed to frosts and fires. Panwar (1973) states: "Without the shelterwood, the frost plays an inhibitive role and has stopped sal from restocking these areas (the meadows). Also the late fires are responsible for maintaining the grassy condition of the meadows because they destroy seedlings of pioneer species like *Terminalia tomentosa* which could otherwise grow to provide low shade, causing decimation of grass and thereby improving conditions for sal to come up."

Bor (1958) wrote that the number of grass species which withstand annual burning is surprisingly low. Schaller (1967) supposed that *Themeda triandra* had largely been replaced by annuals or other perennials in the Kanha Meadow. And according to statements from local people the grass cover grew consistantly taller on the Kanha Meadow some ten or twenty years ago. *Themeda triandra* was common, and the rivulets were bordered by tall species such as *Sorghum halepense* and *Phragmites karka*, whereas today these species are extremely rare in the Kanha Meadow.

Thus it seems realistic to suppose a firm relationship between the present habitat structure and the impact of grazing and or burning, which are known to be effective mechanisms that alter the vegetation.

The following considerations may shed light upon the character of grassland changes and their consequences. I am aware, however, that long term exclosure experiments under controlled conditions could reveal more exact information.

Burning reduces the food availability during the dry season. Yet, the Kanha Meadow which has been burnt annually since the beginning of this century, attracts ungulates during this season, due to better water conditions. Thus, apart from the influence on the grass cover caused by burning alone, the grazing pressure on the Kanha Meadow in the period after burning remains high. Yet, in an area that has a reduced quantity of food, the impact of grazing and trampling by a given number of ungulates is disproportionately more severe, than it would be in an area with large quantities of food. After burning it is the remains of perennial species that are exposed to heavy grazing. Particularly the protein rich sprouts that are induced in perennial grass tufts by burning attract the ungulates. During the growing season the main grazing pressure is still put on a few perennial species which are important constituents of the mainly perennial associations, whereas the mainly annual associations are avoided.

Consequently many taller perennials such as *Bothriochloa odorata, Themeda triandra, Sorghum nitidum, Eulalia trispicata* often do not reach the flowering stage in the Kanha Meadow. Supressed perennials are characteristic for this meadow. It may thus be postulated that the combined effect of burning and heavy grazing is the mechanism responsible for the disappearance of these taller and more leafy perennials. Consequently, small annuals such as *Dimeria connivens, Pseudopogonatherum contortum* and *Schizachyrium brevifolium* and more resistant perennials, like *Mnesithea laevis* have gained ground. Supressed tall perennials and the predominance of the *Dimeria connivens* association affect the low mean grass height of this meadow. *Themeda* spp., which predominate in all other meadows, occur today in the Kanha Meadow merely along forest edges that are not affected by early burning, or in other places that are not subject to regular burning and heavy grazing (Fig. 21).

Ultimately we may consider the effects of burning and grazing discussed here, when joined into a model where ungulate density, food and water initially keep in a state of equilibrium (Fig. 24). Applied to the Kanha Meadow, the ungulate density is kept high due to water availability during the dry season or even promoted by the attraction caused by green sprouts after burning. In the long run the availability of the food decreases and may lead to severe overgrazing. Symptoms of overgrazing are in fact obvious in the Kanha Meadow during the dry season. However, they are mainly confined to perennials.

Spence & Angus (1971), who made a detailed study of two grassland communities in Murchison Falls National Park, distinguished precisely between the effects of burning and grazing. They have also come to the conclusion that these two factors have a combined influence on the grass cover. Pienaar (1966)

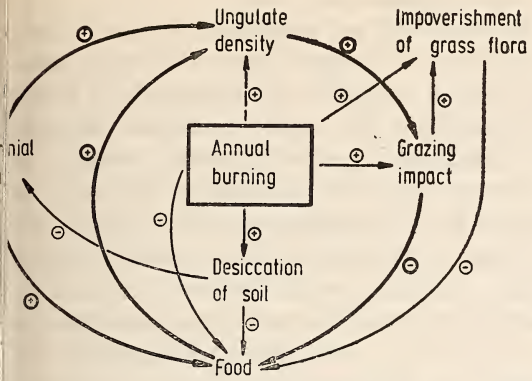

Fig. 24. A model showing the influences of annual burning on herbivore food availability.

described rotational burning practices in Kruger National Park and commented on the danger of overgrazing in the case of annual burns, particularly in the vicinity of watering places. Walter (1964) listed among disadvantages of annual burning in tropical zones:

— Loss of organic material to soils, already poor in humus.
— Unprotected surface against erosion at the beginning of the rainy season and run-off of waters with consecutive promotion of desiccation.
— Washing away of the minerals contained in the ashes.

Annual and extensive burning in densely populated grassland areas that harbour permanent watering places seems thus not to be justified. It must be replaced by rotational burning of blocks and effective protection of unburnt areas by means of fire breaks. Whether triennial rotational burning or longer intervals are the adequate measure has yet to be clarified. In the Kruger National Park areas around permanent water supplies are permanently protected from fire (Pienaar 1968). In Kanha National Park Fire protection measures were introduced in 1972. A further consequence of annual burning might be the considerably lower density of small rodents found by Claude (1973) in the Kanha Meadow, compared with the open areas of the northern intensive study area.

The Kanha Meadow is the centre of the barasingha's cool and dry season range. There is no interspecific avoidance between the major users—chital, and barasingha (mixed herds); on the contrary it was found that the same areas within meadows are subject to heavy exploitation by both species. Overgrazing must therefore affect also the barasingha's living conditions. All the more, so, because the barasingha live almost exclusively from grasses.

VIII Discussion

The original aim of this study was to collect data for an ecological understanding of the factors that determine the living conditions of the barasingha in Kanha—its dispersion and abundance.

Perhaps the most striking fact in the ecology of this species is the practically exclusive grass diet throughout the seasons. The barasingha subsist from grasses to such an extent, that it must be rated a rare event if a barasingha is observed feeding from other resources. It appeared that the barasingha's peninsular distribution was largely restricted to moist deciduous—or more precisely—to sal forests. The fact that the graminivorous barasingha was at all able to colonize these forests must be attributed to the rich grass flora typical for the undergrowth, and open space in level ground sal forests. Shifting cultivation practiced by local tribes opened up the forest, which benefitted the barasingha. The Kanha population is an example of this. The barasingha's existence in this park is based on grassy open areas formerly caused by the shifting cultivation of

Gond and Baiga tribes.

1. Adaptations to the Central Indian environment

The archaean physiographic features of the Central Indian Highlands imply a grassland type that is quite different from those in the alluvial plains of northern and northeastern India. The peninsular rivers are entirely fed by monsoon rains and are, therefore, more or less dry during the dry season. Rivers in Central India moreover eroded vertically and are characterized by the absence of riparian flats and marshes, so typical for the geologically younger Ganges—Brahmaputra river system. Other than in these northern habitats, where flood land supplies lush green grass throughout the seasons, the grassland in Central India is characterized by a more distinct seasonality and a long dry period.

Seasonality is subsequently much more pronounced in the way of life of the typical grass feeder. The barasingha has to adapt to seasonally different food—and water conditions by wandering. It should not be surprising then that the Central Indian population shows a strictly seasonal migration pattern, whereas such elements are absent in the northern populations. In Kaziranga, Assam, the barasingha remain so sedentary around perennial pools (locally: bheels) throughout the year, that Ullrich (1972) was misled to speak of "territoriality". Brander (1923) reported migratory habits of the wild buffalo in Central India, which suggests that adaptation to seasonally different food and water conditions by wandering occurred also in this species. Wild buffalo essentially require the same habitat as barasingha. It is also remarkable that the barasingha in Kanha were most sedentary during the growing period of the grass flora, when the food conditions resembled those at the foot of the Himalaya the most.

It was found that grouping habits are largely a function of environment. Low group stability reflects adaptation of individuals to locally different food and water conditions. Whereas the patchy distribution and local scarcity of resources causes very frequent break-ups of groups in Central India particularly during the dry season, barasingha in the more homogeneous, nutritious grasslands and marshes of northern and northeastern India would be expected to form more lasting associations. Although so far there have been no detailed studies on grouping in the northern populations, observation of barasingha in Kaziranga, Assam strongly support this view.

Thus, it may be concluded that the barasingha's post-tertiary colonization of Central India with its changed environmental conditions had fundamental consequences on the way of life of the species. If the disappearance of the barasingha in Central India is considered, this should be done also in view of these environmental consequences!

2. Relevance to the decline

Retrogressive trends in mammalian distribution patterns are of geologically recent origin, they indeed date back to historical times (Mani 1974). Even the present-day discontinuity in mammalian distribution between the Sub-Himalayan plains and the Peninsula is no more than a relict of a former continuous distribution (Kurup 1974). Destruction of habitat, cultivation and predation by man were the chief causes for these retrogressive trends. It also stands to reason that, where forests remained at all, the grassland species were far more exposed to the pressure of man, than the forest inhabitants. Apart from the barasingha, the Indian gazelle (*Gazella gazella*), the blackbuck (*Antilope cervicapra*), the wild buffalo (*Buba-*

lus bubalis) and the great Indian rhinoceros (*Rhinoceros unicornis*) are all more or less endangered or have reached the verge of extinction. The cheetah (*Acinonyx jubatus*) disappeared from India in 1951 (Talbot 1960).

However, none of the detrimental, man-induced influences would have effected the drastic decline of the barasingha in the area of the present Kanha National Park. If it would not have been in combination with the migratory habit that was generated by the Central Indian environmental conditions.

Before the 1964—enlargement of the park, the barasingha's annual range must have reached far beyond the northern park boundaries into ordinary shooting blocks. Villagers from settlements near the park reported barasingha raiding their crops. Even earlier, between 1943 and 1952 the area lying to the west of the Kanha-Sihora Road also had the status of a shooting block. It comprised the lower part of the Sulcum Valley which embraces the major part of the populations present home range. Until 1969, moreover, the meadows in the northern part of the home range were seriously affected by the settlement in Sonph and the accompanying activities of men and cattle. This means in other words, that until this very late date, the 6-square-kilometre Kanha Meadow was all that existed of suitable, unencroached habitat for the barasingha. Its dispersion, however, was never restricted solely to that area. The lack of group stability was likely to have promoted the dispersal of individuals from the population's home range, which incidentally led to casualties in more distant areas. It remains unknown where the pregnant hinds gave birth during these times. Fawning sites in disturbed or very distant areas might have caused high early fawn mortality, which would give an alternative explanation for the low fawn rate found by Schaller (1967), who postulated that brucellosis might be the cause.

Losses caused by all sort of human predation, emigration effected by men and cattle activities or deteriorated habitat, absence of suitable fawning areas, and perhaps detrimental habitat influences on the natality of the population, therefore were the ultimate reasons for the steady decline of the standing population in Kanha until the nineteen sixties. The species, by now, would possibly be totally absent from Central India, had the Kanha Meadow not have been under rigid protection since 1935. Diseases on the other hand were most probably insignificant. One would expect oscillation of the population numbers if disease was to play an important role in the history of the decline. Brander (1923), moreover, found the barasingha to be resistent towards cattle diseases. Even if the earlier population was taken with brucellosis, as Schaller (1967) suspected, this could not have contributed relevantly to the more or less steady decrease that has continued over dozens of years.

Concisely, the barasingha of Kanha National Park until recently were by no means free from those detrimental factors that were known to have led to the extinction of all other barasingha populations in Central India, namely habitat destruction and predation by man. Also, the habitat requirements of the species and its adaptations to the Central Indian habitat conditions in general promoted the decline.

3. Response to present conditions

During the period of this study the population was increasing. Censuses carried out by the Forest Department in 1973-75 documented a continuation of the increasing trend after the Field phase of this study was completed (Panwar, personal comm.). The reproductive success of the population was found to be well within the limits of a normal production in monoestrous deer with 26.7-41.2 fawns/100 females, tallied more than half a year after the fawning season. The population in 1973 was remarkably young with 36.0% of the males being less than 2 years, and 46.3% being less than 3 years old.

In fact the population increase seems mainly to be based on an increase of the reproduction success since the nineteen sixties and low mortality in the fawn class. Both these factors may be interpreted as a response to more favourable environmental conditions. Those were brought about by the increase in suitable habitat after the enlargement of the park in 1964 and the ban of human and cattle activities from the northern part of the populations' composite home range in 1969. Subsequent fire management, anti-poaching control, and improvement of water conditions added to the suitability of the available grassland habitat. A somewhat lower rate of predation by tiger since the outbreak of the chital population, which acted as a "buffer" prey, may have stimulated the increase. Although, tiger predation under normal conditions seems not likely to be determinative for the abundance of the deer species in Kanha.

We may thus conclude, that the population is best secured if management tends towards incorporation into the park and improvement of grassland habitat in level ground sal forest areas. This is all the more so, since habitat alterations and competitive exploitation caused by the former rigorous burning practices and the fast growing chital population impend over the park centre's Kanha Meadow.

IX Summary

The barasingha of Kanha National Park are the last in Central India. A drastic decrease of the population since the beginning of this century has led to this study. At the beginning of the study period (April 1971 through April 1973) the population numbered less than 100 animals.

The population's range during the study period included 47 square kilometres of the sal forest area below 610 metres elevation in the Sulcum River Basin. Within this area the dispersion was found to be largely restricted to grassy meadows throughout the year. The population congregated in the southern part of its annual home range around the Kanha Meadow during the cool- and dry season (December 15 to May 31). This area was found to have the best water conditions. During the monsoon rains the population dispersed along the course of the Sulcum River into the meadows of the northern part (growing season range). The Sonph Meadow was entirely undisturbed by human activities since 1969. In contrast to earlier times it was found to constitute the main activity centre during the growing season.

During the cool- and dry season the barasingha showed synchronized diurnal activity patterns. Feeding activity occurred in bouts around sunrise and sunset and travelling was more pronounced then during the rest of the year. This was ascribed to relative scarcity of food and water during this period of the year, and the search for shady resting sites.

The utilization pattern during the cool- and dry season was found to be governed by the availability of open rivulet zones and unburnt patches of grassland. During the growing season the barasingha were practically confined to tall grass areas along rivulets.

The barasingha was found to be exclusively graminivorous. The cool- and dry season food included mainly green perennial grasses e.g. *Saccharum spontaneum*, *Bothriochloa odorata* and *Themeda triandra*. During the growing

season a broader variety of species was eaten.

A modified pellet count technique revealed a correlation of barasingha- and chital (*Axis axis*) pellet frequencies which suggested common utilization of open grassland. This was further supported by the frequent observation of mixed barasingha - chital herds. The sambar (*Cervus unicolor*) on the other hand seemed to utilize the meadows differently.

Mean monthly group sizes varied between 3.7 and 13.1 animals/group. In February and March, at the end of the rutting season, the largest aggregations were observed. Except during the rut grouping seemed to be largely determined by environmental factors. Females with fawn at the foot and yearlings tended to remain in open areas more than other classes. Except for the association of the hind with her fawn in its first year the barasingha formed no lasting associations.

During the study period the population increased from an estimated 93 animals in 1971 to an estimated 133 animals in 1973. A comparison with data collected by Schaller (1967) showed, that sex ratios remained more or less constant since 1964-65. In the fawn and yearling classes it was 1:1, whereas it was about 75 males to 100 females among adults. However, the population as a whole was considerably younger during this study period compared to 1964|65. In 1973 36% of the males were less than 2 years old and 46.3% were less than 3 years old. This was due to a higher fawn production, which ranged between 26.7-41.2 fawns|100 females, and generally low mortality in the younger age classes. The rate of tiger predation on barasingha decreased since 1964|65 according to an increase of the availability of chital and the relocation of the tiger baiting site outside the barasingha's activity centre.

A vegetational analysis determined influences of grazing and burning on the appearance of the grassland in the sal forest area. The present appearance of the Kanha Meadow was widely derived from the influence of these two factors. Future management suggestions are given.

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Appendix I

Grass-like plant species of the Sulcum River basin in Kanha National Park

Species		Occurrence	Frequency Kanha Meadow	Other meadows
GRAMINEAE:				
Alloteropsis cimicina			–	–
Andropogon adsariotis			+	+
Apluda mutica	p	Ds (Do, Mo, Ws)	++	+++
Apocopis vaginata	a	Do	++	–
Aristida adscenscionis	a, p	Ds	+	+
Arthraxon quartinianus		Mo (Do, Ds)	++	++
Arundinella bengalensis			–	–
Bothriochloa glabra	p		+	+
Bothriochloa kuntzeana	p	Ws	+	+
Bothriochloa odorata	p	Do, Ds (Mo)	+++	+++
Bothriochloa pertusa		Do	++	++
Brachiaria ramosa			+	+
Capillipedium parviflorum		Ds	+	+
Chionachne koenigii	p	Mo (Do, Ds)	++	++
Chloris dolichostachya	p	Ds	++	+
Chrysopogon fulvus		Do (Ds)	++	+++

Species		Occurrence	Frequency Kanha Meadow	Frequency Other meadows
Cleistachne sorghoides	p		+	+
Coix lacryma-jobi	a, p	Mo	+	–
Cynodon dactylon	p	Do	–	++
Cymbopogon martinii			–	–
Dendrocalamus strictus		Ds	–	–
Diandrochloa japonica		Do	+++	++
Diectomis fastigiata		Do	++	–
Digitaria adscendens			–	–
Digitaria stricta		Do (Mo, Ds)	+++	++
Dimeria connivens	a	Do (Mo)	+++	++
Echinochloa colonum			–	–
Eleusine indica	a		–	–
Eragrostiella bifaria	p	Do	++	++
Eragrostis gangetica	a	Mo (Do)	++	++
Eragrostis tenuifolia	p	Do	++	++
Eragrostis unioloides	a	Mo (Do, Ds)	++	+
Eragrostis viscosa			–	–
Eulalia trispicata	p	Do (Mo, Ds)	++	++
Hackelochloa granularis			+	+
Hemarthria compressa	p	Mo	–	–
Heteropogon contortus	p	Do ((Mo, Ds)	+++	+++
Imperata cylindrica	p	Ds	–	–
Isachne globosa	p		–	–
Ischaemum indicum		Mo (Do, Ds)	++	+++
Ischaemum rugosum	a	Mo	++	++
Iseilema prostratum		Mo (Do)	++	++
Manisuris clarkei	a	Mo	++	++
Mnesithea laevis	p	Do (Mo, Ds)	+++	+++
Narenga porphyrocoma	p	Mo (Do, Ds)	++	++
Oplismenus burmannii		Ds	+	++
Oryza minuta			–	–
Panicum austroasiaticum		Ds (Do)	+++	++
Panicum montanum	p		–	–
Paspalidium flavidum			–	–
Paspalum longifolium		Mo	–	–
Pennisetum hohenackeri			–	–
Pennisetum setosum	a		–	–
Phragmites karka	p	Ws (Mo)	–	++
Pseudopogonatherum contortum	a	Mo Do	+	+
Pseudosorghum fasciculare		Ds	–	–
Rottboelia exaltata	a		–	–
Saccharum spontaneum	p	Do, Ws (Mo, Ds)	+++	+++
Sacciolepis indica		Mo (Do, Ds)	++	++
Sacciolepis myosuroides		Mo	++	–
Schizachyrium brevifolium	a	Do (Mo, Ds)	+++	+++
Sehima nervosum			–	–

Species		Occurrence	Frequency Kanha Meadow	Other meadows
Setaria glauca	a	Do (Mo, Ds)	+++	++
Setaria tomentosa			–	–
Sorghum halepense	p	Ws	–	++
Sorghum nitidum		Mo (Do, Ds)	++	+++
Sporobolus diander	p	Do	++	++
Themeda arundinaceae	p	Mo	–	–
Themeda quadrivalvis	p	Do (Ds)	++	+++
Themeda triandra	p	Mo, Ds (Do)	++	+++
Vetiveria zizanioides	p	Ws (Do, Mo)	++	++
CYPERACEAE:				
Cyperus compactus		Mo	–	–
Cyperus exaltatus		Ws (Mo)	+	++
Cyperus iria		Mo	++	+
Cyperus paniceus		Mo	+	+
Cyperus pilosus		Mo	++	+
Cyperus pumilus		Mo	+	+
Fimbristylis dichotoma		Mo	–	–
Fimbristylis quinquangularis		Mo	++	+
Fimbristylis schoenoides		Mo	++	+
Fimbristylis tetragona		Mo	++	++
Scleria levis		Mo	+	++
ERIOCAULACEAE:				
Eriocaulon oryzetorum			–	–

a = annual; p = perennial; Do = dry open; Mo = moist open; Ds = dry shady; Ws = wet, sandy riverbed; secondary occurrence in brackets.

Frequency	+++	:	in	> 10%	of all $10m^2$ plots
	++	:	in	1 – 10%	of all $10m^2$ plots
	+	:	in	0,1 – 1%	of all $10m^2$ plots
	–	:	in	< 0,1%	of all $10m^2$ plots

Appendix II

Non grass-like plant species of the Sulcum River basin in Kanha National Park

Species	Meadows	Frequency in Sal forest	Mixed forest
TREES:			
Acacia catechu	–	–	–
Adina cordifolia	–	–	–
Anogeissus latifolia	–	–	+
Azadirachta indica	–	–	–
Bauhinia malabarica	–	–	–
Bauhinia racemosa	+	+	+
Bauhinia retusa	–	+	+
Bombax malabaricum	+	–	–
Bridelia retusa	–	–	+
Butea monosperma	++	+	+
Buchanania latifolia	–	+	–
Careya arborea	+	–	–
Cassia fistula	+	+	+
Cordia myxa	+	+	+
Dalbergia paniculata	–	–	–
Diospyros melanoxylon	+	+	+
Syzygium cumini	+	+	+
Emblica officinalis	+	+	+
Ficus bengalensis	–	–	–
Ficus glaberrima	–	–	–
Ficus glomerata	–	–	–
Ficus religiosa	+	–	+
Gmelina arborea	–	–	–
Grewia sp.	–	–	+
Gardenia latifolia	–	–	–
Holarrhena antidysenterica	–	–	–
Kydia calycina	–	–	+
Lagerstroemia parviflora	++	+	++
Lannea coromandelica	+	–	+
Mallotus philippinensis	–	+	+
Madhuca indica	–	–	+
Mitragyna parviflora	–	–	–
Nyctanthes arbor tristis	–	–	–
Ougeinia cojeniensis	–	+	+
Pterocarpus marsupium	–	+	–
Randia sp.	–	–	–
Saccopetalum tomentosum	–	–	–
Shorea robusta	+	++	–
Schleichera oleosa	–	–	+
Stereospermum suaveolens	–	–	+
Sterculia urens	–	–	–

Species	Frequency in Meadows	Sal forest	Mixed forest
Terminalia arjuna	+	–	–
Terminalia belerica	–	–	–
Terminalia chebula	–	+	+
Terminalia tomentosa	++	+	++
Zizyphus jujuba	++	–	+
Zizyphus glaberrima	+	–	+
SHRUBS:			
Carissa spinarum	–	–	–
Embelia tseriamcottam	–	–	–
Moghania congesta	–	+	–
Phoenix humilis	–	–	–
Sterculia foetida	–	–	–
Wrightia tinctoria	–	–	–
Zizyphus xylopyra	–	–	–
Zizyphus nimmularia	–	–	–
CLIMBERS:			
Asparagus racemosus	–	–	–
Bauhinia vahlii	–	–	–
Butea superba	–	–	–
Millettia auriculata	–	–	–
Smilax zeylanica	–	–	–

Frequency

++ : > 10% of all woody plant individuals taller than 2 m
\+ : 1 – 10% of all woody plant individuals taller than 2 m
– : 0 – 1% of all woody plant individuals taller than 2 m

APPENDIX III

LIST OF MAMMALS IN KANHA NATIONAL PARK (EXCLUDING MICE AND BATS)

English name	Scientific name	Status
Common Langur	*Presbytis entellus*	common
Tiger	*Panthera tigris*	approx. 36 (Panwar 1972)
Leopard	*Panthera pardus*	rare
Jungle cat	*Felis chaus*	common
Common Mongoose	*Herpestes edwardsi*	common ?
Jackal	*Canis aureus*	common
Dhole (Indian Wild dog)	*Cuon alpinus*	occas. in packs up to 18
Striped Hyena	*Hyaena hyaena*	rare
Sloth Bear	*Melursus ursinus*	a few
Ratel	*Mellivora capensis*	rare
Threestriped Palm Squirrel	*Funambulus palmarum*	common
Indian Tree Shrew	*Anathana ellioti*	rare
Indian Hare	*Lepus nigricollis*	common
Indian Porcupine	*Hystrix leucura*	rare
Nilgai	*Boselaphus tragocamelus*	prob. less than 30
Fourhorned Antelope	*Tetracerus quadricornis*	common ?
Blackbuck	*Antilope cervicapra*	90 in 1972
Sambar	*Cervus unicolor*	600 in 1972
Barasingha	*Cervus duvauceli branderi*	130-140 in 1972-73
Chital	*Axis axis*	approx. 6,000-7,000 in 1972
Indian Chevrotain (Mouse Deer)	*Tragulus meminna*	present
Muntjac (Barking Deer)	*Muntiacus muntjak*	200 ?
Indian Wild boar	*Sus scrofa*	1,000 ?
Gaur (Indian Bison)	*Bos gaurus*	approx. 530 in 1972

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New Descriptions

A NEW SPECIES OF SKINK OF THE GENUS *DASIA* GRAY 1889 [REPTILIA: SCINCIDAE] FROM CAR NICOBAR ISLANDS, INDIA[1]

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(*With three text-figures*)

Introduction

This description is based on two specimens collected by the Zoological Survey of India from the Car Nicobar Island. The specimens belong to the genus *Dasia* Gray 1839, but do not agree with any of the known species of the genus and are described as a new species.

Dasia nicobarensis sp. nov.

Description: Body and head narrower; snout obtusely pointed, distance between the end of the snout and the fore limb more than one and less than one and a half the distance between axilla and groin; lower eyelid scaly; supranasals entire, narrow behind but not triangular and not in contact with one another, frontal considerably longer than fronto-parietal (nearly twice) and almost equal to the fronto-parietal and interparietal taken together; interparietal just separates parietal; prefrontal separate, its length slightly more than its breadth; fronto-nasal about as long as broad; two enlarged temporals; four large supraoculars, second the largest, first in contact with frontal and prefrontal, second in contact with frontal, prefrontal and anterior corner of the frontoparietal, 3rd touching frontal and frontoparietal, 4th frontoparietal and parietal; 8 supraciliaries, 1st longer and higher than others.

Ear opening very small, slightly larger than the nostril with one projecting lobule in the anterior border; anterior and posterior loreals both longer than high and almost equal in length; 7 supralabials, fifth longest and below the eye; 7 infralabials, 4th longest; 2 pairs of enlarged postmentals; body scales subequal, dorsal scales comparatively broader than long in relation to that of *D. olivacea* and with 3 (rarely five) prominent keels; 26 scales round the body and 38 longitudinal scales on the back (from below head shield to just above the hip joint), tail tapering to a point, slightly longer than body and head; middle row of ventral caudal scales with 9 small scales after the vent, followed by transversely enlarged scales that gradually become narrower posteriorly; the leg reaches nearly beyond the elbow. 18 lamellae beneath the fourth toe.

[1] Accepted November 1976.

Dorsal colour in preserved specimen uniformly dark brown with a pale stripe along the hind part of the flank and base of the tail. Pale bluish-white below, ventral scales almost white in centre with bluish tinge along the borders.

Dasia Gray as the genus is distinguished from *Lygosoma* Hardwicke and Gray by the presence of supranasal and from *Riopa* Gray in having well developed limbs. There are supranasal and well developed limbs in the two skinks from the Car Nicobar. A key to the species of the genus *Dasia* is given below for identification of the present species.

Measurements (in mm) and count:		*D. olivacea*			*D. nicobarensis*	
		Nicobar		Andaman		
Reg. Nos.	2311	2312	12549	13224	Paratype	Holotype
Distance between nostrils	4	4	4.5	4	3.5	3.5
Nostril to end of snout	2	2	3	3	2.5	2.5
Head length between snout to ear	21	21	22	25	19	20
Head breadth at maximum	13	15	15	18	13.5	12.5
Inner canthus to nostril	7	6	6.5	7	6	5
Palpabal fissure	6	5	5	6.5	4	6
Snout to Axilla	37	36	41	47	38	37
Axilla to groin	43	56	55	58	49	45
Snout to vent	91	103	110	124	98	96
Length of forelimb	29	32	33	38	29	31
Length of hindlimb	30	35	40	46	36	37
Vent to tip of the tail	122	X	X	X	102	121
Scales round the body	28	30	28	29	26	26
Scales down middle of back	12+25	13+26	13+25	14+25	13+25	12+26
Lamellae under fourth toe	18	18	19	20	18	18

Material examined: *Holotype*: 1 example; 217 mm; ZSI. Reg. No. 23211; 1 example; Sta. No. 19, Coconut grove, about 2 km. S.W. of Teetop Guest House, Car Nicobar, Dr. A. G. K. Menon and Party; 8-iii-1972. *Paratype*: Reg. No. 23212; 1 example; Sta. No. 6, Circuit House, Malacea, Car Nicobar, Dr. B. K. Tikader, 3-iii-1970.

Remarks: Some abnormalities are there in these two type specimens such as one side of the head of holotype the two loreals are separated by the downward extension of the prefrontal. In the paratype the tail is shorter, almost equal to the body and enlarged ventral caudal scale also begins after the 14th scale row.

Nevertheless, there was no difficulty in placing these two specimens in the genus

The new species comes in between *D. grisea* (Gray) and *D. olivacea* Gray. It agrees with *D. grisea* (scale round the body 26 to 28) in the scale count round the body which is 26 in both the specimens, but markedly differs from it in having well separated supranasals, in the distance between inner canthus and nostril being more than the length of palpable fissure, in anterior loreal being longer than high and almost equal to posterior and also in having colour differences. The present species is so similar in coloration and head shield characters to *D. olivacea* that there is a chance of confusing it with the latter, if scale count is not done. *Dasia nicobarensis* markedly differs from *olivacea* in its scale count round the body (26), in the shape of the head which is comparatively narrower, in the transversely enlarged scales below the tail beginning 9th to 14th scale row below vent (*vice*, starts just down below vent), loreal being almost equal (*vice*. anterior smaller than posterior) and also in dorsal scale keels numbering 3 to 5 (*vice*. 3-7). Dorsal coloration of *D. nicobarensis* is deep brown with a few scattered blackish dots and whitish broad pale stripe along the hind part of the flank and base of the tail but in *olivacea* though the coloration is

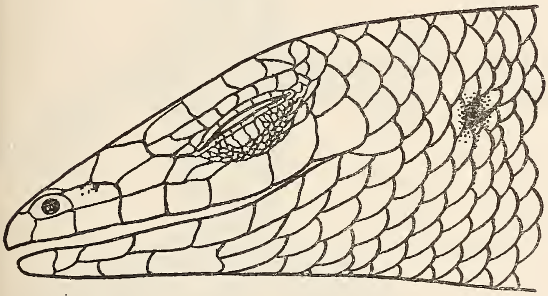
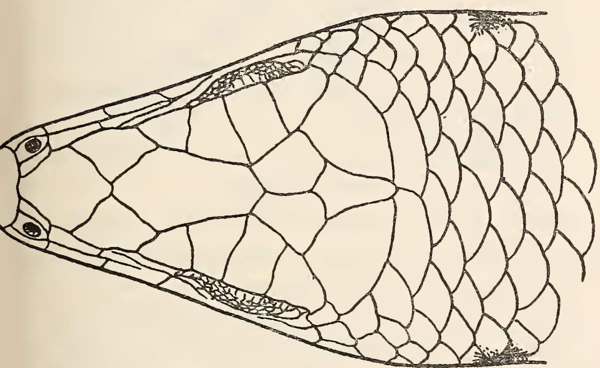
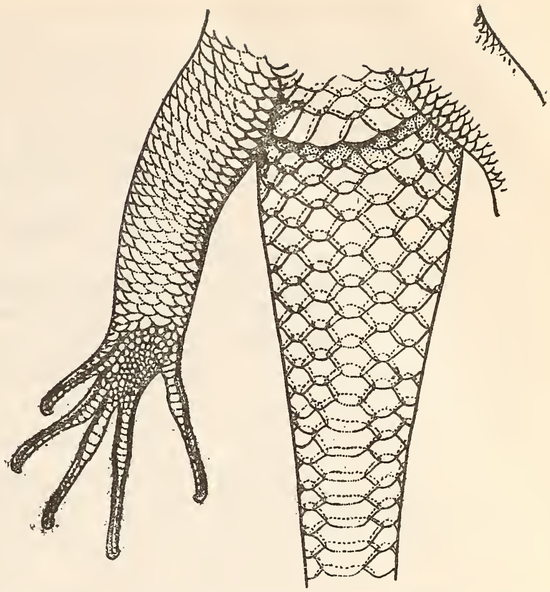


Fig. 1. *Dasia nicobarensis* sp. nov. Lateral view of head (enlarged).



Dorsal view of head (enlarged).



Ventral view, a portion of posterior region of Holotype showing one leg and a part of tail (enlarged).

variable, the general body colour is uniformly greenish-brown above or with black spots arranged in transverse series. Many of these spots bearing central spots of white may also disappear and sometimes there is only a broad pale stripe along the hind part of the flank. In this respect the new species has got some colour similarity. On the other hand in *D. grisea* the general body colour is pale grayish. The back of the head is with rounded spots or markings and dark streaks on the back and sides with an indistinct interrupted pale stripe on each side.

Distribution: The distribution of *D. grisea*, is Malay Peninsula, Indonesia, Philippines, but *D. olivacea* is more extensive as it includes Thailand and Indonesia, Peninsula south of Lat. 15° N; Andaman and Nicobar Islands.

KEY TO THE SPECIES OF *Dasia* GRAY

A_1. Back uniformly coloured or spotted; 26-30 scales round the body.

B_1. Supranasal in contact with each other, 26-28 scales round the body. *D. grisea* (Gray)

B_2. Supranasal not in contact with each other.

C_1. Preanals enlarged. *D. subcaerulea* (Boulenger)

C_2. Preanals not enlarged.

D_1. Postanal ventral caudal scales enlarged transversely after 9th to 14th scale rows; 26 scales round the body. *D. nicobarensis* n. sp.

D_2. Ventral caudal enlarged just after the postanal scales; 28-30 scales round the body. *D. olivacea* Gray

A_2. Back with broad, black, transverse bars; 24 scales round the body. *D. haliana* (Halay & Nevill)

ACKNOWLEDGEMENTS

We are thankful to the Director, Zoological Survey of India, Calcutta for facilities to study the material and to Dr. K. K. Tiwari for his helpful suggestions.

TWO NEW SPECIES OF FROGS (RANIDAE) FROM KHASI HILLS, INDIA[1]

R. S. PILLAI[2] AND S. K. CHANDA
Zoological Survey of India, Shillong 3

(*With three text-figures*)

During the study of the large collection of Amphibia at the Eastern Regional Station, Shillong, we came across two new species of Ranid frogs which are described here.

Rana danieli sp. nov.
(Fig. 1 and Table 1)

Two specimens of frogs collected from Mawphlang and one specimen from Nongkrem are being described as *Rana danieli* sp. nov. in honour of J. C. Daniel, Curator, Bombay Natural History Society who has made guiding contributions to the Amphibian fauna of India.

Colour: (In spirit) Dorsally varying from light brown to dark brown, sometimes with dark irregular patches; two dorsolateral stripes from eye to hind end, the inner edge of which is whitish to grey; lateral side darker forming a dark band which is continued forwards as a preorbital stripe upto the tip of snout through the nostril. Limbs with dark cross bars, ventral side white, throat and breast sometimes mottled.

In life the specimens had a rich brown colour with a reddish tinge.

Head: Rather strongly depressed, as long as broad; snout rounded, projecting little beyond lower jaw by about diameter of tympanum; canthus rostralis obtuse; loreal region concave; nostril a little nearer to tip of snout than to eye, distance between them about one and a half times the interorbital width. Pupil elliptically horizontal, diameter of eye a little more than interorbital width; tympanum distinct, slightly depressed, smooth, about half diameter

[1] Accepted November, 1976.

[2] *Present address*: Zoological Survey of India, Madras 4.

of eye, separated from it by a space about equal to its own diameter. Tongue moderately large, longer than broad, bifid; vomerines in oblique groups between choanae, equidistant from each other and choanae.

Forelimbs: Fairly long, about half the length from snout to vent; fingers a little swollen at tip, without intercalary bone, first longer than second, third longest, as long as snout. Subarticular tubercles prominent.

Fig. 1. *Rana danieli* sp. nov., Dorsal view.

Hindlimbs: Robust, long, 2/3 to 3/4 longer than length of head and body, tibiotarsal articulation reaching tip of snout or a little in front; heels overlapping when limbs are folded at right angles to the body; tibia $3\frac{1}{2}$ times as long as broad, half long as body length and about as long as forelimb or foot. Toes long, slightly swollen with small discs at tip, fully webbed, webbing on two distal digits of fourth toe narrow but connecting tip. Outer metatarsal completely separated, subarticular tubercles prominent; inner metatarsal tubercle oval, projecting; outer tubercle not as large as inner; no tarsal fold.

Skin faintly granulated above, warts and tubercles absent, a glandular dorsolateral fold from behind eye to near vent, the maximum width between them being 1/5 to 1/4th length from tip of snout to vent; another glandular fold (more prominent in the smallest specimen) from below eye to shoulder ending in a glandule. Lower parts smooth.

Skeleton: Upper jaw toothed, diapophyses cylindrical, not dilated; clavicles strong, horizontal, directed slightly forwards; omosternum with a bony style, forked at base; distal phalanx acute.

Measurements: See Table 1.

TABLE 1

BODY MEASUREMENTS IN MM OF THE THREE SPECIMENS OF *Rana danieli* sp. nov. FROM MAWPHLANG (Nos. 1 & 2) AND NONGKREM (No. 3)

	1	2	3
From snout to vent	60	40	61
Head	20	15	20
Width of head	20	15	19.5
Snout	10	8	10
Eye	7	6	7
Interorbital width	5	4	5
Tympanum	4	3	4
Forelimb	32	22	31
First finger	10	5	10
Second finger	8	4.5	7.5
Third finger	11	7.5	10
Fourth finger	8	6.5	9
Hind limb	98	72	96
Tibia	31	21	31
Foot	29	21	27
Third toe	20	14	18
Fourth toe	28	21	27
Fifth toe	20	15	19

Holotype: An adult frog, Reg. No. V/ERS. 804 in spirit, loc. Mawphlang forest (Alt. 1535 m), Khasi Hills, coll. S. Biswas, 1-xii-69.
Paratypes: Two adult frogs, Reg. No. V/ERS. 805 in spirit, loc. Nongkrem (Alt. 1520 m), Shillong, Khasi Hills, coll. B. Datta, 20-i-1969; and Reg. No. V/ERS. 818 in spirit, loc. Mawphlang forest, Khasi Hills, coll. S. Biswas, 1-xii-1969.
Affinities: Presence of forked omosternal style, dorsolateral glandular fold continuous with the supratympanic fold and a distinct and well developed outer metatarsal tubercle constitute a combination of key characters which is found only in *Rana malabarica* Tschudi (Boulenger 1920; Daniel 1975). The outer metatarsal tubercle which is generally absent in the subgenus *Rana* is indistinct or small when present in the Asian and Australian species. *Rana malabarica* and the present species form exceptions to this. In other characters mentioned above also *R. danieli* occupies a position close to *R. malabarica*.

However, the points of differences are as tabulated below:

Rana malabarica

1. Tympanum 2/3 to once diameter of eye.
2. Forelimbs longer, about 2/3 head-body length.
3. Hindlimbs shorter, usually less than 1.5 times head-body length, rarely 1.6.
4. Tibiotarsal articulation reaching tympanum or eye only.
5. Toes 1/3 to 1/2 webbed.
6. Outer metatarsal separated only in the distal half.

Rana danieli

1. Tympanum 1/2 diameter of eye.
2. Forelimbs shorter, 1/2 head-body length.
3. Hindlimbs longer, 1.6 to 1.8 times head-body length.
4. Tibiotarsal articulation reaching tip of snout or beyond.
5. Toes almost fully webbed.
6. Outer metatarsal separated fully.

A perusal of the points of difference enumerated above, particularly with reference to hind limbs, shows that *Rana danieli* although allied to *R. malabarica* is specifically distinct from it justifying the erection of a new species. *R. malabarica* is confined to peninsular India (Western Ghats, Orissa) while *R. danieli* is an inhabitant of Khasi Hills living at elevations around 1500 metres.

Rana mawphlangensis sp. nov.
(Figs. 2 & 3 and Table 2)

A single example of an adult female frog collected from Mawphlang on 13-vii-1973 is being described here as *Rana mawphlangensis* sp. nov.
Colour: (Fresh) Dorsally deep slate or bluish black with no spots, ventrally white or yellowish. Lower jaw, sides of belly and lower sides of limbs spotted or marbled with dark. Inner two toes whitish.
Head: Moderately depressed, as long as broad; snout pointed, a little longer than eye, projecting beyond lower jaw by a distance equal to tympanum; canthus rostralis obtuse; loreal region slightly concave. Nostril equidistant from eye and tip of snout; distance between nostrils more than $1\frac{1}{2}$ times interorbital distance. Tympanum quite distinct, more than half diameter of eye, separated from it by about 2/3rd of its own diameter. Eyes with horizontal pupil. Vomerines in fairly oblique oval groups, behind level of choanae. Lower jaw without bony protuberences in front; tongue large, filling almost the entire buccal cavity, free and bifid behind.
Forelimbs: Fairly stout; fingers long, not webbed, without intercalary ossicles, tips swollen into small oval discs. First finger a little longer than second, third longer than snout; subarticular tubercles well developed. An elongated pad present on the inner aspect of thumb.

Hindlimbs: Long, robust; tibiotarsal articulation reaching tip of snout; heels overlapping when limbs are folded at right angles to the body; tibia 4 times as long as broad, slightly less than 2 times in length from tip of snout to vent, a little shorter than forelimb and longer than foot. Toes long, tips dilated into distinct discs not smaller than that of fingers, nearly fully webbed, last two phalanges of fourth toe free, subarticular tubercles well developed, a feeble fold on fifth toe; inner metatarsal tubercle moderately prominent; no outer tubercle.

Figs. 2 & 3. *Rana mawphlangensis* sp. nov.
2. Dorsal view; 3. Buccal cavity.

Skin of anterior dorsal part smooth upto sacral region, without folds. Hind part and sides granulate and with large glands. Fold above tympanum very indistinct. Lower parts smooth.

Skeleton: As in *Rana danieli* sp. nov. except that omosternum is not forked at base.

Measurements: See Table 2.

TABLE 2

BODY MEASUREMENTS IN MM OF *Rana mawphlangensis* sp. nov. FROM MAWPHLANG (HOLOTYPE)

From snout to vent	90
Head	29
Width of head	31.5
Snout	14.5
Eye	10.5
Interorbital width	6
Tympanum	6
Forelimb	56
First finger	15
Second finger	14
Third finger	18
Fourth finger	14
Hindlimb	139.5
Tibia	51
Foot	45
Third toe	30
Fourth toe	43
Fifth toe	32

Holotype: An adult female frog, Reg. No.V/ERS. 803 in spirit, loc. stream at Mawphlang. (Alt. 1535 m), Khasi Hills, coll. R. S. Pillai, 13-vii-1973.

The single specimen was collected from a rivulet with steep banks and overhanging vegetation. The water was clear and flowed over a gravelly bottom strewn with boulders.

Affinities: The shape of the clavicles, absence of horizontal grooves on digital discs, distinct tympanum and the separated outer metatarsals indicate that we are dealing with a member of the subgenus *Rana*.

Using the key to the species of the subgenus occurring in South Asian, Papuan, Melanesian and Australian regions by Boulenger (1920) one can place it very near to *Rana doriae* Boulenger. A comparison of characters shows that the present species is closely allied to *R. doriae* which is distributed in Tenasserim, Siam, Malay Peninsula and according to Annandale (1917) Andamans. However, there is little doubt about the specific distinctness of the two. In contrast to *R. doriae* the snout in the present species is about one and half times longer than eye and projects beyond the lower jaw. The distance between nostrils is more than $1\frac{1}{2}$ times the interorbital width which is greater than that of upper eyelid. The fold across the head behind upper eyelid that is distinct in *R. doriae* is absent in *R. mawphlangensis*. So is the case with the supratympanic fold which is hardly distinguishable in the latter. Our specimen measures almost double the head-body length of *R. doriae*, the largest of Boulenger's material being a female of 50 mm. The colour pattern of the two are also quite different. Had the differences been restricted to size and colour we would have unhesitatingly assigned the present example as a race of *doriae*. But the overall differences are sufficient to justify the erection of a new species.

Rana modesta from Celebes is allied to the present species. But the short first finger, smaller tympanum, shorter hind limbs and glandular folds distinguish it clearly from *R. mawphlangensis*. The other species which show kinship are *R. grunniens*, *R. macrodon* and *R. magna*. But in all these the first finger is much longer than second and glandular folds are present.

Acknowledgements

We are thankful to the Director, Zoological Survey of India, Calcutta and to J. C. Daniel, Curator, Bombay Natural History Society for helpful criticism and suggestions.

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A NEW SPECIES OF SCORPION OF THE GENUS *SCORPIOPS* PETER (FAMILY VEJOVIDAE) FROM INDIA[1]

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(*With eleven text-figures*)

Since Pocock's classical work on Indian Scorpions (1900) no serious attention has been given to study the scorpion fauna of this country. Recently Mani (1959) and Basu (1964) have described few new species from the Indian sub-continent.

While examining the scorpion collection from various parts of India for the prepara-

[1] Accepted October 1976.

tion of the Fauna of India volume on the group we came across several new species of scorpions. The present paper contains description of a new species of scorpion of the genus *Scorpiops*. The type specimens will in due course be deposited in the National collections of the Zoological Survey of India, Calcutta.

Scorpiops deccanensis sp. nov.

General: Large scorpion with big elongated chela and the patella of pedipalp bearing sixteen to seventeen setal pores on ventral side as in text-figure 5. General coloration of entire scorpion dark-brown to black; but the carapace and first two tergites variegated with yellowish tint. Lateral ocular region dark. Pedipalp uniform brown but carinae and fingers dark. Tips of the legs pale. Caudal region dark; telson yellow and the aculeus brown. Ventral side pale yellowish brown to dark.

Measurements: Total length 55 mm. Carapace 8 mm long; Pre-abdomen 22.50 mm long; Post-abdomen (Cauda + Telson) 24.50 mm long.

Carapace: Entire surface smooth, no keels except slightly raised lateral ocular tubercles. Median ocular tubercles smooth; armed with a pair of short setae on posterior side of median eyes and provided with two yellowish bands, which extend upto the notch of anterior margin. Anterior margin armed with six setae. Three pairs of contiguous lateral eyes, posterior eyes small. Lateral margins slightly crenulated on anterior part and armed with single seta. Posterior margin smooth and nearly straight. Median eyes situated anteriorly in the ratio 1:2 as in text figure 2. Chelicera with dorsal surface of basal segment smooth with black reticulations and more dark on anterior end. Ventral side pale yellow, smooth and covered with tuft of thin short silky hairs. Fingers more dark and brownish at the tips. Immovable fingers much shorter than movable finger and armed with a double and a single teeth. Movable finger armed with three triangular sharp teeth on dorsal arm and ventral arm provided with six small triangular sharp teeth, grouped in 3, 2, 1 as in text-figure 4. Femora of pedipalp slightly longer than carapace, dorso-ventrally flat; intercarinal space granular; inner surface with five large tubercles on crenular carina. Patella shorter than femora but longer than carapace with dorsal posterior carinae smooth and anterior carina granular; carinae on exterior or outer surface smooth, inner surface armed with two strong and two weak triangular tubercles. Carinae on ventral surface slightly crenulate on inner side than on outer side and outer carina provided with a row of sixteen to seventeen setal pores and from each pore a long thin seta arises. Hand of pedipalp large, elongated and longer than patella or femora. Fingers short, nearly half the length of hand. Dentation on fingers scalloped, double dentate; scallops near the base not much deep. Nine teeth on fixed finger and eight teeth on movable finger as in text-fig. 8. Trichobothrial patterns as shown in text-figures 9, 10 and 11. Legs brownish, carinae on femora and patella crenulated on inner side and carinae on tibia crenulated on outer side. A row of five stout sharp spinules on ventral side of tarsus. Pectenes well developed and medium size, twice as long as wide. Middle lamellae separated into 6 sub-circular segments or digits as in text-figure 3. Triangular fulcra well distinguished between the adjacent teeth. Teeth long and seven in number. Basal piece simple. Lamellae and basal piece sparsely clothed with microscopic red setae. Genital operculum completely divided and a pair of conspicuous genital papillae protruding from the posterior edge of sclerites.

Pre-abdomen: All tergites smooth with a pair

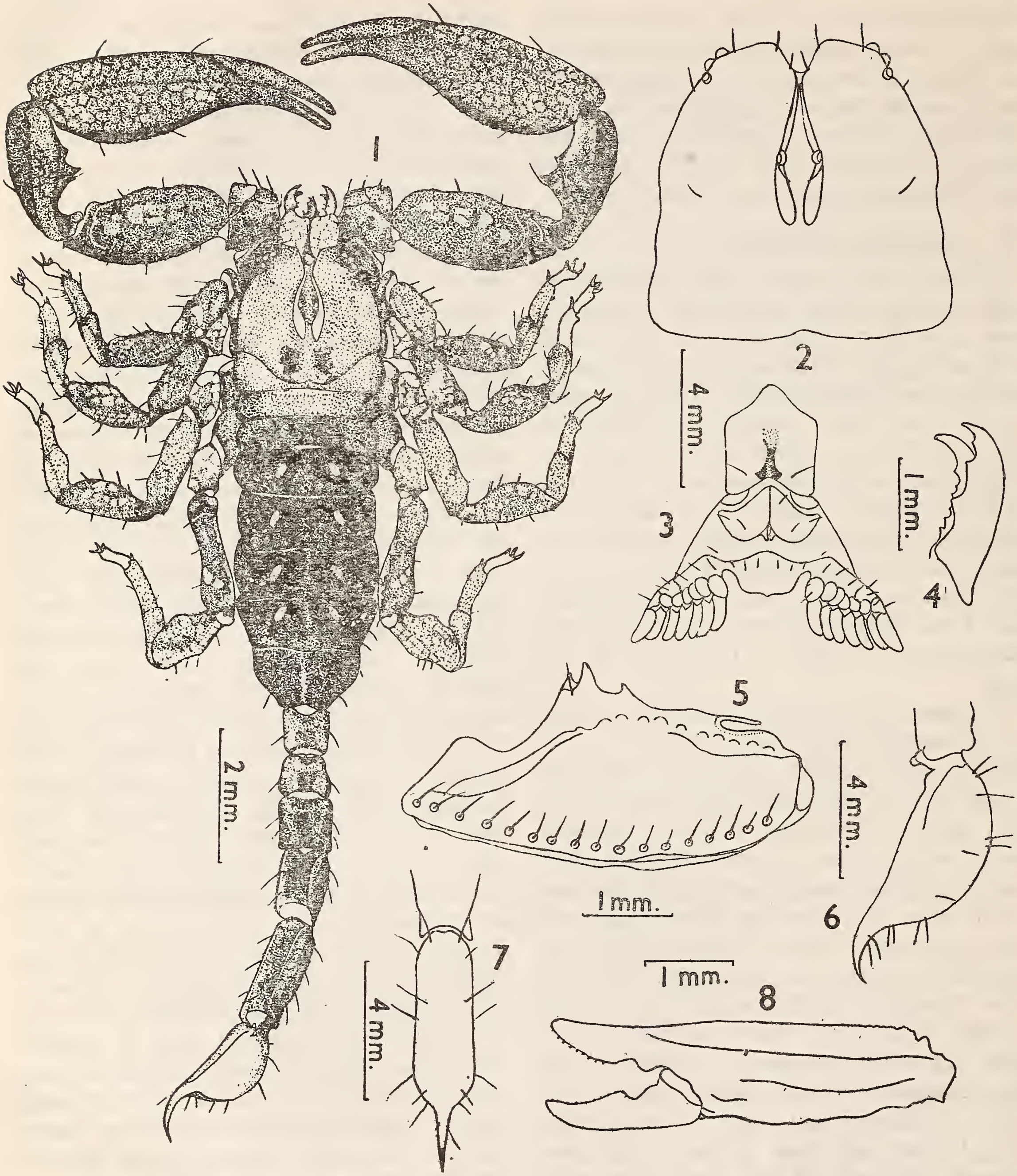
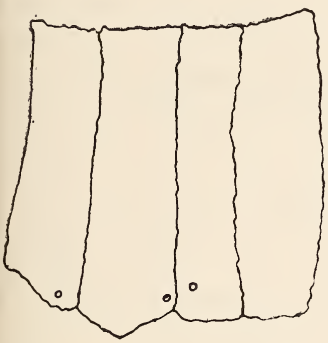


Fig. 1. Dorsal view of Male; Fig. 2. Carapace, dorsal view; Fig. 3. Sternum, Genital operculum and Pectenes; Fig. 4. Movable finger of right chelicera; Fig. 5. Ventral view of patella, showing number of setal pores; Fig. 6. Side view of telson showing number and arrangement of setae; Fig. 7. Ventral view of telson; Fig. 8. Lateral view of chela of pedipalp.

of yellow elliptical spots on middle portion except on VII tergite as in text-figure 1. Single median keel, smooth and poorly developed; no lateral keels but a pair of setae on the posterior margin of each tergite. Tergite VII with a pair of smooth lateral keels. Sternites I-IV smooth, pale but dark on lateral and posterior margins and armed with black setae. Stigmata of book lungs slit-like. Sternite V more black than rest of the sternites, smooth and without keel.

ed on II and III than the IV segments. Fifth segment as long as width of underhand; dorsal keels serrated; lateral keels weakly crenulated posteriorly; inferior lateral keels and single inferior median keel more serrated. Anal rim of this segment provided with crenulate serrated tubercles. Inter-carinal space provided with fine granules. Telson smooth and without annular ring at the base of aculeus, vesicle conspicuous yellow in colour and as long as fifth caudal segment. Setation sparse and a pair of



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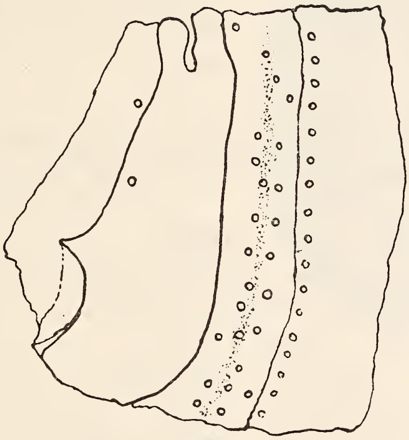

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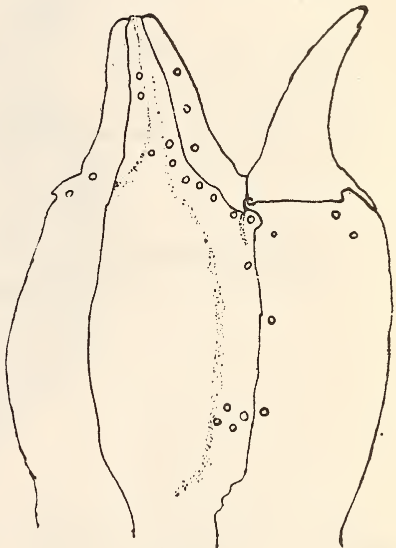

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Fig. 9. Trichobothrial patterns of male pedipalp: Internal; dorsal, external and ventral view of femora; Fig. 10. Trichobothrial patterns of male pedipalp: Internal, dorsal, external, and ventral view of patella; Fig. 11. Trichobothrial patterns of male pedipalp: Internal, dorsal, external and ventral views of manus, finger and tarsus.

Post-abdomen: Cauda twice as long as carapace. Basal segment as wide as long. Segments I-IV provided with dorsal keels slightly serrated but more spiniform on IV segment. Dorsolateral keels smooth and visible upto half of the anterior portion of IV segment. Lateral keels smooth. Inferior laterals and inferior keels weakly crenulated on I, noticeably serrat-

setae on aculeus as in text-figures 6 and 7. Aculeus less curved and its length almost half of the telson.

Type-specimens: *Holotype* male, *paratypes* two immature males, *allotypes* three immature females in spirit.

Type-locality: Sinhgarh, 16 kms South-West of Poona City, Maharashtra, India. Coll. *U. A.*

Gajbe, 25-v-1976. *Paratypes* and *allotypes* (2 ♀ ♀) collected from the above locality by *D. B. Bastawde*, 19-vi-1976. *Other locality*: 1 ♀ (immature) collected from Karla Caves, North of Poona, Maharashtra, India. Coll. *M. B. Rao*, 18-ix-1976.

Discussion: This species closely resembles *Scorpiops montanus* Karsch but can be separated from it as follows: (i) Dorsal keels on caudal segments not much spiniform posteriorly but in *S. montanus* dorsal keels of caudal segments much spiniform posteriorly. (ii) Number of setal pores on posterior ventral side of patella sixteen to seventeen in number but in *S. montanus* the number of setal pores fourteen to fifteen in number. (iii) Last pre-abdominal sternum smooth and without keels but in *S. montanus* the last pre-abdominal sternum with well developed median keels.

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DESCRIPTION OF TWO NEW SPECIES OF WOLF-SPIDER (FAMILY: LYCOSIDAE) FROM LADAKH, INDIA[1]

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(*With six text-figures*)

During an expedition led by Dr. Sálim Ali to Ladakh sponsored jointly by the Bombay Natural History Society and the World Wild Life Fund during June-August 1976, for status survey of some rare birds and mammals, Dr Biswamoy Biswas, Deputy Director, Zoological Survey of India and a member of the expedition collected a few specimens of spiders from Ladakh, Western Himalaya, which he kindly sent to me for study.

Among these specimens I came across two new species of spider belonging to the genus *Pardosa*, which are described here.

The type specimens will in due course be deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

Pardosa ladakhensis sp. nov.

General: Cephalothorax and legs pale brown with dark brown patches; abdomen greenish brown. Total length 8.50 mm. Carapace 3.70 mm long, 2.80 mm wide; abdomen 4.90 mm long, 3.40 mm wide.

Cephalothorax: Longer than wide, pointed anteriorly, clothed with hairs and pubescence. Centre of thoracic region provided with a con-

[1] Accepted November 1976.

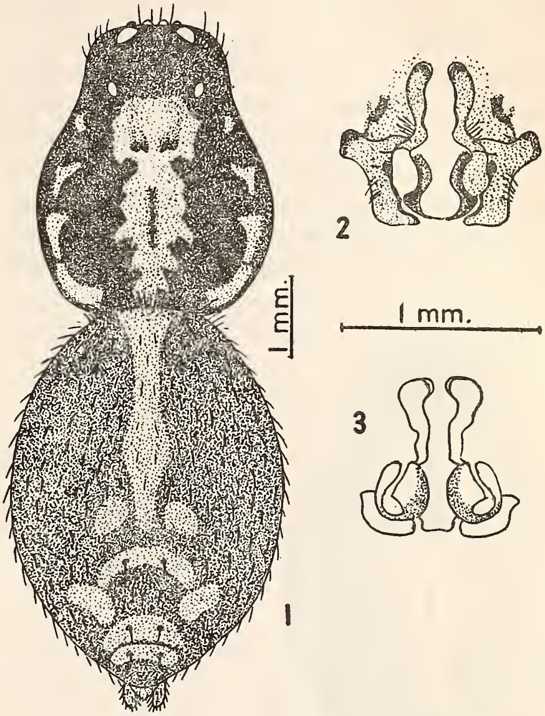
spicuous fovea. Ocular area dark brown and provided with some spine like hairs. Anterior row of eyes straight shorter than the 2nd row, medians slightly larger than the laterals. Ocular quad wider behind and narrowing in front. Eyes of the second row larger than the others. Posterior eyes (second and third row) placed at the extremities of cephalic region and posterior quadrangle much wider behind than in front as in text-figure 1. Two conspicuous dark brown patches present surrounded by a pale area just behind the third row of eyes as in text-figure 1. Sub-marginal area of thoracic region provided with irregular pale patches as in text-figure 1. Sternum black, heart-shaped, pointed behind and clothed with pubescence and some spine like hairs. Labium dark brown and wider than long. Distal end of maxillae wider and provided with scopulae. Chelicerae moderately strong, inner margin of the fang furrow provided with three unequal teeth. Legs long, clothed with spines and hairs and coxae, femora, patella and tibiae provided with conspicuous irregular greenish brown patches. Metatarsi IV longer than the tibia and patella together.

Abdomen: Longer than wide, widest behind the middle, clothed with pubescence and hairs. Anterio-mid-dorsally provided with a longitudinal pale lens shaped marking as in text-figure 1, and rest of the abdomen provided with some pale patches and spots as in text-figure 1. Ventral side with irregular reddish brown patches. Epigyne and internal genitalia as in text-figures 2 and 3.

Holotype female, *Paratype* one female in spirit.

Type-locality: Pulu (*c*. 4633 m high), Fuchu valley, Ladakh, Jammu and Kashmir, India. Coll. *Dr. Biswamoy Biswas*, 30-vii-1976.

Discussion: This species closely resembles with *Pardosa tatensis* (Tikader) but can be separated from it as follows: (i) Sternum black but in *Pardosa tatensis* sternum dark brown. (ii) Ventral side of abdomen provided with irregular reddish brown patches but in *P. tatensis* ventral side pale except few sub-lateral brown irregular patches. (iii) Epigyne and internal also structurally different.



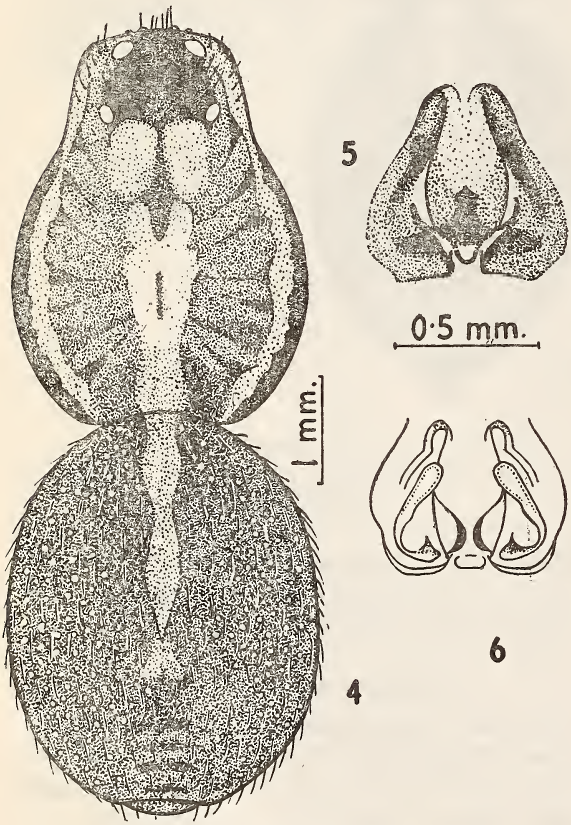
Figs. 1-3. *Pardosa ladakhensis* sp. nov.
1. Dorsal view of female, legs omitted; 2. Epigyne; 3. Internal genitalia.

Pardosa alii sp. nov.[2]

General: Cephalothorax, legs and abdomen brown. Total length 7.10 mm. Carapace 3.60 mm long, 2.70 mm wide; abdomen 3.60 mm long, 2.80 mm wide.

[2] It is with much pleasure that I name this species after the eminent Ornithologist, Dr. Sálim Ali.

Cephalothorax: Longer than wide, convex, narrowing in front, clothed with fine grey and black hairs; cephalic region slightly high. Clypeus vertical. Anterior row of eyes slightly procurved and shorter than the second row of eyes; anterior medians larger than the anterior laterals. Eyes of the second row larger than the others. Posterior quadrangle wider than long and narrower in front than behind as in text-figure 4, and black in colour. Middle of cephalothorax provided with a sharp fovea. Dark brown broad two longitudinal bands extending from bases of third row of eyes to the base of cephalothorax. Lateral edges of cephalothorax provided with longitudinal inner pale and outer dark brown bands as in text-figure 4. Sternum nearly heart-shaped, pointed behind, uniform dark brown and clothed with black pubescence. Labium wider than long. Distal end of maxillae wider and provided with scopulae. Chelicerae moderately strong and inner margin of chelicera provided with three teeth. Legs long, moderately strong, clothed with hairs and spines. Dorsal side of femora of all legs provided with two longitudinal brown bands. Metatarsi IV nearly as long as or slightly longer than the tibia and patella together.



Figs. 4-6. *Pardosa alii* sp. nov.
4. Dorsal view of female, legs omitted; 5. Epigyne; 6. Internal genitalia.

Abdomen: Slightly longer than wide, nearly same width both in front and behind. Antero-mid-dorsally provided with a lens-shaped pale marking; clothed with black hairs and pale dots. Ventral side pale. Epigyne and internal genitalia as in text-figures 5 and 6.

Holotype female, *paratype* one female, in spirit.

Type-locality: Chusul (*c.* 4328 m high) Ladakh, Jammu and Kashmir, India. Coll. *Dr. Biswamoy Biswas,* 2-vii-1976.

This species resembles *Pardosa ladakhensis* sp. nov. but differs from it as follows: (i) Anterior row of eyes slightly procurved but in *P. ladakhensis* anterior row of eyes straight. (ii) Dorsal side of femora of all legs provided with two longitndinal brown bands but in *P. ladakhensis* femora of all legs provided with irregular greenish brown patches. (iii) Epigyne and internal genitalia also structurally different.

Acknowledgements

I am thankful to Dr Biswamoy Biswas, Deputy Director, Zoological Survey of India, Calcutta, for supplying the spiders for study.

A NEW SPECIES OF ROVE BEETLE FROM INDIA (COLEOPTERA: STAPHYLINIDAE)[1,2]

T. R. KEM[3] AND SWARAJ GHAI[4]

(*With a text-figure*)

The genus *Deinopsis* Matth. is found throughout the world near marshes and streams. Only one species *Deinopsis cinnamomea* Kr. is known so far from Andamans (India). In this paper a species collected in Delhi is described as new to science. This species differs from *D. cinnamomea* in size, antennae and thoracic punctations.

Deinopsis puncturatus sp. nov.

Fig. 1

Female:

A small, shiny cinnamon-brown insect, very densely punctate and finely pubescent throughout, antennae and legs yellow. Length 1.5 mm. Head transverse. Eyes large but not prominent. Antennae slender, slightly geniculate, basal segment quite long, even longer than second and third segments together, segments fourth to tenth broader than long and eleventh longer and clavate. Thorax nearly one and half as broad as long, the side rounded, nearly retracted in front, the posterior angles rectangular, prominent. Elytra as long as broad. Wings with normal type of venation and posterior border fringed with long hairs. Intersegmental membrane with small square shaped chitinous portions in longitudinal rows.

Material studied:

Holotype: ♀ slide mounted, collected by Tilak Ram at light at I.A.R.I., New Delhi on 10th August, 1969.

Paratypes: ♀ No. tag mounted, ♀ No. on slide, 3 ♀ ♀ in tube collected from pulse field by Tilak Ram at I.A.R.I., New Delhi on 10th August, 1969. Types in National Pusa Collection, I.A.R.I., New Delhi.

ACKNOWLEDGEMENT

We are thankful to (Late) Dr. S. Pradhan, the then Head of the Division of Entomology, I.A.R.I., New Delhi for having provided necessary facilities for the research.

[1] Accepted February 1977.

[2] Forms part of the dissertation of the senior author submitted to IARI for award of M.Sc. degree.

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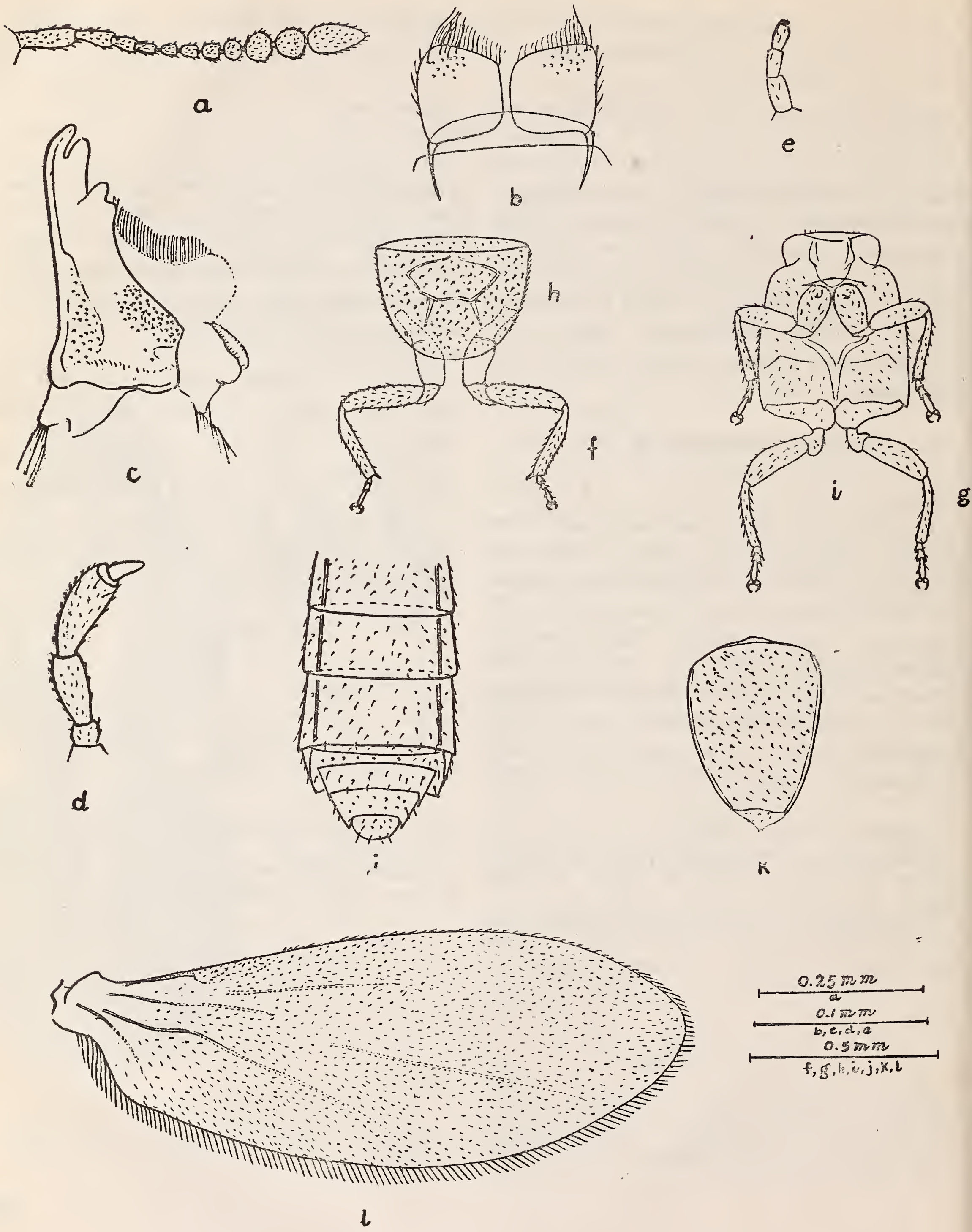

Fig. 1. *Deinopsis puncturatus* sp. nov.
a. antenna; b. labrum; c. mandible; d. maxillary palp; e. labial palp; f. foreleg; g. hind leg; h. pronotum; i. meso-metathorax; j. portion of abdomen; k. elytra; l. hind wing.

Reviews

1. FIDDLER CRABS OF THE WORLD: OCYPODIDAE: GENUS *UCA*. By Jocelyn Crane. pp. xxiv + 737 (28.5 × 22.5 cm). With 50 plates, 101 text-figures and 21 maps (4 in colour). Princeton, New Jersy, 1975. Princeton University Press. Price US $ 75.00.

This is the Magnum Opus of La Grande Dame of ucology, for if there is anybody deserving to be coined a ucologist and to be credited with having founded the science of *Uca*, it is Mrs. J. Crane-Griffin.

The actual origin of this book dates back to more than 30 years when William Beebe "hooked his assistant on fiddler crabs". Quite obviously, this hook proved strong enough to support the author and—in the long run—a reasonable armada of scientific, technical and artistic co-workers through time and tide, mud and museum around the globe. The result is truly impressive from a number of viewpoints:

1. It is the first full and thorough taxonomic review of the entire genus since 1880—and since old, hordes of systematists have pounced upon major and minor collections of *Uca* sometimes creating a veritable chaos of nomenclature; here it boils down to 62 species of *Uca* neatly grouped into 9 subgenera bearing signifying names.
2. A vast amount of morphological details has been arranged in extensive series with regard to their possible (or proven) function in feeding and fighting, combat and copulation, thus giving rise to.
3. A superb survey of the phyletic position of the taxa, depicted in dendrograms.
4. From the 21 maps showing the geographic distribution of the *Uca*-world one gets a unique panorama of the where and—in a good number of cases—why of the species and subspecies. This means:
5. An intricate combination of ecology and behaviour, and it can convincingly be said that the author achieves an ideal synthesis of morphology and ethology.

Crane's "new systematics" of the true fiddlers mentioning 7 new subgenera (out of 9) may well cause some headache to the *Uca*-novice, and an old hand will also have to rename some old acquaintances of his (e.g. *U. insignis* from the tropical eastern Pacific now to be called the subspecies *U. maracoani insignis*, *U.m.* formerly signifying Atlantic origin). Whether subgeneric names like *Boboruca* (from Greek borbor = mud), the muddy fiddlers, and *Celuca* (from Latin celer = swift), the "fast-moving fiddlers" will be long lived remains to be seen. In some cases this lumping does not seem to hold very well as far as names are concerned: the "swift fiddler" *Uca* (*Celuca*) *triangularis* "can only be called lethargic" (p. 286), and certainly *U. insignis* (now: *U. maracoani insignis*) is a "muddy fiddler", but must be grouped under the subgenus *Uca* proper. "*Amphiuca*" would suggest an especially amphibious type of living but is meant to denote "on both sides" of their equivocal position between the less advanced subgenera of the Indo-Pacific and the more highly developed centering in the Americas.

Be this as it may, Crane's opus will prove a must to the *Uca*-addict, a true bible which will remain a challenge as a source of reference, critical checking, meticulous planning and even sometimes pleasant reading: In case the interested reader happens to get into *Uca*-land wearing a white tennis hat which would disturb the fiddlers' social behaviour, "tennis hats can be tinted in coffee or tea" (p. 670). For those zoologists not venturing as far as that, Crane's monumental volume will be a classical example of evolutionary biology based on a lifelong study of an especially enchanting and rewarding type of animal.

R. ALTEVOGT (Münster)

2. BIRDS OF NEPAL. By Robert L. Fleming, Sr., Robert L. Fleming, Jr. and Lain Singh Bangdel. pp. 349 (19 × 12 cm), with 150 colour plates depicting 741 species, many for the first time. Bombay, 1976. Vakil & Sons. Price Rs. 125.00.

It is indeed a pity I did not have this book in the pocket of my rucksack when I trekked from Khatmandu to Thyangboche in the summer of 1967. To have between the covers of one book all the birds, with the majority illustrated, of a large stretch of the Himalayas like Nepal—including a few birds of Kashmir on the one hand and of Sikkim on the other not recorded in Nepal—is a great asset for any traveller in these wonderful mountains, particularly when the result still maintains a handy size easily slipped into a side pocket without adding appreciably to the weight on tired shoulders!

The magic of compressing so much into so small a volume is a result of very brief factual notes on each species, facing the illustrations in the handy Field Guide format now universal for popular bird books of Europe and America. True, the delightful prose of a Sálim Ali is missed but then one cannot have everything.

The intensive field study done in Nepal over a period of two and a half decades by father and son and augmented by information from other ornithologists who have been visiting Nepal in increasing numbers after its opening up in the Forties provides updated, authentic ornithological information for an area which still remains a naturalist's paradise. A significant fact is that the Flemings share the production of the book with Nepalese both in the preparation of the text and the illustrations. The publication of this book is a landmark in the history of ornithology in the sub-continent.

The illustrations by comparison with those of popular European Field Guides are disappointing but it is certainly not fair to compare them with work done by a Singer or a Peterson. Even so, the ducks and the waders are poorly drawn, though the rest are of uniformly high standard. While the warblers, larks and pipits are difficult to illustrate faithfully requiring us they do an artist's brush and a printer's expertise of the very highest order, the birds of prey shown in overhead flight can be hardly improved upon.

The price, though high for an average Indian to pay for an object to decorate his book-shelf, is affordable when budgeting for a Himalayan holiday. While not adding appreciably to the overall costs, or the weight in ones rucksack, its handy presence certainly will guarantee to augment the pleasures of any Himalayan vacation.

LAVKUMAR KHACHER

3. PROCEEDINGS FROM THE SYMPOSIA OF THE FIFTH CONGRESS OF THE INTERNATIONAL PRIMATOLOGICAL SOCIETY. Edited by S. Kondo, M. Kawai, A. Ehara & S. Kawamura. pp. x + 592 (26 × 19 cm), with Black-and-White plates and many illustrations. Tokyo, 1975. Japan Science Press. Price US $ 60.00.

It is exhilirating to note that in a small country like Japan (when compared to India) there are at least 10 Primate Centres of research in addition to Anthropological Institutes where research on monkeys is also carried on. No wonder they called an International Congress.

The fifth Primatological Congress had organized under its auspices five symposia and a special seminar and action programme.

Symposium 1 was devoted to social structure of primates and there were nine papers. The second was on determinants of behavioural variation in Primates and there were five papers. The third was titled locomotor behaviour and hominization; there were nine papers. Symposium four was on perinatal physiology and there were five papers. Neurophysiology and neuropsychology of Primate prefrontal Cortex was the theme of fifth symposium and there were five papers.

Crook, in his conspectas 1974, has brought out clearly how the two orientations of Japanese and Western workers could be brought together. Japanese work has always been done with an anthropological bias with stress on longitudinal diacluonic studies of selected species or populations while western workers study primate social behaviour from sociological and socioecological view points. Crook also pointed out that the papers of Hinde and Kummer brought out a distinction between two perspectives, namely, social process and temporal patterning of social positioning of known individuals. Hanby in describing the primate social structures uses the phrase social nexus which is intended to connote the complex web of relationships produced by individuals that know and interact with one another overtime. She takes examples from the "one-male" groups—the gelada baboon and the hamadryas baboon. If the hamadryas (papio) male is removed, the females scatter while the gelada females all stay together under the same circumstances. In the patas (*Erythrocebus*), which is also a single male society, he does not knit them together and may even be threatened by the females!

Norikoshi and Koyama describe the formation of all male groups in the Japanese monkeys. The groups seem to function as a pressure valve in regulating the centrifugal force behind peripherilization. These males after some time become peripheral males.

Males over five years never stayed in the troop in which their mothers and close relatives were present; this avoided incest and therefore Japanese monkey troops could not be considered as closed; to prevent genetic and evolutionary deterioration of a species, inbreeding should be avoided. The migration of male would naturally lead to gene flow from troop to troop.

Stephenson has evolved a simple test which is called a 'peanut test' for determining the social rank of the monkey during the non-mating season. Of the two monkeys whose social rank you are wanting to determine, hold a peanut and see which gets it by outwitting the other when you wave it between them. The females enter the mating pool when they are about 3.5 years old and the males become effective by entering the pool between 4 to 8.5 years of age in the Japanese monkeys. The males may go up to 38 years and beyond 25, they are senile. It is also noticed in these monkeys that high ranking females preferred high ranking males and low ranking females mated with low ranking males. In addition to this stratification, a female can control which males can successfully mate with them by refusing to raise their hips, during copulation.

Hausfater's studies on the baboon (*Papio cyanocephalus*) brought out the sex-skin-ovarian cycle relationship with a standard deviation 5.3. Within two weeks after the start of menstruation, maximum turgescence of perineal sex-skin is reached. This is maintained for 7-10 days and then rapid deturgence takes place. Thirteen days after this, the next menstrural cycle starts. If the animal has conceived due to successful mating, her paracallosal skin depigments and changes from gray-black to red in colour.

Kummer discusses in his paper on rules of Dyad and group formation among captive gelada baboons, one interesting facet and that is loyalty. There is only one female in a group and her relationship with her male was intense and in the loyalty test, she rejected every advance by another male and she never presented or groomed.

In the wild chimpanzees studied by Kawanaka and Nishida they brought out that there were frequent exchange of females from K-to the M-groups. This is largely because their home ranges overlapped.

In the 2nd Symposium, Sackett, Holm, Davis and Fahrenbruch tackle the problem of incidence, prediction and effect on infant development in the pigtail macaques (*M. nemestrina*). The period of pregnancy was 167 days and the lowest birth weights was for males. The ratio of males to females was 55.4 to 44.6. Breeders carrying male fetuses are less likely to require medical treatment for than female ones! This appears to have a hormonal basis. At approximately 100 gestation days in the rhesus monkey, the male fetus secretes testosterone which passes through the placenta into maternal circulation. The group seem to notice the change in breeders carrying male by their smell, look or behaviour and abstain from attacking her and cause injury.

Rumbaugh and Gill lead us into the realm of the language of apes. The apes have failed to establish competence for speech because the apes vocal tract does not provide for the production of the phonemes used in human speech. By the way Washoe the young female chimpanzee was able to use the American sign language and it is possible these apes may master a set of rules for structuring sentences, i.e. syntax. At the Yerks Regional Primate Centre, there is a computer system; the language is a visual one; the ape faces a key board on which are embosed 75 word-keys each a distinctive geometric configuration. Using these keys, the ape can frame sentences to cause attention to its needs.

The Chairman of the third symposium Preuschoft summarised by saying that they must continue to collect data on locomotion in recent primates so that the ways and reason of hominization process may understood. Ankel-Simmons reinstated that the fossil Australopithecus showed specializations indicative of bipedalism.

Oxnard discussing locomotor functions in primates stated that almost all primates can move bipedally and all can also swing by their arms. With regard to function of the forelimb, it is a broad spectrum; the patas and baboons where the forelimb is used in a cranio-caudal two dimensional arc within a lower quadrant to gibbons and spider monkeys at the other where the forelimb is used in a three dimensional highly mobile cone within a raised quadrant. While young gorillas can brachiate deftly, old male gorillas are exclusively terrestrial.

His studies brought out that austrabopithecines are more different from modern man and these may even be said issues in relation to man.

Ishida, Kimura and Okada discuss the acquisition of orthograde bipedal posture and locomotion in Anthropoid primates. With the aid of EMG (electromyography) of a leg muscle and other observations, 4 patterns are arrived at namely, the human, the chimpanzee the macaque and the gibbon patterns. According to them, the locomotor complex of the chimpanzee and spider monkey may have particular reference to bipedality in man.

Tuttle and Basmajian are approaching the problem of hominization by studying the EMG of *Pan*. Their main aim is to elucidate the mechanisms of knuckle-walking, suspensory behaviour and facultative bipedalism in gorilla, chimpanzee and orangutan and to compare these positional behaviours with hominid bipedalism. There is biochemical evidence for the close relationship of African apes and man. Some authorities feel that large-bodied "brachiators" may have led to the hominid type. Knuckle-walking terrestrial locomotion was considered a stage between brachiation and hominid bipedalism. The above two authors feel that a hylobatian model of hominid evolution may be nearer the truth than a large-bodied brachiator or a knuckle-walking one.

In discussing the ecology and paleoecology of ape locomotion, Kortlandt has some interesting inferences to make. For some 30 million years, the Dryopithecine and African ape evolution has tended towards an adaptation to more open habitats and to more increasingly terrestrial life. According to him the Dryopithecine skeleton was perfectly adopted towards this. The hind limbs enabled them to flee like an antelope and their slim build made them dash across the densest grass like lightening and their foraging habits were so versatile and eurytopic paralleled by the present day langurs. In the African apes, the long arms enabled them to embrace solitary tree trunks and climb and also to reach fruits on far off slender branches. These are considered secondary specializations.

Perinatal physiology was the title of the 4th symposium. Myers discusses perinatal asphyxia. High infant morbidity and mortality due to perinatal asphyxia. He has studied the cardiac and brain asphyxiations.

Panigel discusses the use of non-human primates as a model for the study of human placenta. In the rhesus, the patas (*Erythrocebus*) and the Crab-eating macaques, the placenta is bidiscoidal, the primary disc having the umbilical connections. The secondary placenta can be conveniently detached from the uterine wall so that it has only fetal circulation or this fetal circulation may be cut off when only there is a maternal circulation. Such permutations have shed a lot of light on placental physiology. The uteroplacental circulation has been imaged in the rhesus monkey using labelled radioactive microspheres. Scanning with a special camera "hot spots" at the points of entry on the placenta of the maternal spiral arteries, it has been shown that the circulation of maternal blood is heterogenous in the intervillous spaces of the rhesus monkey.

Symposium 5 was devoted to Neurophysiology.

Desiragu has a paper on the afferents of the prefrontal cortex. This cortex is related to the temporal lobe in 3 ways at least: amygdala—medialis dorsalis—cortex; hippocampus — septum — hypothalamus — thalamus — congulate — cortex; temporal cortex — prefrontal cortex. Fuster has studied the prefrontal cortex by locally cooling certain parts. For this gold plated copper probes were used. Cooling to a temperature 20 to 25C the behaviour of the animal is not affected.

In the special seminar, primate conservation formed the staple of discussion. Papers by Shidei and Kawamura (Japan), Leng-ee (Thailand) and Gartlan (W. Africa), Berhanu (Ethiopia), Eiten and Thorington (S. America) and Chivers (U.K.) were presented. Gartlan brought out that Congolese forest had disintegrated in its margins. Mature forests have been replaced by secondary growth and has led to reduction of primate species. But this has also helped the evolution and radiation of certain species. *Miopithecus talapoin, Pan trogldytes, Gorilla gorilla, Colobus abyssinicus* and *Cercopithecus mona* have actually increased: this is the brighter side.

Eiten and Thorington discuss the South American forests and the primate population. One important conclusion is that in South America if large parks could be established in the 17 areas designated as refuges in Vanzolinis map, most of the neotropical species could be conserved.

Denudation of the rainforests should not be encouraged as these happen to be centres of breeding and radiation of non-human primates. If this is strictly enforced in developing countries, it may be possible to conserve the fast dwindling primate fauna.

The last paper is by McGreal and Eudey on the International primate protection league. Here are some figures of export form his paper.

Thailand: 1962-1971 — 74000 macaques (*arctoides* and *nemestrina*).

74 motherless infants of *arctoides* were noticed by an IPPL representative with an animal dealer. Gibbons are exported from Thailand and the IPPL opposes the use of gibbons in biomedical research and thus conserving the species. Many countries where primates are endemic have now stopped completely or partially the export of monkeys. This angurs well for the conservation of non-human primates.

There are a number of printers devils which irritate a reader. These could have been easily avoided. The book is not only useful for postgraduate students who want to embark on primate studies but also to advanced primatologists. Recommendation of the book to all primatoligists becomes a bit difficult as the price is not marked but in the libraries of institutions doing reproductive biology or primate biomedical work, it is a must.

L. S. RAMASWAMI

4. WILD CATS OF THE WORLD. By C. A. W. Guggisberg. pp. 328 (inclusive of Bibliography and Index) (23 × 15.5 cm), with 29 Black-and-White illustrations. Newton Abbot/London, 1975. David & Charles (Publishers) Ltd. Price £5.50 net.

The author has taken considerable pains to cover Wild Cats of the world from their origin and evolution to present day status. He has quoted various authors who have had personal experience with wild cats and it is obvious that he has limited personal experience of wild cats of the world; his chapters on the African Lion, Cheetah and Serval clearly reveal his focus on the African scene of which there is only a small portion compared to his excellent work "SIMBA" (Life of Lion) 1961. It is a pity that very little is mentioned of the Asiatic lion and while quoting authors connected with this race he has over-looked articles in this *Journal*, by M. A. Wynter Blyth and K. S. Dharmakumarsinhji and L. L. Fenton in 'RIFLE IN INDIA'. On Indian wild cats much is quoted from works by E. P. Gee, George Schaller, R. C. Morris, F. W. Champion, S. H. Prater, etc. with no reference to modern Indian conservationists even in the Tiger chapter. It appears that the author knows little outside his African sphere of large cats and has to quote abundantly from the experience by other writers, thus in the smaller cats sometimes only a few lines are mentioned under habits, and yet, under most of the cats he has given long descriptive notes and of measurements which convey little to the reader in identifying them in the field. The book, however, is full of selected anecdotes by numerous authors which makes interesting reading. It is a pity that just a handful of mediocre monochrome photographs of some of the cats are shown and those of Golden cat, Caracal and young Jaguarandi are of little help in identifying the species. A book of this nature with coloured pictures as given by S. H. Prater in the Book of Indian Animals, 1965 would have added much to its value.

R. S. DHARMAKUMARSINHJI

Miscellaneous Notes

1. TAXONOMIC STATUS OF *MEGADERMA SPASMA MAJUS* ANDERSEN (CHIROPTERA: MEGADERMATIDAE)

While studying the collections of *Megaderma spasma* present in the Zoological Survey of India, Calcutta, I came across some specimens of *M. spasma horsfieldi* Blyth and *M. spasma majus* Andersen which were found to be very difficult to separate. An attempt has here been made to settle the taxonomic status of *Megaderma spasma majus* Andersen.

Material examined: INDIA: Karnataka, 5♂♂, 4♀♀; Andhra Pradesh, 1♀; Maharashtra, 1♂, 2♀♀; Tamil Nadu, 1♀; Goa, 3♀♀; Andaman Island, 1♀; Meghalaya, 1♂, 2♀♀; BURMA: Pegu, 5 (unsexed); Lower Chindwin, 1♀; Tenasserim, 1♂, 2♀♀.

Andersen (1918) separated *M. s. majus* from *M. s. horsfieldi* only on the length of forearm, 62-63 mm *vs.* 54-58.5 mm. Ellerman & Morrison Scott (1951) accepted them as separate subspecies. However, as may be seen from the measurements given by Andersen and those of my specimens (Table), there is complete overlap in the length of the forearm of the two subspecies. The Table also shows that there is no difference in the measurements of other external and skull characters of the two sub-species. *Megaderma spasma majus* Andersen (1918) should, therefore, be considered a synonym of *M. s. horsfieldi* Blyth 1863.

Ellerman & Morrison-Scott (1951) gave the range of distribution of *M. s. horsfieldi* as Peninsula of India and that of *M. s. majus* as lower Chindwin, Burma. Kurup (1968) recorded the species from Kamrup, Meghalaya. The present range of distribution of *M. s. horsfieldi* on the basis of above mentioned specimens is Peninsular India, Assam, Andamans and Burma.

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May 11, 1976.

Y. P. SINHA

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TABLE

COMPARATIVE MEASUREMENTS (IN MM.) OF *Megaderma spasma horsfieldi* BLYTH AND *M. s. majus* ANDERSEN

	M. s. horsfieldi	M. s. majus				
	Peninsular India	Meghalaya	Andaman Is	Lower chindwin	Pegu	Tenasserim
EXTERNAL	7♂♂, 8♀♀	1♂, 1♀	1♀	1 ♀	5 (unsexed)	2 ♂♂ 1♀
Length of forearm ;	53-61 (58)a	60, 62	59	61	57—61(59)	57—62 (60)
Length of tibita :	27—34 (31)	34, 35	31	32	32—33 (32.7)	32—34 (32.8)
Length of foot with claw ;	16—18 (16.5)	17.18	16.2	18	15.2—18.5 (16.6)	16—18 (17)
SKULL	7♂♂, 8♀♀	1♂, 1♀	1♀	1♀	5 (unsexed)	2♂♂, 1♀
Total length :	23.5—25.4 (24.8)	25.2, 25.7	25.4	25	25—25.5 (25.1)	24.5—25 (24.8)
Zygomatic width :	14—14.8 (14.3)	—, 14.5	14-8	15	13.5—15 (14)	14.3—15 (14.7)
Cranial width :	10.4—11.1 (10.7)	10.5, 10.8	10.6	11	10.5—11 (11.8)	10.7—11 (10.8)
Length of upper tooth row (c-m^3)	9.1—10.3 (9.8)	10, 10.5	10.3	10	10—10.2 (10.1)	10—10.2 (10.1)
Length of lower tooth row : (c-m_3)	10—11.4 (10.7)	10.5, 11.3	11.4	11	11—11.3 (11.1)	10.4—11.1 (10.8)
Length of mandible :	16.5—18.3 (17.5)	18, 18.5	18.3	18.2	17.5—18.5 (18.2)	17.5—18.2 (17.8)

Note : Average measurements given in parenthesis.

2. SOME OBSERVATIONS ON THE BREEDING HABITS AND GROWTH OF JUNGLE CAT (*FELIS CHAUS*) IN CAPTIVITY

The present communication dealing with the breeding habits and growth upto the age of six months of the Jungle Cat (*Felis chaus*) is based on the observations made at Nandankanan Biological Park, Orissa.

So far eight births were recorded in this Park as follows: January, 2; March, 1; April, 2; August, 1; and November, 2. Three kittens per litter were born on five occasions, four on two occasions and five on one occasion with an average of 3.5 kittens per litter. There were eight females and twenty males, the sex ratio of females to males being 1:2.5. The weight and size at birth of 24 kittens born during the period from 12-iv-1973 to 7-xi-1975 were as follows: weight—from 83 to 125 gm with an average of 106.21 gm; length from nose tip to tail tip—from 22 to 26 cm with an average of 23.17 cm including the tail lengths of 5.5 to 6.5 cm with an average of 6.08 cm.

The eyes of the kittens were closed at birth and 11 kittens under observation opened their eyes on 11th day (3 kittens), 12th day (3 kittens), 13th day (2 kittens), 13th and 14th day (2 kittens—one eye on each day) and 15th day (1 kitten). The inter-parturition interval varied from 75 to 272 days mostly depending on the period of survival of the young after birth. One female could give birth to four litters in one year in 1973 as all the kittens were killed by the mother or died within 2 to 16 days after birth.

Weekly growth records of three kittens born in one litter on 7-xi-1975 were maintained upto the age of six months and an abstract of the same is given in the table.

Date	Age in weeks	Weight in Kg.		
		♀	♂	♂
7-xi-1975	Birth	0.115	0.125	0.107
21-xi-1975	2	0.283	0.281	0.268
5-xii-1975	4	0.445	0.430	0.417
19-xii-1975	6	0.615	0.648	0.645
2-i-1976	8	0.775	0.878	0.840
16-i-1976	10	0.935	1.200	1.180
30-i-1976	12	1.005	1.475	1.450
13-ii-1976	14	1.085	1.685	1.635
27-ii-1976	16	1.185	1.900	1.825
12-iii-1976	18	died on 10-iii-1976	2.160	2.010
26-iii-1976	20	—	2.260	2.085
9-iv-1976	22	—	2.170	2.020
23-iv-1976	24	—	2.330	1.980
7-v-1976	26 (6½ months)	—	2.332	2.030

The mother after giving birth to these three kittens weighed 4.575 kg. The kittens were brown in colour and helpless at birth. The mother used to carry the kittens in the usual manner of cats.

Little definite is known about the breeding habits of this cat (Prater 1971).

Asdell (1964) states that this cat has two litters a year in India, usually 3 to 4 young. He further states that the young are born in May and November in South India.

The eyes of new-born jungle cat kittens were closed at birth and two kittens under observation opened their eyes on the eleventh day (Acharjyo & Misra 1973). The four kittens born in one litter weighed from 103 to 126 gm with an average of 111.25 gm and measured from 22 to 24 cm with an average of 22.5 cm from nose tip to tail tip including 6 cm to 7 cm long tail at birth (Acharjyo & Misra 1974).

ACKNOWLEDGEMENTS

We are grateful to Sri S. Jee, I.F.S. Chief Conservator of Forests, Orissa, Cuttack and to Shri G. M. Das, I.F.S., Chief Wildlife Warden, Orissa, Bhubaneswar for the facilities provided.

VETERINARY ASSISTANT SURGEON,
NANDANKANAN BIOLOGICAL PARK,
P. O. BARANG, DISTT. CUTTACK.

L. N. ACHARJYO

WILDLIFE CONSERVATION OFFICER, ORISSA,
PLOT NO. 95, SAHEED NAGAR,
BHUBANESWAR 751 007,
June 28, 1976.

S. MOHAPATRA

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PRATER, S. H. (1971): The Book of Indian Animals, Third (Revised) Edition, Bombay Natural History Society, Bombay, pp. 75-76.

3. WILD ASS IN THE LITTLE RANN OF KUTCH

I camped at Dhrangadhra on the 14th, 15th and 16th April for the census of wild life conducted by the Government of Gujarat, Department of Forest, as one of the observers. On 16th April, the day of the count, we enumerated 720 wild asses. On the 15th at sunrise I spotted a herd of nine wild asses near the village of Kuda which is at the edge of the Little Rann of Kutch and about 6 miles from the city of Dhrangadhra. This herd was led by a female wild ass and it was interesting to note that other animals followed her implicitly.

On close observation, I noticed that the leader had stripes on both her shoulders of about 10 inch length. The colour of these two stripes was the same as the colour of the dorsal stripe which all wild asses have. The size as well as the general colour of this animal was the same as of the other wild asses in the herd. Even the size of the ears was the same as that of other animals. Actually, apart from these 2 stripes, the animal looked identical with the others.

I am given to understand that this animal may have been a crossbreed and not a genetic freak.

RANJIT VILAS PALACE,
WANKANER,
GUJARAT,
June 7, 1976.

YUVRAJ DIGVIJAY SINH

4. THE INDIAN RHINO (*RHINOCEROS UNICORNIS*) IN CAPTIVITY

Endangered in the wild, this imposing mammal is modestly represented in zoological gardens. At the end of 1975 the International *Rhinoceros unicornis* Studbook kept by the Basle Zoo registered 32 males and 26 females, a total of 58 animals. This figure exceeds 10% of the wild population living mainly in Kaziranga and Nepal which is estimated at some 450 animals. The relatively high number in zoos may be attributed largely to the fact that the Indian Rhino adapts well and breeds successfully under captive conditions. Of the 58 animals mentioned above, 27 were actually zoo-born (46.6%). Births have even been recorded in the second zoo generation.

The first captive-bred Indian Rhino to survive was born in Basle in 1956, 20 years ago. Basle Zoo thereupon became established as a breeding centre for this threatened species. Up to the time of writing (February 1976) there have been altogether 14 calves. As it is hardly possible for one zoo to keep more than a certain number of Indian Rhinos at a time most of them have been sent to other places, but always either in pairs or so as to enhance the breeding potential. Since 1960 Indian Rhinos have been born every year in captivity, 1971 being a record year with 7 births. Today the captive stock points to having become self-supporting. There is justification for the hope that the zoo progeny may, in time, be released into well guarded reserves or national parks.

Reproductive behaviour in the Indian Rhino has meanwhile been carefully studied. The mean gestation period is 478 days. On an average calves weigh about 70 kg at birth and grow rapidly, gaining 2-3 kg daily. During the first year of life they increase their birth weight tenfold. Females attain sexual maturity at about 4 years of age, males when 7 years old.

Indian Rhinos, particularly the females, become very tame. Our cow, Joymothi, can be easily handled and even allows herself to be milked. It is indeed surprising that this mammal has for so long been spared from domestication.

E. M. LANG

Zoological Garden,
Basel,
Switzerland,
February 18, 1976.

5. TAKIN (*BUDORCAS TAXICOLOR*) IN CAPTIVITY

When the Bronx Zoo acquired a female Takin from the Putato district, Kachin State the Editors recorded a note in Volume *56* No. 1:128 of this *Journal*.

In a letter dated June 8, 1976, Mr. J. G. Doherlig, Curator of Mammals. Bronx Zoo, intimated me that "She died on September 4, 1975 when she was approximately 17 years old. In autopsying this takin it was found that she had quite an extensive cancer of the uterus that had spread into lymph nodes in other parts of her body."

In 1966, the Bronx Zoo paid $ 16,000 for a young male takin approximately eight to nine months old to an animal dealer from New York. The animal dealer received the young male Takin from the Rangoon Zoo in exchange for two giraffes and four zebras from Africa.

The takins were identified as *Budorcas t. taxicolor*.

The locality where the young male takin was captured is not known. The female takin was captured on the Burma-India border by a team from Sankaung Village, Putato district.

25 Inya Myaing Road,
University P.O.,
Rangoon, Burma,
July 8, 1976.

TUN YIN

6. *LEPUS ARABICUS* EHRENBERG FROM JAMMU AND KASHMIR: AN ADDITION TO THE MAMMALIAN FAUNA OF INDIA

During the faunistic survey of Jammu and Kashmir in 1974 a specimen of the Arabian Hare, *Lepus arabicus* Ehrenberg was collected from Udhampur, southeastern Jammu and Kashmir, which according to Ellerman & Morrison-Scott (1951) has not been hitherto recorded from India. Since a detailed report on the collection will take some time to prepare, it was thought desirable to record this addition to the mammalian fauna of India.

Lepus arabicus Ehrenberg

1833. *Lepus arabicus* Ehrenberg, *Symb. Phys. Mamm.*, 2: Sig. r. (Qunfidha, Arabia).

Material:

1♂: Jhajjar Kotli, Udhampur, Jammu and Kashmir; 13 Nov. 1975; coll. S. Chakraborty.

Measurements:

External: Head and body 352 mm; Tail 112 mm; Hindfoot 91 mm; Ear 123 mm.

Cranial: Occipitonasal 69 mm; Nasal 29.6 mm; Bullae 12 mm; Upper tooth row 11.3 mm; Frontal 15.7 mm; Mesopterygoid space 6.2 mm.

Distribution:

According to Ellerman & Morrison-Scott (1951) *Lepus arabicus* is known to occur in Baluchistan, Middle East and Libya. Therefore, the present material not only constitutes its first record from India, but also extends its range further eastward.

Remarks:

The specimen from Jammu and Kashmir agrees well with the description of *Lepus craspedotis* Blanford (currently known as *Lepus arabicus craspedotis*) given by Kloss (1918), but the black bands of hair at the posterior half of the back are much conspicuous and broader than those of the holotype of *craspedotis* and two more August specimens from Baluchistan present in the Zoological Survey of India, collection.

Zoological Survey of India,
8, Lindsay Street,
Calcutta 700 016,
July 31, 1976.

S. CHAKRABORTY

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7. NEW RECORD OF INDIAN GERBILLE, *TATERA INDICA* (HARDWICKE) AS A PREDATOR ON THE ALATE FORMS OF THE TERMITES AT LUDHIANA (PUNJAB)

During July 1973, the Indian gerbille, *Tatera indica* (Hardwicke) was seen preying on winged termites at 9.00 p.m. under a tube light on the main road of the Punjab Agricultural University, at Ludhiana. Most of the time the whole insect was taken but in a few cases the wings were rejected. Very rarely the fore paws were used to catch the prey. The gerbille was so preoccupied that even a collision with the observer did not distract it and only stampings of the foot on the road, made it sense the presence of the observer and it ran away into the bushes. During the period of observation of about 10 minutes, the rat continuously caught the insects. When the observer again came to the same site after 30 minutes, the rat was again preying on the insects. It was however more alert and quickly ran away.

I am thankful to the Professor and Head, Department of Entomology, Punjab Agricultural University, Ludhiana for providing the facilities in the preparation of this manuscript.

DEPT. OF ENTOMOLOGY,
PUNJAB AGRICULTURAL UNIVERSITY,
LUDHIANA, (PB.),
February 17, 1976.

G. S. MANN

8. REPRODUCTIVE ACTIVITY OF *MUS* SPP. IN CROP FIELDS AT LUDHIANA[1]

The knowledge of the reproductive activity of a pest is necessary for devising efficient control measures. The reproductive activity of the field-mice has not been studied in detail in India so far. The information collected on the subject during the years 1968-1972, is presented here.

MATERIAL AND METHODS

In 1968-69, individuals of *Mus musculus bactrianus* Blyth were observed near stacked harvested crops and in burrows for the presence of young and field collected females were reared or dissected to determine pregnancies. Traps were laid from December 1970 to November 1972 for 10-day periods in the first fortnight of each month in different crops at a 100-m distance from one another in a 53-ha cultivated area on the Ludhiana Farm of the Punjab Agricultural University. The trapped individuals were examined for sex, position of testes (scrotal or abdominal) in males and of vagina (perforate or imperforate) in females. When the testes were abdominal, the black-loose skin of the scrotum indicated that they were earlier scrotal. In the absence of black loose scrotal skin the abdominal condition of the testes indicated that the specimen was sub-adult and as evidenced by the senior author's study on the post-natal development of this species (Mann 1969) the scro-

[1] Based on M.Sc. and Ph.D. thesis of the senior author, presently Research Assistant.

tal condition of the adult is attained in 3-4 weeks and thus the sub-adults were approximately one month or less in age. In Females, the previous history of the animal which was known from their early trappings indicated whether it was an adult (which were previously with perforated vagina/lactating) or sub-adult (of comparatively small size and with imperforated vagina). Presence of clear teats was taken to indicate lactating condition.

Results and Discussion

During the trapping of the *Mus* spp., which was carried out in the period of December 1970 to November 1972, 1085 animals were observed with a species-wise break up of 750 in *Mus musculus bactrianus* Blyth, 229 in *Mus booduga* (Gray) and 106 in *Mus platythrix* Bennett (Tables 1-3). The data regarding the observations on reproductive activity of these animals is discussed below species-wise.

Mus musculus bractrianus Blyth. The sub-adults of this species were found throughout the year under the heaps of the harvested crops namely wheat, groundnut, paddy, pearl-millet, Guara, maize and sorghum or in the traps which were placed in these crops. Examination of burrows in the field on 30-v, 22-vi, 27-vi, 2-xii, 5-xii and 28-xii-68 revealed the presence of 2-7 young along with 1-2 adults in each used burrow of this field-mouse. Field collected adults gave birth to 1-7 young in the laboratory in January, February, March June, July and October. Two females collected on 5-ii-69 and 11-iii-69 were dissected and these contained 6 and 8 embryos respectively. Scrotal males were predominant throughout the year except during November to February when the majority of the males had abdominal testes. Reproductively active females (lactating and/or with perforate vagina) were found throughout the year, except during December. The peak population occurred during April and during June to October, Sub-adults were found throughout the year, except during January-March and during May and July in case of males (Table 1).

From the above observations, it is concluded that this mouse was reproductively active throughout the year except during very cool months.

Mus booduga (Gray). Scrotal males were found to predominate throughout the year, except during November to February. Reproductively active females were present during June to September. The lactating females were observed in March and during May to November, the peak reaching during May to October. During April no female was observed. Sub-adults were found throughout the year except during April and June (Table 2).

From the above observations, it may be concluded that this species was also reproductively active throughout the year, except during very cold months. However, in Madras, the young of this species were found in September, October, and February in the fields (Anonymous 1965). This variation may be due to different climatic conditions.

Mus platythrix Bennett. Scrotal males predominated throughout the year, except during November to February, whereas in December and April this species was conspicuous by its absence. Reproductively active/lactating females were present throughout the year except during November and December and no animal was observed during April. Sub-adults were seen during August and then during October to February (Table 3).

From the results, it is clear that this mouse was reproductively active throughout the year, except during November and December. The

TABLE 1

REPRODUCTIVE STATUS OF *Mus musculus bactrianus* BLYTH TRAPPED IN DIFFERENT MONTHS DURING DECEMBER 1970- NOVEMBER 1972

Month	Male				Female				
	Scrotal	Abdominal	Sub-adult	Total	Perforated	Lactating	Imperforated	sub-adult	Total
December	1 (3)	33 (94)	1 (3)	35	NA	NA	NA	13 (100)	13
January	NA	26 (100)	NA	26	1 (5)	2 (11)	NA	16 (84)	19
February	7 (20)	28 (80)	NA	35	1 (7)	NA	NA	13 (93)	14
March	19 (76)	6 (24)	NA	25	1 (8)	10 (77)	NA	2 (15)	13
April	10 (91)	NA	1 (9)	11	5 (63)	2 (25)	NA	1 (12)	8
May	21 (100)	NA	NA	21	1 (11)	5 (56)	NA	3 (33)	9
June	29 (81)	NA	7 (19)	36	6 (55)	2 (18)	NA	3 (27)	11
July	84 (100)	NA	NA	84	25 (69)	6 (17)	NA	5 (14)	36
August	91 (97)	NA	3 (3)	94	24 (59)	6 (15)	1 (2)	10 (24)	41
September	86 (94)	NA	5 (6)	91	19 (66)	4 (14)	1(3)	5 (17)	29
October	27 (66)	6 (15)	8 (19)	41	11 (55)	NA	2 (10)	7 (35)	20
November	NA	20 (80)	5 (20)	25	1 (7)	NA	1 (8)	11 (85)	13
Total	375 (71)	119 (23)	30 (6)	524	95 (42)	37 (17)	5 (2)	89 (39)	226

Figures in the parentheses are per cent of animals falling in that category. NA = No animal was found in this category.

TABLE 2

REPRODUCTIVE STATUS OF *Mus booduga* (GRAY) TRAPPED MONTH-WISE DURING DECEMBER 1970- NOVEMBER 1972

Month	Male				Female				
	Scrotal	Abdominal	Sub-adult	Total	Lactating	Perforated	Imperforated	Sub-adult	Total
December	NA	11 (100)	NA	11	NA	NA	NA	3 (100)	3
January	NA	10 (100)	NA	10	NA	NA	NA	6 (100)	6
February	NA	8 (100)	NA	8	NA	NA	NA	6 (100)	6
March	5 (71)	2 (29)	NA	7	1 (14)	NA	NA	6 (86)	7
April	1 (100)	NA	NA	1	NA	NA	NA	NA	—
May	3 (100)	NA	NA	3	3 (50)	NA	1 (17)	2 (33)	6
June	2 (100)	NA	NA	2	1 (50)	1 (50)	NA	NA	2
July	21 (100)	NA	NA	21	11 (73)	1 (7)	NA	3 (20)	15
August	13 (87)	NA	2 (13)	15	10 (67)	2 (13)	NA	3 (20)	15
September	16 (89)	NA	2 (11)	18	6 (67)	2 (22)	NA	1 (11)	9
October	5 (38)	3 (24)	5 (38)	13	6 (46)	NA	NA	7 (54)	13
November	NA	26 (90)	3 (10)	29	1 (11)	NA	NA	8 (89)	9
Total	66 (48)	60 (43)	12 (9)	138	39 (43)	6 (7)	1 (1)	45 (49)	91

Figures in the parentheses are per cent of animals falling in that category. NA = No animal was found in this category.

Table 3

Reproductive status of *Mus platythrix* (Bennett) trapped month-wise during December 1970- November 1972

Month	Male			Female			
	Scrotal	Abdominal	Total	Lactating	Perforated	Sub-adults	Total
December	NA	NA	0	NA	NA	1 (100)	1
January	NA	3 (100)	3	NA	2 (50)	2 (50)	4
February	NA	3 (100)	3	NA	3 (75)	1 (25)	4
March	2 (100)	NA	2	NA	1 (100)	NA	1
April	NA	NA	0	NA	NA	NA	0
May	1 (100)	NA	1	2 (100)	NA	NA	2
June	3 (100)	NA	3	1 (100)	NA	NA	1
July	10 (100)	NA	10	3 (100)	NA	NA	3
August	12 (100)	NA	12	6 (60)	1 (10)	3 (30)	10
September	12 (100)	NA	12	10 (77)	3 (23)	NA	13
October	2 (29)	5 (71)	7	NA	3 (33)	6 (67)	9
November	NA	2 (100)	2	NA	NA	3 (100)	3
Total	42 (76)	13 (24)	55	22 (43)	13 (26)	16 (31)	51

Figures in the parentheses are per cent of animals falling in that category. NA = No animal was found in this category.

peak breeding season was in May to September.

The reduction in or lack of reproductive activity during winter in *Mus* spp. has been reported in other species of rats and mice also (Sadleir 1969; Schiller 1956; Whitaker 1940), and the same has been attributed to short day light or low temperature under which conditions the testes may become abdominal and spermatogenesis may stop.

ACKNOWLEDGEMENT

We are thankful to the Director, Zoological Survey of India, Calcutta for arranging the identification of the rodents.

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LUDHIANA, (PB.),
June 5, 1976.

O. S. BINDRA

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9. SEX RATIO AT BIRTH IN SOME CAPTIVE WILD MAMMALS

The determination of accurate sex ratio at birth of wild mammals is only possible from the birth records in captivity. From the available literature, it appears that the information available on this subject is limited. This paper presents the data pertaining to sex ratio at birth of 17 species of wild mammals observed at Nandankanan Biological Park, Orissa during the past 15 years (from 29-12-1960 to 31-12-1975). The details of our observations are given in the table below.

A study of this table reveals that there is a remarkable uneven sex ratio at birth with the females outnumbering the males in five species, Tiger, Golden Cat, Hog-Deer, Indian Sambar and Mouse-Deer; whereas the males outnumber the females in eight species, African Lion, Leopard, Common Palm Civet, Common Mongoose, Nilgai, Spotted Deer, Barking Deer and Blackbuck. The number of observations made on four species, Jackal, Rhesus Macaque, Bonnet Macaque and Slow Loris are inade-

TABLE

Species of Mammals	Total	Males	Females	Sex ratio (No. of males to 100 females)
Tiger (*Panthera tigris*)	18	6	12	50:100
African Lion (*Panthera leo leo*)	21	12	9	133.3:100
Leopard (*Panthera pardus*)	38	22	16	137.5:100
Golden Cat (*Felis temmincki*)	8	3	5	60:100
Jackal (*Canis aureus*)	3	1	2	50:100
Common Palm Civet (*Paradoxurus hermaphroditus*)	30	21	9	233.3:100
Common Mongoose (*Herpestes edwardsi*)	6	5	1	500:100
Rhesus Macaque (*Macaca mulatta*)	3	2	1	200:100
Bonnet Macaque (*Macaca radiata*)	3	1	2	50:100
Slow Loris (*Nycticebus coucang*)	2	1	1	100:100
Spotted Deer (*Axis axis*)	143	73	70	104.3:100
Hog-deer (*Axis porcinus*)	9	3	6	50:100
Indian Sambar (*Cervus unicolor niger*)	73	31	42	73.8:100
Barking Deer (*Muntiacus muntjak*)	62	33	29	113.8:100
Mouse-Deer (*Tragulus meminna*)	6	1	5	20:100
Nilgai (*Boselaphus tragocamelus*)	14	10	4	250:100
Blackbuck (*Antilope cervicapra*)	39	21	18	116.7:100

quate to come to any conclusion. However it is felt that much more observations are necessary to confirm these findings.

DISCUSSION

Thirty-two tiger (*Panthera tigris*) cubs were born in eleven litters to one tigress from 1948 to 1959 at New York Zoological Park, the divisions of sexes being nineteen males and thirteen females (Crandall 1965). According to Schaller (1972) the sex ratio of 196 tiger cubs at birth in various Zoological Gardens was 100 males to 100 females. He further states that on 121 occasions adult tigers were encountered in the wild and of these 102 were females and 19 were males, a ratio of about 5:1.

Schaller (loc. cit.) states there were 10 males and 13 females among 25 newborn spotted deer (*Axis axis*) fawns in the Calcutta Zoological Garden, but figures from such a small sample have little relevance. He further states that the disproportion of adult spotted Deer in the wild may be due either to an unequal sex ratio at birth, a higher mortality of male fawns, or both. About Hog-Deer (*Axis porcinus*) Schaller (loc. cit.) states that the sex ratio of adults was about equal or favoured the does only slightly, in contrast to the Spotted Deer which has a disproportionate sex ratio favouring females.

From his study at Kanha National Park, Schaller (loc. cit.) states that Sambar (*Cervus unicolor*) hinds outnumbered the stags by a ratio of about 3:1 and the reason for this great disproportion of the sexes is unknown, but it may be due to selective predation on the males, both as fawns and as adults and perhaps also to an unequal sex ratio at birth.

The ratio of bucks to 100 does among Blackbucks of Kanha National Park on July 1, 1964 was 71:100 whereas in the same Park the sex ratio on June 3, 1965 was 45 bucks:

100 does (Schaller, loc. cit.). He further states that at Sikandra the captive herd showed a higher proportion of bucks (84:100) than the free-living population.

The sex ratio of 36 births of Rhesus Macaque (*Macaca mulatta*) as given by Asdell (1964) was exactly even.

Information on sex ratio of other species mentioned in the table was not available to us from literature.

ACKNOWLEDGEMENTS

We are grateful to Shri S. Jee, I.F.S., Chief Conservator of Forests, Orissa and Shri S. N. Das, I.F.S., Conservator of Forests, Development Circle, Cuttack for providing the facilities for the study.

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OLD SECRETARIATE BUILDINGS,
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January 29, 1976.

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10. DISCOVERY OF A PELICANRY IN KARNATAKA

Recently (first week of April 1976) I noticed a breeding Pelicanry of Spottedbilled or Grey Pelicans (*Pelecanus philippensis*) at Bellur and Bannalli villages of Mandya District of Karnataka State.

The Spottedbilled Pelicans were breeding alongwith hundreds of Painted Storks (*Ibis leucocephalus*). The nests of the Pelicans and Painted Storks were close to each other on the same trees. There are about ten nesting trees at Bellur and three nesting trees at Bannalli, standing in dry agricultural fields (non-irrigated) and in village backyards, very close to human residence.

The following are the details of the trees on which the Pelicans and Painted Storks nest at these villages.

Bellur Village:

Trees	Number	Nesting species
Acacia arabica (small tree)	1	Painted Stork
Acacia arbica (small tree)	1	Painted Stork and a few Pelicans
Tamarindus indicus (medium sized tree)	1	Painted Stork and a few Pelicans
Tamarindus indicus (medium sized tree)	1	Painted Stork
Avenue trees with yellow flowers. (small trees)	2	Painted Storks
Ficus bengalensis (medium sized)	1	Painted Stork
Ficus bengalensis (medium sized)	2	Painted Storks with some Pelicans
Ficus religiosa (medium sized)	1	Painted Stork

Note: In addition to the above two to four nests of Painted Storks were seen on 2-3 more very small trees in the surrounding area.

Bannalli Village:

This village is about a mile away from Bellur. The trees are few in number and Pelicans are in the majority.

Trees	Number	Nesting species
Ficus bengalensis (big tree)	1	Pelican and a few Painted Stork nestlings.
Ficus bengalensis (big tree)	1	Painted Stork and Pelicans.

Note: In addition to above, there are some more nesting trees but with a few nests only.

Some Pelicans were seen incubating and some had nestlings. The Painted Storks had mostly nestlings. Pelicans were seen flying with nesting material in their bill.

The local villagers protect the breeding birds and poachers are heavily fined. The villagers collect the birds' excreta which they claim is a rich manure. Some sell the manure at Rs. 400/- per tree and some use it for their fields.

The Painted Storks were seen feeding in the nearby tanks and irrigated paddy fields. The Pelicans fish in the larger tanks. I counted over fifty Pelicans co-operatively fishing (in two groups) in the Tailur tank, about 10 km from Bellur. Villagers told me that these birds also go to the nearby Simsa river for food.

I estimated that over one hundred Grey Pelicans to be breeding at the Bellur and Bannalli Villages. The villagers' say that the populations of breeding Painted Storks and Grey Pelicans are increasing year by year. I expect them to spread to nearby villages in the coming years, if similar protection to breeding birds is extended by other villagers.

This pelicanry is perhaps the first record for Karnataka State and the fourth or fifth breeding record for the country.

S. G. NEGINHAL

ASST. CONSERVATOR OF FORESTS,
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MYSORE 1,
April 14, 1976.

11. WHITEWINGED WOOD DUCK IN BURMA

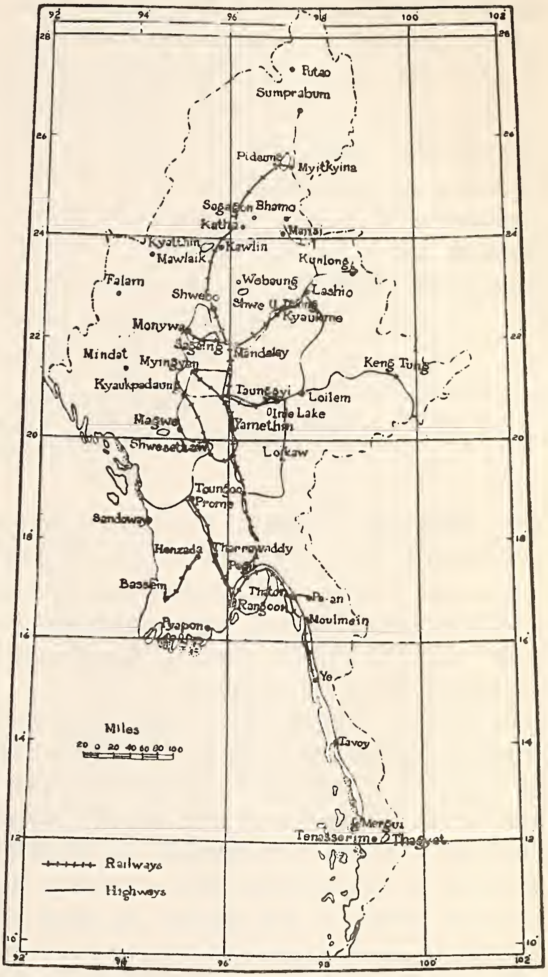
(*With a map*)

In June 1959 Messrs O. Milton and E. D. Estes of the Burma Wild Life Survey observed a female and six ducklings of this rare bird at Changnam Waterhole. Burma Wildlife Survey Report on the Pidaung Wild Life Sanctuary by Messrs Oliver Milton, D. Estes and H. Z. Kimlai. *The Burmese Forester* Vol. XIII No. 2 December 1963, p. 58.

Whether this rare duck now breeds in Pidaung cannot be ascertained owing to the presence of KIA (Kachin Independent Army) rebels in the area.

U Htang Wa, Deputy Secretary, Kachin State Government informed the writer in December 1970 that this rare duck breeds in the Mansi tract, Bhamo district, Kachin State.

In April 1974, U Sein Chit a local big game hunter, flushed one example of this rare duck from a pond near Webaung Village, close to Shwe-U-daung Wild Life Sanctuary. In December 1974, he saw altogether six of the birds in Katha Forest Division. On 29 December 1974 he shot one of the two birds seen in Yin Kha Forest Reserve near Sagagon village at the mouth of the Wai Chaung, a tributary of the Irrawaddy, Katha District. This is all the information available at present, and it is possible that this rare duck still breeds in Pidaung, Myitkyina Forest Division.



Map. Distribution of the Whitewinged Wood-duck *Cairina scutulata* in the Socialist Republic of the Union of Burma.

25, Inya Myaing Road,
University P.O.
Rangoon,
Burma,
July 24, 1976.

TUN YIN

12. THE GOLIATH HERON (*ARDEA GOLIATH*) IN SIND, PAKISTAN

You may be interested to know that I had the opportunity of seeing the Goliath Heron (*Ardea goliath*) at Haleji (Sind) on 21st January. The bird was identified by myself and two other naturalists, Dr & Mrs Graefe, of the Osterreichische Akademia Der Wissenschaften Institut Fur Vergleichende Verhaltensforschung, Austria who have had much to do with herons and who were with me on this visit.

M. NASER-UD-DEEN KHAN

General Manager,
Pakistan Burmah Shell,
Post Box 4712,
Karachi 2,
January 27, 1976.

13. THE SOUTHERN LIMITS OF THE HIMALAYAN CUCKOO *CUCULUS SATURATUS SATURATUS* (BLYTH)

The Himalayan Cuckoo *Cuculus saturatus saturatus* (Blyth, type locality Nepal) has been accepted in Indian ornithological literature as a Himalayan species with some movements into the plains of northern India (Uttar Pradesh, Rajasthan, Bihar and Assam).

In Sharpe's CATALOGUE OF BIRDS IN BRITISH MUSEUM (1891), Vol. 19, p. 254, Shelly listed a specimen obtained by J. Scully at Sulapur. Dr. D. R. Wells in a note in this *Journal* (1972 *69*:179-182) has changed the place to Sholapur in Maharashtra, thus extending the accepted range of the species to south of latitude 18°N.

I would not accept this alteration for the following reasons:-

(1) Scully's ornithological collections were made in Yarkand, Nepal, Gilgit, and the Himalayan regions. There is no evidence of his having collected in peninsular India. The entry in the CATALOGUE bears the date 18th May, but in 1973 it was not possible to trace the specimen at British Museum (Natural History) to determine the year of collection and then ascertain the area by comparison with other specimens collected on nearby dates.

(2) Blanford (1895, Fauna 3:208, footnote) mentions Davison's statement (*Stray Feathers 10*, p. 359) that he *heard* it in the Wynaad in South India, and refers to an earlier note (*P.Z.S.* 1893, p. 317-18) by him (Blanford) in which he has gone into the matter in detail and decided that there is no evidence of the Himalayan Cuckoo being found in India south of latitude 26°N.

(3) The specimens in Sharpe's CATALOGUE are not arranged in the order of accession but mostly geographically, commencing in the north-west extending along the Himalayas and then southwards into peninsular India, Ceylon, Burma and Malaya. The Sulapur specimen is the second in the list being preceded by one from Jodhpur, Rajasthan, and followed by others from Kashmir, Kotegarh, Simla, Naini Tal, U.P., and Nepal. This does suggest a northern bird.

(4) I have gone through 22 volumes of Sharpe's CATALOGUE (Vol. 1 is not available) and have been unable to find any specimen obtained by Scully except in the above-mentioned places, nor does the place named "Sulapur" occur anywhere again. Indian place names as pronounced and written in English show wide diversity and have often undergone startling changes. The similarity between Sulapur and Sholapur (recently changed by Government to Solapur) unsupported by any other evidence is insufficient to accept the extension of the range of a species over 8 degrees of latitude. The former may well be another version of Sitapur or Sultanpur, both in U.P.

A list of Indian Post and Telegraph offices (*c* 1940) refers to 20 Sultanpurs scattered over India, the southernmost being as far south as Berar. Against another it is also said—"old name for Kulu".

I had drawn Dr. Wells's attention to these difficulties and he suggested that I should make the correction myself. A draft note was prepared but the briefcase containing it was stolen from my car and I have shirked going over the work again. However, as this extension of range is quoted without reservation by Desfayes (*JBNHS 71*:146), I am prompted to try and stem the acceptance of the additional range of the species until further evidence is available.

Mr. J. S. Serrao, Librarian at Bombay Natural History Society, helped me with the references.

75, ABDUL REHMAN STREET,
BOMBAY 400 003,
July 7, 1976.

HUMAYUN ABDULALI

14. PERIOD OF INCUBATION IN BRAHMINY MYNA, *STURNUS PAGODARUM* (GMELIN)

So far as known to us the incubation period of this species is not recorded in the existing ornithological literature. Recently we had an opportunity to observe five nests of Brahminy Myna, constructed in artificial nest boxes. The wooden, letter-box shaped nest boxes of the size 15 × 15 × 22 cm, with entrance holes of 4 cm, were nailed on trees at an approximate height of 10 m, in the compound of the Northern Regional Station of the ZSI. Out of a

TABLE

INCUBATION PERIOD IN *Sturnus pagodarum* (GMELIN)

Nest No.	Egg No.	Laid on	Hatched on	Time taken in days
I	1	20-v-76	did not hatch	—
	2	21-v-76	2-vi-76	12
	3	22-v-76	3-vi-76	12
	4	23-v-76	4-vi-76	12
II	1	22-v-76	5-vi-76	14
	2	23-v-76	5-vi-76	13
	3	24-v-76	5-vi-76	12
	4	25-v-76	6-vi-76	12
	5	26-v-76	7-vi-76	12

total of six nest boxes five were occupied by this species and one by the Magpie Robin. Observations to determine the period of incubation were made only in two of the nest boxes. The nests were examined every day between 3 p.m. and 4 p.m., by opening the hinged side of the nest box. Each egg was marked for identification with indelible ink on the day it was laid. The observations are recorded in the table.

As will be evident from the table the eggs were laid at the rate of one a day. The period of incubation, counted from laying of the last egg to the hatching of the same comes to 12 days.

Northern Regional Station,
Zoological Survey of India,
13, Subhas Road,
Dehra-Dun 248 001,
Uttar Pradesh (India),
June 28, 1976.

B. S. LAMBA
A. K. TYAGI

15. OCCURRENCE OF BROWN SHRIKE, *LANIUS CRISTATUS CRISTATUS* LINNAEUS, NEAR DEHRA DUN (U.P.)

Brown Shrike, *Lanius cristatus cristatus* Linnaeus, is a common winter visitor to India. Sálim Ali and Ripley (1972: 98),[1] describe its status and distribution as "Winter visitor. All India including NEFA, Assam, Nagaland and Manipur together with Nepal, Sikkim, Bhutan and E. Pakistan, roughly south and east of a line from Ahmednagar through the Surat Dangs (Gujarat), Mhow (Madhya Pradesh), Lucknow (Uttar Pradesh) and Nepal."

While studying the bird collection of the Northern Regional Station, Dehra Dun we came across a single specimen of this species collected from Sulphur Spring (30° 22′ N., 78° 8′ E., Alt. 650 m), a picnic spot about 12 km North-east of Dehra Dun. The specimen (Regd. No. V 1171), unsexed was collected by Shri P. K. Bose on 10th December, 1965. The measurements are as follows:-

Wing 94; Bill 18; Tarsus 30; Tail 93 mm.

This record extends the northern range of this species to Dehra Dun.

Northern Regional Station,
Zoological Survey of India,
13, Subhas Road,
Dehra Dun (U.P.),
July 16, 1976.

B. S. LAMBA
M. L. NARANG

[1] Ali, S. & Ripley, S. D. (1972): Handbook of the birds of India and Pakistan, Vol. 5, Oxford University Press, Bombay.

16. STUDIES ON THE FEEDING HABITS OF HOUSE SPARROW *PASSER DOMESTICUS* (L.) AND ITS NESTLING IN PUNJAB

The house sparrow, *Passer domesticus* (L.) is omnivorous and its food consists of wheat, pearl millet, maize, sorghum, groundnut, insects, moth beans, newly sown seeds of Egyptian clover and sweet clover, seedlings of chillies and paddy, young lettuce, chrysanthemum, polyanthus, nectaries, buds of currants, gooseberry and mulberry, leaves of primose, polyanthus and spinach, fruits of grapes, peach, pear, apple, plum, and kitchen scraps (Ali 1972; Hussain & Bhalla 1937; Samuel 1951; Sekhon 1966; Srivastava 1964; Theodorewood 1925 and Wright 1959), but its sources of food throughout the year have never been studied in detail.

During the present study, feeding habits of house sparrow and its nestlings were studied. The study was conducted by direct observations in the field as well as by examining the gut contents of 779 (388 males, 391 females) birds collected at weekly intervals from different localities both qualitatively and quantitatively. Similarly, the guts of 64 nestlings of different ages were examined. For qualitative analysis, the different food items from crop/gizzard were just sorted out. But for quantitative analysis, the different food items were assigned numerical values i.e. points depending upon the individual mass by eye estimation. Points of each food were totalled and its per cent proportion with respect to total points of all the foods in a month was worked out.

A variety of food material namely, wheat (*Triticum aestivum* L.), pearl millet [*Pennisetum typhoides* (Burm. f.) Stapf and C. E. Hubb], rice (*Oryza sativa* L.), maize (*Zea mays* L.), sorghum (*Sorghum bicolor* Moench.); groundnut (*Arachis hypogaea* L.), weeds, pulses (green gram, moth beans, Bengal gram) from shops and kitchen scraps and insects depending upon the season formed the diet of the bird, wheat, pearl millet, rice, weeds and insects being the major part of the diet. Wheat in February to August, pearl millet in September to October, rice in October to November, weeds in December to January topped in their proportion. The birds took the maximum insect food during March, May, June and July. In case of maize, sorghum and pulses, groundnut and green leaves, their maximum consumption was observed in March, November and January, respectively.

The insect food taken by the house sparrows in the field and that which was found in the guts of the adults and nestlings (fed by adults) comprised caterpillars, flies, beetles, ants, bugs, grasshoppers and spiders. The following species were identified: Caterpillars, and moths of army worm (*Mythemna separata*), caterpillars of cabbage semilooper (*Plusia* sp.), gram caterpillar (*Heliothis armigera*), lucerne caterpillar (*Spodoptera exigua*), tobacco caterpillar (*Spodoptera littoralis*), taken from Egyptian clover, cotton pink boll worm (*Pectinophora gossypiella*) taken from cotton ginning factory in January, adults of house fly (*Musca domestica* L.), carpenter ants (*Camponotus compressus*), mustard aphid (*Hyadaphis erysimi*) from inflorescence of radish in March, spotted aphid (*Theoaphis maculata*), larvae and pupae of diamond back moth (*Plutella xyllostella*) from cauliflower, surface grasshoppers (*Oxya nitidula* Walker, *Acrida* sp.), honey bee (*Apis* sp.), striped lady beetle (*Brumus suturalis*), syrphid flies (*Metasyrphis* sp.), cereal earhead bug (*Dolichorus indicus*), grey weevil (*Myl-*

locerus sp.), til leaf folder (*Antigastra catalunalis*), larvae of rotten flies, brown wire worm, spotted wire worm and spider (*Oxyopes pandae*). About fifteen species of insects belonging to lepidoptera, orthoptera, hymenoptera, diptera and one species of spider remained unidentified.

House sparrows fed on the green leaves of fumatory (*Fumaria parviflora* Lam.), bird-seed grass (*Phalaris minor* Retz.), lamb's quarter (*Chenopodium album* L.) Egyptian clover (*Trifolium alexandrinum* Juslen), cluster bean [*Cyamopsis tetragonoloba* (L.)], peas (*Pisum sativum* L.), fenugreek (*Trigonella foenum-graecum* L.), toothed bur clover (*Medicago denticulata* Willd.), cauliflower (*Brassica oleracea* L. var. *botrytis* L.), spinach (*Spinacia oleracea* L.) and forked catch fly (*Silene conidea*). The inflorescence of thatch grass (*Saccharum spontaneum* L.), in January, maize in August and nectar of pangara (*Erythrina indica* Lamk. var. *parcellri* Hort.) in April and peacock flower [*Delonix regia* (Boj.) Raf.] in July were also taken Besides, seeds of a number of weeds such as crow-foot grass (*Eleusine aegyptiaca* Desf.), bird-seed grass, lamb's quarter, white cock's comb (*Celosia argentea* L.), and forked catch fly and six unidentified species were taken. The crow-foot grass in December and January (next being lamb's quarter), bird-seed grass in March, April and June topped in consumption. The maximum consumption of lamb's quarter, crow-foot grass and bird-seed grass was observed in December, January and April, respectively. In total, the per cent proportion of crow-foot grass was the highest (30.9), followed by bird-seed grass (27.0), lamb's quarter (16.3) and rest of the weeds.

With regard to the food of nestlings which has been worked in detail for the first time, 84 per cent of the total food comprised of insects, the rest being weeds, wheat and rice. Among the insect species, caterpillars formed the major portion (37.7%) followed by beetles (20.8%), flies (11.5%), grasshoppers (7.2%) and maggots and pupae (5.2%), spiders (1.3%) and ants (1.1%) (Table 2).

Considering the total food during the year of the house sparrow (adults), the per cent proportion of wheat was the highest i.e. 30.8, followed by weeds (16.2), pearlmillet (12.0), rice (11.1), insects (8.1) and rest of the food material (2.6 to 0.9) (Table 1). Sekhon (1966) studied the guts of 71 birds from September to April (for 8 months in 1965-66). He calculated the quantity of individual food item in terms of volume (CC) of water displaced by it in a measuring cylinder and reported that the per cent proportion of wheat as also observed in the present studies was highest, 34.0 followed by pearlmillet (31.0), groundnut (19.0), sorghum (13.0) and moth beans (1.0). He also mentioned that traces of black ants and larvae were observed in the guts of the birds during April and October. Hussain & Bhalla (1937) also reported that the birds feed on the caterpillars of cotton leaf roller (*Sylepta derogata* Fab.) from *Bhindi* plants.

The new food items recorded and identified for the first time in Punjab are as follows: green gram, Bengal gram, caterpillars and moths or armyworm, caterpillars of cabbage semilooper, gram caterpillar, lucerne caterpillar, tobacco caterpillar, til leaf folder, brown wire worm, spotted wire worm, cotton pink boll worm, adults of house fly, carpenter ants, mustard aphid, larvae and pupae of diamond back moth and spider (*Oxyopes pandae*), surface grasshoppers, honey bee, striped lady beetle, syrphid flies, cereal earhead bug, grey weevil; green leaves of peas, fumatory, bird-seed grass, lamb's quarter,

TABLE 1

RELATIVE PROPORTION (%) OF FOODS CONSUMED BY HOUSE SPARROWS IN DIFFERENT MONTHS (AUGUST 1973-JULY 1974)

Month	Number of birds studied	Wheat	Bajra	Rice	Maize	Sorghum	Oates	Groundnut	Weeds	Insects	Pulses	Green leaves
Aug.	27	34.0	6.0	9.7	0.0	0.0	0.0	0.0	16.6	5.1	8.2	0.5
Sept.	44	1.4	44.0	15.0	0.0	0.0	0.0	0.0	15.0	5.0	0.0	0.0
Oct.	15	28.0	30.0	30.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0
Nov.	68	16.3	19.0	24.8	3.0	9.5	0.0	1.3	5.9	1.6	4.0	1.0
Dec.	62	11.6	20.0	14.5	0.0	0.0	0.0	3.5	29.2	4.7	0.0	1.0
Jan.	67	4.0	6.0	3.0	7.9	0.3	0.0	13.8	34.7	3.1	0.6	8.2
Feb.	44	20.0	0.0	18.6	3.6	1.2	0.0	3.0	4.0	0.2	3.6	6.0
March	94	45.0	3.6	4.0	14.0	0.0	0.0	0.0	6.2	11.5	0.0	0.4
April	153	46.8	9.1	1.9	2.0	0.3	0.0	0.0	11.2	2.0	0.0	0.1
May	52	59.3	0.0	1.2	0.0	0.0	0.0	0.0	12.0	15.1	1.5	2.6
June	107	46.9	0.0	3.6	0.0	0.0	0.0	0.0	8.2	19.6	0.0	6.4
July	46	37.0	0.0	0.0	0.0	0.0	14.3	0.0	31.8	11.0	0.0	0.5
Total	779	350.3	137.7	126.3	30.5	11.3	14.3	21.6	174.8	82.2	17.9	26.7
Overall %age	—	30.8	12.0	11.1	2.6	0.9	1.5	1.9	16.2	8.1	1.5	2.2

Note: Grits accounted for 10.4% of total food.

TABLE 2

RELATIVE PROPORTION (POINTS) OF DIFFERENT FOOD ITEMS OF THE NESTLINGS OF HOUSE SPARROW

Age of nestlings (days)	No. of nestlings observed	Food items									
		Cater pillars	House flies/hover flies/others	Beetles	Spiders	Ants	Pupae/ Maggots	Grass hoppers	Weeds	Wheat	Rice
1	8	26	23	3	2	5	0	0	0	0	0
2	7	18	32	3	2	0	7	0	2	0	0
3	8	30	12	18	1	0	0	9	14	3	0
4	3	10	10	16	3	5	0	7	3	0	0
5	14	120	17	68	0	0	35	20	8	12	1
6	9	40	6	28	4	0	3	15	11	1	2
7	4	28	0	9	0	0	0	6	19	12	0
8	4	0	0	24	0	0	0	5	1	7	0
10	6	46	0	0	0	0	0	0	0	2	0
12-14	2	10	0	10	0	0	0	0	0	5	0
Total	65	328	100	179	12	10	45	62	58	42	3
%age of G. total		37.7	11.5	20.8	1.3	1.1	5.2	7.2	6.7	5.2	0.4

Note: Grits accounted for 1.5% of nestlings food.

Egyptian clover, cluster bean, fenugreek, toothed bur clover and cauliflower; nectar of pangara and peacock flower and seeds of crow-foot grass, bird-seed grass, lamb's quarter and white cock's comb.

The study reveals that house sparrow is a pest, mainly of wheat, pearlmillet and rice in the field. But it also feeds on a number of weeds, during December to January and April and on insects (mostly harmful) during its breeding season during March to July except approximately in the second half of April when along with taking insects and other foods they damage the wheat at milk stage especially in those fields which are near villages, trees or hedges. This fifteen days period of damage is practically of short duration. As soon as the bird is actively engaged in breeding, it shifts more or less to insect food which is essential especially for nestling, and by that time, wheat passes the milk stage and becomes ready for harvest. Though wheat formed the major portion of diet from Feb. to Aug., it is not obtained from the standing wheat, but from the harvested fields, threshing yards, houses etc. I feel the real danger of house sparrow as a pest is to pearl millet and rice during August to November. During September to October however, there is a breeding season but it is a minor one in which one brood is raised that too not by all the breeding pairs. During the present study, out of 81 nests observed with eggs during March to July, only 4 per cent contained eggs in September to October. Semaskho (1963) also reported that only 25-30 per cent of sparrows breed twice a year. The insect food requirement of the birds during September-October, is naturally less and therefore less useful activity of house sparrows during the period. Control measures against house sparrow could be directed during August-November also to minimise crop losses.

ACKNOWLEDGEMENTS

I am thankful to Dr. S. S. Guaya, Professor and Head Department of Zoology, Punjab Agricultural University, Ludhiana, for providing necessary facilities, and to Dr. H. S. Toor, Associate Professor of Zoology for his suggestions in the present study. Thanks are also due to Dr. G. S. Sandhu, Entomologist (Research), Department of Entomology for identifying many insect species. Field assistance provided by Mr. Kabul Singh and Mr. Amrik Singh is duly acknowledged.

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November 29, 1974.

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17. ORTOLAN BUNTING (*EMBERIZA HORTULANA* LINN.) IN KUTCH, GUJARAT

The sighting of the Ortolan Bunting was most unexpected during the recent Indian Wild Ass Census. The Chief Wildlife Warden, Gujarat State, Shri K. K. Acharya, IFS, his son, and forest staff and I were in the middle of the Little Rann of Kutch on a dry island known as Waswa Bet on 16th April, 1976. Sitting and having our breakfast close to a small well and shrine amidst a curtain of *Prosopis juliflora*, I watched birds coming to drink at a small puddle which had formed by spillage of water drawn from the well. In this muddy patch were frogs. Among many birds that came to drink, I recognised small groups of Greynecked Buntings (*Emberiza buchanani*) which were in bright plumage. As I was looking at each and every bunting through my Trinovid 10 × 40 magnification, my eyes fell upon one that looked quite different and I was reminded of an article in the *JBNHS* *69*(3):654-55, 1970 by Peter Jackson & A. J. Gaston who had seen the Ortolan Bunting near Delhi on 18 and 19 April. I took down notes of the bird I had seen and a near description of it I found in BIRDS OF ARABIA by R. Meinertzhagen, 1954, p. 112. The bird had a dull grey-green (olive) crown, pale yellow eye-ring, dark brown streaks on mantle; tail brown with outer tail feathers whitish; throat sulphur-yellow merging into dull olive on upper breast; lower breast and abdomen pale yellowish chestnut. Moustachial stripes yellowish and clear, with faint streaks on crown. Bill scarlet-pink, legs fleshy. These features were distinct. The bird was at the water-hole for sometime at a distance of about 35 feet and it flew away with the Greynecks. In comparison with them it may have been a shade smaller. It was no doubt a male and in excellent plumage. I found a good colour illustration of this species, on page 279, Plate 64, of a FIELD GUIDE TO THE BIRDS OF BRITAIN AND EUROPE by Peterson *et al.* 1954 and even the description on page 285 tallies well with what I had noted. Once properly seen recognition of it is unmistakable specially through binoculars. The species must be fairly rare in India since there are very few records of it, and yet some birds could easily have been overlooked.

K. S. DHARMAKUMARSINHJI

BHAVNAGAR,
GUJARAT STATE,
July 17, 1976.

18. EXTENSION OF RANGE OF THE FROG, *RANA CRASSA* JERDON, TO WESTERN HIMALAYAS, U.P.

During a recent survey of the Corbett National Park, we collected three specimens of *Rana crassa* Jerdon, two from Dhela, District Nainital and one from Dhikala, District Pauri. All three examples agree fully with the published description of the species, *Rana crassa* Jerdon.

The known distribution of this species is Sri Lanka, and southern Peninsular India to Varanasi and Agra (Lat. *c* 27°10′ N) in the north (Boulenger 1920; Bhaduri 1944). Their occurrence at Corbett National Park (Lat. *c* 29°35′ N) extends the Northern range to Western Himalayas, U.P. It is quite possible that this species is evenly distributed throughout the foothills of Himalayas, U.P.

ACKNOWLEDGEMENTS

We are indebted to Dr. B. S. Lamba, Deputy Director, Northern Regional Station, Zoological Survey of India, Dehra Dun for facilities and J. C. Daniel, Curator, Bombay Natural History Society, Bombay for confirming the identification.

NORTHERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
DEHRA DUN,
June 19, 1976.

R. N. CHOPRA
K. KUMAR

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19. *ECHIS* IN TREES

It was interesting to read Whitaker's note on *Echis carinatus* in the *Journal* 72:563 in which he makes special reference to the fact that this essentially ground living snake climbs into trees during the rains.

In Saurashtra, this is possibly one of the commonest snakes and we have quite often seen it in the branches of *Mimosa senegal* which forms the scrub jungle around Hingolgadh Fort. I, myself, while descending a steep hill slope reached out to hold a branch ahead of me, fortunately to note—in time—a coiled *Echis* resting in a fork close to where I was about to place my hand. The snake had obviously dozed off after a substantial meal, judging from its bulging appearance. I left it resting and went my way. Incidentally, though without proof, I suspect a large number of young birds in nests are taken by this snake. In our area, some of the victims are White-bellied Minivet, *Pericrocotus erythropygius*. Small Minivet. *P. peregrinus*, Marshal's Iora *Aegithina nigrolutea* and Redvented Bulbul, *Pycnonotus cafer*. All of them nest in the mimosa trees. On several occasions while photographing these birds, I applied motor grease to the branch below the nest to discourage snakes climbing up and was rewarded in each case by seeing the young leave their nests!

Echis is active during the rains and it is then that it will readily climb up trees. Reading Whitaker's note I gained the impression that the snake goes into trees, possibly to evade water-logging. This would certainly not be the case in the hilly ground where I have come to know this viper. Of course, I am no expert but an interest in, and some knowledge of, this snake has been a bonus from my interest in birds.

My attention has been drawn by the Society's Librarian, Mr. J. S. Serrao, to an article entitled "The Wild Plantain (*Musa superba* Roxb.), by G. M. Ryan (*J. Bombay nat. Hist. Soc.* Vol. 15: 589, 1904), where the author writes: 'It perhaps may be interesting to mention here parenthetically that near the end of the rainy season the Foorsa (*Echis carinata*) finds a resting place between the leaf-stalks of the wild plantain leaves in the erstwhile Bombay area. An editorial footnote appended to this sentence reads: "He is also fond of inhabiting the branches of the 'apta' (*Bauhinia racemosa*)".

Commenting on my note Romulus Whitaker to whom it was sent for an opinion, says "terrestrial snakes are tolerant of water and wet ground to some extent but even the larger ones like the cobra and rat snake become more arboreal in habit during the rains. Soaking for too long and extra long contact with substratum below normal, optimum temperature (i.e. from wetness) may lead to respiratory ailments and digestion problems in snakes."

C/o. WILDLIFE FUND-INDIA,
GREAT WESTERN BLDG.,
S. B. SINGH ROAD,
BOMBAY 400 023,
May 18, 1976.

LAVKUMAR J. KHACHER

20. OBSERVATIONS ON THE STRUCTURE OF THE HEMIPENIS IN SOME INDIAN SNAKES

(*With four text-figures*)

A detailed study of the systematic characteristics of the hemipenis of four Indian snakes *Eryx conicus, Lycodon striatus, Naja naja,* and *Echis carinatus* was undertaken. In the snakes studied their active reproductive phase facilitated quicker eversion of the hemipenis than that of inactive condition.

INTRODUCTION

The external genital structures of snakes, called hemipenis, vary with species in morphological details. Cope (1898) was the first to draw attention to the possibility of taxonomic classification of species based upon the structure of the hemipenis. The paper on basic structure of the snake hemipenis by Dowling and Savage (1960) has been particularly important.

The anatomy of the hemipenis of the Indian snakes has received little attention except for the observations of Smith (1943), McCann (1946) and Sabnis (1969). The observations of Smith (1943) were based on ".... poorly preserved material mostly *in situ;*" whereas McCann (1946) has described the external genitalia of some reptiles in everted condition. Sabnis (1969) has described the gross anatomy and histology of the hemipenis of *Xenochrophis picator piscator*. The present study was undertaken in order to contribute further information to the structure of the hemipenis in some Indian snakes in the light of new method of description suggested by Dowling and Savage (1960).

Material and Methods

This study is based on the examination of ten specimens each of the following species:
Ophidia: Family—

Boidae: *Eryx conicus*
Colubridae: *Lycodon striatus*
Elapidae: *Naja naja*
Viperidae: *Echis carinatus*

The specimens were collected in the vicinity of Amravati. In all cases everted external genitalia preparations were made from freshly killed specimens after cutting *retractor penis magnus* and injecting fluid into blood sinus. The fully everted external genitalia were measured against the scales beneath the tail. They were fixed in alcoholic Bouin's fluid and preserved in 70 per cent alcohol.

Observations

The hemipenis of *Eryx conicus* is bilobed and extends up to the sixth sub-caudal. The pedicel is short. In a snake measuring 32.5 cms in length, the hemipenis measures 8 mm in length and 4 mm in breadth. The hemipenis is of the flounced type having transverse scalloped flounces (Fig. 1). The basal region of the pedicel is nude. The margins of the sulcus are clearly marked by fleshy lips. It is bifurcate. The sulcus forks at the level of the fourth sub-caudal and the branches run onto the lobes.

In *Lycodon striatus* the bilobed hemipenis which extends up to the 10th sub-caudal, is blunt and each lobe ends in a spherical head. The pedicel is long. In a snake measuring 60.5 cms, the hemipenis measures 21 mm in length and 6 mm in breadth. The distal one-third part of the head is calyculate-spinulate with four spines on the margin of each calyx. The remainder of the organ has longitudinal folds which are beset with distinct spines. Starting from the calyculate region and extending about half way down the pedicel are prominent folds composed of short fleshy papillae (Fig. 4). The sulcus has a shallow groove which bifurcates at the 6th sub-caudal.

In *Naja naja* the bilobed hemipenis extends up to the 12th sub-caudal in fully everted condition and is forked against 8th sub-caudal. The pedicel is 35 mm long in a snake measuring 135 cms. The head is distinctly divided into three regions which are fairly defined from one another: an apical with minute spines, a middle with large bulbus area containing 44 large spines on either side of the sulcus, and next to this is an area of small spines (Fig. 3). The apical area between the minute spines is smooth. The sulcus is shallow, forked at the bulbus area of the head and bifurcates against the 7th sub-caudal.

The hemipenis of *Echis carinatus* in fully everted condition is bilobed. In snake measuring 64.5 cms, the organ measures 16 mm in length and 9 mm in breadth. It extends up to 10th sub-caudal. It is proximally spinose and distally calyculate. The spinose area extends up to the proximal two-third part of the hemipeneal pedicel and remaining distal one-third bilobed part is calyculate-spinulate with four to five uniform spines on the margin of each calyx (Fig. 2). The pedicel is nude at the base. The sulcus spermaticus is forked and it forks on the shaft with a branch onto each lobe.

The hemipenis everted easily on application of slight pressure to the caudal region in snakes with active testis (*Naja* and *Eryx*), while considerable effort was required to evert penis in snakes with inactive testis (*Lycodon*

Fig. 1. Diagrammatic representation of the everted aspect of the hemipenis of *Eryx conicus*, showing scalloped flounces. Fig. 2. The bilobed hemipenis of *Echis carinatus* with spinulate calyces having 4 to 5 spines. Figs. 3 & 4. The everted aspect of hemipenis of *Naja naja* and *Lycodon striatus*.

and *Echis*). This leads to the conclusion that active reproductive state helps in easy eversion of the organ.

Discussion

The gross anatomical relationship of the hemipenis in Ophidia seems fairly constant although they show taxonomic variations in their structure. As in *Epicrates angulifer* (Dowling & Savage 1960), *Xenochrophis piscator* (Sabnis 1969) and *Python molurus* (McCann 1946) the hemipenis is bilobed in *Eryx conicus, Lycondon striatus, Naja naja* and *Echis carinatus,* although Smith (1943) described the hemipenis of *Eryx conicus* as not forked. A distinct bilobed condition occurs in everted hemipenis of *Echis carinatus* though earlier it has been described as bifurcate type by Smith (1943) who described the organ *in situ.*

The ornamentation of hemipenis in *Eryx conicus* is scalloped flounced type but Smith (1943) has described the flounces as joining distally to form large cups. The hemipenis of *Python molurus* (McCann 1946) is calyculate as in *Loxocemus bicolor, Masticophis flagellum,* and *Opheodrys aestivus* (Dowling & Savage 1960), but it is flounced in *Epicrates angulifer* (Dowling & Savage 1960). In *Lycodon striatus* and *Echis carinatus* it is spinose calyculate type but Smith (1943) and Vad (1959) described it as spinose in the latter species. Dowling & Savage (1960) observed spinulate calyces in *Spalerosophis diadema.* In *Xenochrophis piscator piscator* the apical region of the hemipenis is spinose (Smith 1943, McCann 1946 and Sabnis 1969) but it is without ornamentation or nude in *Natrix sipedon* (Dowling & Savage 1960).

The sulcus spermaticus in *Eryx conicus, Lycodon striatus* and *Echis carinatus* is bifurcate as in Boids and Viperids.

As no detailed information on the structure of hemipenis of many common Indian snakes is available, the above observations and diagrammatic representations will certainly aid in future taxonomic study of Indian snakes based on hemipenis structure.

ACKNOWLEDGEMENTS

We are thankful to Prof. S. A. R. Quadri and Dr. K. V. R. Murthy, Department of Zoology, V. M. V. Amravati for giving us encouragement and help for the work.

DEPT. OF ZOOLOGY,
VIDARBHA MAHAVIDYALAYA,
AMRAVATI 444 604,
February 16, 1977.

J. H. SABNIS
S. S. INDURKAR

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21. NEW LOCALITY RECORD WITH REMARKS ON THE TUCKTOO LIZARD, *GEKKO GECKO* (LINNAEUS) [SAURIA: GEKKONIDAE] FROM TRIPURA

Ten species of the genus *Gekko* Laurenti, 1768, have so far been described, out of which only two species namely, *Gekko gecko* (Linnaeus) and *Gekko smithi* Gray, are known within the Indian limits. According to Smith (1935) the former is distributed through the whole of Indo-Chinese subregion, North-Eastern India (Bengal, Bihar), Burma, Thailand, Taiwan, Andaman Islands and the East-Indian Archipelago; and the latter is found in the Andaman Islands, Java, Malay Peninsula and the Malay Archipelago. Annandale (1907) attributed the occurrence of *G. gecko* in West Bengal, to accidental introduction and such is likely the case in the state of Bihar also. Very recently, Pillai & Talukdar (1973) recorded the occurrence of this species from the Assam Region which fits well with the Indo-Chinese and Malayasian zoogeographical distribution.

While studying the reptile collection brought from Tripura during the year 1972-73 by Dr V. C. Agrawal, I came across a gekkonid lizard which proved to be *Gekko gecko* (Linnaeus). The occurrence in Tripura, bridges the distribution gap between Burma-Malaya and India.

A detailed examination of all the specimens of this species present in the Zoological Survey of India collection reveals that the species occurs in Dacca and Chittagong Hill tracts of Bangladesh and also in Kohphai Islands near the gulf of Thailand. A specimen, however, found from Ajmer (Rajasthan), is either an accidental introduction or it might have been wrongly labelled.

The Tripura specimen was found on the wall of a lavatory of the Chailingata Forest Bunglow, Tripura, at about 10.30 p.m. on December 18, 1972, and defended itself by adapting a threatening pose with widely gaping mouth. The specimen, on dissection, proved to be a female. It measured 336 mm in total length, 168 mm in body length, 47 mm in head length and 39 mm in its maximum width of head. There are 21 lamellae under the fourth toe and 13 supra and 11 infralabials.

It is blue slaty above, profusely spotted with brick-red and whitish blue spots. The tail has broad, bluish and whitish bands, the latter being narrower than the former. Lower surface ashy-white, variegated with grey.

Gut-contents of the specimen were heads and appendages of hymenopterous and lepidopterous insects; elytra and wings of beetles, moths and wasps and cuticular parts of arachnids.

ACKNOWLEDGEMENTS

I am grateful to the Director, Zoological Survey of India, Calcutta for providing laboratory facilities for work. I am indebted to Dr B. Biswas for kindly going through the manuscript and for valuable suggestions and to Shri S. Biswas, Zoologist, for his kind cooperation and advice.

ZOOLOGICAL SURVEY OF INDIA,
27, CHOWRINGHEE ROAD,
CALCUTTA 13,
July 5, 1976.

S. K. TALUKDAR

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22. DISTRIBUTIONAL RANGE OF *WAITEA BUCHANANI* VISWESWARA RAO (PISCES: GOBIIDAE) IN INDIAN WATERS

W. buchanani Visweswara Rao is known from Godavary estuary by a single specimen measuring 72 mm in total length (Visweswara Rao 1972).[1] One of us (K.V.R.R.) had the opportunity to collect this species off Ennore (Madras) during a routine cruise of R.V. "Chota Investigator". This is the first record of it away from its type locality.

MATERIAL: One specimen 74 mm in total length (58 mm in standard length), off Ennore, Madras, 15-20 metres, sandy muddy bottom, R.V. "Chota Investigator", Otter

[1] VISWESWARA RAO, V. (1972): A new fish of the family Gobiidae from Godavary estuary. *J. Bombay nat. Hist. Soc. 69*(1):130-133.

trawl collections, 12-ii-1975, K. V. Rama Rao Coll.

Description: D_1 6; D_2 1+10; A 1+9; P 17; V 5; C 14; L.I. 45; L. tr. 14.

Measurements (in mm): Total length 74, Standard length 58, Head length 21, Snout length 7, Eye diameter 4, Inter-orbital space 2, Post orbital length 12, Snout to: 1st dorsal fin 22, 2nd dorsal fin 33, anal fin 36, Pectoral fin 21, Pelvic fin 21; Height of the body 16, Width of the body 11, Length of the: base of 1st dorsal fin 13, 2nd dorsal fin 15, Anal fin 13, Pectoral fin 18, Pelvic fin 16.

Remarks: This specimen agrees with the original description and the fiigure in all aspects. The specimen has been deposited in the collections of Zoological Survey of India, Madras.

ACKNOWLEDGEMENTS

We are thankful to Drs S. Khera, A. G. K. Menon, A. Daniel, and K. C. Jayaramakrishnan of Zoological Survey of India for providing facilities and for encouragement.

KAZA V. RAMA RAO
T. VENKATESWARLU

ZOOLOGICAL SURVEY OF INDIA,
69, SANTHOME HIGH ROAD,
MADRAS 600 028,
July 30, 1976.

23. A NOTE ON THE SYSTEMATIC POSITION OF *CTENOTRYPAUCHEN MICROCEPHALUS* (BLEEKER) (FAM. TAENIOIDIDAE)

(*With two text-figures*)

Hora (1924) discussed the systematic status of Bleeker's *Trypauchen microcephalus* and assigned it to *Ctenotrypauchen* Steindachner. However, there has been considerable confusion regarding its systematic status. The causes for the confusion and the up-to-date systematic position of the species are briefly discussed in this note.

Two subfamilies are recognised in the family Taenioididae, the Taenioininae and the Trypaucheninae. The separation of these subfamilies is largely based on the possession by the Trypaucheninae of a pouch-like cavity over each opercle, lacking in the Taenioininae. *Ctenotrypauchen* Steindachner is referable to the subfamily Trypaucheninae and the other genera recognised in the subfamily being *Trypauchen* Cuvier and Valenciennes, *Amblyotrypauchen* Hora, *Caragobius* Smith and Seale and *Trypauchenichthys* Bleeker. The members of the subfamily are all characterised by long dorsal and anal fins fully united to or closely continuous to the caudal fin, minute eyes, absent or more or less rudimentary scales, and very oblique mouth (Fig. 1).

The members of the subfamily are very difficult to distinguish based on any of the

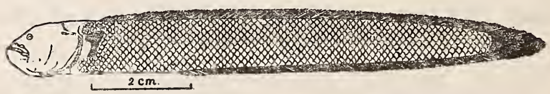

Fig. 1. Lateral view of *Ctenotrypauchen microcephalus* (Bleeker).

external morphological characters except the nature of the pelvic fins which are either completely united to form a funnel shaped disc (*Trypauchen* and *Caragobius*) or wholly (*Trypauchenichthys*) or partly separated (*Amblyotrypauchen*). In the case of *Ctenotrypauchen* the pelvic fins are more or less united like *Trypauchen* but they do not form a complete funnel shaped disc, the disc being slightly emarginate at the posterior end (Fig. 2).

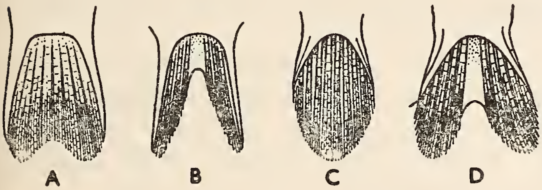

Fig. 2. A. Pelvic fin of *Ctenotrypauchen;* B. Pelvic fin of *Trypauchenichthys;* C. Pelvic fin of *Trypauchen,* and D. Pelvic fin of *Amblyotrypauchen* (Modified after Hora 1924).

The pelvic fins of *Ctenotrypauchen* are liable to be easily torn apart while collecting or handling the specimen thereby creating confusion in its identity. Koumans (1931:144) evidently had a specimen of *Ctenotrypauchen* in which the pelvic fins were separated to the base resembling the pelvic fin of *Trypauchenichthys.* In his later work Koumans (1941) had rectified his mistake and transferred the species to *Ctenotrypauchen.* The emarginate nature of the pelvic disc is a very characteristic feature of *Ctenotrypauchen* which is often overlooked by workers and the fish wrongly placed under *Trypauchen* or *vice-versa* (Smith 1953).

Synonyms

Ctenotrypauchen microcephalus (Bleeker)

1860. *Trypauchen microcephalus* Bleeker, *Act. Soc. Sci. Indo-Neerl. 8*:62 (type locality: Borneo).
1924. *Ctenotrypauchen microcephalus* Hora, *Rec. Indian Mus. 26*:160.
1931. *Trypauchen microcephalus* Hardenberg, *Treubia 13*:417, fig. 6.
1936. *Trypauchen vagina microcephalus* Tomiyama, *Jap. J. Zool. 7*:103.
1941. *Ctenotrypauchen microcephalus* Koumans, *Mem. Indian Mus. 13*(3):307.
1953. *Trypauchen microcephalus* Smith, *Sea Fish. South. Afr.*: 338, pl. 69, fig. 937.
1953. *Ctenotrypauchen microcephalus* Koumans, *Fish. Indo-Austr. archip. 10*:282, fig. 71.
1974. *Centrotrypauchen microcephalus* Orsi, *Publ. Seto Mar. Biol. Lab. 21*(3-4): 174 (misspelt for *Ctenotrypauchen*).

ZOOLOGICAL SURVEY OF INDIA,
69, SANTHOME HIGH ROAD,
MADRAS,
May 6, 1976.

A. G. K. MENON
T. K. CHATTERJEE

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—————— (1941): Gobioid fishes of India. *Mem. Indian Mus. 13*(3):205-329.

SMITH, J. L. B. (1953): Sea Fish. South Africa, 580 pp.—Central News Agencies, Cape Town.

24. MAHSEER IN RAMGANGA RIVER, U.P.

In March 1973 I joined my good friend JRS from Mussoorie on a fishing expedition to what I have always believed one of the finest little fishing rivers in the world—the Western Ramganga in Corbett Park, Uttar Pradesh.

We fished for the *putitor mahseer* [*Barbus* (*Tor*) *putitora*—Ham.] and had, perhaps, our best fishing trip ever, both from the size of the 'bag', scenery enjoyed and wildlife seen.

Most of the larger fish taken we released including *mahsser* of 28, 26 and 24 pounds, the 26 pounder having something I have never seen before. This was two very distinct holes just behind the dorsal fin, each being about 5 mm in diameter and about 4 cm apart. The wounds were not of recent origin, being partially healed. It was clear to us that this fish had been attacked by an otter—which abound in the Ramganga—but had managed to break loose.

Even more unique, however, was our experience in sighting two *distinctly copper coloured* fish!! These two fish were part of a school of normally coloured *putitor mahseer*, ranging in weight from about 4 to 12 pounds. The two copper coloured fish were around 4 and 6 pounds in weight respectively and there was no question in our minds that they were *mahseer*. They were seen at very close hand—perhaps 10 feet, in the crystal clear water in the gorge above Gairal. In fact we took a 5 pound *putitor mahseer* from this very school. There was no mistaking these fish with the black *mahseer;* I have seen enough of the melanistic variety in the Ramganga to know that.

Is it within the realm of possibility that there are to be found in the Ramganga a new species of *mahseer?* Or could this have been the 'copper *mahseer*' [*Barbus* (*Tor*) *mosul*—Ham.], hitherto found only in Assam?

Oddly enough, on thinking back, I can recall that, on my very first expedition to the Ramganga, in 1952 if memory holds good, I landed a small (3 pound) copper coloured mahseer just above the Forest bungalow at Gairal. Unfortunately, in those days, I had not read the late Dr. Sunder Lal Hora's series of articles on the *mahseer* in the *Journal* nor Thomas's ROD IN INDIA or MacDonald's CIRCUMVENTING THE MAHSEER—both classics of their kind—and did not pay enough attention to my catch, other than at the dining table.

[In all probability the fish was a copper Mahseer —Eds.]

C. E. McGREADY

4303 Markham Road,
San Antonio,
Texas 78230, USA,
April 9, 1976.

25. LYCOSID SPIDERS FEEDING ON JUVENILES OF THE SKIPPER FROG *RANA CYANOPHLYCTIS* SCHNEIDER

The genus *Lycosa* is represented in Poonch valley by three species namely, *Lycosa barmanica* Thorell, *Lycosa fletcheri* Gravely and *Lycosa rothaka* Tikader. *Lycosa barmanica* is a fairly common species and lives in the crevices in stones, rocky-ledges near rivers, ponds, and road-side pools.

While collecting of amphibians near Poonch town (33°46′ N, 74°5′ E) Poonch valley four large adults of the spider (*Lycosa barmanica*) were seen attacking two juveniles of the common Skipper Frog, *Rana cyanophlyctis*. The spiders attacked the ventral side of the frog juveniles and fed on them voraciously.

We are thankful to Dr. B. K. Tikader, Zoological Survey of India, Poona for help in the identification of the spider species.

B. D. SHARMA[1]
TEJ SHARMA

DEPARTMENT OF ZOOLOGY,
GOVERNMENT DEGREE COLLEGE,
POONCH (J & K),
July 8, 1976.

[1] *Present address*: Department of Zoology, Th. D.S.B. University College, Kumaun University, Nainital, (U.P.).

26. ADDITIONS AND ALTERATIONS TO THE LIST OF BUTTERFLIES OF NAGALAPURAM HILLS PUBLISHED IN VOL. 52 NOS. 2 & 3— AUGUST-DECEMBER 1954

Ypthima asterope mahratta M. 2 only at side of stream in October 1951.

Ypthima chenui Guer. 1 only at 1000 ft up the hill.

Ypthima ceylonica Hew. These were quite common, but they do not have the conspicious white hind wings as the Ceylon specimens do. None of these three were positively identified until 1960 which is the reason for their not appearing in my original list.

Celastrina puspa gisca Fruh. Note the new genus for *Lycaenopsis*.

Celastrina akasa mavisa Fruh. 1 only in May 1950. Checked by Cantlie. This is one of the three unidentified lycaenids referred to in my original list.

Jamides alecto alosina Swinhoe. 1 only at about 2000 ft. This is another of my three unidentified lycaenids.

Logania massalia Doh. The third of my unidentified lycaenids. This is quite an exciting find. When I caught it at Thantipandal I had no idea what it was and sent it to Evans in the B.M. in London. He replied that I must have made a mistake in the locality as *L. massalia* only occurred in Burma! In the same packet were several other butterflies he had identified for me (all Hesperids) and it was not until I was going through my papered hesperids that I came across *L. massalia* again last year. Since then it has been separately identified both by Col Eliot, and by Howarth as true *L. massalia* (not a sub-species) so this is a new record for S. India. There were several flying rather high in a species of fig including a whitish female, but I was only able to catch the one. Although I went to the same place many times thereafter I never saw another.

The two Hesperids I could not previously identify turned out to be:-

Caltoris kumara kumara M. Not rare— I have three.

Pelopidas conjuncta conjuncta Herrich Schaffer. I have two. Both these were identified at the B.M.

BURMA

Shortly after leaving Rangoon in 1957, a friend of mine sent me a very worn specimen of *Yoma sabina vasuki* Doh. caught in his garden in Rangoon. You may like to add this to the list of Rangoon butterflies.

A. E. G. BEST

1, APPLEWOOD CLOVE,
ST. LEMARDS IN SEA,
SUSSEX, U.K.,
July 15, 1976.

27. ADDITIONS AND ALTERATIONS TO MY LIST OF THE BUTTERFLIES OF BOMBAY AND SALSETTE—VOL. 50 NO. 2—DEC. 1951

Valeria valeria hippia F. I have 2 ♀ ♀ form *Philomena,* taken on the path between Vihar and Tulsi Lake in August 1949.

Mycalesis visala visala M. D.S.F. I found one which I had misidentified as "Mineus". This was caught at Vihar Lake in December 1949. I cannot say whether or not it is common in the area as it so closely resembles both "Mineus" and "Perseus" flight and I may well have overlooked it. The only noticeable difference is the long band.

Spindasis ictis ictis Hew. I have two taken on Malabar Hill in February 1956.

Euchrysops conejus. One at Malad, one at Tulsi and two at Kanheri Caves in April and May 1953. These were wrongly labelled "*C. strabo*", of which later species I have several specimens.

Zizeeria maha ossa Swinhoe. I have many of these—all had been wrongly labelled.

Nacaduba kurava canarica. I have one from Powai dated May 1949. This was checked for me by Sir Kieth Cantlie.

Nacaduba nora nora Fd. I have several all from Kanheri in April 1956.

HESPERIIDAE. I had several about which I was doubtful of the correct identifications, but these have now been thoroughly checked, if necessary by dissection of genitalia, mostly by Cantlie and some by Evans.

Bibasis sena sena. One at light about 8.30 p.m. at my flat at Hill Park, Malabar Hill in February 1956.

Hasora chromus ganapata Fruhl at Vihar Lake 15-vii-52.

Tapena thwaitesi thwaitesi M. 1 Tulsi 15-iii-56.

Coladenia dan dan F. at Powai Lake 8-viii-54.

Taratrocera maevius maevius Fab. One at Trombay March 1956. There were several but I only took the one.

Potanthus pseudomaesa pseudomaesa M. One only at Kanheri Caves March 1956. Genitalia checked by Cantlie.

Telicota colon colon Fab. One at Trombay, 2 at Vihar Lake. Genitalia checked by Cantlie.

Telicota ancilla bambusae M. This is now the correct name for what I listed as "*Astycus pythias bambusae*". My specimens were dissected and checked by Evans himself.

Borbo cinnara Wallace. This is the correct name for the one I listed as "*Baoris zelleri cinnara*". It seems rare in Bombay.

Borbo bevani M. This is quite common. I have 4 males all from Vihar Lake in April 1956.

Pelopidas agna agna M. I only have one male taken at Malad in May 1956. Checked by Evans. It is probably quite common.

Pelopidas mathias mathias Fab. This is also probably quite common. Both my specimens were checked by Evans.

Caltoris kumara kumara M. One at Malad September 1949. I did not include this in my previous list as it was not identified by Cantlie until 1958. It must be rather rare in Bombay as I never came across another.

1, Applewood Clove,
St. Lemards in Sea,
Sussex, U.K.,
July 15, 1976.

A. E. G. BEST

28. ON THE SPECIFIC IDENTITY OF TERMITE *RETICULITERMES ASSAMENSIS* GARDNER (ISOPTERA: RHINOTERMITIDAE: HETEROTERMITINAE) FROM ASSAM, INDIA

(*With a text-figure*)

Introduction

Gardner (1944) described a new species *Reticulitermes assamensis* from Sadiya, Assam, which was incidently the first record of the genus from India. Snyder (1949) in his catalogue of termites, placed it under *R. chinensis* Snyder as a synonym. As there was no other published record of this synonymy I inquired from Snyder the basis for the synonymy and was informed that the synonymy was based on information from Prof. Emerson's card catalogue and it was not based on the examination of actual material.

Following Snyder, other workers Roonwal & Pant (1953), Ahmad (1958), and Roonwal & Chhotani (1962) treated this species as synonym of *R. chinensis.* I have examined and compared the cotypes of *R. assamensis* with paratype material of *R. chinensis,* and found that the soldiers of the former differed from that of the latter species in one essential respect, namely the frontal region being strongly swollen, phragmatic and steeply sloping in front. Hence I feel that *R. assamensis* deserves a distinct specific status. Since Gardner did not select any holotype. I have selected one of the cotype soldiers as *lectotype* and redesignated the rest of the material. The key to Indian species based on soldier caste has been included.

Reticulitermes assamensis Gardner

1944. *Reticulitermes assamensis* Gardner,

J. C. M. *Indian J. Ent.* 6:105-106, *Type-locality*: *India, Assam* (Sadiya).

1949. *Reticulitermes chinensis* Snyder; Snyder, T. E. *Smiths. Misc. Coll. 112*:71. (Material from India only).

1953. *Reticulitermes chinensis* Snyder; Roonwal, M. L. and G. D. Pant, *Indian* For. *Leaffl.* (*Ent.*), No. 121: pt. 9:54.

1953. *Reticulitermes assamensis* Gardner; Rattan Lal and R. D. Menon, *Catal. Indian Insects*. Part 27 (*Isoptera*): 31.

1958. *Reticulitermes chinensis* Snyder; Ahmad, M. *Biologia. 4*(1):71-72.

1962. *Reticulitermes chinensis* Snyder; Roonwal, M. L. and O. B. Chhotani, *Proc. Nat. Inst. Sci. India,* (B) *28*(4):301-302.

1962. *Reticulitermes chinensis* Snyder; Mathur, R. N. and R. S. Thapa, *Indian For. leafl.* (*Ent.*), No. 167:27.

MATERIAL

(A) *Type-specimens*

(I) Three soldiers (2 in spirit and one on card) and several workers (all cotypes) from Sadiya, Assam, India, (No. J.C.M.G. 1750), 14-xii-1933. Det. J.C.M. Gardner.

(II) Three cotype workers from the cotype lot and with the same data as in "Material No. 1". (From Prof. Emerson) Det. as *R. chinensis.*

(B) *Other material*

(III) Seven soldiers and several workers from Samsing, Bengal, coll. Balwant Singh, II. 1934. *Ex.* Unknown wood. Det. J. C. M. Gardner.

Description

1. *Imago*:

Unknown.

2. *Soldier*: (Fig. 1; Table 1).

GENERAL: Head-capsule pale yellow to yellowish brown, except for the ridged frontal portion; mandibles deep reddish brown, paler basally; antennae, labrum, thorax, abdomen and legs paler than head-capsule. Head-capsule moderately, thorax and abdomen rather densely hairy. Total body length *c* 5.25-6,20 mm.

HEAD: Head-capsule subrectangular, much longer than broad; sides subparallel, widest near the posterior third, very slightly incurved anteriorly near the base of antennae; postero-lateral corners rounded; posterior margin straight; frontal region strongly phragmatic, swollen and steeply sloping in front. *Fontanelle*: Minute, placed at the base of swollen part of frons. *Antennae*: With 15-16 segments; pilose; in 15-segmented antennae, segment 2 cylindrical, about one and a half times as long as 3; 3 ring like, shortest; 4 subequal to 5; in 16-segmented condition, 2 slightly longer than 3; 3 almost twice as long as 4; 4 shortest, ring like; 5 shorter than 6; rest progressively increasing in length; last ovate. *Clypeus*: Postclypeus indistinctly separated from frons, subrectangular. *Anteclypeus* hyaline; anterior margin straight. *Labrum*: Tongue shaped; as long as or slightly longer than broad; broadest near the base; sides convex, gradually converging anteriorly into a blunt tip; apex with two long hairs. *Mandibles*: Sabre shaped, short and stout, narrowing anteriorly into a weakly incurved apices; length almost half or slightly more than half the head-length. Left mandible with inner margin smooth and with 3-4 basal crenulations. Right mandible with smooth and straight inner margin; with a rudimentary tooth like projection near the base. *Postmentum*: Club shaped; broadest near the apical fourth; more than twice as wide anteriorly as the long narrowed posterior part; anterior margin substraight; posterior margin concave.

THORAX: *Pronotum*: Flat; trapezoid; distinctly narrower than head-width (pronotum-head with index 0.69-0.80); widest anteriorly; sides converging posteriorly; anterior margin with a prominent median notch; posterior margin weakly to distinctly emarginate medially. *Mesonotum*: Narrower than pronotum;

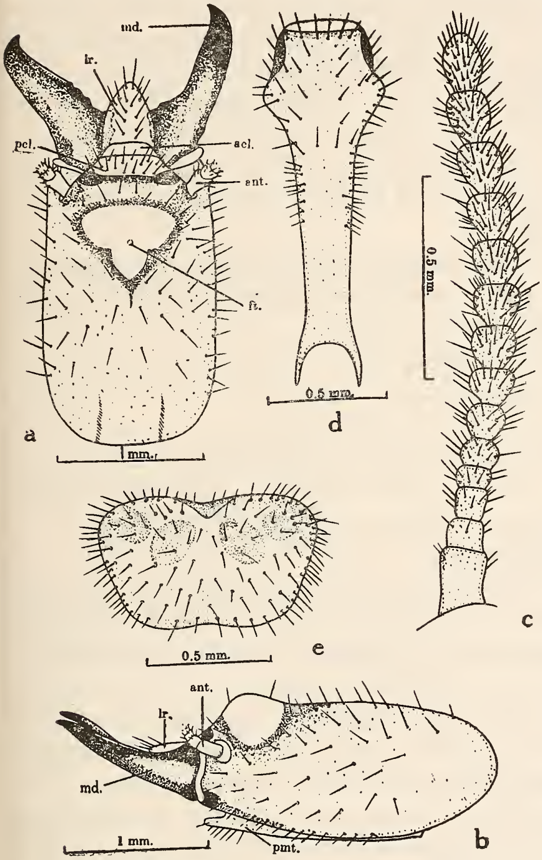

Fig. 1. Caste-Soldier: a. Head capsule, dorsal view; b. Head-capsule in side view; c. Antenna; d. Postmentum; e. Pronotum, in dorsal view. acl. anteclypeus; ant. antenna; ft. fontanelle; lr. labrum; md. mandibles; pcl. postclypeus; pmt. postmentum.

posterior margin substraight to weakly emarginate. *Metanotum*: Narrower than pronotum but broader than mesonotum; posterior margin weakly convex. *Legs*: Long, slender and pilose; tibial spurs 3:2:2; tarsi 4-segmented.

ABDOMEN: Elongate; densely hairy. *Cerci* 2-segmented; *c* 0.10-0.12 mm long. *Styli* one jointed; length *c* 0.08 mm.

TABLE 1

BODY-MEASUREMENTS (IN MM) AND INDICES OF SEVEN SOLDIERS OF *Reticulitermes assamensis* GARDNER.

Body-parts	Range	Mean
I—*General*		
Total body-length *c*	5.25-6.20	5.60
II—*Head*		
Head-length with mandibles	2.75-3.23	2.93
Head-length to lateral base of mandibles	1.80-2.15	1.94
Maximum width of head-capsule	1.08-1.25	1.17
Height of head-capsule	0.88-1.05	0.96
Head-index—I (width/length)	0.56-0.64	0.60
Head-index—II (height/width)	0.78-0.91	0.84
Head-index—III (height/length)	0.43-0.55	0.49
Length of labrum	0.34-0.40	0.37
Maximum width of labrum	0.33-0.38	0.34
Maximum length of mandibles		
(1) left mandible	0.95-1.08	1.02
(2) right mandible	0.95-1.08	1.02
Head-mandibular index—I (left mandible length/head-length)	0.50-0.56	0.53
Head-mandibular index—II (left mandible length/head width)	0.86-0.92	0.88
Min. (median) length of postmentum	1.25-1.45	1.34
Maximum width of postmentum	0.40-0.53	0.47
Minimum width of postmentum	0.15-0.18	0.17
Postmentum index—I (min. width/max. width)	0.31-0.40	0.36
III—*Thorax*		
Length of pronotum	0.53-0.58	0.55
Maximum width of pronotum	0.80-0.95	0.85
Head-pronotum index (pronotum width-head width)	0.69-0.80	0.75
Pronotum index (length/width)	0.61-0.72	0.65

3. *Workers*: (Table 2).

GENERAL: Head-capsule pale yellow to deep straw yellow; antennae, labrum and legs paler than head-capsule; abdomen translucent. Head-capsule fairly, body rather densely pilose

Total body-length *c* 3.50-4.50 mm.

HEAD: Head-capsule subsquarish, almost as long as broad; lateral sides weakly convex, converging posteriorly to rounded posterior margin. *Fontanelle*: Indistinct. *Antennae*: 16-segmented; segment 2 cylindrical, distinctly longer than 3; 4 ring like, shortest; 5 shorter than 6; rest progressively increasing in length; last ovate, slightly longer than penultimate. *Clypeus*: Postclypeus weakly swollen, pilose; length less than half its width. *Anteclypeus* apilose, flat; anterior margin substraight. *Labrum*: Subsquarish, slightly wider than long; broadest in the middle; sides arched; anterior margin convex. *Mandibles*: As in the genus.

THORAX: *Pronotum*: Subtrapezoid, flat; broadest at the anterior margin; anterior margin with a distinct median notch; posterior margin weakly to deeply emarginate medially. *Mesonotum*: Narrower than pronotum; posterior margin substraight to weakly emarginate. *Metanotum*: Broader than pronotum; posterior margin weakly convex. *Legs*: Long, slender and pilose; tibial spurs 3:2:2; tarsi 4-segmented.

TABLE 2

BODY MEASUREMENTS (IN MM) OF 5 WORKERS OF *Reticulitermes assamensis* GARDNER

Body-parts	Range	Mean
I—*General*		
Total body-length	3.50-4.50	3.95
II—*Head*		
Head-length with mandibles	1.30-1.45	1.35
Head-length to lateral base of mandibles	1.00-1.08	1.05
Maximum width of head	1.03-1.10	1.06
Height of head	0.55-0.70	0.60
III—*Thorax*		
Length of pronotum	0.35-0.40	0.37
Maximum width of pronotum	0.60-0.70	0.64

ABDOMEN: Oblong and hairy. *Cerci* 2-segmented; length *c* 0.10 mm. *Styli* one jointed; length *c* 0.08 mm.

Type-specimens

Lectotype: Since no holotype was designated by Gardner one of the cotype soldiers in spirit has been designated as lectotype and deposited in the Entomological Collection of the Forest Research Institute, Dehra Dun.

Lectomorphotype: One worker from the cotype lot and with the same data as in *lectotype.*

Para-lectotypes and *Para-lectomorphotypes*: Two soldiers (one in spirit and one on card) and several workers.

Type-locality:

INDIA: *Assam*: Sadiya.

Geographical Distribution:

Recorded from the following localities.

INDIA: *Assam*: Sadiya (type-locality). *West Bengal*: Samsing. *Meghalaya*: Shillong.

Comparison:

The soldiers of *R. assamensis* Gardner are close to *R. chinensis* Snyder and *R. saraswati* Roonwal & Chhotani but differs as follows:-

From *R. chinensis* Snyder.

The frontal region in the head-capsule of *R. assamensis* Gardner is strongly swollen, phragmatic and steeply sloping in front.

From *R. saraswati* Roonwal & Chhotani.

(i) Pronotum-head width index higher (0.69-0.80 *vs.* 0.67 in *R. saraswati*).

(ii) Larger species.

Key to Indian species:

Soldier Caste:

1(2) Pronotum—head width index higher (0.69-0.80): larger species (total body-length 5.25-6.20 mm; head-length without mandibles 1.80-2.15 mm; head-width 1.08-1.23 mm)

.... *R. assamensis* Gardner

2(1) Pronotum—head width index low (0.67); smaller species (total body-length 4.00 mm; head-length without mandibles 1.53 mm; head-width 1.00 mm) .... *R. saraswati* Roonwal & Chhotani

ACKNOWLEDGEMENT

I express my deep sense of gratitude to Dr. P. K. Sen-sarma for the keen interest evinced in the work and for the many useful suggestions offered.

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July 29, 1976.

M. L. THAKUR

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29. SEX REVERSAL AND HEXAGONAL LAC CELL FORMATION

Dr. R. K. Varshney had the kindness of favouring me with a reprint of his joint communication with Dr. Gauri Ganguly entitled, Hexagonal cell of lac insect, published in this *Journal* (Ganguli & Varshney 1974). Such a cell was first reported by me (Mahdihassan 1923), but mistaken as revealing parthenogensis. Later on it was found that a generation may contain such a majority of winged males that, it becomes a problem for the species to continue in the absence of enough females. However the larva of winged male, when isolated, was able to show sex reversal which permitted the species to continue. Such a cell acquired a hexagonal or crown shaped form as illustrated by Mahdihassan (1930). Now different species of lac insects show variations in their sex-ratios. The primary factor rested with the insect species, and next came humidity, while the nature of host plant proved to be *third in importance*. Since the insect factor became most important, lac insects were recognized as divisible into at least six species.

1. *Kerria communis* Madh., found in Travancore (Kerala), Madras (Tamil Nadu), Cocanada, Hyderabad, (A.P.), Maharashtra and Goa. It has several host plants.

2. *K. mysorensis* Madh., growing mainly on *Shorea talura* in Karnataka.

3. *K. nagoliensis* Madh., growing chiefly on *Schliechera trijuga;* in Central India.

4. *K. chinensis* Madh., on several host plants, in Assam, South China, Burma, Thailand and Vietnam.

5. *K. sindica* Madh., cultivated on *A. arabica* in Sind; found occasionally on *Albizzia lebbek, Zizyphus jujuba and Anona*

squamosa, but not on any *Ficus* sp.

6. *K. ficii* Green, cultivated in Jammu on *A. catechu,* found also in Rajasthan, reported both from Monghyr (Bihar) and Delhi on *F. religiosa.* This insect shows two physiological forms, red and yellow, which seem to be interchangeable. The first five species were grown on a common host plant, *Acacia farnesiana,* and proved to be different from one another. Particularly after five years on this host, *K. nagoliensis* produced its characteristic thick encrustation. Such an experiment was not reported before, nor has been tried subsequently, so that contrary attempts, to class all lac insects as one species, challenges even systematists who, at least as far as *K. ficii* is concerned, have admitted it as a distinct species. The species which grows in northern India, on *Butea frondosa* and *Zizyphus jujuba,* was not studied by me. I designated it as *K. indica,* almost recording it to be an unknown species. Thus there was for me some seven species, six for certain. Now the greatest variation in sex-ratio was found in *K. communis.* It is the one species of lac which never repays the trouble of artificial cultivation any where, because of its regularly producing males in such preponderance that no female is left to offer a crop of lac. The winged male, in the first larval stage, reverses its sex so that, already in the second larval stage, it appears abnormal, as has also been illustrated (Mahdihassan 1930).

Since 1954 I have been studying the lac insect of Sind. Next to *K. communis* the Sind insect shows preponderance of male and is a poor species for cultivating lac. Here again crown-shaped cells are common. At Sohagpur I was able to collect a fully formed crown shaped cell of *K. nagoliensis,* growing on *S. trijuga.* Chamberlin (1923-25) created a new species, *K. rangoonensis,* examining material belonging to *K. chinensis* from Burma. This was the crown shaped cell of *K. chinensis* and not a new species. Thus Chamberlin has unwittingly recognized a crown shaped cell, about 1923, mistaking it for a new species. Strangely enough, he himself, nor any subsequent entomologist, has recognized *K. chinensis* as a new species. I am unaware of any work by modern Chinese entomologists which probably does exist. During eight years of work on *K. mysorensis* I could collect only three crown shaped cells of this species and, as before, only as single cells. On the contrary *K. communis* could deliver innumerable crown shaped cells but again all as isolated specimens. Thus *K. ficii* Green, was left as the only species where the crown shaped cell was not observed, explained by the relatively poor material handled by me. If search be made even this species would reveal crown shaped cells. I have collected both yellow and red wingless male insects. The crown shaped cell belongs to the larva of winged male, which I could not observe. It is this which changes its sex as larva. It would be easier to establish that among its winged males the yellow form predominates, and correspondingly crown shaped cells would be coloured yellow more often than red. Now all workers on lac ignore not only the species I have differentiated but even *K. ficii* which was recognized by E. E. Green and confirmed by Chamberlin, both as systematists.

To discover crown shaped cells merely on new hosts plants would easily enable me to produce a previous list of 60 trees (Mahdihassan 1936) whereas biologically speaking these belong to *K. communis.* In this light observations by Chauhan and others do not assign proper biological origin; host plant is certainly not important from the fact that the crown shaped cell belongs to the generation of winged male insects, and here some species are prone to produce more than others. When the season is rainy or humid, at the time of fertilization, the generation issuing would contain winged males in the majority and some of these larvae will transform later into crown shaped cells. Thus the crown shaped cell was recognized by me in 1923, and unwittingly by Chamberlin (Mahdihssan 1923) independently about the same time. In an article, appearing in this *Journal* (Mahdihassan 1948) to which Ganguly and Varshney also refer, I offered evidence to show the same was unwittingly illustrated in the earliest illustration of lac, dated 1567, for which credit goes to C. Clusius. I have traced the history of this illustration. Garcia sent no illustration nor any specimen of lac to Clusius. The latter had some collected from the market in Europe and illustrated as three samples. At any rate the additional photographs of encrustations I have offered (Mahdihassan 1948) do support the presence precisely at the end of an encrustation of a crown shaped cell seen in the wood-cut of 1567.

Every species of lac produces winged males. Some species produce such males in excess. Their larvae, when isolated, tend to reverse their sex and produce single hexagonal and crown shaped cells. It was first recorded in 1923, fully illustrated in 1930, and an old illustration of 1567 was interpreted, in 1948, as showing the same. The crown shaped cell is to be traced to an *insect species and not to any host plant.*

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North Nazimabad,
Karachi 33, (Pakistan),
November 11, 1975.

S. MAHDIHASSAN

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30. THE BLACK ANT, *CAMPONOTUS* SP. FEEDING ON UREA

In a new suburb of Karachi which was barren land some ten years ago, there is now a well established plant nursery, hedged by two thorny trees, *Spicigera juliflora,* a New World plant, now domiciled, and *Acacia arabica.* Both are about fifteen feet high and their lower branches are heavily infested with colonies of the membracid, *Oxyrhachis taranda,* in turn visited by the black ant, *Camponotus compressus.* The excreta of the membracid is "honey dew", on which the ant feeds. Along the adjoining roads *Dipterocarpus sisoo* are planted as avenue trees, many of which have, at their base, a nest of the above ant. The tree is attacked by another membracid identified as, *Gargara mixta,* whose honey dew also attracts the ant. In this case however the membracid has to be searched for, as they are few in contrast to the heavy population of *O. taranda.* In a garden, just opposite the nursery, there is an *Anona squamosa* tree, bearing encrustations of the lac insect, *Kerria sindica.* Its excreta, or "honey dew", also feeds the ant. However there is a marked difference in the appearance of host plants on which lac was growing and those which supported the membracid, *Oxyrhachis taranda.* In Karachi both these insects can thrive well on *Acacia arabica* so the nature of the host plant would remain the same. The foliage of trees bearing lac appeared sooty. This was traced to drops of "honey dew" of lac insects falling on the branches below. Enough honey-dew could be collected and analysis showed the presence of glucose and fructose. These sugars having fallen on leaves produced the growth of the saprophytic black fungus, *Aspergillus niger*. The trees bearing thick colonies of *O. ternata* membracid, on the other hand, showed normal clean foliage. Its honey dew could not be collected enough for analytical purpose. The absence of any such growth of *Aspergillus* indirectly suggested the absence of sugars in the liquid excreta of the membracid.

In the above city suburb there was an open ground where some nomads had pitched tents and were using open-air latrines. The *Camponotus* ant was found feeding on human urine. It was further established that the ant was a regular visitor to urinals in the neighbouring houses. This suggested that the ant must be feeding on urea and further that urea must be a constituent of the "honey dew" of the membracid. Ammonia is the degradation product of animal protein metabolism but there is proper provision for ammonia to be synthesized into harmless urea which, in the case of man, is undertaken by the liver. In the case of insects Malpiglian tubes seem to play this role. At any rate the fact first to be established was whether *Camponotus* does feed on urea.

Some urea powder was dropped near a nest of *Camponotus* ants but the reaction was not very decisive. Finally a solution of carboxy methyl cellulose, in water, was spread over a spot and urea dropped at one end so that, by the time it dissolved to reach the boundary of that spot, different degrees of urea concentration would occur. The ant was at once attracted to such urea solution. Thus there was no doubt left that *Camponotus compressus* feeds on urea, and accordingly behaves like a scavenger as far as urine is concerned. Very probably the honey dew of membracid is also rich in urea.

Extending the above observations I tried to feed the ant on cane sugar which again attracted the insect. It also took to "liquid glucose" but would not touch Glaxo's preparation "Glaxose D", which is glucose powder fortified with calcium glycerophosphate. The ant was attracted by sorbitol, speciallly 60 per cent liquid sorbitol, manufactured by Merck, Darmstadt. Surprisingly lactose, either as powder or as solution, was refused. Soft cheese but not milk, gave a positive reaction. None of the following aminoacids were acceptable, glycine which is sweet, lysine, and methionine, others were not tried. Thinking that some thing sweet would appeal, soluble saccharine was offered but the response was negative. Whereas urea was welcomed, uric acid was completely ignored.

Urea, a degradation product, to become food of an insect does require an explanation. Incidentally Schmidt-Nielsen of Duke University, U.S.A., found that "whereas most animals with lower urine output cannot urinate enough to expel waste urea the camel can recycle much of his urea through the liver to make new protein thereby keeping achead on both food and water." However it is generally the practice that if urea is added to cattle fodder it results in improving nutrition. The intestinal bacterial flora of cattle can synthesize urea into proteins and probably the same is the case with the camel. Coming to the oriental species of the genus *Camponotus* they all contain intercellular symbiotic bacteria in the intestine so that it is most likely that these can effectively synthesize urea into protein. This would at once explain how *Camponotus* species alone attend upon the colonies of the two membracids mentioned while other ants do not. Work on the isolation of the symbiotic bacteria and their role in the metabolism of the ant will be reported on later.

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31. ON THE LARVA OF *TRAMEA VIRGINIA* (RAMBUR, 1842) FROM INDIA, WITH NOTES ON THE LARVAE OF INDIAN REPRESENTATIVES OF GENUS *TRAMEA* HAGEN, 1861 (LIBELLULIDAE: ODONATA)

(*With ten text-figures*)

Larva of *Tramea virginia* Rambur is described and illustrated on the basis of material from Dehra Dun Valley, India. Notes on the larvae of Indian representatives of the genus is appended (including *basilaris burmeisteri* Kirby and *similata* Rambur).

Introduction

Genus *Tramea* Hagen, 1861, is widely spread in circumtropical region. It comprises a number of closely allied species with migratory tendencies and having almost identical type of larval habitats like lakes, perennial monsoon ponds and marshes.

Fraser (1936) recorded two representatives of the genus *Tramea* within Indian limits, namely, *T. basilaris burmeisteri* Kirby and *T. limbata* (Desjardins); *T. virginia* was recorded by him (loc. cit.) from Burma, throughout Indo-China, China and Formosa. However, recently *T. virginia* has been recorded from various Indian localities namely, Kangra, Himachal Pradesh (Prasad 1976) and Dehra Dun Valley, Uttar Pradesh (Singh & Prasad 1976). Lieftinck (1962) has discarded the specific status of *T. limbata* from E. Asia and Pacific and has designated Indian representative of *T. limbata* as *T. similata* Rambur (per. com.).

Fraser (1919) has briefly described larva of *T. similata* (sub. *limbata*) from Pune (Poona), India; Kumar (1973) has given detailed description and illustration of larva of *T. basilaris burmeisteri* Kirby from the Dehra Dun Valley, India. In the present paper the larva of *T. virginia* is being described for the first time from an Indian locality, Needham (1930) had earlier given a brief description of it from Soochow in China. An attempt has also been made to provide taxonomic characters for the differentiation of these closely resembling larvae of Indian representative of the genus.

Tramea virginia (Rambur) Figs. 1-10

Material: Larvae 1♂, 1♀ (both emerged in the laboratory), perennial pond, Gorakhpur Dehra Dun, India, 26-iii-1976. A. Kumar Coll.; 4 preserved in spirit, same data as above.

Description: Length 26.8 mm (26.0-28.2 mm); width 9.1 mm maximum across 6th abdominal segment. *Colour*: Yellowish green with grey markings.

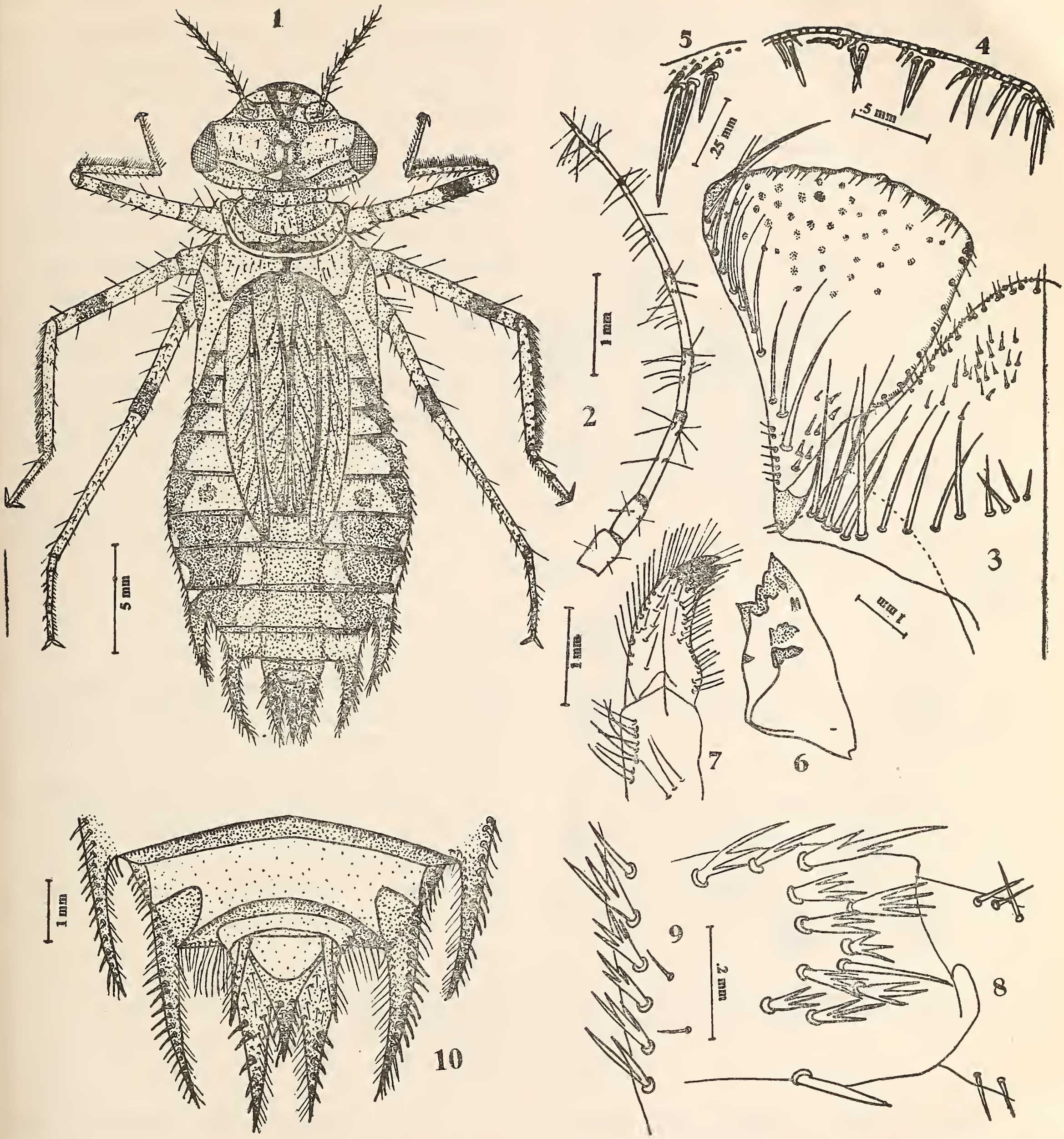
Head: Widest over the vertex across the eyes. Length 5.4 mm, width 7.8 mm. *Eyes*: grey; vertex-sienna; *Antenna* (Fig. 2) long, filiform. The measurement (in mm) of segments being 0.43, 0.47, 0.93, 0.63, 0.83, 1.30, and 0.90; total length 5.49 mm. *Labium* (Figs. 3 & 4) premental setae 14 + 14, 4 median premental setae of either side shorter than half of size of marginal setae, spiniform setae present in mid-anterior region of prementum. Distal margin of prementum strongly convex, bears a row of claviform setae. Palpal setae 11 & 11; distal margin of palpus formed into 12 crenations, each of which, except a few posterior ones, bear 3 very short and 2-3 long claviform setae (Figs. 4 & 5). A number of spiniform setae present at the base and lateral margins of palpus. Movable hook long and slender. *Mandible* and *Maxilla* as shown in figure (Figs. 6 & 7).

Tibial comb: (Fig. 8) comprises a number of compactly arranged furcate setae; tarsi (Fig. 9) beset with furcate and a few simple setae on their outer side. *Abdomen* oval, yellowish with grey spots; spines on segments 8 & 9. Lateral spine of segment 9 extends almost up to the distal end of anal appendages (Fig. 10) these spines thickly beset with simple spinules on their outer side and long thin setae on the inner side.

Anal appendages: (Fig. 10) a little darker than abdomen; epiproct distinctly shorter than paraprocts. *Epiproct* length 2.2 mm, width 1.4 mm (at base); *Paraprocts* length 3.1 mm. Epiproct and paraprocts beset with spinate setae. *Biology*: Larvae have been collected from the perennial muddy ponds at the villages Gorakhpur and Badripur, Dehra Dun, India. Larvae are active swimmers and dwell amidst the weeds. Emergence occurs for a short period in early spring, i.e., end March to beginning of April.

Solitary adults, flying low over the water area, were observed on these ponds throughout April. Coitus was observed on 27-iv-76, when a pair was copulating, perching on a bush about 3 metres above the ground near the pond. Earlier the same pair was seen flying in tandem about 15 m above that bush. Oviposition occurs in tandem, a few pairs were seen flying in this position over the pond.

Diognosis: Larvae of closely allied Indian species of genus *Trame*a appear quite alike. With the present description of *T. virginia*, now the larvae of this and *T. basilaris burmeisteri* are fairly well known. However, Fraser's (1919) description of *T. similata* (sub. *lim-*



Figs. 1-10. Last Instar larva *Tramea virginia* (Rambur): 1. Larva (D.V.) Male; 2. Antenna; 3. Labium (left half); 4. Enlarged view distal margin palpus; 5. Enlarged view one crenation palpus; 6. Mandible; 7. Maxilla; 8. Tibial comb; 9. Setae tarsi; 10. Anal appendages (male).

bata) is not adequate. Since he has not taken into consideration taxonomically important characters like number of premental and palpal setae, etc. However, with our present knowledge the larvae of *T. virginia* could be differentiated from that of *T. basilaris burmeisteri* on the basis of body size (larva of the latter being smaller 22.0-22.4 mm); number of premental and palpal setae (their number in case of *T. basilaris burmeisteri* being 13-13; 10 & 10) and larval habitat; *T. basilaris burmeisteri* typically breeds in Ephemeral monsoon ponds, ovipositing in June-July while its emergence occurs from these ponds in September-October.

Though the description of the larva of *T. similata* is not adequately known, with the known characters, larva of *T. virginia* can be differentiated from it on the basis of number of crenations at the distal margin of palpus; these are 18 in case of *T. similata* while only 12 in *T. virginia*.

Acknowledgements

Our grateful thanks are due to the Director, Zoological Survey of India, Calcutta, for permitting us to undertake the present study, and to Dr B. S. Lamba, Deputy Director, Northern Regional Station, Zoological Survey of India, Dehra Dun, for providing the laboratory and field facilities. One of us (A. K.) is also thankful to Dr M. A. Lieftinck, Netherlands, for his advice on Indian species of *Tramea*.

ARUN KUMAR
MAHABIR PRASAD

Zoological Survey of India,
Northern Regional Station,
Dehra Dun 248 001,

August 25, 1976.

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32. COLOUR ABERRANCE IN *COCCINELLA SEPTEMPUNCTATA* L. (COLEOPTERA: COCCINELLIDAE)

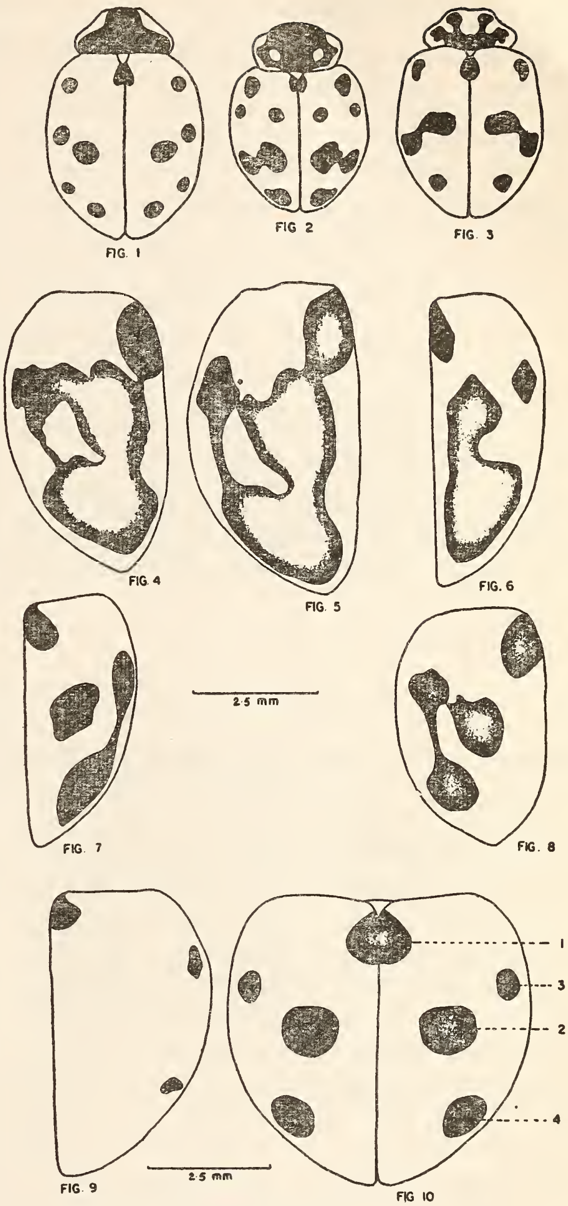
(*With ten text-figures*)

The individuals of the above species depict a variety of colour patterns. The fact has been established by making constant observations on colour aberrance in a huge population of *Coccinella septempunctata* L. throughout the semi-desert areas of Punjab namely, Bhatinda, Abohar and Fazilka during insect collection surveys in 1974-75 on the lines as reported by Balduf (1942) in *Diabrotica* 12-*punctata* and Edona & Soans (1973) in *Henosepilachna sparsa* Herbst. On comparing the abnormal specimens with the usual normal colour type, an interesting phenomenon of marked colour aberrance and coalescence in the usual 7-spotted, *C. septempunctata* L. can be explained not only in the design of elytra but in the head capsule too.

The coalescence was much less in the distantly placed two lateral spots No. 3 & 4 (Figs. 8, 7) in comparison to the medially placed spot No. 2 with others (Figs. 6, 4, 5). The scutellar spot No. 1 also showed coalescence through rarely with the median spot No. 2 (Figs. 4 & 5). Besides elytral pigmentation and coalescence, colour pigmentation in the head-capsule too presented variations (Figs. 2 & 3). The nonpigmented spots, as suggested by Edona & Soans (1973) were also observed in a few cases (Fig. 1).

Kapur (1959) while describing the geographical variations in the colour patterns of some Indian lady bird beetles attributes the geographic isolation as a factor for the distinction of a new species on the basis of colour patterns.

In compliance with Edona & Soans (1973) during the present investigations it is suggested that the colour aberrance and pigmentation distribution is simply due to the severe hot climatic effects i.e. heat and less of humidity in deserts which certainly affect the physiology of different developmental stages and concurrently an unequal flow of pigmentation follows which in turn brings about coalescence (Figs. 2, 3, 4, 5, 6, 7 & 8) and scarcity (Fig. 9) in spotting pigmentation. It is a point of interest to note that this phenomenon of colour aberrance and coalescence, so far has been found only in females of *C. septempunctata* L. and not in males.



Figs. 1-10. *Coccinella septempunctata* L.

ACKNOWLEDGEMENTS

We are most grateful to Dr S. S. Dhillon, Professor and Head, Zoology Department, Punjabi University, Patiala, for constant encouragement and facilities to work. Our thanks are also due to C.S.I.R. for financial support.

ZOOLOGY DEPT.,
PUNJABI UNIVERSITY,
PATIALA, (PB.),
February 26, 1976.

J. P. SINGH
J. S. MANN

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33. THE PREDATORY CENTIPEDE *SCOLAPENDRA* SP.

The large yellow and black-banded centipede of the genus *Scolapendra* is an active and voracious predator of small animals and ground nesting birds during the monsoon in Saurashtra. Nestlings of such birds as larks are in particular danger. I still vividly remember a medium sized toad grasped by the hindquarters by a large *Scolopendra* which had half its four-inch body firmly attached in a crevasse. The toad was held by several pairs of pincer like legs and was being eaten alive —a large wound had already been opened in the victim's left flank by the feeding centipede when I came across the scene! Unfortunately, it was dusk and though I had a camera, I had no flash apparatus to photograph the event.

C/o. WORLD WILDLIFE FUND,
GREAT WESTERN BLDG.,
S. B. SINGH ROAD,
BOMBAY 400 023,
September 1, 1976.

LAVKUMAR KHACHER

34. OCCURRENCE OF *BIPALIUM KEWENSE* MOSELEY (TURBELLARIA: TRICLADIDA) IN INDIA

Bipalium kewense Moseley, a cosmopolitan species has been recorded from Malaya, Indonesia, and in green houses throughout the United States. It is being reported in the present paper for the first time from Jammu and Kashmir State. It has, however, been collected by us from different localities of Jammu Province only, where it appears to be endemic.

Material: 24 exs Poonch (986.1 m) 10 exs Krishnaghati (1645 m) 4 exs Mendar (930 m).

Several individuals were collected on Poonch valley in humid areas where it remains hidden under logs, leaves, and grass etc. Some specimens were also collected from the gutters and drains in urban areas. The species is seen mainly during the monsoon months and is active in the less intensity of light.

In the available literature on the planarians of India there is no reference to the occurrence of any land planarians from the Jammu and Kashmir region. We are therefore, recording, the occurrence of this species in India in general and J & K State in particular.

Acknowledgement

Our thanks due to Dr R. H. Parker, Asst. Director, British Museum (Natural History) for help in the identification of the species of planarian and comments on it.

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June, 28, 1976.

B. D. SHARMA[1]
T. J. SHARMA

[1] *Present address*: Department of Zoology, Th. D.S.B. University College, Kumaun University, Nainital, (U.P.).

35. *ERIA PUDICA* RIDL. (ORCHIDACEAE)—A NEW FIND FROM KHASI AND JAINTIA HILLS

(*With a text-figure*)

An unidentified sheet at the National Herbarium collected by *Prain's collector* (No. 318) in June 1899, from Omtey, Jaintia Hill, Meghalaya has been identified after a critical study and examination to be *Eria pudica* Ridl. Further, the specimen was compared with and found to be identical in characters to the live plant of *E. pudica* received from the Director, Singapore Botanical Garden, in 1965, and now growing in National Orchidarium, Botanical Survey of India, Shillong.

The discovery of this orchid in Meghalaya, outside its type locality, that is Singapore, is highly significant from the phytogeographical point of view. On account of its rarity and to facilitate further search for this species in our country, a detailed description with illustration is furnished.

Eria pudica Ridl., Journ. Linn. Soc. *32*: 294. 1896; Fl. Mal. Penins. *4*:85. 1924; Holttum, Rev. Fl. Malaya *1*:391. 1957.

Epiphytes. *Pseudobulbs* 4 cm long, crowded, cylindrical with several nodes covered by papery sheaths, unifoliate. *Leaves* 7-13 × 1.5-

2 cm, oblong-lanceolate, bifid at apex, coriaceous, *petiole* 4 cm long. *Inflorescence* erect, arising from the node; *scape* and *raceme* 6 cm long, pubescent; *floral bracts* ovate-acuminate, pubescent equalling or little shorter than the pedicellate ovary. *Flowers* many, small, white, somewhat noded; *sepal* white woolly tomentose outside, glabrous inside; *dorsal* shorter and smaller than laterals, 4 × 2.5 mm, apiculate, gland dotted, obscurely 5-nerved, *laterals* 5 × 3 mm broad, ovate, apiculate, adnate to the base of the lip forming a mentum, gland-dotted, 5-nerved; *petals* 4 × 2 mm, elliptic-oblong, falcate, shallowly bilobed at apex, 3-nerved glabrous (nerves raised and purple); *lip* 3.5 × 3 mm, white flushed with purple, adnate to the base of the column by a short claw, 3-nerved; *sidelobes* obscure, *midlobe* reflexed, fleshy, ovate, obtuse; *column* erect, very short; *anther* depressed; *stigma* broad; *pollinia* 8, unequal, barely cohering by sticky masses at their bases; *pedicel* 3 mm long, woolly tomentose;

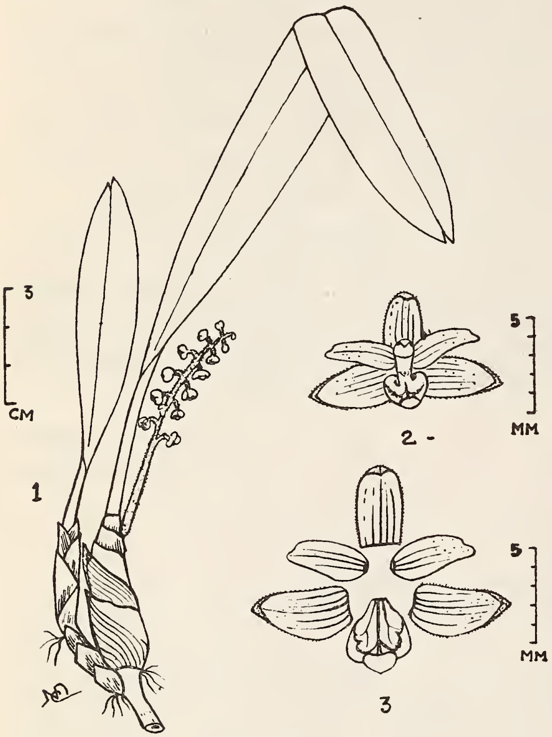

Fig. 1. *Eria pudica* Ridley. 1. Plant, x *c* 1/2; 2. Flower, front view; 3. Perigone with lip.

Flowers. June-July.

Distribution. Singapore and India.

Specimens examined. Prain 318 (CAL), Omtey, Jaintia Hill, Meghalaya, June 1899.

ACKNOWLEDGEMENTS

We are thankful to Dr S. K. Jain, Deputy Director, Botanical Survey of India, Eastern Circle, Shillong, for the facilities and to the Deputy Director, Central National Herbarium for the material for study.

N. C. DEORI
C. L. MALHOTRA

BOTANICAL SURVEY OF INDIA,
SHILLONG,
August 22, 1974.

36. A NOTE ON *LOLIUM DUTHIEI* (HACK. EX HOOK. F.) BARUNA BHATTACHARYA

(*With a text-figure*)

During a study of the genus *Lolium* Linn. occurring in India I came across 2 sheets bearing the field number 10846 collected by Duthie from Kashmir. They have been identified as *Lolium duthiei* (Hack. ex Hook. f.) Baruna Bhattacharya. J. D. Hooker had validated Hackel's epithet by giving a short description, treating it as a variety of the species *Lolium rigidum* Gaud. But after critical examination of sheets on which the variety was based, it has become clear that it differs from *L. rigidum* proper in a number of characters and therefore deserves a specific status.

The differentiating characters between the two taxa are given below:

Bor (1960, p. 546) has commented on this taxon thus: "The specimen called var. *duthiei* by Hook. f. in THE FLORA OF BRITISH INDIA 7, 364 (1896) is, I think, *L. persicum*". But *L. rigidum* var. *duthiei* is easily separable from *L. persicum* by its smaller size, strict, erect spikes, closely appressed spikelets and fewer number of flowers in a spikelet.

Turrell (1968) in his observation has remarked that *L. rigidum* Gaud. var. *duthiei* Hack. ex Hook. f. has affinities with *L. temulentum* var. *gracile* Regel. He further suggested that the characters of *L. rigidum* var. *duthiei* are intermediate between *L. rigidum* Gaud.

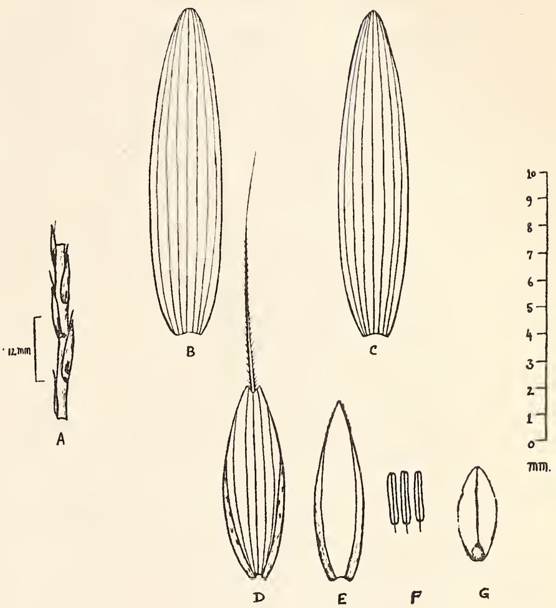

Fig. 1. *Lolium duthiei* (Hack. ex Hook. f.) Baruna Bhattacharya.

	L. rigidum Gaud.	*L. rigidum* var. *duthiei* Hack. ex Hook. f.
Glumes	Shorter than spikelets, oblong	Equal or longer than spikelets, subulate
Lemmas	Awnless, obovate	Awned, oblong, awns weak, 9 mm long
Anthers	2.5-3.5 mm long	1.5-2 mm long
Caryopsis	± 4 mm long, elliptic to oblong	3-3.5 mm long, oblong
Spikelets	5-10 flowered, awnless, longer than inter-nodes	3-4 (-5)-flowered, awned, shorter or equal to the length of the internodes
Spikes	12-22 cm long, 20-30 spikelets in a spike	6-18 cm long, 13-19 spikelets in a spike
Rachis	Curved, rigid, shallowly hollowed	Straight, slender, terete, strict, deeply hollowed
Ligules	Well developed, 2.2-2.3 mm long	Obsolete, 0.4 mm long

proper and *L. temulentum* var. *gracile* Regel. From the present study it appears to be nearer to *L. rigidum* Gaud. in habit than that of *L. temulentum* var. *gracile* Regel from which it differs in many characters.

The differentiating characters are as follows:

The following nomenclature is proposed:

Lolium duthiei (Hack. ex Hook. f.) B. Bhattacharya, STAT et COMB NOV. *L. rigidum* Gaud. var. *duthiei* Hack. ex Hook. f. Fl. Brit. Ind. 7:363. 1896.

Specimens examined. Kashmir, Srinagar, Alt. 5-6000 ft, 8-v-1892, *J. F. Duthie* 10846 (CAL); Kashmir, Srinagar, Alt. 5-6000 ft, 8-v-1892, *J. F. Duthie* 10846 (DD).

ACKNOWLEDGEMENTS

I am thankful to the Director, Botanical Survey of India, for facilities extended, and to Dr R. B. Majumdar and Mr J. L. Ellis for going through the manuscript and for giving suggestions.

	L. temulentum var. *gracile* Regel	*L. rigidum* var. *duthiei* Hack. ex Hook. f.
Culms	Compressed, geniculate	Terete, strict, straight
Blades	7.5-16 cm, much larger	4.5-8.7 cm, much shorter
Spikes	Up to 16.5 cm, slender	Up to 13.5 cm, straight, rigid
Rachis	Compressed, not strict	Terete, strict
Spikelets	Longer than the inter-nodes, up to 2 cm long, 7-9 or more flowered, not closely appressed to the rachis	Shorter than the inter-nodes, up to ± 1 cm, 3-4, rarely 5-flowered, closely appressed to the rachis
Glumes	Shorter than or equal to spikelets, 1.5 cm long, linear lanceolate, herbaceous, nerves visible on both surfaces	Longer than spikelets, 1.05-1.25 cm long, subulate, hard, chartaceous, nerves visible only on the dorsal surface

CENTRAL NATIONAL HERBARIUM,
SIBPUR, HOWRAH 711 103,
February 13, 1976.

BARUNA BHATTACHARYA

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37. *GALIUM PALUSTRE* L. AND *ELEOCHARIS ACICULARIS* (L.) ROEM ET SCHULT.—TWO NEW PLANT RECORDS FOR INDIA

(*With two text-figures*)

While studying the aquatic and wetland vegetation of Kashmir we collected a number of specimens, which on critical scrutiny were identified as *Galium palustre* L. and *Eleocharis acicularis* (L.) Roem & Schult., distributed in Europe, SW. Asia and Africa, but not recorded hitherto from the Indian subcontinent. Both species were collected in paddy fields at various places in Kashmir, indicating that they are well established in the valley and probably have been introduced with the seeds of the rice plants commonly grown in the valley.

Galium palustre L. Sp. pL. 105 (1753): Clapham *et al.* Brit. Isles. 782 (1962).

Ascending or diffusely spreading perennial herb supported by neighbouring vegetation. Roots 6-18 cm long, creeping, with adventitious roots arising from the nodes. Stems weak 28-79 cm long, 1.5 mm broad, quadrangular, glabrous, angles retroserrately scabrellate, nodes thick, internodes 3-4 cm long, upper ones shorter. Leaves 4 on each node, much variable in shape oblanceolate—narrowly elliptical, oblong 1.2-2.5 cm long 2-8 mm broad obtuse, margins retroserrately scabrellate, incurved sometimes recurved with a single central vein prominent from below, scabrous. Flowers 3-4 mm diam., in spreading axillary or terminal cymes, branches 3 flowered; peduncles cylindrical 3-7 mm long thickly scabrous; calyx tubular 0.5 mm long, smooth; petals 4 fused at the base, lobes spreading, thick, broadly ovate, white; stamens 4, epipetalous 0.5-0.8 mm long, filaments hyaline, anthers inserted, introrse, dorsifixed, greenish yellow. Fruit glabular commonly twin, separating when ripe into two seed-like indehiscent one seeded schizocarp, 2-4 mm dia., smooth, black when dry.

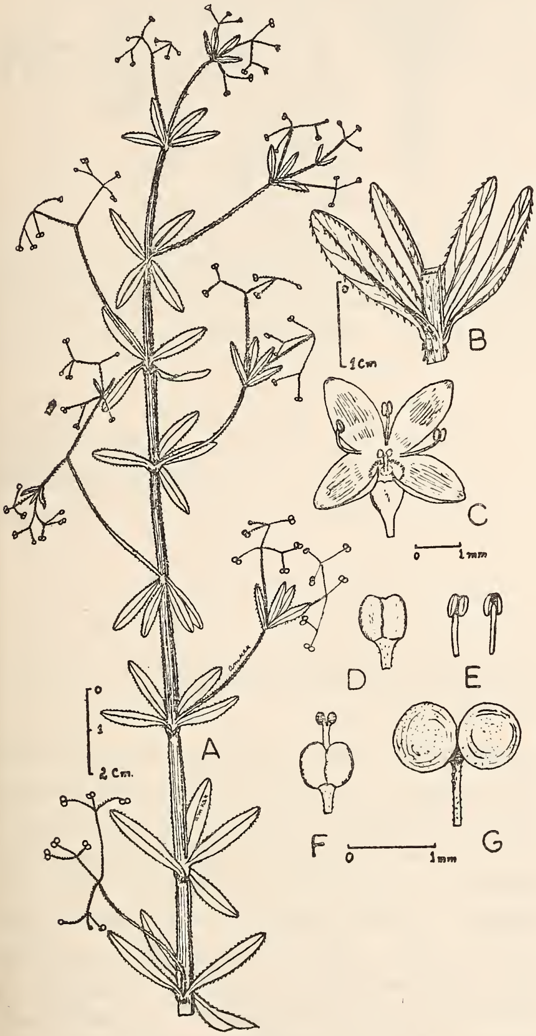

Fig. 1. *Galium palustre* L.
A. Branch; B. Portion of stem and leaves; C. Flower; D. Calyx tube; E. Stamen; F. Carpel; G. Fruit.

Flowers and fruits. July-August.

Specimens examined. Ugjan Dialgam (Kashmir) AMK 1123; Verinag (Kashmir) AMK 1165; in rice field channels.

Eleocharis acicularis (L.) Roem & Schult., Syst. 2:154 (1817); Clapham *et al.* Fl. Brit. Isles. 1062 (1962).

A small tufted perennial herb, with much branched rhizomes, stoloniferous. Stems erect as well as deflexed, setaceous, terete, angular or mostly sulcate, unbranched 3-6 cm high arising directly from the rhizomes ending in a spike. Basal sheaths 1-2 hyaline, brown, loose at the apex, truncate, oblique. Leaves filiform, tufted 3-5 cm long, glabrous acute or blunt, green. Spikes 2-4 mm long, 1-2 mm broad singly on the culms, much variable in shape narrowly ovoid-elliptical, dirty green or brownish with 3-13 flowers all fertile. Glumes 2 mm long 1.5 mm broad, ovate or broadly lanceolate, navicular, dark brown with central green portion, acute margins membranous. Stamens 3, filaments hyaline elongating later on, anthers exserted 1-1.1 mm long, acute, basifixed, dehiscing longitudinally, yellow. Ovary linearly obovoid 0.5-0.8 mm long, style double the size of ovary with swollen base; stigma trifid, branches linear, exserted. Bristles 2 rarely 3-4, shorter or equalling ovary, minutely retroserrate. Nut 0.7-0.9 mm long obovoid nearly terete, rarely trigonous, whitish with a number of longitudinal ribs and minutely pitted. *Flowers and fruits.* July-August.

Common on the margins of rice fields, rarely on muddy banks and wet places.

Specimens examined. Verinag (Kashmir) rice fields AMK 710, Ugjan Dialgam (Kashmir) AMK 1157.

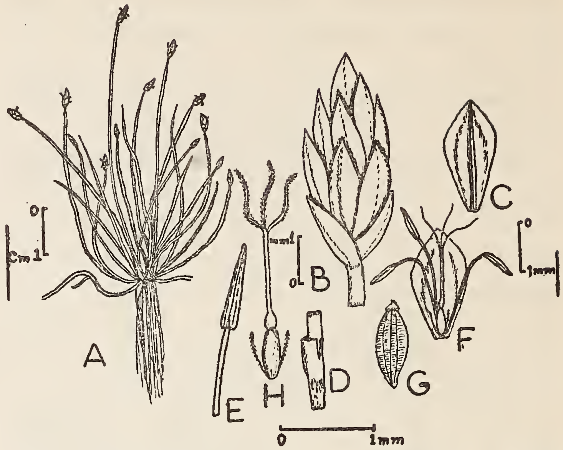

Fig. 2. *Eleocharis acicularis* (L.) Roem et Schult. A. Plant; B. Spike; C. Glume; D. Stem with basal sheath; E. Stamen; F. Flower; G. Nut; H. Carpel with two bristles.

Department of Botany,
University of Kashmir,
Srinagar, 190 006,
September 4, 1975.

A. MAJEED KAK
G. N. JAVEID

38. ON THE IDENTITY OF *ADIANTUM LYRATUM* BLANCO

The East Asiatic *Adiantum lyratum* was described by Blanco (Fl. Filip., 1837) based on specimens from Mandaloyon, near Manila. Christensen (Ind. Fil. 1:665; 1906) expressed the opinion that *A. lyratum* Blanco and *A. caudatum* Linn. are conspecific and this opinion seems to have been prevailing all along. In Central National Herbarium, Sibpur, Howrah, India (CAL) there is a topotype sheet of *A. lyratum* Blanco collected by Merrill (Species Blancoanae No. 284). Merrill also considered *A. lyratum* Blanco and *A. caudatum* Linn. to be conspecific. This is clearly evident from the annotation on the printed label on the sheet which reads: "There is no doubt whatever as to the identity of Blanco's species with *Adiantum caudatum* Linn., which is very common in the country about Manila." The question arises as to whether the above two names are conspecific or not. On a critical examination of the specimens of *Adiantum* housed in CAL we have concluded that *A. lyratum* Blanco and A. *caudatum* Linn. are distinct species. The two species can be easily separated on the basis of the following key.

Pinnae strongly laciniate, lower surface provided only with long, pluricellular ferruginous hairs .... *A. lyratum*

Pinnae not strongly laciniate, lower surface provided with hamate and pluricellular ferruginous hairs .... *A. caudatum*

As the description given by Blanco is very brief a full description of the taxon is provided below.

Adiantum lyratum Blanco, Fl. Filip. 832, 1837; (ed. 2), 575, 1845; (ed. 3) 3:250, 1879.

Rhizome short, erect, scaly; scale brown, lanceolate, margin of the scale entire and hyaline; stipe hirsute throughout, 4-6 cm long, dark brown, cylindrical. Frond simply pinnate, oblong linear, apex proliferous. Rachis hirsute throughout with ferruginous, pluricellular hairs, 12-25 cm in length, brown to deep brown, glossy. Pinnae largest towards the middle, 0.4 to 0.5 cm broad and 1.4 to 1.5 cm long, subsessile, deeply laciniate, close, strongly striate, trapeziform, apex rounded, lower margin straight, 4-5 times lobed, sinus deep, each lobe again lobed slightly; both the surfaces provided with long, ferruginous, pluricellular hairs either scattered or densely, the fertile reflexed tips hairy; venation strictly dichotomous, veins keeled on the lower surface. Sori on each secondary lobe. Spores deep brown, tetrahedral.

Specimens examined. Mandaloyan (Manila), Rizalprovince Luzon, Philippense, *Merrill* species Blancoaneae 284 (Acc. No. 6218), August 1910, (CAL); Luzon Central, Manila, Philippense, *A. Loher* 1226 (Acc. No. 6219), August 1910, (CAL).

CENTRAL NATIONAL HERBARIUM,
INDIAN BOTANIC GARDEN,
SIBPUR, HOWRAH, 3.
September 23, 1975.

N. C. NAIR
S. R. GHOSH

39. *IPOMOEA LEARI* PAXT.—A NATURALISED PLANT OF INDIA

Ipomoea leari Paxt. is known as a beautiful introduced garden climber in India. The species was named after J. G. Lear who in 1839 sent the seeds of the plant from Sri Lanka to Knight's Nursery in England. It is not however a Sri Lanka species, but probably a native of Buenos Aires, S. America.

Recently we got an opportunity to observe this plant in a naturalised condition in Darjeeling on the open roadside towards Kurseong, while exploring that area in May, 1966. Our colleague Dr N. C. Mazumder had also collected the species from a wild area of Sikkim in 1968. We have come across some old herbarium material of the species in the Central National Herbarium (CAL) which gives new light on its distributional record. On the basis of the collection data available so far in India, the species seems widely distributed in Darjeeling (W. Bengal), Gauhati (Assam), Monghyr (Bihar), Patiala (Punjab), Singtam (Sikkim) India and Singapore.

Regional floras of India list *I. leari* Paxt. as a tropical American plant often cultivated in this country. For its correct identity a short description is given below.

Ipomoea leari Paxt. Mag. Bot. 6:267. 1839; Trimen, Hand Book. Fl. Ceylon 3:213. 1895; Prain, Bengal Pls. 2:734. 1903; Haines, Bot. Bihar & Orissa 4:594. 1922; Ridley, Fl. Malay

Penin. 2:462. 1923; Cowan, Fl. Trees & Shrubs in India 124. 1950; Oostroom, in Fl. Malesiana ser. 1:4:466, 1953.

Pharbitis learii Lindley, in Edward Bot. Reg. t. 56, 1841; Curtis, Bot. Mag. 15:t. 3928. 1842.

capitate.

This species is closely allied to the Australian *I. congesta* R. Br. and the Mexican *I. rubro-coerulea* Hook. For the sake of correct identity the characters differentiating these species are shown below:

Ipomoea leari Paxt.	*I. congesta* R. Brown	*I. rubro-coerulea* Hook. (= *I. tricolor* Cav.)
1) Young parts covered with white straight hairs	Young parts slightly pubescent	Plant smooth
2) Leaves usually 3-lobed and whitish pubescent beneath	Leaves entire, pilose hairy beneath	Leaves entire, glabrous
3) Pedicels are of nearly equal length	Pedicels unequal	Pedicels unequal
4) Sepals 2 cm long hirsute, longer than pedicel	Sepals 1.4-2.2 cm, with few hairs at the base and longer than pedicels	Sepals 1.5-1.8 (2.5) cm, smooth, shorter than pedicel
5) Indigenous to Buenos Aires, S. America, (Am. Trop)	Indigenous to Australia	Indigenous to Mexico (C. America)

Twining shrub, young parts hairy. Leaves 6-11 × 5-10 cm, alternate, ovate to 3-lobed, cordate at the base, apex acute to acuminate, upper surface deep green, whitish pubescent beneath; petiole 5-11 cm, pubescent. Flowers in congested cyme at the extremities of lateral shoots, peduncle 8-15 cm; pedicels 0.5-1 cm, 2 lateral pubescent bracts present at the base. Sepals 5-partite, unequal, 2 × 0.3 cm, hirsute. Petals 5, connate in campanulate corolla, 5-9 cm long, deep bluish purple with 5 bands of light colour. Stamens 5, inserted in the corolla tube, filaments ± 1 cm, unequal, finely fringed at the base; anthers filiform. Carpel solitary, ovary ovate; style ± 2 cm; stigma

Distribution: BENGAL: Darjeeling, Kurseong, 23-v-1966—*D. Das* 168 A-C (CAL); PUNJAB: Patiala, 10-vi-1916—*N. B. Dutt* 98 (CAL); BIHAR: Monghyr, 5-ix-1919—G. C. Banerjee 4 (CAL); ASSAM: Gauhati, March 1902—*A. C. Chatterjee* sn. (CAL); SIKKIM: Singhtum, 20-ix-1968—*N. C. Mazumder* 542 (CAL) South India: *Rev. Aug. Sanlire* (Acc. No. 311384) (CAL).

ACKNOWLEDGEMENT

We are grateful to Dr S. K. Jain, Deputy Director, Central National Herbarium, Howrah for encouragement.

DEBIKA MITRA
BHABESH ROY

CENTRAL NATIONAL HERBARIUM,
INDIAN BOTANICAL GARDEN,
HOWRAH 3,
September 23, 1975.

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Breeding habits and associated phenomena in some Indian bats

Part II—*Rhinolophus rouxi* (Temminck)—Rhinolophidae[1]

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Rhinolophus rouxi in Western Ghats near Khandala, Maharashtra State, has a sharply defined breeding season. The females in the colony undergo copulation some time during the last week of December and the early development of the egg is slow. There is a delayed implantation of the blastocyst. Each female carries a single conceptus invariably in the right uterine cornu. After a gestation period of about 150 to 160 days delivery takes place during the last week of May or early in June. This species does not attain sexual maturity in the year of birth. There is an uneven sex ratio with the females outnumbering the males in the adult, while during the juvenile stage the males outnumber the females.

Introduction

Detailed reviews of the earlier work on the breeding habits of microchiropteran bats have been given by several authors (Baker & Bird 1936; Wimsatt 1942; Gopalakrishna 1947, 1955; Madhavan 1971). From these reviews and from a perusal of the earlier literature on the subject it is evident that there are wide variations in the breeding pattern of the microchiropteran bats and that different species inhabiting the same locality differ in their breeding habits.

The family Rhinolophidae has a wide geographic distribution and is represented in Europe, Africa, Asia and Australia. All rhinolophids so far studied appear to have a strict breeding periodicity, but there are fundamental differences between those living in cold climates and those in warmer regions.

[1] Accepted October 1975.

In the European rhinolophids (Fries 1879; Rollinat & Trouessart 1897; Courrier 1924; Matthews 1937) after copulation, which takes place in autumn, the inseminated sperms are stored in a ventrally located pocket of the vagina during winter, when the animals go into hibernation, and effectively fertilise the ova which are released in the following spring when the animals wake from hibernation. After copulation the vaginal canal is blocked by a plug which prevents further copulation. The scanty information which is available regarding the reproductive processes of Indian rhinolophids indicates that, while the periodicity of breeding is strict, there is nothing comparable to the protracted storage of inseminated sperms as noted in the European species (Ramakrishna Iyer 1951; Brosset 1962; Srinivasan *et al.* 1973). Further, there does not seem to be agreement among the authors regarding several aspects of breeding biology of Indian rhinolophids. *Rhinolophus rouxi*, collected from a restricted mountainous region of western ghats, has been chosen for detailed study not only because there is no work on this species from this locality, and this species appears to exhibit different breeding behaviour in different regions (Ramakrishna Iyer 1951; Brosset 1962; Srinivasan *et al.* 1973), and also because it exhibits certain extraordinary features which have not been observed in any Indian bat so far.

Material and methods

The specimens of *Rhinolophus rouxi* were collected at random from three railway tunnels (Nos. 11, 12 and 13) near Khandala in western ghats, Maharashtra State, India. This region receives a heavy rain fall during June-September and has luxurient vegetation. The specimens were collected at intervals of three to four weeks commencing from 7th October 1970 to 25th December 1972 such that every calendar month is represented by one collection or more. During the breeding season the specimens were collected at more frequent intervals with a view to obtaining closely graded development stages. Altogether 406 specimens were examined for the present work.

The specimens were killed by chloroform soon after capture and their body weight recorded. The characters of the external genitalia, the conditions of the mammary and the pubic teats in the females, and the position of the testis and the condition of the penis in the males were also recorded. The genital organs and the accessory reproductive structures were dissected out and fixed in various fixatives such as Bouin's fluid, neutral formalin and Rossman's fluid. After dehydrating them by passing through graded series of ethanol and clearing them in xylol, the gonads and the accessory organs were embedded in paraffin and sectioned at a thickness of 8 μ. The sections were stained with Ehrlich's haematoxylin, counterstained with eosin and mounted in DPX mountant.

The genital organs presented almost the same condition on a given calender date in the two years when the collections were made. Hence, in the following descriptions, only the date and the month are mentioned, where pertinent, except where the mention of the year has a special significance.

A detailed collection diary incorporating the description of each specimen was maintained. Table 1 gives the summary of the collection diary and table 2 gives the monthwise collection of the specimens.

Observations and discussion

1. General remarks on *Rhinolophus rouxi*

The specimens live inside excavations in the walls of the railway tunnels in small

TABLE 1

SUMMARY OF COLLECTION DIARY

	Males				Females							Grand total
	Immature		Adult		Immature		Adult					
Date	Attached to mother	Free		Total of males	Attached to mother	Free	Non-pregnant	Pregnant Right horn	Pregnant Left horn	Lactating	Total of females	
1	2	3	4	5	6	7	8	9	10	11	12	13
7-i-71	—	2	5	7	—	—	—	3	—	—	3	10
9-i-71	—	2	—	2	—	2	—	—	—	—	2	4
11-i-71	—	2	—	2	—	1	—	—	—	—	1	3
14-i-71	—	4	3	7	—	—	—	1	—	—	1	8
18-i-71	—	1	—	1	—	1	—	—	—	—	1	2
21-i-71	—	1	2	3	—	—	—	—	—	—	—	3
23-i-71	—	—	1	1	—	—	—	1	—	—	1	2
26-i-71	—	1	—	1	—	—	—	—	—	—	—	1
1-ii-71	—	—	1	1	—	—	—	9	—	—	9	10
4-ii-71	—	—	2	2	—	1	—	11	—	—	12	14
11-ii-71	—	—	1	1	—	1	—	—	—	—	1	2
12-ii-71	—	1	—	1	—	2	—	1	—	—	3	4
19-ii-71	—	3	2	5	—	—	—	—	—	—	—	5
23-ii-71	—	2	3	5	—	—	—	2	—	—	2	7
26-ii-71	—	—	16	16	—	2	—	1	—	—	3	19
16-iii-71	—	2	4	6	—	2	—	15	—	—	17	23
23-iii-71	—	—	8	8	—	1	—	11	—	—	12	20
29-iii-72	—	—	2	2	—	2	—	1	—	—	3	5
31-iii-72	—	1	1	2	—	1	—	4	—	—	5	7
1-iv-71	—	—	4	4	—	—	—	9	—	—	9	13
21-iv-71	—	2	1	3	—	—	—	2	—	—	2	5
26-iv-72	—	1	7	8	—	—	—	10	—	—	10	18
21-v-71	—	—	3	3	—	—	—	7	—	—	7	10
26-v-72	—	—	2	2	—	—	—	—	—	—	—	2
28-v-72	—	—	7	7	—	—	—	—	—	—	—	7
1-vi-72	—	—	13	13	—	—	—	—	—	—	—	13
14-vi-71	—	2	5	7	—	—	—	—	—	4	4	11
14-vii-71	—	1	4	5	—	1	—	—	—	23	24	29
29-vii-72	—	1	16	17	—	—	—	—	—	7	7	24
1-viii-71	—	—	1	1	—	1	—	—	—	8	9	10
22-viii-71	—	—	—	—	—	1	—	—	—	—	1	1
27-viii-72	—	—	3	3	—	2	17	—	—	—	19	22
17-ix-72	—	—	3	3	—	—	2	—	—	—	2	5
30-ix-71	—	2	5	7	—	1	4	—	—	—	5	12
7-x-70	—	—	1	1	—	—	27	—	—	—	27	28
22-x-71	—	1	2	3	—	—	1	—	—	—	1	4
11-xi-70	—	2	4	6	—	1	16	—	—	—	17	23
24-xi-71	—	1	2	3	—	—	1	—	—	—	1	4
13-xii-70	—	3	7	10	—	3	3	—	—	—	6	16

TABLE 2

MONTHWISE COLLECTION OF SPECIMENS

Month	Male	Female	Total
Jan.	24	9	33
Feb.	31	30	61
Mar.	18	37	55
Apr.	15	21	36
May	12	7	19
June	20	4	24
July	22	31	53
Aug.	4	29	33
Sep.	10	7	17
Oct.	4	28	32
Nov.	9	18	27
Dec.	10	6	16
Grand total	179	227	406

groups of 10 to 50 specimens. There may be several such groups within the same tunnel. During the non-breeding season there is a certain degree of segregation so that the adult males and females live in separate groups within the same tunnel, while during the breeding season they live together. Immature ones of both the sexes, however, occur in all the groups in all the seasons.

The fur on the body of *Rhinolophus rouxi* is usually black but a few specimens had brown coloured fur. Andersen (1917) noted that the change of the fur colour is normal for *Rhinolophus rouxi* and that it is related to moulting, which this species undergoes twice a year, once in spring (about May) and a second time in autumn (about October).

Although the tunnels from which these bats were collected were very busy railway tunnels, the specimens do not appear to be disturbed by the constant movement of trains, but any unusual sound or the approach of human beings near the groups appears to excite the specimens which flutter around and even fly out of the roost.

There were very few specimens in their normal roosts during the period from the middle of December to the first week of January when copulation takes place. Apparently, they appear to migrate elsewhere and return soon after the commencement of pregnancy.

This species does not undergo true hibernation as the European rhinolophids do, but they experience a slight degree of torpidity during July and August when there is incessant rain. Brosset (1962), however, mentioned that there is a definite hibernation in August in this species.

The adult females leave their normal roosts and migrate elsewhere just before delivering their young and return to their roosts only after the young are weaned. Hence, during this period the tunnels contained mostly males and immature females.

2. The female reproductive organs

The general construction of the female genitalia of *Rhinolophus rouxi* resembles that of most of the bats possessing bicornuate uterus. However, in the adult specimens the right uterine cornu is longer and noticeably thicker than the left. Each uterine cornu is about 1 cm long and the uterine cornua are symmetrically placed across the rectum and meet medially. The lumina of the uterine cornua become confluent, and a short cervical canal opens into the vaginal lumen. The vagina measures about 1 to 1.5 mm in length. Although the female genitalia are morphologically bilaterally symmetrical, only the right ovary releases a single ovum during each reproductive cycle and the conceptus is invariably carried in the right uterine cornu. Normally the follicles in the left ovary do not develop beyond the multilaminar stage, but in rare cases they may reach an early vesicular stage.

The mammary glands are on the ventrolateral sides of the thorax and their nipples are distinctly visible only in the parous animals. Pubic teats without mammary glands are present on each side near the groin. They are very small in immature animals, but get enlarged during the first pregnancy and remain as such throughout the rest of their life.

3. Breeding habits

Examination of the collection diary and table 1 reveals that pregnant specimens occurred only from about the first week of January to about the last week of May. This indicates that this species breeds once a year in a sharply defined season. Examination of the ovaries of the adult female specimens collected on 13th December revealed the presence of one large vesicular follicle in addition to numerous smaller follicles in the right ovary, and follicles at various stages of development up to the multilaminar condition in the left ovary. The uterine glands contained copious amount of secretion and the uterine lumen had some amount of cell debris. The vagina contained desquamated cornified cells. Evidently the animals were approaching oestrus. Neither copulation nor ovulation had occurred in these specimens. A late uterine morula was present in the right uterine cornu of adult females collected on the 7th January 1971, 14th January 1971 and 23rd January 1971. The morula in all these specimens was at nearly the same stage of development. The other females collected on these dates were immature. Each of the adult specimens collected between 1st February 1971 and 12th February 1971 contained an unimplanted blastocyst in the right uterine cornu. The adult females collected on 23rd February 1971 had each an early implanted blastocyst. Progressively advanced stages of pregnancy were noticed in the females collected during the following weeks until 21st May 1971. Pregnant females each carrying a full term foetus, and which would have probably delivered within a week more, were collected on 21st May 1971. Further, every adult female in the colony was pregnant between 7th January 1971 and 21st May 1971, and the stage of development of the embryo was nearly the same in all the females collected on any given date. These facts lead to certain interesting conclusions:—

Since the adult specimens collected on 13th December had neither copulated nor did they have preovulatory follicles, and since all the adult females collected on 7th January had an uterine morula it is evident that fertilization must have occurred latest about 4 to 5 days before 7th January, 1971 in these animals. Secondly, there is a retarded development of the embryo during the early stages and a delayed implantation of the blastocyst, which remains free in the uterine lumen for a considerable time.

Between 21st May 1971 and 14th June 1971 neither pregnant females nor females in lactation were present in the railway tunnels which contained only males and immature females during this period. Many females in lactation were collected between the 14th of June and 1st of August, but there was no young at their breasts. These facts indicate that the females migrate elsewhere prior to parturition and that all the females in the colony deliver the young within the short span of two weeks. After parturition the females return to the roosts. The facts that the mothers do not carry the young ones at their breasts incessantly, and that the females were in full lactation until the 1st of August, indicate that the females give suck to the young ones in the roosts and do not normally carry the young ones at breast in flight as many other bats do. The first free weaned young of the year was collected on the 1st of August.

From the foregoing account of the breeding habits of *Rhinolophus rouxi* the annual life of the females of this species can be recognized into the following periods:—

(1) The period of sexual quiescence from August to about the beginning of December.

(2) Copulation in a sharply defined period during the last week of December or the first week of January latest.

(3) Pregnancy involving retarded early development and delayed implantation from about the first week of January until about the last week of May.

(4) Parturition during the last week of May or early in June.

(5) Lactation from the last week of May or early in June to about the first week of August.

Since *Rhinolophus rouxi* has a sharply defined breeding season, it is relatively easy to determine the gestation period from the pregnancy record. From the stages of development of the morula in the three females collected on 7th January one could deduce that fertilization could have occurred about a week earlier. The last date on which the pregnant females were collected was 21st May when the females had each a full term foetus with pigmented skin and well developed patagia. The rhinarium and the median ridge above the nostrils of the foetuses had attained their full development. From these characters of the foetuses one could deduce that the young would have been delivered within another week. On the basis of these facts the duration of pregnancy in *Rhinolophus rouxi* should be about 150 to 160 days. This confirms the observation of Ramakrishna Iyer (1951), but it is at variance with those of Brosset (1962) and Srinivasan *et al.* (1973), who mention a gestation period of 60 to 70 days and three months respectively for this species.

4. Age at maturity

As already mentioned, the young ones of *Rhinolophus rouxi* are delivered in a sharply restricted period between about the last week of May and the first week of June. The young animals grow rapidly during early life and reach a weight nearly equal to the weight of the adult when they are three to four months of age. After this age the young ones cannot be distinguished from the adults on the basis of the weight or the size of the body. However, sexual maturity or otherwise in the females can be determined on the basis of the size and nature of mammary nipples and pubic teats taken along with the pregnancy record. The mammary nipples and pubic teats are very insignificant in the non-parous females. After the first lactation they enlarge in size and remain as such throughout life. Hence, in all parous females they are prominent and large. Sexual maturity in males can be determined on the basis of the histology of the testis. The presence of a few immature females and males during the breeding season indicates that sexual maturity is not attained by either sex in the year of their birth in this bat. Since females are shown to become pregnant in January it is evident that they should be *at least* 19 months of age before attaining sexual maturity. Examination of the testes reveal that spermatogenesis commences late in September. Hence, the males take *at least* 16 months to reach sexual maturity. At least three categories of specimens of each sex can be recognized at the beginning of the breeding season—(a) animals which have bred at least once before, (b) animals which are in their first breeding season, and (c) animals which are sexually immature.

5. Sex ratio

In a total of 406 specimens of *Rhinolophus rouxi* collected at random over a period of two years, there were 227 females including 26 immature ones and 179 males including 38 immature ones. The fact that there is a certain degree of segregation of the two sexes may not warrant a definite conclusion regarding the sex ratio in this species. However, the random collections made during two years shows an uneven sex ratio with the females outnumbering the males in the adult stage. In the juvenile stage, however, the males outnumber the females. It is likely that there is a greater mortality of the males than the females during juvenile life resulting in the uneven female-predominant sex ratio in the adults.

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List of type specimens of some species, varieties, and formas deposited in Blatter herbarium, Bombay[1,2]

P. V. Bole and M. R. Almeida[3]
Blatter Herbarium, St. Xavier's College, Bombay 400 001

The "International Code of Botanical Nomenclature" as we know it today is derived mainly from the 'Laws of Botanical Nomenclature' proposed by Alphonse de Candolle and adopted at the International Botanical Congress of Paris, August, 1887.

The present day code (Ed. 1972) is mainly divided into two divisions, namely I—Principles and II—Rules and Recommendations. The Principles form the basis of the system of Botanical Nomenclature while rules set out in Articles and Recommendations are formulated with a view to upholding the Principles.

One of the Fundamental Principles of this code (Principle—II) is "The application of names of taxonomic groups is determined by means of types."

This "type" concept in the application of names is derived from the so-called 'American Code' formulated by American Botanists. Rev. Fr. H. Santapau (*Science & Culture, 31*: 456-467, 1955) has given a complete history of the development of the type concept in the International Code of Botanical Nomenclature from the time of its entry in the form of a recommendation adopted at Brussels Congress (1910) to the current code which validates the publications of new taxa only when the nomenclatural types are clearly indicated.

The Blatter Herbarium, which was renamed in 1941 after its founder Rev. Fr. E. Blatter, houses some important collections which form the basis of some of our Indian floristic works. A very good account of this herbarium is given by Rev. Fr. H. Santapau, in the Centenary Souvenir of Madras State Herbarium (pp. 38-47, August, 1974). However after this publication several new collections have been added to Blatter Herbarium; of which three need special mention here:

1. Collections from Bombay Natural History society (Woodrow, Bhide, Patwardhan & Cooke)
2. Collections of Mr. Charles McCann, and
3. Dr. M. L. Banerji's collections from East Nepal.

All these collections as well as collections mentioned by H. Santapau contain some important type specimens. Some of these types were already located and kept separately by H. Santapau and co-workers but many have

[1] Accepted August 1975.
[2] Part I.

[3] *Present address*: CIBA-GEIGY Research Centre, Bombay 400 063.

been located later or have been acquired through the kind donation of the herbarium of Mr. Charles McCann, presently in New Zealand.

The following few pages give the list of some of the types separated from Blatter Herbarium and from McCann's collections. The list is made in accordance with rules of the latest code (Ed. 1972).

Acanthaceae

1. **Barleria gibsonioides** Blatter, in Journ. Bombay nat. Hist. Soc. 32(4): 733, 1928.
   Lectotype: E. Blatter — Panchgani-1 (Oct., 1927).
   Syntypes: E. Blatter — Panchgani-2-7 (Oct., 1927).
   Blatter in the original publication mentioned specimens Nos. 1, 2, 3, 5 & 7 as types and specimens Nos. 4 & 6 as cotypes as this species. All these specimens have been collected at Panchgani during a single gathering. Specimen No. 1 is quite good and it is selected herein as the lectotype of the species and remaining specimens have been designated as syntypes.
2. **Barleria pratensis** Santapau, in Kew Bull. 1948: 487, 1949.
   Holotype: H. Santapau—Khandala-1228 (25.x.1942),
   Isotype: H. Santapau—Khandala-1228B (25.x.1942),
   Paratypes: H. Santapau—Khandala-7435-6 (2.x.1945).
3. **Dicliptera abuensis** Blatter, in Journ. & Proc. Asiat. Soc. Bengal (N.S.) 26(1): 347, 1930.
   Holotype: Hallberg—Mount Abu-22856 (Nov., 1916).
4. **Dicliptera ghatica** Santapau, in Bot. Mem. Univ. Bombay 2:80, 1952.
   Holotype: H. Santapau—Khandala-1915 (20.iv.1943).
5. **Strobilanthes hallbergii** Blatter, in Journ. & Proc. Asiat. Soc. Bengal, (N.S.) 26(1): 345-6, 1930.
   Holotype: Hallberg & Blatter—Mount Abu-22675 (27.x.1916).

Amaranthaceae

6. **Achyranthes coynei** Santapau, in Kew Bull. 1948: 488, 1949.
   Holotype: H. Santapau—Khandala-8074 (26.xi.1945),
   Isotypes: H. Santapau—Khandala-8069-73 (26.xi.1945),
   Paratypes: H. Santapau—Khandala-5945-47 (29.i.1945).
   Paratypes: H. Santapau—Khandala-8649 (16.ii.1936).
   Paratypes: H. Santapau — Khandala-27554-5 (Oct., 1918).
7. **Aerva pseudo-tomentosa** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26 (3): 817, 1919.
   Lectotype: E. Blatter & Hallberg—Jaisalmer-5962 (Nov., 1917). (see Santapau, 1959 B).

Amaryllidaceae

8. **Crinum eleonarae** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 32(4): 733-4, 1929.
   Lectotype: C. McCann-Mahabaleshwar-7 (June, 1927),
   Syntypes: C. McCann—Mahabaleshwar-8-10 (June, 1927).
   In the original publication on this species four specimens (Nos. 7, 8, 9 &

10) are mentioned as types. No. 7 is selected herein as the lectoype of the species. There is one more specimen of this species in Blatter herbarium (No. 6), which bears the identification mark of this species in Blatter's handwriting. Although this specimen is not included in original publication and does not form the type material, it is the only specimen containing leaves, the rest of the specimens being portions of an inflorescence.

9. **Pancratium donaldi** Blatter, in Journ. Asiat. Soc. Bengal (N.S.) 26(1): 360-361, 1930.
Lectotype: Donald Elkin—Panchgani-758 (10.vi.1928),
Syntypes: Donald Elkin—Panchgani-759-60 (10.vi.1928).

In the original publication on this species the author mentions three specimens (nos. 758, 759 & 760). No. 758 is the only complete specimen with bulb and flowers and it is selected herein as the lectotype of the species. The other two syntypes bear only flowering pseudostems.

APOCYNACEAE

10. **Carissa congesta** var. **albida** Santapau, in Kew Bull. 1948: 490, 1949.
Holotype: H. Santapau-Khandala-8890 (11.v.1946),
Paratype: H. Santapau—Khandala-8985 (19.v.1946).

ARACEAE

11. **Arisaema longecaudata** Blatter, in Journ. & Proc. Asiat. Soc. Bengal, (N.S.) 26(1): 362-4, 1930.
Holotype: E. Blatter—Mahabaleshwar-P-10 (June, 1925),
Syntypes: E. Blatter—Mahabaleshwar-P-10a-e (June, 1925).

There were a number of specimens of this species in one single folder under P-10. One good specimen out of the whole lot has been selected as the lectotype and the remaining specimens are mounted separately under nos. P-10a-e and designated syntypes of this species.

12. **Cryptocoryne cognotoides** Blatter & McCann, in Journ. Bombay nat. Hist. Soc. 35(1): 17, 1931.
Holotype: T. R. D. Bell—N. Kanara-3091 (Oct., 1971),
Isotype: T. R. D. Bell-N. Kanara-3091a-b (Oct., 1917).

13. **Cryptocoryne tortuosa** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 35(1): 16, 1931.
Isotypes: C. McCann—Lingmala, Mahabaleshwar-3335, 3336, 3340 (24.ix.1930).

14. **Typhonium incurvatum** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 35(1): 22, 1931.
Isotypes: C. McCann—Sion hill-999, 1001 (25.viii.1929).

ASCLEPIADACEAE

15. **Ceropegia evansi** McCann, in Journ. Bombay nat. Hist. Soc. 45: 209, 1945.
Isotypes: H. Santapau—Khandala-137. 22A-C (1.viii.1941).
Paratypes: H. Santapau—Khandala-919A, 920B, 921C, 922D (13.ix.1942).
Paratypes: H. Santapau—Khandala-2261-2 (24.vii.1943).

16. **Ceropegia evansi** var. **media** Huber, in Mem. Soc. Broter 12: 67, 1957.
Holotype: N. A. Irani—Bhimashankar-1194 (19.ix.1955).

Isotypes: N. A. Irani—Bhimashankar-1194A, 1196A-C (19.ix.1955).

17. **Ceropegia huberi** Ansari, in Bull. Bot. Surv. India 10(2): 219-221, 1968.
Isotype: M. Y. Ansari—Amba ghat-105001 (29.viii.1967).

18. **Ceropegia oculata** var. **sub-hirsuta** Huber, in Mem. Soc. Broter, 12: 65, 1957.
Holotype: K. V. Shenoy—Mumbra-4057 (12.viii.1954).
Isotypes: K. V. Shenoy—Mumbra-4054-6, 4059-60 (12.viii.1954).

19. **Ceropegia polyantha** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 24: 936, 1931.
Paratype: C. McCann—Lingmala, Mahabaleshwar-3439 (Sept., 27, 1930).

20. **Ceropegia rollae** K. Hemadri, in Bull. Bot. Surv. India, 10(2): 123-5, 1968.
Isotype: K. Hemadri—Junnar-107472H (29.ix.1965).

21. **Ceropegia sahyadrica** Ansari et Kulkarni, in Indian Forester, 97(12): 688, 1971.
Paratypes: B. V. Reddi—Ambavane-Sakharpathar-99212.
Paratypes: E. Blatter, Hall. & McCann—Khandala-27424 (July, 1919).

22. **Ceropegia santapaui** Wadhwa et Ansari, in Bull. Bot. Surv. India, 10(1): 95-97, 1968.
Isotype: B. M. Wadhwa—Mahabaleshwar-109640E (19.viii.1966).
Paratype: B. M. Wadhwa & M. Y. Ansari—Mahabaleshwar-109651H (13.ix.1966).

23. **Gymnema khandalensis** Santapau, in Kew Bull. 1948: 486, 1949.
Holotype: H. Santapau—Khandala-5434 (1.xi.1944).
Isotypes: H. Santapau—Khandala-5436-7 (1.xi.1944).
Paratypes: H. Santapau—Khandala-5796, 5798-9 (20.i.1945).

In the original publication on this species the author has mentioned two holotypes (Nos. 5434 & 5797). One consisting of the flowering material and the other fruiting. The International Code of Botanical Nomenclature (Ed. 1972, p. 20) Article No. 9 gives the following rule in this regard: "The nomenclatural type (holotype, lectotype or neotype) of a species or other taxon below the rank of a species is a single specimen or other element except in the following case: for small herbaceous plants and for most non-vascular plants, the type may consist of more than one individual, which ought to be conserved permanently and assembled on the herbarium sheet or preparation.

As per direction of the code only one specimen No. 5434 is retained herein as the holotype and other designated as the isotype of the species.

Balsaminaceae

24. **Impatiens balsamina** var. **corymbosa** Santapau, in Kew Bull. 1948: 489, 1949.
Holotype: H. Santapau—Khandala-5459 (2.xi.1944).

25. **Impatiens kleiniformis** Sedgwick, in Rec. Bot. Surv. India, 6: 35, 1919.
Lectotype: L. J. Sedgwick—Castle Rock-2841 (Aug., 1917).
Syntypes: L. J. Sedgwick—Castle Rock-2841 A-D (Aug., 1917).

There are five herbarium specimens of this species under No. 2841. Code (Ed. 1972, Article 9) permits only one herbarium specimen as the holotype. Therefore one herbarium sheet out of the five is selected herein (under No. 2841) as the lectotype and remaining four marked 2841A-D and designated as syntypes.

Begoniaceae

26. **Begonia prixophylla** Blatter et McCann, in Journ. Indian Bot. Soc. 10(1): 27-28, 1931.
Isotypes: C. McCann—Mahabaleshwar-2916, 2918-9, 2923 (22.viii.1930).

27. **Begonia tribenensis** Rao, in Journ. Bombay nat. Hist. Soc. 65(3): 724-5, 1969.
Holotype: C. R. Rao—Kumkum Potti-342A (6.vii.1963).
Isotype: C. R. Rao—Kumkum Potti-342 (6.vii.1963).
Paratypes: C. R. Rao—Tribeni-832, 832B (30.vii.1967).

Cleomaceae

28. **Cleome asperima** Blatter, in Journ. & Proc. Asiat. Soc. Bengal (N.S.) 26(1): 340, 1930.
Holotype: H. Hedberg — Dhulia-7670 Nov., 1928).

29. **Cleome hotsonii** Blatter et Hallberg, in Journ. Indian Bot. Soc. 1: 5, 1919.
Lectotype: Ispikan—90 (7.ix.1918).
In the original publication the authors have mentioned two specimens (No. 90 & 90A). Only No. 90 is available in Blatter Herbarium and is selected herein as lectotype of the species.

Combretaceae

30. **Anogeissus rotundifolia** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(2): 525, 1919.
Lectotype: Blatter & Hallberg—Jodhpur-6594 (Oct., 1917). (See Santapau, 1959 B).

Commelinaceae

31. **Aneilema rigidum** Blatter, in Journ. Bombay nat. Hist. Soc. 33(1): 73-4, 1928.
Holotype: E. Blatter—Panchgani-P-75 (20.viii.1925).

32. **Aneilema siennea** Blatter, in Journ. Bombay nat. Hist. Soc. 33(1): 75, 1928.
Lectotype: E. Blatter—Panchgani-P-74 (Aug., 1925).
Syntypes: E. Blatter — Panchgani-P-74 A-F (Aug., 1925).
There were a number of specimens of this species in one folder kept unmounted under No. P-74. These have been mounted now and one specimen is retained under P-74 and selected herein as a lectotype and the remaining numbered P-74 A-F and designated as syntypes.

33. **Cyanotis cerifolia** Rao et Kamathy, J. Linn. Soc. London (Bot.) 59(379): 305-8, 1966.
Paratype: R. V. Kamathy — Poona-77786F (10.ix.1962).

34. **Cyanotis epiphytica** Blatter, in Journ. Bombay nat. Hist. Soc. 33(1): 76, 1928.
Paratypes: Hallberg — Girsappa-35004 (Oct., 1919).
Paratypes: Hallberg — Girsappa-35047 (Oct., 1919).
Paratypes: Sedgwick & Bell—Malemane, N. Kanara-7193 (Oct., 1919).

35. **Cyanotis sahyadrica** Blatter, in Journ. Bombay nat. Hist. Soc. 33(1): 77, 1928.
Lectotype: Frenchman—Panchgani-P-38 (19.vii.1925),

Syntype: Frenchman—Panchgani-P-38A (19.vii.1925).

There were two unmounted specimens of this species in one folder bearing No. P-38. Out of these two, only one has flowers and has been selected herein as lectotype. The other is marked as P-38A and designated as syntype.

Compositae

36. **Cyathocline purpurea** var. **alba** Santapau, in Kew Bull. 1948; 490, 1949.
Paratype: H. Santapau—Khandala-8883 (11.v.1946).
In the original publication the author has mentioned that "the holotype of the species is deposited in Blatter Herbarium and Paratype is at Kew." However the paratype is in the Blatter Herbarium and the Holotype may be at Kew.

37. **Cyathocline purpurea** var. **bicolor** Santapau, in Kew Bull. 1948: 490, 1949.
Holotype: H. Santapau—Khandala-3421 (24.xii.1943),
Isotypes: H. Santapau—Khandala-3422-3 (24.xii.1943).

38. **Glossocardia setosa** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(2): 536, 1919.
Lectotype: Blatter & Hallberg—Jodhpur-10083 (Oct., 1917) (See Santapau, 1959 B).

39. **Pulicaria rajputanae** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(2): 535, 1919.
Lectotype: Blatter & Hallberg—Jodhpur-10039 (Oct., 1917) (see, Santapau, 1959 B).

Convolvulaceae

40. **Argyreia boseana** Santapau et Patel, in Trans. Bose Res. Inst. Calcutta 22: 35-6, 1958.
Holotype: Z. J. Kapadia—Mahabaleshwar-2083 (15.vii.1956).
Isotype: Z. J. Kapadia—Mahabaleshwar-2082 (15.vii.1956).
Paratypes: H. Santapau—Mahabaleshwar-13139 (17.viii.1951).
Paratypes: H. Santapau—Mahabaleshwar-13220 (19.viii.1951).
Paratypes: V. M. Patel—Mahabaleshwar-1144 (22.xii.1954).

41. **Convolvulus densiflorus** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(2): 545, 1919.
Lectotype: Blatter & Hallberg—Jaisalmer-3515 (Nov., 1917) (see Santapau, 1959 B).

42. **Ipomoea salsettensis** Santapau et Patel, in Trans. Bose Res. Inst. Calcutta, 22: 34-5, 1958.
Holotype: V. M. Patel—Borivali-1509 (25.ix.1955).
Isotype: V. M. Patel — Borivali-1510 (25.ix.1955).
Paratypes: V. M. Patel—Mumbra-823 (7.x.1954).
Paratypes: V. M. Patel—Bhandup-1524 (8.x.1955).
Paratypes: V. M. Patel—Borivali-921, 923 (30.x.1954).

43. **Operculina tansaensis** Santapau et Patel, in Trans. Bose Res. Inst. Calcutta 22: 33-4, 1958.
Holotype: V. M. Patel—Tansa Lake-1619 (18.xii.1955).
Isotypes: V. M. Patel—Tansa Lake-1613-5, 1618, 1620 (18.xii.1955).

Cruciferae

44. **Goldbachia hispida** Blatter et Hallberg, in Journ. Indian Bot. Soc. 1: 3, 1919.
Holotype: J. E. B. Houston—Kalarbahar-247A (27.iv.1918).

Cyperaceae

45. **Mariscus blatteri** McCann, in Journ. Bombay nat. Hist. Soc. 37(3): 532-3, 1934.
Holotype: Nana (Sedgwick's collector)—Mahabaleshwar-7627 (Oct., 1920).
Isotype: Nana—Mahabaleshwar-7627A (Oct., 1920).
Paratype: Nana—Mahabaleshwar-7646 (Oct., 1920).

46. **Pycrius malabaricus** C. B. Clarke, in Journ. Linn. Soc. London, 34: 12, 1898.
Isotype: Woodrow — Lonavala-28B (16.ix.1894).
Paratype: Woodrow—Lanoli-s.n. (Sept., 1895).

Denstadtiaceae

47. **Microlepia hallbergii** d'Almeida, Journ. Indian Bot. Soc. 5(1): 19, 1926.
Lectotype: Blatter, Hallberg & d'Almeida-Madura Dt.-B-11 (248a) (May, 1917).
Syntype: Blatter, Hall. & d'Almeida-B-10 (248b) (May, 1917).

In the original publication both specimens are mentioned as types. Therefore No. B-11 (248a) is selected herein as the lectotype and the other designated as the syntype of the species.

Eriocaulaceae

48. **Eriocaulon indicum** Moldenke, in Phytologia 3: 162, 1949.
Isotype: H. Santapau — Khandala-2924 (4.x.1943).

Rev. Fr. H. Santapau in Flora of Khandala (1960) mentions "The type of this very distinct species was collected by H. Santapau (No. 2924) at Khandala, on the Kune plateau, Bombay, India, on October 4, 1943, and is deposited in the Britton Herbarium at the New York Botanical Garden". But actually the specimen with No. 2924 is available in Blatter Herbarium. It is presumed here that our No. 2924 here is a part of the material sent to Britton Herbarium, New York and the specimen is designated as the Isotype of the species.

49. **Eriocaulon humile** Moldenke, in Phytologia 3: 162, 1949.
Isotype: Blatter, Hall. & McCann—Khandala-28009 bis (Oct., 1918).

According to Rev. Fr. H. Santapau the Holotype of this species with the above number is deposited in Britton Herbarium. Therefore it is presumed here that our specimen is duplicate of the holotype and designated herein as the Isotype of the species.

50. **Eriocaulon lanceolatum** var. **pilosum** Moldenke, in Phytologia 3: 164, 1949.
Holotype: H. Santapau—Khandala-218.2 (5.ix.1941).

51. **Eriocaulon margaretae** Fyson, in Journ. Indian Bot. 2 & 3: 52, 1923.
Lectotype: L. J. Sedgwick—Bidi, Belgaum-2979 (Sept., 1917).

In the original publication Fyson mentioned two specimens for this species (Fyson-3839 & L. J. Sedgwick-2979). L. J. Sedgwick-2979 is available in Blatter Herbarium and is selected herein as a lectotype of the species. The specimen has been identified by Fyson himself. Fyson's specimen No. 3839 may be available in Madras Herbarium and it should be recognised as the syntype.

52. **Eriocaulon santapaui** Moldenke, in Phytologia 3: 166, 1949.
Isotype: H. Santapau—Khandala-1290(2) (7.xii.1942).

53. **Eriocaulon vanheurckii** forma **minima** Moldenke, in Phytologia 5(3): 84, 1955.
Holotype: H. Santapau—Khandala-15849 (22.viii.1953).

EUPHORBIACEAE

54. **Euphorbia jodhpurensis** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(3): 971, 1919.
Holotype: Blatter & Hallberg—Jodhpur-9228 (Oct., 1917).

55. **Euphorbia khandalensis** Blatter et Hallberg, in Journ. Indian Bot. 2: 48-9, 1921.
Holotype: C. McCann — Khandala-s.n. (Apr., 1918).

56. **Euphorbia panchganensis** Blatter et McCann, Journ. & Proc. Asiat. Soc. Bengal (New Series) 26(1): 353, 1930.
Holotype: Blatter et McCann—Panchgani-102 (16.iv.1926).
Isotypes: Blatter et McCann—Panchgani-103-4 (16.iv.1926).

57. **Euphorbia pauciradiata** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2): 483-4, 1933.
Holotype: J. Fernandes—Miranshah-981 (13.iv.1927).
Isotype: J. Fernandes—Miranshah-981a (13.iv.1927).

58. **Phyllanthes talboti** Sedgwick, in Journ. Indian Bot. 2: 124, 1921.
Lectotype: Sedgwick & Bell — North Kanara-7073 (Nov., 1919).
Syntype: Sedgwick & Bell—North Kanara-7073A (Nov., 1919).
Syntype: L. J. Sedgwick—N. Kanara-4869 (Nov., 1918).

In original publication Sedgwick has mentioned Sedgwick & Bell No. 7073 as one of the typical specimen of this species. However in Blatter Herbarium there are two sheets under this number. One of them is herein selected as the lectotype of the species and other sheet is marked 7073A and designated as syntype of this species.

AIZOACEAE

59. **Trianthema pentandra** var. **rubra** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(2) 530, 1919.
Lectotype: Blatter & Hallberg—Jaisalmer-6772 (Oct., 1917) (See Santapau, 1959 A).

GENTIANACEAE

60. **Canscora khandalensis** Santapau, in Kew Bull. 1948: 485, 1949.
Paratypes: H. Santapau—Khandala-2663 (11.ix.1943), 2756 (30.ix.1943), 2779 (1.x.1943) & 5073 (3.x.1944).

61. **Gentiana lowndesii** Blatter, in Journ. Bombay nat. Hist. Soc. 35(4): 841, 1932.
Holotype: D. G. Lowndes—Waziristan-2430 (Oct., 1931).

GERANIACEAE

62. **Erodium adenophorum** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2): 477-8, 1933.

Holotype: E. Blatter & J. Fernandes—Waziristan-368 (26.iii.1930).

63. **Erodium heterocephalum** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2): 478, 1933.
Holotype: E. Blatter & J. Fernandes—Waziristan-201 (23.iii.1930).

64. **Erodium nanum** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2): 477, 1933.
Holotype: E. Blatter & J. Fernandes—Waziristan-613. (13.iii.1930).

Oxalidaceae

65. **Oxalis corniculata** var. **hispida** Blatter, in Journ. Bombay nat. Hist. Soc. 34(4): 898, 1931.
Lectotype: H. McCann—Panchgani-4370 (30.viii.1930).
Syntype: H. McCann—Panchgani-4371 (30.viii.1930).

In the original publication the author mentions the type, as collected by J. Fernandes, from Panchgani-Western Ghats. In Blatter Herbarium there are two specimens identified by Blatter himself which are from Panchgani collected on 30th August, 1930. These sheets are afterwards numbered in ink as H. McCann-4370 and H. McCann-4371. These are probably the specimens collected by J. Fernandez, but at present there is no evidence to prove it. Since these specimens from Panchgani have been annoted by Blatter himself they have been selected herein as lectotype and syntype of this species, respectively.

66. **Oxalis foliosa** Blatter, in Journ. Indian Bot. Soc. 9(4): 203, 1930.
Holotype: J. Fernandez—Saraghora-173 (20.v.1927),
Isotypes: J. Fernandez—Saraghora-170, 144 (20.v.1927).
Paratypes: J. Fernandez — Waziristan-2717 (29.iv.1927),
Paratypes: J. Fernandez—Razamak-1636 (8.v.1927).
Paratypes: J. Fernandez—Rajimi-2943, 2915, 2940 & 4455 (19.iv.1927), 2599 (25.iv.1927).

Graminae

67. **Andropogon concanensis** Hook, f., in Flora of Brit. India, 7: 174, 1897.
Isotype: L. J. Sedgwick—Mahabaleshwar-4652 (Nov., 1918).

68. **Andropogon paranjpeanum** Bhide, in Journ. & Proc. Asiat. Soc. Bengal (New Series) 7: 514, t. 5, 1911.
Syntypes: R. K. Bhide—Castle Rock-9404(3) (21.x.1909),
Syntypes: R. K. Bhide—Castle Rock-9675 (Oct., 1909).

69. **Andropogon woodrowii** Hook. f., Flora British India 7: 173, 1896.
Isotype: Woodrow—Maval-27 (Dec., 1894).

Hooker mentions this specimen as the type of this species. However Dr. N. L. Bor (1960) states that the holotype of this species is at Kew. The specimen in Blatter Herbarium is presumably duplicate of the holotype and is designated herein as the Isotype of the species.

70. **Arthraxon santapaui** Bor, in Kew Bull. 1951: 446, 1952.
Isotype: H. Santapau—Purandhar-11450 bis (10.x.1950).

71. **Arthraxon satarensis** Almeida, in Journ. Bombay nat. Hist. Soc. 66(3): 515-7, 1970.

Holotype————————, Satara-8, Keshyaturda (no date).

72. **Bhidea burnsiana** Bor, in Kew Bull. 1948: 445, 1949.
Isotype: Hallberg & McCann—Mirjan, North Kanara-s.n. (Oct., 1919).

73. **Chloris quinquesetica** Bhide, in Journ. & Proc. Asiat. Soc. Bengal (New Series) 8: 311, 1912.
Lectotype: R. K. Bhide—Papadi, Bassein-A (30.viii.1911),
Syntype: R. K. Bhide—Papadi, Bassein-B (30.viii.1911).

These two specimens were collected by R. K. Bhide from Papadi, Bassein and identified in his own handwriting. These sheets do not have any numbers and are now marked with A & B and specimen A is selected herein as the lectotype and B designated as syntype.

74. **Coelachne minuta** Bor, in Journ. Bombay nat. Hist. Soc. 58: 317-8, 1961.
Isotype: H. Santapau—Mahabaleshwar-22731 (14.ix.1958).

75. **Danthonia gammiei** Bhide, in Journ. & Proc. Asiat. Soc. Bengal (New Series) 7: 513, t. 6, 1912.
Isotype: G. A. Gammie—Castle Rock-A-48 (Oct., 1902).

In the original publication the author has not mentioned the number of the type sheet. Dr. N. L. Bor (1960) mentions that the type of this species is at Kew (A-48). The label of the herbarium sheet in Blatter Herbarium records "Part of the type specimen". Therefore it is called herein as Isotype of the species.

76. **Dichanthium mccannii** Blatter, in Journ. Bombay nat. Hist. Soc. 32(2): 357-8, 1927.
Holotype: C. McCann—Panchgani-s.n. (Oct., 1925).

77. **Dichanthium panchganensis** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 32(2): 357-8, 1927.
Holotype: C. McCann—Panchgani-s.n. (Nov., 1925).

78. **Dimeria blatteri** Bor, in Kew Bull. 1949: 70, 1949.
Holotype: Blatter, Hallberg & McCann-Khandala-9918(17) (Oct., 1918).

79. **Dimeria santapaui** Almeida, in Journ. Bombay nat. Hist. Soc. 66(3): 510-13, 1970.
Holotype: Sedgwick & Bell: Mirjan flats, N. Kanara-6875 (Oct., 1919).
Isotype: Sedgwick & Bell: 6876 (Oct., 1919).

80. **Dimeria woodrowii** Stapf, in Hook. Ic. Pl. sub. tab. 2312, 1894.
Isotype: W. A. Talbot—Marmagoa-2557 (14.x.1891).

81. **Enteropogon badamicum** Bhide, in Journ. & Proc. Asiat. Soc. Bengal (New Series) 7: 517, 1911.
Isotype: R. K. Bhide — Badami-s.n. (8.ix.1911).

82. **Hubbardia heptaneuron** Bor, in Kew Bull. 1950: 385, 1951.
Isotype: L. J. Sedgwick—N. Kanara-7089 (Oct., 1919).

83. **Isachne borii** Hemadri, in Indian Forester 97(4): 223-5, 1971.
Paratype: G. M. Woodrow—Jeur, Sholapur-s.n. (Dec., 1897).

84. **Ischaemum bolei** Almeida, in Indian Forester 98(4): 236-8, 1972.

Holotype: M. R. Almeida—Savantwadi-1535 (18.xi.1970).

85. **Ischaemum bombaiensis** Bor, in Journ. Bombay nat. Hist. Soc. 49(2): 165-166, 1950.
Isotype: C. McCann — Khandala-9904 (Oct., 1919).

86. **Ischaemum borii** Almeida, in Journ. Bombay nat. Hist. Soc. 66(3): 513-5, 1970.
Isotype: M. R. Almeida—Amboli-895A (24.xii.1968).
Paratype: C. B. Patawardhan—Ambewadi-1115 (12.x.1907).

87. **Ischaemum diplopogon** Hook. f., in Hooker's flora of Brit. India, 7: 129, 1897.
Isotype: ————, Mahabaleshwar-No. 4, (Dec., 1896).

88. **Ischaemum raizadae** Hemadri et Billore, in Indian Forester, 96(4): 318, 1970.
Paratype: G. B. Patawardhan—Amberwadi-1115 (12.x.1907).

89. **Ischaemum santapaui** Bor, in Journ. Bombay nat. Hist. Soc. 49(2): 167, 1950.
Holotype: H. Santapau — Karjat-9665 (11.ii.1948).
Paratype: H. Santapau—Karjat-10535-7, 10539-42, 10544-5, 10547 (10.xii.1949).

90. **Manisuris acuminata** var. **woodrowii** Bor, in Grasses of Burma, Ceylon, India and Pakistan, 191, 1960.
Isotype: W. A. Talbot—

91. **Manisuris forficulata** Fisher, in Kew Bull. 1933: 355, 1933.
Lectotype: J. C. Lisboa (?)—Mahabaleshwar.
This specimen was received from the collections donated by Bombay Natural History Society. Dr. S. K. Jain had separated this specimen as type material after some discussions with Rev. Fr. Santapau.

92. **Manisuris mysorensis** Jain et Hemadri, in Bull. Bot. Surv. India, 10 (3&4): 280-282, 1968.
Isotype: G. A. Gammie—Castle Rock-15643D (25.x.1902).
In the original publication the authors have marked Gammie's three herbarium specimens 15643A, 15643B and 15643C. Therefore the duplicate in Blatter Herbarium is marked 15643D.

93. **Manisuris santapaui** Jain et Deshpande, in Bull. Bot. Surv. India, 10 (3 & 4): 277-9, 1968.
Isotype: C. Saldanha—Ratnagiri-7132A (15.ix.1961).

94. **Ochlandra talboti** Brandis, Indian Trees, 784, 1911.
Lectotype: W. A. Talbot—Girsoppa falls, N. Kanara-3628 (7.i.1896).
Brandis in his original work does not indicate any type specimen. But he gives credit of separating this species as a distinct one to Talbot. Therefore Talbot's specimen No. 3628 is selected herein as the lectotype of this species.

95. **Ophiurus bombaiensis** Bor, in Kew Bull. 1951: 167, 1951.
Paratype: L. J. Sedgwick—Siddhapur-7018 (Oct., 1919).

96. **Panicum obscurans** Woodrow, in Journ. Bombay nat. Hist. Soc. 13: 434, 1901.
Isotype: G. M. Woodrow—Jeur, Sholapur-s.n. (Dec. 1897).

97. **Paspalum compactum** var. **fimbriatum** Bor, in Grasses of Burma, Ceylon, India

and Pakistan, 1960.
Isotypes: P. V. Bole—Mahabaleshwar-304-305 (19.x.1951).

98. **Pogonachne racemosa** Bor, in Kew Bull. 1949: 176, 1949.
Paratypes: C. McCann—Khandala-9924-6 (Oct., 1918).

99. **Rottboellia talbottii** Hk. f., Flora Brit. India 7: 155, 1896.
Isotype: W. A. Talbot—Marmagoa-2572 (15.x.1892).

100. **Sporobolus sindicus** Stapf ex Cooke, Flora Bombay Pres. 2: 1018, 1908.
Isotype: Woodrow—Karachi-s.n. (Aug., 1883).

Labiatae

102. **Leucus angustissima** Sedgwick, in Journ. Indian Bot. 2: 123, 1921.
Holotype: Sedgwick & Bell—Jog, N. Kanara-7234 (Oct., 1919).
Paratypes: Sedgwick & Bell—Siddhapur, N. K., 7225 (Oct., 1919).
Paratypes: Hall. & McCann—Jog, N.K., 34988, 35101, 35103 (Oct., 1919).

Lentibulariaceae

103. **Utricularia equiseticaulis** Blatter et McCann, in Journ. Indian Bot. Soc. 10: 122, 1931.
Holotype: C. McCann & J. Fernandez—Panchgani-3508 (3.x.1930).
Paratypes: C. McCann & J. Fernandez—Bhilar-7860-7861 (Dec., 1927).

104. **Utricularia ogmosperma** Blatter et McCann, in Journ. Indian Bot. Soc. 10: 123, 1931.
Holotype: E. Blatter—Panchgani-P-70 (Beg. of Aug., 1925).
Isotypes: E. Blatter—Panchgani-P-70 A-C (Beg. of Aug., 1925).

In the original publication No. P-7 is mentioned as a type of this species. In Blatter Herbarium there are four herbarium sheets (P-70, P-70A, P-70B & P-70C), on which Blatter has mentioned "Types". P-7 is probably a typographical error for P-70.

105. **Utricularia reticulata** var. **parviflora** Santapau, in Kew Bull. 1948: 491, 1949.
Holotype: H. Santapau—Khandala-5422 (31.x.1944).

Liliaceae

106. **Asparagus deltae** Blatter, in Journ. Indian Bot. Soc. 6: 30-31, 1929.
Holotype: E. Blatter—Indus delta-715 (Oct., 1922),
Isotypes: E. Blatter—Indus delta-716-720 (Oct., 1922).

107. **Asparagus gharoensis** Blatter, in Journ. Indian Bot. Soc. 6: 30, 1929.
Holotype: E. Blatter — Gharo, Indus delta-699 (4.x.1922),
Isotypes: E. Blatter—Gharo, Indus delta-700-8, 714 (4.x.1922).

108. **Chlorophytum borivlianum** Santapau et Fernandes, in Journ. Bombay nat. Hist. Soc. 52(4): 898-900, 1955.
Holotype: R. R. Fernandes—Borivali-1810 (14.vi.1954).
Isotypes: R. R. Fernandes — Borivali-1804, 1807 (14.vi.1954),
Paratype: R. R. Fernandes — Borivali-1822 (22.vi.1954).

109. **Chlorophytum glaucoides** Blatter, in Journ. & Proc. Asiat. Soc. Bengal (New Series) 26(1): 361-2, 1930.

Lectotype: E. Blatter—Panchgani-P-73 (Aug., 1925).
Syntypes: E. Blatter—Panchgani-P-73 A-E (Aug., 1925).

There were a number of unmounted specimens of this species in newspapers with a common No. P-73. One of them has been selected and retained under P-73 and selected herewith as a lectotype and remaining marked with A-E and designated as syntypes.

110. **Dipcadi ursulae** Blatter, in Journ. Bombay nat. Hist. Soc. 32(4): 735, 1928.
Holotype: E. Blatter—Panchgani-P-74 (Aug., 1925).

(*to be continued*)

Moult in the Baya Weaver *Ploceus philippinus* Linnaeus[1]

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(*With three text-figures*)

In an earlier article in the *Journal* [*73* (2): 249-260] I had described my studies on the ecology of the Baya in Cuddapah district. In the course of the same study I had opportunity to examine about 2000 Baya Weavers (*Ploceus philippinus* Linnaeus) in different seasons. The plumages and moult of feathers in different stages of life-history of this species were studied in order to work out a basis for judging the age of the birds from external characters.

Materials and Methods

Birds were netted from different villages near Nandalur, Reddipalli, Anantharajupet and Kodur of Rajampet Taluk. In this study 460 nestlings and 1085 older (juvenile adult) birds were ringed out of which 13 nestlings and 58 adult birds were recaptured. Besides these, 513 birds dissected in 1968-69 were also examined. The peculiarities of plumage of each bird were noted at each examination.

Moults

The Baya undergoes two moults of its body feathers (of the capital, spinal, humeral, femoral, crural and ventral tracts) and tail-coverts in a twelve month period, first before breeding (prenuptial moult) and the second after breeding (postnuptial moult). The rectrices and remiges are renewed only once in 12 months. The span of the flight feather moult overlaps that of the body plumage and the two are treated separately.

1. **Postjuvenal moult**

At the time of nest-leaving the fledgling Baya appears fully feathered. Before the young bird is a year old its juvenal plumage is renewed completely. This moult takes place when the bird is 4-6 months old (Table 1). At the population level this moult takes place from November to the end of April.

In the study area the Baya breeds from mid-April to mid- November and therefore the juveniles hatched in the earlier broods wear their plumage longer than those of the later broods. Both body and flight feathers are changed in the postjuvenal moult (Table 1). Sequence of the postjuvenal moult is the same as those of the corresponding tracts of the adults at this time.

2. **First Prenuptial moult**

From the very fresh feathers of recaptured (ringed) birds it is presumed that the female Baya undergoes its first prenuptial moult at about 12 months of age. At Rajampet the female Baya breeds for the first time when

[1] Accepted August 1975.

it is about one year old and the male Baya has breeding potential when it is about 15 months old. In the young males raised early in the previous season (Table 1) the first prenuptial moult may take place at 12-15 months of age. The young birds raised in the later broods of the previous season may in very rare cases breed even before assuming the nuptial plumage (Table 1). The pattern of feather replacement during the first prenuptial moult is the same as that during the subsequent prenuptial moults. In 1968-69 Bayas were dissected throughout the year. Immature males in stages of prenuptial moult were observed as late as July.

3. The second and subsequent prenuptial moults

Both male and female Bayas undergo the prenuptial moult which involves only body plumage, the female without undergoing any change of colours. At the population level the prenuptial moult starts in March and ends in June.

TABLE 1

RECAPTURES OF BAYAS RINGED AS NESTLINGS

Ring No.	Sex	Dates of ringing	Dates of recapture	Stage of moult of feathers at the time of recapture
Prefix 42051		19-9-1970	16-10-1970	Juvenal plumage, not moulting
A 102187		25-8-1970	10-11-1970	Plumage faded as in adult females at this time, spinal tract and H i-iv moulting
AB 19967		8-9-1970	6-1-1971	Plumage faded and worn, all tracts of feathers including rectrices and H i-ii moulting
Prefix 42142		17-10-1970	12-2-1971	Body feathers and H vi-viii and A i and ix moulting
A 102077		23-7-1970	4-1-1971	A i-ii and vii-ix moulting, A iii-vi old, rest of the plumage new
A 95895		25-5-1970	10-11-1970	Faded and worn, H i-iv moulting
AB 19821		27-9-1969	27-4-1970	Feathers of all tracts moulting, A iv-vi old
A 84284		19-9-1969	25-4-1970	Body secondaries and rectrices moulting
A 102122		15-6-1970	1-2-1971	All tracts moulting, A iv-vi old
		Date of leaving nest:		
A 99853	(male)	27-5-1970	23-8-1971	Netted in a breeding colony and breeding plumage and black bill
AB 19972	(male)	26-9-1970 to 29-9-1970	23-8-1971	Female type of plumage and lead coloured bill. A section of the testis of this bird showed spermatocytes
A 102154	(female)	17-8-1970	23-8-1971	Ovary in breeding condition, appearance same as of older females
A 102150	(female)	-do-	25-8-1971	— do —
A 102172	(female)	28-8-1970 to 30-8-1970	23-8-1971	— do —

The Prefix was Hongkong.

4. First and subsequent postnuptial moults

All adult Bayas change their body feathers after the breeding season. At the population level the postnuptial moult starts in October-November and ends in March.

5. Moult of flight feathers in Bayas of all age groups

Between November and May all Bayas moult their primaries, secondaries and coverts of primaries and secondaries, and rectrices. The juveniles moult their flight feathers for the first time when 4-6 months old (Table 1). In the adults this moult occurs once in a 12-month period. The moult starts at the end of the breeding period, almost at the same time when the postnuptial moult also starts, and ends only after the start of the prenuptial moult. At the population level, the primaries are moulted between December and March, and secondaries between December and May. The majority of rectrices are moulted between December and April.

(a) *The Wing*. The Baya has 9 functional primaries and 9 secondaries. The tenth primary is vestigial and the ninth secondary smaller than the others. Following the system used by Stresemann & Stresemann (1966) the primaries are referred to by the symbol H (Handwing) and Secondary by the symbol A (Armwing). The primaries moult from H1 (innermost) to H10 (outermost) systematically in the descendant order, and H10 is the last to drop. The secondary moult starts with A1 (outermost); later on another descendant moult may start from A6. A7 to A9 (tertials) moult differently with A8 moulting first in many cases. In rare cases the central secondaries (A4-5) remain unmoulted, and these feathers are retained (Table 7).

Table 2

Moult of the primaries in the Baya

Months	Total number of birds examined	Stages of moult of primaries H1-2	H3	H4	H5	H6	H7	H8	H9	H10*
October	28	5	—	—	—	—	—	—	—	—
November	23	10	8	4	1	—	—	—	—	—
December	39	9	8	12	6	1	1	1	1	—
January	35	—	1	5	5	8	11	3	2	—
February	46	—	2	1	11	5	13	5	8	—
March	32	—	—	—	—	1	3	5	8	6

* Moult of H10 was not consistently recorded as in many cases it was missing.

Each upper greater primary-covert is shed with the corresponding primary. The greater secondary coverts are shed more or less simultaneously and all of them are usually renewed by the time the primary moult reaches H5-6. The upper lesser wing-coverts moult at the same time as the upper greater coverts, but the upper median wing-coverts are the last to be renewed. The alula quills usually moult with H7-10 so that the alula is renewed by the time primary moult is completed.

The timing of primary moult

The primaries begin to moult in some birds as early as October but only from November-December in any significant numbers. By

TABLE 3

MOULT OF THE BODY, AND TAIL IN RELATIONS TO THE PRIMARY MOULT

Stage of Primary moult	No. of birds examined	Upper greater coverts	Upper median coverts	Upper lesser coverts	Under greater coverts	Under median coverts	Under lesser coverts	Seco-nda-ries	Alula	Scapul-ars	Capit-al	Ventr-al	Dorsal	Fem-oral	Crural	Upper tail coverts	Under tail coverts	Average tail Sco-res
All the 10 old	16										10							
H I	3	3										2	1					
II	6	6									4	3						
III	10	9	1	7	2	2	2			6	6	8	7	4	3			
IV	6	6		3				1			5	3	2	1	2	2		
V	20	20	7	14	7	2	4	10	1	9	13	17	18	11	8			2
VI	13	13	2	5	4	4	5	12	3	4	9	12	12	9	7	4	4	11.7
VII	15	15	7	6	5	3	2	13	7	4	7	11	9	8	7	3	3	25.5
VIII	9	9	2	2	1	1	1	9	2	1	2	4	3	2	2			43.8
IX	9	9	2		1	1	1	9	1		1	1	2	2	2			50.8
X	4							3										50.7
All the 10 New.	27							11			20	21	9		2	10		

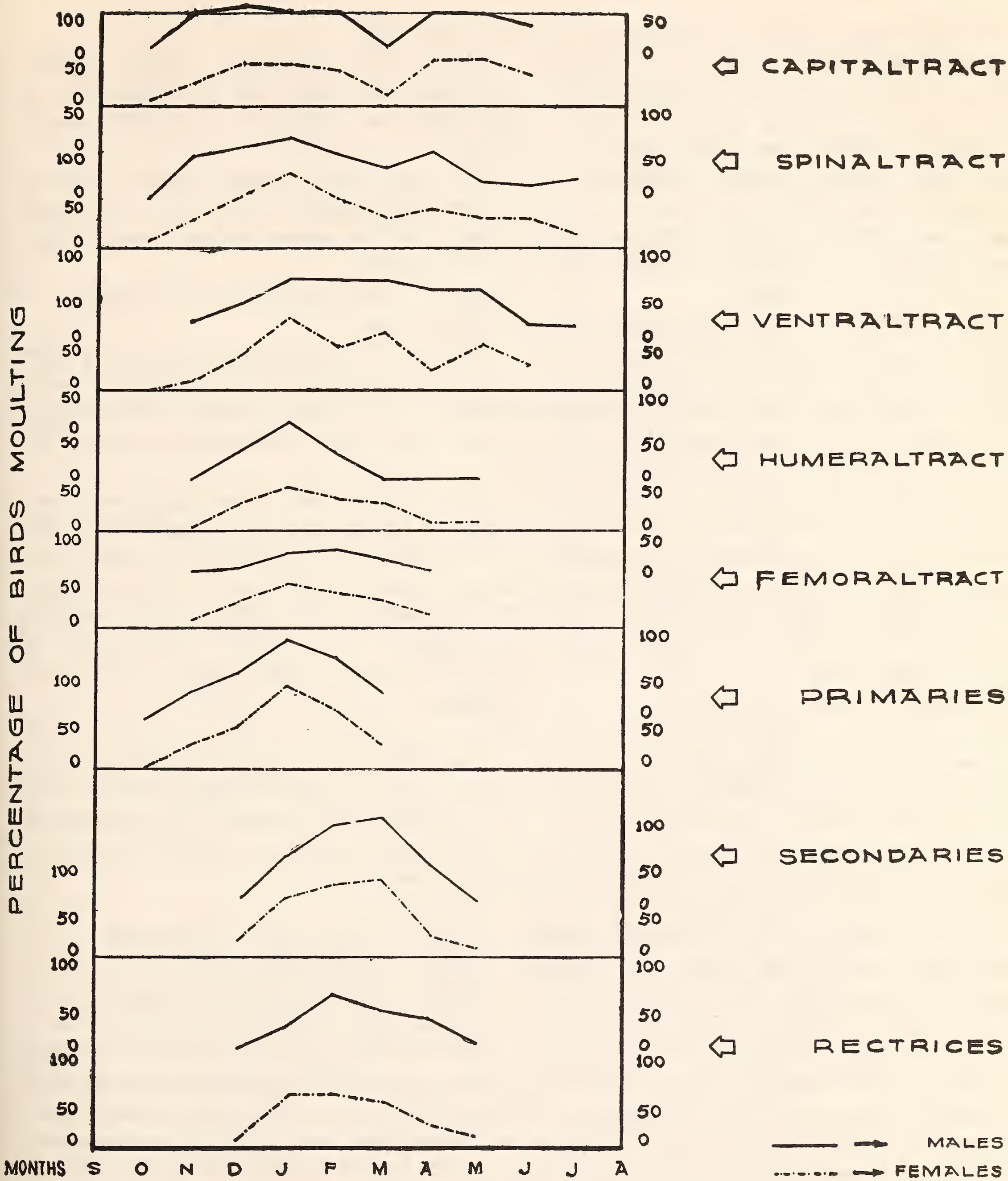

Fig. 1. Showing the progress of moult in the Baya at Rajampet (adult), consolidated data from the year 1968-71.

March-April their moult is completed. The data are summarised in Table 2. In the horizontal columns the number of Bayas in different stages of primary moult is given.

Each bird has been put in the group of its most distal moulting primary irrespective of the length of that quill, e.g. it may be in any stage from small pin to nearly full-grown. The same procedure is followed in judging moult of the primaries in Table 3.

Table 2 shows the birds undergoing heavy moult of the primaries between December and February. Tables 2 and 3 do not include juveniles. A male bird in full breeding plumage and a female with a brood patch were taken as adults. There was considerable variation in the timing and tempo of moult between the individual Bayas of the same area. Moult of primaries proceeded in a systematic manner without a gap of old quills between any two growing quills and with rare exceptions moult of primaries of both sides proceeded symmetrically.

The secondary moult

The secondaries moulted under the cover of new secondary greater coverts from two or more foci. At the population level secondaries moulted between December and May and with rare exceptions moult in the two wings was symmetrical. The example given below taken from an adult female collected on 23 January 1969 is typical of the wing moult of the Baya at this time of the year. Moult pattern was symmetrical. Dorsal aspect: Lesser coverts moulting; Median coverts old; Greater primary coverts—covering H 1-6 new, H 7-10 old; Greater secondary coverts—all new or growing; primaries H 1-6 full-grown or growing, H 7-10 old; Secondaries: A1, 7, 8 and 9 new or growing, 2-6 old; Alula old; Ventral aspect: under greater coverts new; under lesser coverts moulting.

(b) *The tail*

Most of the birds moult rectrices between December and May. Partial replacement of tail feathers were observed in the other months also.

The tail feathers usually moult from the central pair outwards once in a 12 month period, but the tail-coverts are renewed twice in this period.

Moult of the body feathers in relation to primary moult

The span of remex moult overlaps the spans of both postnuptial and prenuptial moult (Figure 1). In some specimens the postnuptial moult started before the primary moult (Table 3).

But the body tracts moult significantly only after the primary moult has reached stage H3. The moults of the dorsal and ventral tracts occupy most of the time of primary moult. The secondaries and rectrices start moulting at stage H5. In figures 1-2 the progress in moult of various feather tracts are plotted on graphs.

Moult of rectrices in relation to primary moult

The birds were arranged according to the stages of primary moult and the average scores of primaries and rectrices were calculated. Each feather was given a score in the following system:

Old feather	0
Feather missing or in small pin stage	1
Feather in large pin or brush stage	2
Feather brush to half grown	3
Feather half to three-quarters grown	4
Feather three quarters to full-grown	5

The average figures plotted on a graph (figure 2) show how the tail moult starts significantly when moult of primaries has progressed about half way. There were exceptional cases of partial replacement of lost feathers in the tail recorded before the start of primary moult.

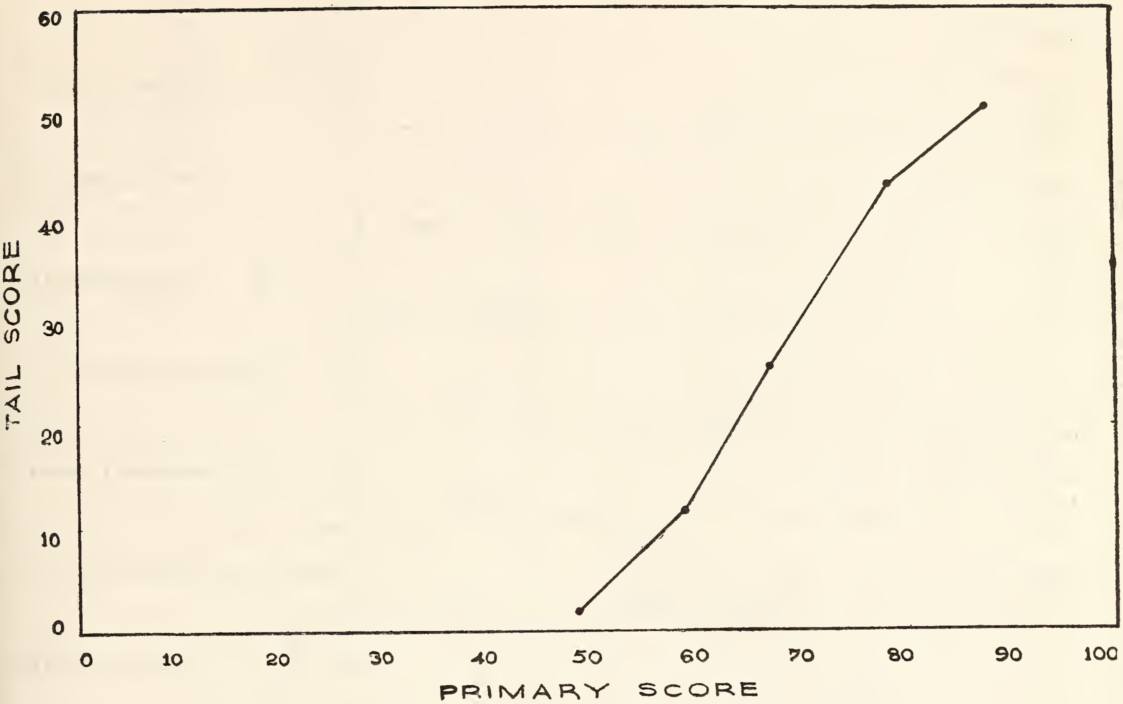

Fig. 2. Tail score with respect to primary score in the Baya.

Moult and the gonadal cycle

The average volume of the left testis in adult Bayas was calculated for each month from March 1968 to February 1969. About 10-15 adult males were measured each month. The monthly averages of volumes of testes obtained from March 1968 to February 1969 are plotted (Figure 3) along with the monthly percentages of adult males in prenuptial and postnuptial moult. Thus in October-November when the postnuptial moult starts the gonads are regressing and in March when the prenuptial moult starts the gonads are enlarging. During a major part of June to October, the period of full gonadal potency the moult is reduced or excluded.

Discussion

Breeding and moult are two physiological events which involve much metabolic strain, in the life of birds. Of the two, breeding is the more important activity and breeding at the most favourable part of the year could be ultimate factor which influences the timing and tempo of moult. King & Farner (1961) tentatively estimated a mean increase in energy intake of 7.6 per cent in the House Sparrow during the postnuptial moult assuming no change in other energy demanding functions. It is reasonable to expect that the Bayas of Rajampet will complete a major part of their moult in the months from November to Feb-

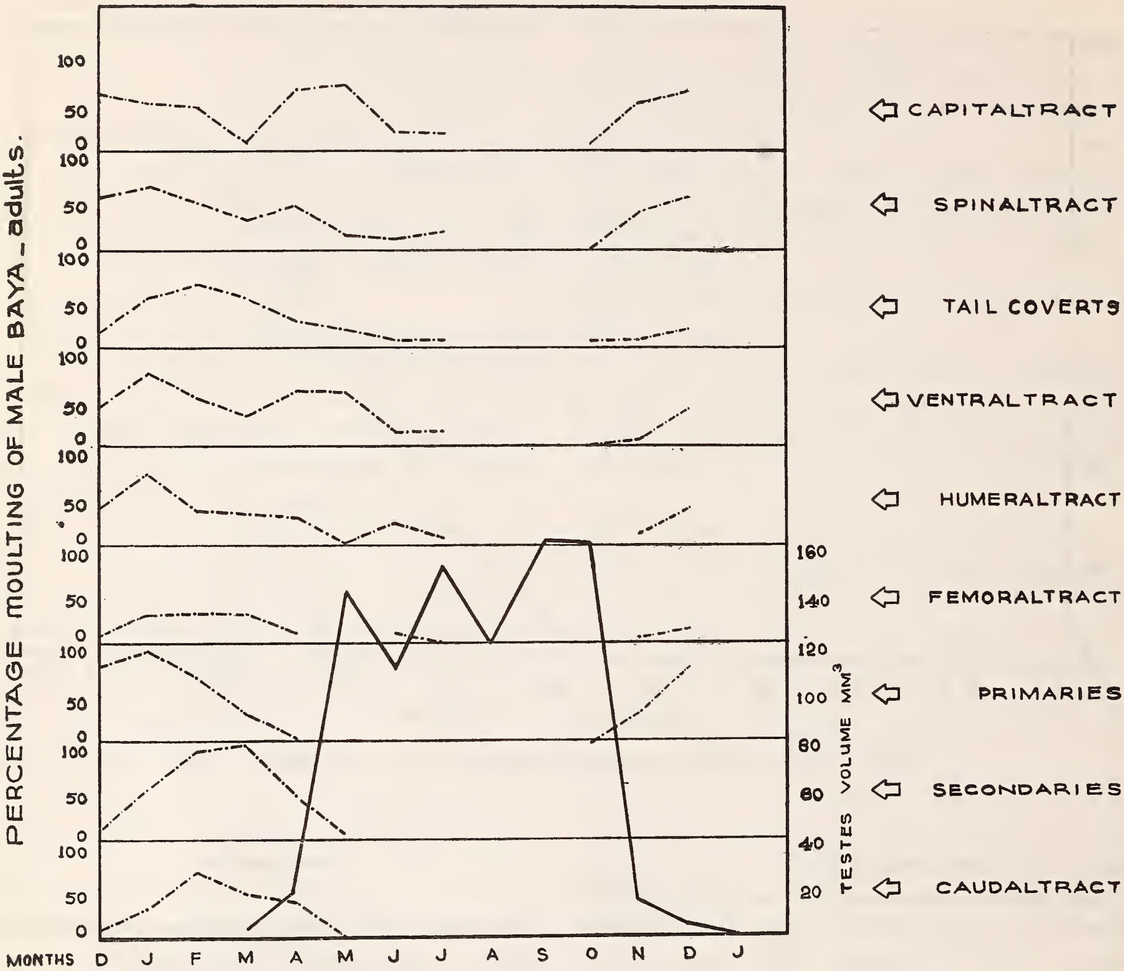

Fig. 3. Gonadal cycle and moult in the male Baya.

ruary when availability of paddy, their principal food, is good. The adult and juvenile Bayas of the study area completed a major part of their moult at this time.

The timing of moult varied in different individuals of the population. But there were many unmated male Bayas in this area and breeding activity did not stop synchronously. Those birds which had less or no parental duties could start moulting earlier.

By October-November the plumage of the adults and older juveniles was considerably worn, brittle, and had many gaps. A total renewal of feathers at this time ensures adequate insulation during the colder months of January and February. A prenuptial moult of the body feathers in March-June reinforces the plumage for the rigours of a long breeding season. The bright plumage of male acquired during the moult, makes the male conspicuous and prepares it for the breeding activities. The primaries and the secondary greater coverts are renewed earlier than the secondaries. Moult of secondaries is less systematic and sometimes incomplete. The orderly renewal of primaries and the slow renewal of all remiges help in keeping the impairment of flight at a minimum. The secondaries are protected at their time of moult by a new set of greater coverts. Stresemann & Stresemann (1966) observed how the secondaries seldom moulted from a single proximal or distal focus. These authors preferred to designate A 9-7 as guard feathers with the function of shielding the folded wing from the sun and rain, in certain groups of birds. These proximal secondaries the Stresemanns observed, were renewed before the exchange of the outer (distal) secondaries started with A1. The pattern of moulting of the proximal secondaries in the Baya is different from that of the rest of the secondaries thus agreeing generally with the above observations.

The temporal separation of the moult and breeding (Figure 2) in the Baya avoids competition between these functions for energy.

To sum up, moult in the Baya at Rajampet is so regulated as to ensure minimum impairment of flight, better insulation in the colder months, exploitation of a period of plenty in its major food item, and conservation of energy. As advised by Prof. Stresemann the details of ringing and recapture of Bayas used in this study are appended.

The first three birds retained breeding plumage for at least 5 months after ringing and A 84241 remained in breeding plumage till 18th November. These illustrate the long period over which breeding plumage is retained by the male Baya at Rajampet.

Summary

This paper covers the results of examination of plumage of about 2000 Bayas of different age classes in Rajampet, 1968-71.

The adult Bayas moult feathers of the body before breeding (March to June), and the entire body and flight feathers after breed-

Table 4

Male Bayas ringed and retrapped in breeding plumage

Ring No.	Dates (1 of ringing 2 of recapture)		Stage of moult of feathers
A 80112	1	12-4-1968	In full breeding plumage, not moulting
A 80112	2	4-10-1968	In full breeding plumage, not moulting
A 80114	1	12-4-1968	In full breeding plumage, not moulting
A 80114	2	3-10-1968	In full breeding plumage, not moulting
A 80115	1	12-4-1968	In full breeding plumage, not moulting
A 80115	2	1-10-1968	In full breeding plumage, not moulting
A 84198	1	12-4-1969	Completed moult in all tracts (non-flight) of feathers. A 4 not cornified
A 84198	2	30-6-1970	Full breeding plumage not moulting
AB 19936	1	3-7-1970	Full breeding plumage not moulting
AB 19936	2	?-8-1970	Full breeding plumage not moulting
A 84241	1	10-7-1969	Full breeding plumage not moulting
A 84241	2	18-11-1969	Full breeding plumage not moulting

TABLE 5

BAYAS RINGED IN BREEDING PLUMAGE AND RETRAPPED IN STAGES OF FLIGHT FEATHER MOULT

Ring No.		Sex	Dates (1 of ringing 2 of recapture)		Stages of moult of feathers
A	80140	M	1	10-10-1968	Full breeding plumage
A	80140	M	2	9-12-1968	H i-ii moulting
A	80151	M	1	10-10-1968	Full breeding plumage
A	80151	M	2	6-1-1969	Remiges, H vi and A ix moulting
A	80170	M	1	5-11-1968	Full breeding plumage
A	80170	M	2	6-12-1968	Capital and spinal tracts, H i-iii moulting
A	80060	M	1	9-12-1968	Full breeding plumage
A	80060	M	2	15-4-1969	A v not cornified, iii-iv old, rest new.
A	84239	M	1	12-7-1969	Full breeding plumage
A	84239	M	2	4-1-1971	All feather tracts H v-vi A i, viii and ix moulting
A	84253	M	1	20-8-1969	Full breeding plumage
A	84253	M	2	6-1-1971	Off plumage
AB	19801	M	1	22-9-1969	Breeding plumage
AB	19801	M	2	4-1-1971	H i-v moulting
A	80119		1	25-4-1968	Not moulting
			2 (a)	3-12-1969	H i-iv moulting
			2 (b)	14-4-1970	Moult complete on all tracts

ing from November to May. The major part of the moults is completed before the commencement of breeding activity. The female moults without any change in the colour of its feathers. The sequence and timings of moult are the same in both sexes of the adults.

The juvenile Baya moults its entire feather coat at the time of the adults' postnuptial moult. The post-juvenal and postnuptial moult are identical in detail. Body moult starts on the head. The primaries which are the first flight features to moult do so, systematically from the proximal to the distal end. The secondaries moult from several foci. The rectrices moulted from the centre outwards.

Moults reach a peak in December-January when paddy is most available. The slow tempo of moult of remiges causes minimum impairment of flight. The postnuptial moult gives the birds a better insulation for the cold months to come. Notes about the recaptures of ringed birds are appended.

TABLE 6

BAYAS WITH FEATHERS IN MOULT AT TIMES OF RINGING AND RECAPTURE

Case No.	Ring No. Sex	Dates (1 of finding 2 of recapture)		Stages of moult of feathers
1	A 80070 M	1	1-1-1969	H i-vi and proximal secondaries moulting
	-do-	2	5-4-1969	A iv-vi moulting
2	A 80084 O	1	6-1-1969	All the flight feathers old
	-do-	2	22-1-1969	H i-v moulting
3	A 95125 F	1	22-1-1970	H i-iv A i and ix moulting
	-do-	2	29-3-1970	Flight feathers other than central secondaries new
4	A 84114 F	1	9-3-1969	Only A iv-v old rest new
	-do-	2 (a)	12-4-1969	A iv moulting rest new
	-do-	2 (b)	30-6-1970	Only one rectrix moulting
5	A 84115 F	1	9-3-1969	A iii-vii old rest new
	-do-	2	12-4-1969	A iv-vi old rest new
6	A 84112 F	1	9-3-1969	Only A iv old
	-do-	2	16-1-1970	H x moulting, A iv-vi old
7	A 84161 O	1	2-4-1969	A ii-v old
	-do-	2	15-4-1969	A moulting still continuing
8	A 80014 M	1	13-11-1968	Only one rectrix moulting
	-do-	2	2-4-1969	A iv-vi old rest new
9	A 80008 M	1	13-11-1968	One rectrix moulting
	-do-	2	9-3-1969	A iii-vii, six rectrices old
10	A 80072 F	1	15-11-1968	Flight feathers not moulting
	-do-	2	1-2-1969	H i-v and one A ix moulting
11	A 95041 F	1	1-12-1969	Flight feathers not moulting
	-do-	2	4-1-1971	H i-iv and A i, viii and ix new or growing
12	A 88039 M	1	-12-1969	H i-iii new or growing
	-do-	2	7-1-1971	H i-vii and A i, viii and ix new or growing
13	A 95094 M	1	13-1-1970	H i-iii and A i-ii and vii-ix new or growing
	-do-	2	2-5-1970	Rectrices moulting A iv-vi old
14	A 99716 O	1	19-2-1970	H viii-x and A i-vii old, rest of the plumage new
	-do-	2	24-4-1970	A v-vi old

Cases 1, 4, 5 and 14 show the slow progress of secondary moult; in 3 primary moult was fast. The time required for completing the postnuptial moult calculated from cases 8, 9 and 13 is about 4 months.

TABLE 7

BAYAS IN OFF PLUMAGE ON FIRST AND IN BREEDING PLUMAGE ON SECOND EXAMINATION

Ring No. Sex	Dates (1 of ringing 2 of recapture)		Stages of moult of feathers
A 80080 M	1	6-1-1969	Spinal tract upper tail coverts, H i-vi and A ix moulting
-do-	2	11-10-1969	Breeding plumage
A 95094 M	1	13-1-1970	All tracts of feathers moulting H i-viii new A (only) iii-vi old
-do-	2	2-5-1970	Capital and ventral tracts moulting into breeding plumage outer 4 rectrices not cornified, A iv-vi old
A 80106 M	1	10-4-1968	Off plumage not moulting
-do-	2	8-10-1969	In breeding plumage not moulting
AB 19932 M	1	30-6-1970	All non-flight feathers moulting A v old
-do-	2	9-9-1970	Only A v old (colour different from rest)
A 95116 F	1	21-1-1970	Body (all tracts) and H i-v moulting
-do-	2	2-8-1970	Netted at a breeding colony not moulting
A 84203 M	1	15-4-1969	Capital spinal ventral and caudal tracts and A iv moulting
-do-	2	20-8-1969	In breeding plumage not moulting

TABLE 8

THE NOTES ON MOULT IN THE REST OF THE RETRAPPED BAYAS

Ring No. Sex	Dates (1 of ringing 2 of recapture)		Stages of moult of feathers
A 80087 F	1	6-1-1969	Two rectrices and H i-iii moulting
-do-	2	18-11-1969	H i-ii moulting
A 95140 F	1	12-2-1970	A iv-v old, rest of the featheıs new
-do-	2	21-10-1970	Not moulting found dead in a nest with chicks
A 84121 F	1	9-3-1969	Moult recently completed
-do-	2	17-2-1970	Secondaries moulting. A v-vi old
A 19927	1	30-6-1970	Not moulting, netted in a breeding colony
-do-	2	9-9-1970	Not moulting, retrapped in the same colony
A 84243 F	1	7-8-1969	Not moulting, first year bird
-do-	2	31-7-1970	Not moulting found dead in nest with chicks
A 84296	1	20-9-1969	Not moulting. Breeding
-do-	2	27-9-1969	Not moulting. Retrapped from a roost
A 80125	1	10-10-1968	Not moulting
-do-	2	18-2-1970	A iii-vi moulting
A 80190	1	1-11-1968	Not moulting
-do-	2	11-11-1970	Not moulting
88020	1	15-11-1969	Not moulting
-do-	2	20-3-1970	All feather tracts other than capital moulting

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Species identification and age classification of the jaws of some common Indian ungulates near Mudumalai Wildlife Sanctuary[1]

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(*With two plates containing four figures*)

On any journey into the Mudumalai Wildlife Sanctuary or surrounding jungle areas of Tamil Nadu, one is likely to find a number of jawbones from ungulate species, the hooved mammals. Many will undoubtedly be those of domestic cattle (*Bos taurus*) and buffalo (*Bubalus bubalis*), while others commonly found will be of Chital (*Axis axis*) or Sambar (*Cervus unicolor*). It behooves both the casual nature-lover and professional field-zoologist alike to be able to distinguish these jaws at a glance. Information obtained in this way may be of value in the study of carnivore food habits and terrestrial ecology (Cohen *et al.* 1977). As adult domestic ungulates are typically larger than wild species, size of the jaw is, of course, a primary consideration. However, it may be more difficult, for example, to distinguish between the jaws of a domestic calf and a yearling sambar, or between sambar and chital fawns.

The material presented here is intended to help clarify and make easier such species and, to a limited extent, age determinations in the hope of stimulating further research along these lines.

Basic Dentition

Most mammals of the families Cervidae (e.g. Chital, Sambar) and Bovidae (e.g. Cattle, Buffalo) have 32 teeth, twelve of which are on the upper jaw (6 per side) and twenty of which are on the lower jaw (10 per side).

Figure 1 indicates the positions of the incisors, canines, premolars, and molars in a generalized ungulate. Note that most ungulates have no upper incisors but instead have a hard pad on the roof of the mouth against which the lower incisors grind. In addition, upper canines are usually lacking while lower canines are usually not specialized and essentially function as incisors. Three premolars and three molars occur on each side of both upper and lower jaws. It is customary to refer to these teeth sequentially as: P_1, P_2, P_3, M_1, M_2, and M_3, and to term them collectively, the molariform teeth.

The fawns and calves of ungulates are born with deciduous ("milk" or "baby") teeth

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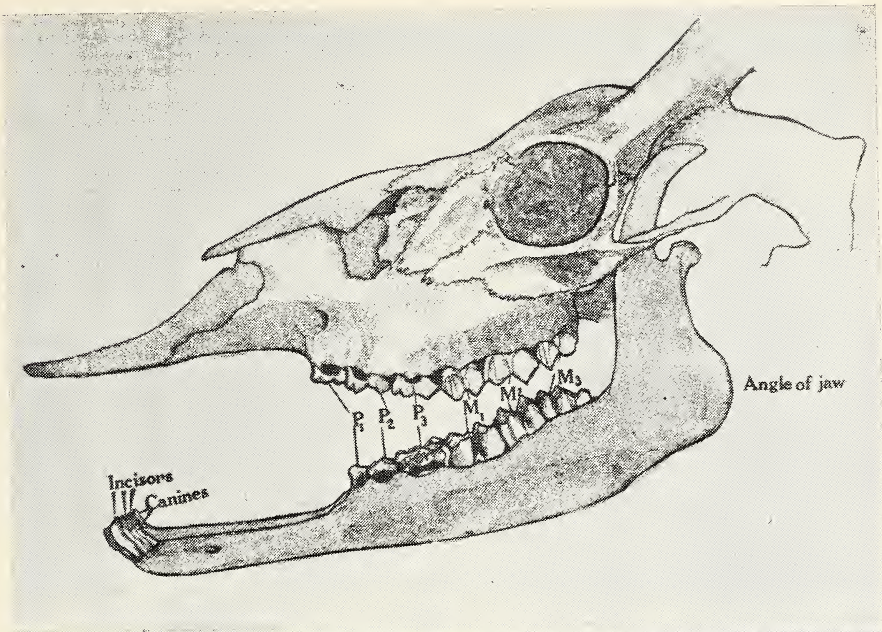
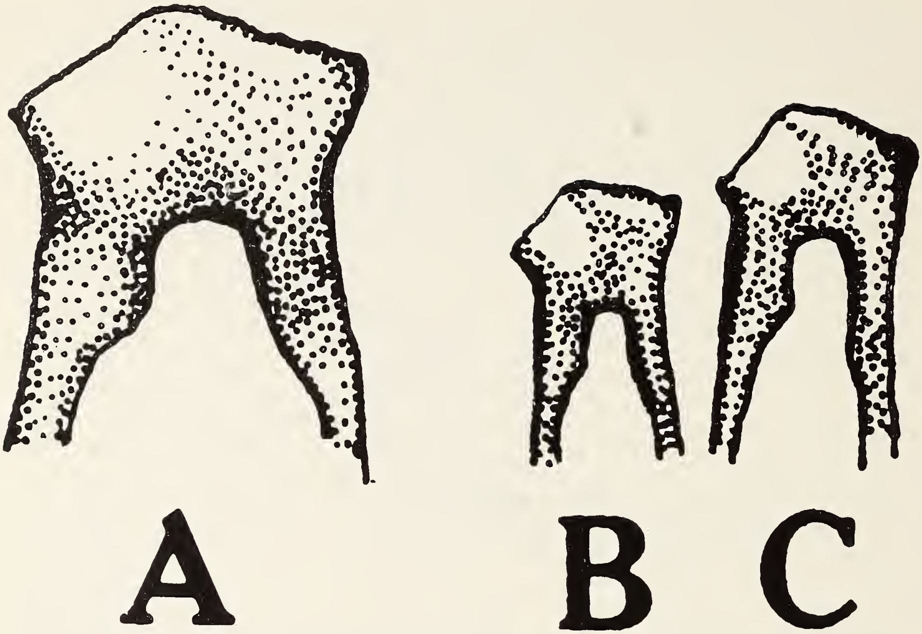
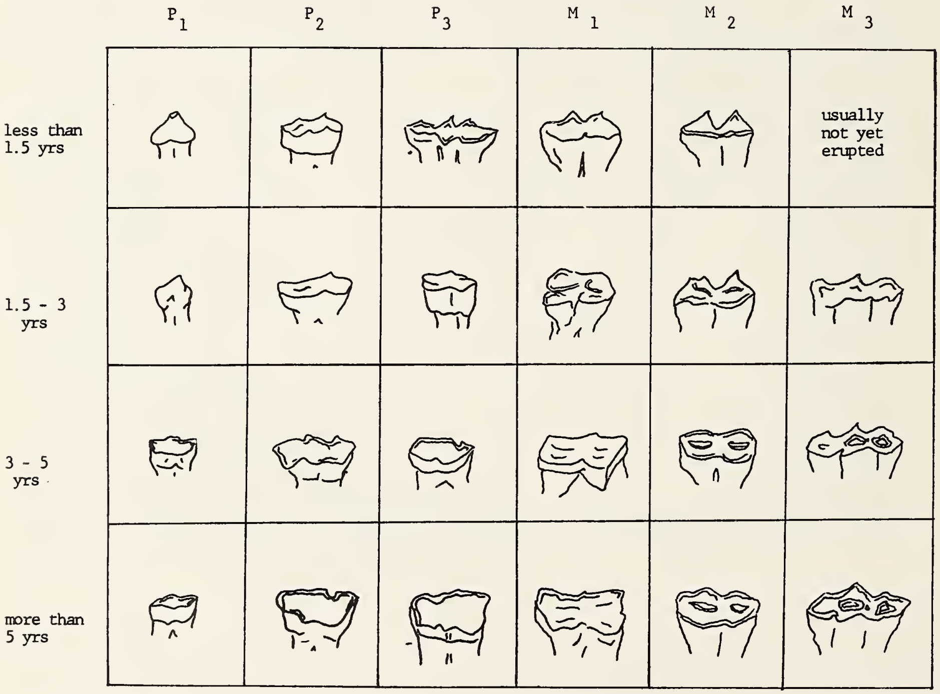


Above: Fig. 1. Dentition of a generalized ungulate. *Below*: Fig. 2. Comparison of various ungulate jaws. From top to bottom: Sambar fawn, Chital fawn, Chital adult, Domestic cattle adult.





Above: Fig. 3. Relative sizes of P_1 in (A) Sambar fawn, (B) Chital fawn, and (C) Chital adult. (Not drawn to scale). *Below*: Fig. 4. General tooth wear pattern for molariform teeth.

which are gradually replaced by a permanent set as the animal matures.

Classification

The following species and age discriminations require the lower jaw only and, as there is usually bilateral symmetry in tooth growth and wear, only one side of the jaw need be obtained. Only the molariform teeth require study.

Species Identification

The first and easiest identification to be made of a jaw in the hand is whether it is from a wild or domestic ungulate. The jaws of wild species may be distinguished by a very prominent bulge at the angle of the jaw which often protrudes beyond the main jawline, forming a "heel" (see Fig. 1).

The jaws of domestic cattle and buffalo, however, have a much less promient "heel" which rarely extends below the jawline (Fig. 2).

In addition, the domestic jaw is much thicker and has much more surface area (proportionately) below the M_3, giving it a heavier "feel" than the wild ungulate jaw.

These points will facilitate the discrimination of, for example, Sambar and Buffalo jaws which might otherwise be confused on a size basis alone.

The jaw of an adult Chital may be easily distinguished from that of an adult Sambar on the basis of size alone, but what about Chital and Sambar *fawns?* The key here is the P_1 which in the Sambar fawn is nearly three times as large as in the Chital fawn and, indeed, twice as large as that of an *adult* Chital (see Fig. 3).

Age Estimation

A precise age determination requires that the jaws of animals of known ages be first studied. These may then serve as "known samples" against which jaws of unknown ages may be compared. This, to my knowledge, has not yet been done for the Indian ungulates and therefore only an approximate age classification may be attempted at the present time. Estimations are loosely based on known age-wear patterns of the American Whitetailed Deer (*Odocoileus virginianus*) as reported by Severinghaus 1949, and personal observations made by me in south India.

A key feature for consideration is the third premolar (P_3). In fawns, calves, and yearlings this deciduous tooth will be tri-cusped, appearing to have three distinct sections, whereas in animals older than about 1.5 years, it is replaced by a permanent bi-cusped P_3. Thus, if the P_3 is tri-cusped, one knows at a glance that the jaw is from a young individual. This may be easily confirmed in some cases by the lack of wear on the molariform teeth. Care must be taken, however, for in certain cases (e.g. some yearlings) the *deciduous* teeth may show considerable wear and one may be led to believe that the jaw is from an aged adult. The number of cusps on the P_3 however, will settle the issue.

Age estimation after about 1.5 years is more difficult as more refined judgement and interpretation are called for. Such estimations are based on the relative degrees of wear on the molariform teeth. In general, as the animal matures, the higher ridges of the teeth become worn away and the chewing surfaces become smooth and concave. Certain teeth wear down earlier than others, however, and this fact enables one to better estimate the age of the jaw.

The M_1 and the M_3 typically begin to show signs of heavy wear before the other teeth. At about 3 years of age the ridges of M_1 appear somewhat worn and the posterior cusp of M_3 is worn to a point well below the first two cusps. If a jaw does not show these signs, it is most likely from an animal of less than three years.

By approximately 5 years of age, the P_2 and P_3 may show heavy wear and smooth concavities appear on the M_1 and posterior cusp of M_3. Heavier wear than this indicates jaws from animals of more than 5 years.

With this information, one may now classify jaws into four approximate age classes:

(a) Birth to 1.5 years
(b) 1.5-3 years
(c) 3-5 years
(d) More than 5 years

Figure 4 illustrates the general tooth wear pattern for each of the molariform teeth. This figure is derived principally from the study of Chital jaws, but is roughly applicable to Sambar and domestic ungulates as well.

It is, of course, important to realize that a jaw which at first appears old and decayed is not necessarily from an old animal but may simply be from one which died a long time ago.

Finer analysis and more precise age classifications must await the study of jaw specimens of known-age from zoos or free-roaming animals.

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New additions to the Pteridophytic flora of India from Great Nicobar Island[1]

K. Thothathri, S. P. Banerjee, P. K. Hajra and G. D. Pal

(*With seven text-figures*)

Introduction

A botanical survey of Great Nicobar Island was undertaken in 1966 under the Joint Scientific Expedition, organised by the Government of India, with a view to explore the plant wealth of this remote island in the Bay of Bengal. Great Nicobar is the largest of the southernmost group of Nicobars, lying between longitudes 93°37′ and 93°56′ E. and latitudes 6°45′ and 7°15′ N. It is roughly 55 km long and 30 km wide with an area of 865 sq km. Two principal ranges of mountains run more or less north to south and the highest point is Mount Thulier. Five perennial rivers (Galathea, Alexandra, Dogmar, Amrit Kaur, Jubilee) take their origin from these hill ranges. The climate is tropical with a heavy rainfall (300 cm per year). The vegetation is divisible into: (1) Mangrove forests; (2) Beach forests; (3) Low evergreen forests; (4) High wet evergreen forests; and (5) Riverine vegetation. The forests are very dense with trees, climbers and shrubs with little herbaceous undergrowth on the forest floor.

The climate, soil, rainfall and the resultant vegetation afford rich and luxurient growth of ferns and fern allies which are both terrestrial and epiphytic. A number of ferns were collected during the above expedition and a careful and critical study of them proved to be not only interesting but many have turned out to be new records for Indian territory. Such new records are treated here with brief diagnostic characters and with illustrations wherever possible. All the specimens are preserved in the Central National Herbarium; Howrah (CAL).

[1]Accepted July 1972.

1. **Acrostichum speciosum** Willd. Sp. Pl. 5:117, 1810. (Fig. 1).

A terrestrial fern, found in mangrove creeks. *Stipe* and *frond* 1 m tall; fronds simply pinnate, lower pinnae sterile while upper ones fertile. *Sterile pinnae* 25 × 4 cm, shortly stalked, base unequal and cuneate, apex narrowly acuminate, blade coriaceous, midrib raised on lower surface; stalk of the pinnae 0.5 cm long. *Fertile pinnae* similar to sterile ones but smaller; sori superficial covering the entire lower surface.

Distribution. Tropical Asia, Malayan Peninsula and Australia.

Specimens examined. Campbell Bay, Great Nicobar, Apr. 1966—*Thothathri* and *Banerjee* 11659 (CAL).

2. **Colysis macrophylla** (Bl.) Presl. Epim. Bot. 147, 1849. *Grammitis macrophylla* Bl. Enum. Pl. Java 119, 1828. (Fig. 2).

An epiphytic fern, common on branches of trees and shrubs. *Rhizome* creeping and clasping by means of roots; scales brown, lanceolate; stipe 3-7 cm long, naked. *Frond* simple, lanceolate, 25-35 × 5-7 cm, gradually narrowed at both ends, entire, thin; veins indistinct, slender and zigzag with copious, uniform, subquadrangular areolae with free veinlets enclosed within. *Sori* in single continuous row between the main veins.

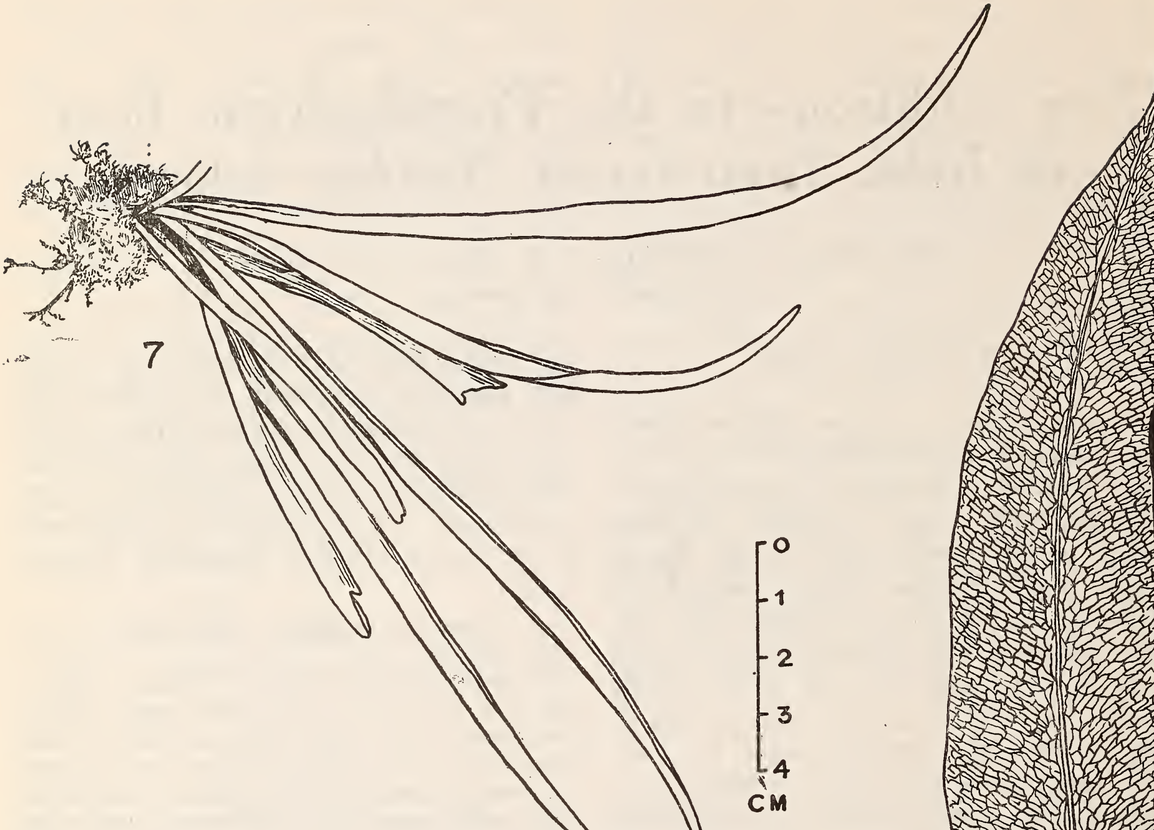

Fig. 1. *Acrostichum speciosum* Willd. Fig. 7. *Vittaria ensiformis* Sw.

Distribution. Malayan Peninsula, Philippines and New Guinea.

Specimens examined. Rosen point, Campbell Bay, Great Nicobar Island, Mar. 1966—*Thothathri* and *Banerjee* 11381 (CAL).

3. **Colysis selliguea** (Mett.) Ching in Sunyatsenia 5: 261, 1940. *Polypodium selliguea* Mett. Pol. III n: 214, 1857. (Fig. 6).

Epiphytic on branches of small trees; rhizome creeping, ± 3 mm thick, scaly; scales black with a tuft of hairs at its base, ± 5 × 1 mm, narrowed above, minutely serrate at margin. *Fronds* 15-30 × 2-3.5 cm, stipe ± 2 cm long, lower part of the blade gradually narrowed, papyracea-herbaceous; primary veins distinct connected by transverse veinlets. *Sori* superficial, 2-4 in a line in between the main veins.

Distribution. Malayan Peninsula and Philippines.

Specimens examined. From Galathea Bay to Pulobaha Bay, Great Nicobar Island, Mar. 1966—*Thothathri* and *Banerjee* 11535 (CAL).

4. **Cyclosorus polycarpus** (Bl.) Holtt. in Fl. Malaya 2: 283, 1954. *Aspidium polycarpum* Bl. Enum. Pl. Java 156, 1828. (Fig. 3).

A terrestrial fern on river banks growing under shade. *Frond* stout, about 1.5 m tall with closely placed sessile as well as reduced pinnae along the stipe; lower pinnae spreading while upper ones gradually reduced merging with the lobed, triangular apex of the frond. *Pinnae* ± 30 × 1.5 cm, base subtruncate with basal segments slightly produced; segments acuminate, margin cut about or beyond halfway to the costa into slightly oblique, entire, blunt lobes; lobes ± 4 mm long; upper surface of lamina mostly glabrous with numerous, round, yellow glands in between veinlets, lower surface and costae covered with short, spreading hairs and yellow glands; veins in each lobe 12 pairs, oblique, lowest anastomosing. *Sori* median on veins, twice as long as broad, occupying most of the lower surface.

Distribution. Malayan Peninsula and Siam.

Specimens examined. Dogmar river, Casuarina Bay, Great Nicobar Island, Apr. 1966—*Thothathri* and *Banerjee* 11600 (CAL).

5. **Humata heterophylla** (Sm.) Desv. Prodr. 323, 1825. *Davallia heterophylla* Sm. Mem. Ac. Turin. 5: 415, 1793. (Fig. 4).

Epiphytic on branches of *Barringtonia asiatica* Kurz. *Rhizome* slender, wide-creeping, ± 2 mm thick, densely scaly; scales dark brown, subulate, attenuate, ± 6 × 1 mm, finely toothed. *Fronds* dimorphous, 1.5-4.5 cm apart; stipes 1-1.25 cm long, slightly winged, densely scaly at base; sterile fronds ovate-lanceolate, 1.5-2.5 cm long, cuneate at base, shortly acuminate at apex, entire to undulate, irregularly lobed at times, coriaceous, lateral veins prominent, once, twice or more forked. *Fertile fronds* irregularly lobed or deeply sinuate-pinnatifid, 4-8 × 3 cm, lobes oblong, rounded at apex; sori terminal on each veinlet, 3-8 on each lobe, indusia ± 1 × 1.5 mm, thin, attached by its broad base.

Distribution. Malayan Peninsula, Sumatra to Pacific.

Specimens examined. Campbell Bay, Great Nicobar Island, Apr. 1966—*Thothathri* and *Banerjee* 11637 (CAL).

6. **Nephrolepis biserrata** (Sw.) Schott. Gen. Fil. t. 3, 1834. *Aspidium biserratum* Sw. Schrad. Journ. Bot. 1800(2): 32, 1801. (Fig. 5).

An epiphytic fern on trunks of large trees. *Fronds* 1.5 cm long, simply pinnate, pinnae about 80 pairs; stipe up to 60 cm long; pinna 18 × 2 cm, basal one gradually shorter and more widely placed, truncate at base, faintly crenate at margin, shortly acuminate at apex, veins faint, once or twice forked. *Sori* globose, superficial, one to each crenature and terminating the unforked vein; indusia circular with a narrow sinus.

Distribution. Pantropical especially in Malayan Peninsula.

Specimens examined. Forests in Campbell Bay, Great Nicobar Island, Mar. 1966—*Thothathri* and *Banerjee* 11390 (CAL).

7. **Trichomanes motleyi** Bosch. Ned. Kruidk. Arch. 5: 145, 1861.

Epiphytic, growing adpressed to barks of tree trunks. *Rhizome* slender. *Fronds* simple or lobed, stalked, 4-6 mm long, not hairy at edges; sterile fronds slightly elongated, rounded at base, ± 4 mm long; fertile fronds cuneate at base, bilobed at apex. *Sorus* single, free and situated in the notch of the frond; indusium tubular, mouth dialated, receptacle sometimes protruding.

Distribution. Malayan Peninsula and Borneo.

Specimens examined. Way to Pulokunio, Casuarina Bay, Great Nicobar Island, Apr. 1966—*Thothathri* and *Banerjee* 11571 (CAL).

8. **Vittaria ensiformis** Sw. Ges. Nat. Fr. Berl. Neu. Schr. 2: 134, t. 7, 1799. (Fig. 7).

Fig. 3. *Cyclosorus polycarpus* (Bl.) Holtt. Fig. 4. *Humata heterophylla* (Sm.) Desv.
Fig. 6. *Colysis selliguea* (Mett.) Ching.

Fig. 2. *Colysis macrophylla* (Bl.) Presl. Fig. 5. *Nephrolepis biserrata* (Sw.) Schott.

Epiphytic on trees. *Rhizome* short bearing closely arranged fronds. *Fronds sessile*, ± 20 × 4-6 cm, subcoriaceous, gradually narrowed at base, acuminate at apex, midrib indistinct on the lower surface. *Sori* in marginal grooves, covered by the reflexed margin of the frond.

Distribution. Malayan Peninsula, Mascarene Islands.

Specimens examined. Galathea Bay, Great Nicobar Island, Mar. 1966—*Thothathri* and *Banerjee* 11478 (CAL).

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Notes on south Indian Hepaticae—2[1,2] The genus *Herberta* Gray

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(*With twenty-nine text-figures*)
[*Continued from Vol. 72*(2): 406]

INTRODUCTION

The genus *Herberta* is represented in the Hepatic flora of South India by four species, namely *H. pinnata, H. capense, H. nilgerriensis* and *H. sanguinea.* Illustrated taxonomic account and critical distinguishing features of the first three species have been given. The observations recorded are entirely based on a collection of plants made by Rev. P. Pfleiderer from south Indian territory as well as on the type specimens obtained from Stephani Herbarium, Geneva.

Our first paper of this series deals with the description of one species each of *Trichocolea* and *Notoscyphus* (Udar & Srivastava 1975). In the present paper detailed and critical taxonomic description of three South Indian species of the genus *Herberta* has been given.

The genus *Herberta* is considered to be one of the important and most isolated member of the leafy liverworts. Previously it was treated under the family Ptilidiaceae (subfamily Ptilidioideae)—a group generally regarded to be primitive. Müller (1948, 1954; emend Fulford & Hatcher 1958) segregated this genus into a distinct family Herbertaceae.

Significant features of this genus are the presence of isophylly, deeply bifid leaves, absence of scattered rhizoids on the stem, intercalary branching, thick-walled cells in the multilayered cortex, peculiar position of antheridia in the axil of bracteoles, multistratose capsule wall and absence of any specialized body of any kind for asexual reproduction.

According to Evans (1917) the rhizoids, although very rare, in this taxon, originate normally from the cells at the base of the underleaves. Apart from underleaves, rhizoids have also been known to occur on the lateral leaves as well. In most of the cases where rhizoids are known, they originate from the abaxial face of the leaf lobes (Schuster 1957). Schuster remarked: " Such a position for the rhizoids is extremely rare in Hepaticae, recurring chiefly in taxa with potentially caducous leaves." However, at times rhizoids have also been shown to originate from the adaxial face of the leaves.

The intercalary branching with thick-walled cells in the multilayered cortex is considered to be primitive. The position of antheridia in the axil of bracteoles is rare in any other liverwort genus except *Mastigophora,* a member of the same family Ptilidiaceae (Schuster

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1957). Although there is no specialized bodies of any type for asexual reproduction, isolated regenerants or propagulae have been found on the adaxial faces of the leaf lobes. The asexual reproduction has been described in some species by fragmentation (as in *H. tenuis*: Schuster 1957) as well as by regenerants produced from the leaves (as in *H. remotiusculifolia*: Horikawa 1934).

The genus *Herberta* is represented in India by 16 species (Montagne 1842; Stephani 1909, 1922; Herzog 1939; Pande & Udar 1950 and Miller 1965).

Herzog (1939) merely named three new species (all nomen nudum) of the genus from Sikkim Himalayas without giving their diagnoses. These are: "*Herberta lonchobasis* Herz. *et* Nich. n. sp. in Herb-Tsomgo Lake, leg. Troll., *Herberta nicholsonii* Herz. n. sp. in Herb-Tsomgo Lake, leg. Troll., *Herberta mastigophoroides* Herz. *et* Nich. in Herb-Darjeeling, leg. Kerston ".

Recently Miller (1965), in a monograph on the genus, has published the diagnoses of the above species under the name *H. lonchobasis* Miller and *H. mastigophoroides* Miller from the original collection of Herzog (1939) and treated *H. nicholsonii* as a synonym of *H. lonchobasis*. He has also given a new name *H. darjeelingensis* Miller for *H. gracile* St.

The Eastern Himalayas predominate in number of species while the Western Himalayas has only one species (*H. kurzii*) of this genus (Stephani 1909). Four species, namely *H. pinnata, H. capense, H. nilgerriensis* and *H. sanguinea* have been known to occur in south India (Montagne 1842; Stephani 1909; Pande & Udar 1950).

In his revision of the genus from Tropical Pacific and Asia, Miller (1965) has included almost all the species originally reported from various localities in India except *H. capense*. Of these only three south Indian species (*H. pinnata, H. nilgerriensis* and *H. sanguinea*) have been described. These, except *H. sanguinea*, have been considerably amplified with relevant illustrations in the present paper and the diagnostic features have been critically discussed. An account of *H. capense* not included by Miller has also been given.

Miller (1965) recognized five sections under the genus *Herberta* on the basis of the primitive and advanced characters of the plants. According to him "... a little differentiated vitta is relatively primitive... and a long and sharply defined one is advanced......; a shallow sinus is less advanced than a deep one; straight leaves are less advanced than curved; an expanded basal disc composed mainly of isodiametric cells is advanced over a basal disc about equally composed of isodiametric and vitta cells; a reduced basal disc composed almost entirely of vitta is also advanced; and elongate cylindrical tip cells apparently derived from vitta initials are advanced over short cylindrical tip cells derived from laminal initial cells."

His five sections of the genus *Herberta* are as follows (species listed under each section are those represented in Indian flora):

1. *Fissiherberta*: 'Leaves bifid 1/2 or less, vitta indistinct, leaf insertion nearly transverse', e.g. *H. darjeelingensis* (*H. gracile*): Eastern Himalayas.

2. *Herberta*: 'Leaves bifid 3/5 or more, leaf segments straight to curved with segments subequal or the antical reduced, leaf tips acute or attenuate by means of short cylindrical cells derived from the lamina', e.g. *H. nilgerriensis, H. pinnata* and *H. sanguinea*: South India; *H. lonchobasis, H. dicrana H. longifissa, H. sikkimensis, H. fleischeri* and *H. fragilis*: Eastern Himalayas.

3. *Cirriherberta*: 'Leaves bifid 3/5 or more,

leaf segments slender, circinate, with the postical segment reduced.' None of the Indian species described so far comes under this category.

4. *Dilatiherberta*: 'Leaves bifid 1/2 or less, vitta distinct, leaf insertion oblique', e.g. *H. himalayana*: Eastern Himalayas, *H. kurzii*: Western Himalayas. The discovery of *H. himalayana* from North America (Miller 1968) makes it a "North American Himalayan disjunct which parallels the distribution of *Takakia* in part, adds more evidence for a common flora, or at least a well-established migration track, between the mountains of Asia and those of North America."

5. *Piloherberta*: 'Leaves bifid 3/5 or more, leaf segments straight to curved with segments subequal or the antical reduced, leaf tips attenuate by means of elongate cylindrical cells derived from the vitta', e.g. *H. mastigophoroides* and *H. wichurae*: Eastern Himalayas.

According to him (Miller 1965, p. 301): "....sect. *Fissiherberta,* or something like it, was the ancient progenitor of the genus as we know it and that sect. *Herberta* developed more recently under conditions highly conducive to retention of genetic aberrations in unsaturated biomes."

He further remarked that " Section *Herberta* was ancestral stock for *Cirriherberta, Dilatiherberta,* and *Piloherberta,* and intergrades into each to the extent that some species could be justifiably placed in either section."

The materials, on which the present investigation is based, were collected by Rev. P. Pfleiderer of Esslingen (Germany) from Western Ghats (South India) and preserved dry in packets. The type specimens of *H. pinnata, H. nilgirriensis* and *H. capense* obtained from Stephani Herbarium, Conservatoire et Jardin Botanique, Geneve, have also been investigated. Only sterile plants were represented in the collections.

Taxonomic Description

Herberta Gray

Herberta S.F. Gray., Nat. Arr. Brit. Pl. 1p 705 (1821). *Schisma* Dum. Common Bot., p. 114 (1822). *Mastigophora* Sect. *Schisma* Nees, Naturgesch. eur. Leb. 3p. 573 (1838). *Sendtnera* Nees, in Gottsche, Lindenberg u. Nees, Syn. Hep., p. 238 (1844).

Gametophyte generally large and robust, reddish brown, consisting of prostrate rhizomatous base which gives off generally intercalary aerial branches. Rhizome distinguished from stem only by the presence of small and distant leaves which may be sometimes absent. Stem stiff, straight and branched, internally differentiated into an outer cortical and inner medullary zone, cortical zone 2-3 cell layers thick, cells with considerably thickened walls having small lumen, trigones distinct, middle or medullary zone composed of comparatively larger cells with larger lumen and less thickened walls. Leaves single, bifid, arranged in three rows, identical in shape and size, transversely or obliquely inserted on the stem, larger on the main stem, smaller on branches, apices acute to acuminate, curved or straight with divisions equal or unequal in size, unistratose, composed of isodiametric cells, smaller towards margin, gradually becoming larger and elongated towards centre (vitta), walls considerably thickened with bulging trigones; lateral leaves similar to those of the underleaves except in size; underleaves usually smaller than the lateral leaves; vitta undivided at the base, forking somewhere below the bifurcations of the leaves, each division of the vitta extends up to or a little below the apices of the bifurcated leaves; vitta

Figs. 1-10. *Herberta pinnata* (St.) Miller.
Fig. 1. A portion of stem with 3 rows of leaves. Fig. 2. Cross section of stem. Figs. 3-5. Leaves. Figs. 6, 7. Underleaves. Fig. 8. Marginal cells of leaf with slime papillae. Fig. 9. Vitta cells. Fig. 10. Cells towards apex of the leaf.

cells more elongated at the base, shortened towards the apex.

KEY TO THE SOUTH INDIAN SPECIES

1. Plants robust and large in size, leaves 2-2.75 × 0.5-1.0 mm, divisions of the leaves divergent, may or may not be curved 2
   2. Leaves 1/3 or more bifid, divisions about 1.4 × 0.5 mm, slightly curved, ending in 2-4 superimposed cells; at the distance of about 0.3 mm from the apex the divisions are 5-6 cells wide, slime papillae stalked and easily met with in majority of leaves .. *H. pinnata*
   2. Leaves 2/5-1/2 bifid, divisions 1.5 × 0.38 mm, highly curved, ending in 4-10 superimposed cells; at the distance of about 0.3 mm from the apex the divisions are 4-5 cells wide, slime papillae sessile and rarely present in some leaves .... *H. capense*
1. Plants medium in size, leaves 0.75-1.9 × 0.5-0.8 mm, divisions of the leaves slightly convergent, curved or almost straight 3
   3. Leaves bifid 1/3-1/2, leaves and underleaves more or less of the same size, about 0.75-1.0 × 0.5 mm .... *H. nilgerriensis*
   3. Leaves bifid about 3/5, leaves and underleaves usually not of the same size, underleaves 1.4-1.7 × 0.6-0.7 mm .. H. *sanguinea*

Herberta pinnata (St.) Miller

Herberta pinnata (St.) Miller, J. Hattori bot. Lab. *28*:299, 1965. *Schisma pinnata* St., Spec. Hepaticarum *6*:361, 1922.

(Figs. 1-10)

Plants dark brown, robust; stem 54-74 mm long, erect, profusely pinnately branched, 0.3 mm in diameter, cortical cells 2-3 layered with thickened walls, middle cells comparatively large with less thickened walls; branching closely pinnate, branches up to 30 mm long. Leaves in 3 rows, lateral leaves 2-2.75 × 0.5-0.9 mm on the main axis, 0.7 × 0.21 mm on branches, bifid approximately 1/3, divisions lanceolate up to 1.4 × 0.52 mm, usually straight, sometimes slightly curved and divergent, acute to acuminate, ending with 2-4 superimposed cells; leaf divisions 5-6 cells wide at the distance of about 0.3 mm below the apex; slime papillae stalked, present at the margins of the undivided portion of the leaf. Underleaves slightly smaller than the leaves, about 2-2.5 × 0.9-1.0 mm, divisions long and straight; marginal cells towards the base more or less isodiametric, *c*. 9-14.4 μ in diam., cells in between the vitta and the margin *c*. 19.2-38.4 × 9.6-12.0 μ, cells towards apex *c*. 38.4 × 9.6 μ. Undivided vitta at the base nearly 326.4 × 316.8 μ, bifid 1/3 or 1/2 of the basal undivided part of the leaf; cells of the vitta *c*. 57.6 × 14.4 μ at the base. Fertile specimens not available.

Locality. Dodabetta (*c*. 8000 ft), Nilgirries (South India). *Legit*: Rev. P. Pfleiderer.

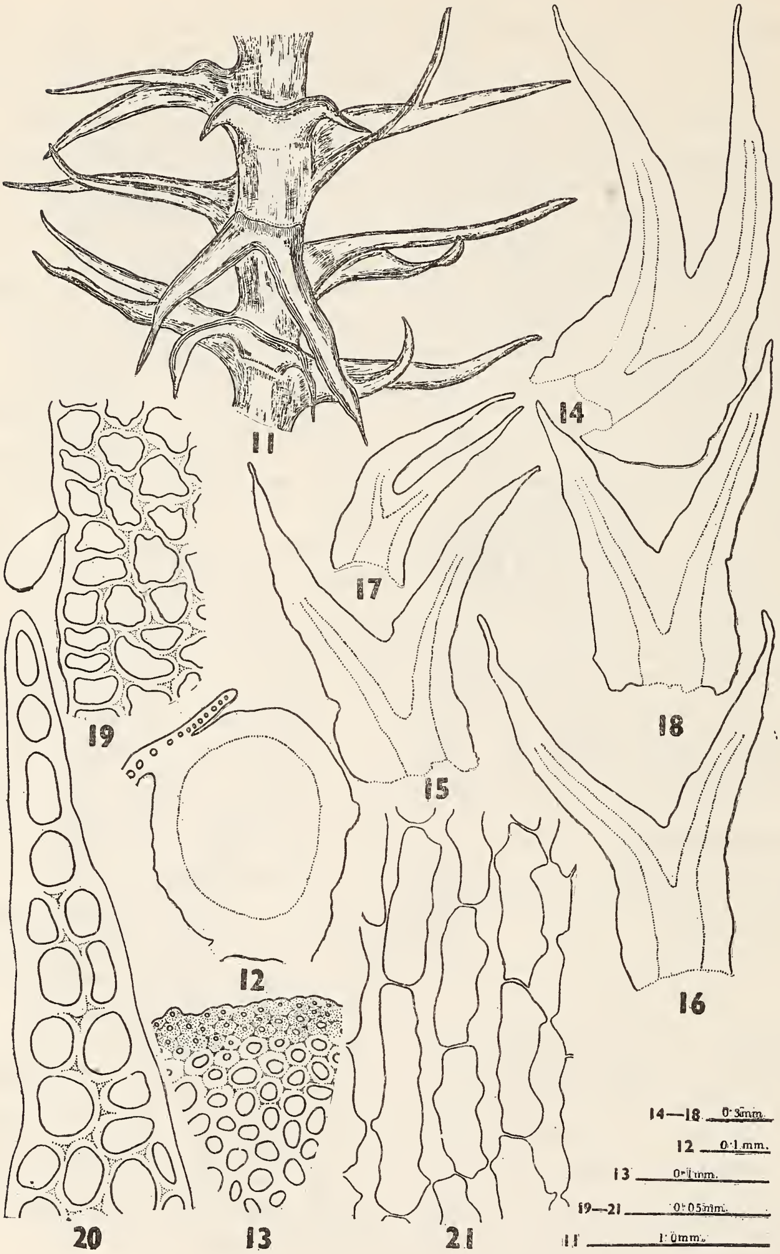
Specimens examined.

1. G 012125: Fondation Stephani; Herbarium E. Levier Original; 6140 *Schisma pinnatum*, Montis Nilgiri India S.W., Dodabetta 8765p-2670 M 12 Sep. 1907: legit Rev. B. Luthi.
2. Lucknow University Hepatic Herbarium: *Legit*: Pfleiderer. *Loc*. Dodabetta (South India).

Herberta pinnata can be easily distinguished by the presence of closely pinnate branching and the large and robust size of the plant. Leaves are symmetrical with well developed and clearly defined vitta (Figs. 3-7). Majority of the leaves show slime papillae which are stalked (Fig. 8). They are usually present at the margins of the undivided basal portion of the leaf. Miller (1965) has however reported the presence of subsessile slime papillae in this species.

Herberta capense (St.) Sim.

Herberta capense (St.) Sim., Trans. Royal Soc. S. Afr. XV: 75, 1926. *Schisma capense* St., Spec.



Figs. 11-21. *Herberta capense* (St.) Sim.
Fig. 11. A portion of stem with 3 rows of leaves. Fig. 12. Cross section of stem. Fig. 13. Magnified sketch of the same. Figs. 14-16. Leaves of the main stem. Fig. 17. Branch leaf. Fig. 18. Underleaf. Fig. 19 Marginal cells of the leaf. Fig. 20. Cells towards apex of the leaf. Fig. 21. Vitta cells.

Hepaticarum 4:6, 1909. *Chalubinskia africana* Lehm., according to Sim.

(Figs. 11-21)

Plants dark brown, 30-50 mm long, about 0.27 mm in diameter, scarcely branched, branches about 11 mm or so long. Leaves in 3 rows, lateral leaves 2/5-1/2 bifid, 2-2.5 × 0.75-1.0 mm, divisions lanceolate and unequal, 1.5 × 0·38 mm, mostly curved with acute to acuminate apices ending in 4-10 superimposed cells; leaf divisions 4-5 cells wide at the distance of about 0.3 mm below the apex. Slime papillae sessile. Underleaves similar to those of the leaves, *c.* 1.5 -2.5 × 0.5-0.75 mm. Marginal cells of both leaves and underleaves *c.* 9.6-19.2 μ in diameter, cells between the margin and the vitta *c.* 18.8 × 9.6 μ, cells towards the apex *c.* 38.4 × 9.6 μ. Vitta 1/3 bifid of the basal undivided part of the leaf, undivided vitta at the base 163.2-172 × 249.6-297.6 μ, cells of the vitta at the base *c.* 57.6-86.4 × 9.6-14.6 μ. Fertile specimens not available.

Locality. Kudremukh (South India). *Legit*: Rev. P. Pfleiderer.

Specimens examined.

1. G 012123: Herbier Stephani: *Schisma capense,* Von Lehman.
2. Lucknow University Hepatic Herbarium, *Schisma capense. Legit.* Pfleiderer. *Loc.* Kudremukh (South India).

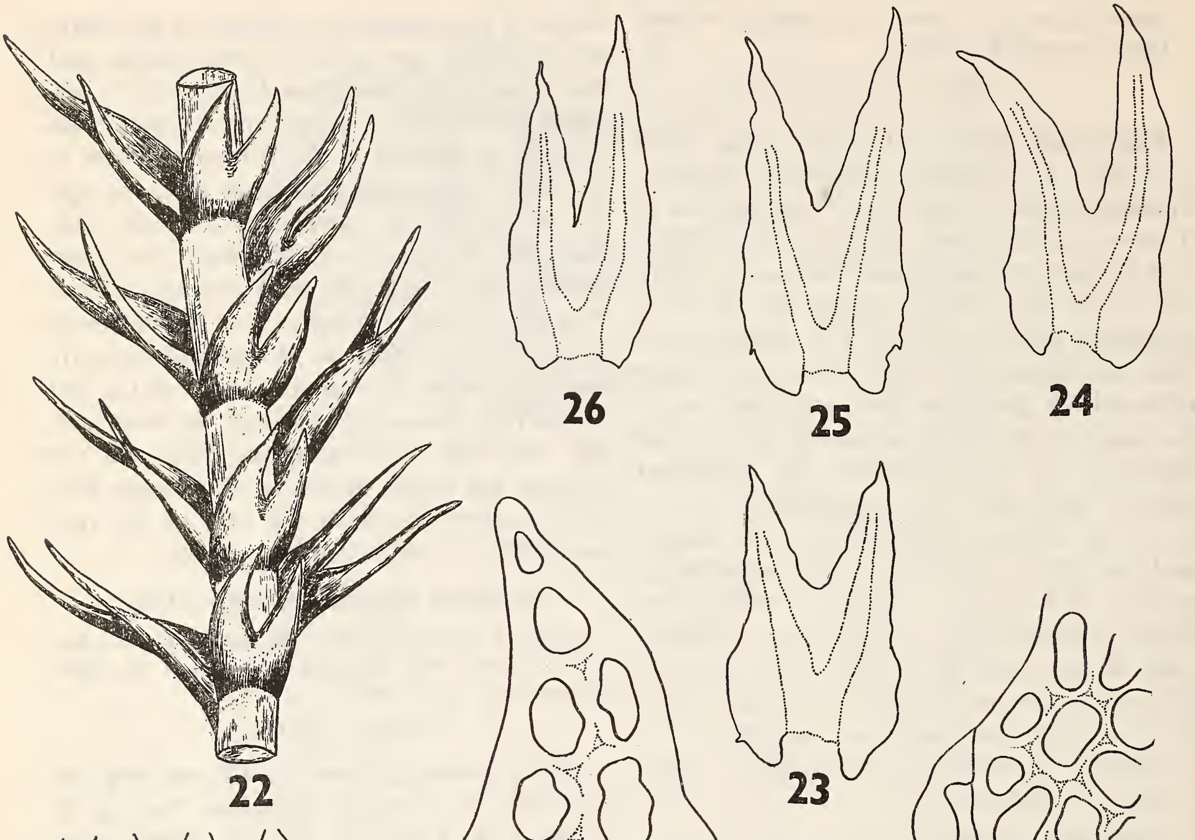
The present species *H. capense* resembles *H. pinnata* in the colour and texture of the plant, stem anatomy, attachment of leaves and also in the marginal cells of the leaf except for a little difference in their size in both the species. Besides these similarities there are fairly large number of distinguishing characters which are significant in delimiting the two taxa. For example, the characteristic profuse branching of the stem in *H. pinnata* is absent in *H. capense,* the leaves of *H. capense* are broader than the leaves in *H. pinnata,* the divisions of the leaves in *H. capense* are greatly curved, longer and less broader in contrast to *H. pinnata.* In addition the number of superimposed apical cells is more in number in the former and less in the latter. At the same distance from the apices of the leaf, *H. capense* is 5-6 cells wide while *H. pinnata* is 4-5 cells wide. The slime papillae are present in both the species but they are stalked and easily met in the leaves of *H. pinnata,* while in *H. capense* they are rare and sessile. The marginal cells of the leaf in the two species are nearly of the same size, but, the cells in between the vitta and the margins are larger in size in *H. pinnata* than in *H. capense.* Similarly the cells of the vitta also differ in size in the two species.

Herberta nilgerriensis (St.) Miller

Herberta nigerriensis (St.) Miller, J. Hattori bot. Lab. *28*:299, 1965. *Schisma nilgerriensis* St., Spec. Hepaticarum *4*:28, 1909.

(Figs. 22-29)

Plants yellowish brown, *c.* 57 mm long and 0.29 mm in diameter, branches few up to 6 mm long. Leaves in 3 rows, lateral leaves 1/2 bifid 0.75-1.0 × 0.5 mm, divisions convergent, *c.* 0.6 × 0.25 mm, unequal, straight or slightly curved, apices acute ending in 1-3 superimposed cells; leaf divisions 7-9 cells wide at the distance of about 0.3 mm below the apex. Sometimes one or two sessile slime papillae occur at the margins of the undivided part of the leaf. Underleaves similar in shape and about of the same size as the leaves, divisions short unequal and converging. Marginal cells of the leaf *c.* 9.6-16.8 μ in diameter, cells in between the margin and the vitta *c.* 19.2-23.2 × 9.6 μ, cells towards the apices *c.* 9.6-12 μ in diameter. Undivided vitta at the base *c.* 96.0-115.0 × 144-153·6 μ about 1/2 bifid of the basal undivided part of the leaf;



Figs. 22-29. *Herberta nilgerriensis* (St.) Miller.
Fig. 22. A portion of stem with 3 rows of leaves. Figs. 23, 24. Leaves. Figs. 25, 26. Underleaves. Fig. 27. Marginal cells of the leaf. Fig. 28. Cells towards apex of the leaf. Fig. 29. Vitta cells.

basal cells of the vitta *c.* 48.0-57.6 × 16.8 μ. Fertile specimens not available.

Locality. Nilgerries. *Legit.* Perottot.

Specimen examined.

1. G 012124: Herb. J. Cardot: No. 89: *Schisma nilgherriensis* St., Hindoustan Nilgherries. *Leg.* Perottot.

The present investigation is based entirely on the specimens obtained from Stephani Herbarium. *Herberta nilgerriensis* differs apparently from *H. pinnata* and *H. capense* in the overall size of the plant as well as in the size and shape of the leaves. This species is smaller in size than the other two species. In addition the divisions of the leaf in *H. nilgerriensis* are almost straight and convergent whereas in *H. capense* and *H. pinnata* the divisions of the leaves are apparently divergent and more or less curved. Greatly curved leaves as commonly found in *H. capense* are almost absent or very rarely present in *H. pinnata* and *H. nilgerriensis.* Leaf divisions are unequal in *H. capense* and *H. nilgerriensis* while in *H. pinnata* this feature is not very stable and therefore in some leaves of the latter the divisions may be uniform and in others they may be unequal. Leaf divisions in *H. nilgerriensis* are comparatively smaller and narrower than in the other two species, but, at the same distance from the apex the leaf divisions are usually 7-9 cells wide in *H. nilgerriensis* and 4-5 and 5-6 cells wide in *H. capense* and *H. pinnata* respectively. Similarly the superimposed apical cells in leaf divisions also differ in the south Indian species. These are 2-3 in *H. nilgerriensis* and 2-4 and 4-10 in *H. pinnata* and *H. capense* respectively. The slime papillae occur in all the three south Indian species but they are very rare in *H. capense* and rather common in *H. pinnata.* The vitta is distinct and well defined in all the three species.

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* Not seen in original.

Ectoparasites from Nepal birds[1,4]

RICHARD M. MITCHELL[2] AND JAMES A. DICK[3]

INTRODUCTION

Ectoparasite occurrence in Nepal birds has received little attention. Worth and Shah (1969) provided a list of 17 birds collected in Nepal, but identified ectoparasites only as lice, fleas, Ascodipteron Diptera, Trombiculid, Laelapid and Listrophorid mites, and ticks. Detailed descriptions of several ticks from birds collected in Nepal also include information on ecology of the parasite and parasite distribution. Hoogstraal *et al.* (1973) described the tick *Ixodes ovatus* collected from the Kalij Pheasant (*Lophura leucomelana*) in Nepal, and Kohls *et al.* (1970) reported on *Ixodes mitchelli* that parasitizes the Monal Pheasant (*Lophophorus impejanus*) and the Snow Partridge (*Lerwa lerwa*). Hoogstraal and Mitchell (1971) described the tick *Haemaphysalis aponommoides* found on numerous domestic and wild mammals and the Monal Pheasant.

Distribution of ectoparasites, other than the ticks mentioned above, among Nepal birds is not available. As field chief of the Nepal Ectoparasite Programme, the senior author collected 152 species of birds of which 78 were infested with ectoparasites. This paper provides a list (Table 1) of all ectoparasites from birds collected in Nepal from 1966 to 1972.

Most birds examined during the Nepal Ectoparasite Survey were captured in Japanese mist nets. Galliformes were obtained by shooting. Birds were collected throughout the 75 districts of the Kingdom of Nepal (see Karan 1960, p. 9).

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[4] Accepted July 1975.

TABLE 1

HOST-PARASITE RELATIONSHIPS FROM NEPAL

Host-Parasites	Number of birds collected	Number of parasites collected
Mallard (*Anas platyrhynchos*)	2	
Mallophaga: *Anaticola crassicornis*		1
Common Merganser (*Mergus merganser*)	1	
Mallophaga: *Anaticola crassicornis*		1
Blackwinged Kite (*Elanus caeruleus*)	1	
Acarina: *Ornithonyssus bursa*		1
Pariah Kite (*Milvus migrans*)	2	
Mallophaga:		
Craspedorrhynchus spathulatus		1
Degeeriella regalis		1
Laemobothrion maximum		1
Sparrow-hawk (*Accipiter nisus*)	1	
Mallophaga: *Craspedorrhynchus nisi*		1
Redbreasted Falconet (*Microhierax caerulescens*)	3	
Mallophaga: *Falcolius jordani*		2
Diptera: *Phthona leptoptera*		2
Kestrel (*Falco tinnunculus*)	1	
Mallophaga		
Degeeriella rufarufa		1
Laemobothrion tinnunculi		1
Snow Partridge (*Lerwa lerwa*)	16	
Mallophaga		
Chelopistes lervicola		8
Colinicola meinertzhageni		7
Lagopoecus meinertzhageni		1
Menacanthus sp.		4
Acarina		
Argas himalayensis		1
Ixodes mitchelli		3
Chukor Partridge (*Alectoris chukar*)	4	
Mallophaga		
Cuculogaster obscurior		1
Goniocotes alatus		1
Gonoides dispar		1
Black Partridge (*Francolinus francolinus*)	14	
Mallophaga		
Cuculogaster theresae		3
Goniocotes sp.		5
Lipeurus sp.		4
Menacanthus kalatitar		4

Host-Parasites	Number of birds collected	Number of parasites collected
Menacanthus sp.		1
Menopon interpositum		1
Anoplura: *Hoplopleura maniculata*		1
Siphonaptera: *Ctenocephalides felis orientis*		1
Acarina		
Haemaphysalis bispinosa		6
Haemaphysalis sp.		
Grey Partridge (*Francolinus pondicerianus*)	5	
Mallophaga		
Goniocotes sp.		2
Menacanthus sp.		2
Siphonaptera: *Ctenocephalides felis orientis*		1
Acarina		
Haemaphysalis bispinosa		1
Haemaphysalis montgomeryi		1
Haemaphysalis sp.		1
Rufousthroated Hill Partridge (*Arborophila rufogularis*)	1	
Mallophaga		
Amyrsidea eibeli		1
Menacanthus sp.		1
Oxylipeurus formosanus		1
Blood Pheasant (*Ithaginis cruentus*)	13	
Mallophaga		
Amyrsidea sp.		1
Goniocotes sp.		4
Gonoides ithaginis		5
Lagopoecus sp.		5
Oxylipeurus baileyi		5
Diptera: *Ornithomya avicularia*		1
Satyr Tragopan (*Tragopan satyra*)	4	
Mallophaga		
Goniocotes haplogonus		1
Goniocotes diplogonus		2
Gonoides eurygaster		1
Gonoides spinicornis		3
Lagopoecus sp.		1
Oxylipeurus baileyi		1
Oxylipeurus himalayensis		3
Monal Pheasant (*Lophophorus impejanus*)	26	
Mallophaga		
Amyrsidea sp.		3
Goniocotes haplogonus		18
Gonoides eurygaster		23
Gonoides ithaginis		1

Host-Parasites	Number of birds collected	Number of parasites collected
Gonoides megaceros		2
Lagopoecus heterotypus		13
Lagopoecus sp.		1
Menacanthus sp.		1
Oxylipeurus baileyi		1
Oxylipeurus himalayensis		22
Acarina		
Haemaphysalis aponommoides		1
Haemaphysalis warburtoni		3
Ixodes mitchelli		7
Kalij Pheasant (*Lophura leucomelana*)	10	
Mallophaga		
Goniocotes creber		1
Gonoides dentatus		2
Gonoides sp.		2
Lipeurus introductus		1
Acarina		
Haemaphysalis bispinosa		2
Haemaphysalis nepalensis		1
Haemaphysalis wellingtoni		1
Haemaphysalis sp.		1
Red Junglefowl (*Gallus gallus*)	13	
Mallophaga		
Gonoides dissimilis		5
Lipeurus caponis		6
Menopon gallinae		9
Anoplura		
Linognathus vituli		1
Polyplax asiatica		1
Diptera: *Icosta maquilingensis*		3
Acarina		
Argas hermanni		1
Haemaphysalis anomala		1
Haemaphysalis bispinosa		6
Haemaphysalis canestrinii		1
Haemaphysalis indica		1
Haemaphysalis minuta		5
Haemaphysalis montgomeryi		1
Haemaphysalis spinigera		1
Haemaphysalis wellingtoni		4
Haemaphysalis sp.		4
Rhipicephalus haemaphysaloides		1
Common Peafowl (*Pavo cristatus*)	11	
Mallophaga		
Amyrsidea minuta		4

Host-Parasites	Number of birds collected	Number of parasites collected
Amyrsidea phaeostoma		2
Colpocephalum tausi		4
Goniocotes rectangularis		1
Goniocotes sp.		2
Gonoides meinertzhageni		1
Gonoides pavonis		4
Lipeurus pavo		4
Diptera: *Ornithoica bistativa*		1
Acarina		
Haemaphysalis bispinosa		6
Haemaphysalis doenitzi		1
Haemaphysalis howletti		1
Haemaphysalis minuta		2
Haemaphysalis spinigera		3
Haemaphysalis wellingtoni		1
Haemaphysalis sp.		2
Common Bustard-Quail (*Turnix suscitator*)	5	
Mallophaga: *Turnicola anguistissimus*		3
Redwattled Lapwing (*Vanellus indicus*)	4	
Mallophaga		
Actornithophilus hoplopteri		2
Quadraceps hoplopteri		1
Quadraceps dasi		1
Saemundssonia africana		1
Acarina: *Haemaphysalis* sp.		1
Spurwinged Lapwing (*Vanellus spinosus*)	4	
Mallophaga		
Actornithophilus hoplopteri		3
Quadraceps hoplopteri		5
Austromenopon sp.		1
Acarina		
Dermacentor sp.		1
Haemaphysalis bispinosa		1
Haemaphysalis spinigera		1
Little Ringed Plover (*Charadrius dubius*)	1	
Mallophaga: *Quadraceps bicuspis*		1
River Tern (*Sterna aurantia*)	1	
Mallophaga: *Quadraceps insignis*		1
Snow Pigeon (*Columba leuconota*)	9	
Mallophaga		
Colocerus sp.		3
Columbicola tschulyschman		6
Campanulotes heteroceros		2

Host-Parasites	Number of birds collected	Number of parasites collected
Siphonaptera: *Callopsylla geminus*		1
Rock Dove (*Columba livia*)	5	
Mallophaga		
Colocerus sp.		1
Columbicola columbae bacillus		2
Diptera: *Pseudolynchia canariensis*		5
Ashy Wood Pigeon (*Columba pulchricollis*)	2	
Mallophaga: *Columbicola columbae bacillus*		1
Acarina: *Laelaps algericus*		1
Rufous Turtle Dove (*Streptopelia orientalis*)	5	
Mallophaga		
Colocerus sp.		1
Columbicola orientalis		5
Diptera: *Pseudolynchia canariensis*		1
Acarina: *Falculifer restratus*		1
Collared Turtle Dove (*Streptopelia decaocto*)	1	
Mallophaga: *Columbicola columbae bacillus*		1
Emerald Dove (*Chalcophaps indica*)	2	
Mallophaga		
Colocerus sp.		1
Columbicola guimaraesi		2
Blossomheaded Parakeet (*Psittacula cyanocephala*)	1	
Mallophaga: *Menacanthus* sp.		1
Slatyheaded Parakeet (*Psittacula himalayana*)	1	
Mallophaga: *Echionophilopterus* sp.		1
Sirkeer Cuckoo (*Taccocua leschenaultii*)	4	
Mallophaga: *Cuculicola* sp.		1
Acarina		
Haemaphysalis bispinosa		2
Haemaphysalis howletti		1
Haemaphysalis indica		1
Haemaphysalis sp.		1
Laelaps algericus		1
Coucal (*Centropus sinensis*)	6	
Mallophaga: *Cuculiphilus snodgrassi*		1
Acarina		
Haemaphysalis bispinosa		4
Haemaphysalis doenitzi		4
Haemaphysalis minuta		2
Haemaphysalis spinigera		1
Brown Fish Owl (*Ketupa zeylonensis*)	2	
Mallophaga		
Colpocephalum turbinatus		1

Host-Parasites	Number of birds collected	Number of parasites collected
Strigiphilus bramae		1
Acarina: *Haemaphysalis* sp.		1
Barred Owlet (*Glaucidium cuculoides*)	3	
Mallophaga: *Kurodaia deignani*		2
Acarina: *Haemaphysalis doenitzi*		1
Brown Wood Owl (*Strix leptogrammica*)	1	
Mallophaga: *Strigiphilus ketupae*		1
Acarina: *Haemaphysalis bispinosa*		1
Indian Jungle Nightjar (*Caprimulgus indicus*)	1	
Mallophaga: *Mulcticola* sp.		1
Acarina: *Hyalomma* sp.		1
Crested Swift (*Hemiprocne longipennis*)	2	
Anoplura: *Hoplopleura pacifica*		1
Common Kingfisher (*Alcedo atthis*)	1	
Mallophaga: *Alcedoffula alcedinis*		1
Whitebreasted Kingfisher (*Halcyon smyrnensis*)	2	
Mallophaga: *Alcedoecus annularis*		1
Anoplura: *Hoplopleura pacifica*		1
Little Green Bee-eater (*Merops orientalis*)	1	
Mallophaga		
Bruelia sp.		1
Meropoecus caprai		1
Meromenopon sp.		1
Green Barbet (*Megalaima zeylanica*)	2	
Mallophaga: *Penenirmus zeylanicus*		1
Bluethroated Barbet (*Megalaima asiatica*)	1	
Mallophaga		
Colpocephalum fregili		1
Myrsidea insolita		1
Philopterus sp.		1
Striated Swallow (*Cecropis daurica*)	1	
Acarina: *Pellonyssus viator*		1
Blackheaded Oriole (*Oriolus xanthornus*)	1	
Acarina: *Ornithonyssus sylviarum*		1
Black Drongo (*Dicrurus adsimilis*)	2	
Mallophaga: *Bruelia* sp.		1
Yellowbilled Blue Magpie (*Urocissa flavirostris*)	3	
Mallophaga		
Menacanthus kalatitar		2
Philopterus extraneus		1
Acarina		
Pterodectes leioplax		1
Proctophyllodes sp.		2

Host-Parasites	Number of birds collected	Number of parasites collected
Redbilled Blue Magpie (*Urocissa erythrorhyncha*)	3	
Mallophaga		
Myrsidea sp.		1
Philopterus sp.		2
Acarina: *Haemaphysalis* sp.		1
Indian Tree Pie (*Dendrocitta vagabunda*)	4	
Mallophaga		
Bruelia meinertzhageni		1
Bruelia sp.		1
Philopterus sp.		2
Diptera: *Ornithophila metallica*		1
Nutcracker (*Nucifraga caryocatactes*)	1	
Mallophaga		
Menacanthus merisuoi		1
Myrsidea brunea		1
Redbilled Chough (*Pyrrhocorax pyrrhocorax*)	3	
Mallophaga		
Bruelia biguttata		1
Menacanthus sp.		1
Myrsidea sp.		1
Philopterus sp.		1
Philopterus thryptocerphalus		1
House Crow (*Corvus splendens*)	1	
Mallophaga		
Bruelia saliemi		1
Colpocephalum fregili		1
Myrsidea insolita		1
Jungle Crow (*Corvus macrorhynchos*)	2	
Mallophaga		
Bruelia saliemi		1
Myrsidea shirakii		1
Philopterus extraveus		1
Philopterus sp.		1
Raven (*Corvus corax*)	3	
Mallophaga: *Myrsidea anaspila*		1
Whitecheeked Bulbul (*Pycnonotus leucogenys*)	1	
Mallophaga: *Bruelia* sp.		1
Jungle Babbler (*Turdoides striatus*)	10	
Mallophaga		
Bruelia mahrastan		5
Bruelia sp.		1
Myrsidea satbhai		6
Myrsidea sp.		1

Host-Parasites	Number of birds collected	Number of parasites collected
Acarina		
Haemaphysalis bispinosa		2
Haemaphysalis sp.		6
Whitethroated Laughing Thrush (*Garrulax albogularis*)	4	
Mallophaga		
Bruelia sp.		1
Myrsidea satbhai		1
Myrsidea sp.		1
Streaked Laughing Thrush (*Garrulax lineatus*)	16	
Mallophaga: *Bruelia sehri*		4
Acarina		
Laelaps algericus		1
Ornithonyssus bursa		1
Proterothrix sp.		2
Plaincoloured Laughing Thrush (*Garrulax subunicolor*)	1	
Mallophaga: *Myrsidea* sp.		1
Acarina: *Ixodes acutitarsus*		1
Blackfaced Laughing Thrush (*Garrulax affinis*)	10	
Acarina: *Argas* sp.		1
Redheaded Laughing Thrush (*Garrulax erythrocephalus*)	1	
Mallophaga: *Menacanthus* sp.		1
Acarina: *Ixodes acutitarsus*		1
Hoary Barwing (*Actinodura nipalensis*)		
Siphonaptera: *Macrostylophora lupata*		1
Redbreasted Flycatcher (*Ficedula parva*)	1	
Acarina: *Proctophyllodes* sp.		1
Orangebarred Leaf Warbler (*Phylloscopus pulcher*)	1	
Siphonaptera: *Ceratophyllus gallinae*		1
Magpie-Robin (*Copsychus saularis*)	1	
Acarina: *Haemaphysalis* sp.		1
Bluefronted Redstart (*Phoenicurus frontalis*)	4	
Siphonaptera: *Ceratophyllus enefdei*		1
Blue Whistling Thrush (*Myophoneus caeruleus*)	2	
Mallophaga		
Menacanthus sp.		1
Myrsidea satbhai		1
Philopterus thryptocerphalus		1
Acarina: *Haemaphysalis anomala*		1
Golden Mountain Thrush (*Zoothera dauma*)	11	

Host-Parasites	Number of birds collected	Number of parasites collected
Mallophaga		
Bruelia daumae		1
Menacanthus sp.		1
Philopterus sp.		1
Saemundssonia africana		1
Siphonaptera: *Callopsylla fusca*		2
Acarina		
Haemaphysalis bispinosa		3
Haemaphysalis indica		1
Haemaphysalis minuta		1
Haemaphysalis spinigera		2
Haemaphysalis sp.		3
Ixodes sp.		2
Whitecollared Blackbird (*Turdus albocinctus*)	2	
Mallophaga: *Philopterus* sp.		1
Redthroated Thursh (*Turdus ruficollis*)	1	
Mallophaga: *Philopterus* sp.		1
Acarina		
Haemaphysalis bispinosa		1
Haemaphysalis minuta		1
Wren (*Troglodytes troglodytes*)	2	
Mallophaga		
Penenirmus zeylanicus		1
Penenirmus sp.		1
Brown Dipper (*Cinclus pallasii*)	1	1
Mallophaga: *Myrsidea* sp.	1	
Rufousbellied Crested Tit (*Parus rubidiventris*)		
Siphonaptera: *Ceratopsyllus gallinae*		1
Hodgson's Tree Pipit (*Anthus hodgsoni*)	10	
Mallophaga: *Menacanthus* sp.		1
Acarina		
Haemaphysalis bispinosa		1
Haemaphysalis nepalensis		1
Haemaphysalis spinigera		1
Large Pied Wagtail (*Motacilla maderaspatensis*)	2	
Mallophaga		
Bruelia sp.		1
Myrsidea sp.		1
Acarina: *Hyalomma* sp.		1
Yellowthroated Sparrow (*Petronia xanthocollis*)	2	1
Mallophaga: *Bruelia* sp.		1
Acarina: *Proctophyllodes* sp.		
Common Rosefinch (*Carpodacus erythrinus*)	14	

Host-Parasites	Number of birds collected	Number of parasites collected
Mallophaga		
Bruelia sp.		3
Philopterus sp.		6
Siphonaptera		
Callopsylla fusca		5
Ceratophyllus enefdei		1
Acarina		
Ixodes mitchelli		2
Dermanyssus sp.		1
Nepal Rosefinch (*Carpodacus nipalensis*)	5	
Mallophaga: *Philopterus* sp.		1
Acarina: *Ixodes berlesei*		1

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Effects of crowding on Temple Rhesus monkeys of Imphal, Manipur[1]

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(*With a text-figure and a photograph*)

Introduction

The rhesus monkeys are common in the cities, villages, forests and temples of northern India and have been intensively studied in this country. Little is known about the effects of overcrowding on the free ranging rhesus monkeys and their interactions with man when their home ranges overlap with human habitations. Southwick, Beg & Siddiqi (1961, 1965) have studied the social interactions of temple rhesus monkeys in northern India. Southwick (1967), and Alexander & Roth (1971) have studied the effects of crowding on the behaviour of rhesus and Japanese macaques respectively under captive conditions. Martin & Hilary Waterhouse (1971) reported the effects of population density in zoo monkeys. Oppenheimer (1973) reported the effects of environmental factors, specially high human density and intensive cultivation around home ranges, on the activity of village langurs in West Bengal.

A group of rhesus monkeys *Macaca mulatta* (Zimmermann) living in Mahabali temple of Imphal, the state capital of Manipur, consisting of a larger number of individuals presented an opportunity to the author to study the effects of overcrowding and interactions between man and monkeys and the observation and inferences are presented here.

[1] Accepted August 1976.

Ecology of the Study Area

Manipur is one of the eastern states of India, extending from 23°47′ and 25°41′ north latitudes and 93°60′ and 94°48′ east longitudes. It is bounded on the north by Nagaland, on the east by Burma and the west by Assam and on the south by Burma and Mizo Hills. The area of the state is 22,372 sq. km., out of which 1942 sq. km form the central valley of Manipur. The elevation of Imphal town is 762 m above the mean sea-level. The forests, mainly of sub-tropical type, are all scattered around the Imphal Valley and the majority of them are located in the hills. The valley consists of alluvial soil with drainage from north to south and enjoys a good climate. The period from November to February is characterised by low temperature and heavy dew at night. Frost is common on winter nights. In April and May temperature rises rapidly but the increasing heat is often moderated by the thunderstorms and light showers. The period from June to September is characterised by heavy rainfalls. The average rainfall is about 131 cm in the valley of which the maximum precipitation occurs in the months of July and August. Winter rainfall is sometimes heavy, often continuing for two to three days.

The range of temperature is generally from 35°F to 94°F with mean daily humidity of 81% in August and 49% in March at Imphal. The prevailing winds blow from the southwest with moderate velocity.

The Manipur Valley is inhabited by Manipuris who are orthodox Hindus by religion and the hills are occupied by various tribes. The population of Imphal, the study area, is about 300,000 with a density of 788 per sq. km. The Hindus form about 61.68% of the population of Imphal.

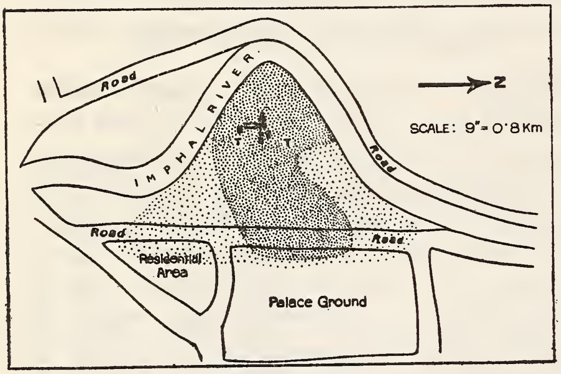

Fig. 1. Home range and core area of temple rhesus. The dotted area represents the total home range. The denser portion in the middle represents the core area. The temple is marked with solid black and other buildings with open squares. The two tanks are represented by the letter — T.

A big group of rhesus monkeys consisting of 128 individuals was located in the Mahabali temple at Imphal. This temple is situated on the south side of the city, in a well-populated area, at the eastern bank of Imphal river (Fig. 1). This river flows through the Chin Hills and the Kale Valley and discharges its water into the Chindwin river of Burma. Besides the temple, there are six other small to moderate-sized buildings, each consisting of one or two rooms. The buildings and the courtyard cover an area of about 28 sq. m. Two medium-sized tanks are located on the north and south sides of the temple courtyard (Fig. 1). The river runs north-south and there is a non-metalled road which runs along the bank, forming an embankment. Another non-metalled road runs almost parallel to this road and passing within a few feet of the temple gate. Tall trees mostly mangoes (*Mangifera indica*) and pipal (*Ficus religiosa*) are abundant on the north, south and west sides of the temple and the ground is covered with shrubs. There is also a big open area on the north. To the east of the temple is the residential area with permanent buildings and courtyards. Some devotees live in the temple area. There is constant human activity in the area particularly during the day time and there is a great rush of visitors to the temple on every Tuesday. The habitat can be classified as human habitation type. The areas of greatest activities of the monkeys are generally in the north, south and west of the temple covering an extent of about 8 hectares.

Methods

This group was studied for a few days in the months of May-June 1974 but the monkeys were observed from dawn to dusk in the month of February 1975. A total of about 70 hours was spent with this group. Group size, composition, intraspecific interactions, relation to man and dogs were recorded. It was possible to keep the group under constant observation from vantage points within the temple campus itself and to watch their daily routine and behaviour.

No attempt was made to interfere with the activities of the monkeys, nor was feeding resorted to except on one occasion. The young which were less than one year of age, usually carried by their mothers and not yet weaned, were classified as infants. The juveniles were identified as young that were independent, weaned and about one or more than one year of age. The monkeys were neither marked nor trapped, individual identification was possible in most cases after a little familiarity and noting particular features, specially body-marking and other features. All the interactions between man and monkeys were recorded during the period of observations.

Results and Observations

Group size and composition The composition of this group in February 1975 was 18 adult males, 38 adult females, 42 juveniles and 30 infants, consisting a total of 128 monkeys. The ratio of adult males to adult females is 1 : 2.11, whereas the ratio of the infants to adult females is 1 : 1.27. Some of the members of the group are shown in the photograph. No change was observed in the composition

Photo. Monkeys waiting for food. Notice the clustering of the monkeys at artificial feeding time.

of the group during the period of study. The main centre of activities of the group was generally confined within the temple premises during the day time, and though occasionally some members moved, into the residential area on the eastern side, they were soon pushed back into the temple area by dogs and people. They were never observed to move out into the city and were always found in the temple area. Local people also confirmed these findings. The group maintained territorial boundaries and their home range covered an area of about 8 hectares with about 5 hectares as core area. Members used trees and roofs of the temple and other buildings inside the temple premises for sleeping during the night. About 60% of the area of the home range and about 50% of the core area were covered with trees. Though good portions of the core area and home ranges were covered with trees, yet the monkeys spent most of their daylight hours on the ground. They even spent less time on the roof of the houses or temple.

Daily activity and diet The monkeys were active throughout the day and were mainly engaged in feeding or moving from place to place in search of food, or indulging in intragroup agonistic behaviour. Play and resting, common among juveniles and adults of rhesus monkeys, were not much in evidence in this group. Occasionally the adult males were groomed for short period by adult females. The general activity of these monkeys tended to increase with the arrival of visitors in the temple when the monkeys cluster round the visitors and even search their belongings for food. A large number of monkeys moved together while searching for food and the members did not scatter over a wide area during the day. The natural food of these monkeys included leaves shoots and fruits of various plants. The visitors to the temple and devotees resident therein, however, contributed bulk of the food material which included fried grams, peanuts, and seasonal fruits. They also consumed grass blades and were also observed looking for food in the water of the tanks. The monkeys drank water two to three times a day, when they made individual or group movements to the two tanks.

Intragroup interactions It is generally held that inter- and intragroup agonistic behaviour are more common in baboons and rhesus than in other monkeys. Southwick (1962) reported on the intergroup agonistic behaviour of the temple macaques of Aligarh. Martin & Hilary Waterhouse (1971) observed a great amount of tension in rhesus monkeys at Bristol Zoo. Frequent agonistic encounters between members of the monkeys of Mahabali temple at Imphal were observed. These encounters consisted of hot chases, attacks, fights and bites; threats were less common than physical attacks. Even the sick and infants were not spared from these attacks. There was less agonistic behaviour between the males. The males generally attacked females, juveniles and even infants. These fights were quite severe, sometimes resulting in deep injuries to the victims. Most of the animals, even the infants, carried scars and deep wounds in various parts of the body. A female whose hind quarters were paralysed and thus rendered unable to move was subjected to repeated attacks by the males. These encounters occurred for food and when an animal approached too close to others. The males mostly initiated these encounters. When the visitors offered food the monkeys rushed to grab it, generally leading to severe encounters among the indiviudals. Tension in these monkeys was so high that individuals attacked others unprovoked. Most of the encounters were severe and usually started with two animals, but soon more animals joined in the frays and the interactions erupted into severe fights. In case of an attack by a male on a female, some time one or two females joined together and formed an alliance, and chased away the attacking male.

An average of 21.13 encounters were recorded per hour in these monkeys. The percentage of intragroup encounters are given in the Table below. The male-female encounter was more, whereas male-male encounter was less.

TABLE SHOWING PERCENTAGE OF INTRAGROUP ENCOUNTERS

Categories	Males	Females	Juveniles	Infants
Males	3.70	24.70	11.11	4.94
Females	11.11	9.89	9.89	6.12
Juveniles	—	1.23	9.89	7.42
Infants	—	—	—	—

It is apparent from the table that even the infants were not spared from the attacks of males, females and juveniles. In such attacks the infants depended for protection on their respective mothers.

Interactions with other species Interactions of these monkeys with humans and dogs were also investigated. In human-monkey encounters rocks were thrown at the monkeys, catapults were used, noises were made and sticks were waved in the air. The main idea of these encounters was to scare away the monkeys from the visitors and from food articles and, of play in the case of children just for fun. These encounters generally lasted for one to five minutes, but a few lasted as long as eleven to fifteen minutes. On an average 15 encounters per hour were observed. In these encounters 73.44% boys and 26.56% adults were involved. Usually two to three boys joined together, whereas the men were usually alone in the harassment of these monkeys. In such harassments the monkeys either climbed up the trees or on roofs, or ignored the threat and continued their normal activity.

Occasionally the dogs belonging to the local people chased and barked at the monkeys and these harassments continued from five to twenty minutes. In such encounters two or three dogs joined in chasing the monkeys.

DISCUSSION

Field studies of free-ranging rhesus monkeys show that intergroup interactions are frequent, but little is known about the intragroup interactions of rhesus monkeys in an overcrowded situation such as in a temple habitat and their encounters with human beings when their home ranges and core areas overlap with human habitation. The rhesus group of Mahabali temple at Imphal, Manipur, consisted of 128 individuals whereas Southwick, Beg & Siddiqi (1965) counted a maximum number of 78 monkeys at Jagvedi Akhara Temple at Chitrakut with 17 males and 35 females. They gave the average group size of temple rhesus monkeys to be 41.9. They also found that the temple group on an average consisted of 7.9 adult males and 15.2 adult females. The present group consists of 18 adult males and 38 adult females. Unlike other temple monkeys they never move out in the other parts of the city. Very little is known about the rhesus population and their distribution in Manipur. Manipuris reported that in the past there were number of rhesus groups at Imphal, and other parts of Manipur but now owing to the expansion of city and the exploitation of their habitats, there are only a few left. It is likely that the existing Mahabali temple group is the remnants of the large population of rhesus monkeys of Imphal that used to exist in the past before the destruction of their normal habitats. The food source and home range of this group is limited, there is no further chance to expand its home range owing to the residential area on the east, Imphal river on the west and the expansion of the city to the north and south. Further the group contained a large number of individuals resulting in over crowding and the number of adult males is much more than normal. All these factors build up high tension in the animals which leads to frequent and violent intragroup interactions. The intragroup encounters in this group are much more than what were reported by Martin & Hilary Waterhouse (1971) in zoo monkeys. Southwick, Beg & Siddiqi (1965) reported that adult males attacked other members of a group including the infants at the feeding time, whereas males of the Mahabali temple attacked group members during feeding and non-feeding times, and even unprovoked. Southwick (1967), and Alexander & Roth (1971) also observed that the aggressiveness in the captive groups of rhesus and Japanese macaques respectively increased under crowding conditions. Alexander & Roth further observed increase in aggressive interactions between the males under such conditions. The present field observations support the findings of Southwick, and Alexander & Roth, but in the Mahabali temple group the male-female encounters were much more than male-male bouts. Martin & Hilary Waterhouse (1971) reported great tolerance by the adult males towards the infants in the zoo monkeys. In this respect the present observation is at variance with that of Martin & Hilary Waterhouse.

Harassments by the adult humans to monkeys were caused for protection of food and property, whereas attacks by the boys were mainly for play. In man-monkey encounters boys were involved more than adults. This agrees with the findings of Oppenheimer (1973) who has reported that the langur groups in his study area were more harassed by dogs and children, than by adult humans.

Summary

The paper deals with the effects of overcrowding, intragroup interactions and human-monkey encounters of a group of rhesus monkeys *Macaca mulatta* (Zimmermann) inhabiting the Mahabali temple of Imphal, Manipur. The group comprised of 18 adult males, 38 adult females, 42 juveniles and 30 infants, a total of 128 animals. This large number of animals in a limited area leads to overcrowding which resulting in great tension in the animals with high degrees of intragroup interactions. In man-monkey encounters, boys figured more than adults.

Acknowledgements

My thanks are due to the Director, Zoological Survey of India, Calcutta for the facilities of work. My thanks are also due to Dr. K. K. Tiwari for his encouragement and for going through the manuscript.

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New records of bathypelagic fishes from the Arabian sea with description of a new species[1]

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(*With seven text-figures*)

The Research Vessel *Varuna* and Fishing Vessel *Velameen* of the Integrated Fisheries Project (formerly Indo-Norwegian Project) during their exploratory cruises for assessment of Deep Sea Resources along the West Coast of India within the depth range of 100 to 225 fathom collected a number of interesting species of fishes. Among these, *Halimochirurgus triacanthus* Fowler (1934), *Parasphenenthias weberi* Gilchrist (1922), *Sibogapistus pleurostigma* Weber (1913), *Acanthocepola cuneata* Smith (1936), *Ariosoma balearica* (da la Roche 1923) and *Caecula lumbricoides* (Bleeker 1864) are new to West Coast of India, while one Heterosomate fish belonging to the genus *Zebrias* appears to be a new species. The gear used was a small trawl net of 6 m, operated with 54 × 34 cm otter boards, weighing 58 kilograms each.

The specimens described in this paper are lodged in the museum of the Marine Research Laboratory of the Integrated Fisheries Project.

Family TRIACANTHODIDAE

Halimochirurgus triacanthus Fowler (Fig. 1)

Halimochirurgus triacanthus Fowler, 1934, Proc. Acad. Nat. Sci. Phil. *86;* Berg, 1947, Classification of fishes both recent and fossil

D. 111, 12, A. 10, P. 7, V. 1 (Spine only)

Head 2.2 in total length and 1.9 in standard length. Depth of body 5.5 in total length and 4.7 in standard length. Eye 6.3 in head and 0.8 in inter orbital space. Fish laterally compressed, snout generally extended, tube like, mouth on the dorsal side of the tube at its terminal part. General body surface rough and with small spiny scales, operculum vertical slit like opening, edge soft. First dorsal with three spines, the first being with locking mechanism. All the three spines fit in a groove over the dorsal side. Ventral with a single long spine with locking mechanism. Encircling the eye a reddish stripe extends to the snout end. Orange above, silvery below, fins with reddish margin.

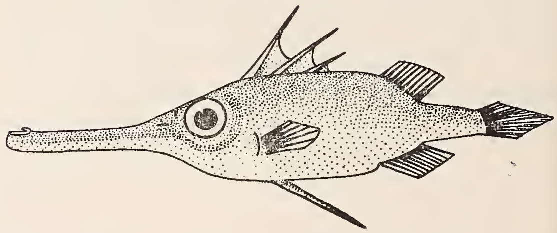

Fig. 1. *Halimochirurgus triacanthus* Fowler, 99 mm.

OCCURRENCE: One specimen (99 mm) off Calicut at Station No. 72, 11°26′ N, 74°47′ E, 160 fathom, 3-vii-1969.

[1] Accepted May 1974.

DISTRIBUTION: China Sea off Southern Luzon. Berg (1947) included this species under the family Triacanthidae, but, expressed a doubt as to its true systematic position. He feels that this species perhaps may represent a distinct family. The species shows characters of both Syngnathid and Triacanthid.

Family OWSTONIIDAE

Parasphenenthias weberi (Gilchrist) (Fig. 2)

Owstonia weberi Gilchrist, 1922, Fish Mar. Surv. Spec. Rep. 3; Barnard, 1925, Annals S. Afr. Mus. *21; Parasphenenthias microlepis* Fowler, 1934, Proc. Acad. Nat. Sci. Phil. *86; Parasphenenthias weberi* Smith, 1949, The Sea Fishes of Southern Africa

D. 111, 23, A. 1, 16, P. 17, V. 1, 5

Head 5.9 in total length and 3.5 in standard length. Depth of body 6.7 in total length and 4.0 in standard length. Eye 3.1 in head and 0.7 in inter orbital space. Drop shaped body with large cycloid scales. Oblique mouth, bearing a single row of conical teeth on the jaws. Teeth at symphysis of the lower jaw fit into a depression in the upper jaw. Eyes large. Angle and lower margin of the preopercle not serrated, no spines on the pre-opercle. Dorsal with three and anal with one weak spines. Ventral spine strong. Caudal lanceolate, rays branched, middle being with two very long branches. Ventral with five rays first being very long. Lateral lines run along the dorsal base, the lines of both sides unite in front of the dorsal and end below the last dorsal ray. Colour crimson-red.

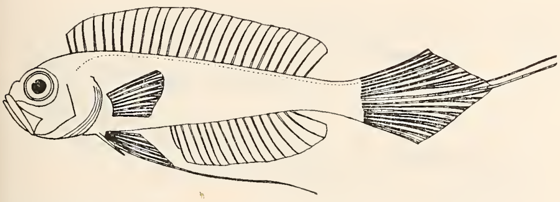

Fig. 2. *Parasphenenthias weberi* (Gilchrist), 413 mm.

OCCURRENCE: Two specimens [413 mm (Fig. 2) and 247 mm] off Calicut at Station No. 77, 11°24′ N, 74°49′ E, 140 fathom, 4-vii-1969.

DISTRIBUTION: Natal to Zanzibar down to 200 fathom, related forms in Japan. Original record from South Africa.

Family SCORPAENIDAE

Sibogapistus pleurostigma Weber (Fig. 3)

Paracentropogon pleurostigma Weber 1913, Siboga Exp. Fische. *57*; *Sibogapistus pleurostigma* Weber & Beaufort, 1962, Fish Indo-Aust. Archip. *11*

D. 111, 12, A. 111, 6, P. 12, V. 1, 5

Head 5.1 in total length and 7.0 in standard length. Depth of body 3.4 in total length and 2.6 in standard length. Eye 3.9 in head and 1.3 in inter orbital space. Body laterally compressed and covered with rudimentary scales. Head naked, anterior profile blunt with a distinct concavity. Inter orbital space with three longitudinal grooves. Maxillary extends to below the hind margin of eye. Preorbital with two spines, a short anterior and a long posterior. Pre-opercle with a spine at the hind margin, four rudimentary ones below, no opercular spines. Dorsal arise above the anterior margin of the pupil. First spine smallest and the third longest. Rays of all fins feebly forked. Twenty two tubes discernible in the

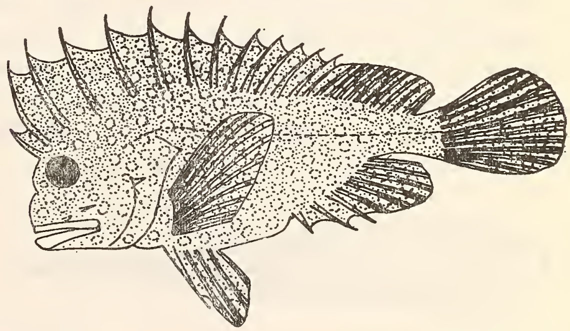

Fig. 3. *Sibogapistus pleurostigma* Weber, 157 mm.

lateral line. Caudal rounded. Brownish with irregular spots. A dark brown blotch on the body behind the operculam.

OCCURRENCE: One specimen (157 mm) off Calicut at Station No. 72, 11°26′ N, 74°47′ E, 160 fathom, 3-vii-1969.

DISTRIBUTION: Between Sala Unatti and Misol. *S. pleurostigma* has been reported only from the type locality (Weber 1962). Weber's specimen measured only 50 mm. The present specimen measuring 157 mm agrees with Weber's description but for the presence of three longitudinal grooves on the inter-orbital space and the feebly branched rays of the fins.

Family Cepolidae

Acanthocepola cuneata Smith (Fig. 4)

Acanthocepola cuneata Smith, 1936, Records Albany Mus. *5;* Smith, 1949, The Sea Fishes of Southern Africa

D. 72-75, A. 81-85

Head 7.5 to 7.7 in total length and 6.9 to 7.0 in standard length. Depth of body 9.2 to 9.4 in total length and 8.4 to 8.6 in standard length. Eye 3.2 to 3.5 in head and 0.7 to 0.8 in inter-orbital space. Body elongated, laterally compressed with minute scales. Cleft of mouth oblique with a single row of fine teeth. Eyes large and lateral. A long dorsal and anal fin continuous with the caudal. Lateral line runs along the base of the dorsal. Ventral thoracic. Gill openings wide, the membrane scarcely united under the throat. A black spot between 8th and 12th rays of the dorsal. The outer edge of the dorsal and anal black. Colour red.

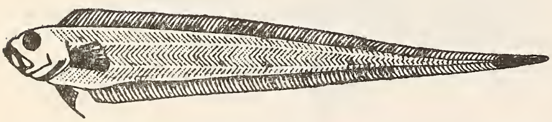

Fig. 4. *Acanthocepola cuneata* Smith, 302 mm.

OCCURRENCE: Three specimens [302 mm (Fig. 4), 296 mm and 298 mm] off Cannanore at Station No. 145. 12°28′ N, 74°14′ E, 150 fathom, 17-xii-1969.

DISTRIBUTION: Natal. Related species down to Pacific and to China.

Family Congridae

Ariosoma balearica (da la Roche) (Fig. 5)

Congermuraena balearica Barnard, 1923, Annals S. Afr. Mus. *13; C. australis* Barnard, 1925, Annals S. Afr. Mus. *21,* pt 1; *Ariosoma balearica* Fowler, 1936, Bull. Amer. Mus. Nat. Hist. *70.*

Head 7.0, depth of body 17.0, both in total length. Eye 8.3 in head. Body robust with loose skin, scales absent. Dorsal and anal confluent with caudal. Mouth fairly large, not extending beyond eye. Teeth small. Dorsal start above pectorals. Colour plain brownish, slightly lighter below. Posterior edge of dorsal and anal fins white.

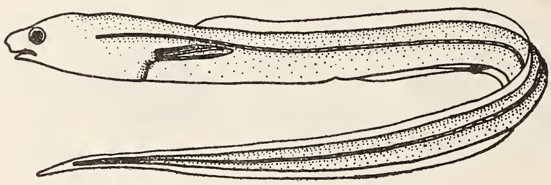

Fig. 5. *Ariosoma balearica* (de la Roche), 99 mm.

OCCURRENCE: One specimen (99 mm) off Alleppey at Station No. 35, 09°35′ N, 75°45′ E, 200 fathom, 4-ix-1969.

DISTRIBUTION: Mediterranean and tropical Atlantic, mostly in deep water.

Family Ophichthidae

Caecula lumbricoides (Bleeker) (Fig. 6)

Ophichthys lumbricoides Bleeker, 1864, Atlas Ichth. Ind. Neerl. *4; Caecula lumbricoides* Munro, 1955, The Marine and Fresh Water Fishes of Ceylon

Head 14.0, depth of body 56.0, both in total length. Elongated slender cylindrical naked body. Eyes small. Tongue present. Pectorals absent. Mouth cleft reaching far behind eye. Teeth small pointed. Gill openings small oblique slits. Tail pointed without fins at end. Dorsal and anal not traceable. Colour brownish.

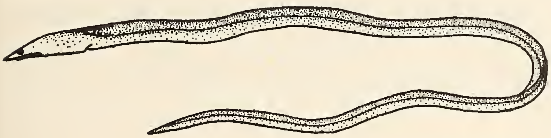

Fig. 6. *Caecula lumbricoides* (Bleeker), 225 mm.

OCCURRENCE: One specimen (225 mm) off Calicut at Station No. 164, 11°22′ N, 74°31′ E, 200 fathom, 9-i-1970.

DISTRIBUTION: Mostly in tropical waters. Related species from East Africa and Madagascar.

Family Soleidae

Zebrias maculosus sp. nov. (Fig. 7)

MATERIAL: Three specimens were obtained from the Arabian sea—two off Alleppey, St. No. 256, 09°30′ N, 75°50′ E, 150 fathom, 18-iii-1972, and one at St. No. 380, 09°35′ N, 75°50′ E, 150 fathom, 25-ii-1973.

HOLOTYPE: No. INP-F. 55a. Total length 134 mm. Standard length 128 mm. Depth of body 3.5 in total length and 3.4 in standard length. Mouth 2.7 in head. Eye 6.0 in head and 0.6 in inter-orbital space. Nasal tube 15.0 in head.

PARATYPES: No. INP-F. 55b. Total length 120 mm. Standard length 110 mm. Depth of body 3.2 in total length and 2.8 in standard length. Head 4.3 in total length and 3.8 in standard length. Mouth 2.8 in head. Eye 5.6 in head and 0.6 in inter-orbital space. Nasal tube 14.0 in head.

b) No. INP-F. 55c. Total length 130 mm. Standard length 122 mm. Depth of body 3.2 in total length and 2.8 in standard length. Head 4.2 in total length and 3.7 in standard length. Mouth 2.6 in head. Eye 5.1 in head and 0.7 in inter-orbital space. Nasal tube 15.5 in head.

DIAGNOSIS: Scales moderately ctenoid with one series of spinules. Eyes in a straight line one below the other and without tentacles. Dorsal with 58 to 66 rays. Anal with 50 to 54 rays. 120 to 135 scales in a longitudinal series. Posterior rays of dorsal and anal completely joined to caudal.

DESCRIPTION: Eyes on right side nearly contiguous, in a straight line, the lower one is slightly larger than the upper one. Anterior nostril of coloured side at the end of a short tube. Nostril of blind side more or less hidden by a membraneous flap. Mouth curved reaching one-third of lower eye. Lips on blind side fringed. Anterior part of head on blind side covered by fleshy filaments. Snout produced into a tapering point overhanging the mouth. Lower jaw not prominent. Preopercle edge covered by skin. A row of fringes along the preopercular border of blind side. Lateral line straight on both sides. Dorsal beginning above and somewhat before eyes. Anterior rays not enlarged and shorter than others. Dorsal and anal continuous with caudal with scarcely distinct and rounded posteriorly. Pectorals very small with broad base and connected by a fold with upperpart of branchiostegal membrane. Pelvic short, free from each other and from anal. Right one connected with genital papilla. Scales ctenoid on both sides. Inter-orbital space scaly. Scales on head and neck of same size as others. Rays of vertical fins scaly. Colour of the fresh specimen brownish with dark patches and spots. Patches and spots arranged as shown in figure 7.

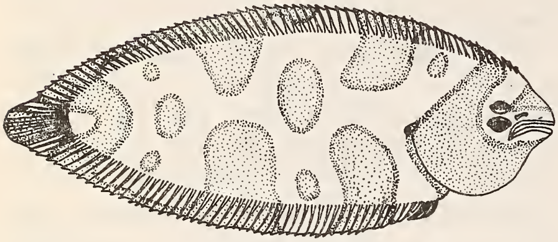

Fig. 7. *Zebrias maculosus* sp. nov.

HOLOTYPE AND PARATYPES: Integrated Fisheries Project Marine Research Laboratory.

TYPE LOCALITY: 09°30′ N, 75°50′ E, 150 Fathom.

DISTRIBUTION: Arabian Sea, Indian Ocean.

REMARKS: Major works on flatfishes from Indian waters are of Day (1878), Norman (1927 & 1928), Weber & Beaufort (1929) and Munro (1955). Abraham (1963) has given a comparatively good account on the flatfishes collected by the Research Vessel *Conch* of Kerala University. Three species of *Zebrias*

TABLE

COMPARATIVE ACCOUNT OF CHARACTERS OF THE SPECIES OF *Zebrias* ALREADY RECORDED FROM THE INDIAN WATERS AND OF THE NEW SPECIES

Characters	*Z. synapturoides*	*Z. quagga*	*Z. altipinnis*	*Z. maculosus*
Mouth	extending to below middle of eye or not quite as far.	extending to below anterior part of eye.	extending to below middle or anterior part of eye.	extending to below one third of lower eye.
Eyes	without tentacles, nearly contiguous, the upper a little in advance of the lower.	with tentacles, nearly contiguous, the upper a little in advance of the lower.	without tentacles, nearly contiguous, the upper a little in advance of the lower.	without tentacles, nearly contiguous, both in a straight line, the lower one slightly larger than the upper one.
Dorsal fin rays	69 – 74	67 – 75	79 – 83	58 – 66
Anal fin rays	59 – 63	56 – 61	65 – 71	50 – 54
Scales	strongly ctenoid, single series of strong spinules on the posterior edge.	moderately ctenoid, with several series of spinules posteriorly.	moderately ctenoid, with one or two series of spinules posteriorly.	moderately ctenoid, with one series of spinules posteriorly.
No. of scales in a longitudinal series	66 – 71	92 – 99	105 – 112	120 – 135
Colour	Greyish, with a number of dark brown cross bands.	Pale brownish or greyish with a number of dark brown cross bands.	Pale brownish or greyish with a number of dark brown cross bands.	Brownish with a number of dark patches and spots.

were described from the Indian Coasts by Norman (1928), i.e. *Z. synapturoides, Z. quagga* and *Z. altipinnis.* Table 1 gives a comparative account of the characters of the species of *Zebrias* already recorded from the Indian waters and of the new species. The new species shows distinct characters of difference from other species of *Zebrias* described earlier. The characters like form and arrangement of spots and patches, the number of scales in a longitudinal series, the number of rays for dorsal and anal fins, the number and arrangement of spinules on the scales and the position and size of eyes and absence of tentacular structures are worth mentioning. The new species is characterised particularly by its blotches and spots by which I name this species *maculosus.*

Acknowledgements

I wish to extend my sincere thanks to Mr. M. Devidas Menon, Director, Integrated Fisheries Project, Cochin for his valuable help in the preparation of this paper. I am also thankful to the captains and crew of R/V *Varuna* and F/V *Velameen* for all their help on board the vessels.

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Breeding of the pigmy hog *Sus salvanius* (Hodgson) in northern Assam[1]

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(*With two plates and a text-figure*)

INTRODUCTION

The 're-discovery' of the pigmy hog *Sus salvanius* in the Himalayan foothills of Assam during March, 1971 put paid to various gathering reports, including E. P. Gee's (1964), that this interesting and unusual member of the pig family was feared to be extinct. The circumstances leading up to the re-appearance of the pigmy hog was referred to in a previous paper (Mallinson 1971), as well as in reports by the 'Oryx' magazine (1971), by Tessier-Yandell (1971 a & b) and by Ranjitsinh (1972).

The purpose of this paper is to record the data that has accumulated between the time of two visits to Assam, during the period May, 1971 and November, 1976. The information, when correlated, presents a much clearer picture as to the reproductive biology of the pigmy hog, as well as establishing some behavioural characteristics that have not previously come to light.

CAPTIVE STOCK

In May, 1971 I obtained some valuable quantitative data on the pigmy hogs kept in three separate locations in the Mangaldai subdivision, of Darrang Division, in Northern Assam. Tables 1-3 provide checklists of specimens that have been taken from the wild state, have been reared in captivity, as well as providing data on the total captive populations on five different occasions in 1971, 1972, 1974, 1975 and 1976 respectively.

TABLE 1

CHECKLIST OF *Sus salvanius* TAKEN FROM WILD STATE

Date	Adults ♂	Adults ♀	Sub-Adults ♂	Sub-Adults ♀	Total
April 71	3	12	0	1	16
1972-73	2	1	0	0	3
1974	1	2	1	2	6
1975	3	2	1	0	6
Total	9	17	2	3	31

TABLE 2

CHECKLIST OF *Sus salvanius* REARED IN CAPTIVITY IN ASSAM

Date	♂	♀	Total	Location
24.Apr.73	3	1	4	Paneery Tea Estate
18.May 76	1	1	2	Attareekhat Tea Estate
May 76	2	2	4	Gauhati Zoo
Total	6	4	10	

It can be seen from Tables 1-3 that in a five year period 1971-1975 inclusive, 31 pigmy

[1] Accepted March 1977.

hogs were taken from the wild state. In addition to the 10 specimens that were reared in captivity, if all of the wild caught specimens had survived, a total population of 41 pigmy hogs (17 ♂♂, 24 ♀♀) could have been expected. However, from the checklist of specimens taken on five occasions over the five and a half year period, it is evident that 24 out of the 31 taken into captivity have since died; and that in November, 1976 only 7 (4 ♂♂, 3 ♀♀) of the wild caught specimens remained.

45.7-50.8 cm. The shoulder height ranges in adult males 22.9-30.5 cm, and in adult females 20.3-21.6 cm. It is interesting to note that the 330 day old male that had been hand-reared at Paneery, was 0.400 kg heavier than an adult female.

Breeding

Gestation Period

So far, no information has been recorded to provide an accurate gestation period for the pigmy hog. The period of gestation for the more common South American collared peccary *Tayassu tajacu* was for a long time considered to be similar to that of the domestic pig 112-116 days; but recently, more exact data has been recorded by Mohr (1960), Schmidt (1976), Sowls (1961, 1966), and by the Jersey Zoo (Mallinson 1974), which presents a gestation range for this species of a period between 142-149 days. However, it is considered that in all probability the gestation period for the pigmy hog is likely to be less than that of a peccary, with an approximate range of 110-120 days.

Breeding Season and Littter Size

Hodgson (1847) stated that the grown male perhaps pairs off for a short period in the

Table 3

Checklist of *Sus salvanius* in captivity in Assam

Date	Adults ♂	Adults ♀	Sub-Adults & Juveniles ♂	Sub-Adults & Juveniles ♀	Total	Reference
25. April 71	3	11	1	3	18	Mallinson (1971) Tessier-Yandell (1971)
8. April 72	2	3	0	0	5	Ranjitsinh (1972)
June 74	3	4	3	1	11	Wrangham (1974)
June 75	7	7	1	2	17	Oliver (1975)
Nov. 76	6	4	4	3	17	Mallinson

Measurements

In a previous paper (Mallinson 1971), Table 1 presented two references to the measurements of *Sus salvanius* that had already been quoted in literature; and Tables 2 & 3 recorded measurement of the 2 specimens that were examined at the Attareekhat and Paneery Tea Estates, in Northern Assam. In this paper, Table 4 presents further references to published data, as well as providing some new recordings of both measurements and weights.

It can be seen in Table 4 that the muzzle (tip of nose) to base of tail range of measurements for adult males is 66-71 cm, for adult females 55.2-62.2 cm, and for sub-adult males

TABLE 4

MEASUREMENTS OF *Sus salvanius*

Age of Specimen	Sex	Muzzle to Base of Tail (cm)	Shoulder Height (cm)	Weight (Kg)	Reference or Source
Adult	♂	66	27.9	—	Burke (1937:152)
,,	♂	66	30.5	—	Lydekker (1900:267)
,,	♂	71	22.9	—	Mallinson (1971:427)
,,	♂	—	—	9.700	Schmidt (1977-*in verbis*)
,,	♀	54.8	—	—	Garson (1883:413)
,,	6 ♀♀	55.2 – 62·2 (range)	20.3 – 21 6 (range)	—	Mallinson (1971:427)
,,	♀	—	—	6.600	Schmidt (1977-*in verbis*)
Sub-Adult	♂	45.7 – 50.8	20.3 – 25.4	3.200 – 4.500	Hodgson (1847:423)
	♂	49.5	21.6	3.700	Mallinson (1971:427)
	♀	49.5	20.3	3.400	Mallinson (1971:427)
Infant development Approx. Av. 3 ♂♂ & 2 ♀♀					
3 days		15·2	—	0.050	Wrangham (1974-*in lit.*)
42 ,,		22.9	—	0.500	,, ,, ,,
63 ,,		33	—	1.100	,, ,, ,,
330 ,,	♂	66	25.4	7.000	,, ,, ,,

breeding season, of which there are said to be two in a year, and the litter to consist usually of but 3 or 4 young ones.

A male and three females were purchased (for £125) by the Zoological Society of London, on 1st May 1882 and 9 young were born in the years 1883-1886 all between the dates 16th May—23rd June (Flower 1929). Zuckerman (1953) only records 8 young in three litters but an examination of the daily occurrences of the Society reveals that there were four litters, the fourth being easily overlooked because it had not been entered as clearly as the others. None of those young lived long as is shown in Table 5.

As has been found to be the case with the records of litter sizes of some other species at the London Zoo, in the 19th Century only live births were recorded; therefore, after taking into consideration the data provided in Table 6 it seems unlikely that the two litters of singletons referred to in Table 5 represent the actual number born to the respective litters.

The only other previously published record as to litter size, was that of the four young, which were conceived in the wild, and born at the Attareekhat Tea Estate in Northern Assam, 1971 (Mallinson 1971). Since that time, eight further births have been recorded all of which were conceived in a captive environment in Assam, and took place within a thirty-seven month period, April 1973—May, 1976.

TABLE 5

CHECKLIST OF *Sus salvanius* BORN AT ZOOLOGICAL SOCIETY OF LONDON

Date	Number born	Comment
23 May 1883	4	1 eaten by dam same day 1 dead next day 1 died day after that
16 May 1884	1	died 2 days later
11 June 1885	3	all died two dayslater
23 June 1886	1	eaten by dam 12th July

TABLE 6

TIME OF YEAR AND LITTER SIZE OF *Sus salvanius* BORN IN CAPTIVITY IN ASSAM DURING PERIOD APRIL, 1971 - MAY, 1976

Litter No.	Date	♂	♀	Unsexed	Total	Location	♂ Reared	♀ Reared
1.	28. April 71	1	3	0	4	Attareekhat	0	0
2.	24. April 73	3	3	0	6	Paneery	3	1
3.	30. April 73	2	1	1	4	Paneery	0	0
4.	May 74			3	3	Gauhati Zoo	0	0
5.	April 75			3	3	Paneery	0	0
6.	April 75			3	3	Attareekhat	0	0
7.	May 75			3	3	Gauhati Zoo	0	0
8.	18. May 76	2	1	0	3	Attareekhat	1	1
9.	May 76	2	2	2	6	Gauhati Zoo	2	2
Total					35 born		10 reared	

It can be seen from Table 6 that during the five year one month period April, 1971 to May, 1976 inclusive, 10 ♂♂, 10 ♀♀, and 15 unsexed pigmy hogs were born in three different locations in Assam. The litter size varied from 3-6; with five litters of 3 two of 4 and two litters of 6 recorded. The pigmy hog only has three pairs of mammae which is considerably less than those possessed by the majority of other members of the pig family. Sowls (1966) reports that the collared peccary has two pairs of functional and two pairs of non-functional mammae, and that in observations taken from 29 litters, 79% of the instances the litter size was two. With the collared peccary, only the posterior two pairs of mammae are completely functional; whereas, all of the pigmy hog's mammae are functional (Joti 1976). The latter factor will obviously facilitate the successful rearing of the slightly larger litters concerned.

Contrary to the previous belief that the pigmy hog probably breeds twice in one year (Hodgson 1847) Fig. 1 shows that all of the birth dates so far recorded in captivity in Assam have occurred within the two months April and May. The four births recorded at the London Zoo in the 1880's occurred within the two months May and June; however, it is considered that the discrepancy of the April/May birth peak recorded in Assam represents a function of the photo-period shift to a more northern hemisphere schedule. Therefore, it is apparent from the data gathered, that the pigmy hog adheres to a definite breeding season which only takes place once a year between the months of April-May. Assuming an approximate gestation period of 110-120 days, from the birth dates shown in Table 6 conception in the wild state probably takes place during the months of December-January; and parturitions, as has been shown with captive specimens in Assam, during the months of April and May.

Climatic Conditions:

Gogoi (1976), states that the rainy season commences in Assam from the month of April and continues up to the middle of October; the intervening period from November to March is almost dry except for occasional showers. The pre-monsoon showers, or as known locally as "the little rains" occur pre-

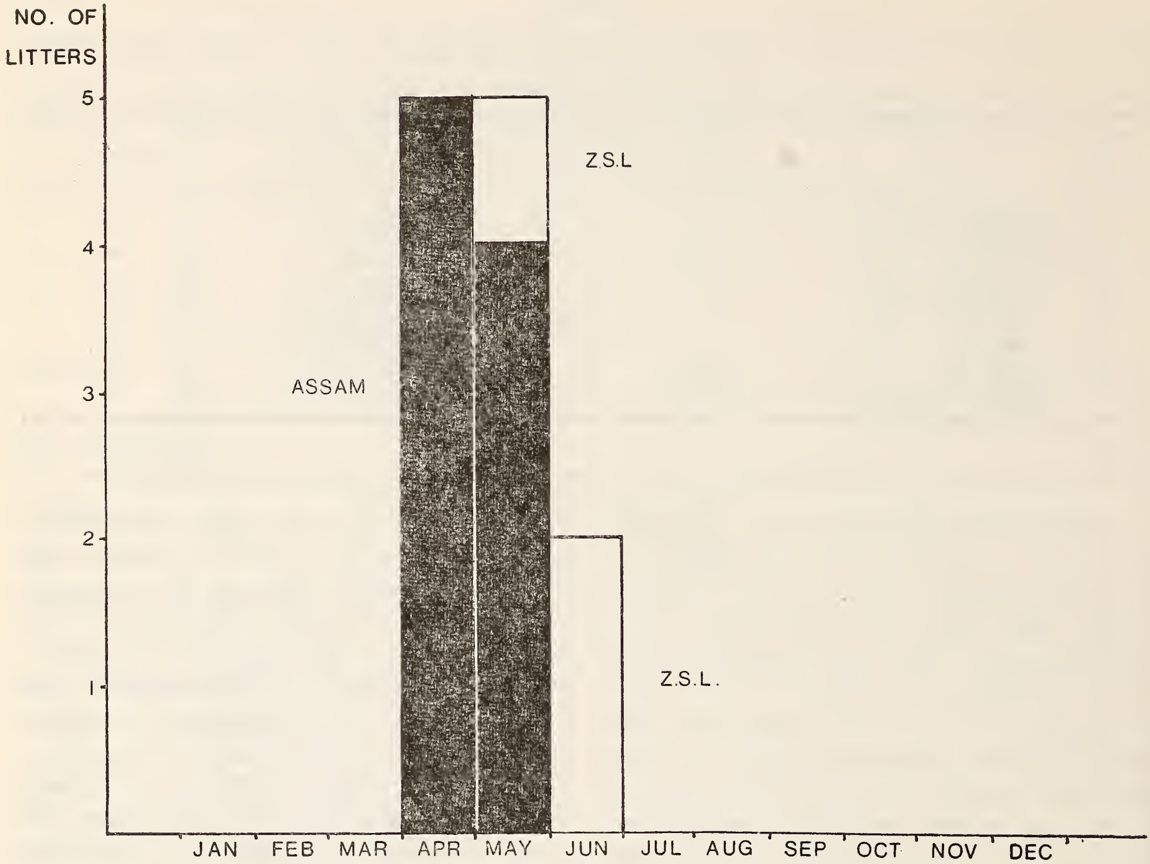


Fig. 1. Frequency distribution of months of birth for 12 litters of *Sus salvanius* born in captivity in Assam and at Z.S.L., London.

dominantly in April; these rains have the effect of resusitating the flora, when leafless deciduous trees become green with new leaves and the grasslands start to re-shoot. The month of May is normally drier prior to the commencement of the main monsoons during the following month. The months of December and January are the coldest part of the year with minimum temperatures varying from 7°C. to 11°C., the higher ranges of the hill districts are colder than the plain areas. The maximum temperatures range from 30°C. to 37°C.

As with many animals, parturitions will take place when environmental conditions are the most favourable. Sowls (1966), confirms that the peccary definitely has a peak of parturition at that time of the year when food is most abundant. The jungle and thatchlands of the Himalayan foothill habitat of the pigmy hog are frequently waterlogged during the main monsoons; which would undoubtedly be unsuitable for the successful rearing of this diminutive species. It therefore only seems natural, that both conception and parturition should take place in the dry season. Also, it appears that parturition in the wild state has been arranged to coincide with "the little rains", so that the newly born piglets may benefit from the additional nutritional foodstuffs that have sprung to life after these rains in April; as well as the hogs benefitting from the drier and warmer weather of the following month, prior to the onset of the monsoon in June.

Rearing:

Out of the ten piglets successfully reared, as shown in Table 6 the four young from litter No. 2 had to be hand-reared due to the loss of the sow at Paneery three days postpartum. The piglets that were reared from litter No. 8 at Attareekhat, and litter No. 9 at Gauhati Zoo, were reared by their respective mothers. However, in both of the latter cases, the sow had been separated from the male or the other adults in the group prior to parturition taking place. They were also kept apart from other adults throughout the period of rearing.

Joti (1976), stated that the sow that gave birth at Attareekhat in May, 1976, confined herself to the nest for the first three to four days, only coming out to feed when nobody was around at night. The piglets did not venture out of the nest until the 5th or 6th day; but when doing so always kept close to, and to the rear of the dam.

The four piglets hand-reared by A. Wrangham at Paneery were initially bottle fed every two hours day and night on un-diluted cow's milk, and they took approximately 12 cc each per feed. The multi-vitamin preparation *Abidec* was added to each feed. When one week old, they were given the baby food preparation *Farex* mixed with cows milk, which was in addition to the bottle feed. At three weeks, the piglets were eating the *Farex* on their own, and by nine weeks they were fed four times a day on a variety of food which included minced meat, sweet potatoes mashed in milk, unpolished rice boiled in milk, fish boiled in milk, fruit and vegetable matter, i.e. papaya, pineapple, mango, lichie, peach, banana, strawberry. A calcium syrup supplementation was also added to the diet.

During the period of rearing, the amount of natural hazards that the piglets may be subjected to is well illustrated by the experiences of Gauhati Zoo during May, 1976. Two out of the six piglets that were born were taken from an un-roofed enclosure at the zoo; one specimen by an Indian Mongoose *Herpestes edwardsi*, and the other by either a Crow *Corvus splendens* or an Eagle Owl, *Bubo* sp. Due to this predation, the sow and the remaining four piglets were removed to a covered-in area provided with plenty of privacy, where they were subsequently reared successfully.

Behaviour

In previous literature, Hodgson (1847) makes reference to the fact that the pigmy hog seems to have the disposition of the peccary as well as the resemblance. The males will fearlessly attack intruders, charging and cutting the naked legs of their human or other attackers with a speed that baffles the eyesight, and a spirit which their straight sharp laniaries renders really perplexing if not dangerous. Hamilton (1921), refers to the pigmy hog moving through the grass with such rapidity that the eye is unable to follow them and that the little creatures have tusks as sharp as razors.

During May, 1971, I observed how surprisingly non-aggressive the ten specimens were that I handled after they had been in captivity for a number of weeks; as well as the fact that they moved like lightning, keeping close together, before reaching the security of a pile of thatch where they would pile on top of each other. It was also observed, that prior to giving birth, the female made a nest within the thatch. Since this observation, further interesting information as to the pigmy hog's ability as a nest maker has been obtained.

As far as the ones held in captivity are concerned, nests are constructed throughout the year, and they are made by both male and female specimens. While making the nest, the hogs will pick the thatch up in their mouths, carry it to the new nest sight, 'chaffing' at the material as they go. Once the nest is completed, the thatch is piled over a slightly raised dais of earth which the hogs have routed into position with their snouts. The surface of the mound is concave, which enables the hogs to lie and rest at slightly above ground level so that when it does rain they are able to dry, from being insulated underneath and protected above by the thatch canopy. Due to the nature of the nest, it is often difficult to determine as to which way the hogs have entered into it, for the thatch seems to fall back into place very easily; subsequently, the camouflage of these resting areas is excellent.

References have already been made to the pigmy hogs speed, as well as to how easily they will take flight. However, it is possible to walk almost right up to the nest before they will break cover, and due to the absence of any obvious exit, it is unlikely that one will know as to which direction they will come out of it. When a potential danger presents itself, it is interesting to note the way that they will approach it in 'fits and starts', trotting a few steps, stopping, and then trotting a few more. However, like so many timorous animals with an extreme tendency to flight, once they have established a safe zone within a known territory; providing this zone is not encroached upon, they will become surprisingly tame. Recently, this was well illustrated by the pair of pigmy hogs that I brought back to Europe in November, 1976; for whilst undergoing the necessary period of quarantine in Zurich, Switzerland, it was not long before these hitherto nervous specimens, allowed their custodian. Markus Borner, "to even handle them a little bit without any excitment at all" (Schmidt—*in lit.*).

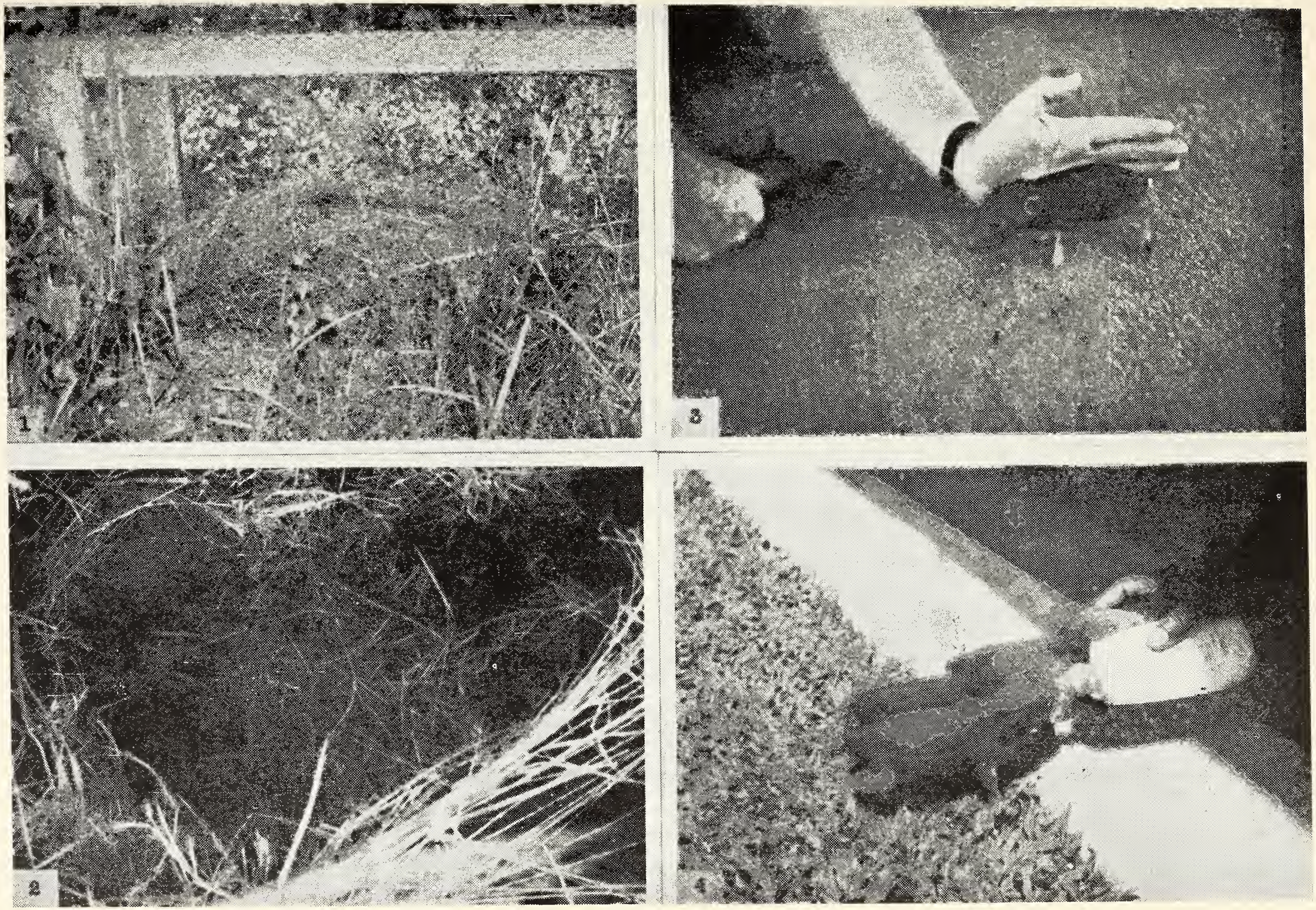
Also Magor (1976) makes reference to how tame the young will become and how they appear to welcome and enjoy human company, coming out of cover to greet people who they know, often relishing a back scratch. Wrangham (1974) refers to how the young will play together 'jousting' nose to nose.

The ability of the pigmy hog to swim well has been described by J. G. Oliver (1976-*in verbis*); for during the height of the monsoons the specimens kept by him on behalf of the Assam Valley Wildlife Society at Pertabghur were frequently observed swimming across a wide gully in their enclosure.

Distribution and recent sightings

The distribution of the pigmy hog along the Himalayan foothills, and the nature of the habitat in which it is to be found has already been dealt with (Mallinson 1971). Therefore, this paper confines its references to sightings and the subsequent locations of the pigmy hog that have taken place in Assam since its 'rediscovery' in 1971.

It is considered that all of the thirty-one or so specimens that have been taken into captivity, originated from the Bornadi Forest Reserve which covers an approximate area of



Photos. 1. A nest of the Pigmy Hog; 2. The inside of a nest; 3. A Pigmy Hog at 3 days old; 4. Pigmy Hogs at 3 weeks old.
(Photos: *A. Wrangham*)

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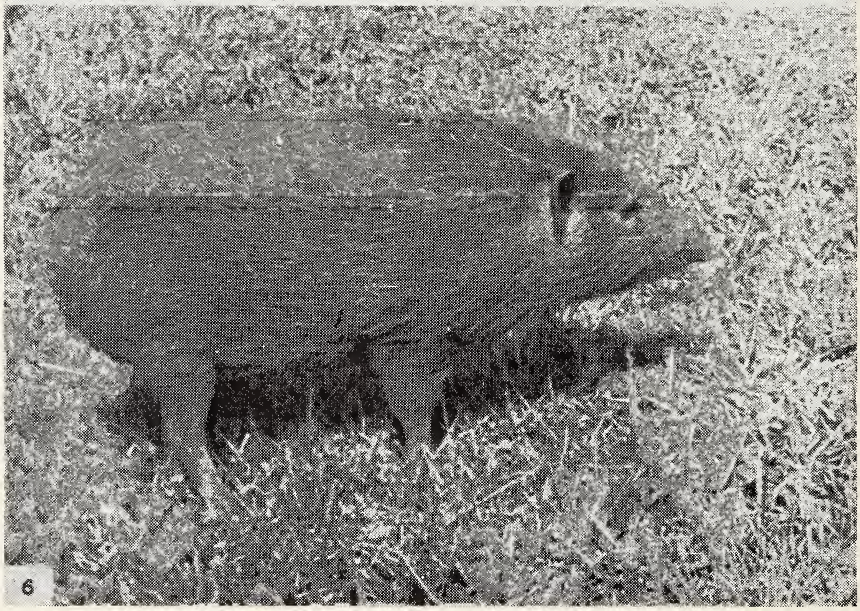

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Two photographs of an adult Pigmy Hog.
(Photos: *D. Joti*)

45 square miles in Northern Assam. The Deodosunga River makes up the northern border of the reserve which is situated on the Assam-Bhutan International boundary. Within this reserve area, sightings of the hog have been made between the Bagamati camp in the west, the Malapara camp in the north-east and the Rajagarh camp in the south. In October, 1976 it was reported that a sounder of seven hogs were observed in close proximity to the Rajagarh range office; and that sounders of up to ten had been seen further to the north of this area.

A pigmy hog was photographed in 1971, in the Manas sanctuary, which is 130 miles to the west of the Bornadi range (*Oryx* 1971). It has also been recorded by Ranjitsinh (1972) to have been reported in six different areas of the Manas sanctuary: Latajhar Forest near Matharguri, north-east of Bhuyapara rest house, west of Bhatgali Beat, north of Bansbari Range H.Q. on both sides of the Matharguri Road, and in the Uchila area; it is also considered to occur in other suitable areas in Manas.

To the east of the Bornadi Reserve: Tessier-Yandell (1971) makes reference to a sighting by Gilchrist in February, 1971 at Nonaipara Tea Estate, situated approximately five miles away; a reported kill on the Majuli Tea Estate in September, 1970 situated approximately 7 miles away; and Ranjitsinh (1972) refers to reports of the pigmy hog in the Nonoi Forest Reserve twenty miles to the east of Bornadi. There have been some rather vague reports that the hogs have been seen in the Orang Sanctuary which is approximately 45-50 miles to the east of Bornadi, as well as claims that they have been observed approximately 100 miles further to the east on the Dufflaghar Tea Estate, just to the east of the Boroi river (Simpson—*in verbis*). From the data so far gathered, it appears that the pigmy hog's distribution in Assam extends from the valley of the Manas river, extending eastwards along the foothills bordering Bhutan and Arunachal Pradesh (Synom. N.E.F.A.) up to Lakhimpur district in the north-east border of Assam. The width of this foothill belt being approximately 5-15 miles.

Conservation

The pigmy hog was afforded total protection in India under the Wildlife (Protection) Act 1972. Ranjitsinh (1972) advocated that the Bornadi Forest Reserve immediately to the north of Rajagarh village, and the unclassified State forest to the west of the Reserve should be declared a reserve for the pigmy hog. Also, that the Nonoi reserve forest to the east of Bornadi should be considered a sanctuary. Suggestions were also made by Ranjitsinh, that a suitable area of habitat should be fenced off, possibly in the Bornadi Forest Reserve or in the Uchila central area of the Manas sanctuary, so that the pigmy hog could be protected, studied, and a controlled breeding programme initiated.

During 1975, the Assam Valley Wildlife Society in collaboration with the Assam Forest Department, erected a chain-link fence round a five hectare enclosure in the Orang Wildlife Sanctuary. In May 1976, a pair of pigmy hogs were released by Mr. J. G. Oliver, Chairman of the Assam Valley Wildlife Society, into a small area within the enclosure; however, some two months later, these were reported to have escaped into the larger fenced in area, and no further sightings of them have so far been reported.

Previously (1971), I suggested that sufficient animals should be caught up in order to strengthen the viability of the existing captive population within the species' range; as well as advocating that some should be translocated to a scientifically managed site. Thanks to the co-operation of the Assam Government, the Chief Conservator of Forests Mr. M. Islam, the Indian Government and the Assam Valley Wildlife Society. The Jersey Wildlife Preservation Trust was granted permission to export up to four specimens of this endangered species to a scientifically managed site in Europe. During 27th/28th November, 1976 I accompanied a proven breeding pair of pigmy hog from Attareekhat tea estate in Northern Assam, by road to Gauhati, and then by air to Calcutta 'en route' to Europe. Owing to quarantine legislation, especially those restricting the movement of members of the pig family; the pigmy hogs were taken to Zurich, Switzerland, were they had to undergo a period of quarantine at the Zurich Zoo. It is now hoped, that with the co-operation of the authorities at Zurich Zoo, that a breeding nuclei of this endangered species will soon be established.

SUMMARY

During my two missions to Assam in May, 1971 and November, 1976 respectively, valuable quantitative data was gathered about this, once considered to be possibly extinct species. The majority of the knowledge that we now have about pigmy hogs, has derived as a consequence of the hogs 're-discovery' in March, 1971 and goes to augment the previous only fragmentary data, the majority of which stemmed from nineteenth century observations.

Contrary to previously published data, the pigmy hog adheres to, a single breeding season which occurs in Assam during the months April/May. Both male and female specimens construct nests made out of 'thatch' and these are utilised both for resting as well as for rearing young. The pigmy hogs are chiefly diurnal; and the young almost entirely lack the longitudinal markings to be found on the back and sides of many other wild pig species. Additional data has also been established as to their measurements, weights, litter sizes, as well as numerous behavioural and husbandry criteriors.

Although the mortality of the ones that have been kept in captivity has been unacceptably high, and the infant survival rate minimal; from the experiences gained, it is now evident that providing the species is kept under favourable conditions, and certain guidelines discussed in this paper adheres to, pigmy hogs can be kept easily and will breed and reproduce readily. However, in interpreting data on the breeding in wild and captive animals, the question always arises as to whether the conclusions drawn from data on captive animals are representative of wild populations.

Since my first mission to Assam, and as advocated previously (Mallinson 1971) preliminary evaluation of the habitat and a plan for the future conservation of the pigmy hog has been carried out by Ranjitsinh (1972). Some further specimens have been caught to strengthen the viability of the captive populations within the species range, (Table 1). And one pair of pigmy hog has been taken to a scientifically managed site in Europe under the custodianship of the Jersey Wildlife Preservation Trust (JWPT). These two animals have been loaned by the Assam authorities so that a captive breeding programme can be initiated and all scientific data recorded from this nuclei is to be sent to the Chief Conservator of Forests in Assam.

However, due to the forever increasing intensity of human encroachment into the pigmy hog's remaining habitat, it is now essen-

tial that a more comprehensive field survey should be carried out of at least three months duration, so that as much information as possible is obtained about distribution, habitat and population. It is taken for granted that the best possible safeguard against continuing decline is to preserve known habitat from further decline. But should this prove not to be possible, more secure captive breeding groups must be established now that the 'breeding in captivity' guidelines have been satisfactorily realised and intensive captive research be therefore possible.

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I am deeply grateful for the co-operation of both the Assam and Indian Governments as well as for the co-operation of the many government officials, International conservationists, businessmen and private individuals whose combined efforts have greatly aided the conservation of this endangered species both in the wild state and in captivity. *India*: Mrs. Indira Gandhi, Mr. S. Haidar, Mr. N. D. Jayal, Mr. M. K. Appayya, Mr. M. Ranjitsinh, Mr. M. A. Islam, Shri Arun Kumar, Mr. S. R. Chhaunkar, Dr. Salim Ali, Shri Zafar Futehally, Dr. Robin Banerjee, Mrs. D. S. Variava, Mr. G. Choudhury, Mr. B. M. Khaitan, Mr. Pierson Surita, Mr. John Oliver. *Europe*: Mr. Gerald Durrell, Sir Peter Scott, The Rt. Hon. Lord Craigton, Mr. Richard Magor, Mr. Richard Fitter, Mrs. J. R. Wrangham, Dr. Peter Weilenmann, Dr. Christian Schmidt, Prof. Dr. Ernst Lang, Dr. Peter Dollinger, Dr. F. Vollmar, Dr. M. Brambell. *U.S.A.*: Dr. Dillon Ripley, Dr. T. E. Lovejoy.

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On the larvae of *Bruchidius* Schilsky (Bruchidae : Coleoptera)[1]

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(*With thirty-three text-figures*)

The present investigations are based on the studies of the last instar larvae of ten species of *Bruchidius* collected from Northwest India. Their comparative morphology has been studied with a view to determining the characters of classification significance. The important characters of each larva along with its host plants and dimensions have been given. The species studied are: *Bruchidius mimosiae* Arora, *B. maculipygus* (Champ.), *B. saundersi* (Jck.), *B. albizziae* Arora, *B. lineolatus* Arora, *B. aureus* Arora, *B. urbanus* (Sharp), *B. angustifrons* Schils., *B. cassiae* Arora, and *B. tephrosiae* Arora.

Introduction

The genus *Bruchidius* includes field forms attacking the wild- and the ornamental leguminous plants. The eggs are laid on the pods of these plants. The first instar larva hatches out and enters the seed where it grows at its expense resulting in complete destruction of the seed.

Steffan (1946), Genduso (1958), and Parnell (1964) described the larvae of *Bruchidius fasciatus* Ol., *B. perparvulus* Boh., and *B. ater* (Marsh) respectively. Boving (1927) is perhaps the only worker who gave taxonomic account of eleven species belonging to the various genera of Bruchidae.

The present investigations, based on the studies of external characters of the last instar larvae of ten species, include the distinctive characters and the host plants of each species.

[1] Accepted January 1974.

Distinctive Characters

Bruchidius mimosiae Arora

Frons with three pairs of setae, but without sensory pits; labrum with three submarginal setae; terminal seta of antenna twice as along as apical papilla; mala with four malar processes; premental sclerite rounded posteriorly; ligular spines absent.

Dimensions: Length 2.88-3.40 mm, Breadth 1.20-1.68 mm.

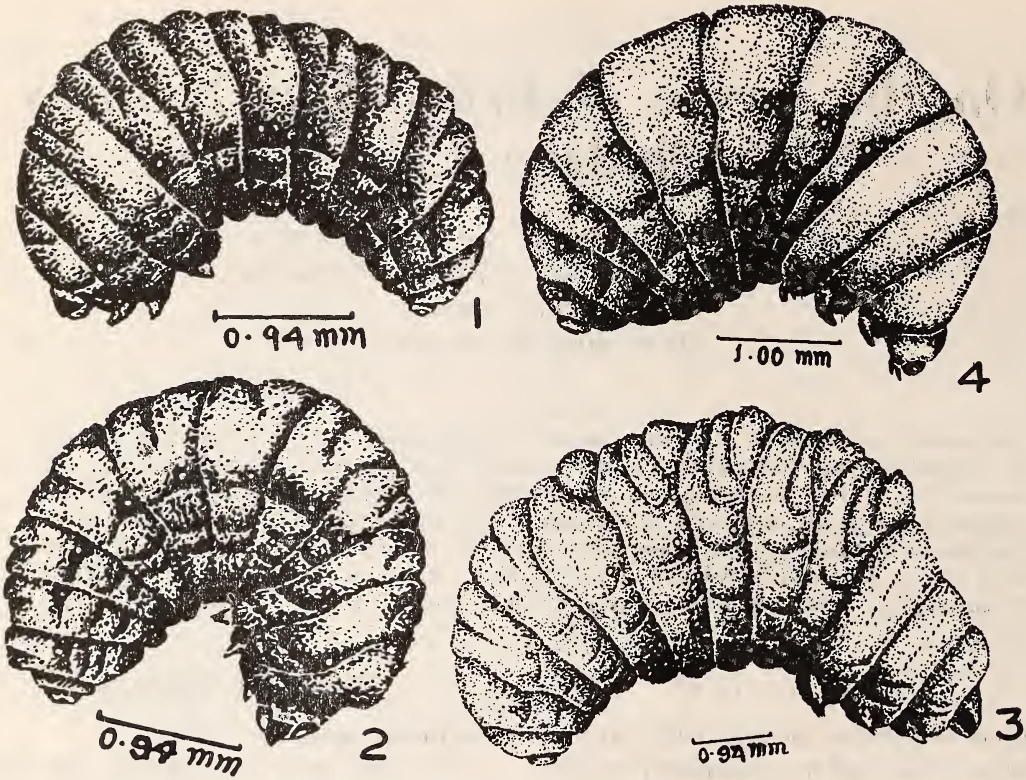
Host Plant: *Mimosa rubicaulis* Lamk.

Bruchidius maculipygus (Champ.)

Frons with three pairs of setae, but without sensory pits; labrum with three submarginal setae; terminal seta of antenna two and a half times as long as apical papilla; mala with four malar processes; premental sclerite truncated posteriorly; ligular spines present.

Dimensions: Length 2.64-3.60 mm, Breadth 1.53-2.01 mm.

Host Plant: *Acacia pennata* (Willd.).



Figs. 1-4. Lateral view of the Larva: 1. *B. mimosiae;* 2. *B. maculipygus;* 3. *B. saundersi;* 4. *B. albizziae.*

Bruchidius saundersi (Jek.)

Frons with three pairs of setae and a pair of sensory pits; labrum with three submarginal setae; terminal seta of antenna reaching the tip of apical papilla; mala with five malar processes; premental sclerite rounded posteriorly and carries a short median process in between the two anterior prongs; ligular spines absent.

Dimensions: Length 6.04-6.28 mm, Breadth 2.55-2.97 mm.

Host Plants: *Albizzia lebbek* Benth., *Albizzia* sp.

Bruchidius albizziae Arora

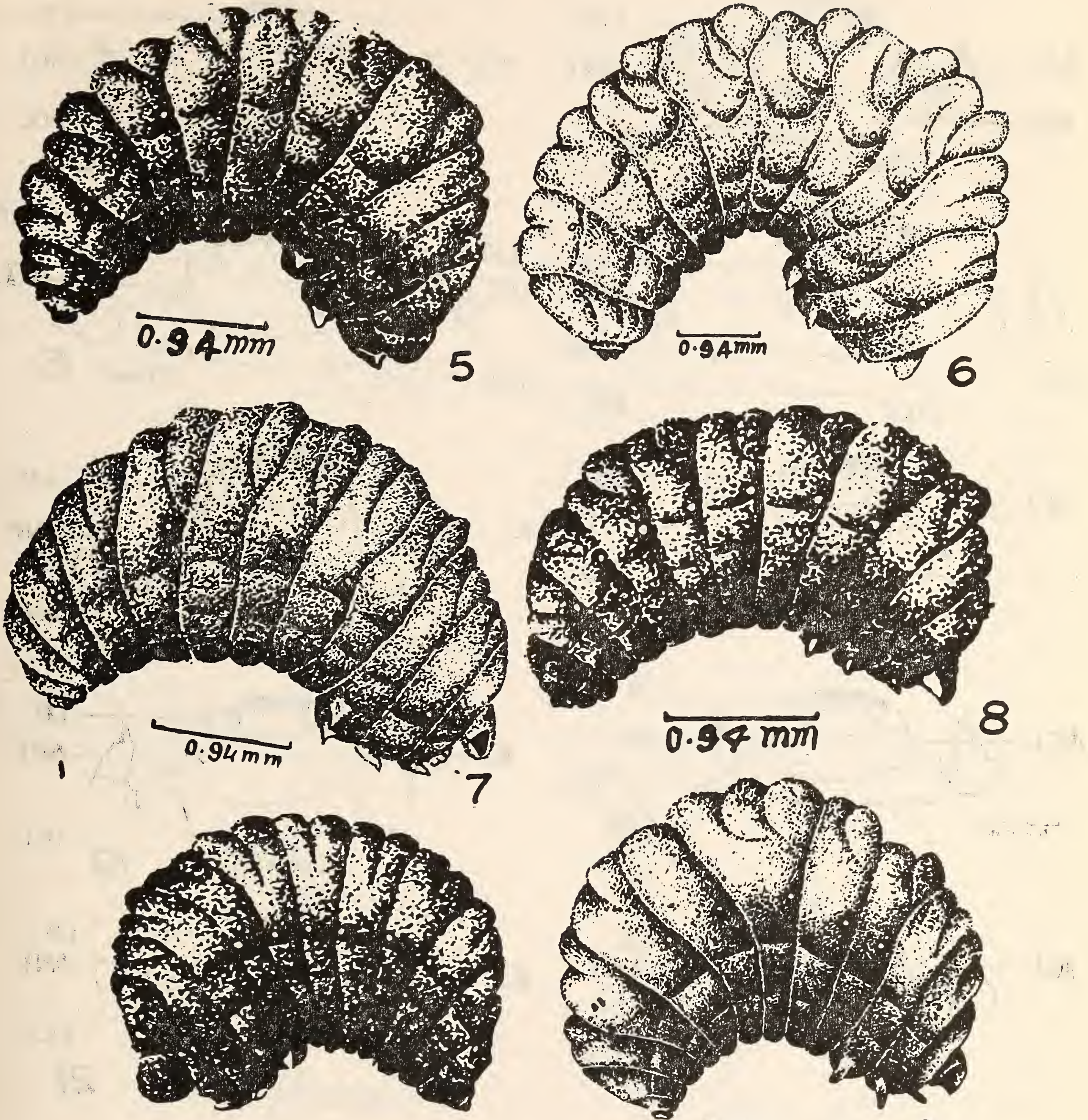
Frons with three pairs of setae and a pair of pits; labrum with three submarginal setae and a pair of sensory pits; terminal seta of antenna twice as long as apical papilla; mala with five malar processes; premental sclerite with a truncated posterior margin; ligular spines absent.

Dimensions: Length 2.97-3.69 mm, Breadth 1.43-1.82 mm.

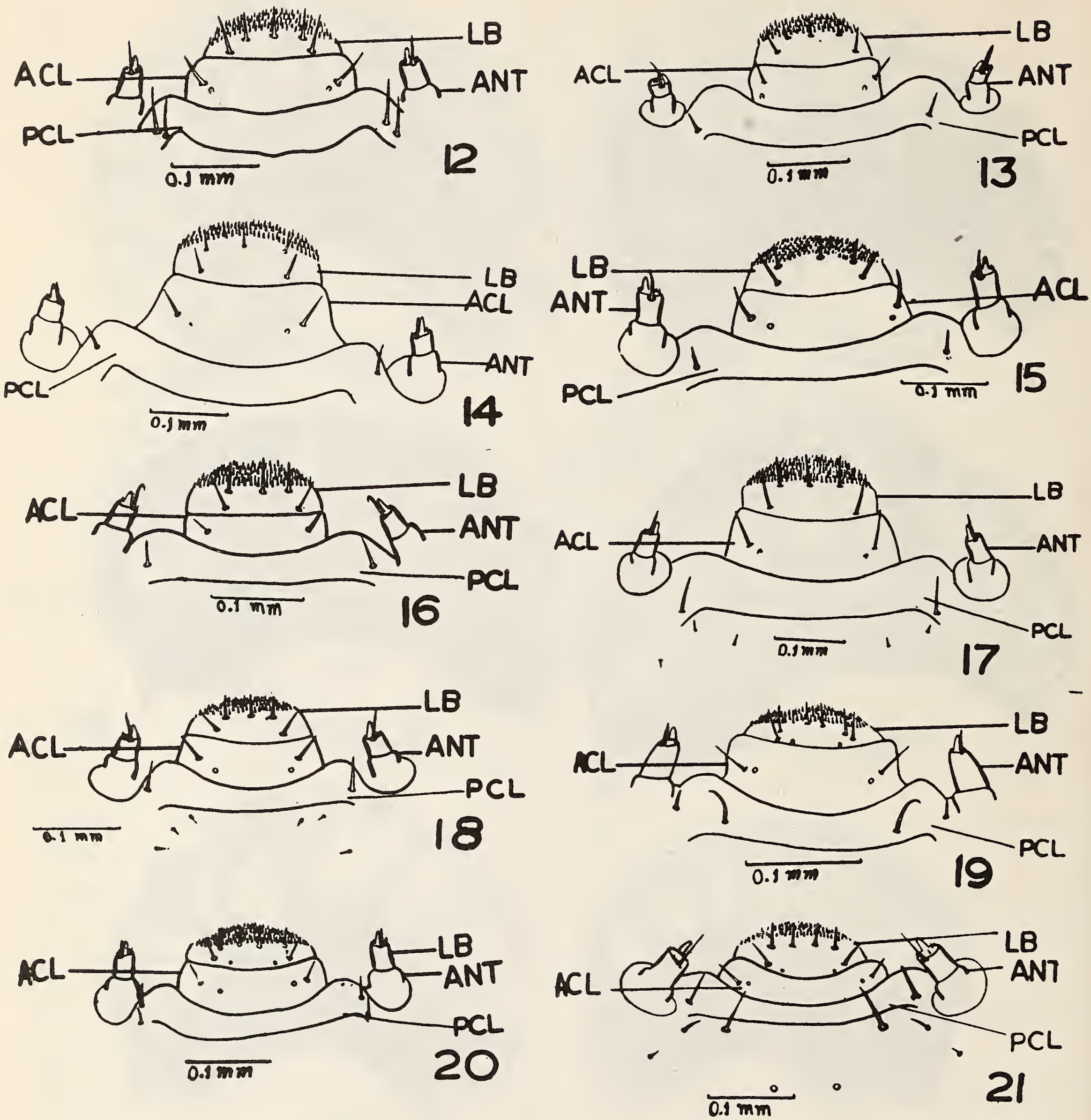
Host Plants: *Albizzia lebbek* Benth., *A. procera* (Roxb.) Benth., *Acacia modesta* Wall., *Acacia catechu* Willd.

Bruchidius lineolatus Arora

Frons with three pairs of setae, but without sensory pits; labrum with three submarginal setae; terminal seta of antenna twice as long



Figs. 5-10. Lateral view of the Larva: 5. *B. lineolatus;* 6. *B. aureus;* 7. *B. urbanus;* 8. *B. angustifrons;* 9. *B. cassiae;* 10. *B. tephrosiae.*



Figs. 12-21. Labrum, Clypeus and Antennae: 12. *B. mimosiae;* 13. *B. maculipygus;* 14. *B. saundersi;* 15. *B. albizziae;* 16. *B. lineolatus;* 17. *B. aureus;* 18. *B. urbanus;* 19. *B. angustifrons;* 20. *B. cassiae;* 21. *B. tephrosiae.*

Abbreviations: ANT—Antenna, ACL—Anterior Clypeus, PCL—Posterior Clypeus, LB—Labrum.

as apical papilla; mala with five malar processes; premental sclerite with a wavy posterior margin; ligular spines present.

Dimensions: Length 2.97-3.24 mm, Breadth 1.58-1.68 mm.

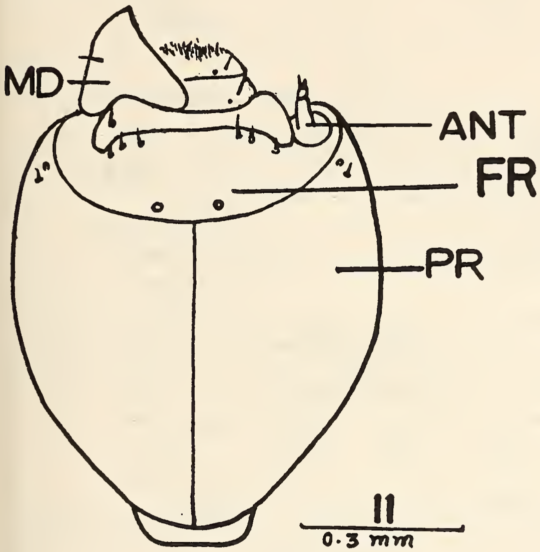


Fig. 11. Dorsal view of the head of *B. ablizziae*. *Abbreviations*: ANT—Antenna, FR—Frons, MD—Mandible, PR—Parietal.

Host Plant: *Albizzia procera* (Roxb.) Benth.

Bruchidius aureus Arora

Frons with three pairs of setae and a pair of sensory pits; labrum with three submarginal setae but without sensory pits; terminal seta of antenna one and a half times as long as apical papilla; mala with five malar processes; premental sclerite rounded posteriorly; ligular spines present.

Dimensions: Length 5.95-6.38 mm, Breadth 2.64-3.12 mm.

Host Plant: *Albizzia lebbek* Benth.

Bruchidius urbanus (Sharp)

Frons with three pairs of setae and a pair of pits; labrum with three submarginal setae, but without sensory pits; terminal seta of antenna twice as long as apical papilla; mala with five malar processes; premental sclerite rounded posteriorly; ligular spines present.

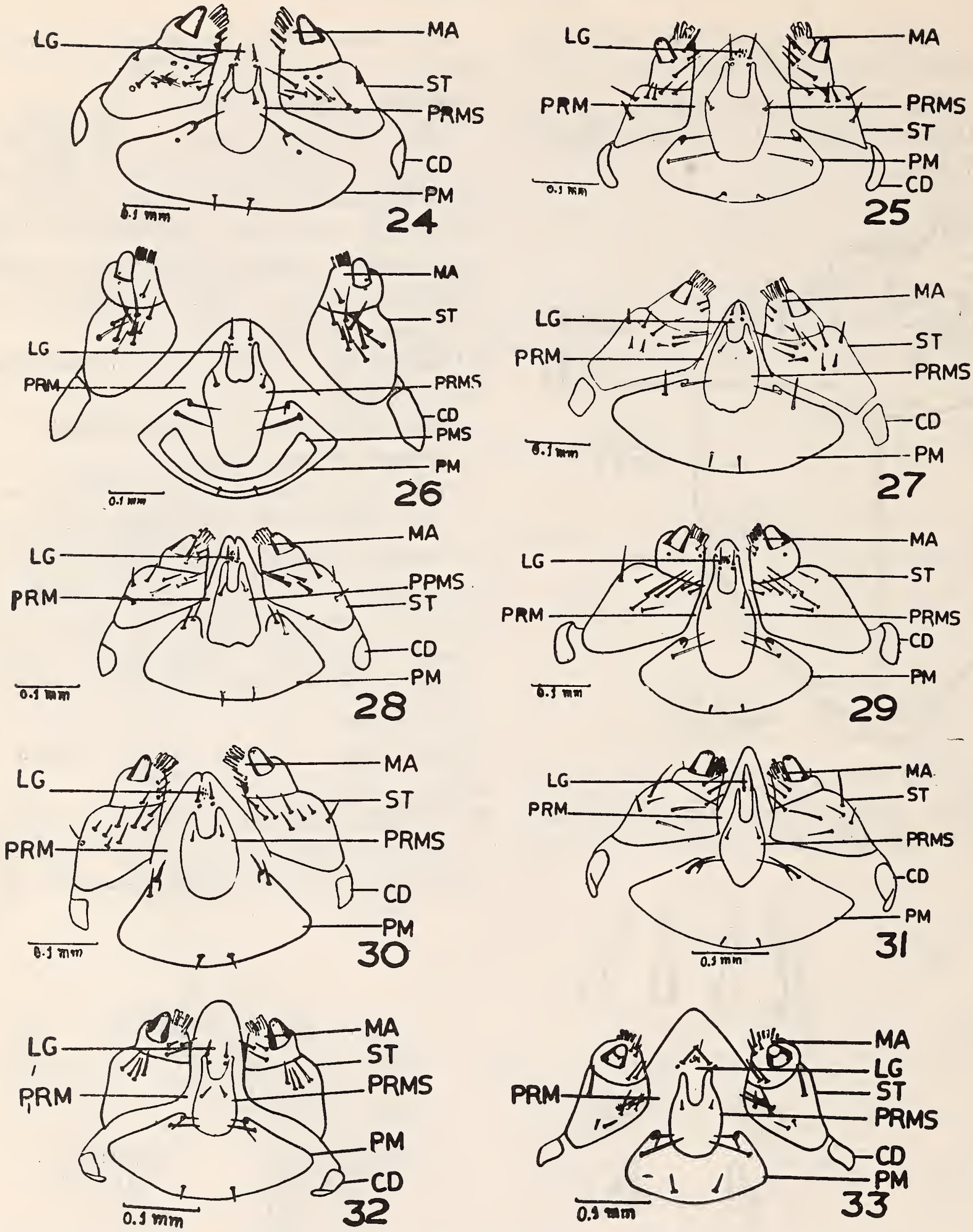
Dimensions: Length 3.40-3.98 mm, Breadth 1.49-2.11 mm.

Host Plant: *Albizzia procera* (Roxb.) Benth.

Bruchidius angustifrons Schils.

Frons with two pairs of setae and a pair of sensory pits; labrum bearing two pairs of sub-

Figs. 22-23. Epipharyngeal surface of labrum: 22. *B. angustifrons;* 23. *B. mimosiae.*



Figs. 24-33. Maxillae and Labium: 24. *B. mimosiae;* 25. *B. maculipygus;* 26. *B. saundersi;* 27. *B. albizziae;* 28. *B. lineolatus*; 29. *B. aureus;* 30. *B. urbanus;* 31. *B. angustifrons;* 32. *B. cassiae;* 33. *B. tephrosiae.*

Abbreviations: CD—Cardo, LG—Ligula, MA—Mala, PM—Postmentum, PRM—Prementum, PRMS—Premental sclerite, ST—Stipes.

marginal setae; terminal seta of antenna slightly longer than apical papilla; mala with five malar processes; premental sclerite conical posteriorly; ligular spines absent.

Dimensions: Length 2.40-2.54 mm, Breadth 1.44-1.55 mm.

Host Plant: *Sesbania sesban* (L.) Merr. var. *bicolor* (W.A.) P.W. Ander.

Bruchidius cassiae Arora

Frons with a pair of setae and a pair of pits; labrum with two pairs of submarginal setae; terminal seta of antenna slightly longer than apical papilla; mala with five malar processes; premental sclerite rounded posteriorly; ligular spines absent.

Dimensions: Length 2.16-2.40 mm, Breadth 0.96-1.20 mm.

Host Plant: *Cassia tora* L.

Bruchidius tephrosiae Arora

Frons with three pairs of setae, but without sensory pits; labrum oval with two pairs of submarginal setae; terminal seta of antenna as long as apical papilla; mala with five malar processes; premental sclerite rounded posteriorly; ligular spines present.

Dimensions: Length 2.64 mm, Breadth 1.58 mm.

Host Plant: *Tephrosia purpurea* (Linn.) Pers.

Acknowledgements

I am thankful to Professor G. L. Arora for his guidance and to Dr. H. R. Pajni for his help. The facilities provided by Prof. G. P. Sharma, Head of Zoology Department, Panjab University, are gratefully acknowledged.

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New Descriptions

STUDIES ON SOME MYGALOMORPH SPIDERS OF THE FAMILIES CTENIZIDAE AND THERAPHOSIDAE FROM INDIA[1]

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(*With thirty-eight text-figures*)

Introduction

Mygalomorphae are primitive, mostly ground dwelling spiders, living in burrows and frequently closing the tube aperture with a movable lid. In these, the chelicerae are paraxial, i.e. the plane of articulation is vertical and respiratory organs are represented by four operculate pulmonary sacs or book lungs. The mygalomorphs popularly called Tarantulas, are the largest spiders found in India.

Pocock (1892, 1895 & 1900) was the first worker, who described a considerable number of these spiders from India, Ceylon and Burma. Subsequently Hirst (1909), Gravely (1915, 1918) and Tikader (1968) made some attempts to work out this neglected group of spiders.

Examination of the spider collections received from Darjeeling, West Bengal; Shillong, Meghalaya; Bangalore, Karnataka; Madras, Tamil Nadu and Bombay, Maharashtra, revealed many interesting Mygalomorphae spiders, which are being described in this paper.

The type specimens will in due course be deposited in the National Zoological Collections, Zoological Survey of India, Calcutta.

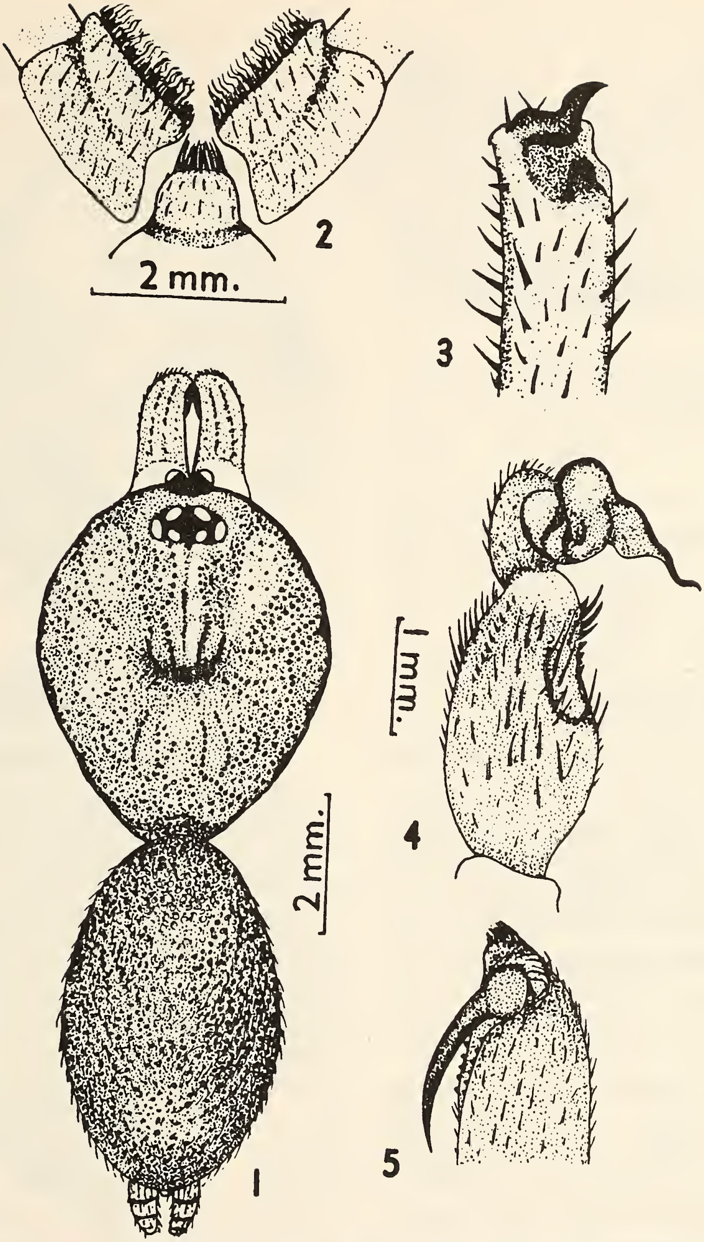
[1] Accepted November 1976.

Family Ctenizidae

1. **Acanthodon garoensis** sp. nov.

General: Cephalothorax and legs greenish-red, abdomen brown. Total length 10.10 mm. Carapace 5.00 mm long, 4.10 mm wide; abdomen 5.00 mm long, 3.00 mm wide.

Cephalothorax: Conspicuously wider in front than behind, flat and provided with small round and circular dots, middle of cephalothorax provided with deep transverse fovea like depression. Eyes eight, nearly pale in colour; anterior lateral eyes situated in the middle of the anterior border of the carapace; the remaining eyes form a group far behind the anterior edge of the carapace. Mandibles strong and powerful; rostellum consisting of stout spines borne upon a distinct prominence. Sternum wider behind than in front, clothed with spines, two pairs of anterior sigilla present but posterior two pairs absent. Legs long and strong, I pair very long, legs formula 1432; tarsi without ungual tufts, with three claws and claws armed with one large basal



Figs. 1-5. *Acanthodon garoensis* sp. nov. 1. Dorsal view of male, legs omitted; 2. Maxillae and labium; 3. Anterior portion of tibia of I leg; 4. Male palp; 5. Right chelicera.

tooth. Anterior tibia of I legs provided with a pointed bent spine. Male palp as in text-fig. 4. Lower portion of tibia of palp bulging and anterior portion provided with a depression and edge provided with conspicuous row of spines as in text-fig. 3.

Abdomen: Longer than wide, narrowing in front, clothed with fine hairs. Spinnerets four; posterior spinnerets long and anterior spinnerets short. Ventral side pale in colour and clothed with hairs.

Type-specimen: *Holotype* male in spirit.

Type-locality: Degrangiri, Garo Hills, Meghalaya, India. Coll. *Shyamrup Biswas*, 10.xi.1973.

This species is related to *Acanthodon fossor* Pocock but it is distinguished from it as follows: (i) Cephalothorax provided with small round and circular dots but in *A. fossor* cephalothorax smooth. (ii) Male palp also structurally different.

2. **Acanthodon madrasensis** sp. nov.

General: Cephalothorax and legs dark chocolate brown and abdomen black. Total length 18.50 mm. Carapace 8.00 mm long, 7.50 mm wide; abdomen 10.50 mm long, 7.50 mm wide.

Cephalothorax: Wider in front than behind; cephalic region high. Posterior region of cephalothorax low and flat and provided with a deep transverse fovea curved in front. Eyes eight, black in colour, anterior lateral eyes situated at middle and near the anterior margin of the carapace. The remaining eyes form a group far behind the anterior edge of the carapace. Mandibles strong and powerful, rostellum consisting of stout spines borne upon a distinct prominence. Labium and maxillae as in text-fig. 7. Sternum wider behind than in front, clothed with spines, two pairs of anterior sigilla present but posterior two pairs absent. Legs long and strong. IV pair longer and stouter than others, legs formula 4123; tarsi without ungual tufts, with three claws and claws armed with one basal tooth.

Abdomen: Longer than wide, wider behind the middle, clothed with fine grey hairs. Spinnerets four and posterior spinnerets slightly longer and anterior spinnerets very short. Ventral side black and legs hairy. Epigyne simple as in text-fig. 9. Internal genitalia as in text-fig. 10.

Type-specimen: *Holotype* female in spirit.

Type-locality: Kulasekeram, K. K., Dist., Madras, Tamil Nadu, India. Coll. *B. V. Balaji* & *R. B. Grubh*, 1960.

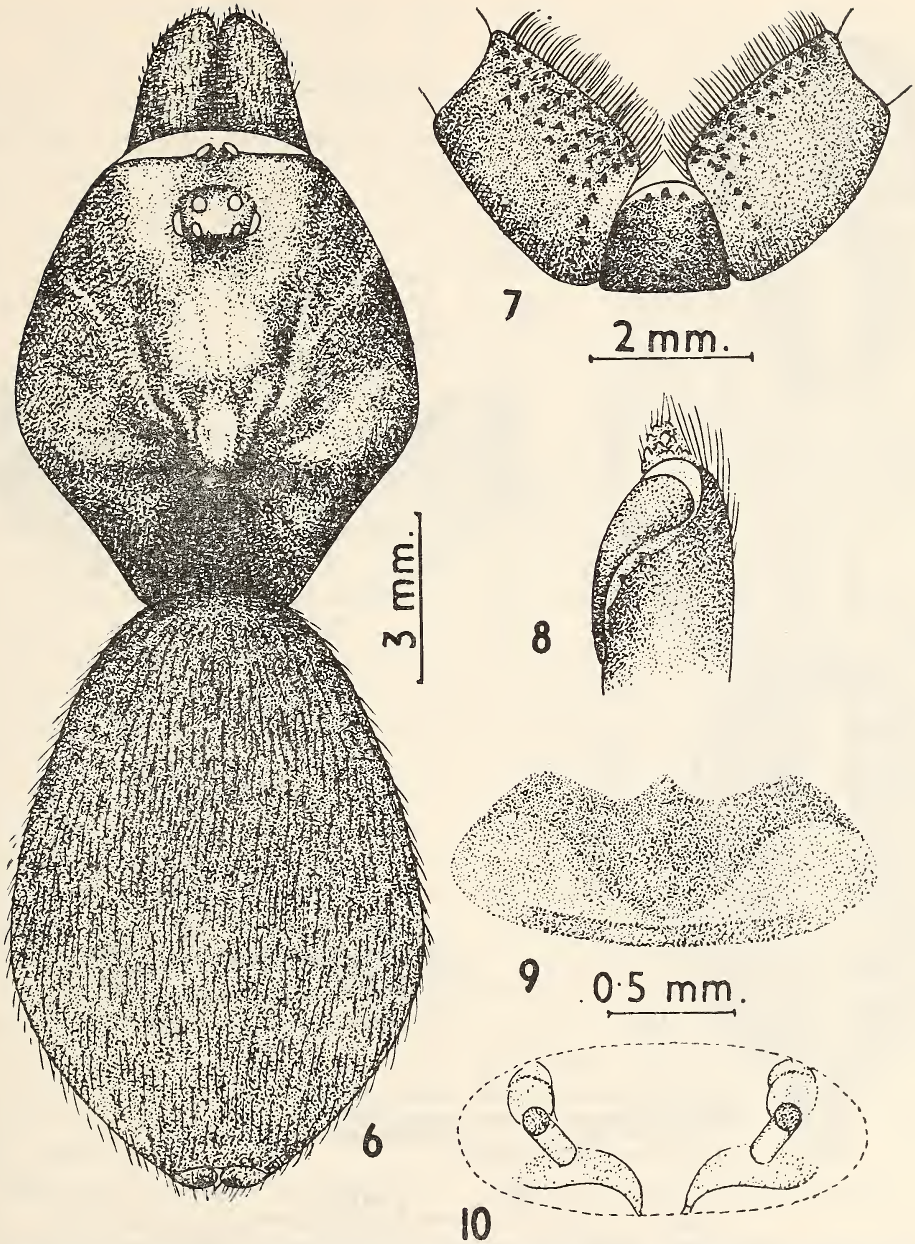
This species resembles *Acanthodon crassus* Simon but can be distinguished from it as follows: (i) Cephalothorax uniform dark chocolate brown but in *A. crassus* sides of the cephalothorax provided with black markings. (ii) Epigyne and internal genitalia also structurally different.

Family THERAPHOSIDAE

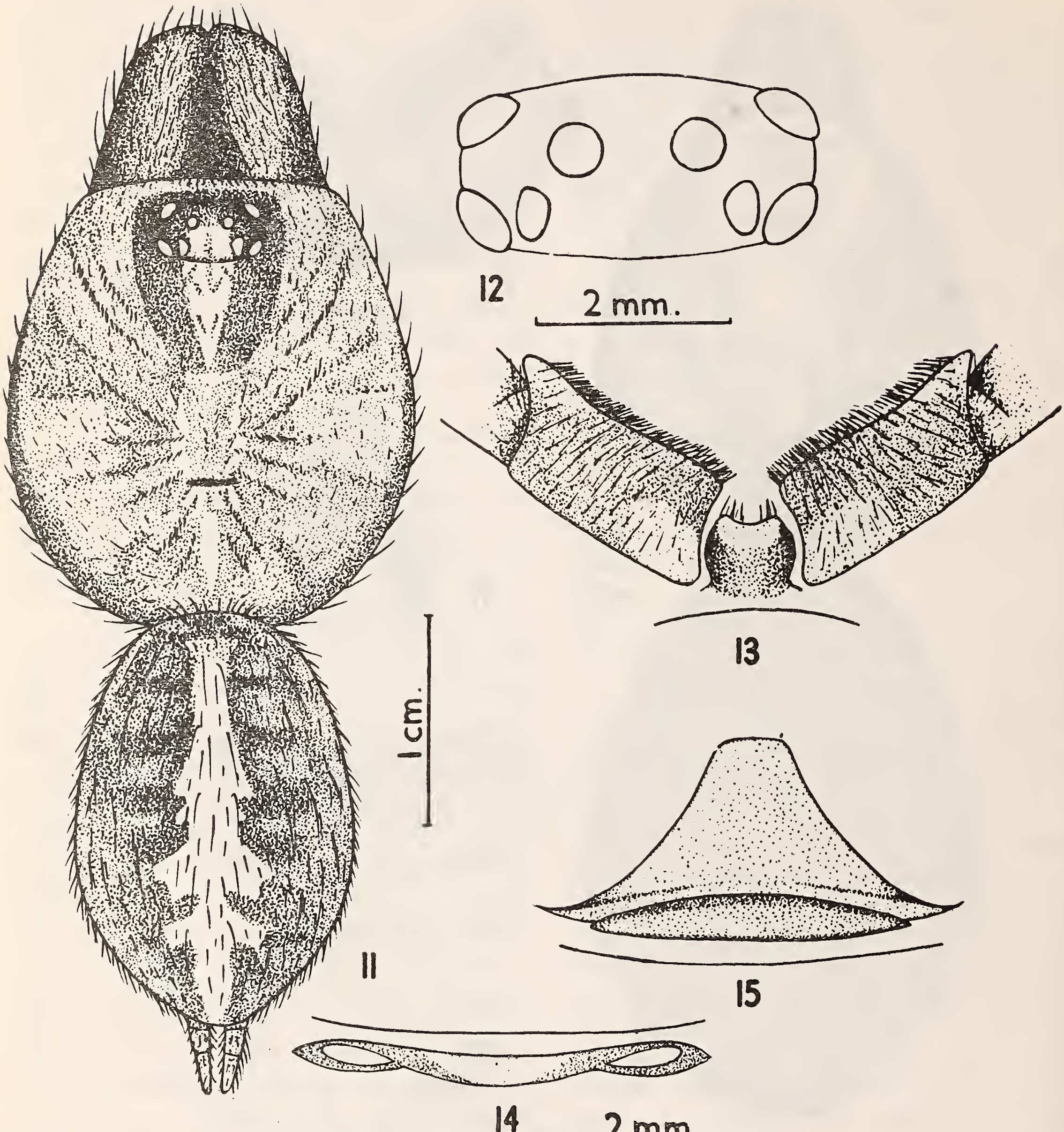
3. **Ornithoctonus gadgili** sp. nov.

General: Cephalothorax, legs and abdomen pale brown, Total length 42.00 mm. Carapace 24.00 mm long, 18.00 mm wide; abdomen 20.00 mm long, 15.00 mm wide.

Cephalothorax: Longer than wide, clothed with fine wool brown and pale hairs. Anterior side nearly as wide as posterior and not high, only cephalic region slightly high. Eyes situated in a group on a slightly elevated tubercle. Ocular tubercle some distance behind the edge of clypeus. Anterior row of eyes strongly procurved; posterior row nearly straight, posterior medians close to adjacent laterals as in text-fig. 12. Middle of cephalothorax provided with a transverse fovea and with a longitudinal pale band as in text-fig. 11. Chelicerae strong, clothed with velvety hairs and some spine-like hairs and rostellum absent.



Figs. 6-10. *Acanthodon madrasensis* sp. nov. 6. Dorsal view of female, legs omitted; 7. Maxillae and labium; 8. Right chelicera; 9. Epigyne; 10. Internal genitalia.



Figs. 11-15. *Ornithoctonus gadgili* sp. nov. 11. Dorsal view of female, legs omitted; 12. Showing eyes position; 13. Maxillae and labium; 14. Epigyne; 15. Internal genitalia.

Inner surface of maxillae sparsely hairy with prominent scopulae and base provided with small black tooth-like tubercles. Labium nearly rectangular, clothed with dense hairs and with some black tooth-like tubercles. Sternum narrower in front than behind, clothed with dense hairs, sternal sigilla small and nearly marginal. Legs very stout and comparatively short, the IV pair being as thick as the I, clothed with thick hairs, and provided with transverse pale bands. Metatarsi and tarsi of all legs provided with conspicuous ventral scopulae.

Abdomen: Longer than wide, narrowing behind, clothed with dense velvety hairs and some spine-like hairs; mid-dorsally provided with a conspicuous longitudinal white band as in text-fig. 11. Ventral side metalic black and clothed with velvety black hairs. A conspicuous white transverse band present just below the epigastric fold. Two pairs of spinnerets, anterior pair small and posterior pair long with three segments, posterior segment slightly longer than others and tapering at the end. Epigyne as in text-fig. 14. Internal genitalia as in text-fig. 15.

Type-specimen: *Holotype* female in spirit.

Type-locality: Bandipur Forest, Karnataka, India. Coll. *Madhav Gadgil,* 8.v.1975.

This species is related to *Ornithoctonus andersoni* Pocock but it is distinguished as follows: (i) Abdomen dorsally provided with conspicuous longitudinal white band but in *O. andersoni* abdomen uniform dark. (ii) Total length is 42.00 mm but in *O. andersoni* total length is 52.00 mm. (iii) Internal genitalia also structurally different.

4. **Ischnocolus decoratus** sp. nov.

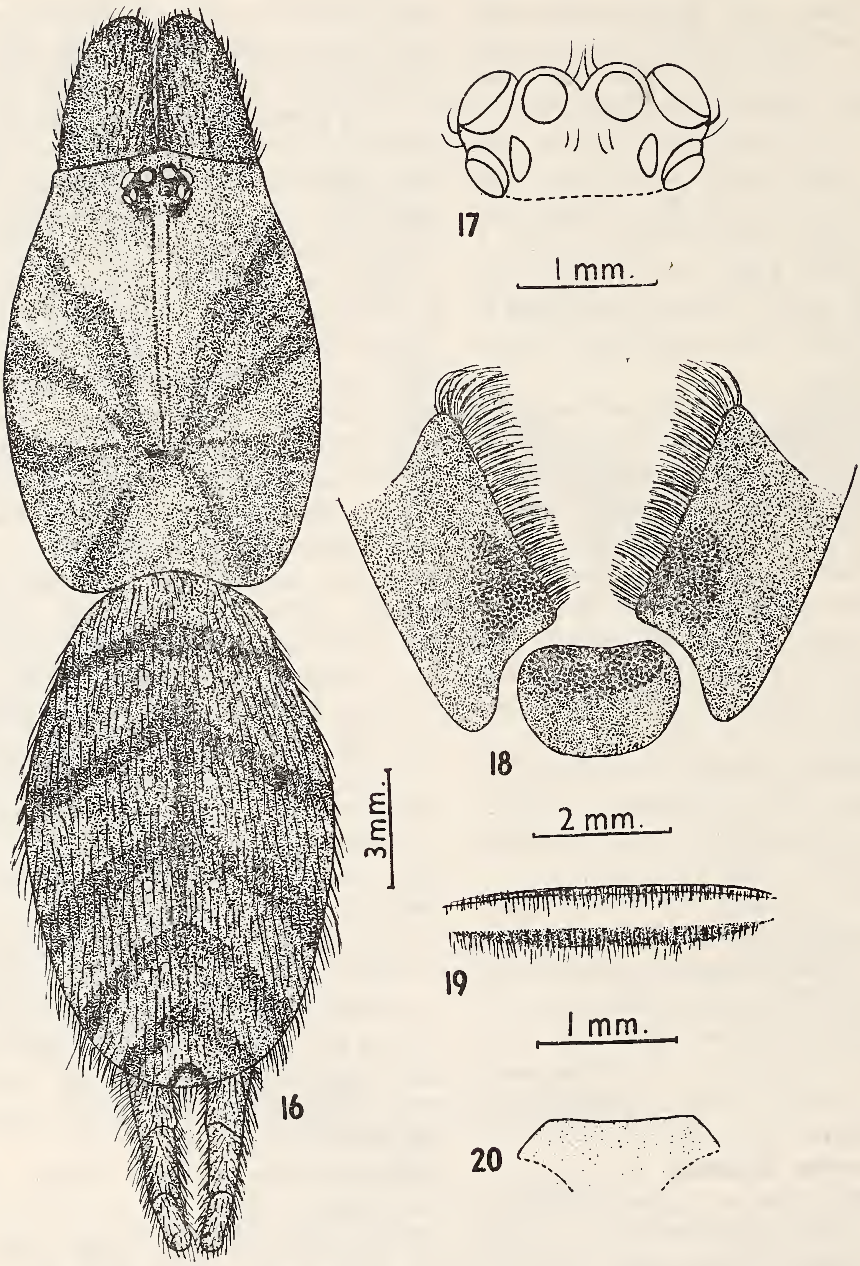
General: Cephalothorax, legs and abdomen reddish-brown. Total length 24.00 mm. Carapace 11.00 mm long, 8.20 mm wide; abdomen 13.30 mm long, 8.10 mm wide.

Cephalothorax: Longer than wide, broader in front, low and clothed with fine hairs. Posterior middle of cephalothorax provided with a deep, short, nearly straight transverse fovea as in text-fig. 16. Eyes eight, pale in colour, situated in a group on a slightly elevated tubercle. Ocular tubercle situated near the edge of clypeus. Anterior row of eyes slightly procurved and lateral eyes much larger than medians and nearly equally spaced. Posterior row of eyes recurved, irregular in shape, laterals slightly larger than medians, posterior medians close to adjacent laterals as in text-fig. 17. Ocular area black and provided with conspicuous spines or spine-like hairs. Chelicerae strong, clothed with thick hairs and rostellum absent. Inner margin of maxillae provided with thick scopulae and base provided with small black tooth-like tubercles. Labium nearly rectangular and slightly wider than long, clothed with thick hairs and anterior portion provided with black tooth-like tubercles. Sternum nearly as wide in front as it is behind, clothed with dense hairs, sternal sigilla not large and remote from the margin. Legs long and moderately strong, I and IV pairs longer than others. Metatarsi and tarsi of all legs provided with ventral scopulae.

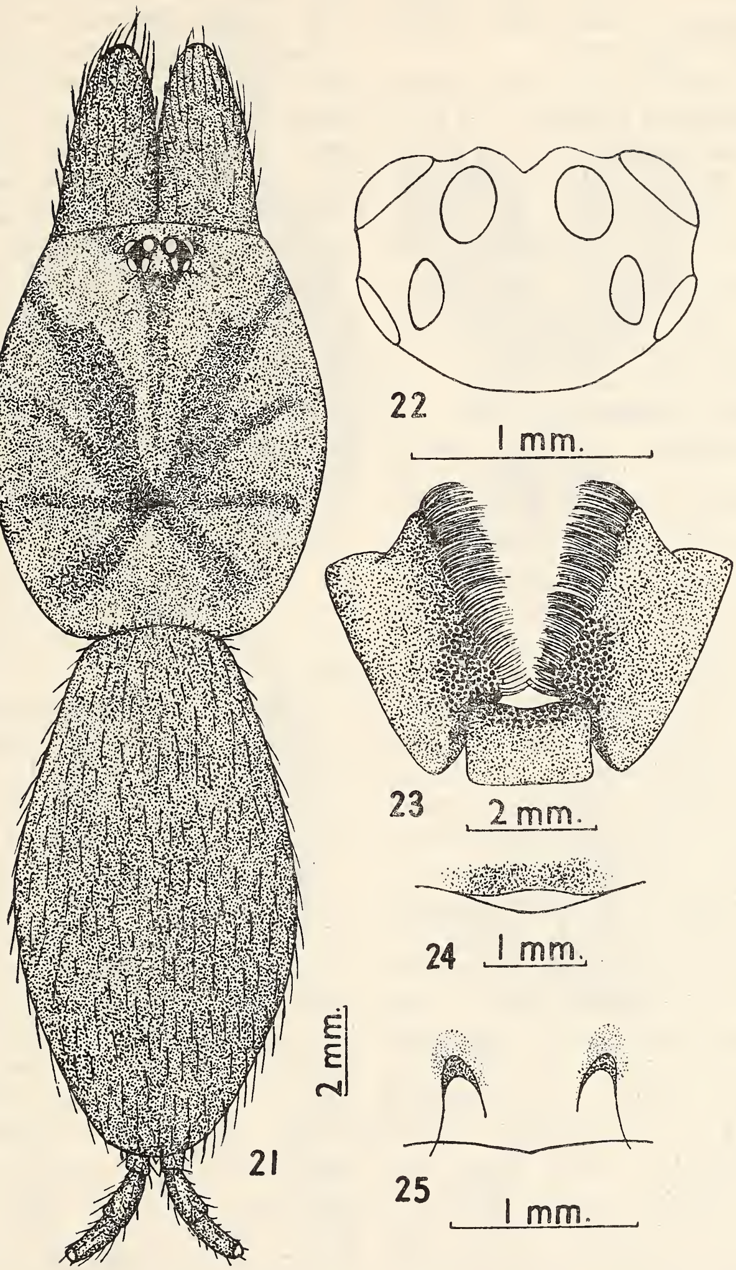
Abdomen: Longer than wide, clothed with dense short and long hairs. Dorsal side of abdomen provided with six transverse, nearly 'V' shaped black bands extending from front to behind. Ventral side uniform brown coloured, clothed with hairs. Two pairs of spinnerets, anterior pair small and posterior pair long, with three segments, basal segment longer than others. Epigyne as in text-fig. 19. Internal genitalia as in text-fig. 20.

Type-specimen: *Holotype* female, *paratypes* two females in spirit.

Type-locality: Borivli National Park, Bombay, Maharashtra, India. Coll. *J. S. Serrao,* August 1975. *Paratype* Medtedi, near Mahabaleshwar, Dist. Satara, Maharashtra, India.



Figs. 16-20. *Ischnocolus decoratus* sp. nov. 16. Dorsal view of female, legs omitted; 17. Showing eyes position; 18. Maxillae and labium; 19. Epigyne; 20. Internal genitalia.



Figs. 21-25. *Ischnocolus khasiensis* sp. nov. 21. Dorsal view of female, legs omitted; 22. Showing eyes position; 23. Maxillae and labium; 24. Epigyne; 25. Internal genitalia.

Coll. *B. K. Tikader,* 29-v.1976 and Borivli National Park, Bombay, Maharashtra, India, Coll. *S. R. Nayak,* August 1976.

This species is related to *Ischnocolus ornatus* Thorell but it is separated as follows: (i) Dorsal side of abdomen provided with six transverse, nearly 'V' shaped black bands extending from front to behind but in *I. ornatus* abdomen ornamented above with small, suboblique pale spots, arranged in two longitudinal rows. (ii) Total length 23.00 mm but in *I. ornatus* total length 12.00 mm. (iii) Internal genitalia also structurally different.

5. **Ischnocolus khasiensis** sp. nov.

General: Cephalothorax and legs reddish-brown, abdomen brown. Total length 21.50 mm. Carapace 9.50 mm long, 8.00 mm wide; abdomen 12.00 mm long, 7.00 mm wide.

Cephalothorax: Longer than wide, slightly broader in front, low and clothed with fine hairs. Middle of cephalothorax provided with a deep, short, straight, transverse fovea as in text-fig. 21. Eyes eight, pale in colour, situated in a group on a slightly elevated tubercle. Ocular tubercle situated near to the edge of clypeus. Anterior row of eyes slightly procurved and lateral eyes larger than the medians and nearly equally spaced. Posterior row of eyes recurved, irregular in shape, medians close to adjacent laterals as in text-fig. 22. Ocular area black. Chelicerae strong, clothed with thick hairs and rostellum absent. Inner margin of maxillae provided with thick pale scopulae and base provided with small black tooth-like tubercles. Labium nearly rectangular and depressed on the middle of anterior end, clothed with hairs, slightly wider than long and anterior portion provided with black tooth-like tubercles. Sternum nearly oval, clothed with spine-like hairs, sternal sigilla of medium size and remote from the margin. Legs long and moderately strong, I and IV pairs longer than others. Metatarsi and tarsi of all legs provided with ventral scopulae.

Abdomen: Longer than wide, clothed with grey long hairs. Ventral side uniform light brown, clothed with hairs. Two pairs of spinnerets, anterior pair small and posterior pair long with three segments, anterior segment longer than others. Epigyne as in text-fig. 24. Internal genitalia as in text-fig. 25.

Type-specimen: *Holotype* female in spirit.

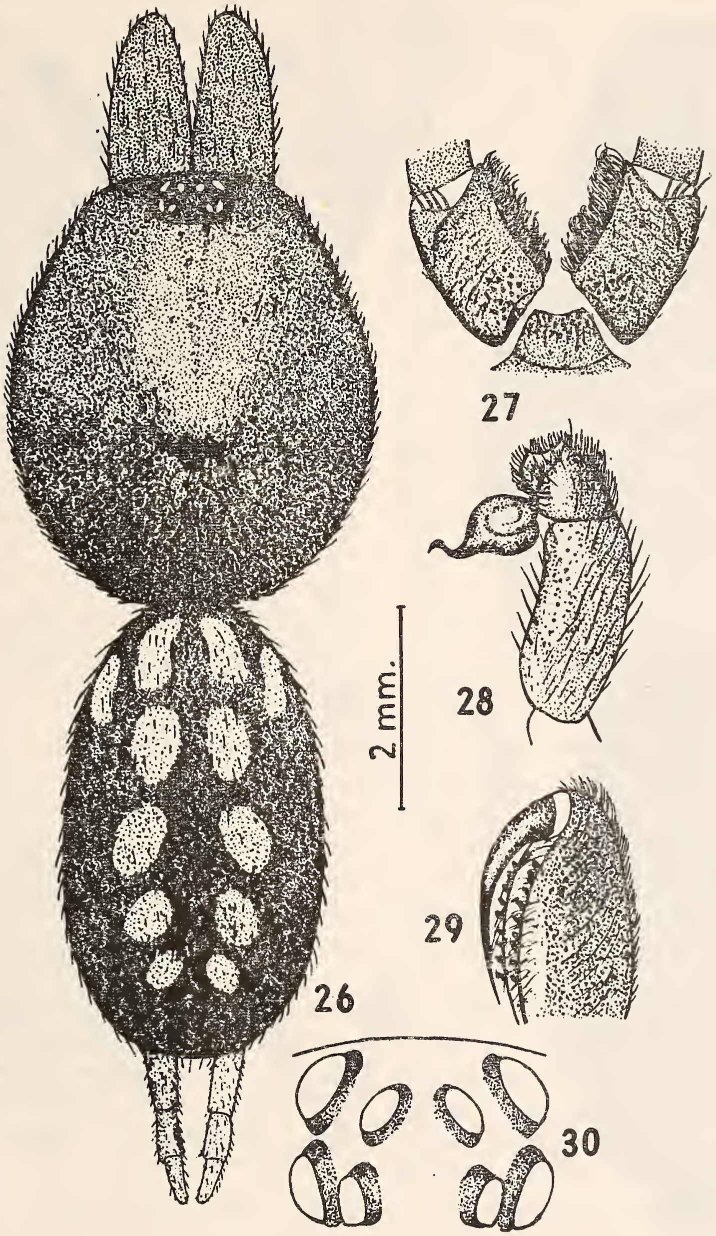
Type-locality: Umshining, Khasi and Jaintia Hills, Meghalaya, India. Coll. *B. Dutta,* 24.vii.1969.

This species is closely related to *Ischnocolus decoratus* sp. nov. but it is separated as follows: (i) Dorsal side of abdomen without any band but in *I. decoratus* dorsal side of abdomen provided with transverse black bands. (ii) Anterior segment of posterior spinnerets longer than other segments but in *I. decoratus* basal segment of posterior spinnerets longer than others.

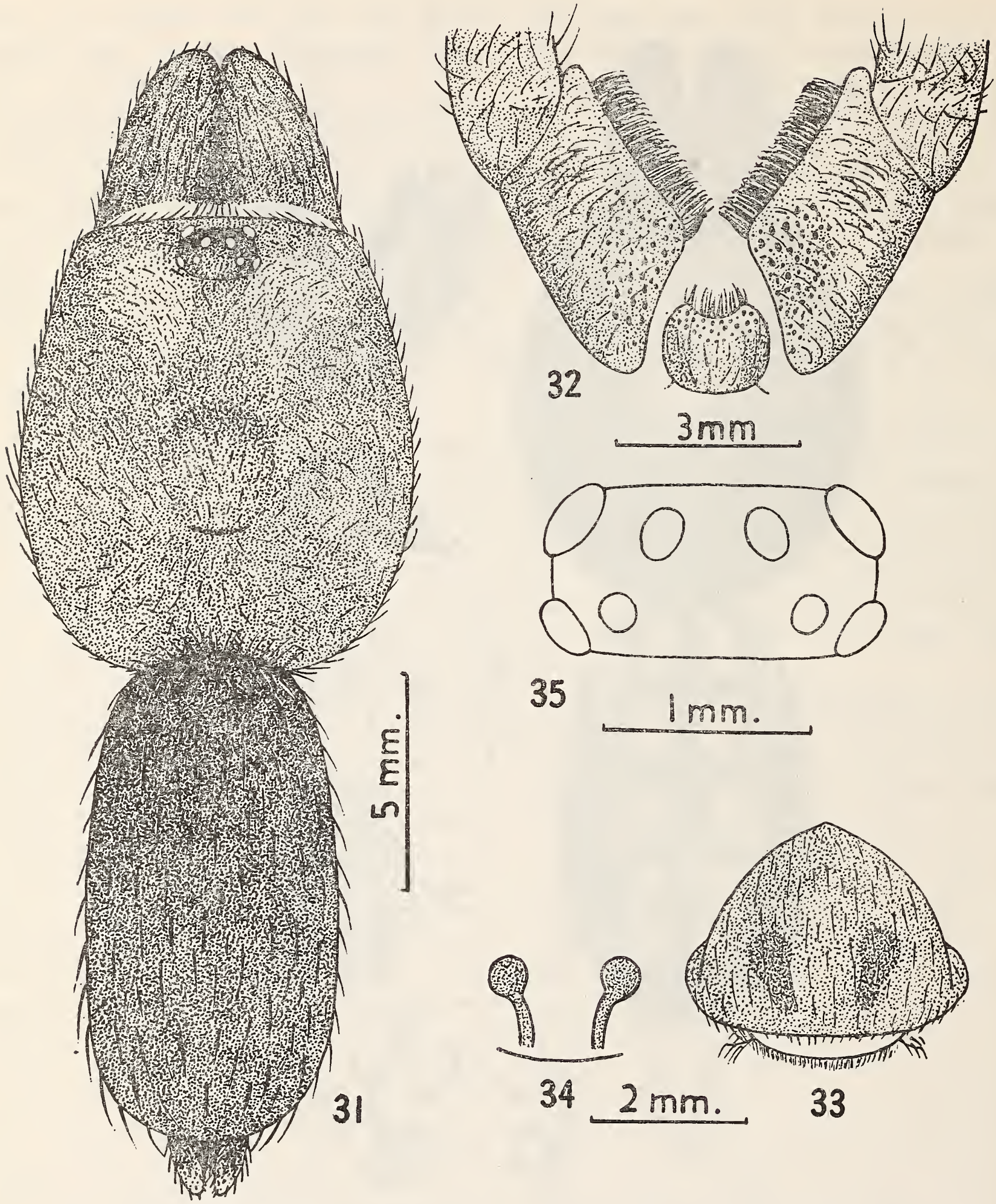
6. **Plesiophrictus meghalayaensis** sp. nov.

General: Cephalothorax black, legs and abdomen deep brown. Total length 8.80 mm. Carapace 4.30 mm long, 3.50 mm wide; abdomen 4.50 mm long, 2.50 mm wide.

Cephalothorax: Longer than wide, low and nearly elliptical in shape, clothed with fine hairs. Middle of cephalothorax provided with a deep, short, straight, transverse fovea as in text-fig. 26. Eyes eight, pale in colour, situated in a group on a slightly elevated tubercle. Ocular tubercle near to the edge of clypeus. Anterior row of eyes slightly procurved and lateral eyes larger than the medians and medians slightly closer to the adjacent laterals; posterior row nearly straight or slightly recurved, irregular in shape, medians very close to adjacent laterals as in text-fig. 30. Chelicera strong, clothed with thick hairs and rostellum absent. Inner margin of maxillae provided with thick,



Figs. 26-30. *Plesiophrictus meghalayaensis* sp. nov. 26. Dorsal view of male, legs omitted; 27. Maxillae and labium; 28. Male palp; 29. Right chelicera; 30. Showing eyes position.



Figs. 31-35. *Plesiophrictus mahabaleshwari* sp. nov. 31. Dorsal view of female, legs omitted; 32. Maxillae and labium; 33. Epigyne; 34. Internal genitalia; 35. Showing eyes position.

pale scopulae and base provided with small black tooth-like tubercles. Labium nearly rectangular, slightly wider than long, and anterior portion provided with black tooth-like tubercles. Sternum nearly round, clothed with spine-like hairs, sternal sigilla marginal. Legs long and moderately strong, I and IV pair longer than others. Metatarsi and tarsi of all legs provided with ventral scopulae. Male palp as in text-fig. 28.

Abdomen: Longer than wide, clothed with fine hairs. Dorsal side of abdomen provided with five pairs of inconspicuous longitudinal pale patches. Ventral side uniform pale coloured, clothed with hairs. Two pairs of spinnerets, anterior pair small and posterior pair long with three segments, basal segment longer than others.

Type-specimen: *Holotype* male, *paratype* one male, *allotype* two females in spirit.

Type-locality: Fruit garden, Nongrim Hills, Shillong, Meghalaya, India. Coll. *M. S. Tyrwa*, 13.iii.1974.

This species resembles *Plesiophrictus sericeus* Pocock but it is separated as follows: (i) The total length is 8.80 mm but in *P. sericeus* the total length is 22.00 mm. (ii) Abdomen dorsally provided with two rows of longitudinal pale patches but in *P. sericeus* abdomen dorsally uniform coloured, without patches.

7. **Plesiophrictus mahabaleshwari** sp. nov.

General: Cephalothorax and legs light reddish-brown, abdomen deep brown. Total length 22.00 mm. Carapace 11.00 mm long, 9.00 mm wide; abdomen 12.00 mm long, 6.00 mm wide.

Cephalothorax: Longer than wide, slightly high, both end nearly of same width, clothed with thick hairs. Middle of cephalothorax provided with a deep, short, straight, transverse fovea as in text-fig. 31. Eyes eight, pale in colour, situated in a group on a slightly elevated tubercle. Ocular tubercle situated near the edge of clypeus. Anterior row of eyes procurved, lateral eyes larger than the medians and nearly equally spaced. Posterior row of eyes recurved, medians close to adjacent laterals as in text-fig. 35. Chelicerae strong, clothed with thick hairs and rostellum absent. Inner margin of maxillae provided with thick pale scopulae and base provided with small black tooth-like tubercles. Labium nearly rectangular, slightly wider than long, anterior margin procurved, clothed with thick hairs and tooth-like black tubercles. Sternum nearly round, clothed with spine-like hairs, sternal sigilla marginal. Legs long and strong, I and IV, longer than others. Metatarsi and tarsi provided with ventral scopulae and with prominent claw-tufts.

Abdomen: Longer than wide, clothed with mouse hairs. Ventral side uniform deep brown or black. Two pairs of spinnerets, anterior pair small and posterior pair long with three segments, basal segment longer than others. Epigyne simple as in text-fig. 33. Internal genitalia as in text-fig. 34.

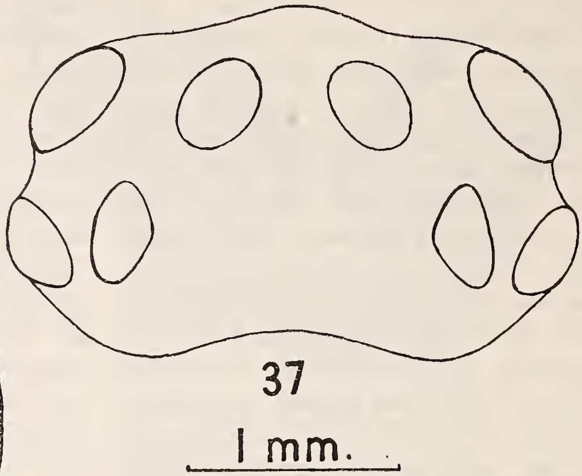
Type-specimen: *Holotype* female in spirit.

Type-locality: Mahabaleshwar, Dist. Satara, Maharashtra, India. Coll. *B. K. Tikader*, 31.v.1976.

This species is closely related to *Plesiophrictus meghalayaensis* sp. nov. but it is separated as follows: (i) Dorsal side of abdomen without any band but in *P. meghalayaensis* dorsal side of abdomen provided with five pairs of inconspicuous longitudinal pale patches. (ii) Internal genitalia also structurally different.

8. **Phlogiodes himalayensis** sp. nov.

General: Cephalothorax, legs and abdomen dark-brown. Total length 33.00 mm. Carapace 18.00 mm long, 15.00 mm wide; abdomen 16.00 mm long, 12.00 mm wide.



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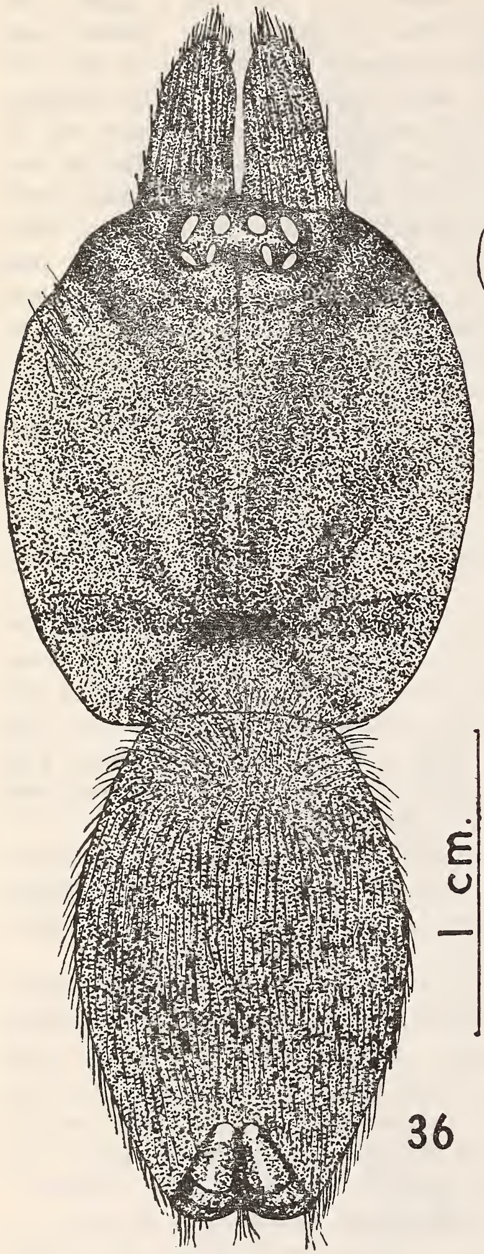

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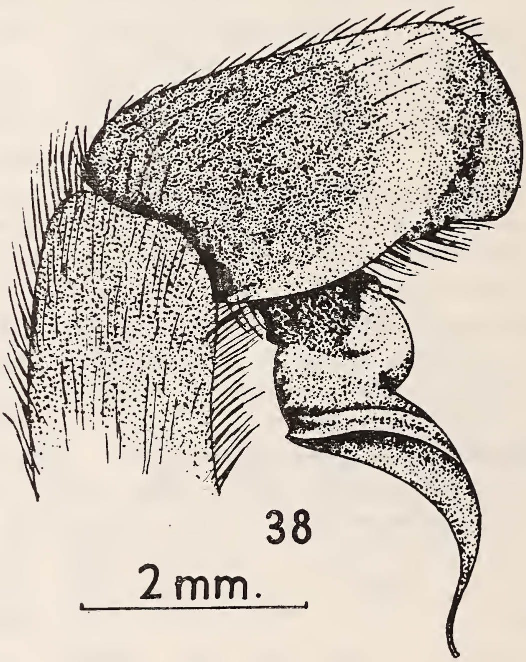

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Figs. 36-38. *Phlogiodes himalayensis* sp. nov. 36. Dorsal view of male, legs omitted; 37. Showing eyes position; 38. Male palp.

Cephalothorax: Slightly longer than wide, clothed with coating of silky grey hairs, anterior portion broad, but slightly narrow than the posterior end. Thoracic region moderately high and convex but cephalic region slightly high. Middle of cephalothorax provided with a transverse deep procurved fovea. Eyes situated in a group on a slightly elevated tubercle. Ocular tubercle situated near the edge of clypeus. Anterior row of eyes slightly procurved, posterior row nearly straight; posterior medians close to adjacent laterals as in text-fig. 37. Chelicerae strong, clothed with silky-grey hairs and rostellum absent. Inner margin of maxillae provided with thick scopulae and base provided with small black tooth-like tubercles. Labium nearly rectangular and wider than long, clothed with thick hairs and anterior portion provided with black tooth-like tubercles. Sternum slightly narrow in front, clothed with dense hairs, posterior sternal sigilla large and remote from the margin. Legs very long and stout, the IV pair being as long and stout as the I; clothed with thick hairs. Male palp as in text-fig. 38.

Abdomen: Longer than wide, narrowing behind, clothed with thick long hairs. Ventral side slightly darker than dorsal and clothed with thick hairs. Two pairs of spinnerets, anterior pair small and posterior pair long with three segments, posterior segment longer than others.

Type-specimen: *Holotype* male in spirit.

Type-specimen: Birch Hill, Darjeeling, Eastern Himalayas, West Bengal, India. Coll. *Bijan Biswas*, 22.iv.1974.

This species is related to *Phlogiodes validus* Pocock but it is separated as follows: (i) Anterior portion of cephalothorax broad but in *P. validus* anterior portion of cephalothorax narrow. (ii) Male palp also structurally different.

Acknowledgements

I am thankful to Dr. Madhav Gadgil, Indian Institute of Science, Bangalore; Mr. J. C. Daniel, Curator, Bombay Natural History Society, Bombay; Dr. A. K. Ghosh, Zoologist, Eastern Regional Station, Shillong and Shri Bijan Biswas, Zoological Survey of India, Calcutta, for supplying the mygalomorph spiders for my study. I am also indebted to Shri S. K. Chanda and Shri P. W. Garde, Artists, of this Station.

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FOUR NEW SPECIES OF PTERIDOPHYTES FROM BOMBAY PRESIDENCY[1]

P. V. BOLE[2] AND M. R. ALMEIDA[3]

(With four text-figures)

During our studies on Pteridophytes of Bombay Presidency, we have come across some taxonomically interesting taxa. Four of them, the new species, are described in the following pages.

Selaginella blatteri sp. nov.

Similis est *S. ciliari* (Retz.) Spring, sed differt ab eo sporophyllis lateralibus laxe dispositus.

Holotypus: Z. J. Kapadia-333 (bis), lectus ex Castle Rock (North Kanara), 16-12-1953 et positus in BLAT.

Selaginella blatteri sp. nov.

Stem prostrate, ± 10 cm long, frequently giving out rhizophores all along the length, with branches on the dorsal side only. Lateral leaves well spaced on the main stem as well as on the branches, ovate-lanceolate, acute at the apex, equal-sided, membranaceous. Median leaves inconspicuous. Spike ± 1 cm long and 5 mm broad. Sporophylls of the lateral plane lanceolate, acute, ± 2.5 mm long and 1 mm broad. Sporophylls of the median plane less than 1 mm long, restricted to one side only (Fig. 1).

Holotype of this species (Z. J. Kapadia: Castle Rock-333-(bis), collected on 16th December, 1953) was collected along with *Selaginella delicatula* Alston, from shady situations, near railway lines. The species is named after Rev. Fr. Ethelbert Blatter, for his pioneer work on the systematic studies on this group.

Pteris almeidiana sp. nov.

Similis est *Pteris heteromorphae* Hook. frondibus abnormale bipinnatifidis sed differt ab eo lobo basali longiore basalis paris pinnorum oppositorum.

Holotypus: M. R. Almeida—1272 lectus ex Savantwadi 8-7-1970 et positus in BLAT. Paratypus: M. R. Almeida—1550 lectus ex Anmode (North Kanara), 14-11-1970 et positus in BLAT.

Pteris almeidiana sp. nov.

Caudex short, erect, with 6-7 fronds spirally arranged, young shoot-apex clothed with scales; scales linear-acuminate, 3-4 mm long, dorsal side, scaly, slightly quadrangular and brown near the basal region, almost rounded, yellowish upwards on drying. Fronds ± 25 cm long, ± 20 cm broad, with 5 pairs of primary lateral pinnae and two much-lobed terminal pinnae; lower 2-3 pairs of pinnae again pinnate or deeply lobed, upper pairs of pinnae entire; the lowest pair of pinnae with a large, ± 9 cm long and 1-1.5 cm broad lobes. Terminal pinna with 5-6 lobes on either side and a long terminal lobe. Fertile fronds little smaller in size than the sterile ones. Sori linear along the entire margin, covered by a reflexed margin (Fig. 2).

Holotype: M. R. Almeida: Savantwadi-1272 (8th July, 1970).

Paratype: M. R. Almeida: Anmode-1550 (14th Nov., 1970).

This fern is found in dense shade at Savantwadi and at Anmode, N. Kanara. Dr. (Miss) F. M. Jarrett of Kew Herbarium informed us

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Fig. 1. *Selaginella blatteri* sp. nov.
1.Habit; 2. Portion of the strobilus; 3. Lateral leaf; 4. Median leaf; 5. Sporophyll; 6. Spore.

Fig. 2. *Pteris almeidiana* sp. nov.
1. Frond; 2. Pinnae showing marginal indusiate sori.

Fig. 3. *Schizolegnia indica* sp. nov.
1. Habit; 2. Ramentum; 3. Sorus; 4. Spore.

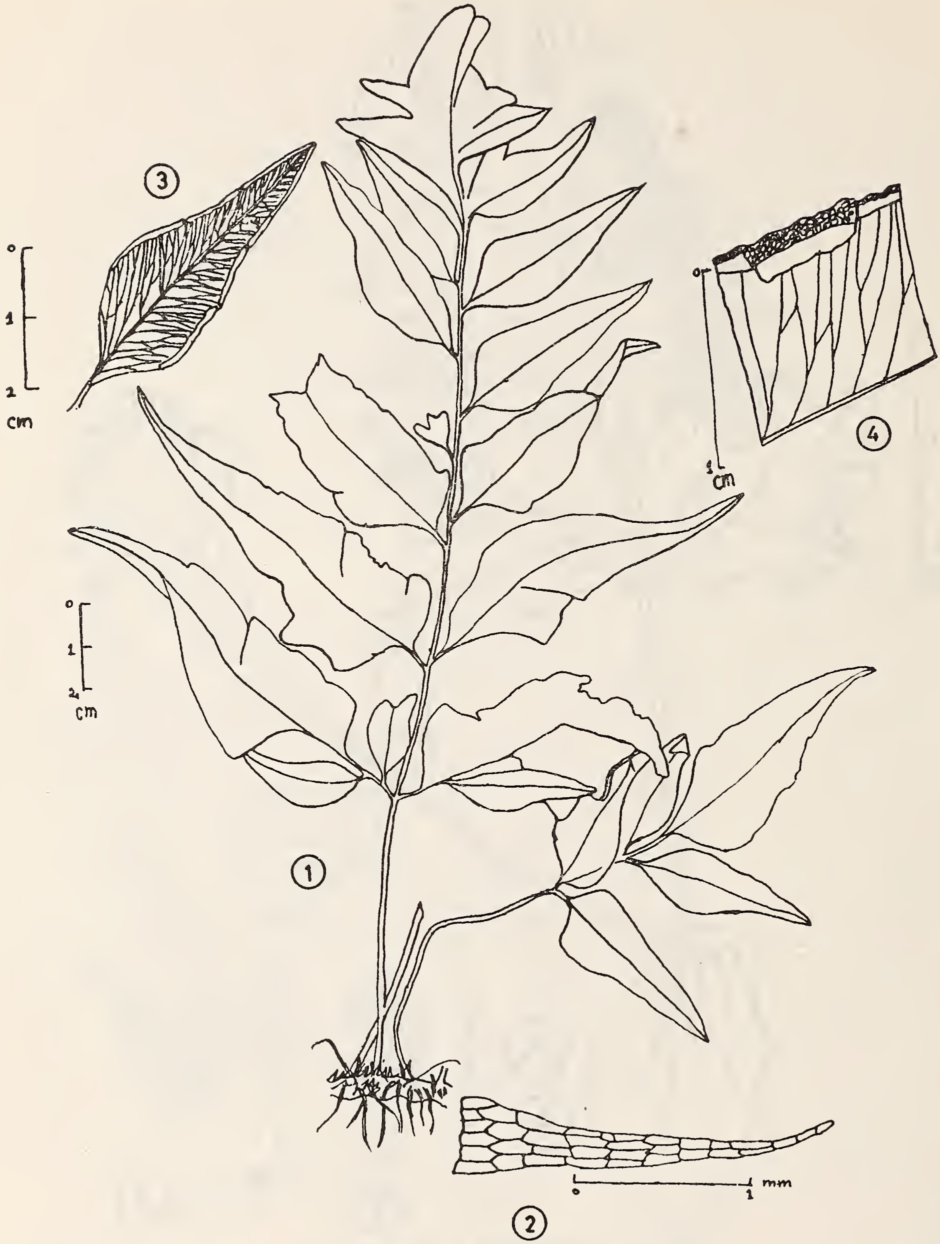

Fig. 4. *Schizolegnia savantwadiensis* sp. nov.
1. Habit; 2. Ramentum; 3. Pinnae showing venations; 4. Portion of pinnae showing sorus.

that there are 2-3 unnamed specimens of this species in Kew Herbarium collected from Bastar District in Madhya Pradesh. She is of the opinion that this fern is probably a cross between *Pteris quadriaurita* Retz. and *Pteris pellucida* Presl. This species is named after Professor J. F. R. d'Almeida, to commemorate his pioneering work on 'Ferns of Bombay'.

Schizolegnia indica sp. nov.

Similis est *S. heterophyllae* (Dry.) Alston, frondibus bipinnatis cum pinnis lobatis, sed differt eo, venis libris et formis pinnarum irregularibus.

Holotypus: M. R. Almeida-926, lectus ex Castle Rock (North Kanara) 27-12-1970 et positus in BLAT.

Schizolegnia indica sp. nov.

Rhizome short, creeping, bearing fronds very close together, scaly at the base; scales about 1 mm long, dark-brown. Stipes quadrangular and grooved, $\pm$ 5 cm long. Fronds $\pm$ 5 cm long and 5 cm broad, simply pinnate; pinnae $\pm$ 3 cm long and 2 cm broad, acute or oblique at the base and gradually increasing in breadth towards the apex. The lower pinnae subopposite and slightly spaced, upper one almost contiguous. All pinnae much lobed and of irregular shape and size. Texture thin, herbaceous. Veins prominent, branching, free. Sori indusiate, running parallel to the margin; indusium thin and crisped, not reaching the edge of the lamina in mature sorus (Fig. 3).

Holotype: M. R. Almeida: Castle Rock-926 (27th December, 1970).

The only specimen of this species was collected from Castle Rock, North Kanara, by the side of a small stream, about 100 metres away from Castle Rock Station, towards the Londa side. It was growing in association with *Schizolegnia encifolia* Alston and *Lygodium microphyllum* R. Br. on white loamy soil.

Schizolegnia savantwadiensis sp. nov.

Similis est *S. encifoliae* (Sw.) Alston, frondibus simplicibus pinnatis, sed differt pinnis triangularibus vel clavatis. *S. encifolia* habet lineares vel lanceolatas.

Holotypus: M. R. Almeida-389 lectus ex Savantwadi 10-6-1966, et positus in BLAT.

Schizolegnia savantwadiensis sp. nov.

Rhizome short, creeping, scaly, with 3-10 fronds arising from the dorsal surface and thin, wiry roots on the ventral surface; scales linear-acuminate, 1-2 mm long and $\pm$ .5 mm broad. Stipes quadrangular, scaly at the base, up to 15 cm long, grooved. Fronds simply pinnate, rarely one or two pinnae producing a short lobe near the base, 10-20 cm long and 8-12 cm broad, with about 7 pairs of subopposite or alternate pinnae. Pinnae shortly petiolate, 5-9 cm long and 2.5 cm broad, lower triangular, upper ovate or lanceolate, sometimes irregularly lobed, acute or acuminate at the apex, obliquely cut at the base, entire along the margins. Texture thin, membranaceous, sometimes herbaceous. Midrib prominent, giving out lateral parallel veinlets which anastomose with each other forming elongated areoles. Sori indusiate, linear along the margins; indusium thin, membranaceous, flap-like, opening from the marginal side towards the midrib (Fig. 4).

Holotype: M. R. Almeida: Savantwadi-389 (10th June, 1966).

Paratypes: M. R. Almeida: Savantwadi-587 (25th May, 1968). M. R. Almeida: Savantwadi-1271 (4th August, 1970).

This species grows in abundance only at one place near St. Francis Xavier's chapel, Charatha, Savantwadi. Like other *Schizolegnia* spp. this species also grows on white loamy soil.

ACKNOWLEDGEMENTS

We wish to record our sincere thanks to Rev. Fr. J. Misquitta, Principal, St. Xavier's College, Bombay-1, for the facilities and encouragement for this work and to Rev. Fr. Conrad Mascarenhas for Latin diagnosis.

A NEW SPECIES OF *DIOSPYROS* (EBENACEAE) FROM WESTERN INDIA[1]

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(*With a plate*)

During a visit to Bangalore, I had the opportunity of studying specimens of *Diospyros* from Hassan District of Karnataka State. Further studies on some of these specimens were made at the Rijksherbarium, Leiden. As a result a new species of *Diospyros* is being described.

Diospyros saldanhae sp. nov.

Arbor, ramulis hornotinis perdense tomentosis, pilis diversis, foliis alternantibus, tenuiter coriaceis, subovate ellipticis, breve obtuseque acuminatis, basi subcordatis, utrinque tenuiter prominule minute reticulatis, supra nervo mediano excepto glabris; nervus medianus parte basali prominens, caeteris impressus, subtus sparse tomentellus; nervi laterales graciles, erecto-patentes, prominuli; petioli brevissimi. Fructus solitarius, breve pedicellatus, dense tomentellus, lobis perianthii oblongis, obtusis, seminibus tribus, endospermio equabili.

Holotypus *HFP 62* ab Nicolson, Saldanha & Ramamoorthy lectus in herbario Collegii Sti Josephi (JCB) positus est. Paratypus *Saldanha 13709*.

Diospyros saldanhae sp. nov.

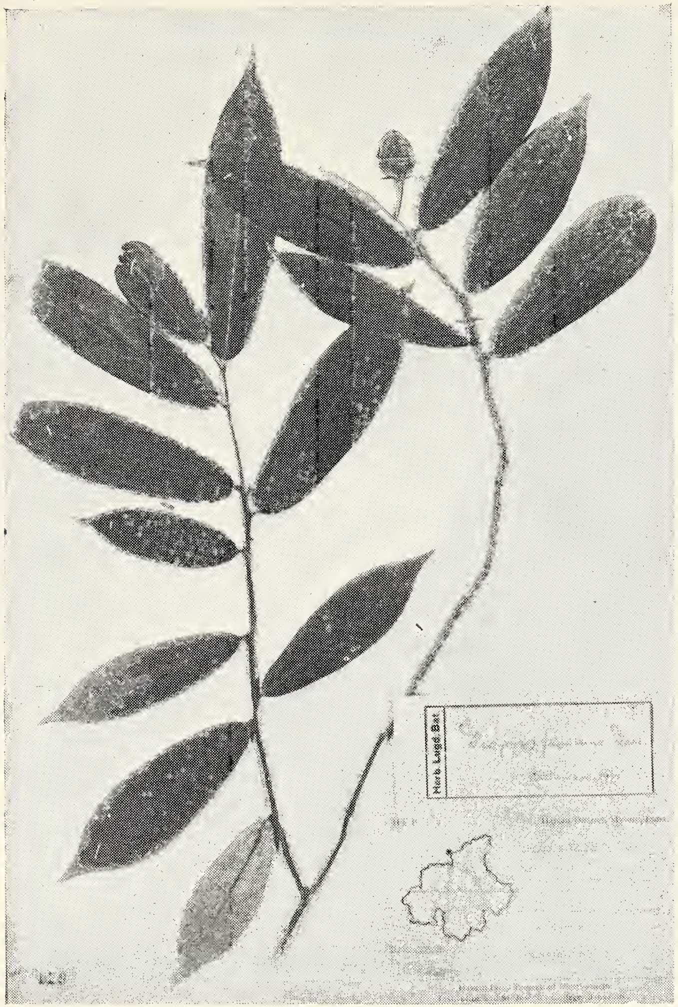
Tree, 8-10 m high. Branchlets very densely tomentose, the indumentum consisting mainly of slender, stiff hairs, *c.* 1 mm long, interspaced with 2 mm long hairs. Leaves spirally arranged, thinly coriaceous, subovate-elliptic, $3 \times 6 - 6 \times 14$ cm, shortly, broadly acuminate with obtuse tip, base sub-cordate, both surfaces finely, prominulously reticulate; glabrous above except on midrib, which is prominent in its basal part and impressed in its upper part; lateral nerves very slender, hardly prominulous; lower surface of leaf tomentellous (denser on the main nerves), midrib prominent, the slender *c.* 10 pairs of erect-patent lateral nerves prominulous. Petiole very short, thick, 3 mm, densely tomentellous. The solitary subovoid-globose, densely tomentellous fruit of 2.5 cm diam. on a 2 mm long, pilose pedicel; perianth lobes 4, oblong-ovate, obtuse, 5 mm long. Seeds 3, narrowly pear-shaped, slightly pointed, smooth, 15 mm long, endosperm equable.

Note: Related to *D. pruriens* Dalz., from which it differs by its larger, broader leaves with sub-cordate base, the much shorter hairs of two kinds and the shortly pedunculate, larger fruit with ovate-oblong, obtuse, short perianth lobes.

The species is named in honour of Father C. Saldanha, S.J. of St. Joseph's College, Bangalore, co-author of the *Flora of Hassan District, Karnataka* (Mysore).

Holotype *HFP 62* collected along a stream between Devalkere and Devarunde in Hassan District of Karnataka, S. India by Nicolson, Saldanha & Ramamoorthy in May 1970. Paratype *Saldanha 13709* collected in the same locality in May 1969. Both specimens in fruit.

[1] Accepted June 1977.



Left: *Diospyros pruriens* Dalz. with distinctive leaves, pedicel and fruit. *Right*: Holotype of *Diospyros saldanhae* sp. nov. The leaves, pedicel and fruit together with the indumentum clearly separate this species from *D. pruriens*.

A NEW SPECIES OF SPIDER OF THE FAMILY OXYOPIDAE FROM GUJARAT, INDIA, WITH NOTES ON OTHER SPECIES OF THE FAMILY[1]

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(*With a text-figure*)

INTRODUCTION

Spiders of the family Oxyopidae have received scant attention in India. Pocock (1900) described four species of the genus *Oxyopes* Latr. Stoliczka (1869) described a new species of genus *Peucetia* from India. Sherriffs (1951) redescribed and figured Pocock's species of *Oxyopes* from Oriental Region. Dyal (1935) described a new species of *Oxyopes* from Lahore. Recently Tikader (1965, 1969 and 1970) described twelve new species of the genus *Oxyopes* and two of the genus *Peucetia* from India. Very recently Biswas (1975) described *P. harishankarensis* as a new species from Orissa, India.

While examining my collection made from different districts of Gujarat State during the period from 1967 to 1975, I came across three species of *Oxyopes* and two species of *Peucetia*, among which one is described here as a new species. The other four species are first records from Gujarat.

Type specimens will be deposited in due course in the National Collections of Zoological Survey of India, Calcutta.

Peucetia akwadaensis sp. nov.
(Fig. 1, a-f)

General: Abdomen brightly green in colour, cephalothorax and legs light green in colour. Total length 11.14 mm. Carapace 4.57 mm long, 3.52 mm wide; abdomen 6.57 mm long, 2.78 mm wide.

Cephalothorax: Longer than wide, moderately high, clothed with fine hairs and few spines. Cephalic region high and broad, separated by a distinct cervical groove; clypeus high with brown discontinuous stripes in front and provided with two black hairs. Centre of the thorax provided with a fovea. Eyes of anterior row strongly recurved so as to form two distinct rows of two eyes each; as in Fig. 1, b; anterior medians smallest. Posterior row slightly procurved, posterior laterals are slightly smaller than the posterior medians, base of all eyes encircled by black. Ocular quad longer than broad, narrowing posteriorly. Sternum heart-shaped, pointed behind, projected in between the coxae IV, clothed with fine hairs and black spines. Maxillae elongate, scopulate at the anterior ends. Sternum, labium and maxillae as in fig. 1, d. Chelicerae long, vertical with two long spines nearer to the base, fange groove unarmed with a short curved fang. Legs long, brownish green, covered with hairs and many long spines, bases of all spines with a dark spot, the legs provided with two pectinate and one small median tarsal claws. Legs 1, 2, 3, 4. Tibiae I and II with three pairs and III and IV with two pairs of ventral spines; metatarsi of all legs provided with three pairs and one median apical ventral spines. Femora of

[1] Accepted August 1977.

all legs with three, patella with two, tibia with one dorsal spines and metatarsi are provided with three pairs of dorsal spines. Leg length of the female is as under: measurements are in mm.:

	I	II	III	IV
Femur	6.57	6.15	5.00	4.89
Patella	1.37	0.94	1.00	0.84
Tibia	3.78	5.84	3.68	4.10
Metatarsus	6.94	5.89	4.57	3.94
Tarsus	3.78	2.89	1.89	1.73
Total	22.44	21.71	16.14	15.50

Abdomen: Longer than wide, narrowing behind, bright green in colour with white patches, clothed with fine hairs. Dorsal side with a mid-dorsal dark coloured broad band, out side of which on both the sides a white stripe extends upto the posterior end of abdomen. In between these white stripes symmetrically arranged white patches are present as in Fig. 1, a. Ventral side is lighter in colour with dark white bands. Epigyne as seen in Fig. 1, c.

Male is similar in colour but little smaller than the female (total length 9.50 mm). Male palpal structure as in fig. 1, e and f.

Holotype female, *Paratypes* two females, *Allotype* one male in spirit.

Type-locality: Akwada, Dist. Bhavnagar, *c.* 4 kilometres south of Bhavnagar, 25.ix-1973. Coll. B. H. Patel. Also collected from Vallabh Vidyanagar, Dist. Kheda, 15.viii.1975. Coll. B. H. Patel.

This species resembles *Peucetia choprai* Tikader but is separated as follows: (i) Cephalic region distinctly separated by a cervical groove, but in *P. choprai* a distinct groove is absent. (ii) Clypeus with discontinuous stripes, but in *P. choprai* two brown lines extend from anterior median eyes to nearer the base of fang of chelicerae. (iii) Arrangement of white and dark stripes and bands on the abdomen is markedly different. (iv) Structure of female epigyne as well as male palp also differ.

Oxyopes wroughtoni Pocock

Oxyopes wroughtoni Pocock, 1901.
J. Bombay nat. Hist. Soc., 13:483.

SPECIMENS EXAMINED: 3 ♀ and 3 ♂, Vallabh Vidyanagar, District Kheda, 15.ix.1967. 4 ♀ and 1 ♂, Anand, Dist. Kheda, 23.ix.1967. 2♀ Agas, Dist. Kheda, 4.x.1968. 6 ♀ and 2 ♂ Ahwa, Dist. Dangs, 2.xii.1968. 3 ♀ Baroda, Dist. Baroda, 9.vii.1970. 2 ♀ and 2 ♂ Ambaji, Dist. Banaskantha, 21.viii.1970. 1 ♂ Ahmedabad, Dist. Ahmedabad, 22.viii.1970. 2 ♀ Napad, Dist. Kheda, 21.ix.1970. Coll. B. H. Patel.

Distribution: India: Lahore; Bulsar, Kheda, Ahwa, Ahmedabad, Baroda, and Banaskantha Districts in Gujarat.

Oxyopes sitae Tikader

Oxyopes sitae Tikader, 1970.
Rec. Zool. Surv. India, 44:75.

SPECIMENS EXAMINED: 2 ♀ and 2 ♂ Ahwa, Dist. Dangs, 17.viii.1970. Coll. B. H. Patel.

Distribution: India: Rohtak, West Sikkim; Ahwa Dist. in Gujarat.

Oxyopes chittrae Tikader

Oxyopes chittrae Tikader, 1965. *Proc. Indian Acad.* Sci., Sec. B, 62:140.

SPECIMENS EXAMINED: 4 ♀ Ahwa, Dist. Dangs, 30.vi.1969. 2 ♀ Napad, Dist. Kheda, 2.viii.1970. Coll. B. H. Patel.

Distribution: India: Poona, Maharashtra; Ahwa and Dangs Districts in Gujarat.

Peucetia latikae Tikader

Peucetia latikae Tikader, 1970.
Rec. Zool. Surv. India, 64:80.

SPECIMENS EXAMINED: 4 ♀ Ahwa, Dist. Dangs, 25.xii.1967. Coll. B. H. Patel.

Distribution: India: Manjithar, West Sikkim; Ahwa District in Gujarat.

ACKNOWLEDGEMENTS

I am indebted to Dr B. K. Tikader, Deputy Director, Western Regional Station, Zoological Survey of India, Poona, for confirmation of the specimens and valuable suggestions. I am grateful to the authorities of the Saurashtra University, Rajkot for the sanction of grants (3147/21199 dated 7.3.74). My sincere thanks are also due to Principal Dr. L. D. Dave and Prof. Dr H. B. Gohil, Sir P. P. Institute of Science, Bhavnagar for their help and keen interest in my work.

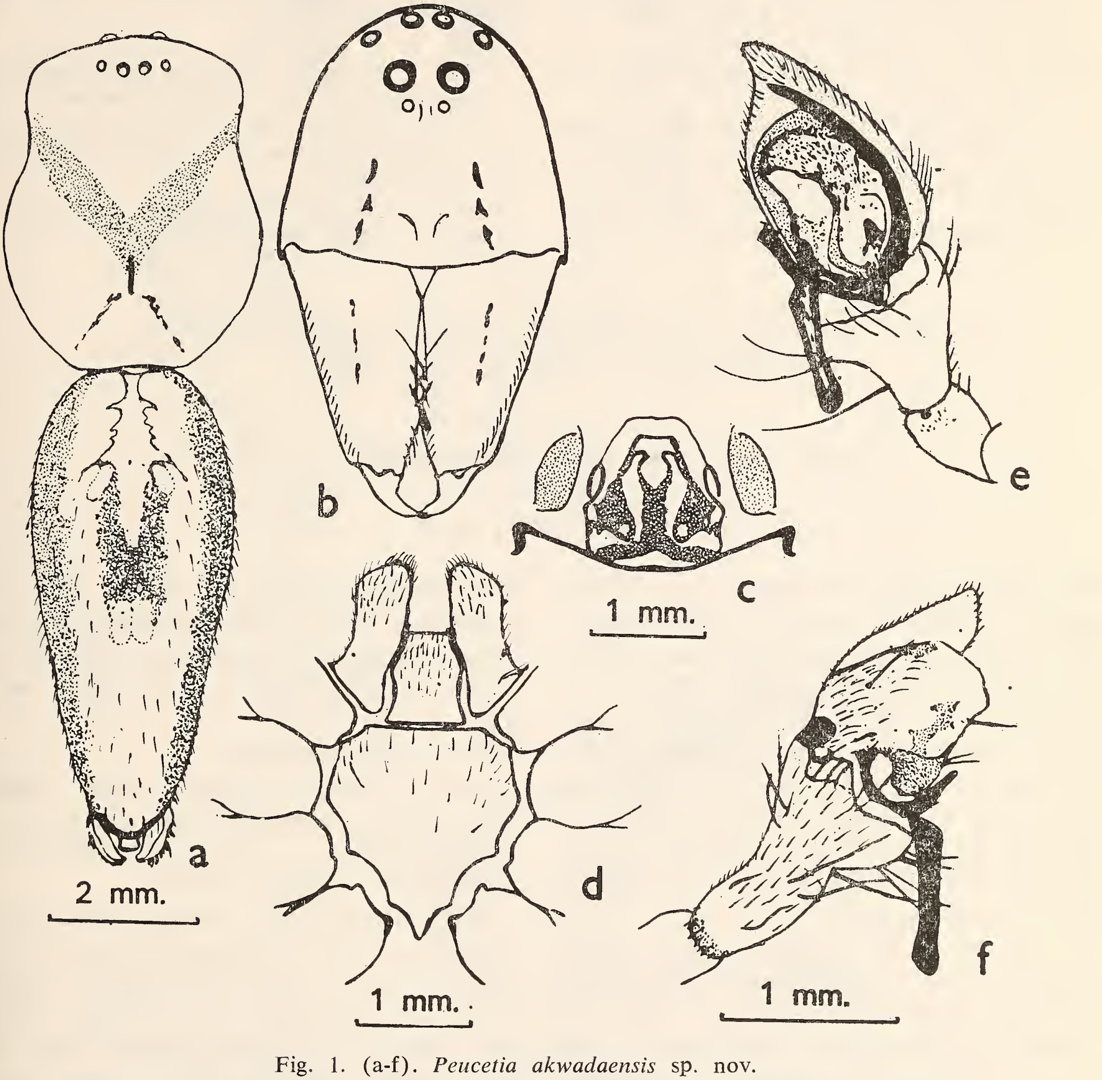

Fig. 1. (a-f). *Peucetia akwadaensis* sp. nov.
a. Dorsal view of female (legs omitted); b. Head—front view; c. Epigyne; d. Sternum, labium and maxillae; e. Male palp—ventral view; f. Male palp—dorsal view.

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A NEW VARIETY OF *GLYCINE WIGHTII* SUBSP. *WIGHTII* VERDCOURT FROM SOUTH INDIA[1]

AJITA SEN

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(*With a text-figure*)

East Asian species described by different authors as *Glycine javanica* is quite different from Linnaeus's species of that name which as proved by Verdcourt (Taxon, Vol. xv (i), pp. 34-36; 1966) is *Pueraria montana* (Lour.) Merrill. The east Asiatic species known as *Glycine javanica* auct. mult. non. Linn. has now been named as *Glycine wightii* (R. Grah. ex Wight & Arn.) Verdcourt enumerates 3 subsp. of, *G. wightii* as:— (1) *wightii*, (2) *petitiana* and (3) *pseudojavanica*.

G. wightii subsp. *wightii* again 2 varieties namely, var. *wightii* and var. *longicaudata*, the former being found in India. While examining the sheets of the above named taxon it was noticed that all collections do not represent identical variety. Some specimens collected from S. India differ in being less hairy, having more elongated raceme and flowers more lax on the axis, not so much overlapping as in the typical variety. These specimens therefore are considered to represent a new variety under subsp. *wightii*.

This is described below:—

Glycine wightii Verdcourt subsp. **wightii** Verdcourt var. **coimbatorensis** var. nov.

Haec varietas a typo sparse pubescentis, racemes laxis, elongatis recedit.

Plants suberect, stem slender, solid, *internodes* long, 7-12 cm, glabrous, except a few scattered hairs. *Leaves* tri-foliolate; leaflets 5.9-6.6 cm long, 4.6-5.9 cm broad, entire, ovate, acute, with a few adpressed hairs on both surfaces, petiole glabrous, almost hairless, 3-5 cm long, petiolules 15 mm long, a pair of 7 mm long *stipules* at the base of leaves, a pair of 2.5 mm - 30 mm long stipels at the base of each leaflet. *Inflorescence* race-

[1] Accepted August 1977.

Fig. 1. *Glycine wightii* Verdcourt subsp. *wightii* Verdcourt var. *combatorensis* var. nov. —A twig of the plant.

me at the axil of the leaves, with a 17-30 cm long peduncle, flowers arranged interspersely on the rachis, the non-flowering part of the peduncle is 3-6.5 cm long; flower bearing part is much longer. *Flowers* bracteate, bracts 3 mm long, with a few hairs, leaf like, ovate. *Calyx* 5, united, cuplike 4 mm long, the posterior pair of teeth united very near to apex, other teeth as long as the tube or cup, sparsely hairy, *standard petal* elliptic, about 6 mm long, 5 mm broad, *wings* about 4 mm long, 1 mm broad, *keel petals* united at the apex, 4 mm long, 2.5 mm broad. *Stamens* 9 + 1, unequal, free stamen longer, anthers basifixed. *Ovary* stalked, superior, with a few ovules on marginal placenta, style short, stigma notched. *Fruit* a pod, sparsely hairy, 2-4 seeded, spongily septate between the seeds; 1.5 - 2.3 cm long, 5 mm broad.

Type locality: Wet lands—Coimbatore,

Holotype: India, Tamilnadu, Coimbatore, 2-xi-65, M. Chandra Bose 28823. Deposited in Herb., S. Circle, B.S.I. (MH).

Paratypes: India, Kerala, Kottayam dt., Kumily to Thekkadi, 21.11.67, K. Vivekananthan 29373 (MH); Salem dt., Pennagaram river forest, 4.12.1964, E. Vajravelu 22433 (MH); Coimbatore dt., Poonachi - Anamalais, 24.10.1961, J. Joseph 13253 (MH); on the road to Shiruvani, K. Subramanyam 1415 (MH); Aliyar submergible area, 24.11.62, K. M. Sebastine 15344 (MH); Bolampatti, South fuel working circle, 7.12.1909, C.E.C. Fischer 1508 (CAL); Kamalapores Sept., 1910, A. Meebold 11285 (CAL).

ACKNOWLEDGEMENTS

Grateful thanks are due to Dr S. K. Mukerjee, ex-keeper, Central National Herbarium (B.S.I.), Shibpore for his kind help and suggestion in preparing this manuscript. Thanks are also due to Director and Keeper of Central National Herbarium (B.S.I.) for their encouragement.

A NEW SPECIES OF SPIDER OF THE GENUS *PLATYTHOMISUS* SIMON (FAMILY: THOMISIDAE) FROM COORG, KARNATAKA, INDIA[1]

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(*With three text-figures*)

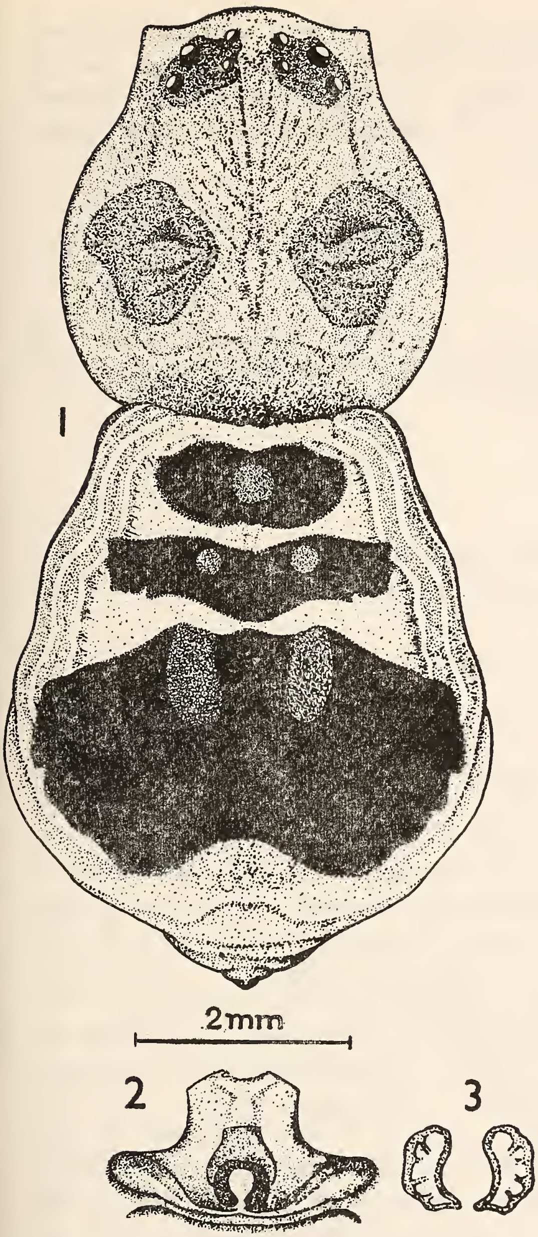
While examining the spider collection from Coorg, I came across a new species of the genus *Platythomisus* Simon, which is described here. Though a considerable work has been done by Tikader (1960-1971) on Indian Thomisidae, only one species of this genus was described by Tikader (1970). It is the second species of the genus *Platythomisus.*

The type specimen is deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

Platythomisus sudeepi sp. nov.

General: Cephalothorax and legs brown, abdomen yellow with black transverse bars.

[1] Accepted July 1977.



Figs. 1-3. *Platythomisus sudeepi* sp. nov. 1. Dorsal view of female, legs omitted; 2. Epigyne; 3. Internal epigyne.

Total length 9.31 mm. Carapace 4.00 mm long, 3.75 mm wide; abdomen 5.31 mm long, 4.50 mm wide.

Cephalothorax: High and rounded, a little longer than wide, dorsolateral side abruptly depressed and anterior portion conical, provided with four rounded black spots, and the eyes situated within the anterior black spots, posterior pair of spots larger. Both rows of eyes recurved, anterior laterals larger, posterior medians smaller and anterior medians pearly white. Sternum brown, longer than wide and triangular in shape. Legs I and II brown; longer and subequal. Femora III and IV light yellow in colour. Legs without spines and metatarsi of legs dorsolaterally yellowish-white, except apical portion.

Abdomen: Longer than wide, broad and conical behind, provided with three transverse black bars. First one provided with a light brown round spot on the middle, second with two round brown spots on the sides and the last bar is very broad and provided with two longitudinal brown lines on the sides. Ventral side black bordered with yellow colour, spinnerets brown at the base, encircled with yellow, Epigyne as in text-figure 2 & 3.

Holotype one female, *paratype* one female in spirit.

Type-locality: Pollibetta, Coorg, Karnataka, India. Coll. *T. B. Fletcher*, 27-x-1915.

This species is closely related to *Platythomisus octomaculatus* Koch. However, *P. sudeepi* differs from *P. octomaculatus* in the structure of female epigyne. Abdomen dorsally provided with three transverse black bands but in *P. octomaculatus* abdomen dorsally provided with seven black patches.

ACKNOWLEDGEMENTS

I am thankful to Dr T. N. Ananthakrishnan, Director, and Shri U. A. Gajbe, Officer-in-Charge, Arachnida Section, Zoological Survey of India, Calcutta, for necessary facilities and greatly indebted to Dr B. K. Tikader, Deputy Director, Western Regional Station, Zoological Survey of India, Poona, for the confirmation of the identification and valuable suggestions.

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A NEW SUBSPECIES OF BAY OWL [*PHODILUS BADIUS* (HORSFIELD)] FROM PENINSULAR INDIA

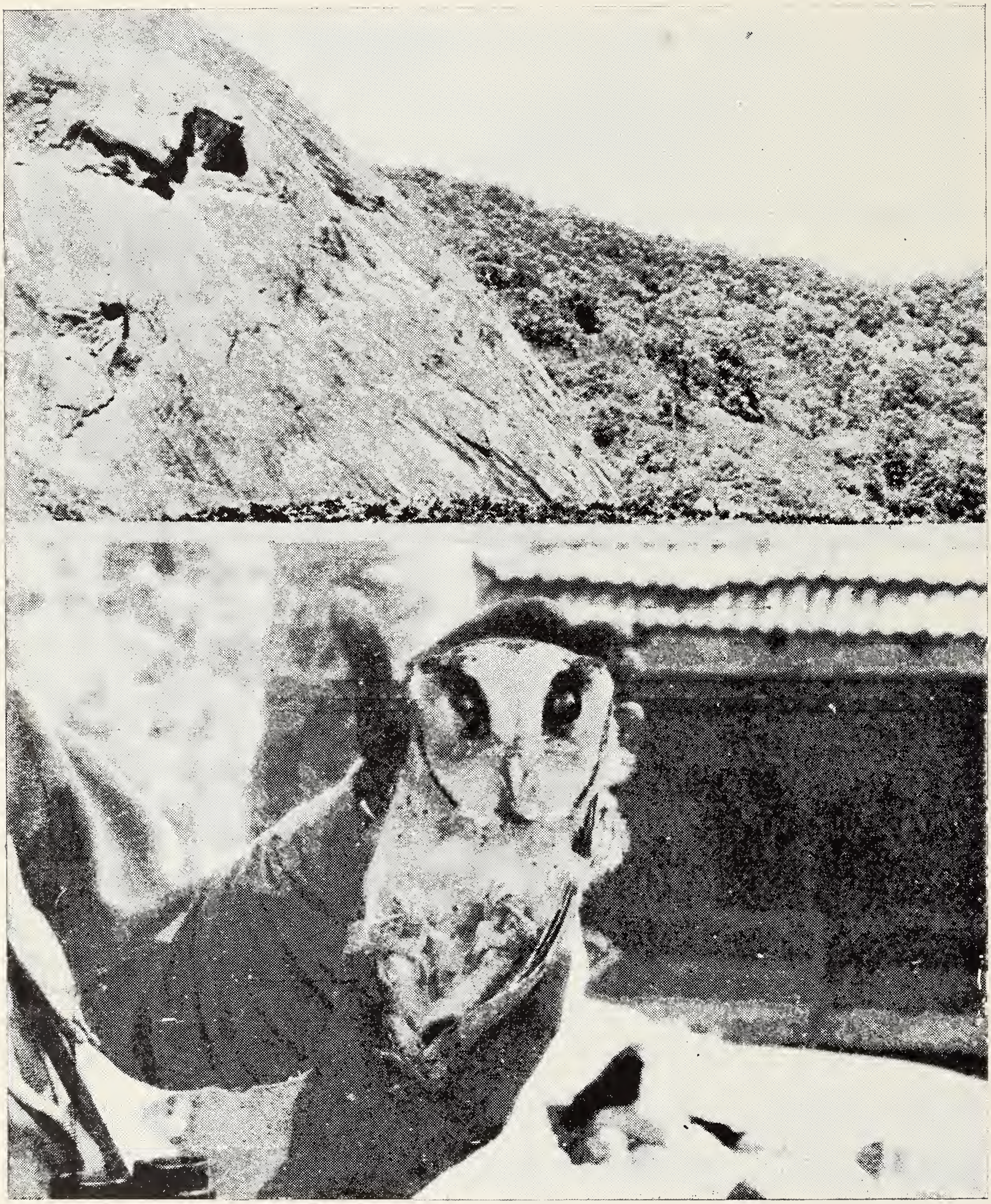
S. A. HUSSAIN AND M. A. REZA KHAN[1]

(*With a plate*)

Two races of Bay owl (*Phodilus badius*) occur in the Indian sub-continent. The Sikkim Bay Owl (*P. b. saturatus*) ranges in the northeastern Himalayas from Nepal, Sikkim, Bhutan, Assam, Nagaland, Manipur and then on to Burma and Malaya, intergrading with the nominate race. The second race, Ceylon Bay Owl (*P. b. assimilis*) is confined to Sri Lanka. Both subspecies are considered to be rare in their respective habitats and so far as the available literature is concerned (Hume 1873, 1875, 1876, 1877; Fairbank 1877; White 1877; Ferguson & Bourdillon 1903-04; Kinloch 1920-1923; Baker 1929; Ali 1935-37; Ripley 1961; Ali & Ripley 1969 and Henry 1971) this owl has not been recorded from peninsular India.

Recently one of us (M.A.R.K.) along with Dr V. S. Vijayan (presently Head of the Wildlife Division, Kerala Forest Research Institute, Trichur, Kerala), while on a survey of the Parambikulam sanctuary environs in the Western Ghats, obtained a specimen of a Bay Owl which, apart from being a new record for the region, appears to be distinct from the Himalayan and Sri Lanka birds. The specimen was sent to Dr S. Dillon Ripley at the Smithsonian Institution, Washington, U.S.A., who very kindly compared it with specimens of *saturatus* and *assimilis* obtained by him from the American Museum of Natural History, New York, and the British Museum, London, and has confirmed our diagnosis. Considering the morphological differences and the ecological isolation of this bird from the other races, we hereby name it as

[1] *Present address*: Lecturer in Zoology, University of Dacca, Dacca, Bangla Desh.



Above: Forests of Nelliampathy, habitat of the owl. *Below*: Southern Bay Owl, *Phodilus badius ripleyi* subsp. nov.
(*Photos*: *Reza Khan*)

Phodilus badius ripleyi[2] subsp. nov.

Type: ♀ collected by M. A. Reza Khan and V. S. Vijayan at Periasolai Coffee Estate, Nelliampathy Hills (*c.* 10°36′ N; 76°40′ E), Palghat Dist. Kerala, S. India, on 30 April 1976 and now in the Bombay Natural History Society's collection bearing Reg. No. 24232.

Taxonomical notes: The specimen, in general appearance, is dark brown to chocolate brown dorsally. Upper breast to abdomen and back from head to rump has dark brownish to blackish spots. Crown, back and wings deep chocolate. Bastard wing and outermost five primaries barred with black, gradually fading on the fourth and fifth. Secondaries barred with black bands, darker and complete on the inner webs and lighter and incomplete on the outer webs. Seven distinct black bars on the rectrices, fading gradually towards the tip.

The main differentiating character is the spotting on breast. Dr Ripley, after examining a series of specimens of *saturatus* and *assimilis*, comments (*in litt.*) as follows: "... The single south India bird is darker above than the single male from Ceylon with much finer spotting, the white spots very much reduced all over as well as in size, reduced about one half the width of those of the single specimen of *assimilis* (AMNH coll.). The crown is dark chocolate-brown with only occasional black spots, lacking the black and white droplets [illegible]nd in *assimilis*. The pale buffy lilac feathers [illegible]he centre of crown exist but they too have [illegible]y black spot in the centre of each feather only 2 mm in width rather than the larger spots in the Ceylon bird which are 4 mm in width. Below the bird is darker, richer lilac, with similarly reduced spotting on the breast feathers, 1.5 mm in width rather than 3 mm in width. The outline of these droplets show a single droplet rather than double droplet..."

The Himalayan subspecies is much larger and paler than south Indian and Sri Lanka birds. There is, however, no difference in size between *assimilis* and *ripleyi*.

Ecological notes: The Periasolai area represents the southern section of the Nelliampathy hills, south of Palghat and contains the typical wet evergreen forest, a biotope similar to the heavy evergreen submontane hill tracts of the eastern Himalayas. The presence of the Bay Owl here may strengthen the recent theories put forward by Hora (1950), Mani (1974), Ripley (1977) and others that the patchy distribution of certain Indo-Malayan and east Himalayan species of the flora and fauna in equivalent biotopes of the southern peninsula are relicts of a once continuous distribution between these areas which was disrupted by geotectonic action marooning disjunct populations in isolated pockets of appropriate country.

ACKNOWLEDGEMENTS

We gratefully acknowledge the help and encouragement given by Dr. Ripley and Mr. J. C. Daniel, Curator, Bombay Natural History Society.

Measurements (in mm):

		Wing	Bill	Tarsus	Tail
			(from feathers)		
saturatus	♂♀	214-237	30-32	47-48	92-97
assimilis	♂♀	197-203	c.30	c.47	81-89
			(from skull)		
ripleyi	♀	208	33	51	81

[2] The bird is named as a tribute to Dr. S. Dillon Ripley, Secretary, Smithsonian Institution, in recognition of his contributions to the ornithology of the Indian subcontinent.

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* Not seen in original.

Obituary

N. KESAVA PANIKKAR (1913-1977)

Our country has produced a number of scientists who have been responsible for moulding the scientific outlook of the country, in keeping with the needs and aspirations of a developing economy. It is in this context that the late Dr N. Kesava Panikkar would be remembered by posterity. Dr Panikkar has, for nearly three decades, dominated in the sphere of fisheries research and development in the Indian subcontinent.

Born on May 17, 1913 in Kottayam, Kerala, he had his early education in the local schools. Since then, during his graduate studies he came under the influence of one of the able Professors of the time, Prof. C. Lakshminarayanan of the Madras Christian College, Tambaram, from where he took his M.A. in Zoology in 1933. Besides being a good student, he was always keen on making direct observations of living organisms in their natural habitat and was a firm believer in the Louis Agassiz dictum—study nature and not books alone. It was thus during his field trips as part of the College curriculum that he developed an intensive fascination for the study of the process of physiological adaptation of aquatic organisms to the dynamic environment of the brackish waters. He actively pursued this problem throughout his research career, initiated and fostered under Professor R. Gopala Aiyar in the Zoological Research Laboratory of the Madras University. His work on the breeding of brackishwater animals of the Adyar estuary in the middle 30s has been an original approach to the problem of environmental adaptation. His thesis on this and allied subjects fetched him the Doctor of Science Degree of the Madras University in 1938.

His academic records brought him the award of the prestigeous 1851 Empire Exhibition Scholarship in 1938 and he worked in London, Plymouth and Cambridge for 5 years.

It was during his stay in the United Kingdom that he came in contact with some of the eminent biologists of the time, like Prof. E. J. Allen, Prof. A. V. Hill, Dr A. Krogh and others. Their work and broad approach to research problems have had a distinct influence on Dr Panikkar as has been clearly demonstrated in his own later publications. The classic work of Dr Panikkar on the osmotic regulation of some crustaceans, which he published from Plymouth, is a brilliant exposition and clearly reveals the skill and wide perspective of the individual in handling research material.

In 1943, Dr Panikkar was called upon to head the Department of Zoology of the University College, Trivandrum which post he held for nearly two academic sessions, until he was appointed as the Director of the Zoological Laboratory of Madras University. It was in 1946 that Dr Panikkar was chosen to organise the fisheries research and development activities of our country and he was appointed as the Officer on Special Duty to help in drawing up a Memorandum to the Government of India. After successfully completing this assignment, Dr Panikkar was absorbed into the newly created Central Marine Fisheries Research Institute. In his capacity as the Physiologist he had brought to play his brilliant academic background in successfully blending it with actual fisheries development programme. Thus, his approach on the physiological adaptation of organisms had given way to a number of basic studies relating to fish and prawn culture. Eventually, Dr Panikkar took over as the Director of this Institute in 1950 and later in 1957 he was appointed as the Fisheries Developmenet Adviser to the Government of India. In this capacity he has been responsible for establishing separate organisations to deal with the technological aspects in fisheries, which have special bearing on fishery industry, education and management.

Gradually Dr Panikkar's horizon widened to encompass the larger field of marine sciences. During 1962-65 as the Director of the Indian Programme of the International Indian Ocean Expedition he was responsible for organising and co-ordinating the national oceanographic research programmes. At the successful culmination of this programme, which was the fore-runner of the establishment of the National Institute of Oceanography, Dr Panikkar was appointed as the Director of the Institute. When the National Commission on Agriculture was set up by the Government of India Dr Panikkar was the natural choice to be the Member for making suitable recommendations on the various aspects relating to fisheries research, development, education and training. During the close of his tenure as the Member of the National Commission on Agriculture Dr Panikkar was appointed as the Vice-Chancellor of the University of Cochin. He was also the Chairman of the State Committee on Science and Technology and later a member of Kerala State Planning Board. Dr Panikkar has represented India in many International Conferences and has presided over several of the sessions.

Honours had come to Dr Panikkar from several quarters ever since he started his career. Apart from the Fellowship conferred on him by many Scientific Academies and the award of the Chandrakala Hora Memorial Medal, the most notable commendation was the National award of *Padmashri* for his valuable contributions to the cause of marine sciences and fisheries. His immense scientific and administrative capability, deep understanding of problems and, above all, his extreme humane considerations have endeared him to a large number of colleagues whom he has left behind. It is noteworthy that Dr Panikkar was an active worker until the last day of his life devoting himself to the cause which was dear to him. In the sudden passing away of Dr Panikkar at Trivandrum on the night of June 24, 1977, the scientific community has lost a very valuable and devoted friend.

R. RAGHU PRASAD

Reviews

1. FLORA OF HASSAN DISTRICT, KARNATAKA, INDIA. By Cecil J. Saldanha & Dan H. Nicolson. With contributions by T. P. Ramamoorthy, K. N. Gandhi, S. S. Hooper, W. D. Stevens and others. pp. viii + 915 (15 × 24 cm), with 1 map, figs. 132 + 20 colour plates. New Delhi, 1976. Amerind Publishing Co. Pvt. Ltd. Price Rs. 75.00.

This is a report of one of the few floristic research schemes under PL 480 grants in India.

This Floristic survey of one of the districts in India is presented in a scholarly and meticulous manner. The book gives an introduction containing general geographical features of the district, a few interesting historical features and the botanical history. It also includes a note on methods adopted for the study, and a concise description of the vegetation including a very brief account of plants in cultivation. The book follows classification of angiospermic families as given by Dr. A. Cronquist (No particular advantage) giving a brief note on families as given in Gamble's Flora of Madras Presidency 1919. (Reprinted 1957).

It contains key to the families (158) of seed plants. The book describes over 1700 spp. of vascular plants i.e. 75 per cent of the total vascular plants of Karnataka State in South India. Characters of families are given in majority of cases genera are all described. Generic and specific keys are given wherever necessary. Each species is treated with all the necessary nomenclatural references, brief description, its habitat in the district and distribution in India and elsewhere. Collections made in the district are indicated under each species.

The figures are the most original contribution of this work and are drawn to the scale. The artists deserve compliment for their excellent work. An alphabetical index to names of families, genera and species mentioned in the work is appended.

There is no doubt that this is the best of the district floristic surveys carried out and published so far in India. It will certainly form a basis for the state flora and set a good example for similar district floristic survey wherever such a survey is necessary.

It is certainly a work of wide distribution in India.

P. V. BOLE

2. PSOCOPTERA OF THE ORIENTAL REGION, Oriental Insects Supplement No. 6. By T. R. New. pp. 83 (17.5 × 24.5 cm), with 155 figures. Delhi, 1977. The Association for the study of oriental insects, C/o Department of Zoology, University of Delhi, Delhi 110 007. Price Rs. 30.00 (India), U.S. $ 5.00 or equivalent (Abroad).

This work summarises the published taxonomic information on Psocoptera from Oriental Region and nearby Palaearctic areas with brief zoogeographical comments. Methods for examination of psocids are outlined, and major taxonomic characters discussed. Keys are given to families and genera of Psocopters recorded until 1975, and outline diagrams of features of a representative range of taxa are provided. An annotated taxonomic bibliography is also given.

This group of insects, which forms an important component of forest litter is very poorly known in the Orient and more so in India. The present review which includes comprehensive keys to the genera and higher taxa will be of great help to any one who intends to study this group of interesting insects.

B. P. MEHRA

3. TAXONOMY OF THE BRUCHIDAE (COLEOPTERA) OF NORTH-WEST INDIA. Part I. Adults. Oriental Insects Supplement No. 7. By G. L. Arora. pp. 132 (17.5 × 24 cm), with 48 black-and-white plates (including 338 figures), and 48 photos. Delhi, 1977. The Association for the study of oriental insects, C/o Department of Zoology, University of Delhi, Delhi 110 007. Price Rs. 60.00 (India), U.S. $ 10.00 or equivalent (Abroad).

The supplement deals with the taxonomy of the adults of the Bruchidae (Coleoptera) from the Northwest India. These insects are of great economic importance because of the damage they do to the seeds of the leguminous plants and seeds, flowers and leaves of some other families as well. This work will be followed up with a similar supplement on the taxonomy of the larvae of Bruchidae.

B. P. MEHRA

Miscellaneous Notes

1. TAXONOMIC STUDIES ON THE GREATER HORSESHOE BAT, *RHINOLOPHUS FERRUMEQUINUM* (SCHREBER) [CHIROPTERA: RHINOLOPHIDAE]

During the faunistic survey of the Jammu and Kashmir State in 1974, two specimens of the Greater Horseshoe Bat, *Rhinolophus ferrumequinum* (Schreber), were collected from Islamabad district by me. From a study of these specimens I am unable to concur fully with the revision of the genus *Rhinolophus* Lacépède by Sinha (1973), particularly in respect of this species. It was, therefore, felt necessary to restudy the species in the light of the existing literature and the specimens present in the collections of the Zoological Survey of India and the Bombay Natural History Society.

Andersen (1905) named the Mussoorie, Kumaon, population as *R. f. regulus* separating it from *R. f. tragatus* Hodgson on the basis of the smaller noseleaf (length 14-15.7 mm as against 16-18 mm, and width 8.2-8.8 mm as against 8.8-9.7 mm). Based on one adult female and eight immature specimens, Cheesman (1921) described *R. f. irani* from Shiraz, Iran, and stated that it was different from *tragatus* in being paler and having longer forearm. Mirza (1965) extended the range of *irani* to Pakistan. Ellerman and Morrison-Scott (1951) recognized four subspecies of *R. ferrumequinum,* namely *R. f. tragatus, R. f. regulus, R. f. irani,* and *R. f. proximus* Andersen within the limits of the Indian subcontinent. Sinha (1973) studied six specimens of *R. ferrumequinum* from the range of *regulus* and found that their measurements overlap those of both *regulus* and *tragatus,* and he rightly synonymized the former with the latter. He also separated *tragatus* from *proximus* and *irani* on the basis of larger ear (more than 22 mm as against less than 22 mm). But from the measurements of different subspecies of *R. ferrumequinum* given by him, it is found that in *regulus* which is a synonym of *tragatus,* the ear is only 20 mm while in *proximus* and *irani* it goes up to 21 and 23 mm respectively. From the analysis of the measurements of different subspecies given by Andersen (1905), Sinha (1973) and those examined by me it appears that ear length in *tragatus* varies from 20 to 25 mm, in *proximus* 19.5 to 23 mm and in *irani* 22 to 25 mm (Table 1). Therefore, separation of *irani* and *proximus* from *tragatus* on the basis of ear length is not convincing. However, on the analysis of the cranial measurements (Table 1) it is obvious that the skull of *tragatus* is larger than that of *irani* and *proximus* specially in respect of condylobasal length, maxillary width (m^3-m^3), upper tooth row (c-m^3) and mandibular length. Accordingly, *irani* and *proximus* should be kept separate from *tragatus.*

Sinha (1973) distinguished *irani* from *proximus* on the basis of longer forearm (more than 58 mm against less than 58 mm). But the table of measurements given by Sinha (op. cit., p. 609) indicates that neither of these two subspecies have forearm more than 58 mm and in *proximus* it ranges from 53 to 56 mm, while in *irani* it varies from 55 to 57.8 mm. The length of forearm of two specimens recently collected from Islamabad, Kashmir, by me are 58 and 59 mm and they fit in all other respect with the topotypes of *proximus* present in the Zoological Survey of India. As regards other measurements no distinct difference between *proximus* and *irani* could be detected (Table 1). However, the topotypic specimens of *irani* are slightly paler than specimens of *proximus,* but no credence should be given to the colour of these specimens as in six specimens of *proximus* at my disposal the colour of dorsum varies from fawn to Mars brown. Thus, I am inclined to believe that *irani* is nothing but a synonym of *proximus* in which length of forearm ranges from 53 to 59 mm, colour of dorsum varies from pale fawn to Mars brown and which has a wide distribution from Kashmir to Iran through Pakistan.

A revised key for the identification of the subspecies of *R. ferrumequinum* occurring in the Indian subcontinent is given below:

1(2). Skull larger in average; condylobasal length, maxillary width, upper tooth row, mandibular length more than 20, 9, 9, and 16 mm respectively. *R. f. tragatus*

2(1). Skull smaller in average; condylobasal length, maxillary width, upper tooth row, mandibular length less than 20, 9, 9 and 15 mm respectively. *R. f. proximus*

MATERIAL EXAMINED:

R. f. proximus: 2♂, 2♀ (in spirit); Gilgit, Kashmir; 1♂, 1♀ (in spirit); Shar and Shikargarh, Islamabad district, Kashmir. *R. f. tragatus*: 1♂, 7♀; Manali, Himachal Pradesh; 1♀ (in spirit); Chamba, Himachal Pradesh; 1♂; Naga Hills, Nagaland. *R. f. irani*: 3♂, 1♀; Shiraz, Iran.

ACKNOWLEDGEMENTS

My thanks are due to the Joint-Director-in-Charge, Zoological Survey of India, for facilities given for this work, and to Dr. B. Bis-

TABLE 1

COMPARATIVE MEASUREMENTS *Rhinolophus ferrumequinum tragatus, R. f. proximus* AND *R. f. irani*.*

External	*R. f. tragatus*	*R. f. proximus*	*R. f. irani*
Ear	20, 21.8, 22, 22.8, 24 (in seven), 24.5, 25 (in three)	19.5, 19.5, 19.7, 20.8, 21, 21.2, 23	22, 23, 24, 25, 25
Forearm	56.5, 56.5, 58, 58, 58.7, 59, 60 (in three)	53, 53.5, 54, 56, 56.8, 58, 58, 59	55 (in three), 56, 57.8, 59, 59
Width of horseshoe	8.2, 8.3, 8.8, 8.8, 9.7	6.5, 7, 7.7, 8, 8	— — — — —
Cranial			
Total length	23, 23.1, 23.7, 24.7, 24.9, 25.7	20, 21, 22, 22.5, 23	20.2, 20.8, 21.1
Condylobasal length	20.3+, 21.6	18.8, 18.8, 19	18.1, 18.3, 18.9, 19, 19.9
Cranial width	9.4, 9.7, 10, 10.2, 10.5, 11	8, 8.8, 9.2, 10.5	10.1, 10.1, 10.2
m^3-m^3	9, 9.1, 9.6	8.1, 8.7, 8.9	8.7, 8.7, 8.8
c^1-c^1	6, 6.5, 7	5.3, 6.1, 6.1	5.9, 6.1, 6.1
Zygomatic width	12.1, 12.3, 12.8, 13, 13.3	10.6, 11.2, 11.5, 12.1	10.7, 10.8, 11, 11.3, 11.5
c-m^3	9, 9.1, 9.2, 9.3, 9.7, 9.9	8, 8.3, 8.6, 8.8	8.1, 8.3, 8.4
Length of mandible	16, 16, 16.5, 16.7, 17.8, 18	14.7, 15	14.1, 14.5, 14.7

* Measurements given by Andersen (1905), Mirza (1965) and Sinha (1973) are also incorporated.

was, Deputy Director and Dr. A. K. Mukherjee, Superintending Zoologist of this department for valuable suggestions and reviewing the manuscript. Further, I am thankful to Shri J. C. Daniel, Curator, Bombay Natural History Society, for allowing me to study the material at his disposal and co-operation in various ways.

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September 16, 1976.

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2. OCCURRENCE OF THE LARGE-EARED HORSESHOE BAT, *RHINOLOPHUS MACROTIS MACROTIS* BLYTH [MAMMALIA: CHIROPTERA: RHINOLOPHIDAE] IN CHERRAPUNJI, MEGHALAYA

While studying some specimens of the genus *Rhinolophus* present in the collection of the Zoological Survey of India, a male specimen (Reg. No. 10921), collected from Cherrapunji, Meghalaya, on 3 October 1926, was identified as *Rhinolophus macrotis macrotis* Blyth.

According to authoritative literature (Dobson 1876; Blanford 1891; Ellerman & Morrison-Scott 1951 and Sinha 1973) this bat is known only from northern Uttar Pradesh and Nepal. The present finding, thus, extends its range of distribution further east to Meghalaya.

The measurements (in mm) taken from alcohol preserved specimen are as follows:

EXTERNAL: Ear 21; noseleaf 10.8; horseshoe 7.7; forearm 39; tail 21; tibia 15.4; foot and claw 8.7.

CRANIAL: Total length 17.3; condylobasal 15.4; inter orbital width 7.4; zygomatic width 8.0; upper tooth row 6.2; width across third molars 5.8; width across canines 3.8; bulla 3.7; lower tooth row 6.3; mandibular length 11.

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ZOOLOGICAL SURVEY OF INDIA,
8, LINDSAY STREET,
CALCUTTA 16,
December 8, 1976.

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3. NOTES ON STUMPTAILED MACAQUE [*MACACA SPECIOSA* F. CUVIER] AND PIGTAILED MACAQUE [*MACACA NEMESTRINA* (LINN.)] FROM MEGHALAYA

The Forest Department of Meghalaya maintains a small zoo in the Lady Hydari Park, Shillong. Most of the animals under captivity are reported to be collected from different areas of the state with the help of local people. Very recently some macaque monkeys have been brought and kept in the zoo. One of us (S. Biswas) identified these as the Stumptailed macaque (*M. speciosa* F. Cuvier) and Pigtailed macaque [*M. nemestrina* (Linn.)]. These macaques are reported to have been caught in the Mawsynram area of Khasi Hills, Meghalaya and as such provide some interesting evidence about distribution of these monkeys, whose distributional records are rather poor or vague.

Stumptailed macaque: In their checklist, Ellerman and Morrison-Scott (1951) mention "Assam, Upper Burma, southern China, Tonkin and Annam" as the distributional range of the races of Stumptailed macaque. Prater (1965) stated that this species "inhabits the Assam hill forests" Kurup (1968) provided a more detailed account and showed 'Lakhimpur, Sadiya in Assam and Changchangpani, Diku river, Merangkong in Nagaland as definite areas of distribution. However he has quoted the then Superintendent of Calcutta Zoological Garden stating that it also occurs in Nongstoin, area of Khasi Hill district. But no positive evidence has so far been found by us about its distribution in the Khasi Hills and as such the present group of 2 monkeys (one ♀ and one young) provide the first confirmation of Kurup's (op. cit) report.

Pigtailed macaque: The distribution of the Pigtailed macaque, appears more confusing. Pocock (1931) while providing a detailed account of this monkey mentioned that the distribution is unknown but "probably some district of British India east of Ganges? Naga hills in Assam". Ellerman and Morrison-Scott (op. cit.) stated that the "locality unknown, described from a single captive specimen". Prater (op. cit.) perhaps following earlier authors, simply mentioned about this animal as 'the pigtailed macaque of the Naga hills", while Kurup (op. cit.) did not include this animal at all in his paper on mammals of Assam and adjoining areas. The present specimens (1♂ and 2♀♀) collected at Lawbah, about 14 km away from Mawsynram thus provide conclusive evidence about its occurrence in Meghalaya, northeastern India.

We are thankful to Dr A. K. Ghosh, Eastern Regional Station, Zoological Survey of India, for his encouragement and for kindly going through the manuscript.

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FOREST DEPARTMENT,
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SHILLONG 793 001,
January 4, 1977.

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4. *LEPUS ARABICUS* EHRENBERG FROM JAMMU AND KASHMIR: ADDITION TO THE MAMMALIAN FAUNA OF INDIA

During the faunistic survey of Jammu and Kashmir in 1974 a specimen of the Arabian Hare, *Lepus arabicus* Ehrenberg was collected from Udhampur, southeastern Jammu and Kashmir, which according to Ellerman & Morrison-Scott (1951) has not heretofore been recorded from India. Since a detailed report on the collection will take some time to come out, it is thought desirable to record this addition to the mammalian fauna of India.

Lepus arabicus Ehrenberg

1833. *Lepus arabicus* Ehrenberg, *Symb. Phys. Mamm.*, 2: Sig. r. (Qunfidha, Arabia)

Material:

1♂: Jhajjar Kotli, Udhampur, Jammu and Kashmir; 13 Nov. 1975; coll. S. Chakraborty.

Measurements:

External: Head and body 352 mm; Tail 112 mm, Hindfoot, 91 mm; Ear 123 mm.

Cranial: Occipitonasal 69 mm; Nasal 29.6 mm; Bullae 12 mm; Upper tooth row 11.3 mm; Frontal 15.7 mm; Mesopterygoid space 6.2 mm.

Distribution:

According to Ellerman & Morrison-Scott (1951) *Lepus arabicus* is known to occur in Saudi Arabia, Palestine, Libya and Baluchistan. Therefore, the present material not only constitutes its first record from India, but also extends its range further eastward.

Remarks:

The specimen from Jammu and Kashmir agrees with the description of *Lepus craspedotis* Blanford (currently known as *Lepus arabicus craspedotis*) given by Kloss (1918), but the black bands of hair at the posterior half of the back are much conspicuous and broader than that of the holotype of *craspedotis* and two more August specimens from Baluchistan present in the Zoological Survey of India collection.

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CALCUTTA 700 016,
January 4, 1977.

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5. A MELANISTIC EXAMPLE OF WOOLLY FLYING SQUIRREL, *EUPETAURUS CINEREUS* THOMAS (RODENTIA: SCIURIDAE)

Literature on the interesting Woolly Flying Squirrel, *Eupetaurus cinereus* Thomas, is scanty and our knowledge about its coloration is due to Thomas (1888), Blanford (1891), Ellerman (1963) and Agrawal & Chakraborty (1970). While going through the collection of squirrels present in the Bombay Natural History Society, we came across four specimens of this species, three similar to the Syntype present in the Zoological Survey of India, the fourth very different from the rest in colour, a fact still unrecorded and therefore, reported here.

The specimen (*BNHS* Reg. No. 7109, without date and sex) was collected by Mr. H. J. Fulton from Chitral, Pakistan. Its entire body including the tail, is covered with thick, long, woolly fur, seal Brown (of Ridgway 1886) in colour. A few hairs on the chin are white tipped. Body is devoid of any grizzling either of gray, ashy or brown. This appears to be a case of partial melanism which is not very uncommon in squirrels. Anderson (1879) reported a large flying squirrel from Kashmir, kept in the Leyden Museum, as "almost jet black on all the upper parts but slightly brownish on the upper surface of forelimbs and flying membrane. The cheeks, chin, throat, chest and belly are brownish with gray line along the middle of the belly." Anderson (op. cit.) regarded it as a melanoid example of *Petaurista petaurista albiventer* (Gray) but Thomas (op. cit.) based on the description, attributed it to *E. cinereus*.

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V. C. AGRAWAL

ZOOLOGICAL SURVEY OF INDIA,
8, LINDSAY STREET,
CALCUTTA 16,
January 4, 1977.

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6. ECOLOGICAL STUDY OF HABITATS, FEEDING AND SURVIVAL OF THE INDIAN GAZELLE *GAZELLA GAZELLA* (PALLAS)

The Indian Gazelle *Gazella gazella* now survives in pockets where it enjoys protection particularly close to localities where live the Bishnoi community of people, who consider it a sacred animal and give it complete protection.

I studied the Gazelle between 1973 and 1975 in the Jodhpur region in various selected habitats, particularly at the Gura-Bishnoi area where the gazelle and the Blackbuck (*Antilope cervicapra*) are common.

The Gura-Bishnoi (Jodhpur) is a largely semi-arid area about 15 km from Jodhpur city. It is mainly sand and scrub wasteland with a fair number of cultivated fields. Cultivation is seasonal (June to October). The average rainfall is 370 mm. Maximum temperature is in summer in June *c.* 45°C and minimum in winter in January *c.* –2°C. Major flora are trees and shrubs:- *Prosopis cineraria, Cocculus cebatha, Maytenus emarginata, Capparis decidua, Lycium barbarum, Zizyphus nummularia, Balanites aegyptiaca* and *Prosopis juliflora* (exotic) perennial herbs—*Crotalaria burhia, Tephrosia purpurea, Fagonia cretica;* perennial grasses—*Cynodon dactylon, Dactyloctenium aegyptium, D. scindicum, Eragrostis ciliaris, Eleusine compressa, Cenchrus* spp., *Cyperus* spp. and *Desmostachya bipinnata.*

The gazelle occurs close to 'Dhanies', the small villages of a few huts of the Bishnoies in the desert area. The Bishnoies protect all animals and birds following the 29 commandments of their prophet 'Jabaji' to protect all trees and animals. The gazelle which formerly occurred throughout the desert region of Jodhpur has been poached severely and none survive except those living close to 'Dhanies' of Bishnoies because the Bishnoies deal so severely with poachers that none dare to poach the gazelle or blackbuck or other animals close to the 'Dhanies' of Bishnoies.

Scrub land having shrubs of *Zizyphus nummularia, Prosopis cineraria* and *Capparis decidua* and abundant *Crotalaria burhia* herbs and some perennial grasses such as *Dactyloctenium* spp., *Eragrostis ciliaris, Eleusine compressa, Cenchrus* spp. and *Cyperus* spp. etc.—is a favoured habitat of the gazelle as it provides food and shelter. Seasonal agricultural fields provide supplementary easily available food to the gazelle. Tanks in low areas locally called 'Nadi', where rain water accumulates stimulates growth of perennial grasses and provide enough green fodder throughout the year and forms the most favoured habitat of the gazelle (*see* Table 1). Perennial agricultural farms provide regular supplementary food and the gazelle population is high close to agricultural farms, situated near a tank, ravine or canal. Table 1 shows successive high population density of the gazelle from scrub wasteland with few seasonal agricultural farms to more seasonal farms and high population (or highest preference) density at a scrub area close to large tank surrounded by farms having plenty of food (perennial grasses or crops and green shrubs) supply almost throughout the year.

Table 1

Habitat preferences of the Gazelle at Gura-Bishnoi (Jodhpur) October 1974

Habitats	Number of herds seen	Gazelle in each herd	Population density per 10 sq km	Remarks
Sadritanka, a semi arid area	1	5		Perennial grasses
with Dhanies	2	8	4.8	scanty
and seasonal farms	3	11		
Thana Ram Dhani, scrub	1	5		
wasteland with some	2	8	7.4	More shrubs and
rainy season farms	3	11		farms
with Dhanies	4	14		
Gura-piao, wasteland scrub	1	5		Much more perennial
surrounded by a few perennial	2	11		farms and a perennial tank
farms, many seasonal	3	17	16.0	with perennial
farms, a perennial	4	22		grasses
tank and Dhanies	5	25		

It is noteworthy that the gazelle occurs at all major localities, areas of Bishnoies, but the Blackbuck occurs at comparative greener belts only having more perennial grass close to a perennial tank or perennially cultivated farms. The gazelle was found less in number or absent where the blackbuck occurs in large numbers. The gazelle thrives better in drier habitat than the blackbuck and avoids competition with the more robust and larger blackbuck.

The gazelle lives in herds of 5, 8 or 11 animals and even upto 25. The herd size increases with rut and is also influenced by climatic conditions. In the rutting season and in summer the large herds break into smaller herds and the fragmented herds unite again into large one seasonally. The leaves of *Zizyphus*, *Prosopis* shrubs and *Cynodon, Dactyloctenium* spp., *Cyperus* spp., and *Eleucine* etc. were found preferred by the gazelle. *Crotalaria burhia* is the most abundant vegetation in its habitats and forms the largest constituent of food taken during the major part of the year as it is easily and abundantly available throughout the year. The gazelle takes it more during summer season, April to June, when other vegetation is scarce. In summer leaves and sprouts of *Capparis decidua, Lycium barbarum, Maytenus emarginata, Fagonia cretica, Tephrosia purpurea* and other vegetation are also taken. In spring *Tecomella undulata* flowers profusely and the fallen flowers are highly relished by the gazelle. The gazelle grazes, at any time of the day or night, but mainly early in the morning and late in the after-noon till after dusk. They invade crops of farms late in the morning and late in the night to avoid the crop watchers.

The gazelle is destructive to agricultural crops. As already stated its population is high in wastelands close to agricultural farms from where they invade near by farms to feed on the growing crops. As local farms are largely seasonal spreading over large areas, the gazelle does not have a serious impact. The farmers also, being largely Bishnoies, who protect the animals do not prevent the gazelles entering their farms. The gazelle causes little harm to bajra *Pennisetum typhoideum* crops, the major crop of the Jodhpur desert region, it also causes little harm to *Sesamum indicum* crops but causes serious damage to crops of Mung *Phaseolus aureus*, Moth *P. aconitifolius,* Guar *Cyamopsis tetragonoloba,* Chana *Cicer arietinum,* Sarson *Brassica campestris* and Wheat *Triticum* sp. Bishnoi farmers chase the invading gazelles by throwing stones at them but otherwise do not harm them.

The gazelle becomes a serious pest at isolated farms growing winter (Rabi) crops—largely Wheat, Chana and Sarson. The cultivators erect fences of cut off branches of *Zizyphus* to prevent the gazelle getting to the crops but the gazelles often jump over fences upto 1.5 metres high. Farmers also keep watch-dogs, these check invasion of gazelle and blackbuck.

TABLE 2

ANALYSIS OF DROPPINGS OF GAZELLE, PERCENTAGE OF CONSTITUENTS OF FLORA FOUND IN DROPPINGS

Shoots of *Crotalaria* or other bushes	Leaves of shrubs	Grasses or crops parts	Seasons
7%	12%	81%	Rainy season
34%	51%	15%	Winter
65%	23%	12%	Summer

Table 2 shows the percentage of various food constituents and changes with the seasons *Crotalaria* and other herbs support it during summer. It prefers grasses and crops but these are available only during the rainy season in the desert region of Jodhpur.

Predation: Jodhpur desert region is largely free of large predators, the domestic dog, the Jackal *C. aureus,* the Fox *Vulpes* and the Jungle cat *Felis libyca* are the major predators in this region, and except the dog these are not serious predators on adult gazelle. Dogs are confined to the 'Dhanies' and the Bishnoies prevent dogs from hunting the gazelle. Rarely dogs succeed in hunting a young or old indisposed or injured (accidentally or in fights) gazelle but the villagers notice and rescue the gazelle. During August-September at some habitats occasionally a few Wolves (*Canis lupus*) migrate from ravines or nearby hills—these occasionally succeed in hunting a few gazelles. New born fawn cannot flee fast enough to escape for the first two days, during that vulnerable period about 20 to 40 per cent of the fawns were observed falling prey to stray dogs and jackals. On the whole predation of the gazelle is not serious in this region.

Poaching: As already mentioned the gazelle occurs (survives) only at localities (Dhanies) of Bishnoies, who give complete protection to the gazelle.

Some times a few gazelles stray out of the limits of the Bishnoi area, these occasionally fall victim to poachers—largely Sanshi or Bhils who hunt animals in the wilderness beyond the boundaries of the Bishnoi areas. Bishnoies complain that some military personnel poach during night with jeeps and search lights close to their 'Dhanies' on gazelles and blackbucks which stray out of the boundaries of their areas.

Survival

The Indian Gazelle is doing well enough near 'Dhanies'. The Bishnoies even provide water in pots close to their huts in the summer season. As the Jodhpur region is devoid of large predators the gazelle thrives well near the 'Dhanies' of Bishnoies and there is no danger of its extinction as long as the Bishnoies give it protection. Suitable Bishnoi areas should be declared reserves for the gazelle and the Blackbuck that may prove the simplest and most practical and reliable way of preserving these species. Declaration of such reserves may encourage and facilitate the protection task of Bishnoies who have been practicing conservation for centuries.

Acknowledgements

I acknowledge my gratefulness to M/s Saga Ram Hariram, and Bhepa Ram and many other Bishnoies who gave me all possible facilities and rendered assistance in their areas for my work. I am also grateful to Dr Ishwar Prakash and Mr S. C. Sakshena for identification of some local flora.

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7. ON SOME MAMMALS RECENTLY COLLECTED IN BHUTAN

Since 1966 the Zoological Survey of India has sponsored and sent teams of zoologists headed by Dr. B. Biswas on four occasions for faunistic surveys in different regions of Bhutan.

Chakraborty (1976) dealt with the mammal collections made during the first three surveys conducted in 1966, 1967, and 1969. The present paper is on the basis of studies of the mammals collected during the Fourth Bhutan Survey conducted during October-December, 1973.

Although the size of the collection is small (29 examples), yet the collection is of great taxonomic interest. The region of investigation of this trip covered the rugged high altitude areas of north-central and north-eastern Bhutan, ranging between 2000 to 3800 metres above sea level, in the upper reaches of the various tributaries of the Manas river. A few specimens were also collected in the foothills region of central Bhutan.

While the detailed and complete report on the mammals of Bhutan cannot be prepared till the faunal survey of that country is completed, opportunity is hereby taken to make available the valuable data of the present collection.

My sincere thanks are due to Dr B. Biswas of the Zoological Survey of India, for his constant encouragement and for kindly going through the manuscript. I am also indebted to him for letting me share with him the thrilling experiences in the rugged terrain of Bhutan.

All measurements are in millimetres unless otherwise stated. The external measurements and field notes were taken in the field. The following abbreviations have been used in the text:

B: Bullae
Bl: Basal length
CB: Condylobasal length
D: Diastema
E: Ear
FA: Forearm
FL: Frontal length
GL: Greatest length
H & B: Head and Body
HF: Hindfoot
IOW: Interorbital width
MW: Maxillary width
N: Nasal
O: Orbit
ON: Occipitonasal
P: Palate
PF: Palatal foramen
PM: Premolar
POW: Postorbital width
T: Tail
TR: Toothrow
ZW: Zygomatic width

LIST OF COLLECTING LOCALITIES

Gaylegphug (alt. *c.* 245 m), Aie Valley, south-central Bhutan.

Donga Pemi (alt. *c.* 3200 m), Donga Range (Kuru Chu Valley), north-eastern Bhutan.

Tashi Yang-tsi (alt. *c.* 2000 m), Kulong Chu Valley, eastern Bhutan.

Chakademi (alt. *c.* 2166 m), Kulong Chu Valley, eastern Bhutan.

Bulfai (alt. *c.* 2476 m), Manas Valley, eastern Bhutan.

Gomchu (alt. *c.* 2286 m), Gom Chu Valley, eastern Bhutan.

LIST OF SPECIES

Family SORICIDAE

Soriculus nigrescens nigrescens (Gray). Gray's Large-clawed Shrew.

Corsira nigrescens Gray, 1842, *Ann. Mag. nat. Hist.*, 10:261. (Darjeeling, West Bengal, India).

Material: 1 subad ♀; Chakademi; 8 Dec. 1973.

Measurements: H & B 76, T 50, HF 11.5, E 6.

Remarks: The specimen was found lying dead on the mule track, apparently trodden on accidentally.

Anourosorex squamipes schmidi Petter. Himalayan Burrowing Shrew.

Anourosorex squamipes schmidi Petter, 1963, *Mammalia*, 27:444-445. (Bomdila, Kameng District, Arunachal Pradesh, India).

Material: 1♂; Gomchu; 25 Dec. 1973.

Measurements: H & B 116, T 14, HF 17, E 9. Cranial: GL 31, BL 29, P 14, ZW 15. Weight 35 g.

Remarks: This subspecies has been known only from its type-locality in Arunachal. The present specimen is the first one of this form taken in Bhutan, and it thus extends its range further west.

Family PTEROPIDAE

Sphaerias blanfordi (Thomas). Blanford's Fruit Bat.

Cynopterus blanfordi Thomas, 1891, *Ann. Mus. Stor. nat. Genova,* 2, 10:884, 921-922, pl xi, figs 1-2. (Leito, Cheba, Karin (= Karen?) Hills, 1000 m, Burma).

Material: 3♂, 1♀; Tashi Yang-tsi; 6 Dec. 1973.

Measurements: H & B ♂ 74-82, ♀ 84; FM ♂ 50-52, ♀ 56; E ♂ 15.5-17, ♀ 17, Weight ♂ 26-29 g, ♀ 30 g.

Remarks: This species was also taken earlier by us from the western part of the country and has been reported by Chakraborty (1976). The present finding confirms its widespread distribution in Bhutan.

Family MUSTELIDAE

Martes flavigula flavigula (Boddaert). Yellow-throated Marten.

Mustela flavigula Boddaert, 1785, *Elench. Animal,* 88. (Type-locality unknown, 'but traditionally fixed as Nepal', Pocock, 1941, p. 331).

Material: 1♂; Gomchu; 25 Dec. 1973; 1♀; Donga Pemi; 29 Nov. 1973.

Measurements: H & B ♂ 522, ♀ 505; T ♂ 413, ♀ 395; HF ♂ 105, ♀ 85; E ♂ 44, ♀ 35. Cranial: CB ♂ 102.6, ♀ 90.1; ZW ♂ 61.3, ♀ 51.4; POW ♂ 23.3, ♀ 23.6; IOW ♂ 23.9, ♀ 20.1; MW ♀ 20.1, ♀ 16.7; PM 4 ♂ 10, ♀ 8.

Remarks: The occurrence of the Yellow-throated Marten in Bhutan is recorded for the first time. It was diurnal and was moving in pairs at Donga Pemi, while it was nocturnal and was moving in a family party of three in the early hours of the evening at Gomchu. The Donga Pemi specimen had its stomach filled mostly (about 70%) with larvae of insects and the rest with figs, berries and seeds of oak.

Family SCIURIDAE

Petaurista nobilis singhei Saha. Bhutan Flying Squirrel.

Petaurista nobilis singhei Saha, *Proc. zool. Soc., Calcutta,* 28(1):27-29. (Gomchu, Gom Chu Valley, eastern Bhutan).

Material (part of the type series): 4 ♀; Gomchu; 25-27 Dec. 1973.

Measurements: H & B 422-461; T 500-590; HF 82-85; E 45-51. Cranial: ON 76.4-79.8; P 38.5-42.7; TR 17.5-18.5; N 23.3-24.3; FL 29-31; O 19.6-20.1; B 12.7-13.2.

Remarks: This is the only species of flying squirrel known from Bhutan. Chakraborty (1976) reported this form under *Petaurista magnificus* (Hodgson). The taxonomic status of *Petaurista magnificus* (Hodgson) and *Petaurista nobilis* (Gray) has been the subject of controversy over the years. Blanford (1891) treated Gray's *nobilis* as a synonym of Hodgson's *magnificus,* and Ellerman (1961) followed the same treatment. Recent studies reveal that these two forms belong to two distinct species. The well-defined saddle patch isolates *P. nobilis* from the rest of the flying squirrels. Detailed discussion has been given in a separate paper (1977). However, the Bhutanese form was found to represent a hitherto undescribed subspecies of *Petaurista nobilis* (Gray), and was so described by Saha (1977).

Widespread in moist deciduous forests between 1000 m to 2500 m altitude.

Callosciurus erythraeus bhutanensis (Bonhote). Bhutan Squirrel.

Sciurus erythraeus bhutanensis Bonhote, 1901, *Ann. Mag. nat. Hist.,* 7:161. (Bhutan).

Material: 1♂; Gaylegphug; 28 Oct. 1973.

Measurements: H & B 222; T 148; HF 48; E 18.5. Weight 402 g.

Remarks: Found to be fairly common in the tropical mixed forests from the foothills to the height of about 2000 m.

Callosciurus macclellandi macclellandi (Horsfield). Himalayan Striped Squirrel.

Sciurus macclellandi Horsfield, 1839, *Proc. zool. Soc. Lond.*, 152. (Assam, India).

Material: 1♂, 1♀; Bulfai; 18 Dec. 1973: 1♀; Tashi Yang-tsi; 4 Dec. 1973.

Measurements: H & B ♂ 118, ♀ 116-124; T ♂ 99, ♀ 90-91; HF ♂ 28, ♀ 24-28; E ♂ 13, ♀ 11-14. Weight ♂ 45 g, ♀ 49-57 g.

Remarks: Widespread throughout Bhutan in different types of forests from the foothills to about 3000 m altitude.

Dremomys lokriah bhotia Wroughton. Bhotia Ground Squirrel.

Dremomys lokriah bhotia Wroughton, 1916, *J. Bombay nat. Hist. Soc.*, 24:639. (Sedonchen, Sikkim, India).

Material: 1♂ Donga Pemi; 24 Nov. 1973: 1♂; Tashi Yang-tsi; 3 Dec. 1973: 1♂, 4♀; Bulfai; 13-19 Dec. 1973: 1♀ Gomchu; 24-27 Dec. 1973.

Measurements: H & B ♂ 151-191, ♀ 175-187; T ♂ 120-140, ♀ 130-140; HF ♂ 42-46, ♀ 41-44; E ♂ 19-22, ♀ 20-22. Weight ♂ 165-205 g, ♀ 140-205 g.

Remarks: Widespread in damp forests from the foothills to about 3200 m altitude.

Ratufa bicolor gigantea (M'Clelland). Malayan Giant Squirrel.

Sciurus giganteus M'Clelland, 1839, *Proc. zool. Soc. Lond.*, 150. (Assam, India).

Material: 1♀; Gaylegphug; 30 Oct. 1973.

Measurements: H & B 352, T 456, HF 86, E 34.

Remarks: Widespread in mixed forests from the foothills to about 2500 m altitude.

Family Muridae

Rattus rattus tistae Hinton. Sikkim House Rat.

Rattus rattus tistae Hinton, 1918, *J. Bombay nat. Hist. Soc.*, 26:68. (Pashok, Sikkim, India).

Material: 1♂, 1♀; Bulfai; 14-15 Dec. 1973.

Measurements: H & B ♂ 152, ♀ 136; T ♂ 170, ♀ 150; HF ♂ 31, ♀ 31; E ♂ 21.5, ♀ 21. Cranial: ♂: ON 36.5, P 17, D 9, N 12.5, TR 6.5, PF 6. (Skull of the female specimen broken). Weight ♂ 92 g, ♀ 66 g.

Remarks: This species of commensal House Rat was found to be spreading very rapidly. Vehicular traffic must have played a significant role in their dispersal.

Rattus nitidus nitidus (Hodgson). Himalayan Rat.

Mus nitidus Hodgson, 1845, *Ann. Mag. nat. Hist.*, 15:267. (Nepal).

Material: 1♀; Bulfai; 19 Dec. 1973.

Measurements: H & B 180, T 180, HF 36, E 22. Cranial: ON 41.8, P 19, D 10.5, TR 7, N 16.3, PF 7. Weight 145 g. Mammae: 3 + 1 + 1 = 6 pairs, lactating.

Remarks: The Himalayan Rat was found to be common in and around the villages.

SUBHENDU SEKHAR SAHA

Zoological Survey of India,
Calcutta 700 016,
February 6, 1976.

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8. THREE BIRD SPECIES SEEN FOR THE FIRST TIME IN SRI LANKA

A short visit (31 October to 11 November 1974) was made to Sri Lanka to see the many endemic birds that occur mostly in the forested areas. Several days of this trip were productively spent on the east coast in the Trincomalee district as far north as Pigeon Island.

The observer carried out four early morning sea watches and an interesting list of sea birds was noted which included the following three species previously unrecorded in Sri Lanka, species well known to him in parts of the world where they are of regular occurrence.

SOOTY SHEARWATER *Puffinus griseus*. Small dark coloured shearwaters were seen on most mornings of which the majority were too far out at sea for accurate identification. A total of 15 birds came close inshore when the size, colour, mode of flight and silvery wing linings allowed positive identification.

BLACKHEADED GULLS *Larus ridibundus*. Two birds were seen together on 7th November in a flock of 23 Brownheaded Gulls *L. brunnicephalus*.

ARCTIC SKUA *Stercorarius parasiticus*. Three dark phase birds were seen hunting together on 9 November. Their size in comparison with the Common Terns *Sterna hirundo* which they were harrying ruled out confusion with the larger Pomarine Skua *S. pomarinus* and the Great Skua *S. skua*.

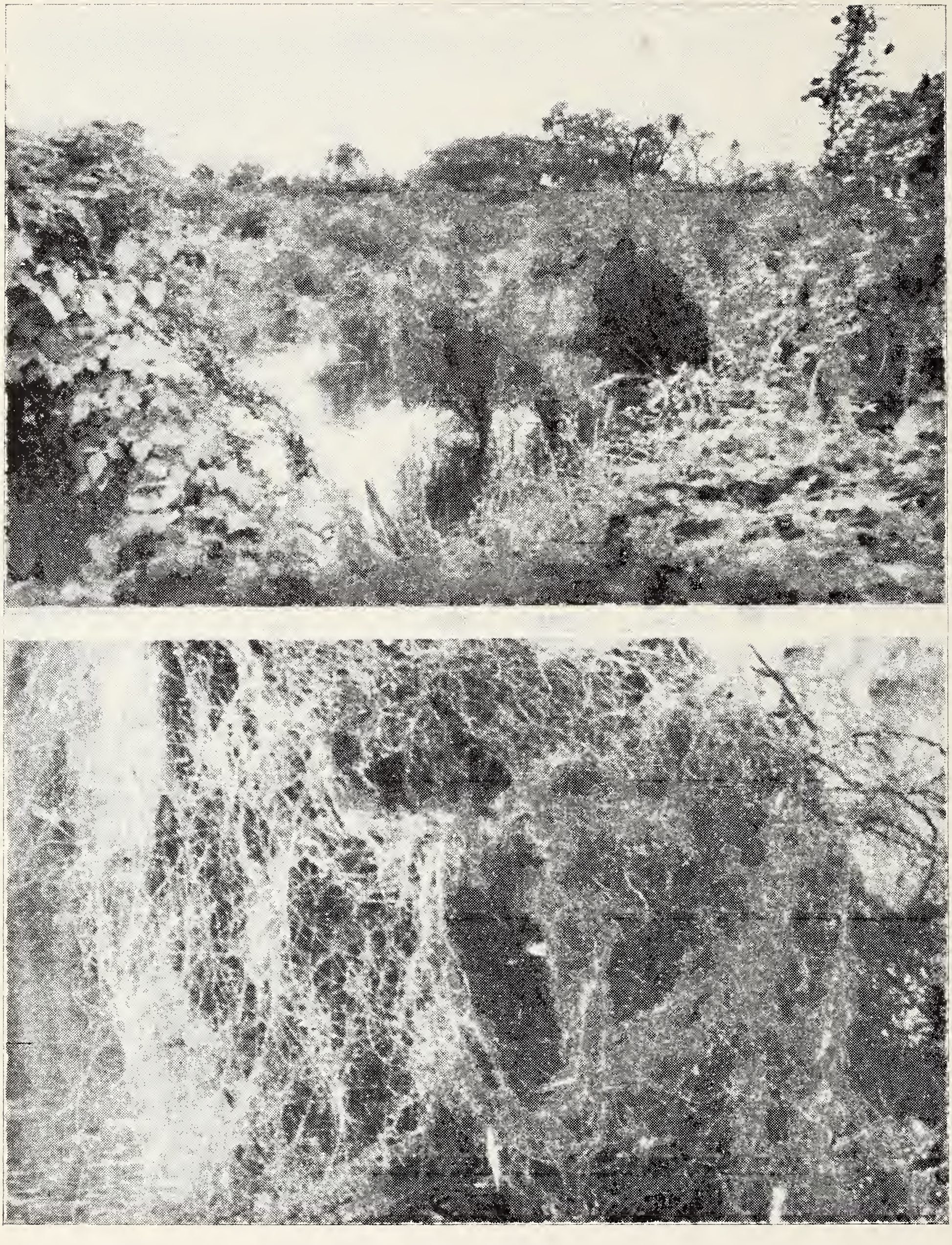
120, MADELINE ROAD,
MORNINGSIDE,
DURBAN, 40001,
S. AFRICA,
January 13, 1976.

J. C. SINCLAIR

9. SPOTBILL DUCK (*ANAS P. POECILORHYNCHA*) FORSTER NESTING IN A TREE

(*With a plate*)

In a reedless pond of the Victoria Park, Bhavnagar, stands a solitary stunted Babul (*Acacia nilotica*), a relict of the past, half dead and much of the tree covered by a parasitic climber (*Cassytha filiformis*) forming a thick mesh over it. The tree was about ten feet high and in its middle, about 4 feet above the water, was placed the nest of the Spotbill. This is the first nest I have seen of this species in a tree. The extraordinary part of this dis-



Above: Nesting tree is in the centre of the photograph. *Below*: Spotbill Duck in the nest.
(*Photos*: *author*)

covery was that it was while watching a pair of Lesser Whistling Teal (*Dendrocygna javanica*) nesting directly above that of the spotbill in the same tree. Both nest entrances in the creeper faced a road which passed some 70 feet from the tree and were almost at eye level when seated in my car. The lower nest had a larger entrance. On 21st August, 1976, when watching the Whistler's nest, I saw the head and neck of the spotbill appear just below. On further investigation I found both nests contained eggs. As the slim branches of the Babul gave little support to the nests, it appeared that both may have been built earlier by herons with a tangle of climber stems supporting the nests. The one of the Whistler appeared to be sagging and in some danger of crashing on to that of the spotbill which had a slightly stronger base. From the behaviour of the Whistler duck, its nesting seemed more recent. However, to have seen two different ducks nesting so close together (within a foot of each other, above and below) is unique, specially when the excellent rains have created ideal nesting cover and habitat for most waterfowl here. Even a Nukta duck was seen with a brood. On the further side of the nesting tree, a pair of Whitethroated Munia were building their ball-nest and a pair of Common Mynas had commenced to build also. Thus this one site was a choice of four different bird species.

The only record of a Spotbill Duck's nest on a tree branch I could find was that by Hume which I quote:

"placed on a drooping branch of a tree which hung down from the canal bank into a thick clump of rushes growing in a jheel that near the bridge fringes the canal. The nest was about 9 inches above the surface of the water and was firmly based on a horizontal bifurcation of the bough." Baker, 1935 NIDIFICATION OF BIRDS OF THE INDIAN EMPIRE Vol. IV, p. 509.

DIL BAHAR,
BHAVNAGAR 2,
August 26, 1976.

R. S. DHARMAKUMARSINHJI

10. MIGRATING HARRIERS

On 29th October Mrs. D. Panday, Jamshed Panday and I had motored to the Gangawada Reservoir on the Godavari above Nasik intending to have a picnic tea on the dam. A forbidding board kept us off and we went on along the Waghai road towards Girnara village hoping the road would further up skirt the edge of the lake where we could picnic. It was not to be so and so we sat on a hillock in the scraggy shade of the only tree we could find to eat the sandwiches and drink some excellent vanila-scented coffee. With still a couple of hours of daylight left we decided to walk down to the water's edge.

It was a glorious evening with the sun's orb reflected in the water and the blue hills beyond. At about 5.30 p.m. we retraced our steps to be on the road before it became too dark.

While having tea we had seen a fine male Pale Harrier flying low over the land from the direction of the gap in the Ghats and go on down the Godavari valley, and very shortly a female followed in the same direction. It was while we were beside the water at 5.15 p.m. that the birds began to appear all flying in the same direction first a solo female, then three females at a considerable height, followed by a magnificent male Montagu's Harrier gliding low past, turning and alighting on a raised earthern bank and then again flying off down the valley. Seeing more birds coming up, I started counting and within the 45 minutes till 6 p.m. and a little after sundown I counted fifty birds mostly Pale Harriers—the females and juveniles could have been either Pale or Montagu's—and one female Marsh Harrier.

There was a wind blowing from the west down which the birds came. Fifteen days later Jamshed took his mother and sister to the same place and again close to sundown they counted over forty Harriers, this time several Marsh Harriers among predominantly identifiable Pale Harriers flying over from the west onto the plateau and on along the Godavari.

Looking at the map suggests to me that we may have here a major migration route along the Godavari. The birds from over Saurashtra and Gujarat seem to cross onto the plateau north of the Trimbakeshwar Hills and then along the Godavari on towards the peninsula. Interestingly too, on both occasions there was a tail wind from the west. This is explained by the fact that in October and November the land and sea breezes again start blowing in the interim period before the N.E. monsoon becomes prevalent. The birds make use of the evening sea wind which brings them over the escarpment onto the plateau.

An interesting comment by Jamshed suggests this to be a narrow passage. The Harriers are not seen over his farm a little to the south-west of Nasik. The birds therefore apparently pass along the drier, more open undulating country north of the Godavari. It would be interesting to monitor the passage next October.

W. W. Fund-India,
C/o. B.N.H.S.,
Hornbill House,
S. Bhagatsingh Road,
Bombay 400 023,
November 29, 1976.

LAVKUMAR KHACHER

11. A NOTE ON HUME'S GROUND CHOUGH *PODOCES HUMILIS* HUME

The Hume's Ground Chough is a rather jolly little bird found on the high bleak plateaux of Tibet. It is an extremely confiding bird walking briskly around, searching for food. During our visit to Mansarovar and Kailas in Western Tibet, Mr. Gurdial Singh and myself were continually charmed by the little bird's perky demeanour. In July, the month we were there, the choughs were busy raising noisy families tucked away in crevices of small rock outcrops and even down burrows of high altitude rodents.

The HANDBOOK only gives the upper parts of the Tista in Sikkim as where this bird occurs in our limits. I found a bird with young at Bara Hoti Plain across the Chor Hoti Pass in Garhwal and one would expect to find it in the west in Spiti and Ladakh. I was therefore surprised to learn that the BNHS/WWF expedition to Ladakh in the summer of 1976 did not record this bird in spite of a special look out for it.

LAVKUMAR KHACHER

W.W. FUND-INDIA,
C/o. B.N.H.S.,
HORNBILL HOUSE,
SHAHID BHAGAT SINGH ROAD,
BOMBAY 400 023,
October 13, 1976.

12. BLACKTHROATED WEAVER BIRD [*PLOCEUS BENGHALENSIS* (LINNAEUS)] BREEDING NEAR BHAVNAGAR (SAURASHTRA)

I found *Ploceus benghalensis* breeding in a stagnant pond few miles south of Bhavnagar in a group of *Typha latifolia* Linne. on 7th October, 1976. There were in all four nests, one without a tubular entrance and not in use. The three occupied had tube entrances measuring as follows: 15, 11, and $8\frac{1}{4}$ cm, the first and last placed close to each other. There was only one cock bird with three hens. Two nests had young, the bird probably young or eggs. I found the species rather shy. The nests are slightly smaller than the common baya and the material used finer. This is the first time I have seen this species nesting in Saurashtra. Referring to HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN by Sálim Ali & Ripley, Vol. 10, p. 97, I find that in distribution for Gujarat (Deesa, Baroda and Kaira Districts) only are mentioned and as a vagrant in Kutch. I hope therefore, this record will add to its distribution.

R. S. DHARMAKUMARSINHJI

DIL BAHAR,
BHAVNAGAR 2,
October 8, 1976.

13. THE BIRDS OF GOA: A CORRECTION

In our paper on "The Birds of Goa" published in the Journal of Bombay Natural History Society (1976) Vol. 73(1), pp. 42-53, we had marked the race of *Falco tinnunculus* (serial No. 15) as *interstinctus* McClelland. It should read *tinnunculus* Linnaeus. Also under serial No. 82, 'from feathers' should read 'from anterior border of nostril'.

These errors were pointed out by Mr Humayun Abdulali, whose interest is appreciated.

ROBERT B. GRUBH
SALIM ALI

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
SHAHID BHAGAT SINGH ROAD,
BOMBAY 400 023,
June 18, 1977.

14. THE DISTRIBUTION OF CANTOR'S POLYODONT SNAKE, *SIBYNOPHIS SAGITTARIUS* (SERPENTES: COLUBRIDAE)

Recently a single specimen of a polyodont snake (330 mm) was picked up by one of us (B.D.S.) from under-stones in the outskirts of Poonch, Jammu and Kashmir which was later identified as *Sibynophis sagittarius* (Cantor).

Boulenger (1890:303) gives its distribution as "Northern India, Bengal and the Nicobar Islands". Wall (1923: *J. Bombay nat. Hist. Soc.* *29*:599-600) recorded it from Western Himalayas, Gangetic Basin and lower Bengal and justifiably questioned its occurrence in Nicobar as attributed to F. A. de Roepstroff. However, a specimen bearing this locality is contained in the collections of the Zoological Survey of India, Calcutta (Reg. No. 8896). Probably Boulenger (op. cit.) has included the Nicobars in the range of this species based on this disputable record. Smith (1943: FBI, *3*:280) gives the range of this species as 'North-eastern India from the Central and United Provinces to Eastern Bengal' and adds "Wall records it from the Western Himalayas". A check up of the available collections of this species in the ZSI and Bombay Natural History Society has, however, revealed the fact that it has since been recorded from Gujarat, Maharashtra, and Orissa and southward in Tamil Nadu and Kerala. The present record from Poonch extends considerably the northernmost range of this species.

The great gap in distribution as found in the literature on this snake has thus been bridged over and it may be, therefore, concluded that it is not as rare as hitherto believed. Further investigations in the remaining unexplored areas may yet testify the wide spread occurrence of this interesting snake in India whose habits are little known.

ACKNOWLEDGEMENTS

We are thankful to the Principal, Government Degree College, Poonch (J & K) and Dr. A. G. K. Menon, Dy. Director, Zoological Survey of India, Madras for facilities and encouragement. Grateful thanks are also due to Shri J. C. Daniel, Curator, BNHS., for confirming the identity of the specimen.

SOUTHERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
MADRAS.

T. S. N. MURTHY

TH. D.S.B. UNIVERSITY COLLEGE,
KUMAUN UNIVERSITY, NAINITAL, (U.P.),
June 21, 1976.

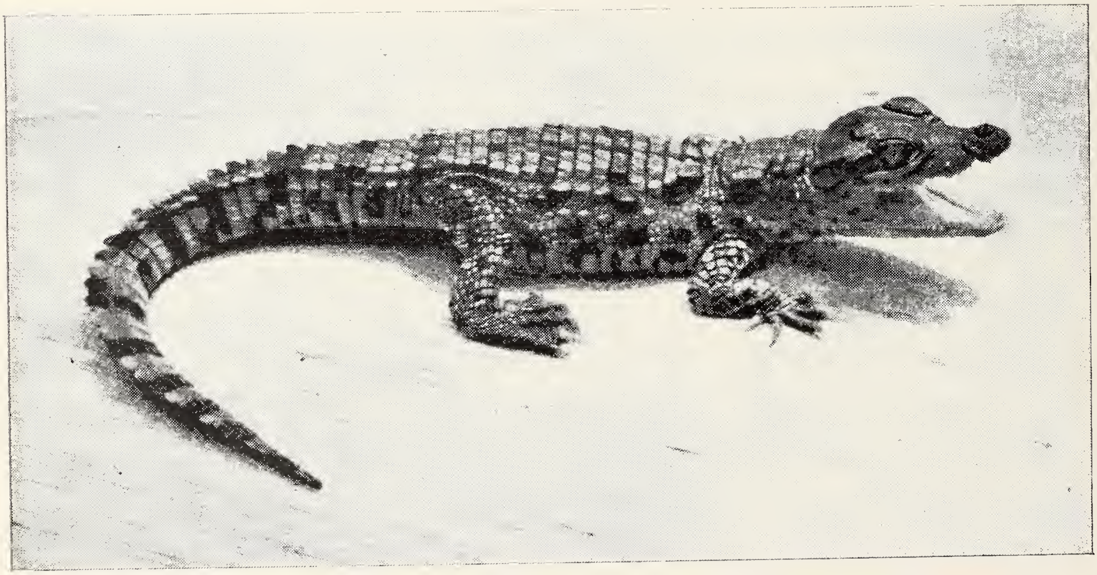
B. D. SHARMA

15. NOTE ON NATURAL HISTORY OF *CROCODYLUS PALUSTRIS*

(*With a plate*)

KEDARHALLA - 1975

Description: The Kedarhalla stream is a minor tributary of the Moyar River which flows from the Kotagiri hills down through narrow chasms in a series of waterfalls. Down near Masipatti where the Nilgiri foothills start to level out, the stream is slower and forms fairly



Above: Pool No. 1 on Kedarhalla Stream. Note rock overhang on left and sandbank, visible through trees on right. *Below*: Juvenile *C. palustris*, age: 24 hours.

large pools at bends and below falls. It is bordered by thin, heavily worked scrub jungle and scattered deciduous trees along the stream. Kedarhalla is fairly remote; there being no road, the only regular human visitors to the area are cow herders and Irula tribals who seasonally camp in the various "pattis" scattered in the foothills. 1975 was a drought year here and as we found it, the stream was not flowing but was just a chain of stagnant pools. The stream is about 350 metres above sea level.

Kedarhalla appears to be just an ordinary hill stream such as you are likely to see by the thousands in the forests of the Western Ghats. The surprising difference was that there was evidence of a breeding population of crocodiles along the stream. In the 4 km stretch which we have visited for two years for observation and egg collection we observed four crocodiles and we believe that there are a total of 8 breeding size crocodiles here.

From our survey of crocodiles in Tamil Nadu this appears to be one of the last populations of crocodiles still existing in natural habitat. With the damming, channelling, embanking and other drastic alterations of most of the former crocodilian habitat, crocodiles are forced to live in the usually barren expanses of reservoir which offer little or no protection or shelter, especially for hatchling and young crocodiles which normally spend a great deal of their time out of water in bushes and grass.

The streams leading into the dam catchment areas like Moyar and Kedarhalla, if undisturbed and the bushes and trees unfelled, provide the alternative habitat needed for the young crocodiles to hide and feed in. This is usually not the case however and as a result the survival rate of hatchlings is near zero in most of the dam areas. Crossing the Moyar at Manglapatti in late April, 1975 we were shown the Kedarhalla Stream by Armugan, the watchman formerly in charge of the TNEB Power House at Manglapatti.

Pool No. 1, about 5 kms from Manglapatti is about 50 metres by 15 metres with a half metre thick mud bottom. The maximum depth is $1\frac{1}{2}$ metres and average one metre. Two crocodiles appear to be resident here. One about seven feet in length was observed basking on a rock shelf at 9.30 a.m. when the sun gets down into the Kedarhalla Ravine. When frightened by our approach the crocodile slid straight into the water and across to its tunnel under the opposite embankment. By probing we ascertained that the tunnel was 6 metres and curved in under the base of a large *Eugenia jumbolana* tree. The tunnel was inclined slightly above water level, the innermost part was muddy with leaves. The tunnel continued to curve in and we think it would eventually be dug to a horse-shoe shape as we observed in Pool No. 2.

We located an already hatched nest on the south bank of the pond, a sand bank. The nest was about 30 ft from the water line and 6 ft above water level. The sand was damp at $\frac{1}{2}$ metre below the surface. No shade nearby, the nest site receives sun from about 9.30 a.m. to 4.30 p.m. A few fresh shells were seen at the nest site but no young. We camped at that site and later in the day found one hatchling, 2 or 3 days old, in grass at the pond edge opposite the sand embankment. Here there was also a large rock overhang (see plate) forming a shelter a foot above the water. Here we saw the small bobbing heads of fifteen hatchlings all in a group. These were easily caught by slowly approaching them in the water and scooping them up a lunghi. When caught, the young grunted and uttered their high-pitched distress cries. That night we caught the remainder of that batch of hatchlings (total: seventeen); the grunting of the hand-held specimens attracted the uncaught ones, which were evidently trying to re-group. From the evidence at hand the parent carried hatched and semi-hatched young ones from the open nest site across the pond to where the overhanging boulder was, with its grass and mud tunnels affording shelter and hiding places. A few shells lay under the boulder and two freshly dead baby crocodiles. They had no marks on them but casualities at hatching time are normal. There was a small unused tunnel in the black mud under the overhang which could have been made by a sub-adult crocodile. One of the hatchlings retreated into this hole and we observed the tracks of hatchlings in smaller holes like unused crab holes. Some of the hatchlings had swollen stomachs (unabsorbed yolk) and three had curled tail tips apparently due to overheating in the nest. Two of them had raw umblical scars.

Pool No. 2: One km upstream from Pool 1. Pool 2 is about 40 metres by 10 metres with a maximum depth of 2.5 metres, and an average of $1\frac{1}{2}$ metres. There is a thick mud bottom and a large number of fish were dead and dying from clogged gills due to recent rain stirring up the mud. (carp, catfish and eels). At 11 a.m. a $1\frac{1}{2}$ metre crocodile was seen sliding into the water and straight across to its tunnel in the opposite embankment. There were tracks of a larger crocodile at the pool edge; later we saw this 2 metre animal. About 15 metres from the pool edge we discovered a slight mound in the bushes, smooth on top from the passage of a crocodile. Tapping on the mound we heard the slight croaking grunts of baby crocodiles about a hatch. We waited till the cool of the evening and carefully dug the covering of 25 cms of earth to the layer of eggs. A hatchling crocodile head was visible and digging further we uncovered a whole nest of 18 eggs 11 of which hatched during the next 12 hours. We were very lucky to have discovered this nest on the point of hatching.

Pool No. 3: About 3 kms above Pool 2 we came to a round pool about 50 metres in diametre of 4 metres depth surrounded by high rocky cliff embankments with a waterfall down to a bare trickle. Two crocodiles of about two metres plopped into the still pond when we were approaching from 100 metres downstream. There were three basking areas and crocodile droppings at several locations. On a night visit we saw two crocodiles. We located two nest sites about 10 metres from the pond which consisted merely of the silt/sand deposits in the dry streambed down-stream. Scattered egg shells showed that the eggs were already hatched or were perhaps dug up by predators. Checking upstream we found one more crocodile; a follow up trip will be made. It is recommended that the Moyar River and its tributaries from Mudumalai Sanctuary to Bhavani Sagar be declared a Crocodile Preserve as one of the last remaining original habitats of the Marsh Crocodile in S. India. The Kedarhalla stream has already been surveyed by TNEB to construct a dam and power station. This would of course very efficiently finish off this particularly interesting and valuable crocodile habitat; perhaps an alternative site can be considered?

R. WHITAKER
Z. WHITAKER

MADRAS SNAKE PARK TRUST,
GUINDY DEER PARK,
GUINDY, MADRAS 600 022,
December 25, 1976.

16. NESTING BEHAVIOUR OF ESTUARINE CROCODILE, *C. POROSUS* SCHNEIDER

During my faunistic survey tour of 1975 in the Bhitarkanika, a delta of Brahamani—Baitarani estuary, Orissa, the collector of estuary Crocodiles for the hatchery of the Forest Department, Government of Orissa at Dangmal, stated that he saw while fishing in the river Kalibhanja Dia near Talichua a Crocodile coming up from the river and moving towards the mangrove jungles. When he followed the Crocodile she turned and chased him. He escaped by climbing up a nearby tree. After this incident she proceeded a further 300 ft into the jungle and after about half an hour the crocodile returned to the river. He came down and inspected the mound nest built up by the crocodile with vegetable matter and mud and collected 46 eggs from inside it.

Deraniyagala's (1939)[1] observation that out of the 4 nests of *C. porosus,* two nests had females guarding in a nearby wallow or a trench and in the other two though the wallows were there the guards were absent. In this respect he noted that the crocodile spends a considerable part of its watch basking on top of the nest. He suggested that this action of the crocodile was of some help for the incubation or protection of eggs from the mid-day Sun. Moreover he explained the absence of guardians in other two nests as due to human disturbance.

The above mentioned fact in case of behaviour of the Bhitarkanika crocodile indicates that for guarding the nest or incubation of laid eggs the presence of the female is not necessary or always associated with the breeding behaviour of Estuarine crocodile in nature.

S. BISWAS

ZOOLOGICAL SURVEY OF INDIA,
27, CHOWRINGHEE ROAD,
CALCUTTA 700 016,
June 28, 1976.

[1] DERANIYAGALA, P. (1939): Tetrapod Reptiles of Ceylon. Dulau & Co. Ltd., pp. x + 412.

17. LOCOMOTOR RESPONSES OF *CALOTES* TO WATER (AGAMIDAE: SAURIA)

The lizards of the genus *Calotes* are superficially quite similar to such iguanids as juvenile *Iguana, Basiliscus,* and *Enyalius.* Furthermore, they share similar habitats, bushes and trees, often along water courses. All are slender bodied lizards with stout heads, long tails, enlarged hind legs and greatly enlarged toes. Most iguanids are capable of swimming and a few can even dash across the surface of water without sinking by special modifications of the hind toes (Laerm 1973). However, even species lacking such structural complexity, such as *Iguana,* and *Amblyrhynchus* of the Galapagos, will dive into the water and swim with lateral undulations of the body. Some incidental observation and preliminary experiments suggest that some other agamids lack the ability to utilize the aquatic habitat.

On 5 May 1974 I observed a large male *Calotes versicolor* in mating pigmentation on the trunk of a large tree besides an oxbow pool on the Bibile road near Mahiyangana, Sri Lanka. Avoiding attempts to noose it, the lizard started to ascend the tree and an assistant used a bamboo rod to flip the lizard into the water. I expected it to dive and swim rapidly to a protected site. To my surprise the lizard remained at the surface and swam slowly to a projecting log. When disturbed it started out again but appeared to tire, soon showing evident signs of distress, so that it was easy to catch while swimming. By this time the red colour had faded completely.

Later that month (14 May) I had the opportunity of testing whether we had observed an isolated instance or a general phenomenon. For several days we stayed at the Bandarapola guest house, the garden of which contained an 8 × 4 metre cement and tile swimming pool. Variously sized specimens of *Calotes versicolor* and *Calotes calotes* were dropped onto the water some 20 cm from the edge or chased onto the surface. The result was the same regardless of the species, the size, or the method of immersion.

As soon as they entered the water, the animals started to swim effectively by adpressing the limbs, swinging the body into lateral undulations, and generally keeping the head above water. However, after a variable distance, never greater than about ten body lengths, they became disoriented, stopped undulating, and started moving ineffectively by alternating limb movements. After 20 to 30 stroke sequences, the lizards would float with the head above water and could be seen to breathe. The lizards might continue the "walking" pattern for a number of additional cycles; however, within the first five minutes each animal would have attempted to breathe without raising its snout above the water. Its relative buoyancy then changed and the lizard would sink to the bottom of the pool where it would walk about aimlessly and presumably would have drowned. When lizards were removed from the water and placed on the grass fringing the pool, they soon recovered and within fifteen minutes were able to escape capture by climbing the hedges. All of the lizards survived the exposure to water.

Water temperature above 30°C was approximately equivalent to the preferred temperature ranges reported for other agamids (Brattstrom 1965). However, the *Calotes* proved to be quite active in rooms that were air conditioned to 20°C; consequently the behaviour was unlikely to be a temperature effect.

These observations suggest some very interesting corollaries. *Calotes* is able to swim effectively by undulatory movements. Slow undulation could presumably be continued for some time whatever the metabolic state of the species. Furthermore, its normal centre of gravity is sufficiently high so that the animal need not expend effort in maintaining its head above the surface. Consequently, *Calotes* should be able to stay afloat almost indefinitely at the water surface. However, the animals seem unable to recognize when they can inhale. The slight change in attitude between extending the anterior portion of the head above the surface, and lowering it so that the nostrils (but often not the eyes) are immersed, makes the difference between sinking and swimming. This attitudinal position of the head is neither energetic nor temperature related. Nevertheless, these lizards not only seem quickly to abandon the effective locomotor method for a less effective and more costly one, but they also appear to lack any mechanism that tells them whether the nostrils are above water or immersed.

The interesting thing about the difficulty encountered by these animals is that it is the lack of a behavioural rather than a morphological or physiological adaptation that poses the problem. These results do of course parallel the observations of Pettus (1958) who noted that when *Natrix sipedon* manages successfully to invade salt marshes, the only recorded specialization is that the marsh populations recognizes the difference between fresh and salt water and avoids drinking the latter. In both cases there is a major increase in the adaptive zone, in this case the habitats, that can successfully be exploited as the result of a relatively minor change in behaviour. Further structural changes would presumably arise only after the adaptive zone had been occupied; they might then represent further adaptations within it.

The observations permit some cautions and also suggest some additional experimentation. The interpretation of an animal's survival capacity should not be based only upon structural and physiological parameters. The basic structural pattern here seen is clearly an arboreal one and the aquatic adaptations are secondary. It is plausible to suggest that the lack of response capacity of these lizards reflects a condition pecular to Sri Lanka, an island which lacked standing water until historic times when the environment became permanently altered due to extensive tank construction associated with paddy cultivation. However, this hypothesis requires parallel experiments with species and populations of agamid lizards, from areas with only limited standing waters and with great environmental diversity. All in all, these notes suggest that observation of the behavioural responses of common animals can still result in interesting and possibly significant results.

Supported by NSF BMS 71 01380. Dr. Karl Krombein and the Smithsonian Entomological Field Project allowed the use of their vehicle. I thank Mr. B. Prasanna Fernando and Mr. W. A. Richard for friendly collaboration in the field, the staff of the Bandarapola lodge for assistance, and H. Mendelssohn, S. Moody and G. Zug for comments.

CARL GANS

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Michigan 48109, U.S.A.,
September 16, 1976.

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18. BEHAVIOUR, COLORATION, LEPIDOSIS AND PRE-ANO-FEMORAL PORES IN JUVENILES OF *UROMASTIX HARDWICKII* GRAY

The behaviour of juveniles is scarcely known in Indian agamids. Bhanotar & Bhatnagar (in press)[1] observed the presence of a brood chamber in some tunnels which may start as a separate diverticule close to the burrow mouth. Outside movements of juveniles are restricted to the vicinity and around neighbouring bushes within a range of 20-40 ft of the tunnels. Juveniles from other burrows too join and do not show territorial instinct unlike adults. However, juveniles show considerable homing instinct. But if alarmed suddenly seek safety in the nearest available burrow or crevice. Juveniles up to 29-40 days old do not dig a burrow and continue to inhabit the parent burrow. This perhaps indicates some tolerance by the parent. Though active and swift, the juveniles can still be caught easily. In nature and in captivity juveniles eat small insects and wild seeds (?). This dietary habit, it appears, continues up to the adult stage. In captivity (in uncontrolled cage) they remained active up to two months. But some survived till subadult stage.

Coloration: Though the general coloration pattern is the same in juveniles and adults, yet, it is varied in the former by the presence of a lateral dark stripe on trunk preceded by a pale buff line and dark broken blotches numbering 7-8 with pale buff all around. These blotches are seen in 25-30 days old individuals and are anteriorly joined. They are not present in subadults. A continuous dark stripe is present dorso-laterally on tail. The black blotch on hind limb is dorso-anteriorly present as in adults, but covers only 4-7 scale length. Individuals are ventrally pale coloured from *genial* to last 4th caudal scale whorl.

Anteriorly, the facial markings from *supra-labial* to *supra-ocular* region differ from that in adults by the presence of 5-7 dark lines with a dark line from *post-ocular* to *occipital region. Gular fold* and *gular pouch* are absent but *pre-gular* fold is present and the whole gular region is pale buff.

Lepidosis: There is a vertical abdominal suture mark, the umbilical scar which appears from where yolk sac is attached and is bordered by distinct 15-19 horizontal scales on each side. Caudal whorls start from anal point where one small dorso-lateral spine is present. Total complete whorls numbered 30-37 and last 2-5 are incomplete. *Latero-caudal* spines are continuous from 3rd whorl upto 2nd or to 5th. Larger spines are on lateral side and are preceded by 3-4 small ones. Similarly on ventral side smooth scales are present from 3-5th caudal whorl in preceding order (of size) from lateral margin to tail tip. Larger caudal spines are present on 4 to 5th row. Spines on hind limbs numbered 3-5 located not antero-lateral as in adults.

Lateral fringe on 3rd to 4th toe not at all pronounced. Scales around pineal eye numbered six with eye in the middle scale. However, in some 8 scales are present around it. Rostral is succeeded by 6-8 scales upwards to frontal region. Genials 13 with a upper dif-

[1] BHANOTAR, R. K. & BHATNAGAR, R. K. (in press): Bio-ecological studies on spiny-tailed lizards *Uromastix hardwickii* Gray. Pt. I. Habits, habitats, distribution patterns and behaviour. *Cheetal. (J. Wildlife Preservation Society of India)*, pp. 1-23, 1 fig.

ferentiable layer of scales and 7-8 scales as counted across from *gular end* to *mid-genial.* Other lepidosis counts are not different in juveniles from adults.

Pre-ano-femoral pores: Location of these pores in juveniles is same as in adults. But both types of pores (preanal anterior to anal opening and femoral on thighs) are in one continuous line. However, *preanal-pores* are on an angular vedge (inverted 'v') anterior to the anal opening and number 4-5 on each arm. The *femoral pores* commence from femoral point to the vedge of the *anal-pores* and number 7-14 on each side of the arm. However, both types of pores are bordered by 4-6 differentiable scales around each pore. In some cases, the number on each side varies and in one case two femoral pores are joined. In live juveniles it was also observed that by pressing a coverslip on these pores no secretion was exuded; also, such individuals did not show development of gonads. This appears to indicate that presence of these pores is not a morphological character age differentiation and sexual maturity and is not a sexual dimorphic character as has been shown in Gekkonids.

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19. EXTENSION OF DISTRIBUTION OF *THRISSINA BOELAMA* (FORSKAL) (PISCES: CLUPEIFORMES: ENGRAULIDAE) WITH REMARKS ON ITS TAXONOMIC CHARACTERS

Though the anchovy species *Thrissina boelama* was described as early as 1775 (Forskal 1775), it was rarely recorded from Indian Coast indicating that it is a very rare species.

Recently while studying the Clupeoid fishes of southeast coast of India, I came across one specimen of *Thrissina boelama,* whose description is given below briefly.

Material: One example from Amalinagar Fishing Village 45 km south of Tuticorin, Tamilnadu, K. V. Rama Rao, 30-i-1973.

Description: Body somewhat full (compared to *Thryssa*), elongated. Head enlongated with somewhat prominent snout. Eye in the anterior half of the head. Belly not sharply keeled. Two scutes before pectoral origin remaining scutes before and after ventral fin base. Maxilla extending upto the margin of preopercle but not quite reaching it. Two premaxillae on the maxilla. Maxilla flattened towards the end before becoming pointed at the tip. Lower edge of maxilla is finely toothed all along the length. Mandible is also similarly toothed along the upper edge. Pectorals do not reach upto ventral fin origin. Elongated axillary scale present at pectoral origin. Ventrals originate slightly before dorsal. Anal origin just behind Dorsal. Caudal deeply forked. Scales fairly large and intact even in preservation. Dorsal side dark in colour becoming silvery laterally. Fins translucent.

Measurements (in mm): Total length 123, standard length 103-5, head length 27.5, body depth 23.0, eye diameter 6.7, snout 5.5, interorbital distance 6.5, prepectoral distance 28.0, pectoral fin length 15.5, preventral distance 45.2, ventral fin length 12.5, predorsal distance 48.5, dorsal base 23.5, maxilla length 23.7.

Pectoral f. r. 13 ventral f. r. 7, Dorsal f. r. I + iii + 12, Anal f. r. iii + 25, Caudal f. r. + 19 +, Prepectoral scutes 2, Prepelvic Scutes 7, Post pelvic Scutes 8, Gillrakers upper arm 17, lower arm 23, Lateral line Scales 36.

Remarks: The specimens recorded by Whitehead (1967) from Arabian Sea do not possess scutes before pectoral origin, resembling those from Red Sea, Gulf of Aden, Mauritius and Cocos Keeling Is. (Whitehead *et al.* 1966). However, records (Fowler 1941, p. 686) are these from Indo-Pacific region with scutes before pectoral origin. The presence of scutes before pectoral origin in the present specimen indicates its nearness to Indo-Pacific population rather than to Arabian and Red Sea populations. Geographically also it stands to reason. Further the present specimen agrees more with Bleeker's original description of *Engraulis encrasicholoides* (Whitehead *et al.* 1966, p. 118) in the presence of prepectoral scutes and lateral line scale counts. However, as pointed out by Whitehead *et al.* (op. cit.) more specimens need to be studied before any conclusions can be drawn regarding the taxonomic reassignment with reference to the presence or absence of prepectoral scutes. For the present it is obvious that the absence of prepectoral scutes forms neither a generic nor a specific character.

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20. OCCURRENCE OF COBITID GENUS *BOTIA* GRAY IN THE WESTERN GHATS OF INDIA

(*With a text-figure*)

Hitherto the genus *Botia* Gray (Pisces: Cobitidae) has not been recorded from the Western Ghats. During our survey of the River Koyna and connected streams, we came across a cobitid species *Botia dayi* Hora (Fig. 1) in a stream at Ambenalli village about 20 km. West of Mahabaleshwar, Satara District. The specimen measures 48.5 mm and agrees well with the description given by Hora (1932) for this species.

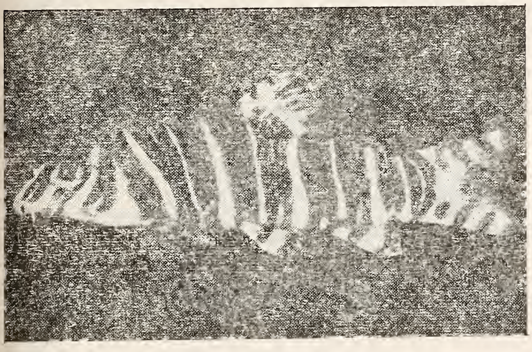

Fig. 1. *Botia dayi* Hora.

Botia dayi is so far reported only from the Himalayan drainage (from Sind, through the Punjab, Himalayas, Valley of the Ganges, Jumna, Sone River and Assam) (Day 1878). Its occurrence in Western Ghats leads to certain interesting discussions regarding its migration. Though it is well distributed along the Himalayan drainage, its occurrence in the Western Ghats can only be explained by the connection of Himalayan region with Western Ghats during the geological past. The connection of Eastern Himalayas with the Western Ghats through the Garo Hills and Satpura-Vindhya-Rajmahal ranges by the elevation of Garo-Rajmahal gap due to the sudden fall of sea level during the glacial period (Pleistocene) has been emphasized by Hora (1944, 1949) and subsequently elaborated by Menon (1951) and in the light of this the present day occurrence of the Malayan fauna in the Western Ghats and Peninsular India has been explained. The occurrence of *B. dayi* in Himalayan drainage and again only in Western Ghats can also be explained similarly. The occurrence of only *B. dayi* in Western Ghats indicates that this species is relatively hardy and also ancient amongst the species of the genus *Botia*.

With the occurrence of the genus *Botia* in the Western Ghats, the present day distribution of the eight genera (Menon 1973) of the family Cobitidae in India is as follows: the genera *Noemacheilus* Van Hasselt and *Lepidocephalus* Bleeker occur throughout the country, the genus *Somileptes* Swainson occurs almost throughout the Himalayan drainage, the genera *Aborichthys* Chaudhuri and *Acanthopthalmus* Van Hasselt are restricted to Eastern Himalayas, the genus *Botia* Gray occurs predominantly in Himalayan drainage and rarely in Western Ghats and the genus *Noemachilichthys* Day is restricted to Deccan while the genus *Jerdonia* Day is restricted to Madras in South India.

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21. HERMAPHRODITISM IN THE MURREL, *CHANNA PUNCTATA* (BLOCH 1793)

Hermaphroditism has been reported in several teleostean fishes (Dawson 1964, 1966, 1971). In addition to the several examples of hermaphroditism in Indian marine fishes (published in different issues of the Journal of the Marine Biological Association of India), mention may also be made of the following freshwater fishes exhibiting hermaphroditism—*Macrones vittatus* (Singh & Sathyanesan 1961), *Puntius stigma* (Sathyanesan 1958), *Cirrhina reba* (Sathyanesan & Rangarajah 1953), and *Hilsa ilisha* (an anadromous fish) (Chacko & Krishnamurthi 1949)—but in chronological sequence. However, this is the first report on hermaphroditism in the family Channidae.

During our studies on *Channa punctata* (Bloch 1793) from Guntur, South India, we came across a 202 mm long (TL) hermaphrodite. Though Dehadrai *et al.* (1973) reported some colour difference between males and females of this species, we do not find it to be a reliable secondary sexual character in the large number of specimens (2400) examined from Guntur. On dissection, it is easy to identify the sex of even juveniles measuring 70 mm TL, because both ovaries extend behind the vent, whereas the testes do not. In the present hermaphrodite, the gonad looks like a testis externally and does not extend behind vent. However, when examined microscopically, both gonads are observed to be ovotestes. The ovarian and testicular tissues are mixed, without any particular position for each. All the ova are immature; yolk deposition has started in a few of the larger ova. The diameter of the ova ranges from 0.023 mm to 0.23 mm. The spermatocytes are clear only under high magnification (X 1000).

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22. THE LIFE-HISTORY OF A CAVERNICOLOUS ORTHOPTERA *KEMPIOLA SHANKARI* SINHA & AGARWAL (ORTHOPTERA: PHALANGOPSIDAE)

(*With two text-figures*)

INTRODUCTION

The Cavernicolous Orthoptera *Kempiola shankari* Sinha & Agarwal was collected from a subterranean cave at Kotumsar, about 35 miles south of Jagdalpur (Bastar district). The shaft leading to the interior is vertical and about 17 metres deep. The interior has numerous stalagmites and stalactite formations and has several small pools fed by seepage water. The temperature in the interior varies between 24° and 29°C.

POPULATION ANALYSIS

The population of *K. shankari* was studied during March, April, May, November and December 1970 and December 1971 (Table 1). During June to October the cave was not accessible due to heavy rains. The population, during the period of study was divided into three morphological types, (a) nymphs without wing bud, (b) nymphs with wing bud and (c) adults (males and females) (Table 2). The data indicate that in December the adults are relatively more. In general nymphs formed bulk of the population.

K. shankari does not have a seasonal life-cycle; it continues to breed and mature throughout the year. Thus all instars can always be seen in the cave. This makes the assessment of lengths of nymphal and adult life very difficult.

Sex-ratio: A record of the total number of adults collected during the study period (Table 1) indicates that normally females are more than males (Table 2). In November 1970, however, more males were found.

Number of instars and growth rate: The number of instars in *K. shankari* could not actually be determined. However, on the basis of observations of specimens collected from time to time, the number of instars appears to be 8 to 10. They could not be reared beyond a month under laboratory conditions simulat-

TABLE 1

POPULATION ANALYSIS OF *K. shankari* FROM MARCH 1970 TO DECEMBER 1971

Date of visits	Time	Total no. of insects collected	Adults	Nymphs with wing bud	Nymphs without wing bud
7th March 1970	2 p.m.	50	7	11	32
20th March 1970	2 p.m.	40	7	4	29
10th April 1970	2 p.m.	40	6	2	32
6th May 1970	2 p.m.	31	2	—	29
6th November 1970	2 p.m.	50	16	1	33
20th December 1970	2 p.m.	70	33	1	36
26th December 1971	2 p.m.	60	14	1	45

(—) shows that the population stage did not occur in the collection.

TABLE 2

SEX RATIO OF *K. shankari*

Date of visits	Nymphs as % of total population		Adults as % of total pupulations	
	Nymphs without wing bud	Nymphs with wing bud	♂	♀
7th March 1970	64	22	2	12
20th March 1970	72.5	10	7.5	10
10th April 1970	80	5	2.5	12.5
6th May 1970	93.5	—	—	6.5
6th November 1970	66	2	22	10
20th December 1970	51.4	1.4	22.8	24.2
26th December 1971	75	1.6	6.6	16.6

(—) shows that the population stage did not occur in the collection.

TABLE 3

CONFORMITY TO DYAR'S LAW ON THE BASIS OF INSTAR MEASUREMENTS OF *K. shankari*

	MALE		FEMALE	
Instars	Observed length in mm	Calculated length*	Observed length in mm	Calculated length*
1	6	6.2	6	7.8
2	7	8.1	9	9.5
3	10	10.9	12	11.1
4	13	11.8	14	12.8
5	15	13.95	15	14.4
6	16	15.5	16	16.04
7	17	17.3	17	17.6
8	18	18.2	20	19.3
9	20	21.7		
10	24	23.00		

* from regression line.

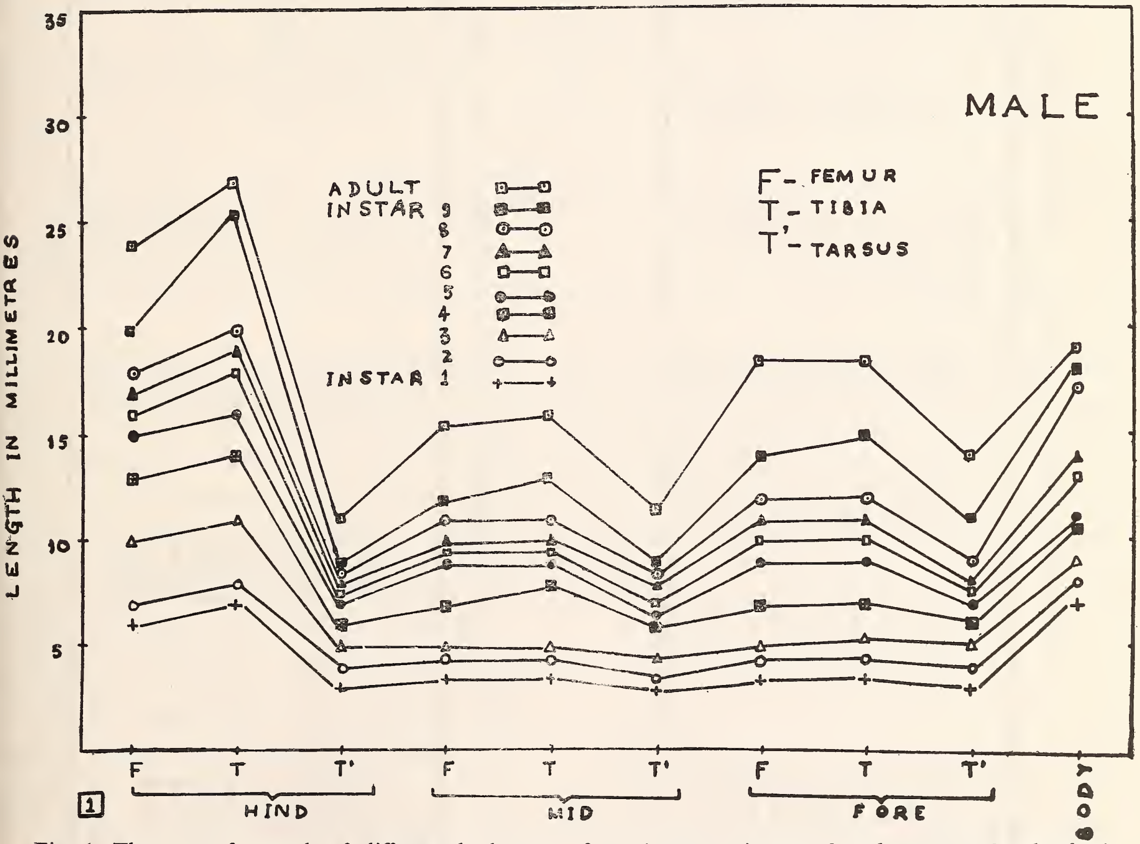

Fig. 1. The rate of growth of different body parts from instar to instar of male *Kempiola shankari.*

TABLE 4

PERCENTAGE INCREASE OF GROWTH IN LENGTH IN EACH INSTAR IN MALES OF *K. shankari*

Instars	1	2	3	4	5	6	7	8	9	10
Hind femur	6 mm	16.6	42.8	30.0	15.3	6.6	6.2	5.8	11.1	20.0
Hind tibia	7 mm	14.2	37.5	27.2	14.2	12.2	5.5	5.2	15.0	17.3
Hind tarsus	3 mm	33.3	25.0	20.0	66.6	7.1	6.6	6.2	5.8	22.2
Mid femur	4 mm	12.5	11.1	40.0	28.8	5.5	5.2	10.0	18.1	18.7
Mid tibia	4 mm	12.5	11.1	60.0	12.4	5.5	5.2	10.0	27.2	23.0
Mid tarsus	3 mm	16.6	28.5	33.3	8.3	7.6	14.2	6.2	5.8	27.7
Fore femur	4 mm	12.5	11.1	40.0	28.8	11.1	10.0	9.0	16.6	32.2
Fore tibia	4 mm	12.5	11.1	40.0	28.8	11.1	10.0	9.0	25.0	23.2
Fore tarsus	3 mm	33.3	25.0	20.0	66.6	7.1	6.6	12.5	22.2	27.2
Body	7 mm	14.2	12.5	5.5	4.1	18.1	15.3	21.4	5.8	5.8

TABLE 5

PERCENTAGE INCREASE OF GROWTH IN LENGTH IN EACH INSTAR IN FEMALES OF *K. shankari*

Instars	1	2	3	4	5	6	7	8
Hind femur	6.0 mm	50.0	33.3	16.6	7.1	6.6	6.2	15.0
Hind tibia	7.0 mm	28.0	38.8	12.0	7.1	13.3	11.7	15.7
Hind tarsus	3.0 mm	33.3	75.0	8.3	7.6	14.2	12.5	5.5
Mid femur	4.0 mm	25.0	40.0	14.2	6.2	11.7	10.5	14.2
Mid tibia	3.5 mm	42.2	50.2	6.6	6.2	11.7	16.8	9.0
Mid tarsus	3.0 mm	33.3	75.0	10.0	18.1	7.6	14.2	12.5
Fore femur	4.0 mm	25.0	60.0	6.2	5.8	11.1	10.0	9.0
Fore tibia	4.0 mm	37.5	45.4	12.4	5.5	5.2	10.0	9.0
Fore tarsus	3.0 mm	33.3	37.5	9.0	25.0	6.6	12.4	11.1
Body	6.0 mm	33.3	25.0	10.0	9.0	16.6	3.5	6.8
Ovipositor	—	1 mm	100.0	50.0	33.0	25.0	120.0	72.7

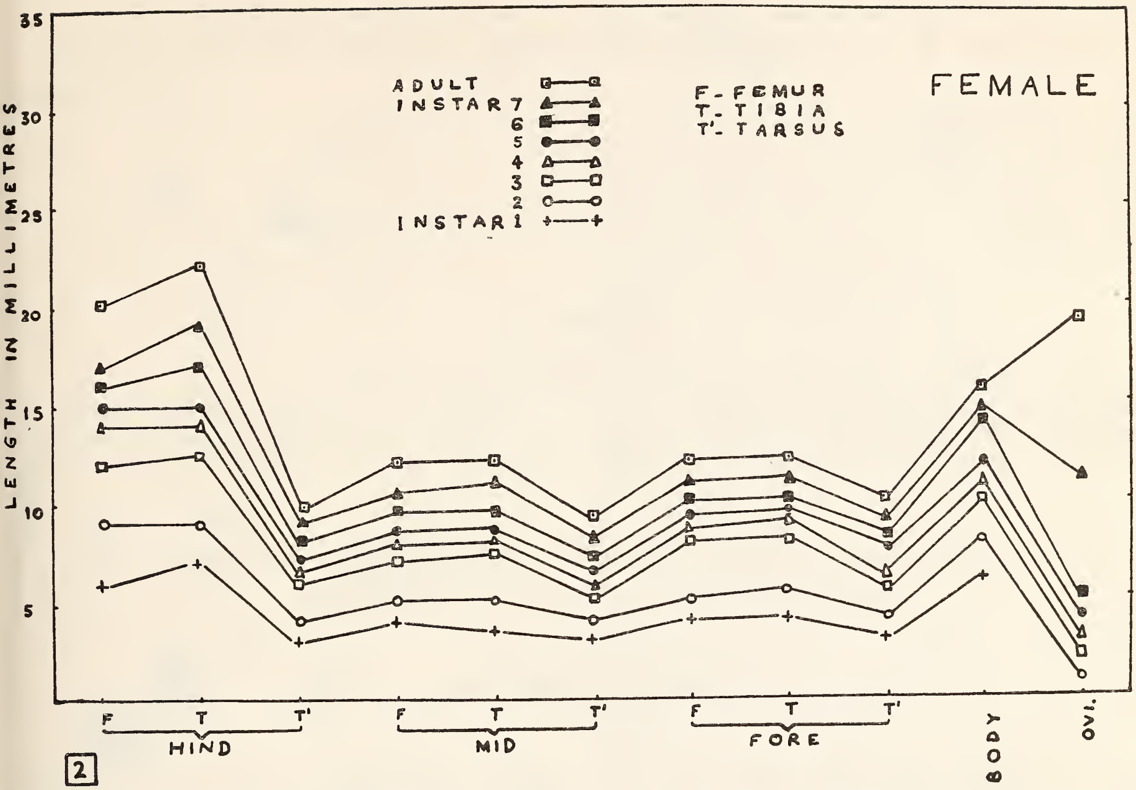

Fig. 2. The rate of growth of different body parts from instar to instar of female *Kempiola shankari*.

ing cave conditions. By comparing the measurements of hind femora and ovipositor it was made out that nine pre-adult instars are passed by males and seven by the females (Figs. 1 & 2). These results agree with the conclusions reached in *Pachyrhamma facifer* (Richard 1961) and in *Ceuthopilus* (Hubbell 1936). That no instars have been overlooked, was checked by Dyar's law (1890) Table 3.

The rate of growth of different body parts from instar to instar has been shown in figs. 1 & 2. The percentage of growth-rates from instar to instar are tabulated in Tables 4 & 5. From these tables it is concluded that the greatest amount of growth occurs at the third and the final ecdysis in male and second and final ecdysis in female. Hind femora undergo the greatest increase at each ecdysis. Ovipositor appearing in the second instar, become almost equal to body length at final ecdysis.

The rate of growth in antennae and cerci was not included in graphs or tables, because they are often broken while collecting.

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23. *CEROCOCCUS HIBISCI* GREEN (HOMOPTERA: ASTEROLECANIIDAE) AND ITS CHALCID PARASITES

(*With fifteen figures*)

Cerococcus hibisci Green
(Figs. A – O)

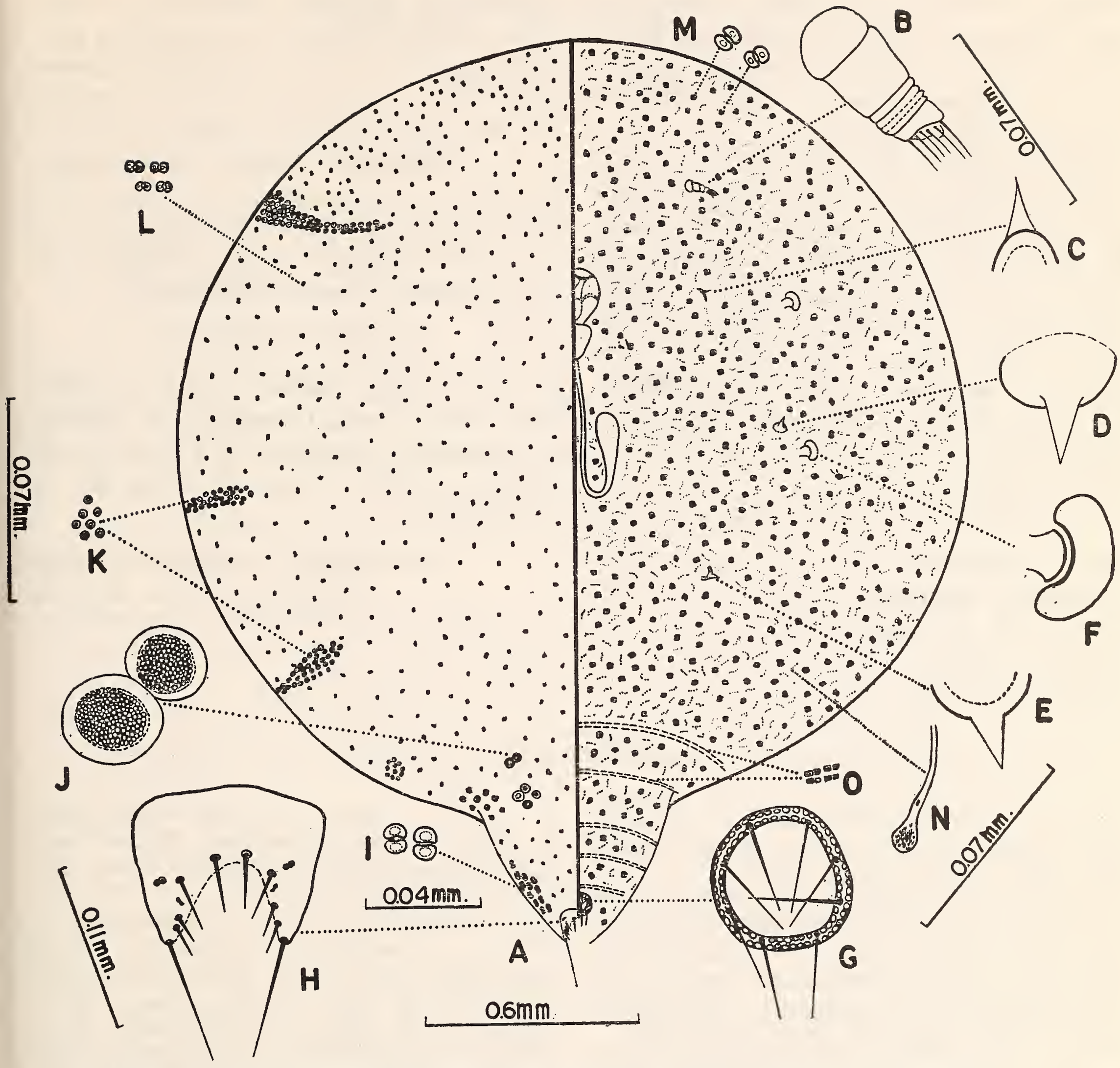
Cerococcus hibisci Green, 1908, *Mem. Dep. Agric. India (Ent.) Pusa, 2*: 19.
Cerococcus hibisci Green; Newstead, 1917, *Bull. Ent. Res., 8*: 127.
Cerococcus hibisci Green; Ayyar, 1929, *Imp. Inst. Agric. Res. Pusa, 197*: 53.
Cerococcus hibisci Green; Ali, 1967, *Oriental Insects 1*: 29-30.

The species *Cerococcus hibisci* Green is widely distributed throughout India infesting a number of plants. This note gives a detailed re-description of *Cerococcus hibisci* Green together with a complete list of parasites so far recorded from India.

Adult Female (Fig. A)

Mounted material circular in outline, posteriorly with a triangular protrusion in middle, 2.7 mm long and 2.3 mm wide. Dorsal surface membranous, covered with sparsely distributed small 8-shaped pores (fig. L); dorsal and marginal setae absent; lateral margins of each side of the body with 4 groups of small pores (fig. K); 6 cribriform-like pores lie anterior to anal opercula (fig. J); anal opercula as shown in fig. H.

Ventral surface membranous with numerous large 8-shaped pores and tubular glands (figs. M, N); labium 1-segmented, slightly wider than long. Legs rudimentary, 0.03 mm long; claws triangular and without denticle (figs. C, D, E). Antennae rudimentary, indistinctly 7-segmented, 0.06 mm long basal segment slightly longer than wide, remaining segments transverse, apical segment with six long setae (fig. B). Spiracles well separated from the lateral margins of the body (fig. F). Anal ring beaded, with 8 long setae (fig. G).



Figs. A-O. *Cerococcus hibisci* Green, adult female: (A) body, dorsal and ventral view; (B) antenna; (C) fore leg; (D) middle leg; (E) hind leg; (F) posterior spiracle; (G) anal opening; (H) anal opercula; (I) large 8-shaped pores; (J) cribriform pores; (K) simple pores; (L,M) small and large T-shaped pores; (N) tubular ducts; (O) paired rectangular pores.

Material examined: 15 ♀, INDIA: Uttar Pradesh, Aligarh, on *Hibiscus rosasinensis* Linn., 8-iv-1976 (R. K. Avasthi). Material deposited in Zoological Museum, Aligarh Muslim University, Aligarh, India.

Hayat (1970, 1972, 1974), Hayat *et al.* (1972) and Shafee *et al.* (1973) recorded nine species of chalcids as parasitising the insect. We bred *Physcus reticulatus* Compere and Annecke, *Promuscidea unfaciativentris* Girault and *Scutellista cyanea* Motschulsky from *Cerococcus hibisci* Green. This brings the total number of parasites to twelve species belonging to the families Aphelinidae, Encyrtidae, Pteromalidae and Thysanidae, a list of which is given below:

(1) *Chartocerus kerrichi* (Agarwal), (2) *Cheiloneurus fusiscapus* Agarwal, (3) *Eriaphytis orientalis* Hayat, (4) *Euaphycus cerococci* Shafee *et al.*, (5) *Homalotylus ferrierei* Hayat *et al.*, (6) *Marietta javensis* (Howard), (7) *Microterys kerrichi* Shafee *et al.*, (8) *Physcus reticulatus* Compere and Annecke, (9) *Promuscidea unfaciativentris* Girault, (10) *Pseudmicroterys angustifrons* Shafee *et al.*, (11) *Pseudmicroterys cerococci* Shafee *et al.*, (12) *Scutellista cyanea* Motschulsky.

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SHAFEE, S. A., ALAM, S. M. & AGARWAL, M. M. (1973): Taxonomic survey of Encyrtid Parasites (Hymenoptera: Encyrtidae) in India. *Alig. Musl. Univ. Publ. (Zool. Ser.) Ind. Ins. Typ. 10*:1-125.

24. FIRST RECORD OF *ANOMALICORNIA* MERCET (HYM.: CHALCIDOIDEA, ENCYRTIDAE) IN INDIA

(*With five text-figures*)

Genus *Anomalicornia* Mercet

Anomalicornia Mercet, 1921, *Trab. Mus. nac. Cienc. nat. Madr.*, 1921: 86; Type-species: *Anomalicornia tenuicornis* Mercet; monotypic.

The genus *Anomalicornia* is well-known and can be distinguished from other encyrtid genera by the characteristic antennae (fig. 1) (Antennae as long as body, funicle 7-segmented, club 2-segmented, pedicel about one-half the length of F 1); bidentate mandibles; gaster with the tenth tergum occupying most of the dorsum; paratergites long and narrow; and the subgenital plate extending to apex of gaster.

Anomalicornia tenuicornis Mercet (Figs. 1-5)

Anomalicornia tenuicornis Mercet, 1921, *Trab. Mus. nac. Cienc. nat. Madr.*, 1921: 86-87, ♂, macropterous (Type in Madrid Museum).—Ferriere, 1955, *Boll. Lab. zool. Gen. agr. Portici*, 33: 352, ♀, brachypterous and macropterous forms.—Erdös, 1957, *Acta zool. Acad. Sci. hung.* 3: 13, ♀, brachypterous.

[1] *Anomalicornia ruschkai* Mercet, 1922, *Boln. R. Soc. espan. Hist. nat. Madr.* 22: 294-296, ♂, brachypterous (Type in Madrid Museum).

Material examined: INDIA: Rajasthan, Lalgarh near Bikaner, 26-x-1975, (1 ♀, macropterous, D.R.S. Reg. No. A/798, partly dissected and mounted on a glass slide), coll. M. Hayat and party by sweeping over grasses.

A detailed description of the species was given by Ferrière (l.c.). The following additional characters are noted in the specimen under report:

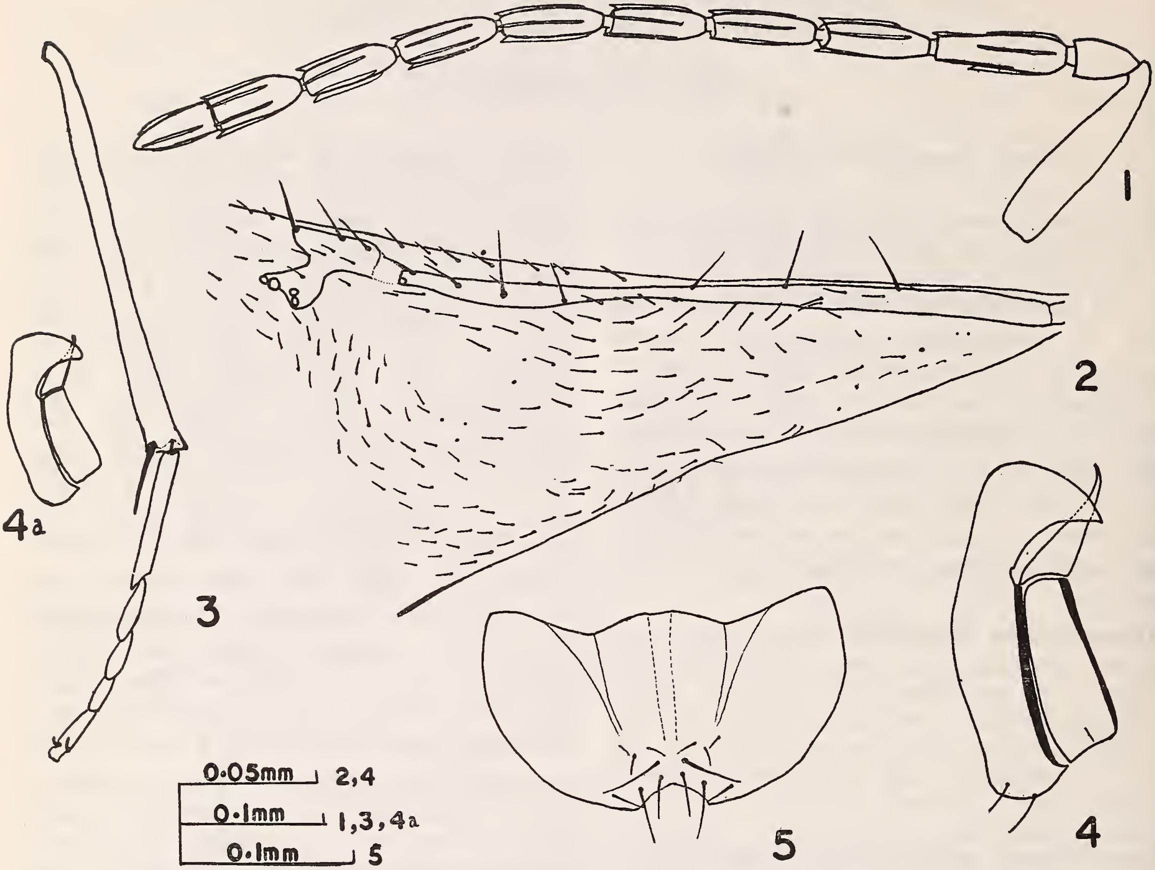
Female.—Length, 0.85 mm. Body colour more or less brownish with the frontovertex dusky yellow; axillae, sides of scutellum and mesopleura dark. Antennal scape and pedicel dusky yellow, funicle and club brownish. Fore wings hyaline in basal fourth (save a small dusky patch at base), distal three-fourths faintly infumate. Legs almost wholly dusky yellow.

Frontovertex about a fourth wider than long; ocelli arranged in obtuse triangle, lateral ocelli removed from eye margins by a distance equal to interocellar distance; eyes small, their dorsal length one-half width of frontovertex. Fore wings about three times as long as wide; venation ending far mesad of middle of anterior margin; marginal vein slightly longer than wide; post-marginal short; stigmal vein with a short neck and expanded apex; speculum closed behind by two rows of discal setae (Fig. 2); marginal fringe short. Gaster as long as head and throax combined; external genitalia very short, extending from about middle of penultimate ventral segment, their total length less than half of middle tibia (Figs. 3, 4a). Genitalia Anagyrine-type: third valvulae absent and second valvifers broad; outer plates rectangular with a ridge along dorsal margin. Subgenital plate as in fig. 5.

Host: *Rhizococcus albidus* Goux [In Bavière (Bavaria)].

Distribution: PALAEARCTIC: Spain, Hungary, CSSR, Austria, FRG, ORIENTAL: India (new record).

[1] *A. ruschkai* was described from a brachypterous male collected in Austria. Hoffer (1964) considers it as a brachypterous form of *A. tenuicornis*, and Trjapitzin (1971) states that only one species is known from the palaearctic region.



Figs. 1-5. *Anomalicornia tenuicornis* Mercet, ♀: (1) Antenna; (2) Fore wing, basal part showing venation and discal setation; (3) Middle tibia and tarsus; (4) Genitalia, left half; (4a) the same, drawn at same scale as fig. 3; (5) Subgenital plate.

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25. ROLE OF *PALAS* [*BUTEA MONOSPERMA* (LAM.) TAUB.] LEAFSTALKS IN *BAISAKHI* STICKLAC PRODUCTION

Palas (Flame of the forest) is one of the commonest trees in the plains of India and is extensively utilised for lac cultivation. Being a deciduous species it sheds its leaves by March-April and, therefore, Glover (1937) considered its leafstalks of only negative value in lac production, since in his view the lac insects which settle on them during *baisakhi* (*rangeeni*-summer) crop also fall along with them.

Closer observations by us on heavily inoculated lac bearing trees, however, revealed that although the leaflets of the trifoliate pinnate compound leaves are shed by the end of March-April, the lac bearing leafstalks consisting of petiole and rachis, remain attached to the shoot till the end of May. These can profitably be harvested *ari* (immature) during April-May as advocated by Malhotra & Krishnaswami (1962). Average length and number per shoot was recorded to be 19.3 cm

TABLE 1

BAISAKHI ARI STICKLAC YIELD* FROM SHOOTS AND LEAFSTALKS

Broodlac Used per tree (g)	Average per tree yield (g)						Percent contributed by leafstalks
	LAC	STICKS		SCRAPED	LAC		
	Shoots	Leaf stalks	Total	Shoots	Leaf stalks	Total	
600	1470	130	1600	502	60	562	10.7
800	1534	232	1766	539	81	620	13.1
1000	1580	274	1854	541	114	655	17.5
1200	2116	370	2486	655	182	837	21.8
1400	2255	392	2647	778	197	975	20.2
1600	2383	400	2783	855	164	1019	16.1
1800	2466	403	2869	965	157	1122	14.0
Average	1972	314	2286	691	136	827	16.5

* Average of 4 Replications.

and 11.7 cm respectively (average of 100 shoots).

In order to assess the precise quantitative contribution of leafstalks, an experiment was laid out under a randomized block design on a total of 280 trees, with seven brood rates ranging from 600 to 1800 g/tree, replicated four times with 10 trees per plot, at Kundri lac area, Palamau, Bihar. Inoculations were done in October 1973 and *ari* harvesting during the first week of May 1974. Yield record has been summarised in table 1.

It is apparent from the above table that on the average 16.5 per cent sticklac (scraped lac) has been contributed by the leafstalks (variation 10.7 to 21.8 per cent). This contribution is lost when the *baisakhi* is cropped at the time of maturity during June-July and becomes available when cropped *ari* during April-May. Malhotra & Krishnaswami (1962) recorded 41 per cent average post-April reduction in sticklac yield and thus advocated *ari* harvesting. They, however, could not satisfactorily explain the causes of this extraordinary discrepancy. The present work endeavours to point out a major source of crop loss and supports the view of cropping of lac as *ari* for the sake of sticklac production in areas of hot climate.

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We are thankful to Dr T. P. S. Teotia, Director for encouragement.

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26. OCCURRENCE OF THE ASPIDOCHIROTE HOLOTHURIAN, *HOLOTHURIA* (*SEMPEROTHURIA*) *CINERASCENS* (BRANDT 1835) ALONG THE COAST OF KANYAKUMARI (S. INDIA)

(*With a photograph and two text-figures*)

INTRODUCTION

During an ecological and faunistic survey of the east coast of India we had an opportunity to collect specimens of an Aspidochirote holothurian from rocky shores along the coast of Kanyakumari at Vattakotai, Leepuram, Chinnamuttom, Kovalam, Kadiapattinam, Muttom and Colachel. Detailed examination of these specimens revealed that they are *Holothuria cinerascens* (Brandt).

Diagnosis: Body cylindrical (Photo. 1), 12 to 28 cm long. Tentacles 20, peltate. Pedicels in three rows ventrally, papillae scattered dorsally. Radials twice larger than inter-radials. Polian vesicle single, bulbous.

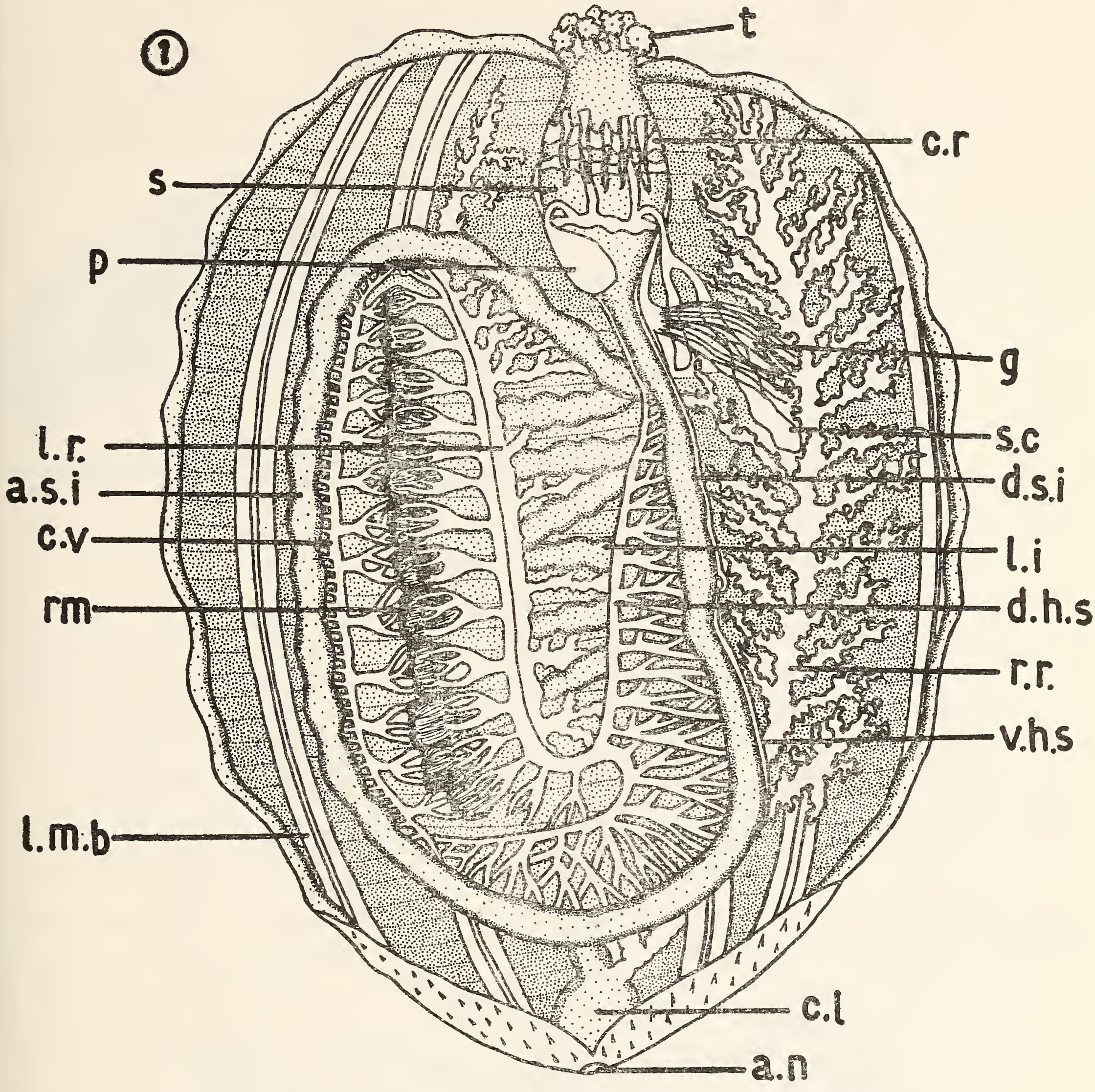

Fig. 1. Internal anatomy of adult, dissected from the dorsal side.
Abbreviations: a.n.—Anus; a.s.i.—Ascending small intestine; c.l.—Cloaca; c.r.—Calcareous ring; c.v.—Collecting vessel; d.h.s.—Dorsal haemal sinus; d.s.i.—Descending small intestine; g.—Gonad; l.i.—Large intestine; l.m.b.—Longitudinal muscle band; l.r.—Left respiratory tree; p.—Polian vesicle; r.r.—Right respiratory tree; r.m.—Rete mirabile; s.—Stomach; s.c.—Stone canal; t.—Tentacle; v.h.s.—Ventral haemal sinus.

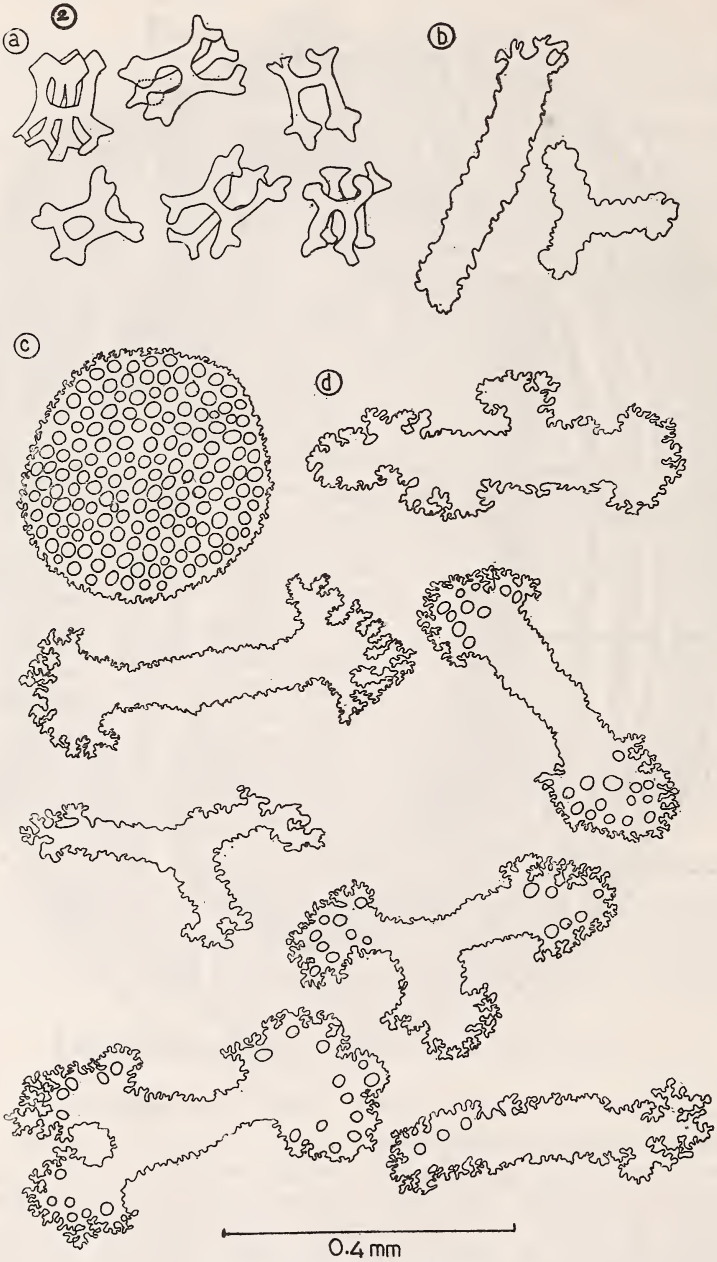

Fig. 2. Calcareous deposits.

The haemal system is well developed with rete mirabile (Fig. 1). Respiratory tree with main trunks which carry numerous small side branches, the left one lie in association with the rete mirabile. Gonad is single with irregularly branching vesicular Caeca.

Photo. 1. *Holothuria cinerascens* (Brandt), dorsal view.

Colour in life yellowish green, changing to brown on preservation.

Calcareous deposits:

Body wall deposits consisting of tables, rods and rounded plates; tables .04 mm long without disc. Fig. 2 (a) spire moderately high, terminating in a few spines forming a maltese cross in dorsal view; rods (b) simple, smaller than in tentacles, some with three arms. The rounded plates (c) have an average diameter of 0.11 mm with numerous holes.

Tentacle rods (d) straight or curved, 0.13 mm long, with short, blunt projections and perforations.

Tubefeet deposits in the form of rounded end plates of .11 mm diameter.

Distribution: This species is a common Indo-Pacific form (Clark & Rowe 1971). In India it has been recorded from Mandapam (Gulf of Mannar, Vizingam (Arabian sea), Minicoy (Laccadives), Rangat Bay (Andamans) (D. B. James 1969). The new localities recorded here enlarge the distribution of this species. As the species is a rock dwelling form, it is likely to have a wider distribution along the rocky coasts of South India.

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27. ON THE NOMENCLATURE OF SOME INDIAN AND BURMESE SPECIES OF *DYSOPHYLLA* BLUME (LAMIACEAE)

Basing on the character of opposite leaves in the genus *Pogostemon* Desf. and verticillate or whorled leaves in *Dysophylla* Blume, together with differences in shape of corolla and some anatomical characters, two groups of species were recognised by El-Gazzar & Watson (1967). Four species of *Dysophylla* constituting Bentham's (1868) section "Oppositifoliae" as elaborated by J. D. Hooker (1885) were removed by them to *Pogostemon* Desf. as these had opposite leaves. These four species include the type species of *Dysophylla* Bl.: *Dysophylla auricularia* (L.) Blume. *Dysophylla* Blume therefore became a generic synonym of *Pogostemon* Desf., and a large number of species of *Dysophylla* were left without a generic name. To avoid many name changes, H. K. Airy-Shaw (1967) very reasonably suggested retaining the name *Dysophylla* for these species by establishing and conserving the genus *Dysophylla* El-Gazzar & Watson (Labiatae) against *Dysophylla* Bl. (Labiatae), with a corresponding new type.

Airy Shaw has given the amended diagnosis as follows: "*Dysophylla* El-Gazzar & Watson, gen. nov. et nom. gen. cons. prop. Folia verticillata, 3-10 pro verticillo, linearia, sessilia, plerumque glabra. Calyx tubularis, 5-dentatus. Corolla subaequaliter quadrifida. Stamina 4, aequalia, exserta. Filamenta barbata. Antherae terminales, uniloculares, tranverse dehiscentes.-Herbae helophyticae—species *c.* 30. Species typica: *Dysophylla quadrifolia* Benth."

As no alternative name was available and the name *Dysophylla* was universally used for the 30 species included in the group, Airy Shaw preferred to retain the name by conserving the same, with the above amended diagnosis.

Keng (1969) in his revision of Malaysian Labiatae, expressed the opinion that if Airy Shaw's proposal is accepted and *Dysophylla* El-Gazzar et Watson is conserved, the type species should be *Dysophylla stellata* (Lour.) Benth. rather than *Dysophylla quadrifolia* Benth. as proposed.

On the other hand, Bakhuizen van den Brink and Van Steenis (1968) pointed out that *Dysophylla* El-Gazzar & Watson ex Airy Shaw became a clear homonym of the earlier name *Dysophylla* Blume. They further pointed out the existence of a synonym of *Dysophylla sens. auct.* namely *Eusteralis* Refinesque, Fl. Tellur. 2:95. 1836, based on *Eusteralis pumila* (Grah.) Rafin. (Basionym: *Mentha pumila* Grah. 1828), which could be used as the generic name for these species of *Dysophylla*. From their statement it appears that they were in favour of retaining the name *Dysophylla*, but they did not clarify why they did not accept the arrangement of Airy Shaw, who had already amended the diagnosis of *Dysophylla* and named as type for the same an early species of the genus. They were of the opinion that *Pogostemon* Desf. (1815) should also be conserved against an older name *Alopecuro-Veronica* L. (1759). There was another proposal to conserve *Dysophylla* Blume (1826) against *Alopecuro-Veronica* L. (1759).

The Nomenclature Committee of I.A.P.T. (International Association of Plant Taxonomy) regarded conservation of *Dysophylla* and *Pogostemon* against *Alopecuro-Veronica* as unnecessary (Taxon 23: 819-820, November 1974). Dr. F. A. Stafleu, of the Association at Netherlands, advised, in reply to a personal enquiry, that "proposals to conserve *Dysophylla*, in one way or another, were rejected." So the attempts to stabilize botanical nomenclature, by conservation of the well-known generic name *Dysophylla*, were not successful in this case. In the present circumstances, the only alternative is to adopt the generic name *Eusteralis* Rafin. for all the verticillate leaved species of *Dysophylla*, resulting in a series of nomenclatural transfers, some of which are proposed below:

1. **Eusteralis linearis** (Benth.) Majumdar Comb. nov.

   Dysophylla linearis Benth. in DC. Prodr. 12:157. 1848; Hook. f. in Fl. Brit. India 4:639. 1885.

   Khasi hills, 4000-6000 ft.

2. **Eusteralis stellata** (Lour.) Majumdar comb. nov.

   Mentha stellata Lour. Fl. Cochinch. 2: 361. 1790.

   Mentha verticillata Roxb. Fl. Ind. 3:5. 1832.

   Dysophylla verticillata (Roxb.) Benth. in Wall. Pl. As. Rar. 1:30. 1830; Hook f. Fl. Brit. India 4:639. 1885.

   Bengal, Sylhet, Rangoon, Burma, Malaya, China, Australia.

3. **Eusteralis quadrifolia** (Roxb.) Majumdar comb. nov.

   Dysophylla quadrifolia (Roxb.) Benth. in Wall. Pl. As. Rar. 1:30. 1830; Hook. f. Fl. Brit. India 4:639. 1885.

   Mentha quadrifolia Roxb. Pl. Ind. 3:30. 1832.

   Khasi hills, Chittagong, Tenasserim, Kanara, Konkan, Mysore.

4. **Eusteralis cruciata** (Benth.) Majumdar comb. nov.

   Dysophylla cruciata Benth. in Wall. Pl. As. Rar. 1:30. 1830. Hook. f. Fl. Brit. India 4:639. 1885.

   Dysophylla tetraphylla Wight Ic. t. 1444.

   Dysophylla quadrifolia D. Don, Prodr. 113. 1825.

   Himalaya: Kumaon to Nepal; Khasi hills; Nilgiri hills.

5. **Eusteralis crassicaulis** (Benth.) Majumdar comb. nov. var. **crassicaulis**

   Dysophylla crassicaulis Benth. in Wall. Pl. As. Rar. 1:30. 1830. Hook. f. Fl. Brit. India 4:640. 1885.

   Himalaya: Kashmir to Chamba, Sikkim; Bengal; Assam: Sylhet, Khasi hills.

6. **Eusteralis crassicaulis** (Benth.) Majumdar var. **pumila** (Grah.) Majumdar comb. nov.

   D. crassicaulis Benth. var. *pumila* Hook. f. Fl. Brit. India 4:640. 1885.

   D. pumila Benth. l.c.; Wall. Cat. 1546.

   Mentha pumila Grah. in Edinb. New Phil. Journ. 393. 1828.

   Bengal; Assam: Khasi and Garo hills.

7. **Eusteralis helferi** (Hook. f.) Majumdar comb. nov.

   Dysophylla helferi Hook. f. Fl. Brit. India 4:640. 1885.

   Tenasserim: East Pagoda.

8. **Eusteralis malabarica** (Heyne ex Hook. f.) Majumdar comb. nov.

   Dysophylla stellata Benth. in Wall. Pl. As. Rar. 1:30. 1830; Hook. f. Fl. Brit. India 4:640. 1885; Wall. Cat. 1542; Bot. Reg. 1845. t. 23.

   Mentha stellata Ham. in Roxb. Fl. Ind. 3:5. 1832.

   Mentha malabarica Herb. Heyne (1777-1819 in Wallich's list 1542) ex Hook. f. l.c. ut syn.

   South India: Belgaum southwards.

9. **Eusteralis tomentosa** (Dalz.) Majumdar comb. nov.

   Dysophylla tomentosa Dalz. in Hook. Kew Journ. 2:337. 1850. Hook. f. Fl. Brit. India 4:641. 1885.

South India: Malabar, South Konkan.

10. **Eusteralis gracilis** (Dalz.) Majumdar comb. nov.

 Dysophylla gracilis Dalz. in Hook. Kew Journ. 2:337. 1850; Hook. f. Fl. Brit. India 4:641. 1885.

 Peninsular India: Sahyadri hills.

11. **Eusteralis erecta** (Dalz.) Majumdar comb. nov.

 Dysophylla erecta Dalz. in Hook. Kew Journ. 2:337. 1850; Hook. f. Fl. Brit. India 4:641. 1885.

 South India: Malabar, South Konkan.

12. **Eusteralis pentagona** (Clarke ex Hook. f.) Majumdar comb. nov.

 Dysophylla pentagona Clarke ex Hook. f. Fl. Brit. India 4:641. 1885.

 Bihar: Singhbhum district, 2000 ft.

13. **Eusteralis griffithii** (Hook. f.) Majumdar comb. nov.

 Dysophylla griffithii Hook. f. Fl. Brit. India 4:641. 1885.

14. **Eusteralis stocksii** (Hook. f.) Majumdar comb. nov.

 Dysophylla stocksii Hook. f. Fl. Brit. India 4:642. 1885.

 South India: The Konkan.

15. **Eusteralis andersonii** (Prain) Majumdar comb. nov.

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 Sikkim terai.

16. **Eusteralis kachinensis** (Mukerjee) Majumdar comb. nov.

 Dysophylla kachinensis Mukherjee in Notes Bot. Gard. Edinburgh 19:304. 1938.

 Upper Burma: Kachin.

17. **Eusteralis peguana** (Prain) Majumdar comb. nov.

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 Burma: Pegu, Moulmein.

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28. *SESBANIA SESBAN* (LINN.) MERRILL VAR. *PICTA* COMB. NOV.

While describing, and systematically rearranging the new species and the species not mentioned by J. G. Baker in the FLORA OF THE BRITISH INDIA, under the genus *Sesbania* Adans. corr. Scop. Prain (1897) had made certain varietal combinations under *Sesbania aegyptiaca* Poir. corr. Pers. Besides var. *typica*, the following varieties have been mentioned by Prain on the basis of the colour of the flowers:

1. var. *picta* Prain; and 2. var. *bicolor* Wight & Arn.

Merrill (1912) studied the taxonomic status of the *Sesbania* spp. found in Manila, and treated *S. aegyptiaca* Poir. corr. Pers. as a synonym of *S. sesban* (Linn.) Merrill.

Andrews (1952), while reviewing the species of *Sesbania* recorded from Sudan, found that the var. *bicolor* Wight & Arn. was not mentioned under *S. sesban* (Linn.) Merrill, and made a new combination *S. sesban* (Linn.) Merrill var. *bicolor* (Wight & Arn.) Andr.

The new variety '*picta*' created by Prain, mentioned as, 'apparently not native to India though widely cultivated there', has not been combined under *Sesbania sesban* (Linn.) Merrill, which necessitates a new combination. Therefore, the following new combination is proposed:

Sesbania sesban (Linn.) Merrill var. **picta** (Prain) Tenjarla & P. S. Gupta

S. aegyptiaca Poir. corr. Pers. var. *picta* Prain, *J. Asiat. Soc. Beng.*, *66*, pt. II(2), 367 (1897); *S. picta* Poir. corr. Pers., Synop. Plan., II, 316 (1807); *Aeschynomene picta* Cav., I.c. iv. 7, t. 314.

ACKNOWLEDGEMENT

We are thankful to Mr K. Kashyapa, Scientist, Publications and Information Directorate (CSIR), for his valuable suggestions.

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October 30, 1975.

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29. AN ADDITION TO INDIAN POLYGONUMS FROM NORTHERN HIMALAYAS

(*With a text-figure*)

While studying the Polygonaceae of Northern Himalayas, I came across some interesting specimens of *Polygonum* at an altitude of about 4000 m. On critical examination of the specimens I concluded that the specimens belong to section Bistorta sensu. Hook. f. Hooker in FLORA OF BRITISH INDIA has kept *Polygonum bistorta* L. as a doubtful and imperfect species due to the mixture of specimens of different species. My specimens turned out to be of *P. pacificum* V. petr. as described in Flora USSR. Since the taxon has not been reported earlier from India it is recorded here. The voucher specimens are deposited in Herbarium, Department of Botany, University of Kashmir, Srinagar.

Polygonum pacificum V. petr. in herbario Petrop. (1917) nomen; Kom in Not. Syst. ex Herb. H.B. p. VI (1926) 2, diagnosis; Kom. in Fl. USSR. 4: 682. 1936. (Fig. 1).

Perennial herb, ascending to erect with tufted and creeping branched root stock, 50-80 cm high. Flowering stem slender; internodes glabrous, hollow, grooved. Leaves simple, alternate, coriaceous, hairy; basal leaves petiolate, oblong to lanceolate with cordate base, acute to acuminate, crenulate, ciliate, 20-30 cm long, 4-10 cm broad; upper leaves amplexi-caule or sub-sessile, lanceolate, cordate acuminate, crenulate, ciliate, 8-20 cm long, 2-6 cm broad; veins forming 30-45° with mid vein. Ochrea brown, 4-7 cm long, tip free, nerves prominent, hairy on nerves. Flowers in stout ± curved, dense, 3-10 cm long racemes. Flowers 1-2 mm across, bracteate, pedicellate; bracts membranous, imbricate, attached and covering the lower half of the pedicels, lanceolate, acuminate, 2-3 mm long; perianth 5, in two whorls, elliptic to ovate, equal or unequal, 2-3 × 1-1.7 mm, pinkish green; stamens 8, in two whorls, filaments long, exserted. Ovary trigonous, 0.7-1 mm; style 3, exserted, stigma small, deciduous. Pedicels 3-7 mm long. Not 3-5 × 2-3 mm, trigonous, brown, shining.

Flowers: July-October.

Locality: Kashmir: Mahadev Range: AHM 1690, AHM 1791, AHM 1795. Bobjan: AHM 1930, AHM 1963, 1967.

A. M. MUNSHI

DEPT. OF BOTANY,
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SRINAGAR,
October 23, 1975.

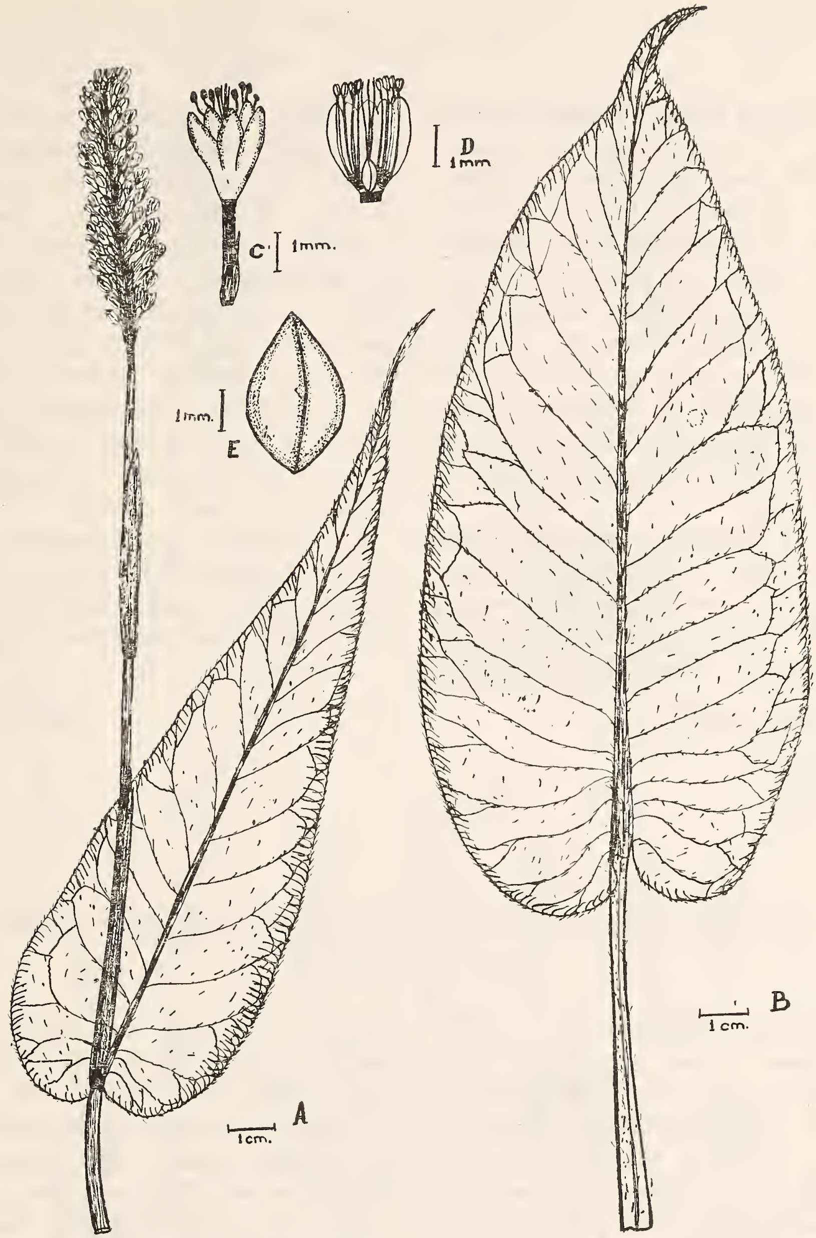

Fig. 1. *Polygonum pacificum* V. Petr.
A. A branch; B. Basal leaf; C. Flower; D. V.S. of Flower; E. Nut.

30. OCCURRENCE OF *PEPLIDIUM MARITIMUM* WETTEST. IN RAJASTHAN

The genus *Peplidium* Delile (Scrophulariaceae) is represented by two species, an endemic Australian species and *P. maritimum* Wettest., distributed in Kurdistan, Egypt, Australia, Sri Lanka and W. peninsular India. Recently, the species has also been reported from the Gangetic plains (*see* Checklist of the Flora of the Upper Gangetic Plains. M. A. Rao, 1969). *P. maritimum* has not been reported earlier from any locality in Rajasthan, hence, its occurrence at Darah in Kotah district and Luni river near Jodhpur are new locality records for the species.

The species is found in fresh, still water of ponds and rivers forming a pure community. It closely resembles *Microcarpaea. muscosa* Br., but can be distinguished by the following characters: Submerged or free-floating herbs; stem 15-30 cm or more long, flexuose, much branched, interlaced; leaves opposite, not exceeding 2 × 1.5 cm, exstipulate, obovate or oblong, fleshy, entire; petioles sheathing and two of a node are connected by a membrane; flowers white or pinkish white, 1-3 in the axils of the leaves, shortly pedicelled; calyx-teeth 5, obtuse; corolla 2/3; stamens 2, included; anthers 1-celled; stigma one, spathulate, curved towards 2-celled ovary; capsule ovate or oblong, enclosed in the enlarged calyx, papery, bursting irregularly; seeds many, small, oblong.

The specimens are deposited in the herbarium of Department of Botany, J. V. College, Baraut (Meerut) *Singh* 110013 and Arid Zone Circle, BSI., Jodhpur (*Tiwari* 651).

ARID ZONE CIRCLE, B.S.I.,
D-7, SHASTRI NAGAR,
JODHPUR, (RAJ.),
October 30, 1975.

VIJENDRA SINGH

31. OCCURRENCE OF *IPOMOEA SINDICA* STAPF IN S. INDIA

(*With a text-figure*)

During routine plant collection visits to Law College Hills near Poona, an unusual plant of *Ipomoea* type was noticed. Morphological features of the collected plant were quite different and we could not match it with any local species of the Convolvulaceae occurring in Western Maharashtra. The plant is herbaceous, slender, prostrate annual with wiry hispid stem and hastate deltoid leaves. It grows luxuriently among grass and low shrubs. In open exposed areas and in coarse soil, it is sub-erect and dwarf. However in clayey, loamy or black soil, it usually twines around itself and spreads on neighbouring tall grass and shrubs. Flowers are white showing striking similarity with *Ipomoea eriocarpa* R. Br. The deceptive resemblance to the above species may be perhaps the reason why its occurrence was ignored till now.

The species is very closely related to *Ipomoea eriocarpa* R. Br. from which it is distinguished by (1) small size of the plant, (2)

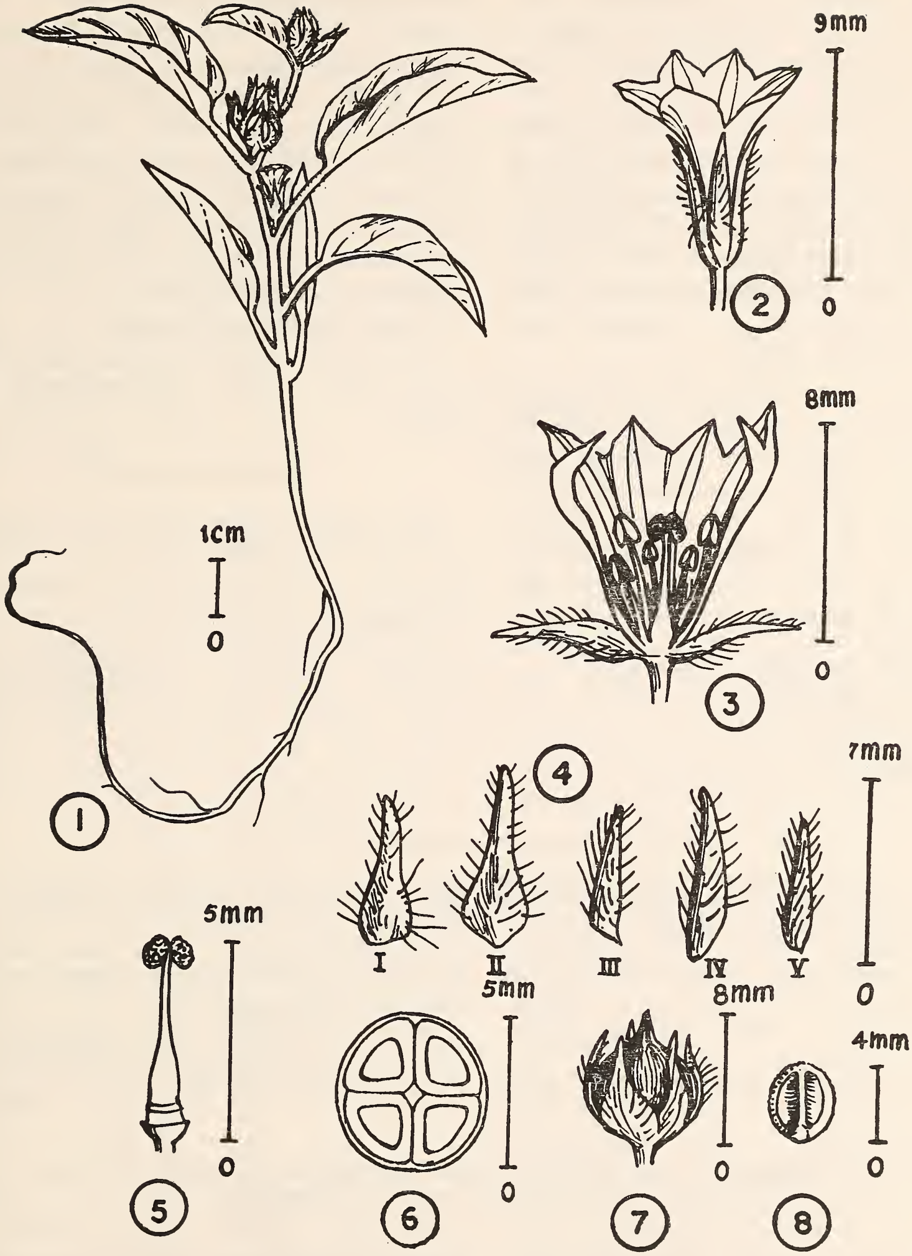

Fig. 1. *Ipomoea sindica* Stapf

1. Plant; (Erect form); 2. Flower; 3. V.S. of flower; 4. Bracts; 5. Carpal; 6. T.S. of ovary; 7. Capsule; 8. Seed.

more hispid nature of the leaves and other parts of the plant, (3) pure white colour of the flower, (4) glabrous capsule and (5) black grey velvety seeds.

Otto Stapf (1894) had recorded *Ipomoea sindica* from Sindh for the first time. Its geographical distribution was supposed to be limited to the arid zone of Sindh, Baluchistan and Afghanistan. Maheshwari (1963) reported its occurrence from Delhi area and it was also reported near Pavagad in Gujarat State by Chavan & Oza (1966).

The present note records this species from Poona probably for the first time. The distribution of the species now extends to Poona District which forms the southern-most limit of its record in the Indian sub-continent. Vartak (1957, 1959, 1962) reported the possible migratory path of some xeric and ephemeral species from North Africa, Arabia, Baluchistan and North West India to Deccan Plateau. He has also quoted occurrence of Middle East species like *Monsonia senegalensis* Guill., *Senebiera pinnatifida* DC., *Nothosaerua brachiata* Wight., *Indigofera anabaptista* Steud., *Taveriniera nummularia* DC., *Elyonurus royleanus* Nees, in Central Maharashtra. He suggests the same possible migratory route of this species via Gujarat plains.

Flowers: August-October.

Fruits: September-November.

Voucher Specimens: Poona Law College Hills.—Very common. (H: M.A.C.S. 20125, 20138).

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We wish to acknowledge our indebtedness to Dr. G. B. Deodikar and Dr. T. S. Mahabale, M. A. C. S. Poona, for guidance and encouragement.

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32. OCCURRENCE OF WATER FERN *MARSILEA* NEAR DIGHA SEA BEACH IN WEST BENGAL (INDIA)

The Water fern *Marsilea* is known to be a fresh water fern. It was surprising therefore to locate this fern near Digha sea beach about 100 km from Calcutta. The fern was seen growing luxuriantly in a short nullah adjacent (about 100 metres) to the sea beach. It was obvious that this part of the nullah is regularly inundated during high tide though in the month of June, 1973 when we visited this particular locality was not flooded by sea water. In any case the location of this fern just adjacent to a sea coast is quite unusual and not reported so far. That this particular *Marsilea* has become used to salinity was obvious when some live plants brought by us from this locality refused to grow in the Botanic Garden of Government College, Ajmer. Generally *Marsilea* is a fern which can be easily cultivated in the garden. As there were no sperocarps we could not identify the species but since only *M. minuta* is found in West Bengal, one may assume with a fair degree of certainty that this *Marsilea* growing near Digha sea beach is *M. minuta*. Tolerance and adaptability to saline conditions adds another dimension to the wide ecological amplitude of this plastic genus. Further records of this genus around sea beaches would be gratefully received by us.

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33. TWO NEW PLANT RECORDS FOR INDIA

Subsequent to the publication of Hooker's FLORA OF BRITISH INDIA (1872-96) several workers, including Duthie (1893-94), Meebold (1909), Coventry (1923-30), Blatter (1927-29), Rao (1960-61), Dutt, *et al.* (1965) have contributed materially towards the enumeration of flowering plants of Kashmir valley. Recently Stewart (1972) who collected plants from Jammu and Kashmir State from 1916-1966 published a catalogue of plants occurring in the area. A perusal of the above and other available literature reveals that the following two taxa of the family Brassicaceae (Cruciferae) have not been reported so far from India, so the authors put it on records.

Lepidium virginicum Linn., Sp. Pl. 645, 1753.

Annual herb, 6-68 cm tall, branched or unbranched, erect (rarely procumbent) with long curved, appressed, simple hairs. Basal leaves upto 8 cm long, lyrate or pinnately lobed with ± rounded terminal lobes, ± rough; middle and upper leaves simple, sharply toothed, with hairy margins; uppermost linear, 10 mm long, c. 1 mm broad. Racemes 8.5 cm long in fruit, 100-flowered. Flowers 1.5 mm across. Sepals elliptic-ovate, 1-1.3 mm long, lateral saccate. Petals white, 1.5-2 mm long. Stamens 2 or 4. Pedicels spreading, filiform, 3-4 mm long. Siliculae glabrous, suborbicular, 3(–4) mm long, 3(–3.5) mm broad, winged above, shining and reticulately veined. Style short and stigma included within notch. Seeds brown, narrowly winged, 2 mm long, 1 mm broad; radicle accumbent.

Type: Described from Virginia, Jamaica.

Specimens examined (Herbarium, University of Kashmir). *A. R. Naqshi,* Lagama (Uri) 4970 & 4971; Cheshmashahi (Srinagar) 3112; Sonervani 3720; Verinagh 3208. *B. A. Wafai,* Baderwah (Doda Distt.) 435 under *L. ruderale* L. Kashmir University Herbarium No. 4580, 4581 & 4579 under *L. ruderale* L.

The plant occupies an intermediate position between *L. ruderale* L. and *L. densiflorum* Schrad. and has been misidentified as *L. ruderale* L. in our area. The taxon can easily be distinguished from the above mentioned taxa by accumbent radicle as against incumbent in the other taxa. Two very commonly occurring species in our area (*L. capitatum* Hook. f. & Thoms., *L. apetalum* Willd.) are very closely allied to the taxon in a number of characters, but can easily be isolated from newly reported plant by having petals shorter than sepals, when present; siliculae ovate-oblong; radicle incumbent.

Jafri (1973) in his Brassicaceae of West Pakistan does not seem to have recognised its occurrence in the area, but has included in his book referring Kitamura's (1964) report from W. Pakistan. Similar is the case with R. R. Stewart (1972), who totally refutes its occurrence either in Pakistan or in Kashmir, and gives it a dubius place in his catalogue of Vascular Plants of W. Pakistan and Kashmir.

Malcolmia taraxacifolia Balbis ex Vass., in Kom., Fl. U.R.S.S. **8**:283, 1939; Ball, in Fl. Europ. **1**:277, 1964; Rech. f., Fl. Iran. **57**: 260, 1968.

Cheiranthus taraxacifolia Balbis, Syn. Pl. Bot. Taur. app. *1*:10, 1814; *M. africana* var. *intermedia* C. A. Mey., Verz. Pfl. Cauc. 186, 1831; Jafri, l.c. 220; *Fedschenkoa taraxacifolia* (Balbis ex Vass.) Dvorak, in Fedde, Report. *81*(*6-7*): 403, 1970; *Strigosella intermedia* (C.A.M.) Botsch., J. Bot. U.R.S.S. *7*(*9*):1083, 1972.

Annual herb, 10-20 cm tall, erect to suberect, lower portion densely hairy with simple to branched hairs. Basal leaves long stalked, rosulate, oblong-lanceolate, entire to sinuate-dentate, upto 6 cm long; cauline leaves sinuate-dentate, stalked, smaller above. Racemes 5-10 flowered, lax in fruit. Flowers 4-5 mm across. Sepals slightly saccate at base, 2.5-3 mm long. Petals pinkish, 4-5(–8) mm long. Stamens 6; filaments 2:3 mm long. Pedicels horizontal-erect, as thick as fruit, 1-1.5 mm long. Siliquae quadriangular, glabrous, linear-oblong, 35-60 mm long, 1 mm broad; valves 1-3 veined. Style *c.* 1 mm long. Seeds uniseriate, upto 35 in each locule, oblong, brown, ± compressed.

Specimens examined (Herbarium, University of Kashmir).

A. R. Naqshi, Fort Hariparbat (Srinagar) 3132 & 3966.

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34. OCCURRENCE OF ALTERNATIVE VERNATION IN SPATHE OF *ZANTEDESCHIA AETHIOPICA* AND OTHER ARACEAE

(*With six photographs*)

Introduction

In an earlier paper we have described four types of cyathia in *Euphorbia milii* (Euphorbiaceae) with regard to the vernation of bracts in clockwise, counter clockwise and neutral manner (Bahadur & Reddy 1975). In continuation of our studies on handedness in Indian plants, we propose to describe in this communication hitherto unknown observations on alternative vernation of spathe in four genera of Araceae namely *Zantedeschia aethiopica, Typhonium trilobatum, Caladium bicolor* and *Xanthosoma* species.

Table 1

Frequency of left and right handed spathes in *Zantedeschia aethiopica*

Population Number	Left spathes	Right spathes	Total L+R	L–R	X^2 1:1	p value%
1	156	133	289	–23	1.484	50-20
2	98	104	202	+ 6	0.178	80-50
3	53	36	89	–17	3.247	20-5
4	44	40	84	– 4	0.190	80-50
5	29	20	49	– 9	1.653	20-5
6	12	17	29	+ 5	0.862	50-20
Total:	392	350	742	–42	2.377	20-5

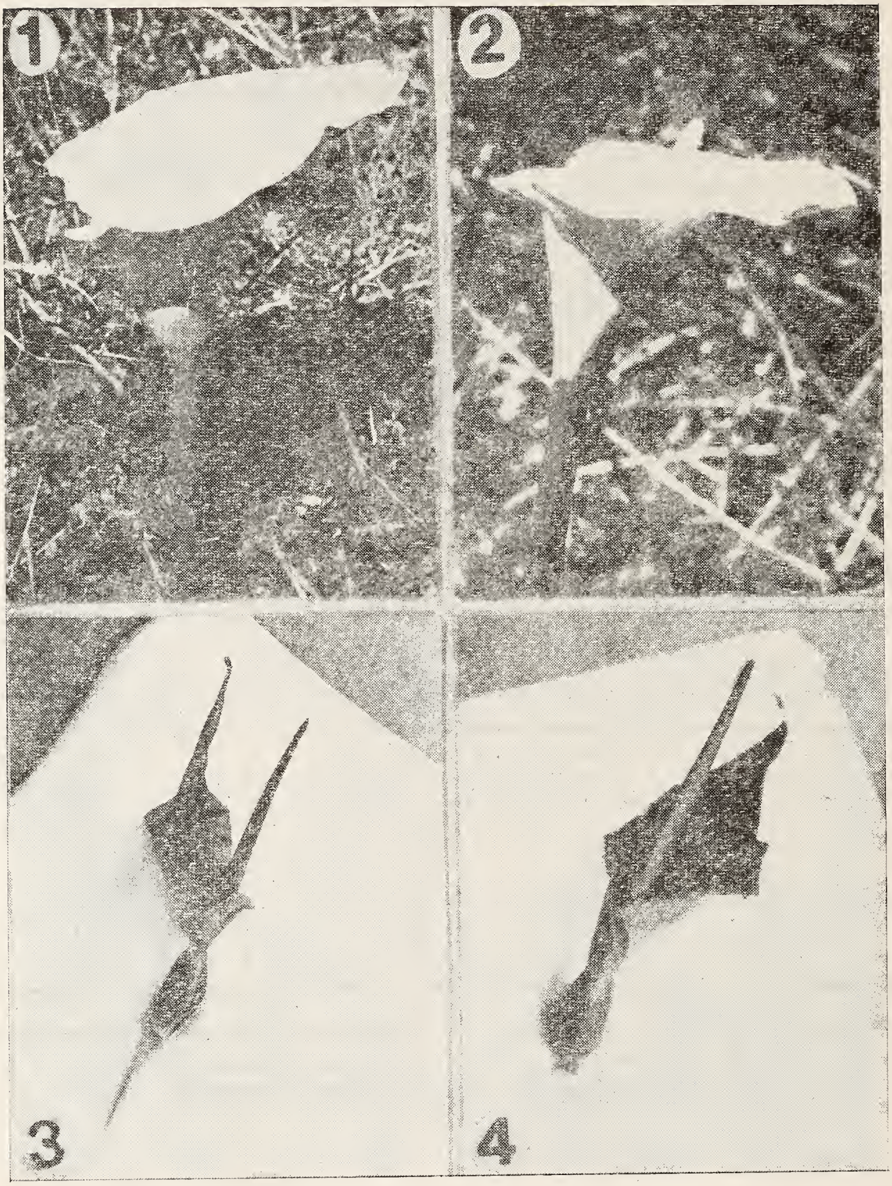
Populations 1 to 4 around the Lake at Ootacamund
Populations 5 & 6 near Railway bridge, Ootacamund

Materials and methods

Data on *Zantedeschia aethiopica* Spreng. was collected while the authors were on a field trip to Ootacamund, Tamil Nadu. But on *Typhonium trilobatum* Schott., *Caladium bicolor* Vent., *Xanthosoma violaceum* Schott., and *X. sagittifolium* Schott., plants growing in the Botanic Garden, Post Graduate Centre, Warangal, provided the data. The spathes show convolution to the left (clockwise twisting) or to the right (counter clockwise twisting) which in bud condition remains tightly coiled around the spadix but as the bud unfolds the convolution of the spathe becomes more clear. Such left and right handed spathes were sampled for all the species for over 3 years except *Z. aethiopica* which was sampled once during September, 1972.

Observations and results

Zantedeschia aethiopica: This species grows in marshy habitats at higher altitudes and forms dense strands around the lake at Ootacamund. The species has an under ground



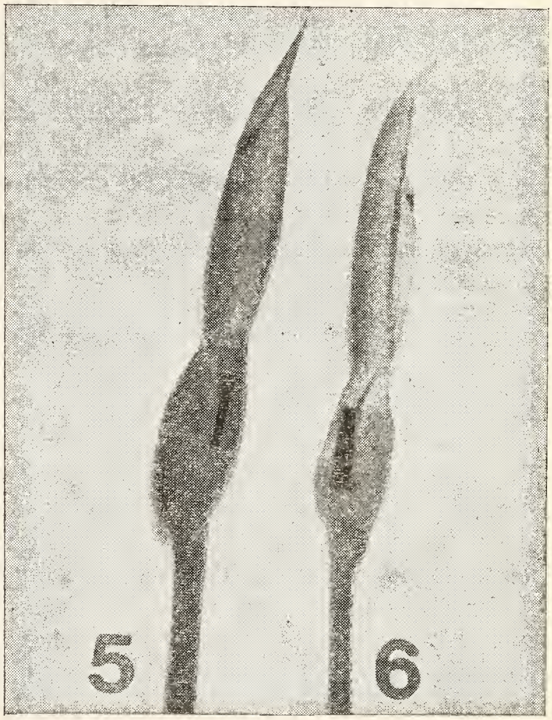
Photos. 1 & 2. Left and right handed spathes of *Zantedeschia aethiopica*. Photos. 3 & 4. Left and right handed spathes of *Typhonium trilobatum*.

tuber which gives off large, simple, radical, cordate leaves on rather long petioles. The spathe is white, twisted to the left or right in any given spadix, Photos. 1 & 2 forming a constricted mouth with an inflated basal region, expanded above into a spotless white limb. The spadix is white, silky, and bears numerous minute unisexual flowers. Data on left and right handed spathes on individual plants was difficult as it was impossible to locate the under ground tuber as belonging to a given plant. Hence numerical data on the frequency of left and right handed spathes was collected on plants forming well defined populations (clones!) and the results are summarised in Table 1. Out of 742 spathes sampled, 392 were left handed, 350 were right handed with no neutrals.

Of the two populations showing excess of right handers, population 2 is not different from equality but population 6 shows deviation, the X^2 and p value is not significant. Rest of the populations show excess of left handers including on the total (52.9%). The X^2 values on populations 3 and on the total are significant.

Typhonium trilobatum: This species is a tuberous herb with radical, trilobed lamina on a long petiole. The spadix is 15 to 20 cm long and 6 to 8 cm wide tapering into a pointed limb which may be either straight or twisted. The spathe at the base clearly shows twisting either to the left or right in a given spadix on one and the same plant, Photos. 3 & 4 forming a constricted mouth enclosing numerous unisexual flowers in its inflated bulb. The spathe is reddish purple within and purplish green outside while the appendix of the spadix is bright red, tapering, hollow and sterile. It flowers locally during summer and opens during night emitting foul smell. In all 52 spathes were sampled on 13 plants out of which 30 were left and 22 were right handed without neutrals. The X^2 for deviation from equality for 1 d.f. is 1.23 which is not significant ($p = 50\text{-}20\%$).

Caladium bicolor: This highly decorative tuberous species occurs locally in three varieties. Since the flowering in these is not profuse combined data for the three varieties is given. The leaves in all are saggitate and the lamina differently pigmented with spots or streaks of red and white. The species flowers during high summer. The spathe measures 8 to 12 cm and is boat shaped, whitish green inside and purplish to whitish green outside depending on the variety while the spadix is



Photos. 5 & 6. Right and left handed spathes of *Caladium bicolor*. (A strip of black paper has been introduced in spathe to facilitate clarity in convolution).

white silky and is devoid of appendix. In all 25 spathes were sampled out of which 15 were left handed and 10 right handed, Photos. 5 & 6. The X^2 for deviation from equality for 1 d.f. is 1.00 (p = 50–20%) which is not significant.

Xanthosoma violaceum: This species has a caudex stem which gives off sagittate leaves of purplish violet colour. The spathe is faintly purplish violet and shows twisting either to the left or right. In all 14 spathes were sampled out of which 10 were left and 4 were right handed with no neutrals. The X^2 for deviation from equality is 1.71 (p = 20–5%) which is significant.

Xanthosoma sagittifolium: This giant species has a rather thick trunk and very large sagittate leaves. The spathes are rather large and are clearly twisted to the left or right. In all 13 spathes were sampled out of which 8 were left and 5 were right handed. If the data on both the *Xanthosoma* species are combined, there are 18 lefts and 9 rights. There is a great excess of left handers which gives a X^2 value of 3.00 for deviation from equality with 1 d.f. is significant (p = 20-5%).

Discussion

Clockwise and counter clockwise convolution of spathe in the family Araceae is so far unknown in the literature. A survey of the Indian floras, however, revealed that the convolute character of the spathe has been recorded for many genera namely *Lasia, Anaphyllum, Plesmonium, Amorphophallus, Arisaema, Colocasia, Alocasia, Remusatia* and *Theriophorum* (Gamble 1957; Cooke 1958; Haines 1961). Since in the taxonomic studies few species are generally examined, it is no wonder that the character under study escaped the notice of many botanists. It is likely that the above mentioned authors might have examined either left or right handed spathe and not both.

Remarkably, this character escaped notice of even the modern botanists. Jindal (1968) on p. 27 of his book ORNAMENTAL BULBOUS PLANTS, gives a photograph of two spathes of *Arisaema griffithii*, which on close examination was found to contain both the left and right handed spathes. Similarly, Proctor & Yeo (1973) provide a photograph on page 290 of *Arum maculatum* which also shows 2 right handed and one left handed spathe. Thus, these two genera clearly show alternative vernation of spathe as described for four Araceae.

Recently, Gupta (1968) has separated the genus *Arum* from *Sauromatum* on the basis of convolute character of spathe in the former and a cylindric spathe in the latter, thus emphasising the convolute character to be of taxonomic importance.

The only work on 'asymmetry' in Araceae is that of Davis (1970) and Davis & Ramanujacharyulu (1971) on *Scindapsus officinalis*. The authors sampled 627 leaves for ptyxis of lamina and the petiolar sheath with regard to handedness. They further showed that left convolution of leaf is followed by right and this they opine as due to the distichous condition in the species. Unfortunately in the present work it was not possible to maintain regular record of spathes produced by the species under study since the time lag between the first and the successive spathes was considerable. Nevertheless, few observations on *Typhonium trilobatum* and *Caladium bicolor* show a left handed spathe is followed by a left and very rarely by a right. Occasionally, however, only a single spathe was observed. In *Xanthosoma violaceum* a pair of left handed spathe was often observed and this perhaps accounts for the excess of left handers in the species. These observations are new and are comparable to that of Davis & Ghosh (1969) on *Cordyline rubra* (Agavaceae) which shows a slight excess of right handed shoots. These authors further showed a correlation between the direction of foliar spiral and the convolution of the lamina, both of which show handedness.

Recently, Bahadur & Venkateshwarlu (1976 a & b) have studied contortion of corolla in *Jatropha* spp. and *Carica papaya* and proposed the term isomerism to the left/right handed (Levo/Dextro) aestivation of corolla. It may be remarked that Meyen (1974) earlier introduced the term bioisomerism to plant organs showing mirror image forms and further showed that this is accompanied by mathematical isomorphism.

Since isomerism of levo and dextro forms is common in plants, being shown by whole plant and variety of plant organs, it has been of great interest and speculation as to its causes (Meyen 1973; Bahadur 1974). According to Davis (1962) handedness in coconut palms is not genetical but could be gene regulated (Bahadur 1974); since according to Dormer (1965) the self regulation as displayed by morphogenetic phenomena of geometric nature represented by solid patterns like the one under study includes among others the stereoisometric configurations of genic nature. Clearly the one described for several Araceae involving mirror image patterns represents the same about the functional aspects of which presently nothing is known. Recently, Bahadur & Reddy (1975) and Bahadur & Venkateshwarlu (1976 a & b) have proposed that stereoisomerism of hormone molecule or the optical activity of some chemicals in the plant determines mirror image patterns through the morphogenetic movements.

It would be interesting if isomerism of spathe in Araceae particularly those monoecious (e.g. *Arisaema*) in their natural habitat be examined to possibly find out if a correlation between the convolution of spathe and its pollinators.

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We thank Prof. Jafar Nizam for his interest and for encouragement.

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ERRATUM

Volume 73(2): August 1976

Miscellaneous Note 15

The lizard *Sitana ponticeriana* in captivity

On page 402, right column, line 30
For 27-xi-75
read 27-xi-74.

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An ecological reconnaissance of the proposed Jawahar National Park[1]

S. Sathis Chandran Nair[2]
P. Vijayakumaran Nair[3]
H. C. Sharatchandra[3]
and
Madhav Gadgil[3]

(*With five plates & four text-figures*)

The proposed Jawahar National Park embracing an area of 2000 sq. kms will comprise of the Bandipur and Nagarhole national parks (Karnataka) and Mudumalai (Tamilnadu) and Wynad (Kerala) wild life sanctuaries. It is one of the most extensive contiguous forested areas in Peninsular India, and probably harbours the largest population of the elephant in India. The undulating terrain lies at the trijunction of the Western Ghats, the Nilgiri hills and the Deccan plateau. Its natural vegetation is primarily of the moist deciduous and dry deciduous types, with patches of evergreen forest and scrub. This has been replaced in many parts by degraded scrub forest and by plantations and cultivation. The mammalian fauna includes the Indian elephant, gaur, sambar, chital, wild boar, mouse deer, black-naped hare, sloth bear, dhole, grey or hanuman langur and giant squirrel, occurring in good numbers, at least locally. Rarer species include the four-horned antelope, barking deer, panther, tiger, jackal and the striped hyena. In addition, the Nilgiri tahr, Nilgiri langur and liontailed macaque occurred in areas very close to this sanctuary complex until very recently. If the Brahmagiri sanctuary of Coorg were to be included within the Jawahar National Park, these species could be reintroduced there. Blackbuck could thrive in Masingudi area of Mudumalai. With these introductions, this sanctuary complex could harbour all the major South Indian mammals. It has a good population of peafowl locally, and crocodiles exist on Kuruwa islands close to the sanctuary, and in the river Nugu.

[1] Accepted April 1977.

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This entire area was surveyed on foot by our team over three months during monsoon 1975. Our party mapped the areas of wild life concentration, and studied the various environmental factors affecting the wild life. The Kabini reservoir, along with the encroachments in the vested forest of Pulpally have drastically reduced the area of wild life habitat and have almost completely split the habitat into two, severing many traditional migration routes of the elephants. Plantations, and other disturbances have also sharply reduced the summer range of elephants in the forest in the Wynad areas. Most of the forest is subject to serious overgrazing by domestic cattle and forest fires in the dry months. The cattle also bring in diseases like the rinderpest which almost wiped out the gaur population of this region in 1968. The forest department is inadequately equipped to control poaching, and poaching of all animals ranging from tiger and elephant down to regular trapping of blacknaped hare and mouse deer is reported. We urge strong action on many fronts to conserve this finest of elephant forests in India.

CONTENTS

I. Introduction

ELEPHANT, the largest and the most venerated of our wild animals, still survives in sizeable numbers along the Western Ghats in Peninsular India, in Orissa, Bihar, West Bengal, Assam and Uttar Pradesh. It is likely that the elephant has suffered the least among our larger wild life in terms of actual decline in numbers over the past half-a-century. Elephant meat is not consumed in India, and the only item of value to the hunter or poacher is the tusks. The tuskless females are therefore, relatively immune from hunting pressure, and so is the tuskless makhna males. Religious sentiment has also been in favour of not killing this magnificent animal which gave Lord Ganesha his head. The hunting and poaching pressure on the elephants has therefore, been relatively light. Capture for domestication has been more significant, and must to an extent have affected the wild populations. But elephant takes domestication well, and tame elephants at forest camps continue to mingle and mate with wild animals; so this capture too does not withdraw too many animals from their forest habitat.

Elephants survive for more than sixty years, and are tolerant of a wide variety of habitat conditions ranging from dry scrub to moist deciduous forest. They also feed widely on crops like ragi, paddy and sugarcane. Spared of heavy mortality at the hand of man, the fate of all other wild animals in India, this long-lived and versatile beast has survived in good numbers to this date. There is, however, no cause for complacency. Although an animal may maintain populations far in excess of the carrying capacity of the environment for the period of one or two generations, it cannot continue to do so indefinitely. The numbers that the elephants are maintaining today are those more appropriate for an environmental carrying capacity of half-a-century ago. The elephant habitat has drastically deteriorated in the recent decades, and it is a matter of but a short time before the elephant numbers also crash in keeping with the very much diminished carrying capacity of their habitat. In the process they may inflict considerable damage on the rest of the forest ecosystem.

Elephant has been intimately associated with the culture and people of India for the past two thousand years or more, and there is a vast lore on elephants in India. Little scientific information is however, as yet available, the only scientific accounts being those of Singh (1969) and Krishnan (1972) for India and McKay (1973) for Sri Lanka. These accounts suggest that the elephant populations of the northern and eastern parts of the country are not very substantial, and that the Western Ghat population is by far the largest. This population has never been properly surveyed, but it was possible for us to obtain estimates of it from experienced foresters. We have put together a tentative picture of the distribution of elephants on the Western Ghats on the basis of such information (fig. 1). It must be stressed that these are all merely educated guesses, and likely to be correct only to the very rough order of magnitude. It nevertheless provides a broad picture of the elephant distribution on the Western Ghats.

It will be evident from this figure that the best elephant habitat is the area proposed to be constituted as the Jawahar National Park, embracing the present-day national parks of Bandipur and Nagarhole in Karnataka, and the wild life sanctuaries of Mudumalai in Tamilnadu and Wynad in Kerala. We therefore, chose this area for an exploratory study of the elephants on the Western Ghats. We have been engaged in ecological studies in one part of this sanctuary complex, namely, Bandipur, since May 1974 and this work furnished the background for the present study (Sharatchandra & Gadgil 1976). The present survey

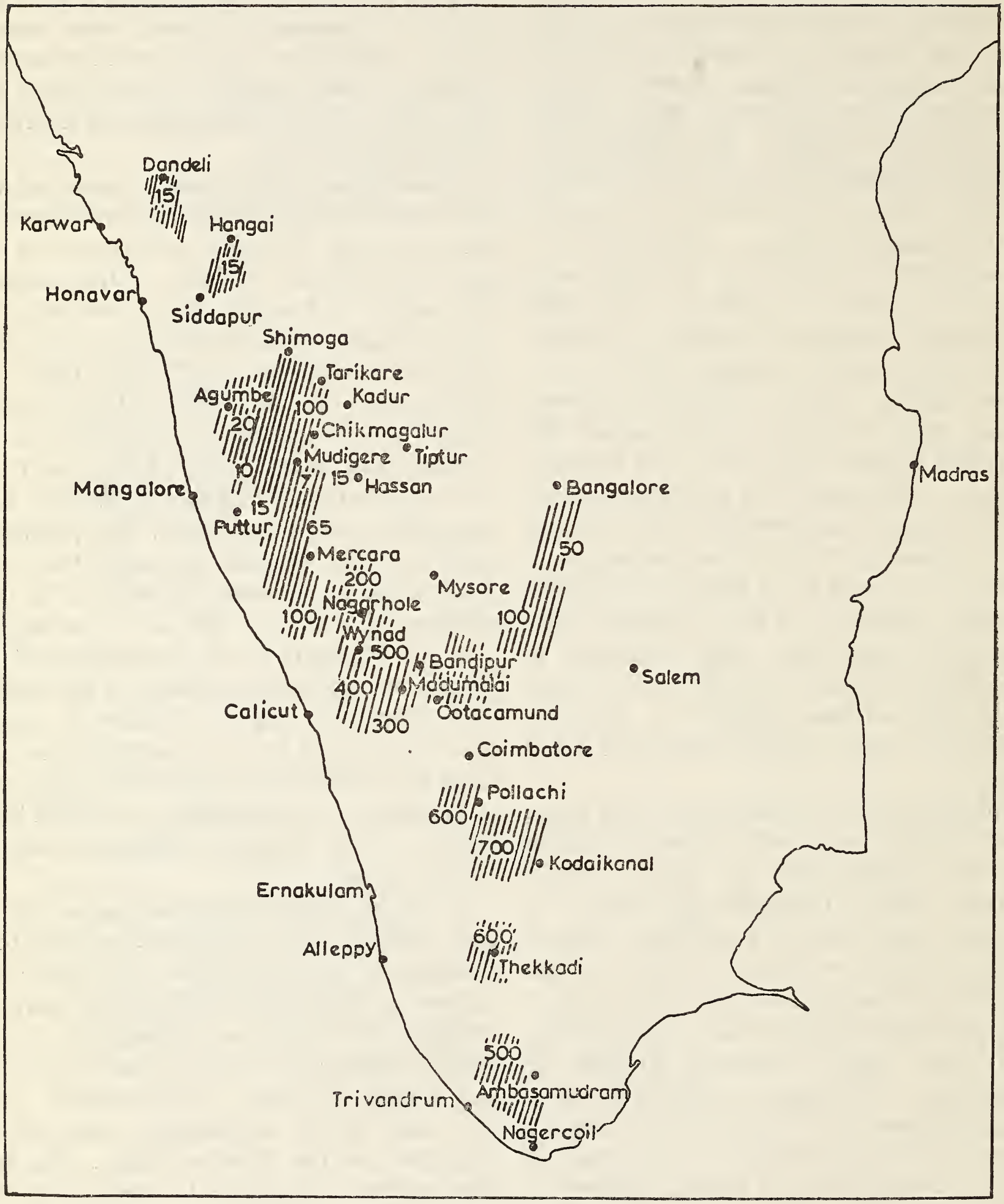

Fig. 1. Distribution of the Asian elephant population in South India. Population estimates are only approximate and are based on information supplied by the forest departments.

itself was carried out over a period of three months from July to October, 1975, during which time almost all of the total area of 2,000 square kilometres of the proposed Jawahar National Park was visited by one or more of us on foot.

Although primarily directed towards developing the methodology for estimation of elephant populations, the survey yielded considerable information on the vegetation, other wild life and the environmental factors affecting this ecosystem. In view of the great significance of the survey area for conservation of wild life in Peninsular India, we felt that it would be useful to present this information, albeit rather incomplete, in a systematic fashion, and we do so in the account that follows.

II. Locality and Methods

The area surveyed is the complex of national parks and wild life sanctuaries of Bandipur and Nagarhole in Karnataka, Mudumalai in Tamilnadu and Wynad in Kerala, which is proposed to be united into the Jawahar National Park. In addition, we visited parts of Brahmagiri sanctuary in southern Coorg of Karnataka, Padri (North) and Kuruva reserve forests in Wynad in Kerala and Kalmalai reserve forest near Mudumalai in Tamilnadu. This area forms an arc like tract lying within latitudes 11° 13′ N to 12°15′ N and longitudes 76° 5′ E to 76°55′E (fig. 2). The terrain is hilly, the altitude ranging from 700 m to 1000 m in the plateau areas with a number of peaks rising up to 1500 m. This area forms the largest continuous tract of good elephant forest in Peninsular India, and includes the famous old Khedda capture area of Kakankotte and the pit capture areas of Tittimati and Mudumalai—Muthanga forests. This locality includes most of the principal vegetation types and larger mammals of Peninsular India. The only major vegetation type which is poorly represented is the montane evergreen forest, and the two major mammalian species lacking are the Nilgiri tahr (*Hemitragus hylocrius*) and the liontailed macaque (*Macaca silenus*). Even these were probably wiped out only in recent times. The locality is also subject to the whole gamut of anthropogenic factors affecting the elephants including plantations, cultivations, forest fire, cattle grazing, submersion due to reservoirs, elephant capture and poaching. It therefore, makes for an interesting study, not only of nature in the wild, but also of all the human influences on it.

The locality was well-suited for an extensive survey of this type, because although it includes steep hills and riverine tracts, it is mostly an easily negotiable plain with moist deciduous forest. It has well-developed lines of communication and other facilities making for easy access everywhere. The forest departments of all the three states had most kindly put these facilities at our disposal.

The initial survey lasted from 15th July to 10th October, 1975. This particular season, the peak rainy months of south-west monsoon, was selected because—

(*a*) Elephants from heavier rainfall, more inaccessible terrains such as the Nilgiri escarpments, Coorg western ghats and Wynad western edge congregate in the survey area. Although this might give an exaggerated population count for the survey area, some information on the status of the entire population could then be gathered.

(*b*) The lusher, plentiful forage and adequate water during the rainy months prevent the animals from ranging too widely hence reducing chances of duplication of counts.

(*c*) Though the thicker undergrowth reduces visibility, it helps undetected close approach by investigators.

(*d*) The more humid cool rainy months permit greater physical exertion, i.e., greater coverage of area per day, than is possible in

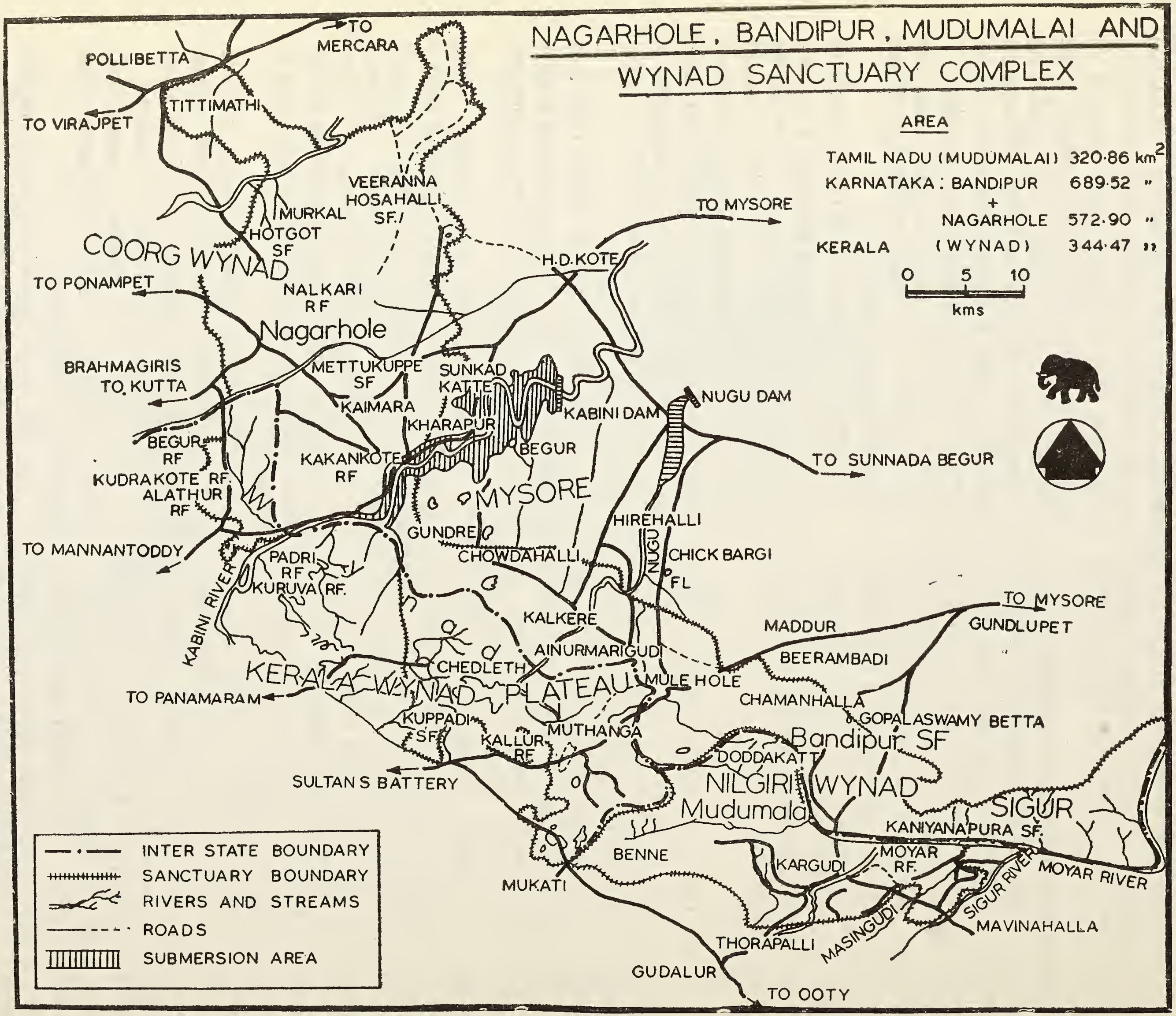

Fig. 2. Map of the proposed Jawahar National Park.

NOTE: The correct area of Kerala (Wynad) is 473·72 sq. km and not 344·47 sq. km as shown in figure 2.

summer months when even drinking water becomes hard to get. Because of this it was possible to survey the entire area in the short time available.

(*e*) Vegetational data could be gathered only during the lush period before the plants shed their leaves or dry up and get burned in annual summer fires.

(*f*) During the rainy season the forests and the wild life are least disturbed by cattle graziers, minor forest produce collectors, forestry operations etc.

The survey was conducted by a party of 4 biologists who covered the terrain on foot. The survey area was divided into approximately 10 sq. kilometre compartments with the aid of maps and each of the compartments surveyed by one investigator with the help of a guide—a local forest tribal or an experienced forest guard. Walking in a zigzag route the entire terrain, especially, areas favoured by elephants such as swamps, stream banks, bamboo thickets etc., were traversed. Whenever herds were encountered they were approached under cover and observed through binoculars and data on the number, age classification, identifiable body marks and activity engaged in were recorded. Based on elephant tracks and dung, approximate number of animals in the group, direction of passage, time since passing, activity engaged in (i.e. walking along, feeding, resting etc.) were noted. Whenever possible, circumference of clear imprints of right foreleg was measured as a possible individual identifying feature. Distribution and degree of abundance of other wildlife, based on sightings as well as spoor marks were also recorded besides information relating to vegetation and soil.

The help of Kurubas especially those who have worked in various elephant camps was invaluable for carrying out the elephant tracking. Although it was attempted to cover as much area as possible within the sanctuary complex, due to various unavoidable circumstances certain areas were surveyed only fleetingly. The north-west part of Benne (compartments 29 and 38), Gopalaswamy betta area of Bandipur, Balijadihalla—Kallalla area north of Mulehole, Gulibetta, Chelvarayana Katte, Alangikatte area of Gundre and Kadatalkatte, Vanakegundihalla area of Nisna Begur as well as some areas near Chowdahalli could not be exhaustively surveyed.

III. Physical Features

The survey area lies at the junction of the Western Ghats to the north-west, the Nilgiris to the south-west, and the Mysore plateau to the east. The western tracts are wetter, and are characterized by swamps (or wyals) in the low lying areas. This terrain is therefore, known as wynad or the land of swamps.

The wynad region is subdivided into the Coorg Wynad in north, the Nilgiri Wynad in south, with the more extensive Kerala Wynad in between. This Wynad passes over into the drier Mysore plateau to the east, with the very dry Sigur plateau lying at the southeastern end.

(1) **Coorg Wynad :**

This plateau is indistinguishable from Kerala Wynad stretching north-east from Kabini along a main northern axis up to Brahmagiri range (Maximum elevation 1736 m) in north-west and Mysore plateau in the east. All of Brahmagiri sanctuary and part of Nagarhole National Park fall in this sub-division. (Photograph 1). This is a heavy rainfall area which is more undulating and is drained by Kabini, Nagarhole and Lakshmantirtha, the last two flowing east and joining the Cauvery. There are many gadde or hadlu (marshes) present, many of which are under cultivation

(2) **Kerala Wynad :**

This gently undulating plateau is an eastern extension of the main western ghats with a general elevation of 700-900 metres. Its major peaks include Kalimale betta and Brahmadevar Vattom. It is gently sloping to the east and north and merges with the Mysore plateau. This area receives the heaviest rainfall and consequently is drained by a large number of perennial streams all eventually joining Kabini. The major streams are :

(1) Streams draining Kuruva (which is an island in the river Kabini) reserve ;
(2) Kadumanthodu and Naratipuzha draining eastern and western portions of Padri reserve and joining Mannantoddy puzha ;
(3) Murmavuthodu and its tributaries Kurichiyat puzha, Doddapallam and Waterfall streams draining Kurichiyat reserve ;
(4) Nulpuzha draining Nulpuzha, Mavanhalla and Rampur reserves ;
(5) Mavanhalla stream draining certain portions of Mavanhalla reserve and Rampur reserve and joining Nulpuzha forming Nuguhole ;
(6) Ammanvayal thodu—this drains Kurichiyat reserve and joins Nuguhole ;
(7) Manjathodu drains part of Kurichiyat, Kuppadi and Rampur reserve and joins Nulpuzha ;
(8) Kattihalla joins Nuguhole draining Rampur reserves ;
(9) Ammankuli thodu draining Mavanhalla and joins Nulpuzha ;
(10) Kallur thodu drains Kallur and Alathur reserves and joins Nulpuzha ;
(11) Bavelihole drains Begur, Alathur and Kudrakote reserves and joins Mannantoddy puzha which empties into Kabini.

(3) **Nilgiri Wynad :**

This extensive plateau has an average elevation of 1000 metres. Beginning from the northwestern edge of Nilgiris it stretches northwest merging imperceptibily with Mysore plateau and with Kerala Wynad to the west. It is gently undulating and slowly rises to the north to a low range of hills running east-west which includes Jainberi betta and Narathi betta (1236 m). This range forms the watershed between the dry Doddakatti area and wetter Mudumalai reserve. The Nilgiri Wynad forest includes Benne and Mudumalai reserves and a part of it formerly belonging to Nilambur Kovilakam is under cultivation now.

Mudumalai reserve is drained to the west by Bennehole which joins Nulpuzha, a tributary of Nuguhole, the latter joins Kabini. Southern part of the forest is drained by Bedarhalla and Kekkanhalla both flowing into Moyar.

There are a large number of extensive swamps (vayals) in this tract some of which are cultivated and some still intact.

(4) **Sigur Plateau :**

This is the narrow belt of land from the foot of the very steep northern edge of Nilgiris to Moyar river with an average elevation of 900 m. It is gently undulating near Masingudi and the steep Morganbetta can be considered its boundary with Nilgiri Wynad to the west. This plateau continues east beyond Masingudi to Anaikatti area outside the sanctuary. The Sigur plateau gently slopes north towards Moyar gorge and on its eastern edge merges with the Coimbatore plains. Receiving the least amount of rainfall in the entire survey area, it is dry and differs from Nilgiri Wynad forming the rest of Mudumalai sanctuary.

Sigur plateau is drained by Kadarhalla, Averahalla and Moyar. Moyar river on the northern edge has here formed the deep gorge (up to 260 m) known as Moyar gorge or Mysore ditch. This steep sided canyon extends from the junction of Kekkanhalla with Moyar to where Sikattihalla meets with Moyar outside the sanctuary. It is almost impossible to cross the gorge except along a few regular animal paths. The Kalmalai, Averahalla and Moyar reserves fall within this Sigur plateau.

(5) Mysore plateau :

The major portion of the survey area falls within this topographical sub-division. This is part of the Deccan plateau with an average elevation of 1000 m. It is also gently undulating dotted by isolated hills, which include Masal betta, Jainbari betta and Shige betta, the highest of the hills being Gopalaswamy betta (1454 m). The Mysore plateau slopes gently east. Its southwestern extremity is marked by Moyar gorge. The entire area receives little rainfall. Parts of Nagarhole National Park and all of Bandipur National Park fall within this sub-division. It merges to the west with Kerala Wynad and to the northwest with Coorg Wynad. The Kabini reservoir is situated in the trijunction.

The southeastern portion of Bandipur sanctuary is drained by Moyar through its tributaries Kekkanhalla, Sikattihalla, Hebballa, Waranchi etc. The western portion of Bandipur is drained by Mulehole (Nugu), northwestern portion by Nugu and northern part by Kabini.

Moyar joins Bhavani near Peerkadavu on Coimbatore plains and Bhavani joins Cauvery. Nugu and Lakshmanatirtha also join Kabini which drains into Cauvery.

In addition to the streams, the Mysore plateau area contains about 40 tanks many of which are perennial. They appear to be man-made.

(6) Special features :

Marshes (vayals, gaddes or hadlus) are a common feature of Wynad plateau. They are swampy areas in between rounded hills with a meandering stream along the middle or draining the waterlogged area from one end. Their common characteristics include a deep black clayey soil that is waterlogged with 30 to 50 cm of standing water during the rainy season, a very lush grass growth in the slush and bamboo growth along the fringes. It is usually open, but is at times dotted by isolated trees or bushes. (*a*) the gentle undulating terrain with no definite direction of drainage ; (*b*) the low hills with gentle slopes resulting in slow surface run off and little percolation and an impeded but not totally arrested drainage ; (*c*) thick vegetation and thick humus on the hills retaining and letting water drain slowly in an area where rainfall is high, and (*d*) the continuous washing down of clay colloids further slowing drainage are the various reasons pointed out as causing the formation of vayals.

IV. Climate

The survey area being entirely within the plateau with an average elevation of 1000 metres, climatic extremes are not met with. Reliable climatological data from no location within the survey area is available. Temperatures range between 17°C-30°C with a mean value of 24°C. The tract receives rainfall from both southwest monsoon and northeast monsoon, with preponderance of each depending on the specific locality. Masingudi and adjacent areas receive two-third of the annual rain from northeast monsoon whereas Kerala and Coorg Wynad receive only one-third or less. Generally the entire tract receives a few heavy pre-monsoon thunder showers during April-May but southwest monsoon sets in by middle of June and lasts till August-September. Later, October-November are northeast monsoon months. The driest month is February and wettest July. In many localities mostly to the eastern edge of the tract, there is a second peak of rainfall in October.

The annual rainfall for some locations in and adjacent to the survey area are given below based on older data.

Kerala Wynad	..	1524 mm—2540 mm
Mudumalai	..	1448 mm
Benne	..	1753 mm
Kargudi	..	1448 mm
Masingudi	..	916 mm
Gundlupet	..	686 mm
Bandipur	..	916 mm
Kalkere	..	1270 mm
H. D. Kote	..	1092 mm

There is a very perceptible gradient of increase in total annual rainfall from east to west and north to south. The heaviest rainfall is in southwest and western portions.

V. Vegetation

The dominant natural climax vegetation of this locality is the southern tropical moist deciduous forest in the wetter tracts of the Wynad and the southern tropical dry deciduous forest in the drier tracts of Mysore plateau, and scrub on the very dry Sigur plateau. In addition, there are pockets of semievergreen and evergreen vegetation.

The natural climax forest vegetation has been considerably modified either historically or recently over most of the terrain and much of the vegetation is in various stages of secondary succession. Much of the Mysore plateau was probably under cultivation at one time, as witness the numerous man-made tanks scattered throughout the forest in this area. There is historical evidence that this region was depopulated during the regimes of Hyder and Tippu Sultans in the eighteenth century and the forest cover must have come back over the past two centuries. The Wynad tracts, on the other hand, were probably always very thinly populated because of the high incidence of malaria, and the only form of cultivation historically practised must have been the shifting cultivation by tribals.

Modern forestry operations and plantations began in parts of this region over a century ago, and have been gathering pace ever since. They have become particularly intensified over the past quarter of a century. Selection fellings have opened up the forest canopy, generally followed by the invasion of *Lantana* and *Eupatorium.* Areas brought under plantation are also susceptible to invasion by these weeds, and by weedy tree species such as *Kydia calycina.* Extraction of wood, grazing and fire have changed considerably the character of many forest areas, rendering them drier and more scrubby. Extensive areas in this tract are also being put under cultivation. Many marshy areas in the Wynad are put under paddy, even inside the Reserved Forests. Large tracts of Reserved Forests were released for cultivation for settling of landless people, particularly the refugees whose lands were submerged under the Kabini reservoir. Revenue Forests have been mostly released for cultivation. Finally large tracts of vested forest in Kerala have been encroached upon by cultivators, the 25,000 acre tract of Pulpally being a particularly striking example.

All of these changes have resulted in the vegetation assuming a highly complex chequered pattern which makes it difficult for us to provide a reserve by reserve description.

(1) (*a*) Moist Deciduous :

This type of vegetation is characteristic of Nilgiri Wynad (Benne, Mudumalai and Kumbarkolli Reserves), whole of Kerala Wynad excluding the northern edge of Rampur and Mavanhalla reserves and the whole of Coorg Wynad (Begur, Kakankote Reserves and whole of Nagarhole sanctuary except the degraded portions). Economically this is the best forest type and wildlife is rich. Moist deciduous forests occur where rainfall is between 1150 mm and 1900 mm; where rainfall increases still further, evergreen species predominate and where rainfall is less, dry deciduous forest takes over. Typically the floral composition of this type of forest is :—

TREES

Tectona grandis
Lagerstroemia lanceolata
Dalbergia latifolia
Phyllanthus emblica
Buchanania latifolia
Ficus infectoria
Stereospermum chelonoides
Stereospermum xylocarpum
Terminalia bellerica
Grewia tiliaefolia
Terminalia tomentosa
Pterocarpus marsupium
Anogeissus latifolia
Shorea talura
Adina cordifolia
Ongeinia dalbergioides
Bombax malabaricum
Albizzia odoratissima
Schleichera trijuga

The lower canopy is composed of :—

Emblica officinalis
Grewia tiliaefolia
Cassia fistula
Kydia calycina
Gmelina arborea
Bauhinia racemosa
Butea monosperma
Bridelia retusa
Xeromphis spinosa
Zizyphus sp.
Cordia myxa

The shrub growth is composed of :—

Kydia calycina (young)
Helicteres isora
Hemidesmus indicus
Lantana camara
Desmodium sp.
Grewia hirsuta
Solanum ferox
Solanum indicum
Holárrhena antidysentrica
Eupatorium glandulosum
Vernonia sp.

Climbers are :—

Acacia concinna
Acacia caesia
Entada scandens
Calycopteris floribunda
Smilax sp.
Asparagus racemosus
Clematis sp.
Jasminum sp.
Ventilago sp.
Vitis sp.

Common grass species include :—

Cymbopogon flexuosus
Cymbopogon citratus
Imperata arundinacea
Andropogon contortus
Themeda cymbaria
Themeda imberbis
Spatholobus roxburghii

(1) (*b*) Sub-types :

C. R. Ranganathan in his working plan for Nilgiri Division classified this type of forest in Mudumalai into two sub-types namely: (1) a belt of non-teak forest along the southern boundary of Mudumalai range and south western portions of Benne (areas of heavy rainfall), and (2) where rainfall is less, with teak always present. Though the original floristic difference is still discernible, it has been greatly altered due to forestry operations, extraction of teak etc. These two types are discernible in the adjoining Kerala Wynad forests too.

Where teak is prominent, the forest is upto 20 metres in height, canopy is more or less closed, soil is reddish and deep, ground vegetation is thin and herbaceous, typically wild arrowroot and occasional patches of wild turmeric. Few *Helicteres, Solanum, Flemingia, Desmodium* etc., occur and where forest is disturbed, *Eupatorium* and *Lantana* grow in profusion. In summer, the herbaceous cover dies off completely leaving the soil bare. Sapling density (i.e., regeneration rate) is very low. Patches of this type of forest occur on fire protected, well drained hill slopes. They are heavily worked at present and altered in Mudumalai and elsewhere. Opening of canopy results in profuse *Eupatorium* and tall grass—*Andropogon* and *Imperata*—growth. Similar patches occur in Nulpuzha, Mavanhalla, Rampur, Kurichiyat, Begur and Kudrakote reserves of Kerala and Chowdahalli—Bannurgadde areas of Bandipur and most of Nagarhole sanctuary core area where vegetation has not been unduly altered and along Kabini in Kakankote forests.

On steeper slopes where soil is shallow and on the crests of hills, trees are well spaced and less (10-12 m) in height. Density and height increases down the slopes, and in the valley floor there is a sudden transition to deep marshes with swamp grass and thick bamboo clumps (*Bambusa arundinacea*) along the fringes. In area this type of forest is more extensive in the moist deciduous belt.

Benne reserve and Morgan betta area of Theppakkadu in Mudumalai sanctuary, Kudrakote, Padri, Kurichiyat (Narathi betta, Kalimala areas) and Nulpuzha reserves contain patches of evergreen or semi-evergreen forests. *Bambusa arundinacea* is profuse. *Hydnocarpus wightiana*, *Palaquium ellipticum*, *Artocarpus hirsuta* etc., are common.

Gregarious patches of evergreen *Shorea talura* occur in Theppakkadu, Doddakatti in Mudumalai, Chamanhalla area, parts of Beerambadi, Ainurmarigudi and Begur forests of Bandipur and Rampur and Mavanhalla reserves of Kerala.

In the more open forest there is a great preponderance of teak of a wide range of girth classes but *Terminalia tomentosa* is the key species. Soil is of great diversity and there is a lush undergrowth of grass, the height of which depends on closeness of canopy and soil moisture. It is up to 3 metres in open forest, consisting of *Cymbopogon* sp., *Themeda* sp. and *Imperata*. Where canopy is dense, instead of grass there is a mat of *Spatholobus roxburghii*. *Eupatorium* is prolific and *Dendrocalamus* is also common.

Where fire annually sweeps over the forest or where the soil is very shallow and the rainfall less, a retrograded type of the above forest type is met with where the canopy is very open, trees only sapling sized, 3-5 metres tall, and stunted. Mishappen gnarled teak and *Anogeissus* are profuse. There is a thick undergrowth of tall grass and *Phoenix humilis*.

The marshes or vayals are dotted with *Randia uliginosa*, *Butea monosperma*, stunted *Terminalia tomentosa*, *Careya arborea*, *Zizyphus xylopyrus* etc.

(2) **Dry Deciduous :**

The greater part of Bandipur core area is of this type. The rainfall is low and soil rocky. Canopy is open and 6-12 m high. Tree species include

Anogeissus latifolia
Terminalia tomentosa
Terminalia bellerica
Terminalia chebula
Terminalia paniculata
Gmelina arborea
Albizzia odoratissima
Schleichera trijuga
Stereospermum chelonides
Tectona grandis
Pterocarpus marsupium
Dalbergia latifolia
Grewia tiliaefolia
Salmalia malabarica
Dalbergia paniculata
Careya arborea
Odina wodier
Butea monosperma
Stereospermum xylocarpum
Lagerstroemia parviflora
Phyllanthus emblica
Gardenia sp.

The second storey consists of :—

Vangueria spinosa
Wrightia tinctoria
Zizyphus jujuba
Zizyphus xylocarpus
Bridelia retusa
Cassia fistula
Xeromphis spinosa
Xeromphis uliginosa
Santalum album
Kydia calycina
Shorea talura

The undergrowth consists of grasses, *Lantana*, *Eupatorium*, *Phoenix humilis*, *Helicteres isora*, *Desmodium* sp., *Curcuma* etc. (Photograph 2).

(3) **Scrub :**

This is typical of Sigur plateau (Moyar Reserve forest of Mudumalai sanctuary and Moyar state forest of Bandipur sanctuary). The rainfall is very low, soil rocky and is poor in humus. The vegetation is open deciduous scrub or even thorn forest of scattered bushes of no economic value. Sandal occurs sporadically. There are few gregarious patches of evergreen *Hardwickia binata* near Moyar.

TREES

Anogeissus latifolia
Albizzia amara
Derris glabra
Canthium didymum
Elaeodendron glaucum
Atlanta monophylla
Ficus sp.
Cassia fistula
Chloroxylon swietenia
Cordia sp.
Acacia leucophloea
Stereospermum chelonoides
Acacia sundra
Erythroxylon monogynum
Bridelia retusa
Dalbergia paniculata
Santalum album
Zizyphus jujuba
Diospyros montana
Zizyphus xylopyrus
Bauhinia racemosa
Azadirachta indica
Acacia catechu
Shorea talura

The undergrowth consists of :—

Opuntia dillenii
Sentia indica
Toddalia aculeata
Pterolobium indicum
Webera corymbosa
Cipadessa fruticosa
Solanum sp.
Grewia asiatica
Gymnosporia montana
Cassia tora
Cassia auriculata
Argyreia cuneata
Wendlandia notoniana
Clausena wildenovii
Desmodium sp.
Dendrocalamus (sporadic)

This area is subject to very heavy grazing and fire effect.

(4) **Plantations :**

Extensive plantations of teak and species of *Eucalyptus* occur over the entire tract. Plantations are relatively insignificant in the Mudumalai and Bandipur proper area, but occur over large areas of Begur, Kudrakote, Kuppadi, Kurichiyat, Mavanhalla and Rampur Reserve Forests in Wynad in Kerala, of Kalkere and Begur Reserve Forests in Bandipur National Park and Nagarhole Reserve Forest in Nagarhole National Park in Karnataka. Areas of Bandipur and Nagarhole also have thakkal plantations, which are sites of slash and burn cultivation planted with teak in the second half of last century and the first quarter of this century. The thakkal plantations are often indistinguishable from the surrounding indigenous forest, but the larger plantations are not. They are often susceptible to invasion by *Lantana* and *Eupatorium*, and if unsuccessful by weedy tree species such as *Kydia calycina*. The plantation areas tend to be sterile from the view point of wildlife.

VI. Elephant

The major focus of the present survey was on the elephant, and every attempt was made to gauge the population density and the distribution of this animal. This attempt is fraught with many difficulties, and the methodology described above probably failed to surmount the various problems completely. Table 1 shows the details of the elephant tracks and actual sightings encountered during the course of this survey. We have undoubtedly missed some herds and doubly counted others. This

Table 1

The location and numbers of elephants seen at various localities during the survey and the data from the elephant tracks observed

Area and date	Tracks and numbers (approximate)	Sightings
Bandipur core area 15-7-75 to 25-7-75	Two group tracks (M)*	3 aggregation totalling 22, 19 and 28 animals each
Benne 28-7-75 to 29-7-75	Two group tracks (L)* One lone tusker track	One group of 4 Group of 8
Mudumalai 30-7-75 to 2-8-75	Two group tracks (L) one group track (M)	Group of about 24 lone tusker
Kargudi 3-8-75 to 4-8-75	Two lone tusker tracks one group track (L)	two lone tuskers
Theppakkadu 5-8-75 to 6-8-75	One group track (L) one group track (S)*	Makhna Group of 8 Group of 6 Group of 5 Pair of elephants two lone tuskers
Masingudi 7-8-75 to 8-8-75	Group track (M) 3 lone tusker tracks	
Chamanhalla 16-8-75 to 17-8-75	Lone tusker track Group track (M)	A pair of elephants Group of 10
Maddur 18-8-75 to 19-8-75	Lone tusker track Group track (M) two group tracks (S) two group tracks (L)	
Mulehole 20-8-75 to 21-8-75	One lone tusker track two herd tracks (M)	

Area and date	Tracks and numbers (approximate)	Sightings
Rampur 22-8-75 to 25-8-75	two group tracks (S) two group tracks (L) four group tracks (M)	Group of 18 Group of 16 Group of 11 Group of 20 Group of 30 1 lone tusker
Chickbargy 26-8-75 to 28-8-75	3 lone tusker tracks 2 group tracks (L) 4 group tracks (M) 1 group track (S)	1 group of 9 group of 22 group of 5
Moleyur 29-8-75 to 30-8-75	3 lone tusker tracks 1 group track (M) 2 group tracks (L) 2 group tracks (S)	2 lone tuskers group of 11 group of 5
Kalkere 31-8-75 to 4-9-75	2 Group tracks (M) 2 group tracks (S)	Group of 6 Group of 5 Group of about 15 Group of 18 Group of 13
Chowdahalli 5-9-75	4 group tracks (M)	Group of 9 lone tusker
Bannurgadde 6-9-75	1 Group track (M) 5 lone tusker tracks 2 group tracks (L)	Group of 16
Gundre 7-9-75	Group track (L) 3 lone tusker tracks	Group of 6 Group of 3 Group of 7 Group of 7
Byrankuppe 9-9-75 to 10-9-75	8 lone tusker tracks Group track (M)	One lone tusker pair of elephants Group of 8 Group of 8 Group of 10
Kaimara 11-9-75 to 12-9-75	2 Group tracks (S) 4 group tracks (L) 3 group tracks (M) 4 lone tusker tracks	Group of 4 Group of 6 Group of about 16
Sunkadkatte 13-9-75 to 15-9-75	3 lone tusker tracks 4 group tracks (M) 1 group track (L) 1 group track (S)	Group of 18 Group of 19 Group of 15 Group of 25 Lone tusker

* Group track (S)—Small, about 5 animals.
Group track (M)—Medium, 5 to 20 animals.
Group track (L)—Large, more than 20 animals.

Area and date	Tracks and numbers (approximate)	Sightings
Mettukuppe 15-9-75 to 16-9-75	Group track (M) 3 lone tusker tracks	2 lone tuskers pair of elephants Group of 9 Group of 6
Murkal 17-9-75 to 19-9-75	8 lone tusker tracks 3 group tracks (M) 1 group track (L) Track of a pair of elephants	3 lone tuskers Group of 4 Group of 11
Nagarhole 20-9-75 and 22-9-75	2 Group tracks (M) 1 Group track (L) 5 Group tracks (S) 3 lone tusker tracks	Group of 8 Lone tusker
Tittimathi 21-9-75	1 Group track (M) 3 lone tusker tracks	
Tholpetti 27-9-75	3 lone tusker tracks 1 group track (M)	
Chedleth 30-9-75 to 2-10-75	4 lone tusker tracks Group track (M) Group track (S)	Lone tusker
Muthanga 3-10-75 to 9-10-75	Group track (L) 2 group tracks (M) 3 group tracks (S) 3 lone tusker tracks	

data however does seem to indicate that the number of elephants in the area is not insubstantial, and may be somewhere in the vicinity of 1,500 animals, though this is just an educated guess.

Several interesting features emerge from the data presented in Table 1. The greatest concentrations of elephants were met within the Bandipur core area, Rampur, Kalkere, Sunkadkatte, Gundre and Begur (along Kabini) and Nagarhole core area. Smaller concentrations occurred in Theppakkadu area of Mudumalai and in Benne reserve. The entire Kerala Wynad was almost devoid of elephants (see figure 3).

The very noticeable disparity in distribution, with few animals recorded from the heavy rainfall Coorg and Wynad areas, and with a heavy concentration in the dry deciduous forests of Bandipur and along Kabini suggest local seasonal migrations. (Photographs 3 and 4.) Observations reported by the local foresters and tribals suggest that the elephant tends to move out of the wetter parts of the sanctuary complex during the monsoon season into the drier forests of the Mysore plateau. The heavy rainfall, rank vegetation, tall grass, slushy ground, the abundance of blood sucking insects and leeches as well as the normal reproductive cycle of the animal may have a role to play in favouring the animals leaving the wetter Wynad forests during the monsoon season. The movement also appears to be correlated with the ripening of crops in the drier parts. The

Photo 1. View of Brahmagiris in the Coorg Wynad.
(*Photo*: *Sharatchandra*)

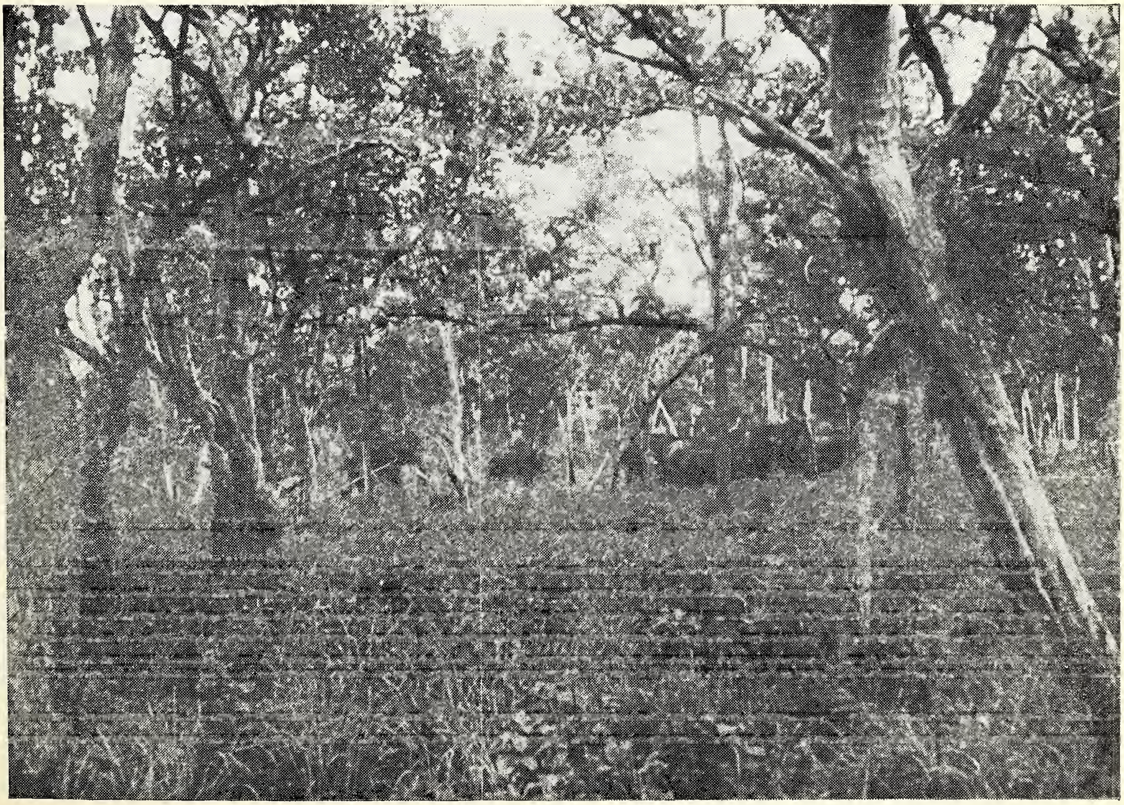

Photo 2. Dry deciduous forest of Bandipur, a typical elephant habitat.
(*Photo*: *Sharatchandra*)

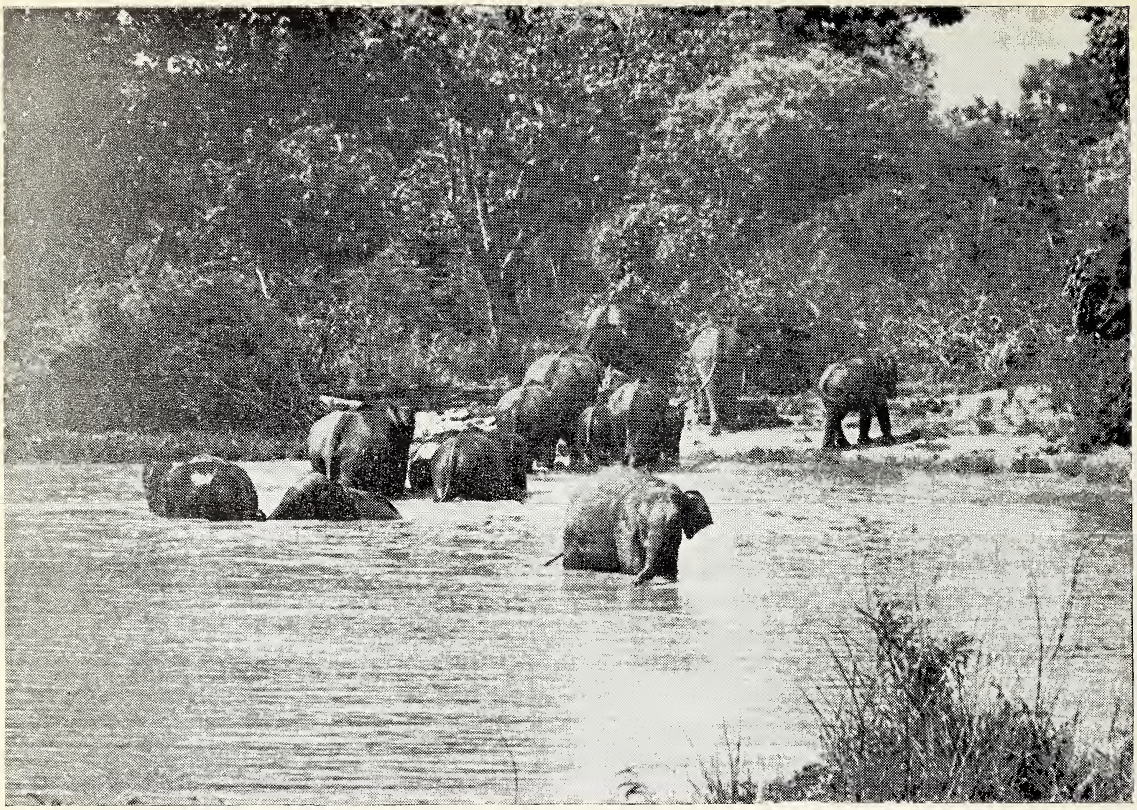

Photo 3. A herd of elephants leaving the Nanjanapura Pond at Bandipur national park.
(*Photo*: *Sharatchandra*)

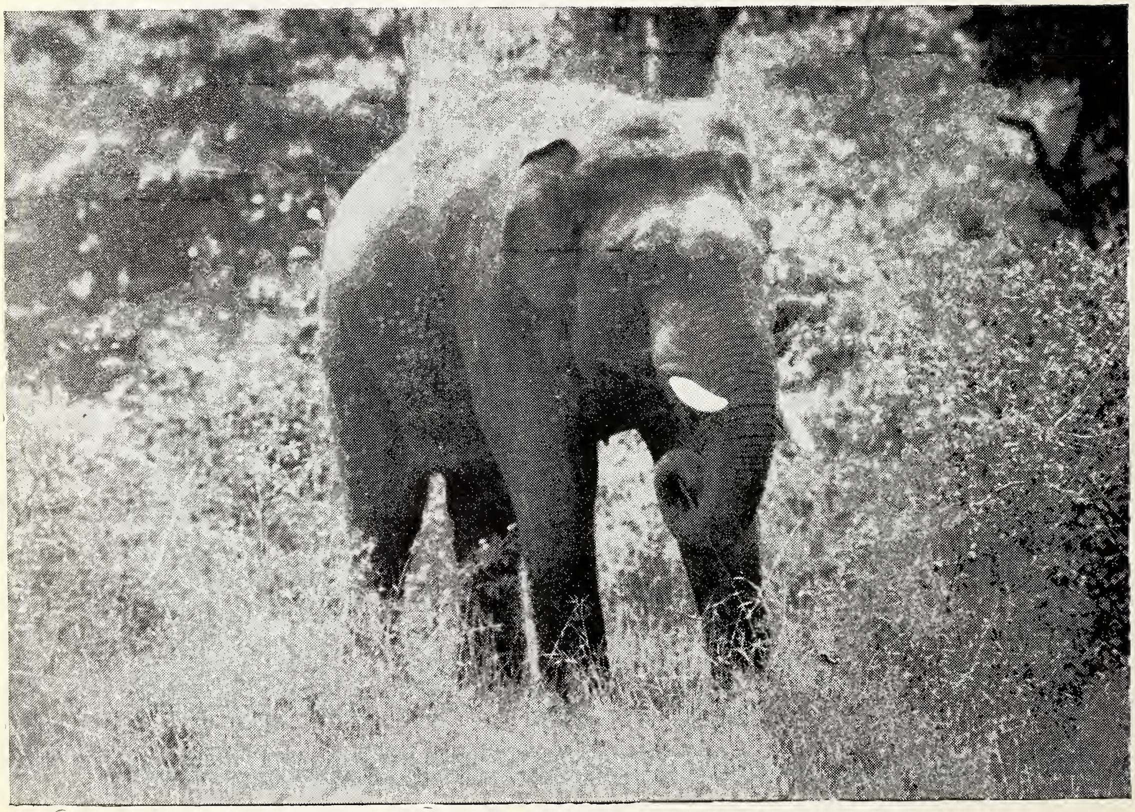

Photo 4. A solitary tusker.
(*Photo*: *Sharatchandra*)

Photo 5. A mouse deer.
(*Photo*: *Sharatchandra*)

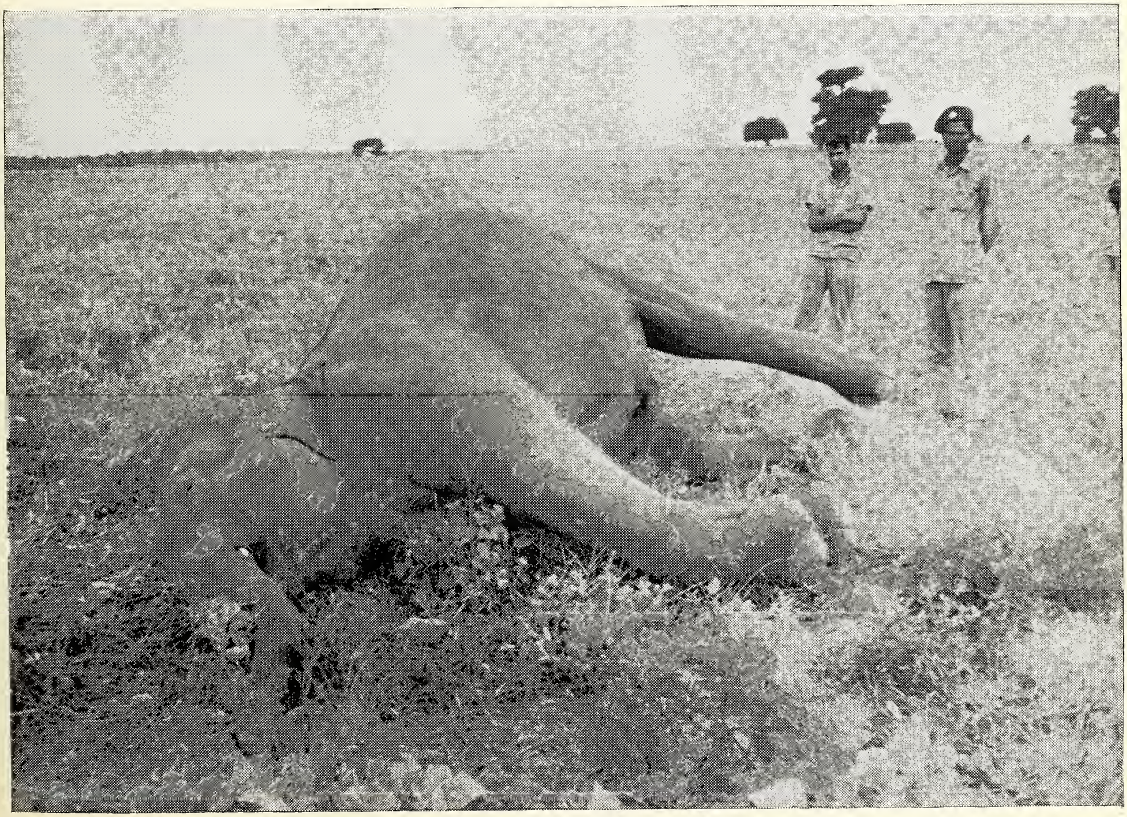

Photo 6. A cow elephant shot while raiding crops.
(*Photo*: *Sharatchandra*)

Photo 7. A chital killed by a fast moving vehicle on the Mysore-Ooty highway.
(*Photo* : *Sharatchandra*)

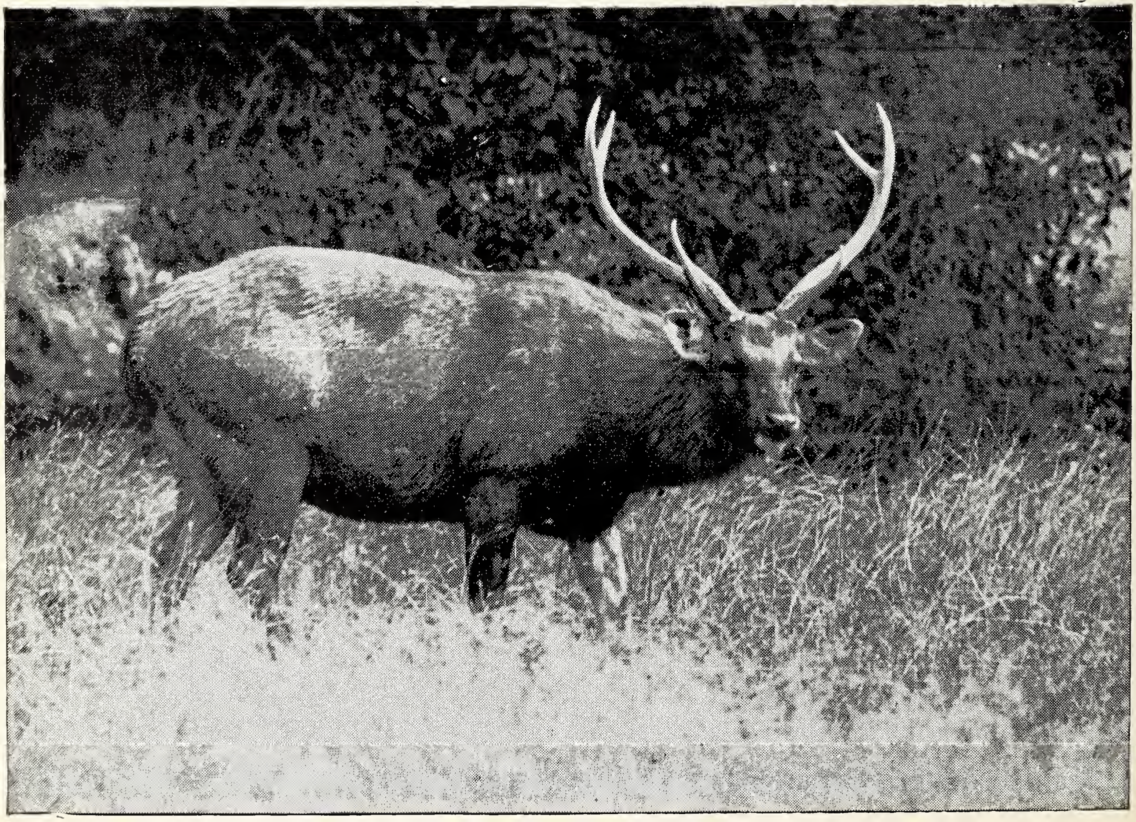

Photo 8. A sambar stag.
(*Photo* : *Sharatchandra*)

Photo 9. A herd of village cattle deep inside the sanctuary.
(*Photo* : *Sharatchandra*)

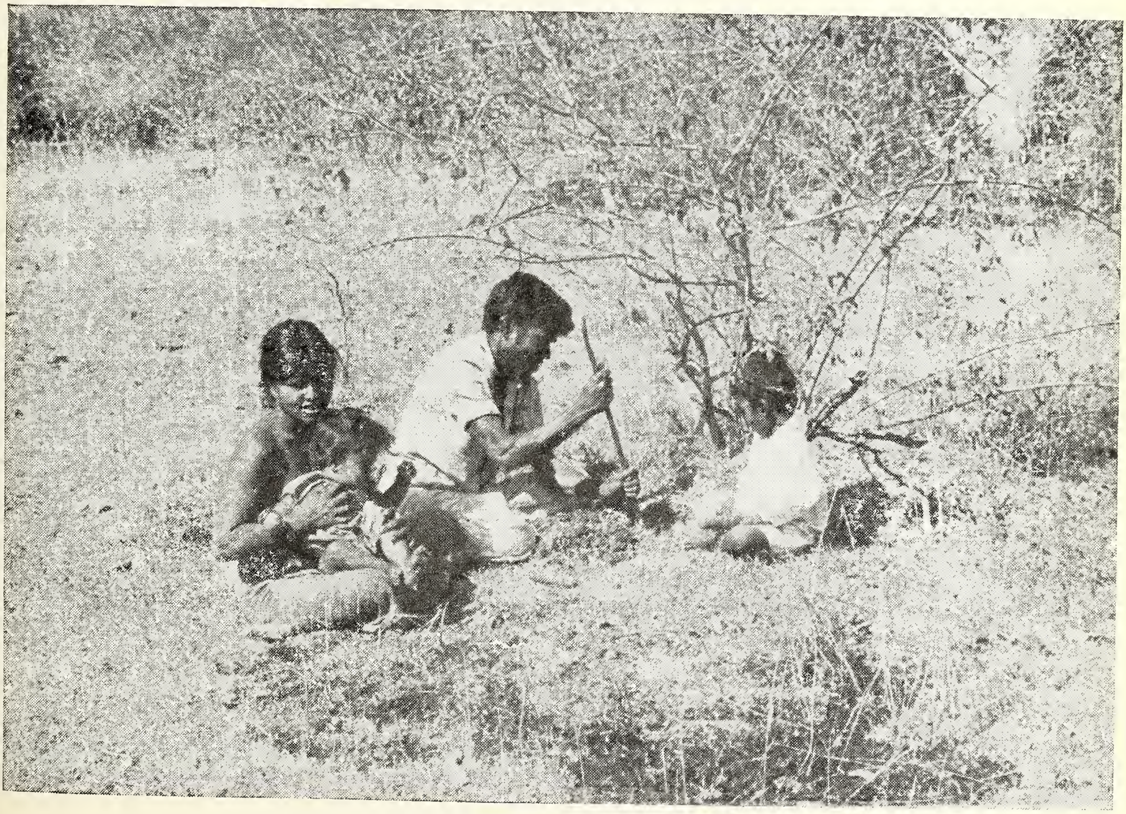

Photo 10. Kadukuruba tribals digging out *Dioscorea* tubers.
(*Photo* : *Sharatchandra*)

elephants were in fact congregated on the boundaries of the cultivation in many localities, particularly near Rampur—Kalkere and Chowdahalli. The fact that in these very same areas the buffer zones between the reserve forests and farm land provided by revenue forests are being removed is notable.

Migrations of elephants were probably much more extensive in the past than they are now. During the course of the survey, we came across a number of places where the traditional routes of the elephants are now in the process of being severed. For example, at Chick Bargi in Bandipur National Park, part of a migration route lying between two hills passes through a low lying area which has recently been put under cultivation. Elephants continue to move through these fields in their passage. Many other migration routes must have been cut off, and the elephants totally prevented access to them.

During the course of these movements, elephants presumably spend the drier months in the wetter forests of Coorg, Kerala and Nilgiri Wynads, this part of their range having a much better supply of fodder and water during the dry months. This summer range of elephants has been much disturbed particularly in the Kerala Wynad region, by the raising of plantations, and encroachment for cultivation. The Coorg Wynad is also subject, though to a lesser degree, to these activities. This must have resulted in a serious depletion of fodder in the summer range, and is likely to result in the degradation of the habitat by the consequent overgrazing by these animals.

The near total lack of elephants in Kerala Wynad is particularly striking. It is no doubt partly due to emigration from this area during the monsoons. However it must also to some extent be due to the tremendous scale of disturbance in those forests. In particular the destruction of the 25,000 acre of tract of Pulpally forest must be the reason for the very high densities of elephants in the Gundre-Begur area of Bandipur National Park.

Finally, though our inexperienced team blundered into unsuspecting herds of elephants scores of times, often at very close quarters, there was no instance of an elephant chasing us intruders. It was always the discrete withdrawal or precipitous flight on the part of the pachyderms. This no doubt goes a long way in identifying those guilty for the elephant's present sad plight.

VII. Other Wildlife

Though the primary purpose of the survey was to obtain data on the spatial distribution pattern of the Indian Elephant, data on flora and fauna was also collected to have a superficial picture of the plant and animal communities of the sanctuary complex. Though no attempt was made to estimate the population of the major animals other than the elephant, locations of concentration of species based on frequency of sightings and spoor evidence was collected. Since the survey party traversed the terrain following no fixed route covering a compact area as intensively as possible, it is expected that a rough indication of the distribution of the reported animals was obtained for the particular time of the year. For a picture of the wildlife concentration points in the survey area see fig. 4.

(1) **Gaur** (*Bos gaurus*) :

In the survey area this large herbivorous species ranges from scrub forest to semi-evergreen forest but seems to prefer undulating hilly terrain with moist deciduous vegetation and moderate undergrowth. Till the 1968 population crash due to rinderpest this species was very common over most of this tract but now the largest remaining aggregation is in the

Nagarhole sanctuary core area. A good population also exists in the Kalkere area of Bandipur National Park. Very small populations occur in Mudumalai, mostly in the Morganbetta area near Theppakkadu and few stragglers in Masingudi, Kekkanhalla and Benne areas of Mudumalai sanctuary. Begur forest of Kerala Wynad also has a small population and stragglers are present in southeast part of Bandipur core area. In addition to the considerable number of gaur in Nagarhole core, Sunkadkatte-Bisalwadikere area of Nagarhole sanctuary also has a good population.

Predation must be restricted mostly to calves. But poaching, though slight because of the restricted distribution at present, does exist. Since the flesh of a full grown animal would fetch a considerable sum, poachers from Kerala Wynad are reported to kill animals in Nagarhole sanctuary and Kalkere area.

Once the population builds up, the threat of communicable diseases like rinderpest would be greater. Though innoculation and checking of cattle exists along most of the interstate routes, preventive measures in local villages and forest settlements are inadequate. The recent gaur deaths in Periyar sanctuary point to the need for constant alertness.

(2) **Sambar** (*Cervus unicolor*) :

Sambar normally prefers broken terrain with thick undergrowth. But they were repeatedly encountered even in the very open scrub of Moyar forest of Mudumalai. The population in the sanctuary complex is subject to predation by most of the larger carnivores and poaching also takes a heavy toll. Though compared with spotted deer they were infrequently encountered, they are distributed over the entire survey area and considerable numbers exist in the Nagarhole core area, Kalkere area of Bandipur and also along the northeastern portions Begur, Kurichiyat, Rampur and Mavanhalla reserves. (Photograph 8.)

(3) **Chital** or **spotted deer** (*Axis axis*) :

This is the most significant prey animal in this tract. It favours plains with rather open vegetation and has the tendency to congregate around human habitations. Very large congregations of this species occur in the Masingudi area of Mudumalai, Bandipur park headquarters area and Nagarhole core area. Opening up of forests by man for plantation activity is helpful to this animal. Their considerable number, gregarious habit and tendency to favour open forest result in heavy poaching. In Bandipur park headquarters area domestic dogs have developed the habit of killing the fawn and immature animals. The largest single aggregation seen during day time numbered over 150 animals in Moyar forest of Mudumalai. (Photograph 7).

(4) **Wildboar** (*Sus scrofa*) :

Together with Chital, wild pig forms the most plentiful prey animal. It is extremely adaptive and occurs in every type of terrain and survives the very heavy poaching pressure in parts of Wynad. The impenetrable thickets that smother cleared land afford shelter and hence the intrusion of *Eupatorium* and *Lantana* should have favoured this animal. They are most numerous in the marshlands with soft soil and succulent vegetation. Due to their frequent occurrence in degraded forests around cultivations from where they regularly raid the crops, conflict with man is frequent and poaching of this species is perhaps heaviest. A single party of 18 animals with 9 piglets from two litters numbering 5 and 4 was encountered in the Nagarhole sanctuary at Hasihindalkadalu near Mettukuppe.

(5) **Four horned antelope** (*Tetracerus quadricornis*) :

This animal is very rare and in the entire sanctuary complex reliable reports suggest its occurrence only in the Sunkadkatte-Bisalwadikere area and the only animal actually seen was near Bisalwadikere, a very open savannah type of habitat. Obviously this interesting animal needs careful watching over to prevent any further reduction of the population.

(6) **Barking deer** (*Muntiacus muntjak*) :

This beautiful, elusive animal is possibly far more numerous than is apparent from sightings and track data since it frequents thick undergrowth, is solitary and is extremely wary. Because of these very same reasons poaching of it might not be heavy. This animal forms another important prey animal for the larger carnivores.

(7) **Mouse deer** (*Tragulus meminna*) :

Like the barking deer the Indian chevrotain or mouse deer also occurs over the entire tract in considerable numbers as was evident from the track data. It prefers very thick undergrowth hence is commonest in overgrown plantations. Trapping of this animal, especially by crush traps must be heavy along the periphery of the forest, for example, in the Beerambadi-Maddur area. (Photograph 5).

(8) **Blacknaped hare** (*Lepus nigricollis nigricollis*) :

Grasslands and open forests, even glades in the thicker forests constitute the habitat of this common animal. They survive in very degraded forests along the edges of cultivation and hence get heavily trapped or otherwise poached. It must also form a major food item for most carnivorous mammals and birds.

(9) **Tiger** (*Panthera tigris*) :

Based on track evidence, tiger seems to occur widely in the sanctuary complex with no specific preference for particular habitat type. They seem to frequent the following areas : Doddakatti, Kargudi, Kekkanhalla, Bandipur core area, Kalkere, Rampur, Bannurgadde, Kaimara, Bisalwadikere-Sunkadkatte, Nagarhole core area and Dasankatte area of Kerala Begur. In Nagarhole sanctuary near Mettukuppe between Madamahalli cart track and Mathanahallikkadu on Nagarhole stream, extremely frequent movement of more than one tiger and also of leopards was noted. Conflict with cattle graziers (who might then attempt to poison tigers) could adversely affect this totally protected species. Bandipur National Park being a project tiger area, is primarily conceived as a tiger reserve and the official estimate of the tigers within this reserve is about 19 animals. The only animal encountered during the survey was in the Begur forest of Kerala Wynad.

(10) **Leopard** or **Panther** (*Panthera pardus*) :

This perfectly camouflaged, highly adaptive carnivore occurs not very rarely over most of the survey area but seems to occur most commonly in the overgrazed degraded forests. Most of the cattle lost to carnivores could be attributed to it. Leopard is the sole predator of the larger arboreal mammals in this area. The pug marks were most frequent in the Moyar reserve of Mudumalai and in Nagarhole core area and also Sunkadkatte area. In addition, Morganbetta area and Kekkanhalla area of Mudumalai, Rampur-Kalkere area of Bandipur and adjacent parts of Kerala Wynad along the boundary (Rampur and Kurichiyat reserves) and also Begur reserve along Karnataka boundary appear to be their favoured haunts.

(11) **Sloth Bear** (*Melursus ursinus*) :

Sloth bears are widely distributed over most of the survey area especially in the more open drier forests. Their numbers apparently are highest in the Doddakatti area, Mudumalai camp area and around Masingudi in Mudumalai sanctuary, Bandipur core area, the interstate border areas of Rampur, Mavanhalla reserves of Kerala Wynad and also Sunkadkatte-Mettukuppe areas of Nagarhole. Of the six occasions the animals were encountered, thrice it was in Rampur-Mavanhalla reserves of Wynad (once a pair), once in the Begur reserve, once in Kurichiyat and once in Nagarhole sanctuary core.

(12) **Dhole** or **Wild Dog** (*Cuon alpinus*) :

Over most of the sanctuary complex wild dog appears to be plentiful which may perhaps be an exaggerated impression due to their high mobility. This pack hunter was most frequently encountered in Mudumalai camp area, Masingudi and Theppakkadu of Mudumalai sanctuary, Kaimara area of Bandipur, over most of the Nagarhole sanctuary especially Sunkadkatte area and Begur forest of Kerala near Karnataka boundary. They were not at all seen in the remaining portions of Kerala Wynad.

In the characteristic human way, this carnivore is branded a 'vermin' and is killed indiscriminately, especially since it has no trophy value either.

(13) **Jackal** (*Canis aureus*) :

Jackals prefer open scrub and degraded forests near human habitations and are apparently infrequent in most of the sanctuary area. The only animals encountered were a pair near Masingudi in Mudumalai. They are not infrequent in parts of Kerala Wynad.

One member of the survey party and a forest departmental staff saw an animal in Kattikulam reserve forest which could be the Indian fox (*Vulpes bengalensis*).

(14) **Striped Hyena** (*Hyaena hyaena*) :

Hyena is reported to occur in the scrub forests around Masingudi though none were seen.

(15) **Hanuman langur** (*Presbytis entellus*) :

Hanuman langur occurs in fairly tall, canopied but rather open forest in most of the surveyed tract but the distribution is highly sporadic. They were most commonly seen over most of the Mudumalai sanctuary except Benne forest but occur in Moyar forest along the stream banks. They are fairly numerous in Bandipur sanctuary but very sporadic in most of the other areas. Along with one troop of Hanuman langur in Morganbetta area a black coloured animal—most probably a Nilgiri langur—was seen on two occasions and the same animal had been reported by local officials also. The animals were extremely shy in most of the areas outside Mudumalai.

(16) **Bonnet macaque** (*Macaca radiata*) :

Bonnet macaques are not very common within the sanctuary complex and occur mostly along the periphery, near human habitations. They were seen at Kargudi, Theppakkadu, Benne and Kekkanhalla area of Mudumalai, Bandipur, Maddur and Mulehole areas of Bandipur national park and Muthanga area of Wynad, everywhere near settlements. Troops were also seen deep inside the forest in Kaimara-Rampur areas and in Mavanhalla reserve.

(17) **Giant squirrel** (*Ratufa indica*) :

This occurs throughout moist deciduous and semievergreen habitat in the survey area but in more open forest is very rare or absent. The largest numbers were encountered in Mudumalai sanctuary excepting Moyar reserve. Nagarhole sanctuary and undisturbed forests of Kerala Wynad also have fairly good populations. Poaching pressure on this animal is not very heavy.

(18) **Peafowl** (*Pavo cristatus*) :

Peafowl occurs over most of the surveyed area but heavy poaching and trapping has reduced the population considerably in most of the area. It apparently prefers scrub and deciduous forest. Concentrations of peafowl within the sanctuary complex are in Masingudi area, Theppakkadu, Bandipur core area, Chickbargi, Sunkadkatte, Nagarhole sanctuary core area and border areas of Kerala Wynad in Begur, Kurichiyat and Rampur reserves.

(19) **Crocodile** (*Crocodylus palustris*) :

Together with the carnivores, this reptile has been persecuted by man heavily and has been almost wiped out in most of its previous haunts. Any undisturbed stream with deep pools and adequate prey is potential crocodile habitat. It might have existed all along Kabini, Nugu, Lakshmantirtha, Panamaram puzha, Nulpuzha, Mannantoddy puzha and Moyar but it was encountered within the survey area only in the Kuruva Island reserve in North Wynad. This reserve does not actually come within the sanctuary limits. Reliable information is available on the existence of crocodiles in Nugu. Two animals were seen in Kuruva. Though this highly endangered species is given total protection by wildlife act, actually it is receiving little protection. Poaching does take place in Kabini. Since the small population of crocodiles existing within the sanctuary complex is distributed along the river downstream from Kuruva amidst the large number of small islands, with encroached Pulpalli lands on one side and cultivated revenue lands on the other at least in part of the area, poaching is hard to control. At least one instance of crocodile meat openly put for sale from a poached animal occurred in 1974.

(20) **Species introduction :**

Introduction of animals by man into a habitat where they never occurred previously, is generally harmful to the concerned ecosystems and is not a recommendable step. But reintroduction of species into habitat wherefrom they were wiped out should be an essential conservational measure. The reintroduction of thiee species of threatened animals into this sanctuary complex should be contemplated.

(i) Blackbuck (*Antilope cervicapra*) :

This plains dwelling herbivore, the only Indian antelope, was widely distributed over the entire Deccan plateau including part of the present-day sanctuary complex but is so greatly reduced that the only large population in south India is in the Point Calimere sanctuary, Tamil Nadu. The habitat of this animal is comparable to that of Masingudi area—Moyar, Averahalla and parts of Kalmalai Reserve. If the cattle grazing is restricted in this area it could form an ideal Blackbuck habitat enriching the fauna of the sanctuary and providing an alternate breeding nucleus of Blackbuck.

(ii) Nilgiri tahr (*Hemitragus hylocrius*) :

The ' mountain goat ' of the Western Ghats is another threatened species of herbivore that could be reintroduced into its former haunts. The Brahmagiri range was tahr habitat till recent times and records of tahr sightings in the Periyar reserve of Kerala, not far removed, date as recent as the early 1960's. The Brahmagiri sanctuary and its western Kerala slopes should form a composite protected area connected with this complex and tahr could be reintroduced here. Tahr at present survives in adequate numbers only in the Nilgiri escarpments and the Eravikulam area of Kerala High ranges.

(iii) Primates :

This sanctuary could also become a haven for the Nilgiri langur (*Presbytis johni*) and perhaps the liontailed macaque (*Macaca silenus*). As no detailed survey of the Brahmagiri sanctuary nor the western slopes in Kerala were conducted, first hand information on the distribution of these species is not available but local information suggests the total wiping out of these two animals there.

VIII. Conservation

(1) Maintenance of habitat integrity :

No part of a self-perpetuating natural ecosystem could be preserved for any length of time in isolation. It has to be conserved as a natural unit irrespective of administrative or political boundaries. Wild elephants cannot be preserved independently of their habitat. To maintain a genetically viable population of a large, highly mobile, gregarious, herbivorous species like the elephant in an area where the availability of forage and water are prone to drastic seasonal fluctuations, a significantly large undisturbed area must be left aside. More than direct poaching, the most serious threat to this population of elephants is the alarmingly rapid and continuing fragmentation of its habitat due to a variety of reasons ranging from deforestation, extension of plantations, agriculture, dams and other construction activity (see fig. 3).

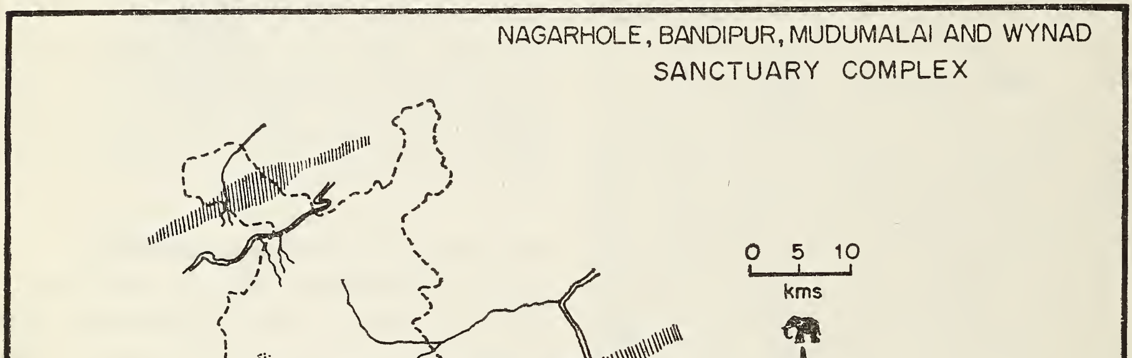

Fig. 3. Elephant concentrations and habitat discontinuities in the proposed Jawahar National Park.

In this sanctuary complex, the carrying capacity of the habitat is low in summer except in the Nagarhole core area, along Kabini (Kakankote and Begur Reserve Forests), along Moyar in Mudumalai forest and in Benne Reserve Forest as well as the whole of Kerala Wynad where plantations have not extended destroying cover and forage. From the food and water availability in Kerala Wynad this area seems vital for the elephants in the survey area in summer. Forest officials and local information confirms the annual summer influx of elephants into Wynad but unfortunately poaching and habitat destruction are severest here. In the entire Wynad wildlife sanctuary of Kerala, the only sufficiently large areas with natural forests that can support elephants are in the Northeastern portions of Begur, Kurichiyat, Mavanhalla and Rampur Reserve Forests. All the remaining areas are pock-marked by plantations and cultivations. Further reduction of forests here would certainly adversely affect this elephant population south of Kabini.

For the continuity of this elephant habitat and for the integrity of the population of elephants, the most serious and immediate threat is the Kabini project, the impounded waters of which meeting with the Pulpally encroachments in Kerala, threaten to cut this population into two distinct halves. On the south bank of Kabini in Kerala, opposite the Kakankote forest of Karnataka, the Pulpally forests along the river for a length of 8-13 kilometres, encompassing an area of about 25,000 acres have been encroached upon and clear felled during the last one decade. Further north along Kabini, the reservoir waters would be too wide for the elephants to cross from one bank to the other.

Near Baveli, in Karnataka along the Kerala State Border, forests are being clear felled for plantations which will further hinder movement of elephants from one state to the other. Those that do move into the Begur Reserve Forest of Kerala from Karnataka forests will not be able to move into any other forest to the south in Kerala, since beyond Padiri Reserve Forest (which is outside the sanctuary), the Pulpally encroached lands rule out the movement of all animals. To the west from Begur Reserve Forest the Kudrakote Reserve Forest is so greatly altered that elephants will not find it easy to pass on to the north—the Thirunelli area.

In Karnataka along Kabini on the eastern side, in the Gundre-Begur area, elephants congregate in summer from adjacent drier Mysore Plateau forests. These forests are the prime haunts of elephants but besides the large tract submerged by the Kabini reservoir, vast areas are being cleared for resettling people evacuated from the cultivated lands submerged due to the project. Forests around the once famous Kharapur have given place to hard baked fields, the same ' development ' is taking place in Begur and Gundre.

The Tittimathi forests and Kachuvanchalli forests, north of Lakshmantirtha river is yet another area famous in the olden days for wild elephants where they now face severe pressure. The Hadlu cultivators (encroachers cultivating the wetlands in these forests) denying the use of the marshy areas to the animals and the disturbances caused by these people have rendered these areas almost devoid of wildlife. Poaching even of elephants is also reported.

In Bandipur national park, an area of severe pressure on the elephants and its habitat is along the Gundlupet—Sultan's Battery road, from Beerambadi—Maddur to Mulehole. The revenue forests along the reserve boundary in this area, which had acted as a buffer for so long, are all being cleared. Unless habitat degradation is arrested in this area immediately, this would become a bottleneck restricting free movement of the animals across.

The position in Kerala Wynad is by far the most alarming. Already the sanctuary part is in two isolated halves with cultivation in between. In the northern half, the Kudrakote Reserve Forest (west of Mannantoddy—Mercara road) originally of rich moist deciduous vegetation with plenty of available water has been extensively clear felled for plantations rendering it practically non-usable by elephants. Further south, the small Edakode Reserve Forest and Kattikulam Reserve Forest, south of the Kattikulam-Baveli Road are ringed in by cultivations.

In the southern half, the Kuppadi Reserve Forest is practically cut off from all other forests to the west by cultivations. There are two slender links between Kuppadi Reserve and Kurichiyat Reserve, one through Malappadi west of Chedleth Rest house and another between 3rd and 5th miles along S. Battery—Chedleth Road, which might permit elephants to enter. The reserve is heavily grazed, disturbed and elephant poaching cases in recent years are many. Kallur Reserve, Alathur Reserve and Edathori Reserve are small reserves with cultivation all around.

Mavanhalla, Rampur and Kurichiyat reserves are large in extent but even here extensive plantation activity is going on. Even the narrow belt of natural vegetation along the interstate boundary is heavily grazed except in a few localities and poaching appears to be very common. The entire western boundary of Kurichiyat Reserve is subject to heavy human disturbances from the encroachers in the Pulpally area from which the reserve is separated only by a stream—the Kannegalhole or Kannaram puzha. The Neminad Reserve south of S. Battery—Gudalur Road is also isolated and reportedly plans are afoot for clear felling and planting the entire reserve.

In Mudumalai sanctuary, the southern edge of the Kumbarkolli Reserve where it faces Nilambur Kovilakam patta lands and also the extreme eastern portion near Moyar, Singara and Mavanhalla villages face very heavy grazing pressure. Poaching in the forest to the east outside the sanctuary to the Anaikatti area impede movement of elephants from Nilgiri escarpments to Masingudi area.

Though this sanctuary complex by Indian standards covers a large area of forest extensions are suggested to include adjacent habitat types harbouring endangered species not seen in the existing sanctuary area but where they had been exterminated recently and where they could be reintroduced successfully. Bringing under the protection of sanctuaries those corridors that provide links with other extensive forest tracts is essential to retain avenues for free movement of wildlife.

The present sanctuary complex does not have any west coast tropical evergreen forest within its confines. Brahmagiri sanctuary in Coorg has the evergreen shola-grassy down habitat so typical of Kerala high ranges and Nilgiris. Including this sanctuary and linking it up with the Nagarhole-Bandipur complex would enrich the variety of scenary and biota of the complex. While the Brahmagiri sanctuary is situated on the eastern slopes of the Brahmagiri range, the Thirunelli, Kambanmalai, Thrissileri, Kottiyoor forests cover the western slopes. These rich evergreen forests in Kerala should also be given protection by declaring them as a sanctuary especially so since they contain a small relict population of Nilgiri langur and harboured Nilgiri tahr till very recent times. On reintroduction, if protected, these species would thrive in the rolling grassy hillocks of the Brahmagiri range.

In the Kerala Wynad between the ravaged Kudrakote Reserve Forest and Coorg border, the Alathur Reserve (of Begur range) containing very rich bamboo forest should also be included in the sanctuary as it supports a good population of elephants. Ideally the entire belt of forest along the Coorg Kerala border should become a protected area.

Kuruva Island reserve is another forest area highly recommended for inclusion within the sanctuary complex. This reserve besides being ecologically and floristically notable, harbours crocodiles too. The belt of forest including Kalmalai reserve linking the Mudumalai sanctuary with the Nilgiri escarpment forests should also be brought within the sanctuary to safeguard this corridor enabling unhindered movement for wildlife from Nilgiris right across the plateau to the western ghats.

(2) **Buffer Zones :**

The degradation and consequent destruction of forests by human activity is an insidious process most apparent along the forest edges where the intact biotope can be seen being nibbled away. Any forest ecosystem that is to be kept intact should have a peripheral buffer zone for absorbing the unavoidable human interference. But unfortunately, instead of creating buffer zones all around the outer perimeter of existing sanctuaries and reserves, the trend is to remove all existing buffer zones. This actually points to the lack of a co-ordinated national policy of land management and an integrated agency for directing and implementing it. The consequences are an irreversible deterioration of land, both forested and cultivated.

Conservation of any forest ecosystem depends vitally on the existence of a buffer zone around it to absorb the unavoidable human interference. Revenue forests, lying between the reserve forests and villages, everywhere used to serve this purpose. Release of these revenue forests for cultivation in many areas is bound to have a deleterious influence on the sanctuary.

In Bandipur National Park, along the western margin of Beerambadi forest, for example near Maddur, there was a belt of revenue forest, ecologically indistinguishable from the reserve forest. This entire belt of forest is being or has already been clear felled and handed over for cultivation. These forested areas formed a buffer zone between the village lands along the Gundlupet S. Battery road and the reserve forest, shielding the latter from the human exploitational pressure. In the process the revenue forests were overgrazed and overfelled. The same fate will befall the reserve forest now that the protective buffers are lost. The uncontrolled denudation of revenue lands in this particular tract will have far reaching detrimental ecological consequences. The reserve forests clothe the rocky, steep slopes of the Gopalswamibetta and its spur hills whereas the revenue forests are on the foothills and on the edge of the plains. Destroying the vegetation cover along the many rocky streams where they debouch from the steep hillsides will lead to destructive erosion and alter the hydrology of the farm lands in the plains. This is taking place in Moleyur area too.

In Kerala Wynad, the former private forests now vested with the Government, often lie adjoining the sanctuary and the reserve forests. The management of these vested forests is at present in no way compatible with the concept of protecting the adjoining sanctuary. The Kakkodan vested forest is an ideal but not an isolated example.

The tragic consequences of the lack of buffer zones on the adjoining reserve forests are very apparent in the Mudumalai sanctuary towards Thorapalli in compartments 20 and 6 facing the utterly devastated Nilambur Kovilakam patta lands. The forests are heavily overgrazed, lopped and poaching is heavy. The Pulpally encroachments, just a decade back sylvan forests, now stand as charred stumps and countless hutments. The spill-over ecological effects and inroads made by the expanding population here will have irreparable and costly effects on the reserves of Kuppadi, Kurichiyat and Padiri and will affect the entire Wynad plateau.

(3) **Forestry operations :**

Interests of nature conservation and forest management for exploitation are not necessarily incompatible. It should certainly be possible to organize forestry operations in such a way that the wildlife interests are safeguarded without drastically reducing the sustained yield from the forest.

Certain core areas should be designated as sanctum sanctorum areas, and left totally untouched. These should be chosen so as to represent all the rich diversity of vegetation present in this sanctuary, and this diversity should be maintained intact. These sanctum areas will serve as the stores of genetic variability wherefrom the future generations can find or develop useful or even essential requisites. As far as possible, this indigenous vegetation should form a continuous belt of forest, as it is well known that a continuous piece of habitat is much more valuable for the maintenance of biotic diversity, than the same area fragmented into a number of habitat islands. As of today, all the Bandipur National Park is set aside for conservation without any forestry operations being allowed. Nevertheless, heavy human disturbances do affect many parts of that National Park also. The sanctum sanctorum area of Nagarhole is not free of forestry operations, and should be made so. There are no such sanctum areas in Mudumala or Wynad.

Selection felling could continue outside the sanctum sanctorum areas. Selection felling, on the whole does not disturb the habitat as much as clear felling, and is preferable to the latter practice within the sanctuary areas. Even here, provision should be made to leave a few of the large sized, overmature trees standing, as these furnish many important requisites for the wildlife, such as nest holes.

Plantation activity should be kept at a minimum within this sanctuary complex. The plantations of single species of trees are very sterile from the point of view of the biological community as a whole. They are also subject to invasion by *Lantana* and *Eupatorium*. The thick growth of these weeds is of little forestry or wildlife value. They choke out all tree saplings and other plants, and cause severe fires. *Eupatorium* is not touched by any birds or mammals—elephants avoid it like plague. The plantation areas are leased out for the so-called taungya cultivation for two to three years in Kerala and other places. These cultivators often cause great disturbance to the wildlife. There should be strict supervision to ensure that they are taking proper care of the plantation, checking fires in the plantation area, and not indulging in poaching.

Bamboo forms an important component of the vegetation throughout this sanctuary complex. Its shoots are relished by elephants and other wild animals. It also serves the function of holding soil on stream banks. Bamboo flowers gregariously, and the whole crop dies on flowering. Such gregarious flowering and mass death of bamboo clumps has occurred over much of the sanctuary complex during the past twelve years. It is a matter of grave concern that the bamboo crop has totally failed to re-establish itself over many areas following the last gregarious flowering, thus wiping out an important forest produce and source of nourishment for wildlife. Excessive exploitation, fires and overgrazing are the three major causes of this. Serious consideration should be given to checking all of these over the sanctuary complex in future.

Development is often equated with the construction of roads. But if the roads are through forests, it is often the beginning of the end for the forests. Roads accelerate degradation of forests directly and indirectly. Besides fragmenting the habitat, they provide with equal impartiality access for woodcutters and poachers, cattle graziers and smugglers. The opened up canopy encourages the strangle growth of *Lantana* and *Eupatorium*.

The entire survey area has a lengthy network of forest departmental and public roads; in addition there is an extensive coup and bamboo extraction road network. These coup roads are always left intact honey-combing the entire forest, allowing the jeep and flashlight poachers and illegal woodcutters in bullock carts easy access. These roads should be rendered unserviceable as soon as the original purpose is served by cutting deep trenches across where they join the permanent roads.

Another ill conceived development of the last few years is the construction of unnecessary panchayat roads etc., cutting through forests. Many such roads were opened as part of drought relief programme often through forests just because land was free. The Moyar-Mavanhalla panchayat road and Nagampalli-Muthukuli road in Mudumalai, the H. D. Kote-Murkal new road through Hotgot forest in Nagarhole and Mettukuppe-Murkal road are some examples.

Private individuals are issued passes for the collection of dead firewood from many forest areas within the sanctuary complex. They are a source of great disturbance, and have a tendency to create dead wood by cutting down living trees. It would therefore be desirable if issuance of such passes is altogether cancelled, and the dead wood collected under departmental supervision and issued from the depots, just as the issue of licences for collecting bamboos for basket-weavers has been stopped.

(4) **Water Resource Development :**

A number of reservoirs have been constructed, or are under construction, or are proposed to be constructed throughout this sanctuary complex. There are in addition to the gigantic Kabini project in the heart of the area, the Nugu dam and Moyar power house along the periphery in Karnataka and Tamilnadu respectively. Though of a much smaller size, the Maruvakkandi dam in the Masingudi area of Mudumalai and the Taraka dam under construction near Mettukuppe in Nagarhole sacntuary have submerged and altered a considerable area of the habitat. A small dam is being built at Moolapura in Bandipur. Though now shelved, there was a proposal to construct a dam across Moyar in Theppakkadu area of Mudumalai sanctuary which would have completely destroyed the best part of Mudumalai forest. There are some projects under investigation in Wynad part of Kerala too.

The devastation brought about by the dam during construction activity and by the subsequent backing up waters is irreparable and extensive. The Kabini project alone has submerged or otherwise resulted in the destruction of the best part of Kakankote and Gundre-Bagur forests. The best part of the elephant habitat in the entire survey area is being destroyed by this project. In addition to the vast area inundated (5000 acres) still more extensive areas of forest has been deforested (10,000 acres) for resettlement of displaced people. Nisna Bagur spreads raw and barren over the hills, till so recently verdent woods. In this state with a comparatively low population density, other equally suitable lands could have been located for resettlement. 3,000 more acres are set aside for clearing in future. Moreover the resettlement done unscientifically will damage the project itself by accelerating silting up. For the elephants completion of the Kabini project, beside depriving them of the best part of their range, has also resulted in severing the population into two isolated halves. Because of this, the optimal density of elephants this tract can support will get reduced considerably especially in summer.

On the other hand effectively protected and developed along properly planned lines, these water bodies can enhance the recreational value of the habitat, create more variety of niches and by being the congregation points for wildlife in summer become focal points for tourists.

(5) **Cultivation :**

Enclaves of cultivated land in the otherwise extensive reserves are nothing exceptional in India but in this particular tract this kind of cultivation is most extensive. The entire Wynad plateau is dotted by marshlands most of which are occupied by cultivators. These lush moist nuclei of wildlife also control the stream flow over the entire tract. These marshes are usually interconnected, girding the gentle hills and most of the extensively used wildlife trails meander along their edges. Even those under cultivation but where poaching is not heavy remain foci of wildlife congregation (for example ' Kurichiyat vayal '). The list of major wildlife areas in the survey area given elsewhere attest to their importance. The more grassy open terrain dotted by thickets providing cover and plentiful water round the year must be the attractive features. In Kerala Wynad very few vayals remain uncultivated. Most of the accessible ones are cultivated mostly by encroachers and those deep within the forest are occupied by Chetties on lease who do not disturb the surrounding forest or wildlife unduly. But their huge unproductive cattle population cause a great deal of destruction, grazing and trampling and directly competing with wildlife to the latter's exclusion.

In Mudumalai sanctuary too many of the vayals are under cultivation in the Mudumalai reserve. The Tittimathi forests of Nagarhole are almost devoid of wildlife due to the very wide-spread Hadlu cultivations.

The best growth of the large bamboo (*Bambusa arundinacea*) is found along the edges of the marshes and elephants invariably congregate here. The soft soil and abundance of tubers and bulbs attract wild boar and most other herbivores. The preservation of marshes is most essential since they are the richest part of the ecosystem supporting a variety of wildlife, are the favoured haunts of elephants and also key-holders of the perennial stream flow. As a part of the ecosystem restricted to this locality and about which so little is known, for future studies at least some of these undisturbed marshes should be totally protected.

Scenically they are a most attractive feature of the sanctuary. The gently sloping hills with dark, rank vegetation and huge feathery bamboo clumps giving way abruptly to tall waving grass with small isolated thickets of trees and the streams along the centre with huge wild mango trees (*Mangifera indica*) and screw pine thickets are very beautiful.

Most of the fertile land along streams, river banks and most of the marshes are cultivated in Kerala Wynad either leased out by the forest department or from the revenue department. Since wildlife too prefers this type of habitat, conflict is unavoidable, predictably always to the detriment of the latter. Their very nature, encircling and isolating the forested hillocks, leads to the total fragmentation of the habitat once these marshlands are under cultivation. The remnants of the wildlife will have to run the gauntlet of guarded paddy fields or other cultivation to cross from one patch of higher ground to another where alone they can shelter from persecution. Hence the often voiced justification of ' crop protection ' gun and the menance from ' crop raiding wild animals '.

Specifically, the Ombatta Vayal and the Cheenakolli Vayals in Mudumalai should be completely protected. Similarly, the cultivators from the Kurichiyat Vayal and Golur Vayal in Kerala Wynad should be relocated, and these vayals be left as permanent resources for wildlife. The hadlus in Nagarhole sanctuary should also be maintained intact.

In addition to these pockets of cultivation within the sanctuary, cultivation is encroaching on the wildlife habitat all along the periphery of the sanctuary. As mentioned above, most of the revenue forests are being released for cultivation. Cultivators have also encroached on many parts of former private and presently vested—forests in Kerala, the 25,000 acre Pulpally forest being the most striking example. Grant of further land within or on periphery of the forest for cultivation needs to be carefully watched.

(6) **Cattle :**

Together with large scale plantation activity and man-made fires, cattle constitute one of the foremost habitat degradating factors. In the survey area perhaps due to its plateau nature and accessibility from the human settlements all around and within, grazing forms a very severe threat to the forests. At present cattle grazing has been controlled to some extent only in the Bandipur Project Tiger area. (Photograph 9).

Controlling the grazing should involve differential approach to the cattle maintained by the cultivators, mostly chetties, within the forest and from the peripheral villages or settlements. For the former there is no option but to graze them in the forest all around. For the latter the revenue forests, maintained as Gomalas in Karnataka had also provided fodder but now that the revenue forests are vanishing ever so rapidly, the pressure on the reserve forests is increasing. The cattle, especially those kept by chetties are of very little productivity being mostly maintained for dung. For them a cheap system of converting vegetation to fertilizer, it is destructive for the habitat. Regeneration of vast areas of the forest is greatly curtailed or altogether stopped. The cattle churn up the mat of vegetation in the marshlands and trample down the soil elsewhere. The continuous trodding of hooves on slopping ground cause heavy erosional soil loss. The forest tracks are rendered impassable in wet as well as in the dry season by them. The cattle compete with wildlife for forage, scare away wildlife especially with the noisy wooden bells used in Wynad. They also very successfully transmit diseases to wildlife (the rinderpest outbreak that wiped out Gaur in Mudumalai-Bandipur area in 1968-69 was carried by cattle).

The graziers indulge in vandalism such as cutting down saplings, setting forest fires sweeping over this area, collecting forest products illegally etc. Bamboo shoots removed by these people affect bamboo regeneration to a hitherto unrecognised degree. In Kerala Wynad at least they are known to chase elephants out of the locality. It can be categorically stated that absolutely no area in the present Kerala Wynad sanctuary is free from grazing. The magnitude of destruction caused by cattle to Moyar-Masingudi area of Mudumalai sanctuary could be visualized by the fact that over 20,000 cattle are permitted to graze in this area for a very small grazing fee for which the mangy beasts are allowed to destroy the vegetation in this dry scrub area where regeneration is naturally slow. The following locations in the sanctuary complex appear to be alarmingly degraded due to cattle grazing though most of the land is overgrazed (see fig. 4).

Wynad wildlife sanctuary	*Mudumalai sanctuary*
Kavamad (In Kudrakote) Chambalam vayal (Begur).	Kunivayal and Thavanavayal in Benne Vellarankolli vayal area along Benne-Mudumalai road.

Wynad wildlife sanctuary	*Mudumalai sanctuary*
Kattikulam—all along the river banks	Muthukuli-church road area.
Begur vayal.	
Cheeyambam thodu, Kolachi old elephant entry area.	Keelekolli-Nambikkunnu area of Compartment 20.
Odopallam.	Ombatta vayal near Kargudi.

Manjathodi area.	Moyar valley road area.
Athirthithodu and Sickthadi vayal area near Mulehole.	Maruvakkandi dam area.
Ambuthivayal, Vattambra vayal in Mavanhalla reserve.	Bhoothanattam, Basaveswara temple area in Moyar Reserve.
Kurichithod vayal and Kumbalakkallu vayal in Nulpuzha reserve.	

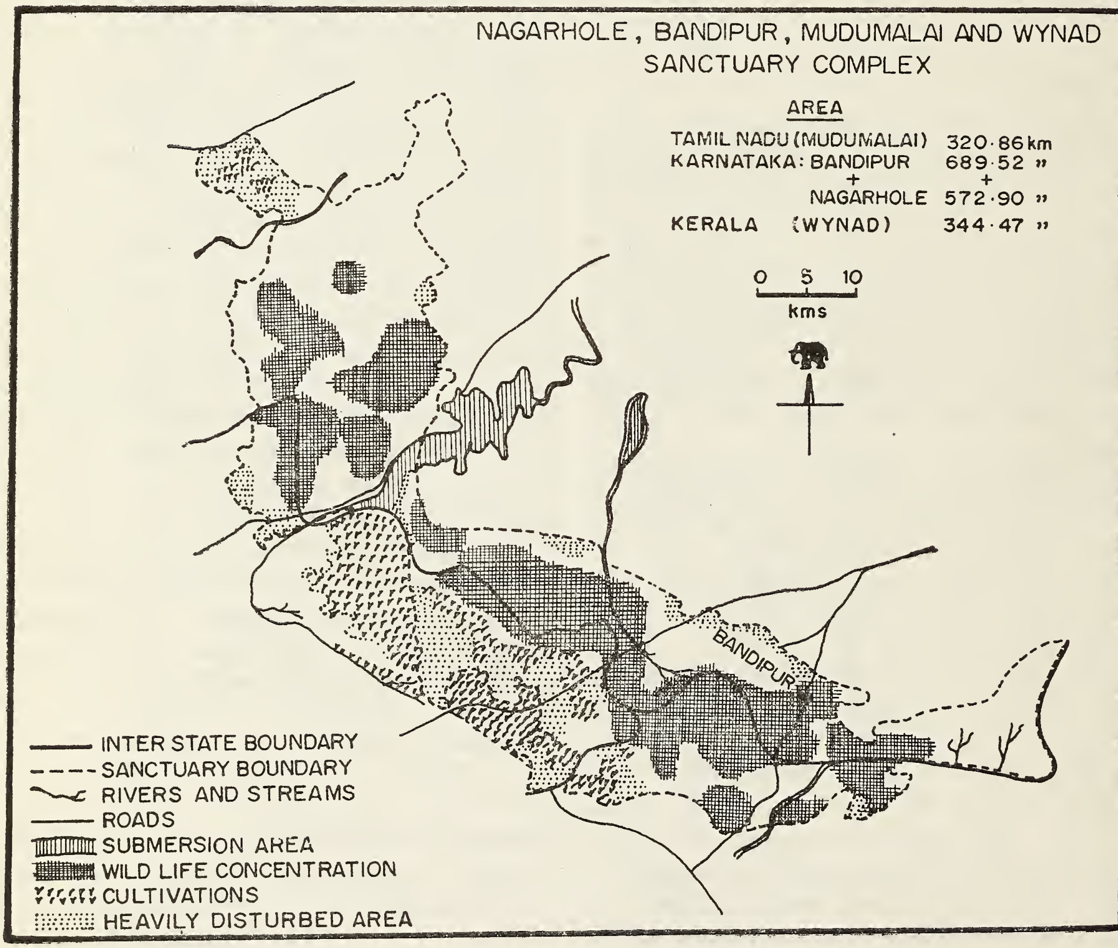

Fig. 4. Wild life concentrations and disturbances in the proposed Jawahar National Park.

NOTE: The correct area of Kerala (Wynad) is 473·72 sq. km and not 344·47 sq. km as shown in figure 4.

Bandipur National Park

Borgare pinchi, Tekadu mara Kolachi and Gapalpura area near Chamanhalla.
Marikkatte, Bankegowdana kattehalla area.
Beerambadi, Maddur area.
Rampur to Kerala boundary.
Moleyur—Seegotikere.
Kalkere area adjoining state border.
Bannurgadde state border area.
Bannurgadde—Gundre game road after Ganganekollihalla.

Nagarhole National Park

Around Byrankuppe.
Kamalegedde thodu—Kuthirasatta halla.
Sunkadkatte—Mettukuppe area.
Around Murkal township.
Anaichowkur and Uduvepura path, Gunasoor area of Tittimathi.

Controlling grazing is a most essential but perhaps the most difficult step in effectively conserving this habitat with far reaching socio-economic and cultural implications. Only a long duration programme involving inter-departmental effort (for, e.g., involving Animal Husbandry, Tribal Welfare Department etc.) could succeed. Population of cattle allowed in the forest should be greatly curtailed. A strictly maintained rotation system of forests closed to grazing (in addition to the core area where grazing is prohibited at all times) should be enforced. The carrying capacity of each of the forest ranges based on availability of running water, annual rainfall, type of terrain, density of wildlife etc. should be determined using the value for the driest month of the year as the base value and a ceiling number for grazing in each determined. The present system of blanket permits is very harmful.

All efforts to improve the genetic stock of cattle especially of the chetties cattle within the forest should be made so that enforced reduction of permitted cattle need not cause any human hardship.

Constant vigil and regular inoculation of every head of cattle in or near the forest against infectious diseases should be enforced in all the three states.

(7) **Fire :**

Man-made fires sweep over this entire sanctuary complex during the months of January, February and March. They destroy the seedlings and saplings and thereby prevent forest regeneration. They also slowly kill the weaker trees. They destroy the humus on the ground, and thereby damage the soil ecosystem. This coupled with reduced ground cover leads to more rapid soil erosion. The fires also adversely affect many insects, amphibians, reptiles and ground nesting birds and mammals. They greatly reduce the forage available to the grazing herbivores and acentuate the pinch period.

Fires are often set by cattle graziers to promote the growth of tender grass shoots during the early pre-monsoon showers. They are also set by minor forest produce collectors and poachers. (Photograph 10). The increasing plantation activity favours wide-spread fires even in the wetter forests of Kerala and Coorg which are not naturally fire prone. Extensive plantations of *Eucalyptus* with their thick undergrowth of *Eupatorium* suffer heavy damage from uncontrolled fires.

It is imperative that serious measures be introduced to control forest fires throughout this area. A well trained staff of fire watchers who maintain fire lines and fire breaks and carry out systematic operations of early controlled burning should be maintained throughout the sanctuary complex. In addition, local people everywhere should be educated, and perhaps forced to keep fires under check by being held responsible for any fires set around their camps.

(8) **Protection :**

Poaching, by organized gangs going for big money items such as ivory and tiger pelt, as well by locals for meat is prevalent in many parts of the sanctuary complex. The forest departmental staff are very poorly equipped to cope with either of these, because of the lack of weapons, and transport and because of the tortuous legal procedures. The staff should also be given adequate rewards to encourage them to take action under the difficult circumstances they face.

IX. Acknowledgements

It is a great pleasure to acknowledge the generous co-operation of the forest departments of the three southern states of Karnataka, Kerala and Tamilnadu. The Chief Conservators of all the three states gave their full support to this project, and this was translated into very concrete assistance in the field by the concerned Conservators, Divisional Forest Officers, Rangers, Foresters and Forest Guards. To all of them we are most grateful ; this work could not even have been contemplated, let alone executed without this support. Authorities of the Indian Institute of Science supported this work in many ways, particularly through their visiting scientist programme. We are also grateful to the members of the Southern Indian Regional Committee of the World Wildlife Fund for their manifold encouragement.

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APPENDIX I

Location of Reserve	State Forest	Area in Sq. Km
KARNATAKA STATE		
Bandipur Sanctuary ;		
Mysore District		
	Moyar RF	60.86
	Kaniyanapura SF Block I ..	6.20
	-do- Block II and III	26.44
	Bandipur SF	85.96
	Beerambadi SF	265.47
	Ainurmarigudi SF	128.46
	Begur RF	116.13
	Total ..	689.52
Nagarhole Sanctuary ;		
Coorg District	Arakeri RF	72.35
	Hotgot	109.85
	Nalkari	103.09
Mysore District	Mettukuppe SF	141.06
	Kakankote SF	70.07
	Veerannahosahalli SF	48.33
	Kachuvanahalli SF	28.15
	Total ..	572.90
TAMILNADU		
Mudumalai Sanctuary ;		
Nilgiri District	Mudumalai Kumbarkolli }	193.61
	Benne Benne addition }	46.12
	Averahalla Moyar }	26.00
	Moyar Moyar addition }	54.95
	Total ..	320.68

APPENDIX I—(*contd.*)

Location of Reserve	State Forest	Area in Sq. Km
KERALA STATE		
Wynad Wildlife Sanctuary :		
(1) Cannanore District	Kudrakote	14.27
	Begur	61.92
	Kattikulam	75.00
	Edakode	71.53
(2) Calicut District	Kurichiyat	74.42
	Kuppadi	32.04
	Alathur	4.77
	Edathori	2.37
	Kallur	8.41
	Mavanhalla	52.42
	Rampur	72.84
	Neminad	3.73
	Total	473.72

TOTAL AREA :

Tamilnadu	320.68 Sq. Kms.
Karnataka	1262.42 Sq. Kms.
Kerala	473.72 Sq. Kms.

APPENDIX II

Brahmagiri sanctuary :

Only a brief visit was paid to this beautiful sanctuary in the Coorg District of Karnataka. This sanctuary is situated on the eastern slopes of the Brahmagiri range, a spur hill of Coorg Western Ghats. The forest is restricted to the slopes of the hills and are of west coast tropical evergreen and typical shola vegetation interspersed with large grassy downs. The adjacent western slopes form the Thirunelli reserve forests of Kerala. Though very rich in avifauna, the vegetation is heavily grazed, down to bare rock in some parts and wildlife signs are sporadic. This habitat once must have contained the Nilgiri tahr and Liontailed Macaque.

Padri Reserve and Kuruva island reserve :

There is a large intrusion of cultivated land into the area of the sanctuary complex that cuts into two the Kerala Wynad plateau constituting the Wynad sanctuary. This is Pulpally encroachments. Isolated between the Kabini and this cultivated tract, separated from the southern Kurichiyat reserve of Calicut Division by the encroached lands, is the Padri reserve (of 5262.94 hectares) not included in the sanctuary. The southern half of the Padri reserve is a long narrow strip very much fragmented by Patta lands and old encroachments. Though rich in bamboo, it is very heavily disturbed. The northern section of padiri reserve stretching along Kabini is rich semi-evergreen forest and in spite of a great deal of human disturbances contains some wildlife. Its northern edge bordering the river is mostly patta lands.

Kuruva island reserve is a large island, 146.01 hectares in area, in the Kabini river immediately after the confluence of the Panamaram puzha and Mannantoddy puzha. It is uninhabitated, perfectly flat and is covered by natural forest. It harbours crocodiles, water monitors and large fresh-water tortoises in the two fresh water ponds in the centre of the island in addition to a remnant mammalian fauna. Ideal for scientific field studies, this island reserve is gradually getting denuded by human activity. It is not included in the sanctuary. There are a large number of islands of varying sizes dotted along the river down stream from Kuruva but the completion of Kabini dam will result in the submergence of many of the islands and perhaps even of Kuruva.

Revised classification of the family Aphelinidae (Hymenoptera : Chalcidoidea)[1]

M. Younus Khan [2]

and

S. Adam Shafee

(*With forty-nine text-figures*)

A brief historical review of the family Aphelinidae is given. The new generic characters of pronotum, subgenital plate and female external genitalia have been studied in thirteen genera of the family Aphelinidae. These characters together with the generic characters proposed by earlier workers have made the identification of genera more clear and perfect. A revised key to Indian genera of the family Aphelinidae is also given.

Introduction

Thomson (1876) proposed the tribe Aphelinina for the genus *Aphelinus* Dalman. Howard (1881) raised the tribe Aphelinina to subfamily rank Aphelininae of the family Chalcididae and placed the genera *Aphelinus* Dalman and *Coccophagus* Westwood in it. Ashmead (1904) considered Aphelininae as subfamily of Eulophidae and divided it into two tribes, Aphelinini and Pteroptericini, mainly based on number of tarsal segments. Later, this system of classifying the Aphelinids into tribes was followed by Howard (1907) and Mercet (1912). Girault (1915) considered Aphelininae as a subfamily of Encyrtidae. Viereck (1916) raised the subfamily Aphelininae to family rank, Aphelinidae. Mercet (1930) added the subfamily Calesinae, thereby placing three subfamilies (Aphelininae, Pteroptericinae and Calesinae) within the family Aphelinidae. De Santis (1948) divided the family Aphelinidae into three subfamilies, Aphelininae, Coccophaginae and Calesinae, principally based on the number of tarsal segments and presence or absence of speculum. Further, he dropped the subfamily Pteroptericinae from the family Aphelinidae.

Ghesquiere (1955) proposed a new subfamily Eriaporinae in the family Aphelinidae for the genus *Eriaporus* Waterston. Later, Subba Rao (1969) synonymised *Eriaporus* Waterston with *Promuscidea* Girault and shifted it to the family Pteromalidae. Alam (1956) emphasized for the first time the generic importance of the characters of pronotum, subgenital plate and genitalia. These characters later have been upheld by Agarwal (1966), Hayat (1971) and

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Shafee (1973). In this respect his work may be taken as a basis for future researches.

Erdös (1964) divided the family Aphelinidae into three subfamilies, Aphelininae, Pteropterícinae and Eriaporinae. Ferriére (1965) added Coccophaginae as the fourth subfamily to Aphelinidae. Nikol'skaya and Yasnosh (1966) divided the family Aphelinidae into five subfamilies, Aphelininae, Calesinae, Coccophaginae, Prospaltellinae and Azotinae. Further, they dropped the subfamily Pteroptericinae from Aphelinidae and distributed its genera among other families. They exclude the subfamily Eriaporinae from Aphelinidae.

A key to Indian genera of the family Aphelinidae is proposed, mainly based on pronotum, subgenital plate, first valvifers, second valvifers and outer plates. Further, the already existing characters as far as possible, have been used as supporting characters for the genera.

Revised key to the Indian genera of the family Aphelinidae

1. Tarsi 4-jointed 2
— Tarsi 5-jointed 3
2. Antennae 5-segmented ; club long, entire ; pronotum formed of two separate sclerotic pieces (fig. 1 ; Hayat, 1972b, fig. 7) ; first valvifers triangular with basal and apical angles at different levels (fig. 38) ; second valvifers of uniform width (fig. 26) ; third valvulae of moderate length and movably articulated with second valvifers (fig. 26) ; posterior margin of subgenital plate semi-circular with a notch in middle (fig. 14)...*Eretmocerus* Haldeman
— Antennae 7-segmented ; club short, 3-segmented ; pronotum formed of one continuous sclerotic plate, narrow in middle (Alam 1956, fig. 37) ; first valvifers triangular with base slightly curved (Alam 1956) ; third valvulae immovably articulated with second valvifers (Alam 1956)...... .... *Casca* Howard
3. Fore wings with speculum.................. 4
— Fore wings without speculum................ 10
4. Antennae 5 to 7-segmented................ 5
— Antennae 4-segmented ; funicle and club each 1-segmented ; pronotum formed of two separate sclerotic pieces (Hayat 1974b) ; marginal vein longer than submarginal vein ; post-marginal vein absent ....*Marlattiella* Howard
5. Antennae 6 or 7-segmented.................. 6
— Antennae 5-segmented ; fore wings hyaline with an obscure patch below stigmal vein and a group of conspicuous setae on middle of mesal margin of speculum ; mesonotum with 4 longitudinal black bands ; abdominal dorsum with 5 black transverse bands. .... *Syediella* Shafee
6. Antennae 6-segmented ; club entire ; marginal vein well-developed ; stigmal vein short........ 7
— Antennae 7-segmented ; club 2-segmented ; pronotum formed of one sclerotic plate, anterior margin deeply concave, posterior margin straight (fig. 6 ; Hayat 1972c, fig. 2) ; marginal vein distinctly shorter than submarginal vein ; stigmal vein well-developed ; first valvifers almost triangular (fig. 42 ; Hayat 1972c, fig. 4) ; second valvifers of uniform width with dorsal marginal ridge ; third valvulae movably articulated with second valvifers (fig. 30 ; Hayat 1972c, fig. 4) ; subgenital plate with anterior margin straight, posterior margin with semi-circular notch in middle (fig. 18 ; Hayat 1972c, fig. 3)...*Eriaphytis* Hayat
7. Pronotum formed of two separate sclerotic pieces (figs. 2, 3, 5 ; Nikol'skaya & Yasnosh 1966, figs. 151, 172 ; Hayat 1972a, fig. 9 ; Hayat 1973, fig. 3) ; fore wings generally without hyaline spots or bands of transparent setae and body without pronounced white spots or maculations........ 8
— Pronotum formed of one continuous sclerotic plate (fig. 4 ; Nikol'skaya & Yasnosh 1966, fig. 164 ; Agarwal 1964b, fig. 28) ; fore wings with hyaline spots or bands of transparent setae, or body with pronounced white spots or maculations, most frequently with both ; first valvifers almost semicircular (fig. 41 ; Agarwal 1964b, fig. 30) ; subgenital plate with a mid-longitudinal groove (fig. 17) .... *Marietta* Motschulsky
8. Last sternite (subgenital plate) reaches to middle of abdomen ; ovipositor uncovered and straight ; general body colour yellow ; subgenital plate with broadly truncated posterior margin and without anterolateral apodems (fig. 16) ; parasites of eggs and Coccids 9
— Last sternite (subgenital plate) reaches to apex of abdomen covering the ovipositor except apex which is curved upward ; general body colour black ; subgenital plate V-shaped with greatly reduced posterior margin, anterolateral apodemes distinct (fig. 15) ; first valvifers triangular (fig. 39) ; parasites of aphids..........*Aphelinus* Dalman

9. Body generally elongate ; wings narrow ; legs long and slender ; ovipositor generally more or less prominent ; parasites of eggs...*Centrodora* Foerster

— Body short; wings broad ; ovipositor not or little prominent ; parasites of Coccids..*Aphytis* Howard

10. Pronotum formed of one continuous sclerotic plate (figs. 7-11 ; Alam 1956, figs. 10, 31 ; Agarwal 1964b, fig. 17 ; Hayat 1971, fig. 8 ; Hayat 1974b, fig. 12) ; first valvifers of varying shapes (figs. 43-47 ; Alam 1956, figs. 12a, 35a ; Agarwal 1964b, fig. 21).................................. 11

— Pronotum formed of two separate sclerotic pieces (figs. 12, 13 ; Alam 1956, fig. 2 ; Agarwal 1964a, fig. 25 ; Nikol'skaya & Yasnosh 1966, fig. 456 ; Hayat 1974a, fig. 2) ; first valvifers triangula with basal and apical angles at different levels (figs 48, 49 ; Alam 1956, fig. 6b ; Agarwal 1964a fig. 29) 15

11. Antennae 8-segmented ; club 3-segmented ; posterior margin of pronotum straight with submarginal ridge (figs. 7, 8 ; Alam 1956, fig. 10 ; Hayat 1971, fig. 8) ; first valvifers triangular with basal and apical angles at different levels (figs 43, 44 ; Alam 1956, fig. 12a ; Zinna 1961, Pl. 7 fig. 2 ; Nikol'skaya & Yasnosh 1966, fig. 20) second valvifers of uniform width, third valvulae short (figs. 31, 32 ; Zinna 1961, Pl. 7, fig. 2, Nikol's kaya & Yasnosh 1966, fig. 20) ; subgenita plate narrow, anterior margin connected with posterior margin by a mid longitudinal groove, central notch of posterior margin without laterally directed ridges (figs. 19, 20).................. 12

— Antennae 7-segmented ; club 1 or 2-segmented ; posterior margin of pronotum concave and without submarginal ridge (figs. 9-11 ; Alam 1956, fig. 31 ; Agarwal 1964b, fig. 17 ; Hayat 1974b, fig. 12) ; first valvifers quadrate or semi-circular ; second valvifers and third valvulae usually long and narrow (figs. 33-35) ; subgenital plate moderately broad, central notch of posterior margin with laterally directed ridges (figs. 21-23)...... 13

12. Funicle segments cylindrical ; postmarginal vein usually well-developed....*Coccophagus* Westwood

— Funicle segments flattened ; post marginal vein usually absent ; base of mid tibiae with rows of bristles.............................*Aneristus* Howard

13. Funicle 4-segmented ; club entire ; pronotum with a submarginal ridge along each lateral margin (figs. 10, 11 ; Alam 1956, fig. 31 ; Agarwal 1964b, fig. 17 ; Hayat 1974b, fig. 12) ; first valvifers semi-circular, with basal and apical angles in one plane (figs. 46, 47 ; Alam 1956, fig. 35a ; Zinna 1962, Pl. 35, fig. 3) ; second valvifers and third valvulae long and narrow (figs. 34, 35 ; Zinna 1962, Pl. 35, fig. 2 ; Agarwal 1964b, fig. 22) ; subgenital plate broad, anterior margin connected with posterior margin by a midlongitudinal groove (figs. 22, 23)..................... 14

— Funicle 3-segmented ; club 2-segmented ; pronotum without submarginal ridge along each lateral margin (fig. 9) ; first valvifers quadrate with basal and apical angles at different levels (fig. 45) ; second valvifers uniformly broad with mid longitudinal ridge ; third valvulae short (fig. 33) ; subgenital plate transverse and without mid longitudinal groove (fig. 21) ...... *Physcus* Howard

14. Fore wings with group of long black setae ; stigmal vein swollen ; subgenital plate without anterolateral apodemes (fig. 22 ; Agarwal 1964b, fig. 19) .... *Azotus* Howard

— Fore wings not so patterned ; stigmal vein long, slender ; subgenital plate with anterolateral apodemes (fig. 23 ; Hayat 1974b, fig. 15) .... *Ablerus* Howard

15. Fore wings broad with usually short marginal fringe, with setae at radius 16

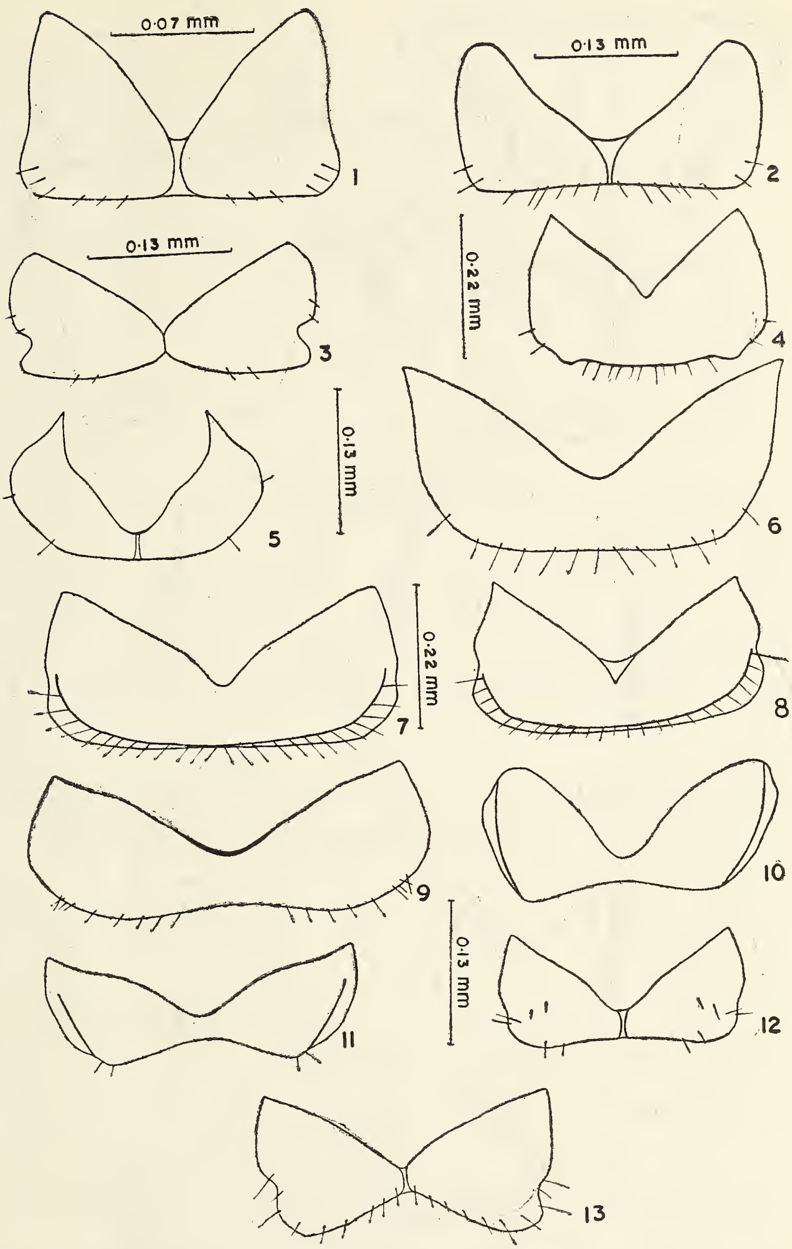
— Fore wings narrow with long marginal fringe, bare at radius ; outer plates of ovipositor narrow in proximal region, gradually broadening distally with distal end narrowly rounded, dorsal margin followed by a long narrow submarginal ridge (Alam 1956, fig. 6a)......*Aspidiotiphagus* Howard

16. Funicle and club each 3-segmented.......... 17

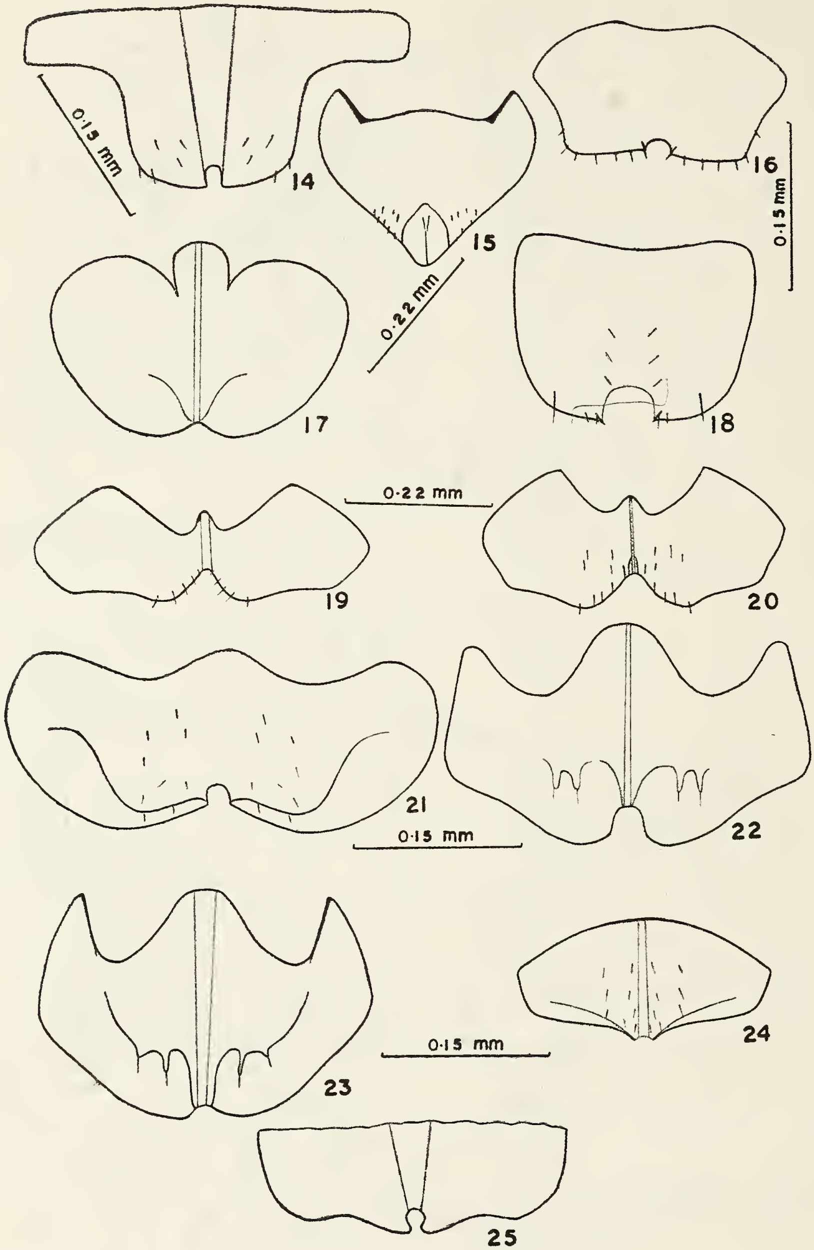
— Funicle and club 4-and 2-segmented respectively ; posterior margin of subgenital plate with a notch in middle (fig. 25) ....*Trichaporus* Foerster

17. Antennal club not distinctly separated from funicle ; club conical at apex ; marginal vein shorter than submarginal vein (Hayat 1974a, fig. 2)................ *Coccophagoides* Girault

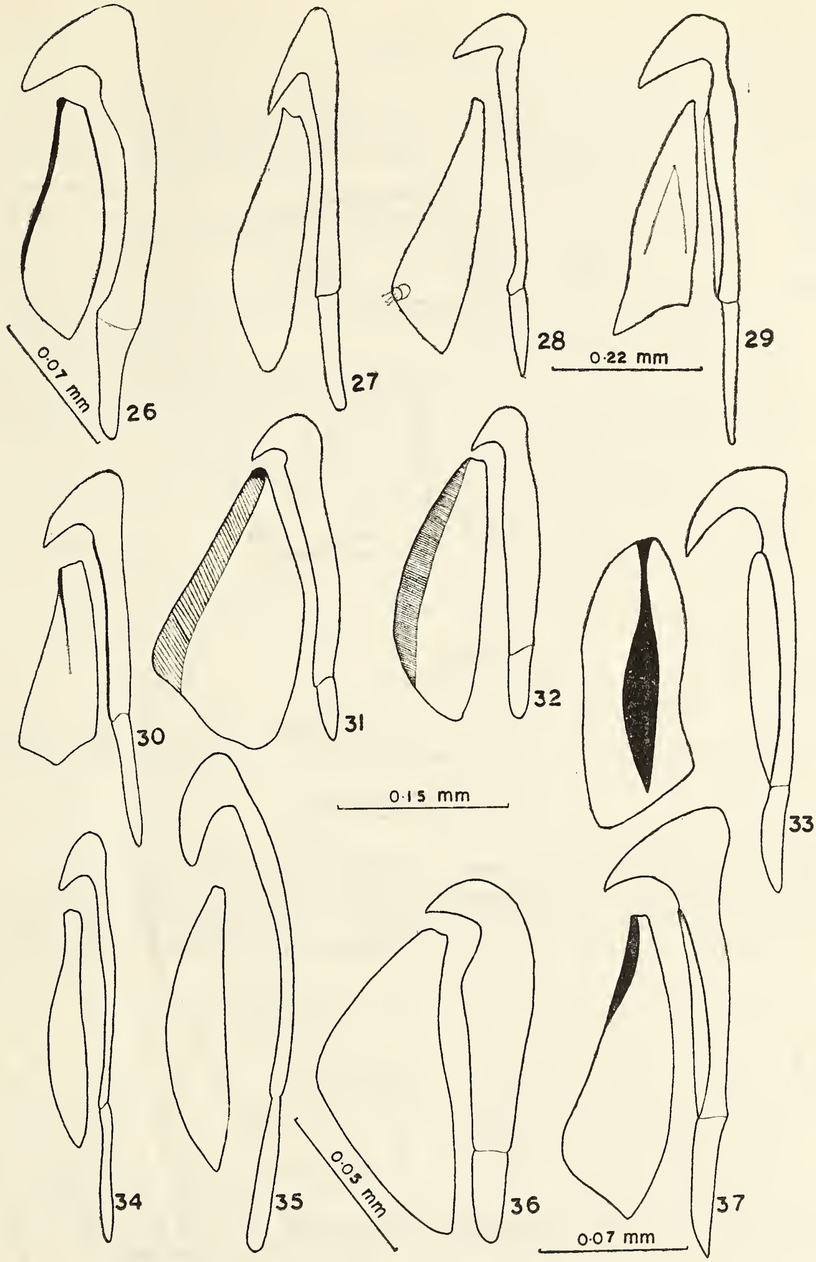
— Antennal club distinctly separated from funicle ; club blunt at apex ; marginal vein longer than submarginal vein .... *Prospaltella* Ashmead



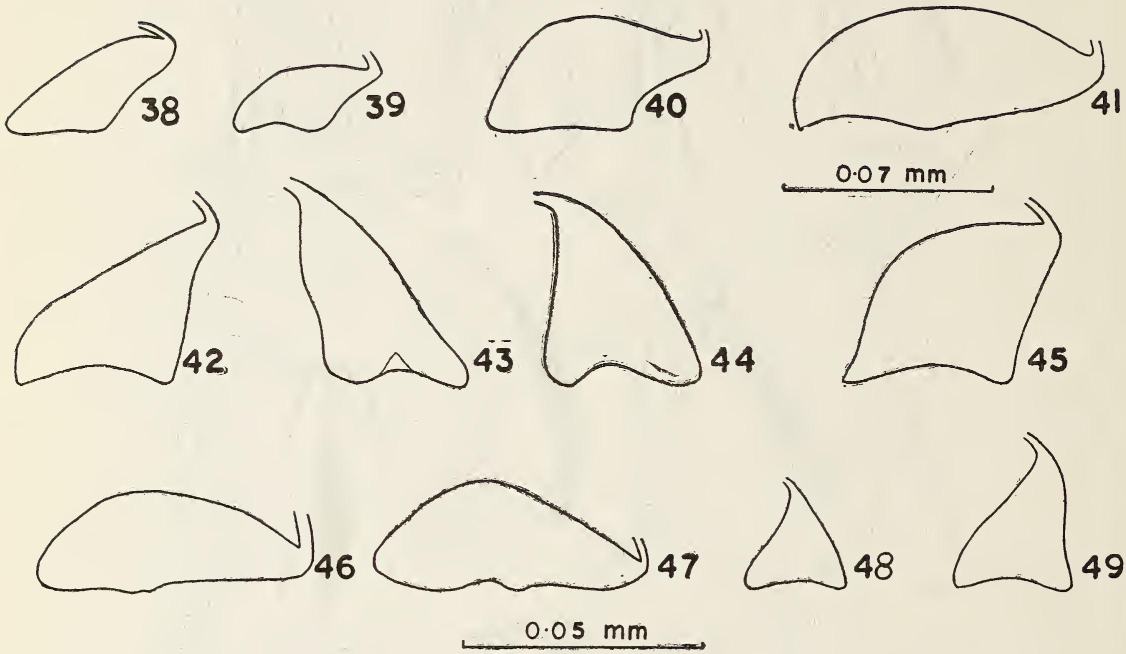
Figs. 1-13. Female pronotum : (1) *Eretmocerus haldemani* Howard ; (2) *Aphelinus mali* (Haldeman) ; (3) *Aphytis alami* Agarwal; (4) *Marietta orientalis* (Howard); (5) *Centrodora azizi* Hayat; (6) *Eriaphytis orientalis* Hayat ; (7) *Coccophagus shafeei* Hayat ; (8) *Aneristus ceroplastae* Howard ; (9) *Physcus albipodus* Agarwal ; (10) *Azotus qadrii* Agarwal ; (11) *Ablerus aonidiellae* Hayat ; (12) *Prospaltella flava* Shafee ; (13) *Trichaporus partenopeus* (Masi).



Figs. 14-25. Female subgenital plate : (14) *Eretmocerus haldemani* Howard ; (15) *Aphelinus mali* (Haldeman) ; (16) *Aphytis alami* Agarwal ; (17) *Marietta orientalis* (Howard) ; (18) *Eriaphytis orientalis* Hayat ; (19) *Coccophagus shafeei* Hayat ; (20) *Aneristus ceroplatae* Howard ; (21) *Physcus albipodus* Agarwal ; (22) *Azotus qadrii* Agarwal ; (23) *Ablerus aonidiellae* Hayat ; (24) *Prospaltella flava* Shafee ; (25) *Trichaporus partenopeus* (Masi).



Figs. 26-37. Part of female external genitalia : (26) *Eretmocerus haldemani* Howard ; (27) *Aphelinus mali* (Haldeman) ; (28) *Aphytis alami* Agarwal ; (29) *Marietta orientalis* (Howard) ; (30) *Eriaphytis orientalis* Hayat ; (31) *Coccophagus shafeei* Hayat ; (32) *Aneristus ceroplastae* Howard ; (33) *Physcus albipodus* Agarwal ; (34) *Azotus qadrii* Agarwal ; (35) *Ablerus aonidiellae* Hayat ; (36) *Prospaltella flava* Shafee ; (37) *Trichaporus partenopeus* (Masi).



Figs. 38-49. First valvifer : (38) *Eretmocerus haldemani* Howard ; (39) *Aphelinus mali* (Haldeman) ; (40) *Aphytis alami* Agarwal ; (41) *Marietta orientalis* (Howard) ; (42) *Eriaphytis orientalis* Hayat ; (43) *Coccophagus shafeei* Hayat ; (44) *Aneristus ceroplastae* Howard ; (45) *Physcus albipodus* Agarwal ; (46) *Azotus qadrii* Agarwal ; (47) *Ablerus aonidiellae* Hayat ; (48) *Prospaltella flava* Shafee ; (49) *Trichaporus partenopeus* (Masi).

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Phytogeographical reassessment on the flora of Rajasthan[1,2]

VIJENDRA SINGH [3]

(*With three text-figures*)

A re-evaluation of the phytogeographical status of Rajasthan has been made. The Perso-Arabian element predominates the Indo-Malayan element almost throughout the State. Drude's (1890, 1913) line of demarcation between Western and Eastern elements has been brought more towards east beyond the limits of Rajasthan. The possible route and means of migration have been mentioned with a map. An attempt has been made to relate the floristic elements to their ecological conditions for determining the possible route of migration of species. Evidences are given in favour of decreasing barrier effect of Aravallis, regular migration of Western element and increasing desert conditions towards east. A list of twenty-eight taxa endemic to Rajasthan has been given with a map showing their distribution and exact locality of occurrence.

INTRODUCTION

Since the publication of Drude's 'Handbuch der Pflanzengeographie (1890)' and 'Die Oekologie der Pflanzen (1913)', several workers conducted phytogeographical studies on the flora of Rajasthan (Biswas & Rao 1953; Blatter & Hallberg 1918-21; Blatter & Sabnis 1929; Chatterji 1939, 60; Jain 1967, 68, 70; Legris & Meher-Homji 1967, 68; Maheshwari 1968; Meher Homji 1962, 1970a, 1970b; Mulay 1960; Nair & Kanodia 1959; Nair & Nathawat 1957; Puri & Jain 1960; Puri 1960; Puri *et al.* 1960; Ramdeo 1969; Ratnam 1951; Saxton & Sedgwick 1918; Sharma 1965; Singh 1974; Vyas 1967 and Wadhwa 1960 etc.).

Some workers like Biswas & Rao 1953; Blatter & Hallberg 1918-21; Blatter & Sabnis 1929 and Meher-Homji 1962, 70, have confirmed Drude's (1890, 1913) line of demarcation between Perso-Arabian (Western) and Indo-Malayan (Eastern) elements starting from the Gulf of Cambay northwards along the Aravallis, while studying the phytogeographical aspects of Western Rajasthan.

On the other hand, Mulay (1960), Nair & Kanodia (1959), Nair & Nathawat (1957), Ramdeo (1969) and Vyas (1967), based on their studies on the vegetation of Aravallis and eastern Rajasthan, have concluded that the demarcation line between the elements of western and eastern origin should be shifted further eastwards beyond the limits of Rajasthan. A perusal of literature on the vegetation of Rajasthan and surrounding regions thus reveals that the phytogeographical status of Rajasthan is debatable.

The present study was undertaken since 1968 to re-evaluate the findings of earlier workers in the light of available literature and herbarium specimens.

[1] Accepted January 1977.

[2] For economy of space taxonomic literature on the vegetation of Rajasthan has not been mentioned.

[3] Botanical Survey of India, Arid Zone Circle, Jodhpur (Rajasthan).

Results and Discussion

The vegetation of Rajasthan is interesting phytogeographically, since it consists of four distinct elements namely, (i) Perso-Arabian (Western) which includes the species coming from Africa, Mediterranean region, Madagascar, North African-Indian desert belt, Western Asia, Arabia, Persia, Turkey, Indus plain, Saharo-Sindh or Sudano-Rajasthan etc.; (ii) Indo-Malayan (Eastern) which includes the species coming from Malaysian peninsula, China, Burma, Thailand, Indonesia, Indo-China, Central, Eastern and South-east Asia etc.; (iii) Indian which includes the species of widespread occurrence in the subcontinent and (iv) General element consisting of pantropical, pleuriregional species, species of warm countries and exotics introduced from various parts of the World.

The above analysis (Table 1) reveals that the Indian element dominates other adventive taxa in Bharatpur, Churu, Jaipur, Sikar, Jhunjhunu, Tonk and Udaipur districts. It forms 36.6% of the flora in Churu district—the highest in Rajasthan. Remaining eleven districts are dominated by Perso-Arabian element and in three districts namely Kotah, Bundi and Jhalawarh the General element dominates the vegetation and it forms 41.8% of the flora. In Alwar district the Indian element represents 25.4% of the flora—the lowest in Rajasthan. The

Table 1

Total number of species studied, percentage of various elements and ratio of Eastern and Western elements in different parts of the State

Locality	Total number of species studied	Indian element %	General element %	Indo-Malayan element %	Perso-Arabian element %	Ratio of Eastern & Western elements
Ajit Sagar Bundh ..	380	35.2	33.6	8.9	22.3	1 : 2.5
Ajmer ..	360	31.9	23.5	11.3	33.3	1 : 3
Alwar ..	440	25.4	18.7	18.8	37.1	1 : 1.9
Banswara ..	..	..	..	..	..	..
Bundi, Kotah and Jhalawarh ..	1107	29.2	41.8	10.4	18.6	1 : 1.7
Bharatpur ..	286	32.6	19.5	17.5	30.4	1 : 1.7
Bhilwara ..	..	..	..	..	..	..
Chirawa ..	272	33.0	24.5	14.2	28.3	1 : 2
Chitorgarh ..	..	..	..	..	..	..
Churu ..	246	36.6	19.2	8.5	35.7	1 : 4.4
Dungarpur ..	..	..	..	..	..	..
Ganganagar ..	344	31.6	17.0	8.7	43.7	1 : 5
Harshnath hills ..	224	33.0	28.6	12.6	25.8	1 : 2
Jaipur & Sikar ..	328	32.7	26.9	10.3	30.4	1 : 3
Jhunjhunu & Mendrela ..	358	30.9	28.6	11.2	29.3	1 : 2.6
Jaisalmer, Jodhpur, Jalour, Nagour, Barmer, Pali, Bikaner, Sirohi ..	1280	31.4	19.5	7.0	42.1	1 : 6
Khetri town ..	380	35.5	21.3	14.4	28.8	1 : 2
Lohargal ..	347	37.5	18.5	11.5	32.5	1 : 2.8
Pilani ..	457	31.0	20.0	14.0	35.0	1 : 2.5
Sawaimadhopur ..	..	..	..	..	..	..
Tonk ..	375	32.8	21.3	15.3	30.6	1 : 2
Udaipur ..	514	32.1	18.2	17.5	32.1	1 : 1.8
Mt. Abu ..	467	33.7	34.8	17.6	13.9	1 : 0.78

Indian element mainly consists of the species coming from Kutch, Sindh, Saurashtra, Gujarat and neighbouring Gangetic plains. A comparative study of the vegetation of Rajasthan with neighbouring regions mentioned above indicates that the six families namely Leguminosae, Gramineae, Compositae, Malvaceae, Convolvulaceae and Euphorbiaceae form the dominant constituent of the flora of these regions. The Himalayan and N-E Indian species are poorly represented and most of them are reported from Mt. Abu and eastern Rajasthan ; some of these species are : *Ipomoea muricata* (L.) Jacq., *Isachne disper* Trin., *I. globosa* (Thunb.) O. Ktze., *Pueraria tuberosa* (Roxb. ex Willd.) DC., *Crotalaria albida* Heyne ex Roth, *Caesaria elliptica* Willd., *Moghania strobilifera* (L.) Hill. ex Jacks, *Arenaria serpyllifolia* Linn., *Didymocarpus pygmaea* Cl. and *Oryzopsis aequiglumis* Duthie etc. This indicates the close affinity between the flora of Mt. Abu and eastern Rajasthan. The vegetation of eastern Rajasthan also resembles considerably that of western Rajasthan. About 50% plants are common to eastern and western zones of the State and these are mostly the species of wide distribution which occur from sea level to 1000 m. e.g. *Argemone mexicana* Linn., *Polygala erioptera* DC., *Cassia auriculata* Linn., *Ageratum conyzoides* Linn., *Echinops echinatus* Roxb., *Cleome viscosa* Linn., *Tridax procumbens* Linn., *Calotropis procera* R. Br., *Zizyphus nummularia* (Burm. f.) Wt. & Arn., *Oxalis corniculata* Linn., *Tamarix* sp. etc. Further, the first four positions among the ten dominant families in both the regions are occupied by Leguminosae, Gramineae, Compositae and Cyperaceae. The taxa like Guttiferales, Multiovulatae-terrestre, Multiovulatae Aquaticae, Ericales, Olacales and Micrembryae etc. are either poorly represented or absent in the floras of eastern and western Rajasthan.

The vegetation of southern regions of Aravallis (Mt. Abu) is more complex than that of the north (Harshnath hills). A comparative study shows that the subtropical evergreen forests of Mt. Abu are characterized by the presence of *Syzygium cumini* (L.) Skeels., *Mangifera indica* Linn., *Crateva magna* (Lour.) DC., *Bauhinia purpurea* Linn., *Jasminum humile* Linn., *Rosa moschata* Mill. ex Herr., *R. involucrata* Roxb., *Carvia callosa* (Nees) Brem. and *Aerides crispum* Lindl. etc., which are usually found in northeast India. Harshnath, on the other hand, supports a thick growth of species of *Bambusa*, *Anogeissus*, *Holoptelea*, *Salvadora*, *Acacia*, *Prosopis*, *Zizyphus*, *Capparis* etc. and the common species between these two hills are only those which are either marginal or have a wide range of distribution.

Out of 134 dicot genera, listed by Chatterji (1939) as endemic to India, only few like *Ougenia*, *Butea*, *Caesulia*, *Glossocardia*, *Petalidium*, *Bremekampia* and *Goniocaulon* occur in Rajasthan. Further, taxa like 1. *Cleome gynandra* var. *nana* (Bl. & Hall.) Bhandari, 2. *Convolvulus blatteri* Bhandari, 3. *Farsetia macrantha* Bl. & Hall., 4. *Cleome brachycarpa* var. *glauca* Bl. & Hall., 5. *Abutilon fruticosum* var. *chrysocarpa* Bl. & Hall., 6. *A. indicum* var. *major* Bl. & Hall., 7. *Pavonia arabica* var. *glutinosa* Bl. & Hall., 8. *Melhania magnifolia* Bl. & Hall., 9. *M. futteyporensis* var. *major* (Bl. & Hall.) Santapau, 10. *Zizyphus truncata* Bl. & Hall., 11. *Psoralea odorata* Bl. & Hall., 12. *Lasiurus caudatus* Saty. & Shank., 13. *Strobilanthus hallbergii* Bl., 14. *Hydrilla polysperma* Bl., 15. *Justicia heterocarpoides* Bl., 16. *Oldanlandia clausa* Bl., 17. *Euphorbia jodhpurensis* Bl. & Hall., 18. *Tephrosia multiflora* Bl. & Hall., 19. *T. incana* Grah. var. *horizontalis* Bl. & Hall., 20. *Alysicarpus monilifer* var. *venosa* Bl. & Hall., 21. *Anticharis glandulosa* Aschers. var. *caerulea* Bl. & Hall. ex Santapau, 22. *Barleria prionitis* Linn. var. *dicantha* Bl. & Hall., 23. *Convolvulus gracilis* Bl. & Hall., 24. *Tribulus rajasthanensis* Bhandari, 25. *Pulicaria* *rajputanae* Bl. & Hall., 26. *Ipomoea cairica* var. *semine-glabro* (Bl. & Hall.) Bhandari, 27. *Dicliptera abuensis* Bl. and 28. *Cenchrus minutiburensis* Kanodia & Nanda are endemic to Rajasthan, particularly to the western desertic zones of the State. The serial numbers of the above species correspond to the numbers given in the map (Fig. 1).

Next comes the Perso-Arabian (Western) element which predominates the vegetation of eleven districts and the Indo-Malayan element throughout the State, except Mt. Abu. The percentage of Indo-Malayan element increases gradually as one proceeds from west to east. In the west of Aravallis, the ratio of Eastern to Western element varies from 1 : 4.4 to 1 : 6. The maximum percentage of Eastern element is 8.7 and the maximum percentage of Western element is 43.7 in Ganganagar district. In eastern Rajasthan it ranges between 1 : 1.7 to 1 : 3. The minimum percentage of Eastern element is 10.4 in Kotah division and the maximum percentage of Western element is 37.1 in Alwar district. If Drude's conclusions regarding the line of demarcation between the Perso-Arabian and Indo-Malayan flora as starting from Gulf of Cambay northwards along the Aravallis are correct, one should get in Eastern Rajasthan the Indo-Malayan element in higher percentage than Perso-Arabian. On the contrary, the vegetation of eastern Rajasthan has a larger proportion of the Perso-Arabic element ; hence, the line of demarcation between these two elements should be shifted more towards east, beyond the limits of Rajasthan.

The percentage of Western element decreases from 43.7% in western Rajasthan to 37.1 in Alwar, 33.3 in Ajmer, 18.6 in Kotah division to 8% in Madhya Pradesh in the eastern direction, and to 19% in north Gujarat, 13 in southern Gujarat to 2.5% in South India, particularly the western coasts (Legris & Meher-Homji 1968). The possible explanation for the gradual decrease of Western element towards the eastern and southern regions of the State may be due to the vegetation of western Rajasthan being destroyed comparatively on a large scale than in the eastern Rajasthan causing denudation of vegetation cover and exposure of soil and sand. The original natural flora of this area is being gradually eleminated and xerophytic vegetation characteristic of Perso-Arabian and African regions become pioneer to land in this modified plant climate resembling the climate of Libyan desert and Cyrenaica (Das & Sarup 1951). Further, on the western boundary of India, there is no remarkable barrier to check the migration of xerophytic elements of Afro-Arabian origin to the Indian desert.

In Rajasthan, the Aravallis, extending from Champaner in Gujarat in the South-west to near Delhi in North-east, separate three-fifth western desertic part from two-fifth fertile tract of eastern Rajasthan and act as an imperfect barrier in the migration of Perso-Arabian element towards east. The low altitude of Aravallis towards North-east (Mt. Abu—5650 ft., Harshnath—3000 ft. above m.s.l.) and the gap in this range near Sirohi are, probably, the routes of eastward migration of xerophytic elements. Recently, several plants of Afro-Arabian origin like *Dipterygium glaucum* Decne, *Astragalus prolixus* Sieb., *Heliotropium calcareum* Stocks, *Premna resinosa* Schau., *Asparagus dumosus* Baker, *Juncus maritimus* Lamk., *Dignanthia hirtella* Stapf, *Tripogon roxburghiana* Bhide, *Crypsis schoenoides* Lamk., *Chrysopogon aucheria* Stapf, *Trigonella hamosa* Linn., *Taverniera cuneifolia* Arn., *Indigofera astragalina* DC., *Pavonia petans* (Andr.) Chiov. etc. have invaded the western desert. Of the recent introductions, about 15% have been recorded in eastern Rajasthan. This shows that the adventive taxa of western origin first establish on desert soils and then migrate towards east. It is likely

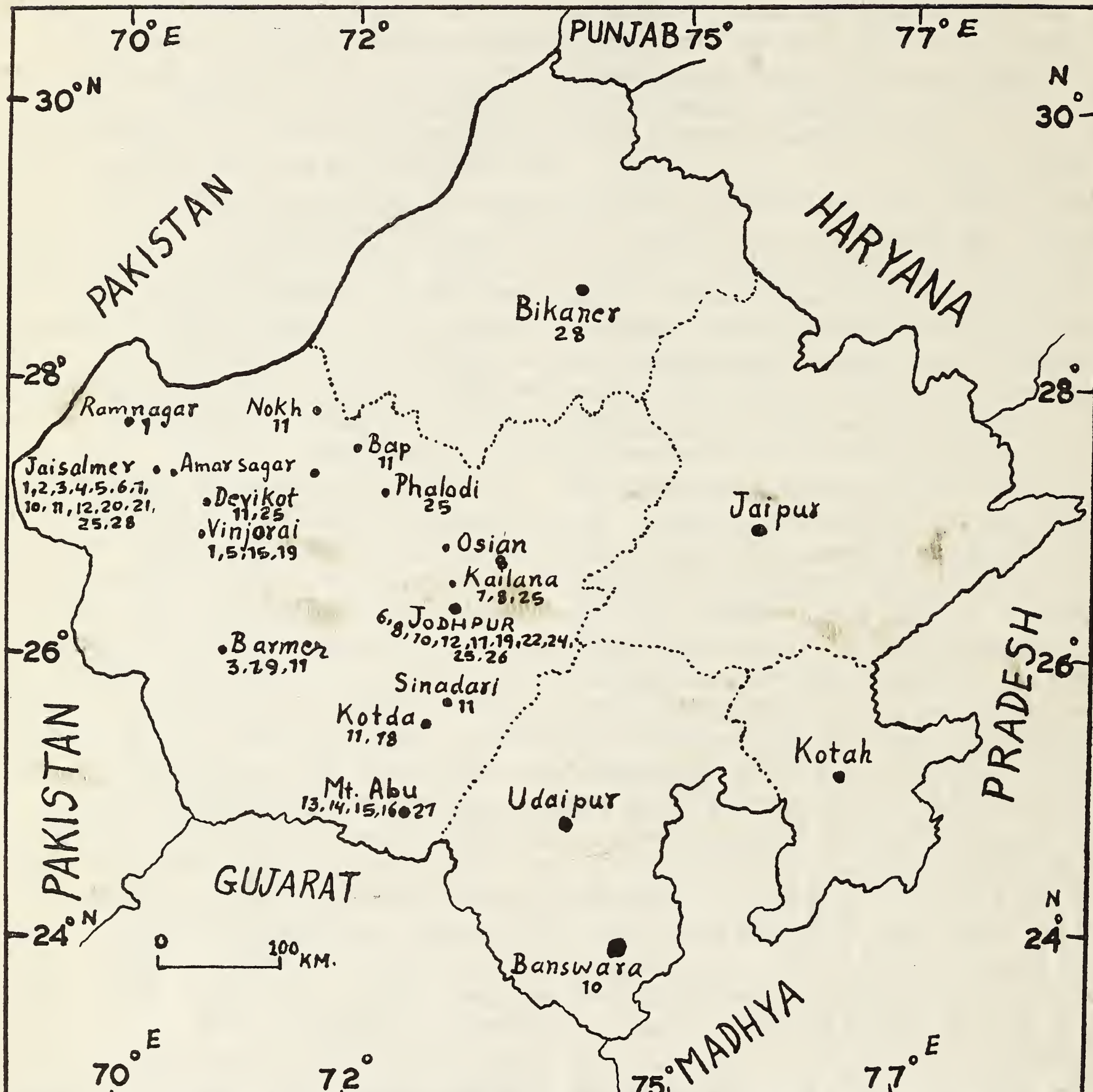

Fig. 1. Map showing the distribution of endemic species in Rajasthan.
(The numbers given in the map represent the endemic species described in the text).

that in the near future the Western element would be recorded in higher percentage from eastern Rajasthan than today and also a higher proportion of taxa of western origin will probably invade the Indian desert tract. Then, it would be one more evidence to show the decreasing effect of Aravallis as a barrier; regular migration of Western element and the increasing desertic conditions towards east. It is suggested that adequate means should be adopted to save the original natural flora from further devastation.

Further, the study of climatic data (Fig. 2), reveals that as there is a decrease in the temperature and increase in the rainfall from west to east and south-east direction, there are simultaneous changes in the percentage of Perso-Arabian and Indo-Malayan elements. The Perso-Arabian element occurs in its highest percentage in the western Rajasthan where the mean maximum annual temperature is 46°C and mean maximum annual rainfall is less than 400 mm. The highest annual evaporation in this desert tract ranges between 424 to 485 cm. As there is a gradual fall in temperature (32°C) and evaporation (305 cm) and increase in mean annual maximum rainfall (882 mm) towards east, there is a notable decrease in the percentage of Western element and an increase in Indo-Malayan element. This shows that Western element is a denizen of dry habitats and Eastern element of humid climate. This view finds further support from the phytogeographical analaysis of the vegetation of Mt. Abu where mean maximum temperature is 30°C and mean annual rainfall is 1560 mm and the percentage of Eastern and Western elements is 17.6 and 13.9 respectively.

The most possible means of migration of Afro-Arabian element are the high velocity winds from south-west and west towards north-east and eastern direction, birds, animals and transport agencies, particularly in respect of the plants colonised in the coasts. The fruits and seeds of most species of western origin are well equipped for dissemination by these agencies. The possible routes of migration have been shown in the map (Fig. 3).

The Indo-Malayan element dominates the vegetation of N-E India (24-33%); southern India, particularly the Western coast, is the second zone of its concentration (23-31%). Some plants like *Dipterocarpus turbinatus* Gaertn. f., *Hopea wightiana* Wall., *Polyalthia fragrans* Benth. & Hook. f., *Myristica attenuata* Wall. etc. of eastern origin occur mainly in north-east India and the western and eastern Ghats of South India. The percentage of Eastern element further decreases from 22% in Central India to 18.8 in eastern Rajasthan (Alwar) and 8.7% in western Rajasthan (Ganganagar). The most suitable explanation for this seems the presence of a land connection and the resemblance of plant climate between Eastern India and Malaysian peninsula. The absence of any marked barrier in the west of eastern India facilitates its migration in further westwards direction. The rising temperature and evaporation and decreasing rainfall towards western parts of the country, however, considerably check the invasion and ecesis of this element, as a result of which the percentage of eastern element decreases gradually towards western India. In eastern Rajasthan, this element has locally migrated from Punjab, Haryana, Western Uttar Pradesh and Madhya Pradesh mainly by the agencies of bird, animal transportation and rarely by wind. The Aravallis, extending from south to north-east direction in Rajasthan, further, considerably check the westward movement of this element and so that the percentage of Eastern element falls to 7% in Jodhpur, Jaisalmer and Barmer area. It is interesting to note the low percentage of Central and East Asian taxa in the flora of Rajasthan; it is perhaps due to the recent rise in Himalayas with Siwaliks.

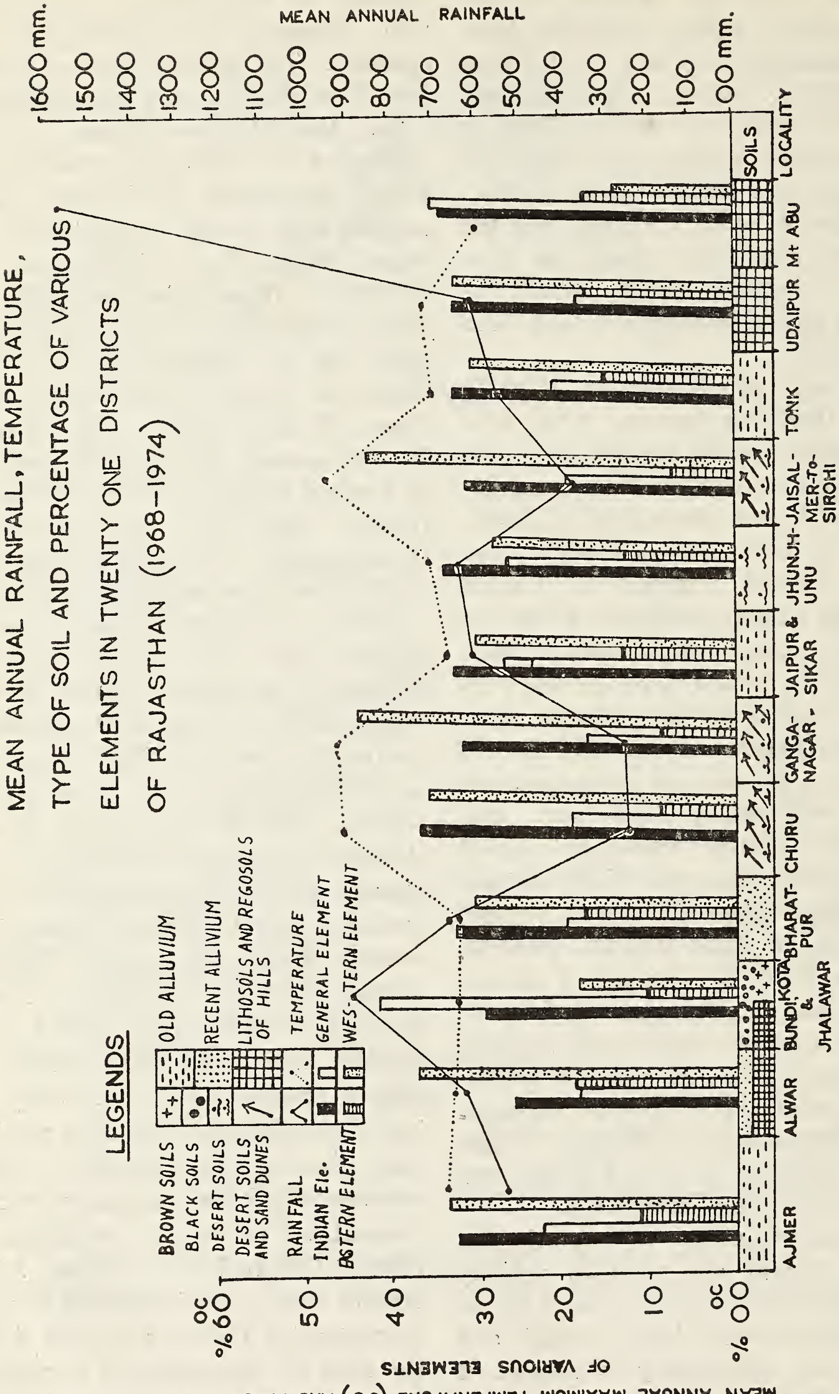

Fig. 2. Mean annual rainfall, temperature, type of soil and percentage of various elements in twenty-one districts of Rajasthan (1968-1974).

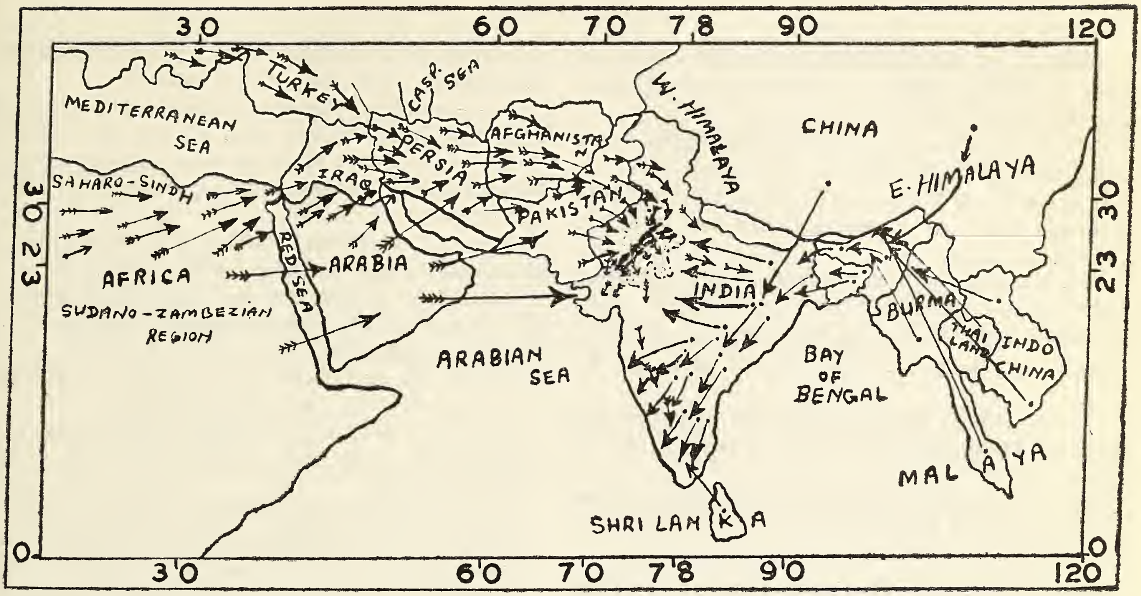

Fig. 3. Map showing possible route of migration of western (→→——→) and eastern (←——·) element from neighbouring countries. The dotted portion in the map represents the location of Rajasthan (after Chatterji, D. 1960).

The general element occupies the third position in the flora of Rajasthan. It includes a large number of cosmopolitan plants and exotics introduced variously from different parts of the World chiefly from Europe, Mexico, West Indies, East Indies, America, Australia, Java, China, Japan, Philippines, Panama, Cuba, New Granada, Chile, France, Argentina and Brazil etc. It forms 17% flora—the lowest, in Ganganagar district and 41.82%—the highest, in Kotah division, where it dominates all the other elements. Among the wild introduced elements only those which are generally very aggressive have established in the soils of Rajasthan. The Australian element is very poorly represented in this State and India as a whole.

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Bionomics of *Micronecta scutellaris* Stål.[1]

MUKHTAR AHMAD[2] AND NAWAB H. KHAN[3]

(*With three text-figures*)

Micronecta scutellaris Stål., is commonly found in stagnant water of ponds, lakes and streams in India and can be commercially used as cage bird and poultry feed. During the present studies bionomics of *M. scutellaris* was studied at different temperatures and the effects of various food materials on the oviposition of the species have also been investigated.

INTRODUCTION

Members of the family Corixidae comprising over two hundred species of waterboatmen are voracious feeders on a wide variety of plankton and can injest detritus from the bottom ooze. They are world wide in distribution and are commonly found in ponds, lakes, streams and rivers and even in some brackish waters (Butler, E.A. 1923). They occur from below sea-level to an elevation of about 15,000 feet in the Himalayas (Usinger 1956) and are equally adapted to cold waters of the sub arctic and the warm waters of the tropics.

A species commonly found in stagnant waters in India is *Micronecta scutellaris*. It can be used as cage bird and poultry feed and therefore an attempt has been made to study its bionomics and to find out if it can be bred for commercial purposes.

METHODS AND MATERIALS

Adults of *M. scutellaris* were collected from Nilichhattri and Jamalpur ponds located in the vicinity of the University campus. The bugs were kept in batches of fifty to hundred in glass trough, 33 cm in diameter × 13 cm in height and having a 2·5 cm thick layer of sand at the bottom. The troughs were filled with pond water upto a height of 4 to 6 cm and aquatic plants such as *Hydrilla* sp. and also bottom ooze from a natural pond and decaying organic matter from a drain were added to the container. Water and the decaying organic matter were changed after every 24 hours in order to provide the insects with fresh nourishment. Oviposition readily occurred on the stems and leaves of the submerged plants and parts of the plants bearing the eggs were transferred to glass beakers containing water for the hatching of the eggs.

Oviposition

The eggs of *M. scutellaris* are usually laid on the roots, stems and leaves of *Hydrilla* sp., *Marselia* sp. and other aquatic plants.

If however no suitable host plant is available, the eggs may be deposited on pieces of wood or stones in the vicinity of water. They are deposited singly or linearly arranged in groups without any definite structural pattern. While depositing an egg the female grasps a leaflet or a portion of the plant selected for oviposition with its fore and middle pairs of legs, and then with a longitudinal motion of the abdomen, the tip resting on the spot, deposits an egg and

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swims away. We were successful in obtaining eggs on filter papers which were placed along the edges of the glass troughs. The temperature of the water was kept at 21 ± 1°C.

Nothing is known concerning the duration of the preoviposition and oviposition periods in this insect and hence single pairs of freshly emerged adults of *M. scutellaris* were kept in small 250 cc beakers at 21 ± 1°C. The preoviposition period varied from 3.0 to 11.0 days, while the oviposition period lasted from 7 to 12 days, a single female laying a total of 69 to 163 eggs. More than 60 per cent of the total number of eggs were deposited during the first five days of the oviposition period.

Eggs

The oval whitish eggs measure from 0.45 to 0.49 mm in length and 0.11 to 0.19 mm in width and bear short tubular projections on their dorsal surfaces (Figure 2A).

Effect of temperature on the hatching of the eggs

Batches of fifty freshly laid eggs were placed in three different beakers of 250.0 ml capacity each and filled with water. The temperature of the water was maintained in each at 18.2°, 24.0° and 31.0°C respectively and the eggs were examined at twelve hour intervals to determine the rate of their hatching. These observations proved that the temperature does affect

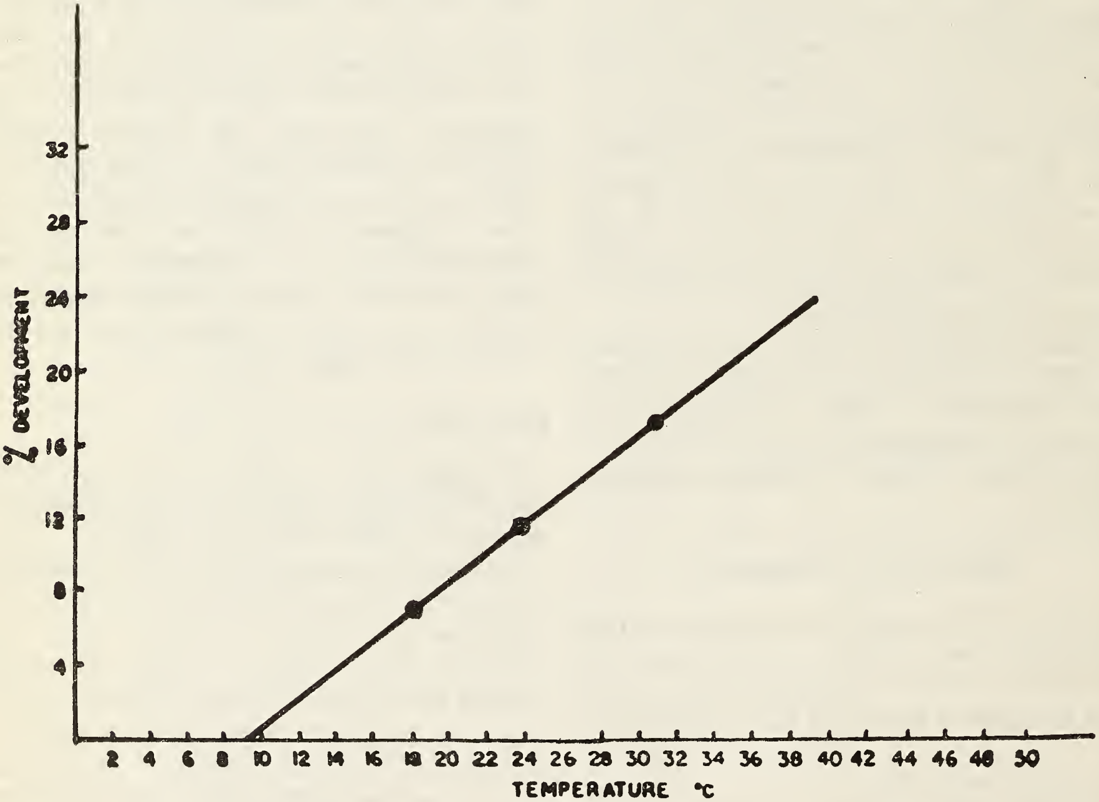

Fig. 1. Effect of temperature on the development of eggs.

the hatching of the eggs. At 18.2°C only 5.2 per cent eggs hatched and at 31.0°C, 58.1 per cent as compared to 78.0 per cent hatching observed at 24.0°C. This shows that temperatures below 20.0°C and above 30.0°C are unfavourable for the hatching of the eggs of *M. scutellaris.* Temperature of about 24.0°C seem to be more favourable for hatching as at this temperature the hatching of the eggs was found to be the maximum. That the duration of the egg stage is also affected by the temperature is clear as seen in figure 1. It was 14.2, 8.7 and 5.9 days at 18.2°, 24.0° and 31.0°C respectively, showing thereby that the incubation period decreases with an increase in temperature. The threshold temperature for the development of the eggs as established by figure 1 lies at 9.4°C, the value of K as determined by the following formula (after Chapmen, 1931) being :

$$Y (X-a) = K$$

where Y = incubation period in days at temperature X

a = threshold temperature

X = Temperature at which K is to be determined.

K = constant

The values at different temperatures were

18.2°C = 127.60

24.0°C = 127.07

31.0°C = 127.44

The values of K at the three temperatures are almost similar, so that the theoretical threshold temperature as determined above seems to be correct.

Nymphs

Fernando & Leong (1963) successfully reared the nymphs of *Micronecta quadristrigata* in open glass troughs filled with water and containing some bottom ooze from the ponds.

During the present studies the nymphs of *M. scutellaris* were reared individually as well as collectively on decaying organic matter. Eggs were collected from the leaves and stems of the *Hydrilla* plant and were allowed to hatch. The first instar nymphs were kept singly in glass beakers of 250 ml capacity and filled with pond water upto a height of about four centimetres. Water was changed after every 24 hours. The nymphs were also reared collectively in glass troughs as described in methods above.

There were five nymphal instars, the existence of which was checked by applying the formula of Dyar (1890). The ratio of increase in each instar was obtained by dividing each observed width of the head with that of the preceding

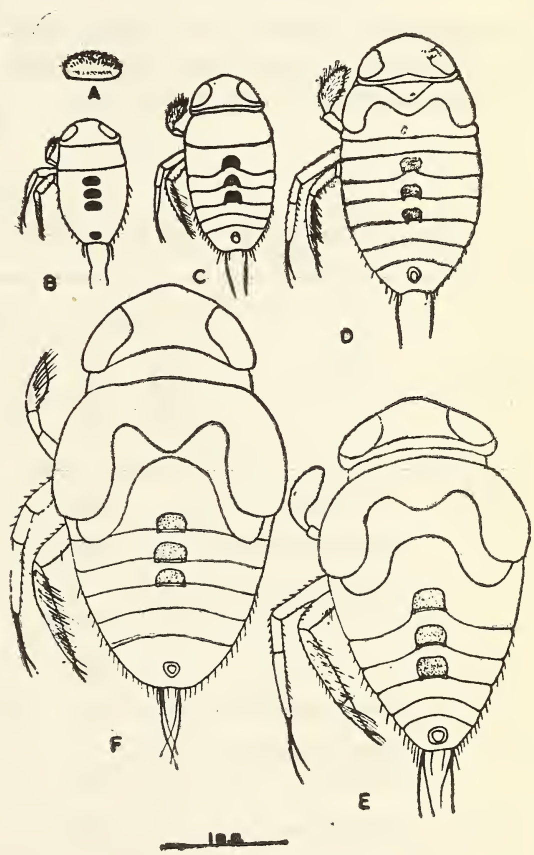

Fig. 2. Egg and developmental stages, of *M. scutellaris.*

A. Egg ; B. First instar ; C. Second instar ; D. Third instar ; E. Fourth instar ; F. Fifth instar.

instar. The average of such ratios came to 1.31. By using this ratio as a factor, the width of the head of the various instars was calculated and found to be :

Instar	Observed width	Calculated width
First ..	0.42 mm	0.42 mm
Second ..	0.69 mm	0.55 mm
Third ..	0.88 mm	0.72 mm
Fourth ..	1.07 mm	1.00 mm
Fifth ..	1.19 mm	1.31 mm

The calculated widths do not depart considerably from the measured ones showing thereby that no ecdysis had been overlooked.

Effect of temperature and food on the duration of the nymphal period

This effect was studied by rearing lots of 50 nymphs each at 18.0°, 24.0° and 32.0°C. They were fed on yeast powder, *Spirogyra* filaments or decaying organic matter from the drains.

The first instar nymphs when kept at 18.0°C failed to develop any further and died within eight hours of hatching. The nymphs reared at 24.0° and 32.0°C however completed their development when fed on decaying organic matter from the drains. Those reared on yeast powder and *Spirogyra* filaments survived only upto the second and the fourth instars. The development per day of the various instars accelerated with a rise in temperature (Table 1).

Table 1

Effect of temperature and food on the development of the nymphs of *M. scutellaris*

Temperature (°C)	Fed on	I Instar		II Instar		III Instar		IV Instar		V Instar		Total nymphal duration (days)
		Duration (days)	% Mortality	Duration (days)	% Mortality	Duration (days)	% Mortality	Duration (days)	% Mortality	Duration (days)	% Mortality	
18.0	Yeast powder	..	100.0	..	..	..	..	..	..	..	..	..
	Spirogyra filaments	..	100.0	..	..	..	..	..	..	..	..	..
	Decaying organic matters	..	100.0	..	..	..	..	..	..	..	..	..
24.0	Yeast powder	8.0	80.0	..	20.0	..	..	..	..	..	..	..
	Spirogyra filaments	7.5	60.0	8.0	20.0	6.5	10.0	..	10.0	..	..	..
	Decaying organic matters	7.5	20.0	6.0	15.0	6.0	15.0	6.5	10.0	6.0	10.0	32.0
32.0	Yeast powder	7.0	90.0	..	10.0	..	..	..	..	..	..	..
	Spirogyra filaments	7.0	50.0	6.0	30.0	6.5	10.0	..	10.0	..	..	..
	Decaying organic matters	7.0	30.0	5.5	20.0	5.0	10.0	6.0	10.0	5.0	10.0	28.5

The different nymphal instars may be identified with the help of the following key :

1. Wingpads absent (Fig. 2-B & 2-C) ; antennae indistinct; hind tibiae with few short hairs; middle legs without setae ; body length less than 2 mm 2
— Wingpads present (Fig. 2-D, F ; 3-A) ; antennae distinct (Figure 3-B, E) ; hind tibiae with numerous long hairs ; middle legs with setae ; body length more than 2 mm 3
2. Abdominal segments not clearly demarcated ; dorsal abdominal gland openings indistinct ; body length less than 1 mm (Fig. 2-B)...... *1st instar*
— Abdominal segments clearly demarcated ; dorsal abdominal gland openings clearly distinct ; body length more than 1 mm (Fig. 2-C).... *2nd instar*
3. Wingpads well developed (Figures 2-E, F ; 3-A) ; antennae two segmented ; basal segment distinct ; apical segment much broad or club like (Figures 3-C, E) ; body length more than 2.5 mm........ 4
— Wingpads rudimentary (Figure 2-D) ; antennae unsegmented ; long and finger like ; body length less than 2.5 mm .... *3rd instar*
4. Wingpads extending beyond posterior margin of thorax (Figures 2-F, 3-A) ; antennae with basal segment well developed (Figures 3-D, E) 5
— Wingpads not extending beyond posterior margin of thorax (Figure 2-E) ; antennae with basal segment very narrow and contiguous with the broad apical segment (Figure 3-C)............ *4th instar*
5. Wingpads not extending beyond mid of abdomen (Figure 2-F) antennae with basal segment transverse and contiguous with broad apical segment (Fig. 3-D)........................ 5th *instar*
— Wings well developed extending upto apex of abdomen (Figure 3-A) ; antennae with basal segment as long as wide and clearly separated from club shaped apical segment (Figure 3-E)........ .... Adult.

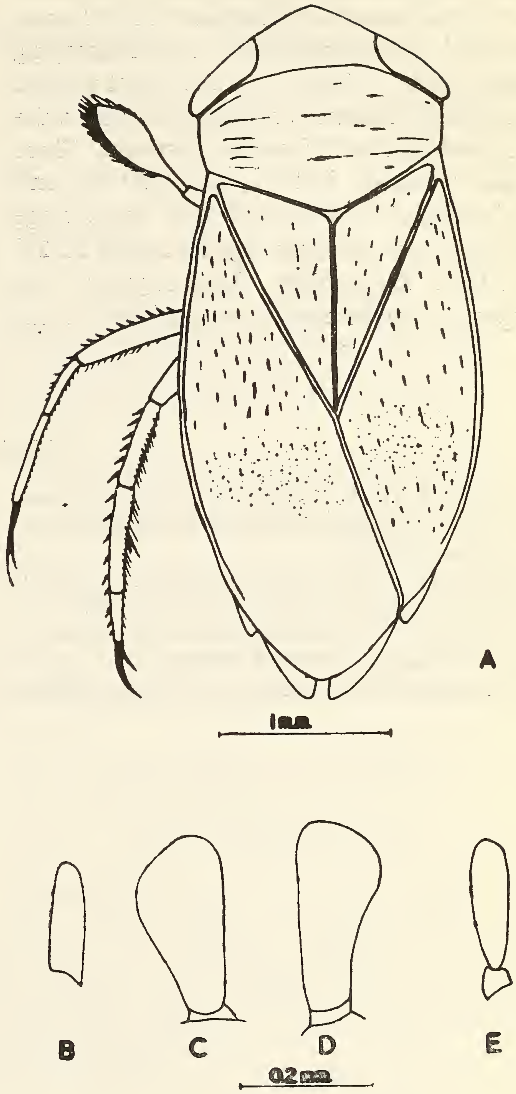

Fig. 3. A. *M. scutellaris*—Adult ; B. Antenna of third instar ; C. Antenna of fourth instar ; D. Antenna of fifth instar ; E. Antenna of adult.

SUMMARY

Micronecta scutellaris is generally found in stagnant waters of ponds, pools and the lakes and deposits its eggs on the roots, stems and leaves of *Hydrilla* sp., *Marselia* sp. and other aquatic plants. The preoviposition period varies from 3.0 to 11.0 days and a female lays 69 to 163 eggs over a period of 7.0 to 12.0 days. The incubation period is greatly affected by temperature conditions and the threshold temperature for the development of the eggs lies at 9.4°C. A temperature of 24.0°C seems to

be most suitable for the hatching of the eggs. The nymphs reared at 24.0° and 32.0°C completed their development when fed on decaying organic matter. Those reared on yeast powder and *Spirogyra* filaments survived only upto the second and the fourth instar respectively. There are five nymphal instars. Only 30.0% and 20.0% nymphs could reach the adult stage when reared on decaying organic matter at 24° and 32.0°C respectively. This suggests that the species can be reared successfully on the decaying organic matter at temperatures varying between 24.0° and 32.0°C.

Acknowledgements

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Ferns of Dharamsala Hills[1]

Ophioglossaceous, Schizaeceous and Hymenophyllaceous series

K. K. Dhir[2] and K. S. Datta

(*With twenty-one text-figures*)

This study deals with 21 species of ferns of Dharamsala hills. All important morphological characters on which the classification is based namely type of rhizome, dermal appendages on rhizome, stipe, rachis, rachilets or costules (when present), lamina, venation, soral position, industrial architecture (if present) and sporangial organisation are described and illustrated. Keys to genera and species have been prepared.

Beddome (1863, 1883 & 1892), Clarke (1880) and Hope (1899-1904) presented good taxonomic accounts of Indian ferns. Regional catalogues of ferns pertaining to particular places in the North Western Himalayas have been given by Hope (*vide* Collett, 1921), Blanford (1888) and Bir (1963) from Simla hills ; Marten (1909), Mehra (1939) and Stewart (1942) from Mussoorie hills ; Stewart (1945, 51) from Kashmir and Pahlgam ; Loyal & Verma (1960) from Nainital ; Mehra & Dhir (1968) from Dalhousie hills and Dhir & Sheera (in press) from Dharamsala hills. Recently, good taxonomic accounts of a few families namely Athyriaceae, Aspleniaceae, Blechnaceae, Loxogrammaceae and Polypodiaceae of Simla ferns were given by Bir & Shukla (1966, 1968 & 1971). Bir & Trikha (1968, 1969 & 1974) have revised the taxonomy of a few Polypodiaceous taxa like *Microsorium*, *Polypodium lineare* complex and *Lepisorus excavatus* group. But none of the authors since Hope (l.c.) have attempted a taxonomic revision of all the ferns of one area. An area-wise key to the plants is a general necessity for easy recognition of different fern genera and species.

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This study was carried out on 21 species of ferns belonging to 11 genera and 10 families. Every aspect of external morphology has been studied in great detail and keys to the genera and species are given. Voucher specimens are deposited in the Panjab University herbarium (PAN). Mehra (1961) has been followed for the arrangement of families and genera.

Ophioglossaceous Series

Family Ophioglossaceae

Terrestrial herbs ; rhizome short, fleshy, not scaly ; fronds solitary or few, straight (not circinate) in venation ; sporangia embedded in or seated upon a stalked spike, sporangial walls more than one cell in thickness and annulus absent.

Ophioglossum Linn.

Sterile blade simple, entire ; veins anastomosing ; spike arises from the centre of the barren segment bearing two rows of sporangia which are joined together almost completely, each opening by a transverse slit.

The genus is world wide in distribution. Clausen (1938) has recognised only 38 species whereas some authors split it into 56 species. One species is recorded here.

O. vulgatum Linn., Sp. Pl, 2, 1062, 1753 ; Clarke Trans. Linn. Soc. Lond. II, Bot., 1, 586, 1880.

Rhizome short more or less elongated, naked ; fronds usually solitary or few, straight in vernation, 2.5-12.5 cm long, but sterile part usually 2.5-6 cm long ; stipe 1-4 cm long, terete, elongated ; lamina or blade simple, 1-2.7 × 0.6-1.5 cm, ovate to ovate-oblong, margin entire, midrib usually indistinct ; texture herbaceous, green ; venation reticulate with few free veinlets at the margin ; fertile spike simple, 0.5-1.8 cm long, borne on a 0.5-8.5 cm long peduncle arising from the base of the blade, apex having a sterile projection or elongation of the axis ; sporangia borne in two alternate rows, fused together on the spike, each opening by a transverse slit ; spores globose, non-perisporiate, tetrahedral, exine thin and smooth (Fig. 1).

A low altitude species found growing among grass in exposed and rather dry conditions near Chetru at an altitude of 850 m.

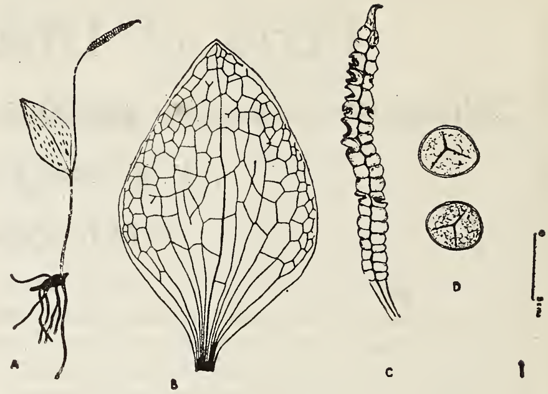


Fig. 1. *Ophioglossum vulgatum* ; A. A plant, × 4.7 (reduced) ; B. Leaf blade, showing venation, × 4.7 ; C. A fertile spike, × 4.7 ; D. Spores, × 291.

Fig. 2. *Lygodium flexuosum* ; A. A part of plant, × 3.7 (reduced) ; B. A sterile pinnule, × 3.7 ; C. A fertile pinnule, × 3.7 ; D. A fertile spike, × 8.7 ; E. A sporangium, × 80 ; F. Spores, × 292 ; G. Hair on the pinnules, × 80.

Schizaeceous Series

Family Schizaeaceae

Terrestrial ; rhizome creeping ; venation circinate ; sporangia regarded as marginal in origin, but often apparently dorsal, each with a complete distal annulus, dehiscence longitudinal.

Lygodium Swartz

Rhizome hairy (without scales) ; fronds scandant by twining rachises ; pinnae conjugate-palmate lobed ; sterile leaflets entire or toothed or regularly lobed ; veins free, forked, often uniting at their tips with a thickened margin ; fertile leaflets narrower than sterile, fringed with narrow lobes along the edges ; each lobe bearing two rows of sporangia, each covered with small indusium, dehiscing by a vertical slit ; spores tetrahedral.

Pantropic in distribution with about 40 species. The genus is represented by only one species in the area.

L. flexuosum (L.) Sw. in Schrad, Jour., 1800[2], 106 (pt.) 1801; Clarke, Trans. Linn. Soc. Lond., II, Bot., 1, 584, 1880.

Rhizome creeping, long, hairy; hairs unicellular; fronds stipitate-pinnate; climbing rachis up to 1 mm thick; secondary pinnae bearing alternately arranged pinnules, usually 3-5 on each side with a forked terminal pinnule, the whole being 4-15 cm long; largest secondary pinna 6.5 × 3.5 cm; stalk 1-5 mm long, broadly rounded to cordate at the base to sub-palmate or variously lobed, narrowing gradually at the apex, edges of the sterile segments finely toothed or serrated, hairy (hair unicellular); texture thin but firm, green; veins forked 1-3 times, very oblique at their origin from the midrib; fertile segments with lamina a little narrower than sterile; fertile lobes 1-4 mm long; sporangia in two alternate rows covered by a small indusium, pear shaped with an annular ring round the narrow end; spores tetrahedral non-perisporiate, exine thick and smooth (Fig. 2).

A rare fern found near Sidhpur at an elevation of 800 m growing along the forest margin twining around the bushes.

Family MARSILEACEAE

Typically sub-aquatic, heterosporus ferns, growing on mud; rhizome creeping, hairy; fronds simple and linear, circinate when young, without leaflets or with 2 or 4 opposite leaflets; veins forked, anastomosing; sori in hard structures called sporocarps at the base of stipes, consisting of mega and microsporangia, megaspores solitary, microspores numerous.

Marsilea Linn.

Fronds cruciform with two contiguous pairs of opposite leaflets, sori numerous attached to the inner wall of the sporocarp.

The genus has 70 species distributed all over the world. Only one species is found in the area under study.

M. minuta Linn., Mant., 308, 1771 (excluding β), Mehra & Dhir, Bull. Bot. Surv. India, 10, 303, 1968.

Rhizome slender, submerged, creeping, hairy; hairs pleuri-cellular and uniseriate; fronds cruciform, erect, well spaced along with close groups of fronds on short branches of the rhizome and rooting at the base; roots often long and wiry; petiole glabrous, terete, 4-14 cm long; leaflets 4, arranged symmetrically crosswise at the apex of the stipe, obovate, 1.5 cm both sides, with an entire, rounded apex and cuneate base; texture thin herbaceous, green; veins fine, dichotomously branched, anastomosing to form narrow radiating areoles; sporangia borne in a distinctly stalked sporocarp present at the base of the stipe; sporocarp ovoid in shape with two spines just close to the union of the stalk with the sporocarp; anterior spine often larger than the posterior one; spores of two kinds, mega and microspores; microspores globose, non-perisporiate with smooth exine (Fig. 3).

A common hydrophyte growing in the rice fields near Dari at an altitude of 850 m.

Family ADIANTACEAE

Terrestrial; rhizome creeping; fronds simple to pinnate, usually firm-herbaceous or coriaceous; veins free usually forked; sori marginal, globose to linear, usually numerous and distinct, sometimes confluent and continuous; indusium of the same shape as the sorus, formed of the reflexed margin of the fronds, bearing the capsules on its underside; spores tetrahedral.

Adiantum Linn.

Rhizome creeping or short-erect, scaly; scales brown to black and narrow; stipe dark-polished; lamina pinnately-decompound with

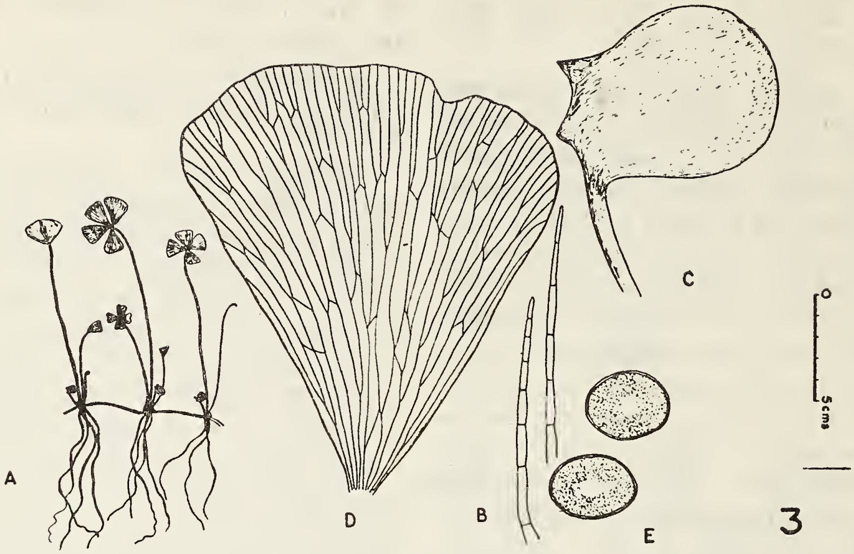


Fig. 3. *Marsilea minuta* ; A. A plant, × *c* 3.6 (reduced) ; B. Hairs on the rhizome, × *c* 17.2 ; C. A sporocarp, × *c* 3.6 ; D. A leaf-let showing venation, × *c* 3.6 ; E. Spores, × 221.2.

dimidiate or flabellate pinnules, sometimes simply pinnate ; veins free, extending into the reflexed margin ; sori terminal on the veins, covered with reflexed margin of the frond ; spores tetrahedral and smooth.

The genus is represented by more than 200 species in the world. Five species are reported from the area under investigation.

KEY TO THE SPECIES

A. Fronds pinnate, rooting at the apex ; pinnae entire or shallowly lobed.
  B. Stipe and rachis variously hirsute.
    C. Lamina hirsute ; pinnae dimidiate shortly-stalked, lobed ....*A. incisum*
    C. Lamina glabrous ; pinnae triangular, dimidiate, sessile with an almost straight upper margin ....*A. edgeworthii*
  B. Stipe and rachis glabrous ; pinnae lunulate to sub-dimidiate, glabrous ....*A. lunulatum*
A. Fronds decompound, not rooting at the apex.
  B. Ultimate pinnules small, flabellate to obdeltoid, cuneate, aristately-serrate ; indusia round-reniform attached to a notch ....*A. venustum*
  B. Ultimate pinnules larger, dimidiate, lobed with oblique flabellate base ; indusia transversely oblong or round-reniform ....*A. capillus-veneris*

A. incisum Forssk., Fl. Aeg. Ar. 187, 1775 ; Mehra & Bir, Res. Bull. Panjab Univ. (N.S), 15, 105, 1964.

Rhizome short, erect, densely scaly ; scales brown, linear, hair pointed, 3-6 mm long ; fronds fasciculated together, elongated and rooting at the apex; stipes terete, pubescent, 5-7 cm long, scaly, scales similar but smaller than those of rhizome scales ; lamina linear-lanceolate, 20-37 × 1-2.5 cm ; pinnae 10-35 jugate, basal ones somewhat smaller, deflexed and upper ones gradually diminished towards the apex ; rachis hirsute throughout with long ferruginous hairs, distinctly scaly, scales linear, hair pointed ; pinnules hairy, shortly stalked, anterior inner base truncate, margin deeply incised into 3-5 lobes, generally 1 × 0.5 cm ; texture herbaceous green ; veins fine, flabellately forked ; sori 3-5 on each pinnae, present at the margin of each lobe ; indusium laterally oblong or sub-reniform, brown, glabrous ; sporangia with 15-celled annulus ; spores tetrahedral, trilete, non-perisporiate, exine smooth (Fig. 4).

A very common low altitude fern found near Chari at 850 m, growing on shaded walls along the road.

A. edgeworthii Hook., Sp. Fil., ii, 14, t. 81B, 1851 ; Bedd., Handb. Ferns Brit. India, Suppl., 17, 1892.

Rhizome short, erect, wiry, sparsely scaly at the apex ; scales brown, lanceolate, subulate, rigid ; fronds fasciculated, several together ; stipes terete, glossy, castaneous, 4-10 cm long, wiry but firm, glabrous with a scaly base; scales linear, hair pointed and uniseriate ; lamina linear-lanceolate, 8-14 cm long, 1.5-2.3 cm broad ; pinnae 8-28 jugate, patent, basal ones somewhat smaller, deflexed, upper ones gradually diminished towards the apex, sessile, dimidiate, 1-1.2 × 0.5-0.6 cm, apex rounded, anterior inner base truncate, margin more or less lobato-incised, sterile pinnae cut nearly half way down into 3-5 oblong, roundish or bifid segments ; primary rachis scaly ; scales linear, hair pointed and uniseriate; texture herbaceous ;

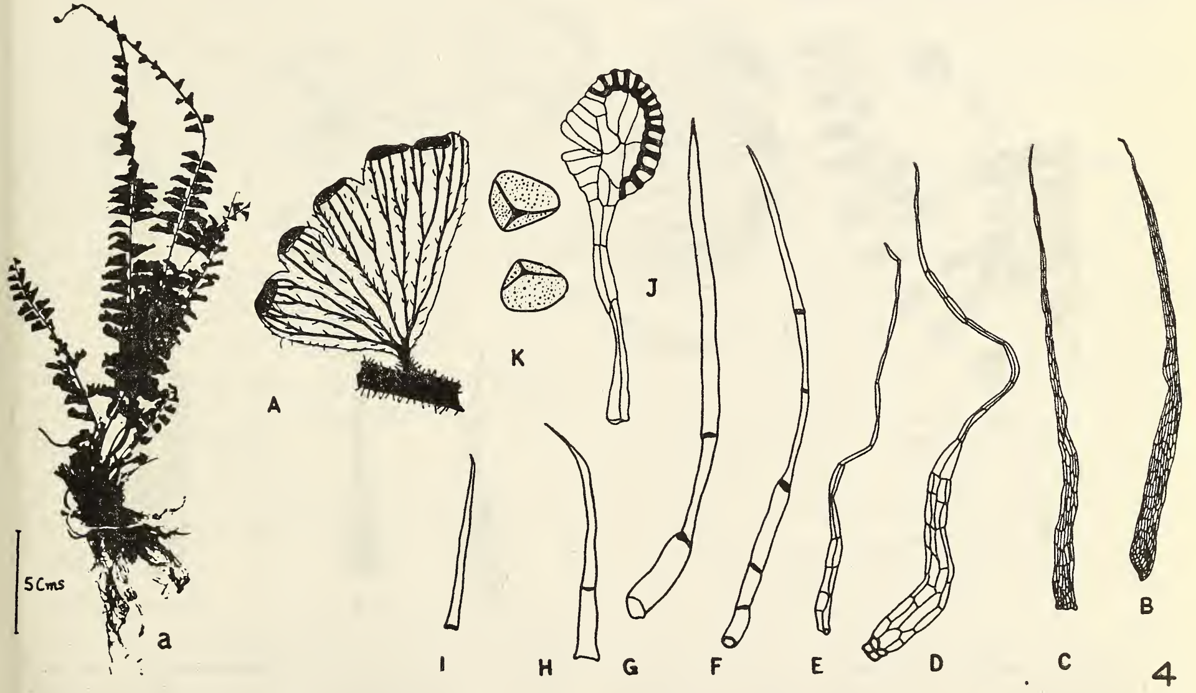
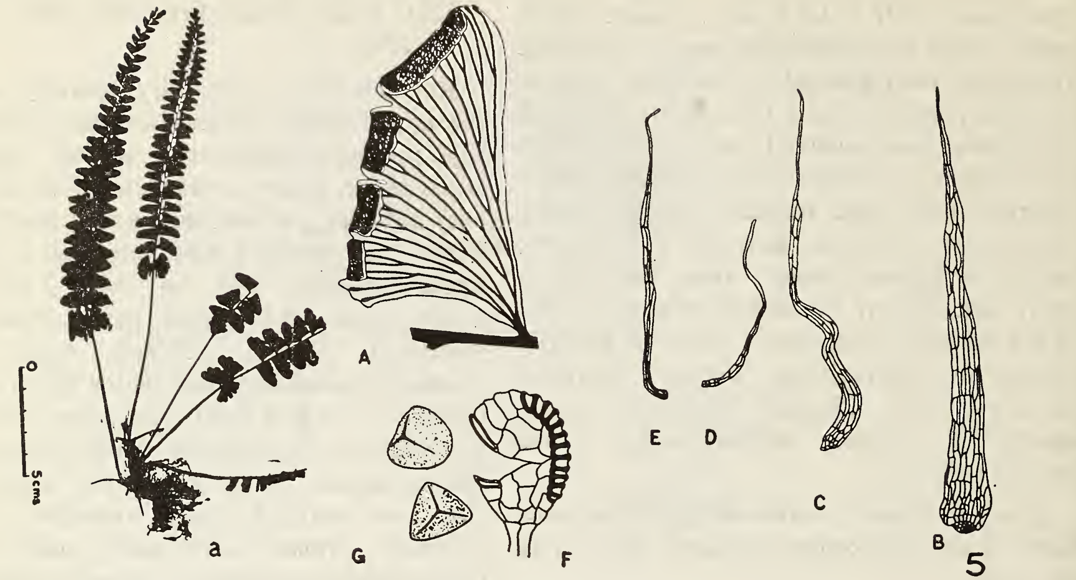


Fig. 4. *Adiantum incisum* ; a. A plant ; A. A pinna showing venation, × *c* 4 ; B, C. Rhizome scales, × *c* 11.2 ; D. E. Stipe scales, × *c* 18.6 ; F, G. Hairs on the rachis, × *c* 85.2 ; H, I. Hairs on the pinnae, × *c* 85.2 ; J. A sporangium, × *c* 85.2 ; K. Spores, × 248.



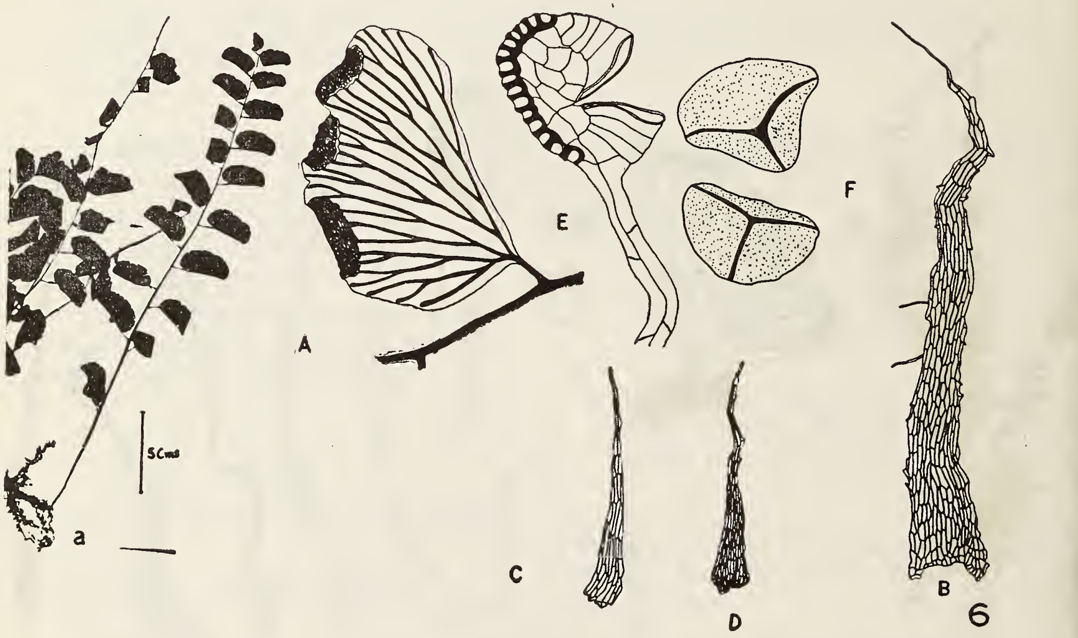


Fig. 5. *Adiantum edgeworthii* ; a. A plant ; A. A pinna showing venation, × *c* 4 ; B. A rhizome scale, × *c* 18.6 ; C. A stipe scale, × *c* 18.6 ; D, E. Scales of the rachis, × *c* 85.2 ; F. A sporangium, × *c* 85.2 ; G. Spores, × 248.

Fig. 6. *Adiantum lunulatum* ; a. A plant ; A. A pinna showing venation, × *c* 4.4 ; B. Rhizome scale, × *c* 12.4 ; C, D. Stipe scales, × *c* 21.2 ; E. A sporangium, × *c* 96 ; F. Spores, × 277.2.

veins fine, flabellately forked ; sori 2-7 to each pinna ; indusium laterally oblong or sub-reniform, brown, glabrous ; sporangia with 13-celled annulus ; spores with characteristic tri-radiate markings, tetrahedral, non-perisporiate, exine smooth (Fig. 5).

A rare fern of the area found along the road side in moist and shady places near Dari at 850 m.

A. lunulatum Burm. Fl. Ind. 235, 1768 ; Clarke, Trans. Linn. Soc. Lond., II, Bot., 1, 452, 1880.

Rhizome short, erect, wiry, densely scaly at the apex ; scales dark-brown, ovate-lanceolate, subulate, hair-pointed, 1-3 mm long ; fronds caespitose, elongated and rooting at the apex ; stipes dark chestnut brown, terete, glossy or castaneous, scaly below, glabrous above, 2-21 cm long ; lamina linear-lanceolate, 9-33 cm × 2-8 cm, unipinnate ; pinnae 2-15 jugate, sub-dimidiate, the basal ones larger and uppermost ones gradually diminished in size towards the apex, provided with long, shining 0.2-2.5 cm long stalk, nearly in line or oblique to the rachis, alternate, half-moonshaped, inner basal part truncate, margin more or less lobato-incised or entire ; veins fine, flabellately forked ; indusium laterally-oblong, glabrous, curved ; sporangia with 14-16 celled annulus ; spores tetrahedral, tri-radiate, non-perisporiate with thick smooth exine (Fig. 6).

A common low altitude species growing luxuriously on humus rich shaded walls along the roads. Seen near Dharamsala and Chetru between 800-1350 m.

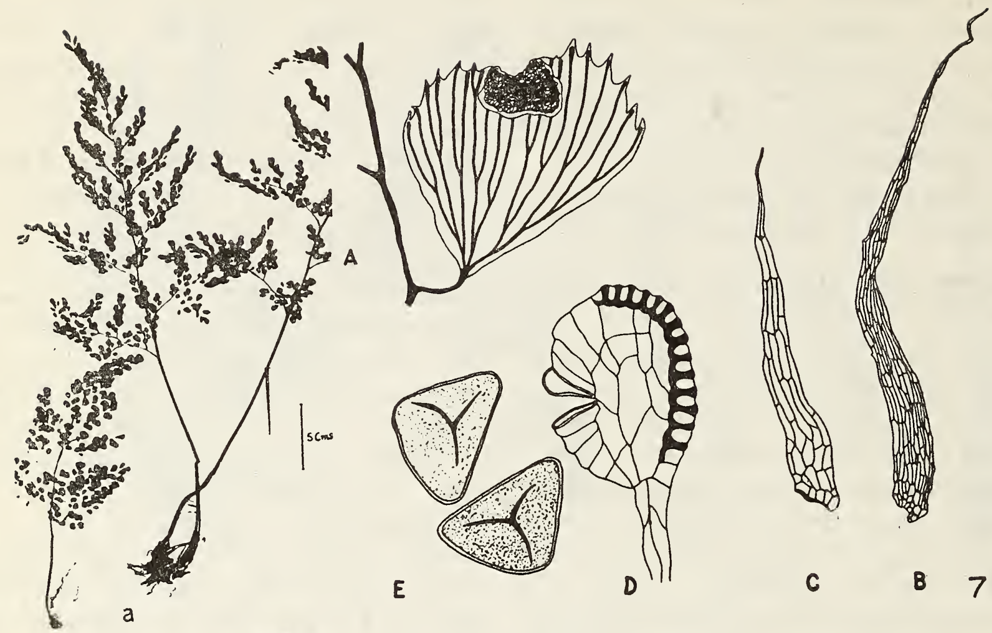
A. venustum D. Don, Prod. Fl. Nepal, 17, 1825 ; Clarke, Trans. Linn. Soc. Lond., II, Bot., 1, 453, 1880.

Rhizome wiry, widely-creeping, growing point densely clothed with scales ; scales nitide, light-brown, ovate-lanceolate, hair pointed, entire ; fronds caespitose ; stipe castaneous slender, firm, terete, glossy, 11-25 cm long, glabrous above the scaly base ; lamina deltoid-ovate, shorter than stipe, tripinnate ; pinnae 2-5 jugate under elongate pinnatified apex, petiolate, basal ones the largest, deltoid-lanceolate, 4-13 cm long, 3.5-6 cm broad ; pinnae of second order oblong, petiolulate, obtuse, with 1-4 pairs of ultimate close pinnules which are of flabellate shape with rounded, dentate aristately serrate outer margin, distinctly petiolulate, 2-6 mm each way ; rachis, rachilets, costa and petiolules shining or castaneous ; texture herbaceous, glabrous above, glaucous beneath, fertile lobes with 1-3 notches, each with a sorus at the bottom ; indusium light brown, thick rotundo-reniform, 1-1.5 mm long with sterile margin on both sides, aristately-serrate ; sporangia with 14-16 celled annulus, spores trilete, non-perisporiate, smooth (Fig. 7).

This is a fern of shaded and humus rich habitats. Frequently observed near Mcleod-ganj and Khanjjar Mahadev Temple at 1300 m.

A. capillus-veneris Linn., Sp. Pl. 2, 1096, 1753 ; Clarke, Trans. Linn. Soc. Lond., II, Bot., 1, 453, 1880.

Rhizome short, creeping, densely clothed at apex with dark-brown, linear, entire, scales ; fronds caespitose ; stipes 3-18 cm long, glossy, ebeneous, naked ; lamina deltoid-ovate, 8-18 cm long, 3-6 cm broad, usually bipinnate ; pinnae 1-5 jugate, alternate, with zigzag rachis, petiolate, basal ones much the largest, oblong-ovate, 1-5 cm long, 1-2.5 cm broad ; pinnules 5-7 jugate, petiolate, alternate, the lower ones pinnate, upper ones 2-3 foliolulate, the uppermost ones simple, rachilets also strongly flexuose ; penultimate pinnules 1-1.5 cm each way, flabellate with sinuate outer margin, petiolulate ; lobes entire with deeply incurvate outer edge ; texture membranaceous, green ; veins fine, flabellately forked ; sori one to each lobe, 2 mm each way ; indusium more or less curved, brown, persistent ; sporangia with usually 15-celled annulus ; spores trilete, non-perisporiate with smooth exine (Fig. 8).



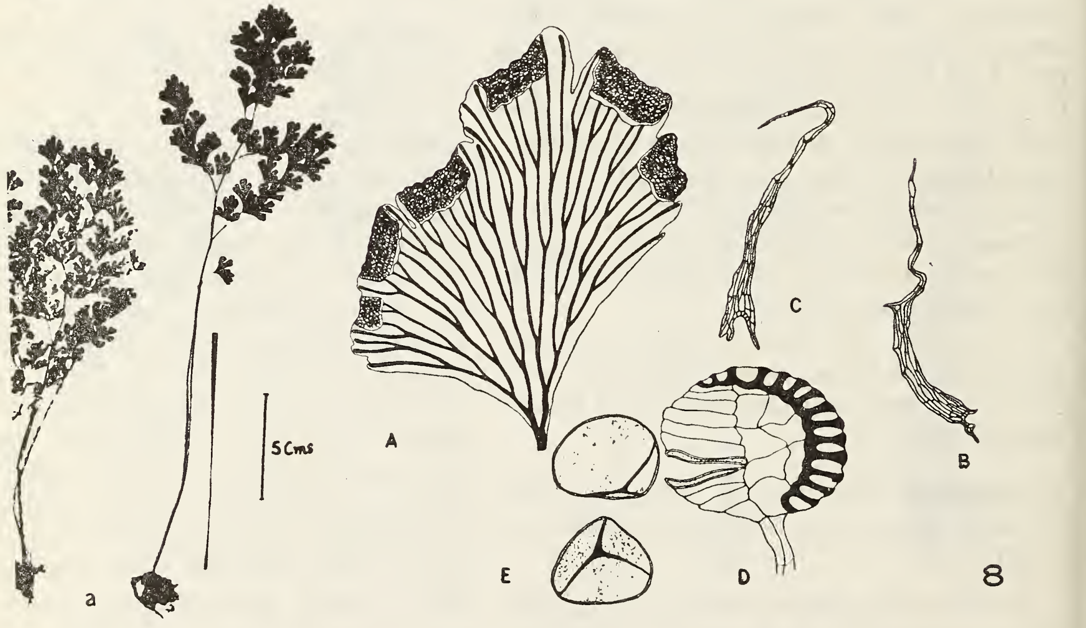


Fig. 7. *Adiantum venustum* ; a. A plant ; A. A pinnule showing vein pattern, × *c* 5 ; B. A rhizome scale, × *c* 5 ; C. Scale at base of stipe, × *c* 24.2 ; D. A sporangium, × *c* 109 ; E. Spores, 315.

Fig. 8. *Adiantum capillus-veneris* ; a. A plant ; A. A pinnule showing venation, × *c* 4.4 ; B, C. Rhizome scales, × *c* 12.4 ; D. A sporangium, × *c* 96 ; E. Spores, × 277.2.

It generally prefers moist and humus rich places along water channels. Occasionally found near Dharamsala, Chetru and Kangra between 800-1350 m.

Family Cryptogrammaceae

Terrestrial; rhizome creeping, solenostelic, short or compact, scaly; fronds decompoundly pinnate, sometimes dimorphic, ultimate pinnules small and narrow, glabrous, herbaceous or sub-coriaceous; veins free, forked; sori continuous along both margins, covered with scarious introrse marginal or sub-marginal indusium, so broad that the two on each pinnule meet on the costa, without paraphyses; spores tetrahedral, hyaline, ribbed or tuberculate epispore.

Onychium Kaulf.

Sori placed upon a continuous linear receptacle, which connects the apices of several veins; indusium parallel with the margin of the segments, linear, pressed down over the sori, the edge nearly or quite reaching the midrib.

The genus has about 10 species distributed in the Indo-Japanese region. One species is recorded presently.

O. contiguum Hope, Jour. Bomb. nat. Hist. Soc., 13, 444, 1901; Mehra & Bir, Res. Bull. Panjab Univ. (N.S.), 15, 108, 1964.

Rhizome 0.8-1.5 cm thick, short, procumbent, densely scaly, apex clothed with lanceolate, light-brown, castaneous scales; fronds caespitose; stipes 15-27 cm long, black at the base, pale-straminous above; lamina glabrous 25-40 × 15-26 cm, broadly-ovate, acuminate, very finely 5-pinnate; pinnae 8-12 jugate, the basal pair much the largest, triangular, acuminate, petiolate, oblique; pinnules of 2nd and 3rd order petiolate, united; ultimate segments linear-lanceolate, apiculate, entire, 3-5 mm long; texture herbaceous, pale-green, naked on both sides; veins fine, one to each segment, fall short of the acute apex, clavate; sori linear, short; indusia large, broad, membranaceous, pale-grey, entire, persistent, reaching the costule from both sides, rather overlapping; sporangia with 20-21 celled annulus; spores tuberculate with ridge-like projections giving rugose appearance, reticulations sparse (Fig. 9).

It is an elegant fern of humus rich forest floors near Dharmkot at an elevation of 1950 m. Occasionally it covers large areas and borders the forest.

Family Sinopteridaceae

Terrestrial; rhizome short-creeping or erect bearing tufts of fronds, scaly; fronds small pinnate to decompound, narrow to broadly-deltoid; veins free; sori marginal on the tips of the veins; indusium formed by the reflexed margin, discrete but often more or less confluent; spores globose to tetrahedral without perispore.

Cheilanthes Swartz

Fronds sub-coriaceous, 3-4 pinnatified; veins free, forked; sori on the tips of veins along the laminar edge, more or less protected by reflexed marginal flaps; spores tetrahedral, granulose to tuberculate.

The genus has about 200 species, distributed in tropical and warm temperate regions, characteristically inhabiting dry but cool places. It is represented by 4 species in Dharamsala Hills.

Key to the Species

A. Scales bicoloured; lamina lanceolate to deltoid.
  B. Scales present on rachises and costae; indusium margin lacerated or having finger-like projections .... *C. albomarginata*
  B. Scales present upto principal rachis and do not extend beyond to rachilets and pinnules;

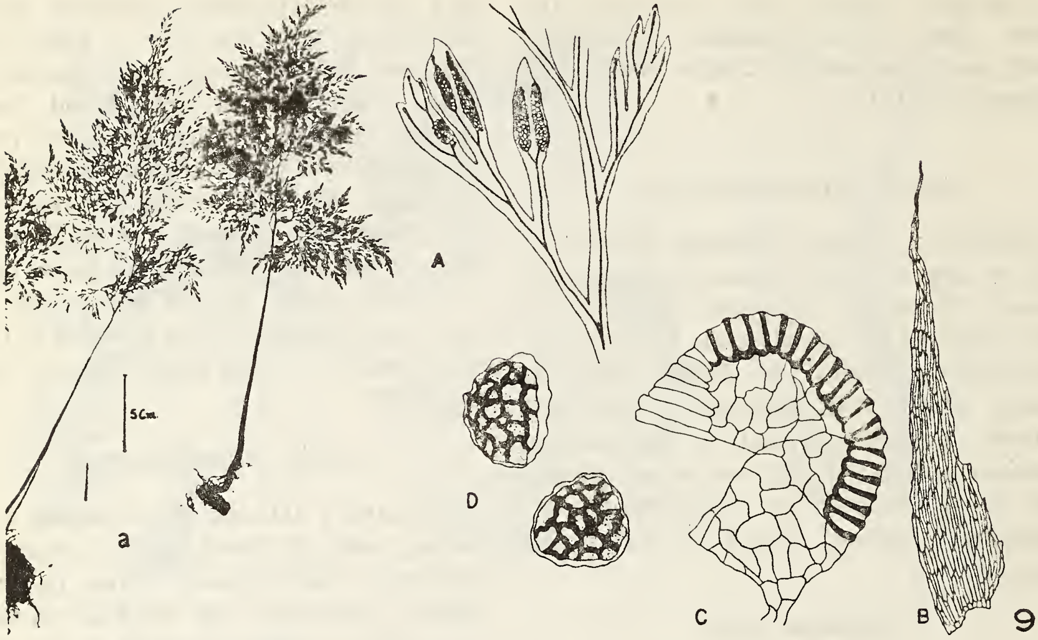


Fig. 9. *Onychium contiguum* ; a. A plant ; A. Ultimate pinnules showing venation and position of sori, × *c* 1.7 ; B. A rhizome scale, × *c* 11.6 ; C. A sporangium, × *c* 88.8 ; D. Spores, × 256.6.

Fig. 10. *Cheilanthes albomarginata* ; a. A plant ; A. A part of the pinna showing the vein pattern and position of sori, × *c* 3.4 ; B. A rhizome scale, × *c* 5.8 ; C. A stipe scale, × *c* 9.4 ; D. A scale on the rachis, × *c* 12 ; E, F. Scales on the rachilets, × *c* 12 ; G. Sporangium, × *c* 73.2 ; H. Spores, × 210 ; I. Indusium, × *c* 12.

lamina lanceolate and farinose ; indusium sub-entire

..........*C. anceps*

B. Scales present only at the base of the stipe ; indusium margin with numerous glandular cells

..........*C. farinosa*

A. Scales concolorous, lamina deltoid-lanceolate to deltoid.

B. Scales large, membranaceous, thin papery ; lamina never farinose ; indusium with toothed margin

..........*C. dalhousiae*

B. Scales at the stipe sometimes concolorous but not membranaceous

..........*C. farinosa*

C. albomarginata Clarke in Trans. Linn. Soc. Lond., II, Bot., 1, 456, t. 52, 1880 ; Bedd., Handb. Ferns Brit. India, 94, 1883.

Rhizome short, ascending to sub-erect, broader upwards, narrow below, densely scaly ; scales 3-6 × 0.5-1 mm, deltoid to deltoid-lanceolate, hair uniseriate and pointed, bi-coloured, margin smooth sometimes with peg-like projections near the base, central region dark-brown with hyaline peripheral cells ; fronds closely tufted, paleaceous, deltoid or deltoid-lanceolate ; stipes hard, deep-brown, cylindrical, 4-18 cm long, without groove, scaly althrough ; scales like those of rhizome except for smaller in size ; lamina deltoid-lanceolate, 6-24 × 3.5-10 cm, unipinnate above, bipinnate below with extreme apex pinnatifid, sub-basal pinnae the largest, rachis and rachilets prominent, scaly ; scales on the rachis bicoloured but on the rachilets concolorous or bicolorous ; lamina densely farinose underneath ; farina either white, cream-yellow or even yellow ; sori mixed, occur superficially on the under-surface at the dilated vein ends ; veins finely forked ; sori covered by a broad, membranaceous, lacerated indusium ; sporangia conspicuously large, pyriform to globose, with 18-20 celled annulus, stalked ; spores dark-brown, globose tetrahedral, exine densely verrucose (Fig. 10).

A common fern of moist and humus rich walls in exposed situations near Forsytheganj, Mcleodganj and Khanjjar Mahan Dev Temple between 1600-1800 m.

C. anceps Blanford in Simla nat. Hist. Soc. Leaflet, 25th June, 1886 ; Mehra & Bir, Res. Bull. Panjab Univ. (N.S.), 15,109, 1964.

Rhizome short, ascending, broader upwards, narrow below, densely scaly ; scales 3-4 × upto 0.5 mm, linear-lanceolate, hair uniseriate, pointed, bicoloured, margin smooth ; fronds fasciculate or caespitose, lanceolate, under surface thickly coated with white powder ; stipes hard, cylindrical, deep chestnut coloured, 3-15 cm long, scaly ; scales like the rhizome scales except for the size ; lamina deltoid-lanceolate, 8-18 × 3-9 cm, unipinnate above, bipinnate below with extreme apex pinnatifid ; basal pinnae the largest ; rachis and rachilets prominent, scales on the principle rachis and not beyond that ; scales usually concolorous ; sori contiguous, occur superficially on the under surface at the vein ends ; veins finely forked ; indusium more or less continuous, with a broadly lobed margin ; sporangia large, globose with 20-22 celled annulus ; spores dark-brown, globose, tetrahedral, narrow flap-like ridges on the exine (Fig. 11).

Frequent on exposed rocks along the roads near Dharamsala, Chetru, Dari and Chari between 800-1400 m.

C. farinosa sensu Blanford in Asiat. Soc. Bengal, 57 : 301, 1888.

Rhizome short, ascending, densely scaly ; scales linear-lanceolate, hair uniseriate and pointed, usually 4-6 mm × 0.5-1 mm, bicoloured, margin smooth ; fronds caespitose, sub-coriaceous, deltoid-lanceolate or lanceolate, glabrous, white powdery beneath ; stipe more or less elongated 15-25 cm long, ebeneous, chest-nut coloured, hard, deciduously scaly ; scales concolorous rarely bicoloured, linear-lanceolate,

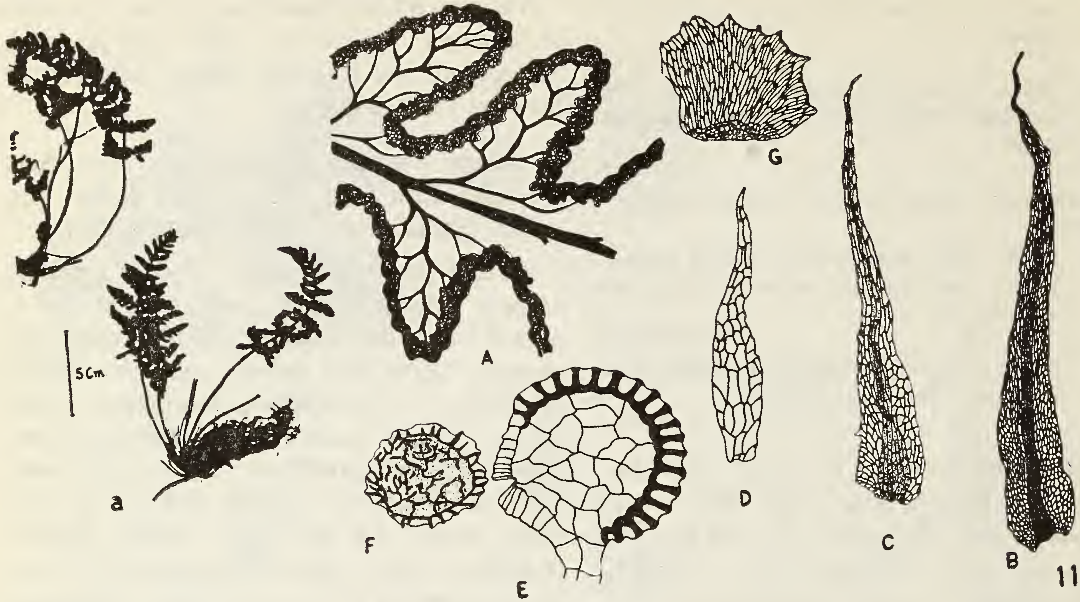


Fig. 11. *Chelianthes anceps* ; a. A plant ; A. A part of the pinna showing venation, and position of sori, × *c* 4.4. B. A rhizome scale, × *c* 12.4 ; C. A stipe scale, × *c* 21.2 ; D. Scale on the rachis, × *c* 21.2 ; E. Sporangium, × *c* 61.2 ; F. Spore, × 277.2 ; G. Indusium × *c* 21.2.

Fig. 12. *Cheilanthes farinosa* ; a. A plant ; A. A part of the Pinna showing venation, × *c* 1.6 ; B. Rhizome scale, × *c* 11.6 ; C. Stipe scale, × *c* 11.6 ; D. Sporangium × *c* 88.8 ; E. Spore, × 256.6 ; F. Indusium, × *c* 18.6.

3-4 × upto 0.5 mm, hair pointed ; lamina farinose, deltoid to deltoid-lanceolate, 10-18 × 6-12 cm, unipinnate above, bipinnate below, sub-basal pinnae the largest ; rachis and rachilets naked, glossy, castaneous ; texture sub-coriaceous, green ; sori contiguous, occur superficially on the under surface at the vein ends ; veins finely forked ; indusium brown, globose, sometimes confluent, with glandular margin ; sporangia large, globose with 20-24 celled annulus ; spores globose to tetrahedral with flap-like ridges on the exine (corrugated) (Fig. 12).

It is a fern of rock crevices and grows under shade. Commonly found near Chamundey Temple at 1200 m.

C. dalhousiae Hook., Sp. Fil., 2,80, t. 75B, 1852 ; Mehra and Bir, Res. Bull. Panjab Univ., (N.S.), 15, 109, 1964.

Rhizome short, ascending to sub-erect, densely scaly, scales 3-8 × 1-3 mm, ovate-lanceolate concolorous, membranaceous, yellowish-brown ; fronds caespitose, deltoid-lanceolate thin in texture ; stipes 10-13 cm long, firm ebeneous, glossy, deciduously scaly at the base scales large ovate-lanceolate, concolorous with smooth margin ; lamina deltoid-lanceolate to lanceolate, glabrous on both sides 10-16 × 4-8 cm, never farinose ; sori at the vein ends, protected by involucres ; indusium close but distinct, sometimes confluent, with a toothed or lacerate margin ; sporangia large, globose with 18-22 celled annulus ; spores dark-brown, globose-tetrahedral with scanty ridges or flaps on the exine (Fig. 13).

Occasionally found growing in moist and shaded localities near Dharmkot at an elevation of 1950 m.

Family Gymnogrammaceae

Terrestrial ; rhizome short-creeping or rudimentary, paleate ; fronds small to fairly large, pinnate to tripinnate with few and large, entire to incised leaflets, herbaceous or more firm ; veins free, forked, ending in hydathodes ; sori elongate along the veins except near the margin, exindusiate ; spores bilateral or tetrahedral, smooth or faintly ribbed.

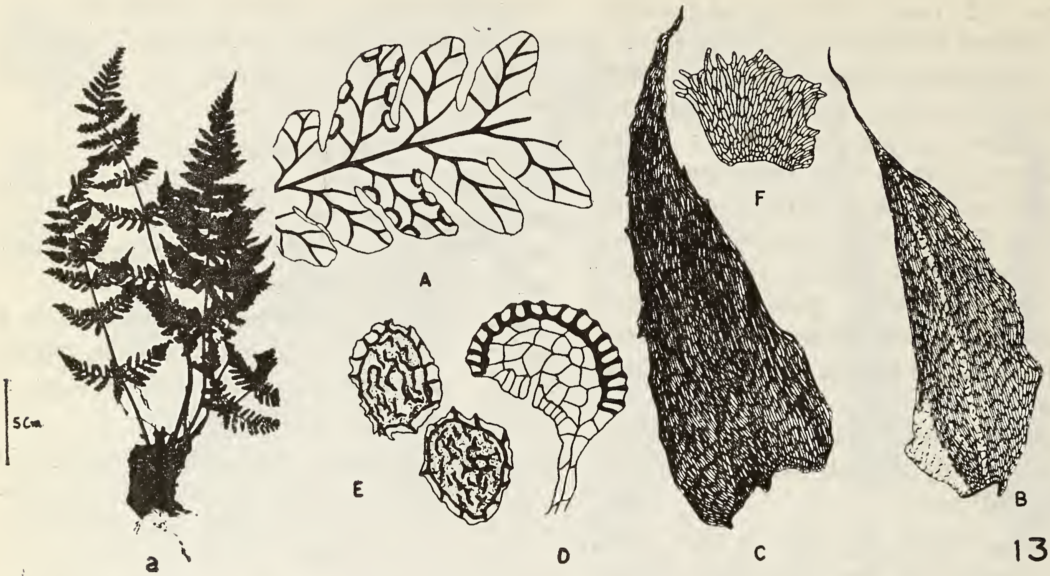
Coniogramme Fee

Rhizome scales rather narrow ; stipe grooved ; texture herbaceous ; veins free, distinct, forked near the base ; spores yellow, tetrahedral, non-perisporiate.

A small genus of about 20 species with a limited distribution in Sino-Japanese region, Africa and Mexico. Only one species is reported from the present area.

C. intermedia Hieron., Hedwigia, 57, 301, 1916 ; Ching, Ic. Fil. sinica., Pl. 143, 1935 (description only) ; Mehra & Dhir, Bull. Bot. Surv. India, 10, 304, 1968.

Rhizome 0.8-1 cm thick, wide-creeping, densely scaly ; scales brown, ovate-lanceolate, acuminate with sub-entire margin ; fronds distant ; stipes 20-25 cm long, glabrous above the scaly base (scales linear-lanceolate, acuminate), pale-straminous, terete below, grooved above ; lamina ovate-deltoid, 30-45 × 15-35 cm, bipinnate at the base, simple pinnate above, lateral pinnae 3-6 jugate, alternate, the basal ones much the largest, more or less opposite and petiolate, 4-15 cm long, tripinnate but rarely pinnate also, the upper ones simple but sometimes the second pinnae further divided, petiolate but rarely the uppermost ones adnate, 5-8 × 1-1.5 cm, broadly-lanceolate with attenuate apex, base rounded or rotundo-cuneate, margin sharply serrate ; texture herbaceous, light-green, glabrous ; rachis naked, glossy, pale-straminous ; veins free, distinct, oblique, generally forked near the base, veinlets fine, parallel, extending till the base of teeth with a clavate apex ; sori pale-brown, exindusiate, following the veinlets, till a short distance from the margin ; sporangia with 15-celled annulus ; spores tetrahedral, trilete, non-perisporiate, exine thick and smooth (Fig. 14).



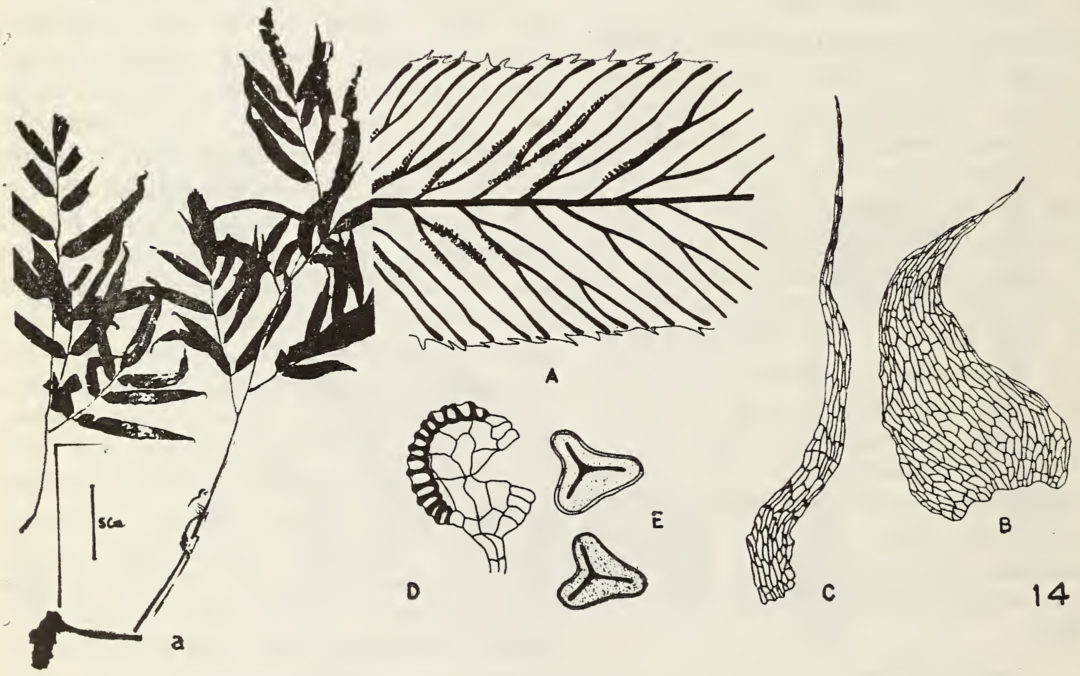


Fig. 13. *Cheilanthes dalhousiae* ; a. A plant ; A. A part of the pinna, showing venation, × *c* 1.6 ; B. Rhizome scale, × *c* 11.6 ; C. Stipe scale, × *c* 11.6 ; D. Sporangium, × *c* 88.8 ; E. Spores, × 256.6 ; F. Indusium, × *c* 18.6.

Fig. 14. *Coniogramme intermedia* ; a. A plant ; A. Part of the Pinnule showing venation and position of sori, × *c* 4.4 ; B. Rhizome scale, × *c* 12.4 ; C. Scale on the base of stipe, × *c* 21.2 ; D. Sporangium, × *c* 61.2 ; E. Spores, × 277.2.

The present taxon conforms to the var. *glabra* Ching.

It is a high altitude fern growing on humus rich forest floor in exposed situations, sometimes covering large areas. Seen near Triund at 2700 m.

Family Pteridaceae

Rhizome erect or creeping, scabrous ; veins free or anastomosing ; sori marginal, linear, continuous, borne on a marginal connecting commissure ; indusium the same shape as the sorus, usually membranaceous ; spores tetrahedral, surface usually papillose or reticulate.

Pteris Linn.

Rhizome erect or creeping, bearing tufts of 2-3 pinnate fronds, scaly ; veins free except in the sori ; sorus continuous along the margin, protected by the reflexed margin, paraphysate; spores tetrahedral sculptured.

A genus of more than 280 species with a tropical distribution extending to New Zealand, Africa, Japan and United States. Presently it is represented by 3-species.

Key to the Species

A. Pinnae all simple, entire, sessile, lower ones gradually reduced
..........*P. vittata*

A. Pinnae deeply lobed or the lowest pair branched.

- B. Lamina oblong with basal pinnae divided into 2-4 linear-pinnules ; sterile pinnae stalked with serrate margin ; spores smooth
..........*P. cretica*
- B. Lamina bipinnatifid with lower pinnae bipartite or even bipinnate ; pinnae stalked with sub-entire segments
..........*P. quadriaurita*

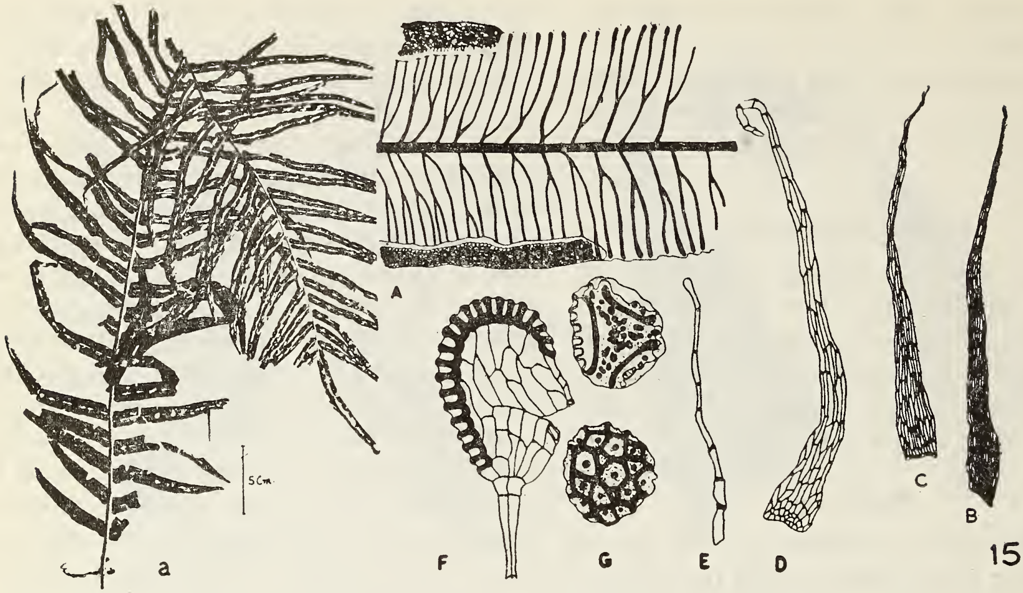
P. vittata Linn., Sp. Pl., 1074, 1753, Mehra and Dhir, Bull. Bot. Surv. India 8, 304, 1968.

Rhizome 1-1.5 cm thick, short, sub-erect, densely covered with pale-brown, shining scales ; scales 0.4-0.8 cm long, linear-lanceolate, hair pointed, concolorous, entire ; fronds subcaespitose, oblong-lanceolate, pinnate with a terminal pinna like the lateral ones ; stipes 5-20 cm or more in length, rigid, pale, scaly almost throughout, but the stipe, rachis and rachilets are thickly pubescent in the smaller forms ; pinnae 30-40 pairs, 1-5 cm apart, pubescent, basal ones gradually reduced and often very short, upper ones slightly reduced but much shorter than the terminal pinna except in large fronds, all pinnae sessile and oblique ; largest pinnae 6-12 × 0.4-0.7 cm, base broadly cuneate to cordate, apex acuminate ; rachis distinct and scaly ; texture sub-coriaceous ; veins fine distinct on both surfaces, nearly at right angle to the costa, usually forked, not anastomosing ; sori continuous from near the base to near the apex of each pinna ; indusium membranaceous and yellowish brown; sporangia with 22-celled annulus, intermixed with pleuricellular hairs; spores non-perisporiate, reticulate (Fig. 15).

This species is locally abundant along the streamlets where sufficient humus has accumulated. Met with near Dari, Chari and Chetru between 800-900 m.

P. cretica Linn., Mant., 130, 1767, Bedd., Handb. Ferns Brit. India, 106, 1883.

Rhizome 0.5-1.5 cm thick, short, suberect, sparsely scaly ; scales pale-brown, linear-lanceolate, 4-6 mm long, hair uniseriate and pointed, dentate; fronds caespitose; stipes 20-40 cm long, erect, wiry, naked, straw-coloured and shining; lamina 20-25 × 10-15 cm, oblong, with distinct purplish rachis, pinnate ; basal pinnae further divided with secondary pinnae having adnate decurrent bases ; pinnae 7-15 × 1-1.5 cm, terminal pinnae longer than the rest of the pinnae below, sterile pinnae broader with spinulose-serrate margin ; texture coriaceous, green ; veins usually once forked near the costa only, 40-60 veins, ending just within the margin, costa raised and grooved above ; fertile pinnae



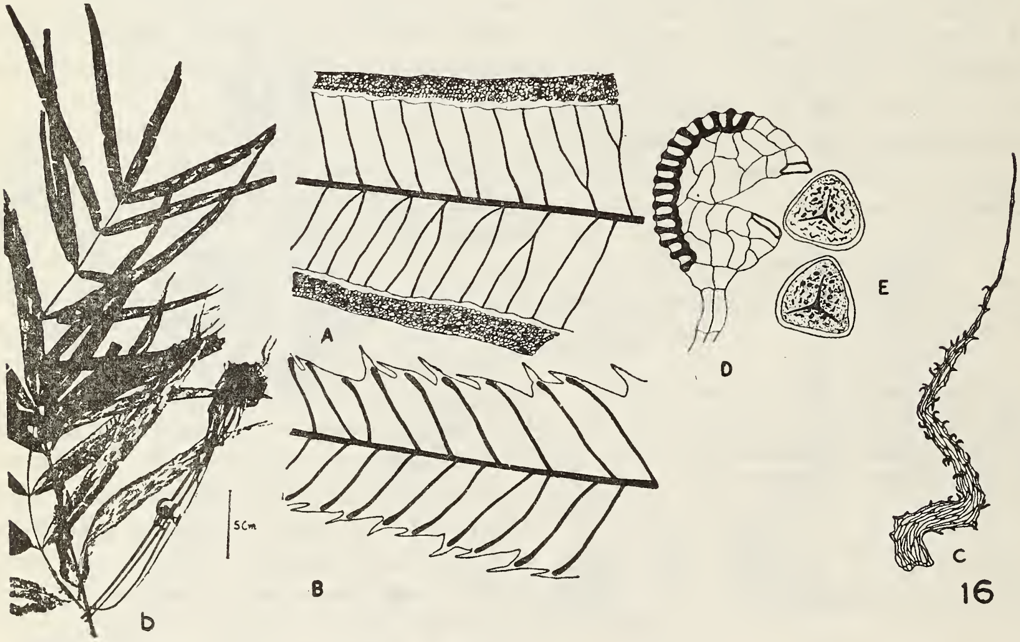


Fig. 15. *Pteris vittata* ; a. A plant ; A. Part of the pinna showing venation and position of sori, × *c* 1.6 ; B. Rhizome scale, × *c* 11.6 ; C. Stipe scale, × *c* 11.6 ; D. Scale of the rachis, × *c* 19.6 ; E. Hair on the rachis, rachilets and among sori, × *c* 34.4 ; F. Sporangium, × *c* 88.8 ; G. Spores, × 256.6.

Fig. 16. *Pteris cretica* ; a. A plant ; A. Part of fertile frond showing venation and position of sori, × *c* 4 ; B. Part of the apex of the pinnule showing vein pattern, × *c* 4 ; C. Rhizome scale, × *c* 10.9 ; D. Sporangium, × *c* 85.2 ; E. Spores, × 248.

usually soriferous all along the edges except for a short distance from the apex where the edges are undulate and hardly toothed ; sori rather broad when mature ; indusium pale membranaceous; sporangia with 16-17-celled annulus; spores trilete, tetrahedral, perisporiate (Fig. 16).

Grows along the road side in moist and humus rich soil conditions. Frequently met with near Khanjjar Mahan Dev Temple and Dharamkot between 1700-2000 m.

P. quadriaurita Retz. in obs. Bot., 6, 38, 179 (sensu lato) : Bedd., Handb. Ferns Brit. India, 110, 1883.

Rhizome short, oblique, densely scaly ; scales dark-brown, lanceolate, rigid, appressed; fronds caespitose ; stipes 15-40 cm long, rufo-straminous near the base, light-coloured upwards, scales at the base similar but smaller to rhizome scales ; lamina broadly ovate-lanceolate, 30-40 × 15-26 cm ; pinnae 7-11 jugate under a single apical pinna ; the basal pinnae the largest, deltoid with 1-2 additional pinnules on the lower side of the costa, all subsessile with shortly decurrent base ; the middle ones 13-15 cm long, 2.5-3 cm broad, pinnatifid nearly down to costa into 20-30 pairs of linear, subfalcate, obtuse segments under the caudate, entire apex ; segments 0.5-1.5 × 0.4-0.6 cm ; veins 6-14 forked pairs of which posterior basal one 2-4 times forked ; veinlets almost reach the margin with a clavate apex and meet the marginal commissure ; texture sub-coriaceous, green, glabrous ; rachis pale-colored, terete below, furrowed on the dorsal side with a spine at the base of each pinna ; sori continuous from near the sinus reaching upto the apex of the segment ; indusium membranaceous, grey, entire ; sporangium with 17-21 celled annulus ; spores trilete, perisporiate ; perispore folded (Fig. 17).

It grows luxuriously on shaded and humus rich walls along the road near Khanjjar Mahan Dev Temple at an elevation of 1700 m.

HYMENOPHYLLACEOUS SERIES

Family Hypolepidaceae

Terrestrial, rhizome creeping, more or less densely covered with hairs ; vascular system a solenostele ; fronds large, pinnately compound, coriaceous ; veins free or joined at the margin with a commissure, forked ; sori apical on the veins or nearly so or close to the margin and protected by a small thin reflexed margin (outer or false indusium), the inner (true) one developed or obsolescent ; spores tetrahedral-oblong, papillose, tuberculate or rarely smooth.

Key to the Genera

A. Sori elongate along the margin, rachis and rachilets pubescent
.... *Pteridium*

A. Sori not elongate along the margin, rachis and rachilets glabrous
.... *Hypolepis*

Pteridium Scopoli

Rhizome long-creeping, hypogaeous, solenostelic, clothed with hairs ; fronds pinnately-compound, coriaceous, more or less densely hairy, veins free except for a marginal strand ; sorus continuous along the margin, borne on the connecting vein, indusium double, the outer (false) one formed by the reflexed margin, the inner (true) one developed or obsolescent, paraphyses none, sporangium slender-stalked ; spores tetrahedral or globose tetrahedral, smooth.

A monotypic genus distributed in the tropical and temperate regions of the world.

P. aquilinum (L.) Kuhn ex Decken, Reisen in Ost. Afrika, 3, 11, 1879 ; Mehra & Bir, Res. Bull. Panjab Univ. (N.S.), 15, 118, 1964.

Rhizome stout, creeping, hypogeal, clothed with pale-brown, generally long, unicellular hairs ; fronds rather distant ; stipes 15-30 cm

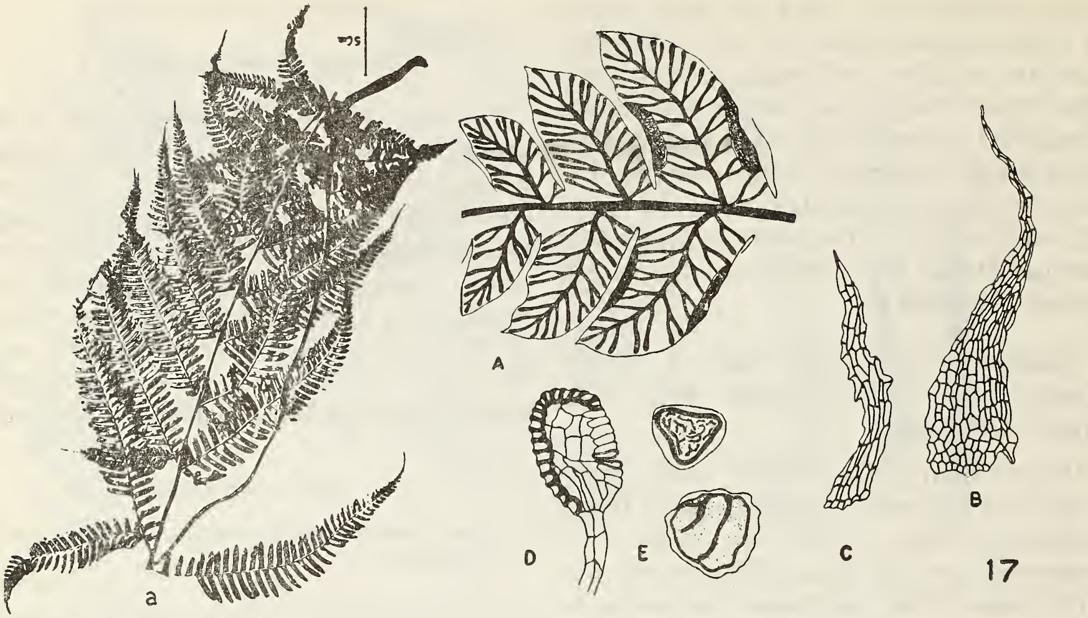


Fig. 17. *Pteris quadriaurita* ; a. A plant ; A. Part of the pinnule, showing venation, × *c* 4.2 ; B. Rhizome scale, × *c* 20.4 ; C. Scale at the base of stipe, × *c* 20.4 ; D. Sporangium × *c* 58.8 ; E. Spores, × 266.

Fig. 18. *Pteridium aquilinum* ; a. A plant ; A. Part of the pinnule showing venation and position of sori, × *c* 1.6 ; B, D. Rhizome hairs, × *c* 11.6 ; C. Hair on pinnules, × *c* 11.6 ; E. Sporangium, × *c* 88.8 ; F. Spores, × 256.6.

long, strong, erect, grooved, naked ; lamina 20-35 × 40-60 cm, deltoid, tripinnate ; pinnae 10-35 × 5-20 cm, often long, distinctly stalked, opposite to sub-opposite, basal one is the longest, gradually reduced upward ending in an acuminate apex ; pinnae at the apex simple, lanceolate ; pinnae finely dissected into 10-20 lanceolate-acuminate, alternate, 6-12 × 0.8-2 cm pinnules ; pinnules further dissected finely into 10-25, 0.7-1.5 × 0.3-0.5 cm segments ; segments contiguous, more or less falcate, pubescent, narrowed more or less evenly from the dilated base to the rounded apex, cut almost or quite to the costa ; rachis and rachilets distinct, yellowish-brown, sparsely hairy ; hairs long, with cells placed end to end in a single row ; texture coriaceous, yellowish-green in colour ; venation indistinct, usually 6-12 veins on either side of costule ; forked 1-3 times with a marginal commissure joining the apices of the veins ; sori sub-marginal, linear, indusiate ; indusium double, outer consisting of thin reflexed, edge of the pinnule, the inner thin attached just below the receptacle ; sporangia with 18-20 celled annulus, globose, stalked ; spores tetrahedral, pale-brown, minutely papillose, with a characteristic trilete marking, non-perisporiate (Fig. 18).

This species colonizes recently cleared places along streamlets. It is available near Dharamsala at an altitude of 1350 m.

Hypolepis Bernh.

Rhizome creeping, solenostelic, clothed with usually reddish hairs ; fronds mediocre to large, bipinnate or more compound, hairy or glabrous, herbaceous ; veins free ; sorus typically almost marginal and protected by a reflexed tooth, rarely inframarginal and naked, terminal on its vein ; spores oblong, spinulose or tuberculate, rarely smooth.

Pantropic with more than 45 species, represented in the area by a single species.

H. punctata (Thunb.) Mett., Kuhn, Fil. Afr.,120, 1869 ; Bedd., Handb. Ferns Brit. India, Suppl., 19, 1892.

Rhizome slender, creeping, short-hairy, without scales ; fronds distant, erect, pale-green, 100-126 cm long ; stipes hairy upto 30-65 cm long ; rachises and costa bearing short crisp hairs on both surfaces ; lamina deltoid, deeply quadripinnatifid, the large lower pinnae opposite, the smaller upper pinnae alternate ; largest pinnae 20-30 cm or more long, oblique to the main rachis, broadly deltoid, upper pinnae gradually more narrowly deltoid ; basal pinnule of lowest pinnae 10-20 × 1-2.5 cm ; oblique to pinna-rachis ; largest leaflets of third order 1-1.5 × 0.3-0.6 cm, pinnate to a narrowly winged costa almost to the bluntly pointed apex ; leaflets of fourth order lobed, apex rounded, usually with a sorus on the acroscopic margin of a lobe near the base of the sinus ; sori terminal on a vein, usually covered or partly covered with a pale reflexed marginal flap, but sometimes quite exposed ; sporangium with 16 celled annulus ; spores oblong with minute projections on its surface (spinulose) (Fig. 19).

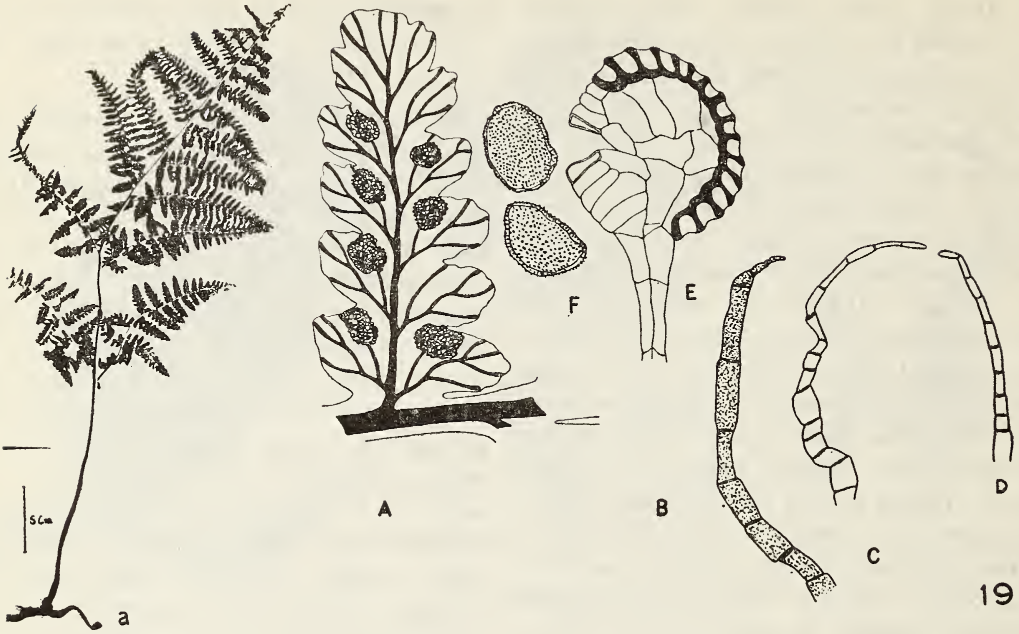
Very common near Khanjjar Mahan Dev Temple at 1700 m in exposed places.

Family Davalliaceae

Epiphytes ; rhizome wide-creeping, fleshy ; covered with peltate scales ; fronds membranaceous and flaccid, simple to decompoundly pinnate ; stipes smooth, jointed to the rhizome, each with several vascular strands (except *Leucostegia*), veins free, forked ; sori intra or sub-marginal or dorsal on the frond, usually indusiate ; spores bilateral.

Araiostegia Copeland

Fronds large, pinnately-decompound and finely dissected, thin in texture, mostly lanceolate ; sori sub-marginal, solitary at the ends of



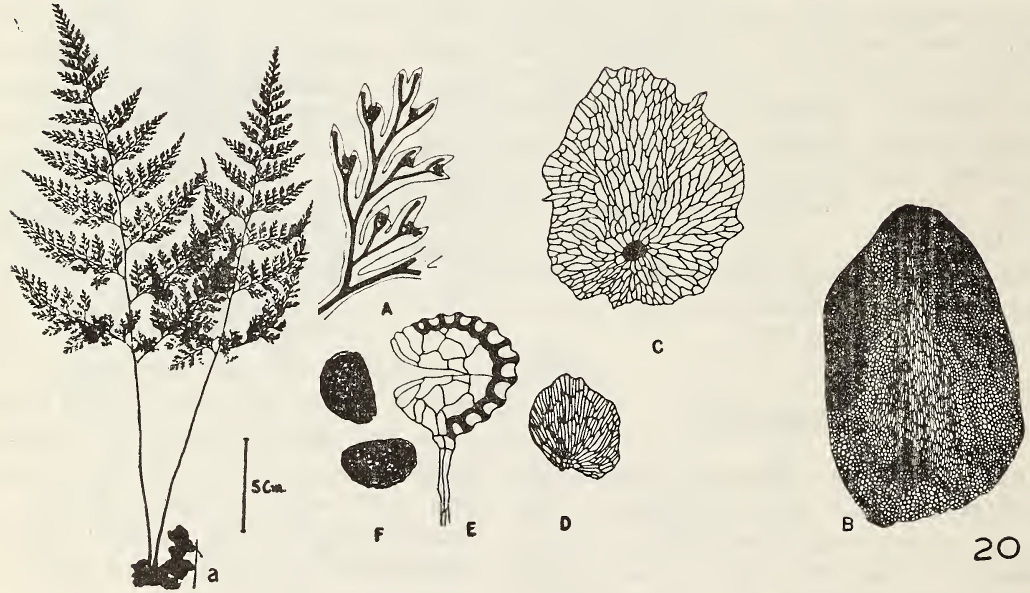


Fig. 19. *Hypolepis punctata* ; a. A plant ; A. A part of pinna showing venation and position of sori, × *c* 3.6 ; B. Rhizome hair with brownish contents, × *c* 17.6 ; C, D. Rhizome hairs, × *c* 17.6 ; E. Sporangium, × *c* 80 ; F. spores, × 231.

Fig. 20. *Araiostegia pseudocystopteris* ; a. A plant ; A. Part of the Pinna showing venation and position of sori, × *c* 3.6 ; B. Rhizome scale, × *c* 10.4 ; C. Stipe scale, × *c* 17.6 ; D. Indusium, × *c* 17.6 ; E. Sporangium, × *c* 80 ; F. Spores, × 231.

single veins in a cup-like indusium attached on the side remote from the margin ; spores bilateral, oblong, granulated.

Key to the species

A. Lamina deltoid-oblong, 4-pinnate ; indusium more or less globose, margin wavy ; stipe scales ovate ....*A. pseudocystopteris*

A. Lamina deltoid, 5-6 pinnate ; indusium broader than long with entire margin ; stipe scales deciduous ....*A. delavayi*

A. pseudocystopteris (Kze.) Copel., Phil. Jour. Sci., 34, 241, 1927 ; Mehra & Bir, Res. Bull. Panjab Univ. (N.S.), 15, 119, 1964.

Rhizome 3-6 mm thick, woody, wide-creeping, epigaeous, densely scaly ; scales 3-6 × 2.5-3 mm, golden-brown, ovate, persistent ; fronds rather approximate ; stipe 6-10 cm long, sparsely scaly ; scales ovate, golden-brown like those of rhizome scales ; lamina deltoid-oblong, 7-28 cm long, 4.5-15 cm broad, 4-pinnate ; pinnae 3-12 jugate, patent, sessile, 2.5-9 × 2.5-4 cm ; ultimate pinnules pinnatifid with 2-4 small ligulate acute, uninerved segments, 1-2 mm long, 0.5 mm broad ; texture thin herbaceous, pale-green, glabrous ; sori small, situated at the forking of ultimate lobes ; indusium small, membranaceous, grey, persistent, more or less globose, sporangia with 13-celled annulus ; spores bilateral, granulated with thick exine (Fig. 20).

This species grows both as an epiphyte and on moist and humus rich rocks. Met with near Mcleodganj at 1200 m covering the branches of *Quercus incana* (oak).

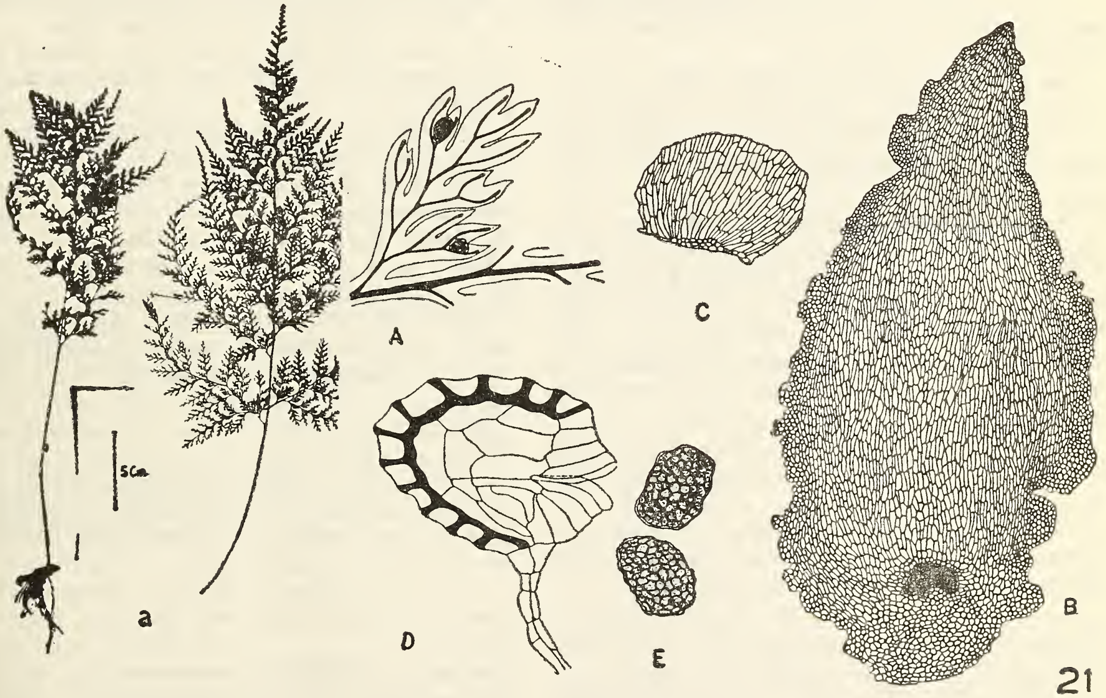


Fig. 21. *Araiostegia delavayi* ; a. A plant ; A. Part of lamina showing venation and position of sori, × *c* 4.4 ; B. Rhizome scale, × *c* 12.4 ; C. Indusium, × *c* 21.2 ; D. Sporangium, × *c* 61.2 ; E. Spores, × 277.2.

A. delavayi (Bedd. ex Clarke et Bak.) Ching in Chien et Chun, Fl. Reipubl. Pop Sin., 2, 289, 1959.

Rhizome 2-5 mm thick, woody, wide-creeping, epigaeous, densely scaly; scales dense, golden-brown, ovate, persistent; fronds rather approximate; stipes 4.5-6 cm long, sparsely covered with ovate, deciduous scales; lamina 33 × 25 cm, deltoid, 5-6 pinnate; pinnae stalked, basal pinnae largest, ultimate pinnules linear and pointed; rachis naked; veins forked, slightly swollen at the tips; sori triangular (nearly cordate) present at the forking point of ultimate veinlets; texture herbaceous, pale-green, glabrous; indusium small, membranaceous, grey persistent, broader than long with entire margin; sporangia with 12-13 celled annulus; spores globose, granulated, exine thick (Fig. 21).

A common epiphyte near Mcleodganj and Dharmkot between 1700-2000 m.

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Biology and host-range of *Trabala vishnu* Lefevere[1, 2]

Y. S. Rathore[3] and J. K. Verma

(*With a text-figure*)

Biology of *Trabala vishnu* Lefevere was studied in a BOD incubator at 27 ± 1°C and 60-65 % relative humidity. Eggs were creamy-white and were covered with brown hairs. Incubation period was 8 to 10 days. Larvae of three different colours, namely yellow, grey and pinkish grey hatched out from the eggs of a single female. There were 5 larval instars. Total larval duration was 29 to 33 days in female and 24 to 29 days in male. Pupal period was 11 to 12 days in female and 12 to 14 days in male. Application of Dyar's law was tested to ascertain the growth and the larval instars. Out of 55 plant-species tested, 5 were accepted by the larvae. *Tecoma stans* (L.) H.B. & K. was preferred over castor, (*Ricinus communis* L.); *Syzygium cumini* (L.) Skeels was equally preferred ; *Eucalyptus botryoides* S., *Rosa* sp. and *Shorea robusta* Gaertn. f. were preferred less than castor. The host range of *Trabala vishnu* is restricted to woody plants.

The castor hairy caterpillar, *Trabala vishnu* Lefevere (Lepidoptera : Lasiocampidae), is a sporadic polyphagous pest that occurs throughout India, Burma (Fletcher 1919 and Beeson 1941), Sri Lanka (Light 1929), East Indies (Van Hall 1919) and Indo-China (Ngayen-Cong-Tien 1939). Sevastopulo (1939) and Beeson (1941) have given a general account of its biology and listed the plant species on which it feeds. Most of the hosts reported were forest trees. Since large scale deforestation has taken place in tarai region, it was thought pertinent to study the biology and host-range of this insect to explore the possibility of its being a pest of cultivated and fruit crops in the absence of wild flora on which it feeds.

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Materials and Methods

The eggs were obtained from the stock culture maintained in the laboratory on castor. The first instar larvae (0-14-hr old) were reared individually on castor leaves in plastic petri-dishes at 27 ± 1°C and 60-65% relative humidity in a BOD incubator. The observations on the biology of the insect were recorded daily and the head capsules collected at each ecdysis were stored. To determine oviposition potential, 1 male and 1 female were kept in a plastic container (12×10 cm). Adults were fed on 10% sucrose solution.

To test Dyar's law, head capsules of the larvae of first-second instar were measured across the greatest width of the head at the base of the mandibles with a stereomicroscope fitted with an ocular micrometer. However, in later instars the head capsule width was measured with a microscope in which scale was directly fitted. For each instar 50 head capsules were measured.

Three days after pupation, sex in pupae was determined on the basis of morphological characters in the external genitalia.

Host-range was studied in the laboratory by disc method following the procedure of Kogan & Goeden (1970). Three discs of each host measuring 1 cm^2 were cut and fixed alternately and equidistantly (i.e. standard *vs.* test plant) near the perimeter of the petri-dish with an entomological pin No. 20. Discs were held 3-4 mm above the surface. For proper fixing of pins 1 cm thick layer of plaster of paris was placed in petri-dishes whose top was lined with moist blotting paper. Tests on each plant species were replicated thrice. The fourth instar larvae, used as test insects, were isolated and starved for 24 hr. One larva in each petri-dish containing discs was allowed to feed for 90 min. The amount of feeding was measured by graph paper. The following formula of Kogan & Goeden (1970) was used to calculate the preference index :

$$C = 2A/(M + A)$$

where C = comparative analysis of plants tested (preference index), A = feeding on test plant, and M = feeding on standard plant. The index measures the relative amount of feeding on 2 species of plants present in the arena in a 0 to + 2 scale. A C-value of 1 indicates that feeding on test plant was equivalent to the feeding on the standard. A C-value > 1 indicates a preference for test plant ; and a C-value < 1 indicates a less acceptance to the test plant.

Fifty-five plant species belonging to 30 families were tested for host-range study. The arrangement of plant families is made following the system of Hutchinson (1973) who divided Dicotyledons into two main divisions, 'Lignosae' (woody plants) and 'Herbaceae' (herbaceous plants). The following plant species were tested :—

1. Pteridophyta — CYATHEACEAE — fern (*Cyathea dealbata* Swartz).
2. Spermatophyta—
   - A. Gymnospermae — PINACEAE — pine (*Pinus decidua* Wall).
   - B. Angiospermae—(Dicotyledones) Division—Lignosae.

ANACARDIACEAE—mango (*Mangifera indica* L.) ; BIGNONIACEAE—Yellow bells [*Tecoma stans* (L.) H. B. & K.] ; BRASSICACEAE—leaf mustard, rai [*Brassica juncea* (L.) Czern. & Coss. var. *cuneifolia* Roxb.], cabbage (*B. oleracea* L. var. *capitata* L.), water cress (*Nasturtium officinale* R. Br.), radish (*Raphanus sativus* L.) ; CAESALPINIACEAE—red cedar (*Acrocarpus fraxinifolius* Wight & Arn.), Kachnar (*Bauhinia variegata* L.), Amaltas (*Cassia fistula* L.), Gulmohur [*Delonix regia* (Boj.) Raf.], Ashoka tree (*Saraca indica* L.), tamarind (*Tamarindus indica* L.) ; CARICACEAE—papaya (*Carica papaya* L.) ; CHENOPODIACEAE—sugarbeet (*Beta vulgaris* L.) ; COMPOSITAE—corn flower (*Centaurea cyanus* L.), sunflower (*Helianthus annuus* L.), cone flower (*Rudbeckia bicolor* Nutt.); CUCURBITACEAE—Parwal (*Trichosanthes dioica* Roxb.) ; DIPTEROCARPACEAE—sal (*Shorea robusta* Gaertn. f.) ; EUPHORBIACEAE—chenille plant (*Acalypha hispida* Burm.), safed arond (*Jatropha curcas* L.) ; FABACEAE—bean (*Dolichos lablab* L.), soybean [*Glycine max* (L.) Merr.], Locust tree (*Robinia pseud-acacia* L.) ; LYTHRACEAE—Crapemyrtle (*Lagerstroemia indica* L.) ; MAGNOLIACEAE—Champa (*Magnolia globosa* Hk.) ; MALVACEAE—hollyhock [*Althaea rosea* (L.) Cav.], tree cotton (*Gossypium arboreum* L.), okra [*Abelmoschus esculentus* (L.) Moench] ; MELIACEAE—Mahogani tree [*Swietenia mahagoni* (L.) Jacq.] ; MORACEAE—banyan (*Ficus benghalensis* L.), peepul (*F. religiosa* L.) ; MYRTACEAE—gum tree (*Eucalyptus botryoides* S.), guava (*Psidium guajava* L.), jamun [*Syzygium cumini* (L.) Skeels], turpentine tree (*Tristania conferta* R. Br.) ; NYCTAGINACEAE—bougainvillea (*Bougainvillea glabra* Chois.) ; PUNICACEAE—pomegranate (*Punica granatum*

L.) ; ROSACEAE—Rose (*Rosa* sp.) ; RUBIACEAE—Kadam (*Anthocephalus indicus* A. Rich.), cape—jasmine (*Gardenia jasminoides* Ellis) ; RUTACEAE—lemon [*Citrus limon* (L.) Burm. f.], Kamini [*Murraya paniculata* (L.) Jack] ; SALICACEAE—white poplar (*Populus alba* L.) ; SOLANACEAE—night jessamine (*Cestrum nocturnum* L.), tomato (*Lycopersicon esculentum* Mill.), petunia (*Petunia hybrida* Vilm.), brinjal (*Solanum melongena* L.) ; VERBENACEAE—teak (*Tectona grandis* L.).

Angiosperme—(Monocotyledones).

ARACEAE—Arum [*Colocasia esculenta* (L.) Schott] ; LILIACEAE—lily (*Lilium* sp.); POACEAE—sugarcane (*Saccharum officinarum* L.), maize (*Zea mays* L.).

RESULTS AND DISCUSSION

LIFE-HISTORY

Egg : Laid in straight double rows, occasionally also in 3 or 4 small rows. Oval, creamy white and covered with brown hairs. Measure 1.53 mm × 1.34 mm after the removal of hairs. Incubation period ranged from 8 to 10 days.

Larva : Freshly hatched larvae feed from the margin of the leaves gregariously. This habit persists up to second instar or early third instar. First instar 3.75 mm long. Body yellow with blue-black crossbands. Hairs grow prominently with the growth of larvae, giving them the characteristic appearance of hairy caterpillars. Grown up larvae are defoliators. Tender plants are attacked seriously while bigger plants may withstand their attack. There are 5 instars, except in 1 case where they were 6. Three different colours namely yellow, grey and pinkish-grey were observed in full grown larvae reared from eggs of a single female. From field collected eggs sometime grey larvae were obtained but larvae of all the three colours were found frequently. Sevastopulo (1939) has reported yellow, brownish grey, olive brown or pinkish brown and blackish forms of larvae but not from the eggs of the same female. We did not observe black larvae but we consider that grey and yellow forms might exist in nature. Pinkish-grey larvae could be from the cross of yellow and grey. All the three types of colour in larvae from single female suggests the existence of heterozygous condition of the population in nature. Sevastopulo (1939) and Beeson (1941) reported 6 larval instars, which are not in accordance with the present investigation. The full grown larva measures on an average 5.06 cm in length. They have fine network of vertical and horizontal lines. Pencil-like dark brown hairs arise from the first somite in all instars. Average larval period for both the sexes was 28.3 days (Table 1).

Pupa : Pupae were reddish-brown. Pupation took place inside the cocoon on the surface of the glass-jar and on the paper. In nature cocoons were found on leaves or on the stem of leaves. The colour of cocoon was same as that of the larvae. Each cocoon has 2 humps on dorsal side and 2 openings, one on each end. From the one opening final moult occurs and from the other the adult emerges. Male cocoons were smaller in size than female cocoons ; male pupae were also smaller in size than female pupae, their size varied from 1.76 to 2.26 cm and from 2.26 to 3.02 cm respectively.

An attempt was also made to sex pupae on the basis of morphological characters in the external genitalia. In the female pupae bursa copulatrix (BC) is present on the eighth sternite, whereas the oviporus (O) on the ninth sternite (Fig. 1). The eighth and ninth segments on ventral side are divided completely. In male pupae the ninth sternite has 2 small, oblong pads on each side of the mid-ventral line. The prepupal and pupal periods were longer in males than in females (Table 1).

TABLE 1

DURATION (DAYS) OF VARIOUS STAGES OF *Trabala vishnu*

Stage	Female		Male	
	Range	Mean	Range	Mean
Larval period	29-33	31.4	24-29	26.1
First instar	5-6	5.7	5-6	5.2
Second instar	4-5	4.2	4-5	4.4
Third instar	4-5	4.8	3-5	4.1
Fourth instar	5-8	6.9	4-7	5.5
Fifth instar	7-10	9.3	6-8	6.8
Prepupal period	1-2	1.6	2	2.0
Pupal period	11-12	11.5	12-14	13.0
Adult longevity	3-8	4.4	4-10	6.6
Preoviposition period	1-2	1.0		
Oviposition period	1-5	3.2		
Postoviposition period	0-1	0.3		
Fecundity	22-297	187.5		

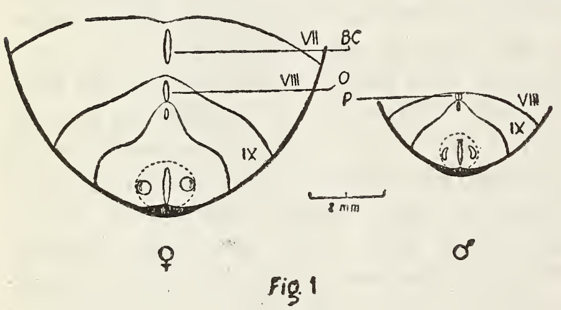

Fig. 1. Ventral side of the female and male pupae of *Trabala vishnu*.
(BC = bursa copulatrix, O = oviporus, P = pad)

Adult : The male moths are green, with an average wing expanse of 4.79 cm, whereas, females are thick, sluggish and greenish yellow or yellow, with big anal tufts. They measure 6.20 cm across the wings. Bipectinate antennae were present in both sexes but bristles were quite large in males. Female lived shorter than males. A peculiar habit of the adults was that costal edge of the hind wings was projected in front of the forewing while at rest.

Oviposition : A female after a successful copulation laid on an average 187 eggs (with a range of 22 to 297 eggs) within five days. Females also lay eggs parthenogenetically ; the number in such cases varied from 40 to 289 eggs/female. Parthenogenetically laid eggs did not hatch even up to 2 months. Preoviposition and oviposition periods were 1-2 days and 0-1 day respectively.

Dyar's law

Application of Dyar's law (Dyar 1890) was tested in the present investigation. It was found that there was no overlapping between the head-capsule widths in all the instars (Table 2). Growth ratios calculated for different instars did not show much variation except for the second and third instars where a little deviation was observed. When log values of average head-capsule width were plotted

TABLE 2

RELATION OF HEAD-CAPSULE WIDTH AND DIFFERENT INSTARS OF *Trabala vishnu*

Instar	Observed head-capsule width (mm) Range	Average*	Growth ratio
I	0.863-0.984	0.917 (-0.038)	
II	1.292-1.468	1.374 (0.138)	1.503
III	2.038-2.480	2.244 (0.351)	1.633
IV	3.000-3.800	3.376 (0.528)	1.504
V	4.200-7.300	5.208 (0.717)	1.542

* Data mentioned in the parentheses indicate log values.

against the instars a clear straight line relationship was observed, indicating that growth in successive instars was in regular geometrical progression and follows Dyar's law. This also indicates that no instar was omitted during the investigation.

Host-range

Out of the 55 plant species tested, 5 were acceptable to the larvae of *T. vishnu* when castor (*Ricinus communis* L.) was used as a standard host. Their relative preference is given below:—

Type of preference	Test plant	Preference index
More preferred	*Tecoma stans*	1.55
Equally preferred	*Syzygium cumini*	1.03
Less preferred	*Rosa* sp.	0.50
	Eucalyptus botryoides	0.17
	Shorea robusta	0.17

Larvae did not feed on Pteridophytes and on Gymnosperms in Spermatophytes. Among Angiosperms only Dicotyledonous plants were selected as its food and among Dicotyledons only those belonging to Lignosae. *Tecoma stans* was preferred to castor and is being recorded as its new host. Beeson (1941) reported that its larvae feed on guava but our studies did not support it, perhaps because of varietal difference. Jamun was equally preferred to the standard host ; sal and gum tree were acceptable to larvae but were much less preferred to castor. Rose was better preferred than sal and gum tree. No field, fruit or vegetable crops were accepted by the larvae in our investigation.

To confirm whether the host-plant range of *T. vishnu* is restricted only to Dicotyledons, the plant species reported in literature (Lefroy 1909, 1971 ; Fletcher 1917, 1919 ; Anstead 1918 ; Beeson 1919, 1941 ; Van Hall 1919 ; Light 1929 ; Pruthi 1936 ; Ngayen-Cong-Tien 1939 and Sevastopulo 1939) were also taken into consideration. From the combined information it was observed that the preference of this insect was restricted only to Dicotyledons. However, 3 plant species, namely *Berberis asiatica* DC., *Pelargonium* sp. and *Verbascum thapsus* L. were found as its host in Herbaceae group of Dicotyledons. In Myrtales (Myrtaceae, Lythraceae, Combertaceae) there were 13 host species belonging to 8 genera. From Euphorbiaceae family 3 plant species, including castor, were reported as its hosts. Thus it was concluded that the preference of *T. vishnu* is restricted to woody plants.

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A report on the birds of Addu Atoll (Maldive Islands)[1]

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INTRODUCTION

In December 1963, the *Journal of the Bombay Natural History Society* published a paper by W. W. A. Phillips, entitled, 'The Birds of the Maldive Islands, Indian Ocean'.

The paper opened with a review of the ornithological record to date, and some notes on the ecology and climate of the Maldive Islands. This was followed by a detailed account of the breeding seasons of resident species, and a discussion on migration. The occurrence of casual visitors was tabulated, and in the following systematic list the status of species was indicated where possible.

Addu Atoll was by far the best documented part of the whole archipelago, with records mainly from two sources—namely, Phillips own notes made during 1958-59, and the observations of J. J. Latham covering the period 1960-62.

From 1962 until the closure of the Royal Air Force base at Gan, early in 1976, further records were kept by several observers resident on Addu Atoll. The object of the present paper is to update the atoll list by incorporating this additional information. These notes are therefore best considered as a local supplement to Phillips original paper.

It is hoped that the reader will have access to 'The Birds of the Maldive Islands, Indian Ocean'—still the only comprehensive account of the ornithology of these islands, that has so far been published.

ADDU ATOLL

Addu Atoll, which is situated just half a degree south of the Equator at a longitude of approximately 73 degrees East, is the most southerly group of the Maldive Archipelago.

A necklace of low lying islands and sandbars, enclose a shallow lagoon of some 30 square miles extent. Five of the islands are permanently inhabited, and here the natural vegetation has been largely replaced by cultivated gardens and coconut groves. There are extensive mud flats between the shoreline and the boundary reef, on the oceanic side of some islands, whilst inland are to be found a number of brackish pools with associated areas of marsh.

Gan—the southernmost island of the atoll—differs from the others in two main respects. Firstly, most of the marshy areas have been successfully drained, and these have been replaced by grassland. Secondly, in some parts that are undisturbed, there has been considerable regeneration of the natural scrubland—a habitat none too common on this densely populated atoll.

The Addu Atoll climate is moist, oceanic, and rather humid. Annual rainfall averages 100 inches, and although there are no well-defined wet or dry seasons, the period October-

[1] Accepted March 1977.

[2] The Collage, Crown, Nr. Praze, Camborne, Cornwell, U.K.

December is generally the wettest time of year, with January-March correspondingly dry. The daily temperature range is small, usually around 24-30°C, and readings above 32°C, or below 21°C are rarely recorded. Apart from early in the year when NE'ly winds predominate, and for a few weeks around June-August when SE is a common direction, prevailing winds are between SW and NW, usually in the range 5-15 knots. The atoll lies outside the latitudes that are affected by tropical storms, however localised disturbances of surprising intensity—if of short duration—occur from time to time.

Birdlife

The systematic list that follows deals with 120 or so species, including several that are additions since the publication of Phillips paper. Many of these are also new records for the Maldive Islands.

Breeding species are poorly represented at Addu Atoll, and there are only half a dozen that can be claimed as regular nesting birds. These are the Grey, Little Green, and Pond Heron, White-breasted Waterhen, and two species of tern—the Black-naped and the White Tern. A further four species have nested sporadically, including the Cattle Egret, which as an irregular visitor, has on one occasion stayed behind to nest. The large Pratincole attempted to breed at Gan during 1960—possibly quite accidentally. Two other species, the White-tailed Tropicbird, and the Brown Noddy, have bred on the atoll, but so far there have only been single records for each of these birds.

Seabirds are represented by six species of shearwater, one of which is known to breed elsewhere in the Maldive Islands, two boobies, two frigate species and a tropicbird. One of the frigate species and the tropicbird are probably both widespread residents elsewhere in the archipelago.

Shorebirds account for over 30 species, almost all of them winter visitors or passage birds from the Palaearctic region. Several are quite common including Turnstone, Whimbrel and Curlew Sandpiper, but others such as the Ruff and Terek Sandpiper are less frequently recorded. A number of species are regular non-breeding 'loiterers' throughout the summer period.

Skuas, gulls and terns account for another fifteen species, and although at present most can only be considered as visitors to the atoll, further tern species may eventually prove to be breeding residents.

Of eleven raptors on the list, a few such as the harriers, Honey Buzzard and Kestrel are regular winter visitors, whilst others like the Osprey and Peregrine are much less frequently noted. Near-passerine birds include several swifts and cuckoos, including the Koel that breeds elsewhere throughout the Maldive Islands. Less regular are the Hoopoe and European Bee-eater.

Songbirds only account for sixteen species, all winter visitors or passage migrants. Among the most regular are Swallow, Sandmartin and Isabelline Wheatear. A handful of birds are of Indian rather than Palaearctic origin, and these include Cotton Teal, Plaintive Cuckoo and Paradise Flycatcher.

Migration :

Phillips noted that not only do large numbers of birds (mainly waders), spend the winter months at Addu Atoll, but that others pass onward to Chagos Archipelago, some 250 miles further south. He also noted the regular occurrence of some passerine birds, and evidence of a return migration through Addu Atoll early in the spring.

It would seem likely that the majority of birds reach Addu Atoll by moving southward from island to island, through the Maldivian chain. Since Sri Lanka is also a wintering ground for large numbers of Palaearctic species, there may also be a passage of birds from a NE'ly direction, direct to the southern atolls. That birds pass onward to Chagos, there can now be no doubt, however it is not yet possible to say whether others pass through the atoll, en-route to Seychelles, and thence to wintering grounds in Africa.

Some birds such as the Large Pratincole may represent examples of more local movements, just involving the Laccadive, Maldive and Chagos groups.

Systematic List

Where there is nothing significant to add to the information already published by Phillips, a species is briefly dealt with. However, birds not previously recorded from the atoll, and others for which new information is available, are more fully documentated.

Order of species follows that used by Phillips, and where there has since been a change in the generic name, the original is placed in brackets. With a few exceptions, sub-species are not dealt with in this paper, and the reader is referred to Phillips for information on specimens collected at Addu Atoll. There have been a number of necessary changes in common names, and an asterisk placed after the specific name indicates that the bird is an addition to the atoll list.

The abbreviated status (to the right of the common name), is derived from examination of all the notes to hand. Further records—especially over a period of time—would doubtless lead to a number of amendments.

Abbreviated Status :

R/r.	Resident	Species regularly breeds on the atoll.
P.	Passage	Species occurs on passage.
W/w.	Winter	Occurs during the northern winter period.
S/s.	Summer	Occurs during the northern summer period.
L/l.	Local	Breeds on other Maldive atolls wanders to Addu.
V.	Vagrant	Considered to be a vagrant to the atoll.
?.	Doubtful	Insufficient data to establish status.
(p).	—	Passage through the atoll is assumed to occur.
(b).	—	Irregular breeding records (successful or not).

Use of a capital letter indicates the principal status of the species, with small letters showing lesser status (where applicable).

*** Species occurs annually in some numbers.

** Species either occurs annually, but only in small numbers, or has been recorded a number of times, during several different years.

* Species rarely recorded, or records during only a few years.

— Species is of uncertain occurrence—lack of sufficient data.

Procellariidae and Hydrobatidae

Oceanites oceanicus *

WILSON'S STORM PETREL S—

An antarctic species that disperses widely outside the breeding season. One record, a sick bird ashore 17 Sept. 1975.

Pelagodroma marina *

WHITE-FACED STORM PETREL P—

A passage species. One record, a dead bird ashore 21 July 1974.

Bulweria bulwerii

BULWER'S PETREL W—

A winter visitor from the North Pacific. One record 22 Aug. 1958.

Puffinus (Procellaria) lherminieri

AUDUBON'S SHEARWATER L—

Breeds elsewhere in the Maldive Islands, but not at Addu Atoll. Recorded in small numbers, near the atoll, during 1958.

Puffinus (Procellaria) pacificus

WEDGETAILED SHEARWATER S—

A southern hemisphere species, that disperses widely outside the breeding season. Noted in small numbers, close to the atoll, March-June 1958.

Puffinus (Procellaria) carneipes

PINKFOOTED SHEARWATER P—

Probably mainly a passage species. Noted March-May 1958, and again 16-20 Oct. 1975, when hundreds of birds passed close inshore.

PHAETHONTIDAE

Phaethon lepturus

WHITETAILED TROPIC-BIRD Lr**

Nesting recorded July 1958. Principally a wanderer from nearby atolls, where it is known to breed, being mainly recorded from October till January. Not common, only six records during 1975.

SULIDAE

Sula leucogaster

BROWN BOOBY Ws**

A fairly common visitor to the lagoon, most frequently seen between December and February, occasionally in small parties.

Sula dactylatra

MASKED BOOBY ?—

A single record 28 Nov. 1962. So far there have been no records of another booby, namely, *S. sula*—the Redfooted Booby. This last species may be reasonably assumed to occur around the Maldive atolls.

FREGATIDAE

Several observers have reported 'Frigates' without noting the species. The Lesser Frigate Bird, has been recorded as a Maldivian breeding resident, although not at Addu Atoll. In general Frigate Birds are most commonly seen between September and December, occasionally in small parties. During late 1975 sightings were quite frequent. Abbreviated Status is tentative.

Fregata minor

LARGER FRIGATE BIRD SW—

Noted during 1958, and May-June 1961.

Fregata ariel

LESSER FRIGATE BIRD L ***

Highest count, 36 birds on 8 June 1958.

ARDEIDAE

Ardea cinerea

GREY HERON R ***

A common resident with breeding recorded throughout the year, except during March, April and October. There are normally two broods a year, most commonly June-August and December-February. Only one or two chicks are usually raised on each occasion. At Addu Atoll nesting sites are often in the tops of Pandanus trees, with the smaller Pond Heron, sharing the same tree, and nesting at a lower level. The species does not seem to form true nesting colonies, as are to be found in some other parts of its range.

Ardea purpurea

PURPLE HERON W **

An irregular visitor with records between July and January, but most commonly from October till December. Nine pre-1963 records, since when single birds noted, Oct. and Dec. 1967, and Dec. 1970.

Butorides striatus

LITTLE GREEN HERON R1 ***

Least common of the three resident herons, and numbers seen to be decreasing. Breeds throughout the year, most commonly during the period October till February. On 17 Sept. 1975, pale birds of the race *didii* were seen—evidence of inter-atoll movements. The local race at Addu Atoll is *albidulus*.

Egretta garzetta

LITTLE EGRET W *

Irregular winter visitor, with only two records. One at the beginning of the century (perhaps suspect), the other during 1957.

Egretta alba

LARGE EGRET W *

Occasional winter visitor. Two records, 20 Dec. 1958 and 31 Jan. 1959.

Bubulcus ibis

CATTLE EGRET W (b) **

Irregular visitor—common some years, unrecorded others. Breeding strongly suspected Sept. 1960, and perhaps also during 1967-68, when up to ten birds were present between October and May. Two to four birds noted October till January 1970-71.

Ardeola grayii

POND HERON R ***

A very common resident, breeding throughout the year, but mainly during the period September till April. A survey carried out covering the period June-December 1975, at Gan, showed a steady 15% of the birds to be in full breeding plumage. A normal brood size seems to be 3-4 chicks.

Ixobrychus sinensis

LITTLE YELLOW BITTERN W *

Irregular winter visitor, with only two records, both during 1958.

Ixobrychus cinnamomeus

CHESTNUT BITTERN SW*

Uncommon visitor. Four records, all during 1961.

Dupetor flavicollis

BLACK BITTERN SW *

Uncommon visitor. Three birds June 1958, one bird 10 March 1961.

Botaurus stellaris

COMMON BITTERN W *

Uncommon visitor. Three records, all during period Oct.-Dec. 1961.

PLATALEIDAE

Plegadis falcinellus

GLOSSY IBIS W *

A rare visitor. Two records, January 1959 and October 1961.

ANATIDAE

Anas crecca *

COMMON TEAL W *

Irregular visitor. Noted among a mixed flock of wildfowl, during October 1965.

Anas querquedula

GARGANEY W **

Winter visitor, probably quite regular. Oct.-Jan. 1958-59, flocks up to 25, Sep.-Oct. 1964 up to 18. Others noted October 1965, and October 1975.

Anas acuta

PINTAIL W *

Irregular visitor. Several noted October-December 1958.

Anas (Spatula) clypeata

SHOVELLER W *

Irregular visitor. Only recorded November-January 1958-59, in small parties.

Aythya nyroca

FERRUGINOUS DUCK V—

Probably a vagrant. A single record of a female 5 Nov. 1958.

Nettapus coromandelianus

COTTON TEAL W *

Irregular winter visitor. Noted Dec. 1958, and several during October 1965.

Accipitridae

Buteo sp.

BUZZARDS W **

Buteo species have been recorded from October till January. Usually solitary, but two birds present during December 1975. Other records during 1959, 1967 and 1970.

Pernis apivorus

HONEY BUZZARD W **

Regular winter visitor, most common from November till January, although some birds linger well into the summer. Usually solitary, although a party of five were recorded flying southwards from Gan, on 9 January 1971.

Circus aeruginosus

MARSH HARRIER W **

Irregular winter visitor, mainly recorded from October till February. Noted during 1961, 1964, 1967-68, and 1970—occasionally in pairs.

Circus macrourus and C. pygargus

MONTAGU'S/PALLID HARRIER W **

Regular winter visitors from October till April. Since birds seen are in immature plumage, these species cannot be safely separated. That both occur has been established by Phillips, who collected specimens.

Pandion haliaetus

OSPREY WS *

An irregular visitor. Two records, July 1960 and December 1975.

Falconidae

Falco peregrinus

PEREGRINE FALCON W **

An irregular visitor recorded between September and December. Three pre-1963 sightings, since then, one on 27th Sept. 1970, and two exhausted birds seen in December 1972.

Falco vespertinus

REDFOOTED FALCON W **

A regular winter visitor recorded between November and March. Rather scarce some years, but six birds were present during the period Nov.-Jan. 1964-65.

Falco subbuteo *

HOBBY W **

No pre-1963 reports, but since recorded regularly between November and May. Recognised from the previous species by the following features. Male has boldly streaked underparts, distinct white throat and cheeks, with a clear moustachial stripe. Females are also well marked below, and both sexes have yellow legs.

Falco naumanni

LESSER KESTREL W **

A regular winter visitor between October and February. Usually 1-3 birds together, but five were seen on 12 Jan. 1975.

Falco tinnunculus

KESTREL W **

A regular winter visitor from October till May. Usually solitary, but four together at times during the period 1964-65 (perhaps a case of misidentification with the previous species).

RALLIDAE

Amaurornis phoenicurus

WHITE-BREASTED WATERHEN R ***

A common resident. Breeds throughout the year, but especially during the period May-January. The nesting season seems to be influenced by rainfall, since the driest months are those with the least breeding activity. Brood size probably 4-6 chicks. Skulking and rather crepuscular in habits.

Gallicrex cinerea

WATERCOCK L *

Does not breed at Addu Atoll, so the single record during 1957 must have been a wanderer from another atoll, where breeding has been recorded.

CHARADRIIDAE

Chettusia gregaria *

SOCIABLE PLOVER ? —

Status uncertain. A single record of one bird 24-25 Sept. 1975. Phillips treated reports of this species in the Maldive islands with caution, suggesting that they might have been misidentified. The authenticity of this single Addu Atoll record is however beyond doubt.

Charadrius hiaticula

RINGED PLOVER W (p) **

Regular winter visitor in small numbers, recorded mainly between October and March.

Charadrius dubius

LITTLE RINGED PLOVER W (p) **

Irregular winter visitor, not seen every year. Records between November and February, solitary or in parties of 2-3 birds.

Charadrius alexandrinus

KENTISH PLOVER W (p) **

Irregular winter visitor, occasionally in small parties. Recorded between October and February.

Charadrius mongolus

LESSER SAND PLOVER WP ***

A regular winter visitor and passage migrant in moderate numbers. Records between August and April, with counts of upto 50 birds.

Charadrius leschenaultii

LARGE SAND PLOVER Ws (p) **

A regular winter visitor in rather small numbers, with a few records of summer non-breeders. Recorded mainly between August and April, parties to 15.

Charadrius asiaticus

CASPIAN PLOVER W *

One record of two birds November 1958. Despite no further reports, the bird is probably better considered as a rare winter visitor, than as a vagrant.

Pluvialis squatarola

GREY PLOVER Ws (p) ***

A regular winter visitor in moderate numbers, a few summer non-breeders. Mainly recorded from August till April. Highest counts, 30 birds.

Pluvialis dominica

ASIATIC GOLDEN PLOVER W (p) ***

A regular visitor in large numbers. Records August till May, with flocks of around 50 birds regular October-March. 115 birds Dec. 1975.

Arenaria interpres

TURNSTONE WPs ***

Abundant passage migrant and winter visitor, with a few birds remaining all summer.

Maximum flocks of 200-500 during the passage months of October, November and February.

SCOLOPACIDAE

Capella sp.
SNIPE W **

Three species of snipe have been recorded, and these are best dealt with collectively. They are regular winter visitors recorded from September till April, in small but variable numbers. In many instances observers have not specified actual species, but the following records were all concerned with a particular bird :—

C. stenura
PINTAIL SNIPE

Several 1958-59, also two birds 26 Sept. 1975.

C. megala
SWINHOE'S SNIPE

A single record—December 1958.

C. gallinago
COMMON SNIPE

Several 1958-59, and a few Oct.-Nov. 1975. Most records of 'snipe' probably refer to this species.

Numenius arquata
CURLEW Ws (p) **

A scarce but regular winter visitor, mainly recorded between October and April. Irregular records of summer non-breeders. Sometimes to be found among flocks of Whimbrel.

Numenius phaeopus
WHIMBREL Ws (p) ***

A regular winter visitor in large numbers, with non-breeders all summer. Mainly recorded between August and March, in flocks of up to 30-40—occasionally 60.

Limosa lapponica
BARTAILED GODWIT W **

An irregular winter visitor in small numbers, recorded from June till January. Usually solitary, but a party of four 12 Nov. 1970. Reports of the rather similar *L. limosa*. The Blacktailed Godwit probably refer to this species.

Tringa glareola
WOOD SANDPIPER W **

A fairly regular winter visitor in small numbers, recorded from August till February. Usually solitary, but a party of six were seen 18 Feb. 1961.

Tringa hypoleucos
COMMON SANDPIPER W ***

A regular winter visitor in moderate numbers, recorded from August till April. Solitary in habit, but as many as 15 have been seen in a single day at Gan (23 Oct. 1975).

Tringa stagnatilis *
MARSH SANDPIPER W **

An irregular winter visitor in small numbers, only recorded during September and October. Usually solitary, but a party of seven on 25 Sept. 1975.

Tringa totanus
REDSHANK W *

An irregular winter visitor in surprisingly small numbers, recorded between September and March. Several pre-1963 reports, otherwise one on 3 Oct. 1970, and two on 22 Sept. 1975.

Tringa nebularia
GREENSHANK Ws (p) ***

A regular winter visitor in moderate numbers, mainly recorded from October till March. Non-breeders remain throughout the summer. Often seen in small parties of up to a dozen birds.

Xenus cinereus
TEREK SANDPIPER W *

An irregular winter visitor. Records between September and December, usually of single birds. Noted during 1958, 1968 (pair) and 1975.

Calidris sp.
STINTS W (p) **

Three species have been recorded, although many observers do not attempt to separate them. Best treated collectively, when they can be referred to as regular winter visitors in rather small numbers, mainly recorded from October till February. Often solitary, but a party of 15 were seen on 1 Oct. 1970. Selected records include :—

C. minutus
LITTLE STINT

Several pre-1963, also noted 1967, 1970 and 1975.

C. temminckii
TEMMINCK'S STINT

Some 1958 (one during May), one bird Oct. 1970.

C. subminutus
LONGTOED STINT

Several pre-1963 records. Single birds October and November 1975.

Calidris alpina
DUNLIN W (p) *

An irregular winter visitor in small numbers. Several Nov.-Feb. 1958-59, others noted Oct.-Dec. 1972.

Calidris testaceus
CURLEW SANDPIPER WPs ***

A regular winter visitor and passage migrant in large numbers, with some non-breeders throughout the summer. Most common from September till April, in flocks of up to 100. Maximum count 500 birds on 9 Nov. 1967.

Calidris alba
SANDERLING W (p) **

An irregular winter visitor in small numbers. Records between October and March are usually of single birds, but four noted 14 Oct. 1975.

Philomachus pugnax
RUFF W *

An irregular winter visitor recorded during October and November. Two during 1958, and a single bird 23 November 1975.

RECURVIROSTRIDAE, GLAREOLIDAE, DROMADIDAE

Himantopus himantopus
BLACKWINGED STILT V—

Probably a vagrant. Two records, 5 Nov. 1961 and 1-3 Oct. 1970.

Glareola pratincola
LARGE (COLLARED) PRATINCOLE L (b) ***

Mainly a winter visitor during the period October till January. Pre-1963 records include flocks of over 25 birds, but since then only noted in small parties of up to five birds. There is a record of attempted nesting at Addu Atoll during 1961, but the status of the species as a regular breeding bird of the Maldive Islands, has yet to be confirmed.

Dromas ardeola
CRAB PLOVER ? —

Status uncertain. The only records are of two birds on 8 June 1958, and a party of five (including one juvenile) at Gan 12-26 October 1975. May be resident elsewhere in the Maldive Islands, but this cannot yet be confirmed.

Stercorariidae

Stercorarius skua

GREAT SKUA ? —

A single record during 1961—presumably of the Antarctic race.

Laridae

Larus ridibundus

BLACKHEADED GULL V —

Probably a vagrant. One record December 1961. So far there have been no reports of *L. brunnicephalus*, the Brown-headed Gull, a bird common around Sri Lanka during the winter months.

Larus fuscus/argentatus *

LESSER BLACKBACK/HERRING GULL ? —

A single immature *fuscus* or *argentatus* bird was seen at Gan 29 Sept. 1970.

Chlidonias leucoptera

WHITEWINGED BLACK TERN W **

A fairly regular winter visitor in small numbers, recorded from November till February. Usually 2 or 3 together, but a flock of six were seen near the atoll on 6 Feb. 1975.

Gelochelidon nilotica

GULLBILLED TERN W **

A winter visitor in small numbers, recorded from September till March. All reports are of single birds.

Hydroprogne tschegrava (caspia)

CASPIAN TERN W *

An irregular winter visitor. The only records are of nine birds during 1961, and two on 5 January 1965.

Sterna hirundo

COMMON TERN W **

An irregular winter visitor, recorded from October till February. Two 1959 records (race *tibetana*), other records during 1967, and 26 Oct. 1975. The species has probably been overlooked, since in winter dress it bears a strong resemblance to the locally common Blacknaped Tern.

Sterna sumatrana

BLACKNAPED TERN R ***

A common resident that nests on sandbars and islets. Breeding at Addu Atoll has been noted during June and July. Large numbers can often be seen resting on sandbanks, or at the edge of the reef.

Sterna fuscata

SOOTY TERN L ***

A common visitor—no confirmed breeding records for the atoll, but considered to be a widespread resident elsewhere in the Maldive Islands.

Sterna anaethetus

BRIDLED TERN ? —

Status uncertain, but may breed elsewhere in the Maldive Islands. One record of a single bird 15 June 1959.

Sterna albifrons

LITTLE/SAUNDER'S TERN Lw ***

Best treated as two separate species :—

S. a. albifrons

A rare winter visitor, one record 15 November 1958.

S. a. saundersi

Believed to breed in some numbers elsewhere in the Maldive Islands, but no Addu Atoll records as yet. Recognised by its dark primaries, large numbers have been recorded throughout the year.

Sterna (Thalasseus) bergii

LARGE CRESTED TERN L *

An uncommon visitor, no breeding records. Assumed to be a resident elsewhere in the Maldive Islands. Pre-1963 records, also seen during 1975, when three birds on 26 Oct., and another two on 10 Nov.

Sterna (Thalasseus) bengalensis

LESSER CRESTED TERN L ***

Much commoner than the previous species, but the same breeding remarks apply. Records between October and May, noted by most observers. 32 were counted on 7 Feb. 1975, and large numbers seen 7 Oct. and 11 Dec. of the same year.

Anous stolidus

BROWN (COMMON) NODDY Lr ***

A single Addu Atoll breeding record April 1959. Birds seen are assumed to be mainly visitors from elsewhere in the Maldive Islands Quite common with 40 on 12 Sept. 1968, and large numbers at roost late 1975.

Gygis alba

WHITE TERN R ***

Very common throughout the atoll. Breeds all year, but especially during the periods Jan.-Feb. and May-June. Nests mainly in Coconut Palms, often around villages, where the birds are quite undisturbed by the local population. Very aggressive towards other species, especially larger raptors. The absence of the House Crow, *Corvus splendens*, on the atoll may be due to the presence of White Terns. As yet the species is confined to Addu Atoll, and does not breed elsewhere in the Maldive Islands.

COLUMBIDAE

Streptopelia orientalis *

RUFOUS TURTLE DOVE W *

An irregular winter visitor, so far only recorded during September and October. No pre-1963 reports, but since when, 6 birds on 29 Sept. 1970, and two immatures present 28 Sept-24 Oct. 1975.

CUCULIDAE

Cuculus canorus

COMMON CUCKOO W **

A regular winter visitor, recorded from September till January. One or two birds are recorded almost annually.

Cacomantis merulinus

INDIAN PLAINTIVE CUCKOO W *

An irregular visitor with two records only. January 1959 and November 1961.

Penthoceryx sonneratii *

BAY BANDED CUCKOO ? —

A bird fitting the description of this species, was seen and photographed one autumn during the late 1960's. Little detail available, so perhaps the record is best treated with caution.

Eudynamys scolopacea

KOEL L **

A regular non-breeding visitor, most commonly recorded between November and January. The species breeds throughout the Maldive Islands, except for Addu Atoll, where it is excluded by the absence of its host, the House Crow.

STRIGIDAE

Asio flammeus

SHORT EARED OWL ? —

A single old record made around 1900. No further reports.

APODIDAE

Collocalia brevirostris

EDIBLE-NEST SWIFT W *

An irregular visitor, two pre-1963 records, and one bird on 13 Nov. 1970.

Apus affinis

WHITE RUMPED HOUSE SWIFT Ws **

An irregular visitor, with half a dozen records, mainly of solitary birds, during the winter months. However, 7 were noted 16 Dec. 1961, and two birds during May 1975.

Apus apus

COMMON SWIFT W (p) **

A regular winter visitor, with records between September and November. Often solitary, but up to five birds together during September 1975.

Apus pallidus*

PALLID SWIFT W *

An uncommon winter visitor, twice recorded, 3 Oct. 1970, and 20 Sept. 1975. The latter bird was examined in the hand. It was of distinctly pale appearance, with no 'sooty' aspect to the plumage. The forehead was almost white in colour.

Hirundapus caudacutus *

NEEDLE-TAILED SWIFT ? —

Uncertain status. One record 22 October 1970.

MEROPIDAE

Merops apiaster

EUROPEAN BEE-EATER ? —

Uncertain status. One record, a party of three January-March 1959.

CORACIIDAE

Coracias benghalensis *

INDIAN ROLLER W *

An irregular winter visitor. Two records, 16-23 Nov. 1964 and 11 Nov. 1970.

UPUPIDAE

Upupa epops *

HOOPOE ? —

Status uncertain. One bird at Gan, for several days during the autumn of 1972.

HIRUNDINIDAE

Hirundo rustica

SWALLOW WP ***

A regular winter visitor and passage migrant. Records between 14 September and 17 January. Usually in small parties of up to 6 birds, but a flock of 20+ has been recorded.

Delichon urbica

HOUSE MARTIN W (p) **

An irregular winter visitor, with records from 3 October till late December. Usually solitary (sometimes among Swallows), but a party of four were recorded in Dec. 1972.

Riparia riparia

SAND MARTIN WP **

A regular winter visitor and passage migrant, with records between 25 September and 11 November, except for a single bird on 5 May 1968. Usually in ones and twos, but a party of ten were seen during 1970.

Riparia paludicola *

PLAIN SAND MARTIN ? —

Status uncertain. A single record 30 November 1967.

TURDIDAE

Oenanthe oenanthe *

COMMON WHEATEAR ? —

Status uncertain. A single record 1-3 October 1970.

Oenanthe isabellina
ISABELLINE WHEATEAR W (p) **

A fairly regular visitor in small numbers. Eight sightings, between 19 October and 8 December. All singles except for a pair on 19 Oct. 1975.

Oenanthe pleschanka (leucomela)
PIED WHEATEAR W (p) **

Irregular winter visitor in small numbers. Six sightings, between 24 October and 16 December—all singles.

Saxicoloides fulicata *
INDIAN ROBIN ? —

Status uncertain. A single female/immature 22 November 1967.

MUSCICAPIDAE

Tchitrea paradisi
PARADISE FLYCATCHER ? —

Status uncertain. Two records, 27 October 1961 and 12 November 1967.

MOTACILLIDAE

Motacilla cinerea
GREY WAGTAIL W *

A rare winter visitor. Two records, 17 Dec. 1958 and 14 Nov. 1968.

Motacilla flava
YELLOW WAGTAIL W (p) **

A winter visitor in small numbers. About a dozen records, during the period September till November. Usually solitary, but five on 27 Oct. 1961.

Anthus cervinus
REDTHROATED PIPIT W (p) *

An irregular winter visitor with records from September till December. Several pre-1963 reports, otherwise just a single bird 7-9 Nov. 1975.

LANIIDAE

Lanius collurio (cristatus)
BROWN SHRIKE W**

A winter visitor in small numbers, with some half a dozen reports—all of single birds between 3 November and 12 January. Birds seen during 1975 were of the race *phoenicuroides*, the Rufous Shrike.

SYLVIIDAE

Phylloscopus sp. *
WARBLERS ? —

A single bird seen 10 October 1974. Considered by the observer to be *P. trochilis*, the Willow Warbler.

STURNIDAE

Sturnus vulgaris *
COMMON STARLING V —

A single bird was seen among a flock of Turnstones on 22 October 1975. Close examination (from about 20 feet), left no doubt as to identity. Must be considered as a vagrant—perhaps shipborne ?

ORIOLIDAE

Oriolus oriolus *
GOLDEN ORIOLE W (p) *

Probably an irregular winter visitor or passage migrant. Two records, both females, 10 October 1970 and 22 October 1975.

LIST OF CONTRIBUTORS

The following people provided the personal notes that were used in this paper. For pre-1963 contributors see Phillips original paper.

D. Bodley : B. Cooper : J. Duncan : R. F. File : R. George : I. Hurston : J. P. Jenner : F. Kime : T. D. Rogers : A. Spillar : M. J. Strickland.

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On the fishes collected by the Ladakh Expedition, 1976[1]

P. K. Talwar[2]

(*With two text-figures*)

The paper reports on the fish collection of the Ladakh Expedition, 1976. The collection though small, is of interest as it contains an undescribed species of the Palaearctic cyprinoid genus *Gymnocypris* Günther, 1866, a specialised Schizothoracine genus reported here for the first time from the faunal limits of India. An annotated list of the fish fauna of Ladakh district of Jammu & Kashmir State, is presented.

Introduction

The Ladakh Expedition, 1976 was sponsored jointly by the World Wildlife Fund and the Bombay Natural History Society to determine the present status of the blacknecked (or Tibetan) crane, *Grus nigricollis* Przevalski, the barheaded goose, *Anser indicus* (Latham) and other so-called game birds and mammals. The present communication reports on the fish collections made in the cold and inaccessible regions traversed by the Expedition which was led by Dr. Sàlim Ali and included in its team Dr. Biswamoy Biswas of the Zoological Survey. The collection though small, is of interest for the purpose of ascertaining what are the chief characteristics of the fish fauna and what relationship it bears with those of the contiguous Asiatic regions.

The fish fauna of Kashmir has attracted considerable attention ever since Heckel (1838) published 'Fische aus Cashmir', the majority of the contributions, however, pertain mainly to the Kashmir Valley (Silas 1960 ; Das & Subla 1966 ; Das *et al.* 1964 ; Das 1965 ; Das & Nath 1965 ; Saxena 1968) and the fishes occurring in the Ladakh region beyond the limits of the Kashmir Valley are not included. Studies have rather rarely been undertaken in the Ladakh region of Jammu & Kashmir State and most of our knowledge of the fishes of this region is due to the labours of the Second Yarkand Mission (Day 1876, 1878) and the Yale North Indian Expedition in 1932 (Hora 1936 ; Mukerji 1936). The present collection consists of three species belonging to the family Cobitidae, and two cyprinoid species of the subfamily Schizothoracinae of which one is new to science. Opportunity is taken here to present an annotated list of the fish species reported from the Ladakh district of Jammu & Kashmir State with the hope it will serve as a base for future ichthyological and general fisheries research in this region.

[1] Accepted July 1977.

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SYSTEMATIC ACCOUNT

Order Cypriniformes

Family Cyprinidae

Subfamily Schizothoracinae

Gymnocypris biswasi sp. nov.

Material :

(i) Holotype (Text-fig. 1), a fish 117 mm in standard length, Chushul (Ladakh), *c* 4358 m, 1. vii. 1976, coll. B. Biswas ; Zoological Survey of India Regd. no. FF 1064.

(ii) Paratype, a fish 129 mm in standard length, same data as for the holotype; ZSI Regd. no. FF 1065.

(iii) 9 juveniles, 6-31 mm SL., Chushul, *c* 4358 m, 1. vii. 1976, coll. B. Biswas, ZSI Regd. no. FF 1066.

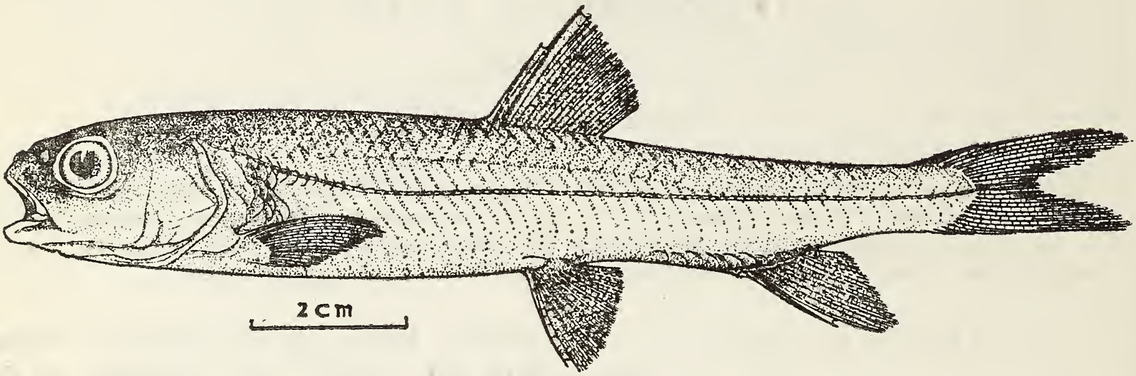

Fig. 1. Holotype of *Gymnocypris biswasi* sp. nov.

Measurements (in mm) (those of the paratype given in parenthesis): Total length 140 (155), standard length 117 (129), depth of body 17.5 (20), length of head 28 (30), eye diameter 7.5 (8.0), interorbital width 7.5 (8.0), length of upper jaw 7.5 (8.5), length of lower jaw 10 (10.5), length of pectoral fin 20 (21.5) and length of pelvic fin 16.5 (17.5).

Description : Based on the holotype and the paratype.

Brst iii ; D III 8 ; A II 6 ; P i 19 ; V i 10 ; C 19.

Gillrakers on first arch 1+12, short and stout (paratype examined only).

Body elongate, slightly compressed, abdomen rounded. Head moderate, conical, snout tip distinctly above the level of the lower margin of eye. Eyes large, rounded. Mouth terminal, transverse, without peculiarities, margin of lower jaw rounded and its inner edge with a horny covering; maxillary extending to below vertical from anterior border of eye. No barbels. Gill openings moderate, gill membrane attached to isthmus opposite to preopercular angle. Vent near origin of anal fin, surrounded by a spongy pad.

Pharyngeal teeth in two rows, 2, 3/3, 2.

Body naked except 3 to 5 rows of scales above the pectoral fin axil and on the commencement of the lateral line, and a scaly sheath of 17 to 20 enlarged tiled scales behind the base of ventral fin to along the base of anal fin. Pelvic fin with an axillary scale. Lateral line at first descends gently and then reascending attains the middle of the body opposite the posterior extremity of the dorsal fin.

Dorsal fin short, its origin slightly nearer to tip of snout than to base of caudal fin; first dorsal spine minute and embedded in the skin (hence not shown in fig. 1), third dorsal spine rather coarsely serrated posteriorly in its basal two-thirds. Pectoral fin low, considerably shorter than head length. Pelvic fin origin below vertical from 3rd to 4th soft dorsal ray. Anal fin short, reaching the base of the caudal fin when laid flat. Caudal fin forked.

Colour : In alcohol, back grayish black, sides lighter, with no distinctive markings. Peritoneum dusky.

The new species is named in honour of Dr. Biswamoy Biswas, Deputy Director, Zoological

Survey of India, Calcutta, the collector of the species.

Remarks: The genus *Gymnocypris* was established by Günther (1868) for the reception of a new species, *G. dobula* based on a specimen from the Haslar Collection from an unknown locality. This genus is closely allied to the genus *Schizopygopsis* Steindachner, 1866, from which it differs in having a terminal mouth and the presence on the lower lip of a horny layer on the inner side (*versus* anterior margin) and absence of a sharp horny covering to the lower lip which is characteristic of the latter genus (see fig. 2). *Gymnocypris* is one of the specialised Schizothoracine genera (Hora 1953) and

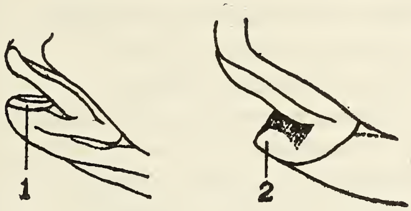

Fig. 2. Showing the difference of the horny structure of the lower jaw between the genera *Gymnocypris* and *Schizopygopsis* (after Tchang, Yuch & Hwang, 1964).

1. horny layer on the inner side of the lower jaw in the genus *Gymnocypris*. 2. horny layer covering the anterior margin of the lower jaw in genus *Schizopygopsis*.

the record of this genus from the faunal limits of India for the first time, is of significance. Jayaram (1974) in a discussion of the distributional patterns of the primary freshwater fishes of India, listed only the following four genera which are restricted to the Palaearctic of India: *Schizopygopsis*, *Schizothorax*, *Ptychobarbus* and *Cyprinion*.

Among the species of *Gymnocypris* described by Herzenstein (1888), Regan (1905), Stewart (1911) and Tchang *et al.* (1964), *Gymnocypris biswasi* is most closely allied to *G. waddellii* Regan, 1905. It differs from the latter species by the absence of 'humping' in front of the dorsal fin and by the smaller number of pharyngeal teeth (2, 3/3, 2 *vs.* 4, 3/3, 4). Further, there are no spots on the back of the body.

Das *et al.* (1964) in a paper not seen by me, discussed the Palaearctic elements in the fish fauna of Kashmir. *Gymnocypris biswasi* represents another Palaearctic element in the ichthyofauna of Kashmir. Silas (1960) and Saxena (1968) were of the opinion that the bulk of the indigenous fish fauna of Kashmir Valley is composed of the Palaearctic elements (of Central Asiatic origin).

Schizopygopsis stoliczkae Steindachner

Schizopygopsis stoliczkae Steindachner, 1866, *Verh. zool. bot. Ges. Wien.*, **16** : 786, pl. 16, fig. 2; Day, 1878; *Fishes of India*: 531, pl. 124, fig. 2.

Material: 1 ex., 88 mm SL., Chushul, *c* 4358 m, 6. vii. 1976, coll. B. Biswas; ZSI Regd. no. FF 1067.

Distribution: Endemic in the North-west Himalaya (Jayaram 1974); Ladakh, the Kashmir Valley and headwaters of the R. Indus.

Remarks: Das & Subla (1966) reported this species from the Kashmir Valley. Jayaram (1974) was of the opinion that it occurs at lower elevations only very rarely and the few isolated reports represent no doubt stray specimens that have been washed down to the lakes in the plains by sporadic flash floods, to which most of the Himalayan rivers are subject.

Family Cobitidae

Noemacheilus deterrai Hora

Nemachilus deterrai Hora, 1936, *Mem. Conn. Acad. Arts Sci.*, **10** : 311, fig. 4 (type loc. : Man Lagoon, Ladakh).

Material: 1 ex., 56 mm SL., Chushul, *c* 4358m, 6. vii. 1976, coll. B. Biswas; ZSI Regd. no. FF 1069.

Distribution: Ladakh.

Remarks: This species was hitherto known only from its type-specimens and the present collection is hence of interest.

Noemacheilus ladacensis Günther

Nemachilus ladacensis Günther, 1868, *Cat. Fishes Br. Mus.*, **7**: 356 (type loc.: Ladakh); Hora, 1922, *Rec. Indian Mus.*, **24** (1): 78.

Material; 5 ex., 43-56 mm SL., Chushul. *c* 4358 m, 6. vii. 1976, coll. B. Biswas; ZSI Regd. no. FF 1068.

Distribution: Ladakh.

Remarks: Hora (1922) has shown that Day's *Nemachilus ladacensis* differs from Günther's original account of the species and probably represents a different species. Only a few specimens of this species are known so far and, in consequence, its specific limits have not yet been precisely defined (Hora 1936). The present collection of five topotypes is, therefore, of importance.

Noemacheilus panguri Hora

Nemachilus panguri Hora, 1936, *Mem. Conn. Acad. Arts Sci.*, **10**: 318, fig. 8 (type loc.: Pangur Tso, *c* 14,203′ and Tzo Nyak, Ladakh).

Material: 1 ex., 59 mm SL., Chushul, *c* 4358m, 6. vii. 1976, coll. B. Biswas; ZSI Regd. no. FF 1070.

Distribution: Ladakh.

Remarks: This species was earlier known only from its type-specimens and the present record is hence of interest.

The species at present known from the Ladakh District of Jammu & Kashmir State may be classified as follows:

Order Siluriformes

Family Sisoridae

Glyptosternon reticulatum McClelland
Glyptosternon stoliczkae (Day)

Order Cypriniformes

Family Cyprinidae

Subfamily Schizothoracinae

Diptychus maculatus Steindachner
Gymnocypris biswasi Talwar
Oreinus richardsonii (Gray)
Ptychobarbus conirostris Steindachner
Schizopygopsis stoliczkae Steindachner
Schizothorax curvifrons Heckel
Schizothorax esocinus Heckel
Schizothorax hugelii Heckel
Schizothorax labiatus (McClelland)
Schizothorax longipinnis Heckel
Schizothorax micropogon Heckel
Schizothorax nasus Heckel
Schizothorax niger Heckel
Schizothorax planifrons Heckel
Schizothorax progastus (McClelland)

Family Cobitidae

Noemacheilus deterrai Hora
Noemacheilus gracilis Day
Noemacheilus hutchinsoni Hora
Noemacheilus ladacensis Günther
Noemacheilus microps (Steindachner)
Noemacheilus panguri Hora
Noemacheilus stoliczkae (Steindachner)
Noemacheilus tenuicauda (Steindachner)
Noemacheilus yarkendensis Day

Recent workers (Misra 1962 : Saxena 1968 ; Menon 1971, 1974 ; Tilak & Sinha 1975) treated the species of *Schizothorax* listed above under the genus *Schizothoraichthys* Misra, 1962, and considered *Oreinus richardsonii* (Gray) under the genus *Schizothorax* Heckel, 1838. I have shown (Talwar, MS) that the genus *Schizothoraichthys* Misra is a junior synonym of the genus *Schizothorax* Heckel and further that the genus *Oreinus* McClelland is a valid genus in accordance with Article 69 of the International Code of Zoological Nomenclature.

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Field notes on the Odonata around a fresh water lake in Western Himalayas[1]

ARUN KUMAR[2]

(*With a text-figure*)

Distribution of Odonata around a fresh water lake, namely, Renuka Lake, Parush Ram Tal (Perennial pond) and two small streams have been studied in the field. Notes have been made on the behaviour of the dragonflies present around these habitats.

INTRODUCTION

It is well known that the shape and size of a body of water are important in habitat selection of Odonata—and normally the distribution of dragonflies is affected by the nature of aquatic habitat available, Corbet (1962). Kumar (1972) discussed parochialism in certain species in the tropics which confine themselves to the larval habitat available in the form of streams, permanent standing water bodies or temporary monsoon ponds.

The Renuka Lake (Dist. Sirmaur, H.P.) is a fresh water lake at an altitude of *c* 650 m, and is situated in the Renuka Wild Life Sanctuary. The lake is about 1 Km in length and approximately 300 m in width and has an irregular shore line. The lake is fed by a small stream on its south-west side. The stream originates from a perennial pond, the Parush Ram Tal, about 100 m in diameter which in turn is fed by a hill stream at its south-eastern side (fig. 1).

The lake provides an excellent breeding ground for dragonflies. The Odonata fauna of the lake and its vicinity comprise about 31 species (Kumar & Juneja 1976). Field observations on the distributional pattern of the dragonflies around Renuka Lake have been recorded in the present study. The distribution can be broadly classified into three groups (fig. 1).

Odonata species :

(1) along the stream,
(2) at the perennial pond with open banks,
(3) and around the irregular lake shore.

1. Species near the Stream :

(i) *Both banks with vegetation :* (Fig. 1, Stretch A & C).

Only a few species were observed in stretch A of the hill stream which was about 1.5 mt. in width and approximately 50 cm. in depth and had a sand and pebble bed shaded by bushes on either side. The most common species was *Neurobasis chinensis chinensis* (Linn.) which was seen perching on overhanging vegetation or fluttering over the stream. The other species observed and collected were *Bayadera indica* (Selys), *Nepogomphus modestus* (Selys) and *Trithemis festiva* (Ramb.).

The stretch C of the stream (the link stream between Parush Ram Tal and Renuka Lake)

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is also almost like stretch A of the stream except that it is a deep channel with scarce vegetation. The common species at stretch C are *N. chinensis chinensis*, and *Rhinocypha quadrimaculata* Selys. At the place where this stream merges with the Renuka Lake *Pseudagrian decorum* (Rambur) and *Coenagrian dyeri* Fraser were most frequent, flying about 10 cm above the water surface. *T. festiva* was also actively flying nearby.

(ii) *with open beds* (Fig. 1, Stretch B) :

This stretch of the feeder stream to Parush Ram Tal has a number of *R. quadrimaculata* adults resting on boulders on the bank. *P. decorum* and *C. dyeri* were flying in abundance low over the water surface, where the stream merges into the Pond. A few *T. festiva* were also flying in the short stretch.

2. Species around the Perennial pond (Fig. 1) :

Parush Ram Tal has an open and shallow bank line and in post monsoon period it extends almost upto the surrounding Road. The western side of the pond has a little deep shore line and the species frequent there are *Ceriagrion coromandelianum* Fabr., *Pseudagrion rubriceps* (Selys), *Orthetrum pruinosum neglectum* (Ramb.), *Orthetrum triangulare triangulare* (Selys), *Brachythemis contaminata* (Fab.), *Crocothemis s. servilia* (Drury) and *Trithemis aurora* (Burm.). A few *Ictinogomphus rapax* (Rambur) were also seen.

C. coromandelianum, *P. rubriceps*, *P. decorum*, *Ischnura delicata* (Hagen), *Ischnura forcipata* Morton, *I. rapax*, *Orthetrum sabina* (Drury) and *T. festiva* were common on the wing towards the shallow eastern part of the pond. *P. decorum* and *O. sabina* were frequent over the open surface of water while the other species were flying low or perching amidst the partially submerged vegetation on the bank. A few *B. contaminata* were seen on the road around the pond. Often the adults of *O. sabina* were observed clashing and chasing each other over the open water surface of the pond.

3. **Species around the irregular Lake Shore** (Fig. 1) :

(i) *Among the Reeds* (*marshy area*) :

The most common species are *Neurothemis tullia tullia* Drury and *B. contaminata*. A large number of emerging adults of *N. tullia tullia* were collected in the month of April. The other species flying among the reeds are *C. coromandelianum*, *Ceriagrion cerinorubellum* Fab. (very rare), *O. pruinosum neglectum*, *C. servilia servilia*, *T. aurora*, *Diplacodes nebulosa* (Fab.) and *Acisoma panorpoides panorpoides* (Ramb.) (Rare). All these species were observed either perching on the partially submerged vegetation or flying and sometimes ovipositing in the shallow water. *B. contaminata* and *T. aurora* were seen perched in large numbers in the dense vegetation on the eastern side of the lake which generally remains dry.

(ii) *Along the Deep Shore Line :*

Species hovering and patrolling along the shore line of the lake are *P. rubriceps*, *Libellago lineata lineata* (Burm.), *O. pruinosum neglectum*, *B. contaminata*, *C. servilia servilia*, *Orthetrum brunneum brunneum* (Fons.) and *T. aurora*. Among these *L. lineata lineata* and *P. rubriceps* were observed flying lazily at a low level above the surface of the Lake but would not go beyond a few metres from the shore line. A large number of *P. rubriceps* were observed in tandem and in process of ovipositing in the submerged shore vegetation. The adults of larger Anisoptera would venture further away from the shore and *B. contaminata* and *T. aurora* were frequently observed on the open water surface towards the middle of the Lake. Some adults were seen chasing each other violently over the lake surface and they would often do aerobatics over the water surface. However,

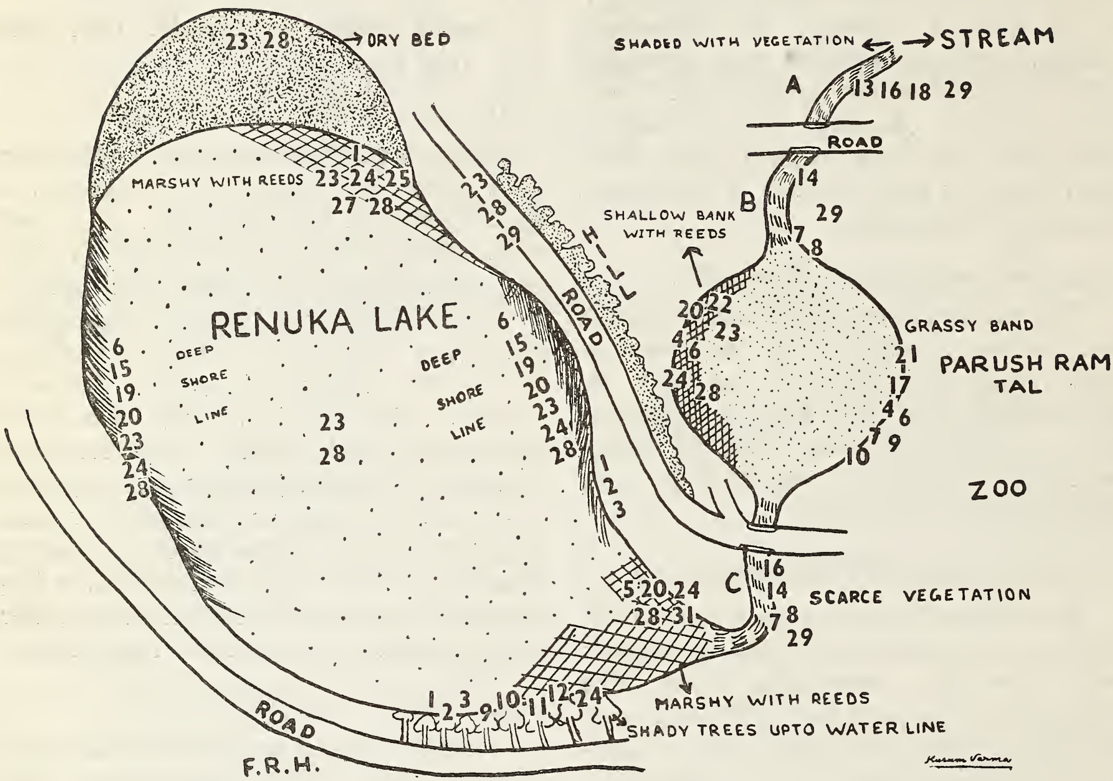

Fig. 1.

1. *Copera annulata* (Selys) ; 2. *Copera marginipes* (Ramb.) ; 3. *C. vittata* (Selys) ; 4. *Ceriagrian coromandelianum* Fabr.; 5. *C. cerinorubellum* (Brauer) ; 6. *Pseudagrion rubriceps* Selys ; 7. *P. decorum* (Ramb.) ; 8. *Coenagrion dyeri* Fraser ; 9. *Ischnura delicata* (Hagen) ; 10. *I. forcipata* Morton ; 11. *I. senegalensis* (Ramb.) ; 12. *Agriocnemis pygmeae* (Ramb.) ; 13. *Bayadera indica* (Selys) ; 14. *Rhinocypha quadrimaculata* (Selys); 15. *Libellago lineata lineata* (Burm.); 16. *Neurobasis chinensis chinensis* (Linn.) ; 17. *Ictinogomphus rapax* (Ramb.) ; 18. *Nepogomphus modestus* (Selys) ; 19. *Orthetrum b. brunneum* (Fons.) ; 20. *O. pruinosum neglectum* (Ramb.) ; 21. *O. s. sabina* (Drury) ; 22. *O. t. triangulare* (Selys) ; 23. *Brachythemis contaminata* (Fabr.) ; 24. *Crocothemis s. servilia* Drury ; 25. *Diplacodes nebulosa* (Fabr.) ; 26. *Neurothemis fulvia* (Drury) ; 27. *N. t. tullia* Drury. ; 28. *Trithemis aurora* (Burm.) ; 29. *T. festiva* (Ramb.) ; 30. *T. pallidinervis* (Kirby) ; 31. *Acisoma panorpoides panorpoides* (Ramb.).

oviposition was not observed at the open surface of the lake.

(iii) *Away from the water among the shady vegetation :*

The western part of the Renuka Lake has a dense growth of trees with dense vegetation underneath. A large number of smaller Zygopteran species were observed flying lazily among the shaded vegetation. Common species are *Copera annulata* (Selys), *C. marginipes* (Ramb.), *C. vittata* (Selys), *I. delicata*, *I. forcipata*, *Ischnura senegalensis* (Ramb.), *Agriocnemis pygmeae* (Ramb.) and *C. servilia servilia*. The adults are most active on wing in the fore-noon. Perching adults of *C. vittata* were also observed frequently on the hedge of the Forest Rest house and among the vegetation on the surrounding hill, which were approximately 20-25 m away from the water site.

(iv) *On the Road and Boulders around the Lake :*

A large number of adults of *B. contaminata*, *T. aurora* and *C. servilia servilia* were observed flying a few centimetres above the road surface or perching on large boulders with spread wings especially so if they were exposed to the sunshine. It was observed that in case of *B. contaminata* the adults along the road were predominantly females while the males were generally patrolling along the lake shore. However, in case of *T. aurora* males were conspicuous, perching on the boulders. A few *T. festiva* were also observed.

Discussion and Conclusion

The distribution of 31 species of Odonata at and around Renuka Lake has generally demonstrated that the species restrict themselves either to the flowing water or stable water bodies. *B. indica*, *N. chinensis chinensis*, *R. quadrimaculata* and *N. modestus* were restricted in their activities to the streams while *T. festiva* was irregularly distributed. The composition of species among smaller, shallow and open bordered Parush Ram Tal and the larger Renuka Lake also differs. The species composition of Parush Ram Tal is poorer than the Renuka Lake. *I. rapax* was restricted only to the Parush Ram Tal while species of genus *Copera*, *C. cerinorubellum*, *L. lineata lineata*, *O. brunneum brunneum*, *N. tullia tullia* and *A. panarpoides panarpoides* were confined to the Lake. The distribution of the remaining species overlapped.

It is evident from the above observations that the adults of those species which have their larvae in hill streams, namely *N. chinensis chinensis*, *R. quadrimaculata* and *B. indica* (Kumar 1972), restrict themselves to the streams ; while some of the riverine species like *O. brunneum brunneum*, *L. lineata lineata*, *P. rubriceps*, etc., have generally restricted themselves to the straight deep shore line of the Renuka Lake. Similar behaviour of the adults of other riverine species has been discussed by Corbet (1962). The typical, standing water breeding species like *C. marginipes*, *C. coromandelianum*, *I. delicata*, *A. pygmeae*, *I. rapax*, *O. sabina sabina*, *B. contaminata* and *A. panarpoides panarpoides* etc., (Kumar 1972, 1973a, 1973b) seem to confine themselves to the reeds and marshy vegetation at the Renuka Lake and Parush Ram Tal.

In addition to the site selection and larval habitat preference, which have been discussed here, other factors responsible for the habitat selection and oviposition in dragonflies have been dealt in detail by Corbet (1962). Presence or absence of a particular type of shore vegetation may also be an important factor in such habitat preference especially in those species which oviposit endophytically or have their larvae living amidst the upright vegetation.

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Breeding habits and associated phenomena in some Indian bats

Part III—*Hipposideros ater ater* (Templeton)—Hipposideridae[1]

A. Gopalakrishna[2] and A. Madhavan

The study is based on the examination of 419 specimens of *Hipposideros ater ater* (Templeton) collected at frequent intervals from deep wells in Marathwada region, Maharashtra, India, for a period of two years from February 1965 to the end of February 1967 so that every calendar month is represented by one collection or more. A colony consists of 200 to 300 individuals. There is a sharply defined breeding season. All females in the colony become pregnant between mid-November and mid-December, and the young are delivered, one by each female, during the last week of May and end June after a gestation of 190 to 200 days. The young are carried by the mothers for about 25 days after which they become free, but visit the mother for sucking for a few more days. The growth is rapid during the suckling period and the young reach nearly the adult size. Sexual maturity is attained by the females within the year of birth. There is an abnormal sex ratio in the total population with the females outnumbering the males, although the sex ratio is even at birth. The uterus is bicornuate, but the left side is physiologically dominant over the right in bearing pregnancy.

Introduction

There is no detailed work so far on the breeding biology of any member of the family Hipposideridae, and the little information, which is available, is in the nature of casual references to the occurrence of pregnant specimens in one or a few random collections made by workers while they were studying some other aspect of the life of these animals (Blanford 1891 ; Matthews 1941 ; Gopalakrishna 1958 ; Gopalakrishna & Moghe 1960 ; Brosset 1962 ; Asdell 1964). Recently Menzies (1973) noted that *Hipposideros caffer* from north-west Nigeria undergoes copulation in November and delivers the young at the end of the following April or early May after a gestation period of about 5 months. He also noted that the females breed within the year of their birth.

The paucity of information on the reproduction of the hipposiderid bats encouraged us to undertake detailed investigations on the breeding biology of members of this family. This paper embodies observations on the female reproductive cycle of *Hipposideros ater ater*.

Material and Methods

The specimens of *Hipposideros ater ater* were collected from Dongerkheda, Barad and Shirol in Marathwada region, Maharashtra. The collection work was started on 10th February 1965 and continued until 25th February 1967 in such a manner that every calendar month is represented by one collection or more. Altogether 419 specimens were collected and examined for the present report.

Hipposideros ater ater is usually found within the dark hollows in the walls of wells. The presence of these bats in the well can be detected by the characteristic odour emanating from the

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well. These bats are active and can be often seen flutterring about in the well even during the day time. They come out into the open late in the evening. They are very delicate, and a highly humid atmosphere is very essential for their survival. Each well, from which these specimens were obtained, contained two to three hundred specimens, and there was no segregation of the specimens on the basis of age, sex or season.

This is a comparatively small bat with an average body weight of 5 to 6 gm, fore-arm length of 34 to 38 mm and the wing span of about 230 mm. The fur is dark grey on the dorsal side and greyish-white on the ventral side. The specimens were captured with the help of butterfly nets, and killed with chloroform. Their body weights were recorded immediately. The condition of the external genitalia and accessory structures were noted, and a complete collection diary was maintained. The reproductive organs and accessory reproductive structures were dissected out and fixed in Bouin's fluid for 24 hours and preserved in 70% ethanol. The tissues were dehydrated by passing through graded ethanol, embedded in paraffin and sectioned at 10 μ thickness. Most of the sections were stained with Ehrlich's haematoxylin and counterstained with eosin and mounted in Canada balsam after clearing in xylol.

The specimens collected on a given calendar date presented almost the same condition during the two years when the collections were made. Table I gives the summary of the collection diary, and table II gives the monthwise distribution of the specimens collected.

Observations and Conclusions

1. General remarks

Although this species has a bicornuate uterus like most bats, only one cornu bears a single conceptus during each pregnancy. The unweaned young normally cling to the mothers in the head-to-tail position holding one of the pubic dugs of the mother by its teeth and hooking the claws of the toes to the fur or the neck of the mother. The young reverses itself while sucking milk. The free flying young remain in the colony and continue to suck milk from their mothers. Apparently there is community suckling of the young for some time after the young become independent.

The mammary glands are pectoral in position and are present on the ventro-lateral aspect of the thorax, one on each side. The mammary nipples are directed laterally. There is a pair of pubic dugs without mammary glands, one on each side in the inguinal region. The mammary nipples and pubic dugs are insignificant in size during juvenile life, but become enlarged during the first pregnancy and lactation and remain as such during the rest of the life of the animal.

2. Breeding habits

Hipposideros ater ater has an annual reproductive cycle and breeds in a sharply restricted season. These conclusions are based on the following facts. Examination of the collection diary and table I reveals that pregnancy, as evidenced by the occurrence of a bulbous uterine cornu, is noticed only from about the last week of November to about the last week of June. Two females, each carrying a young at the breast, were collected on 24th May. The mothers' uteri were still in the post-partum stage, and the young ones at their breast had each a fresh umbilical stub and closed eye lids. Each of them weighed 1.5 gm, which is also the weight of the full term foetus. These facts indicate that the young ones had been delivered a few hours earlier. During the following weeks there were progressively more females in the colony which had delivered their young. Two pregnant females collected on 24th June had full term foetuses, which, gauging from their

TABLE I

SUMMARY OF COLLECTION DIARY

Date	Male				Female							Grand total
	Immature		Adult	Total	Immature		Non-pregnant	Adult				
								pregnant		Lactating	Total	
	Attached	Free			Attached	Free		Right horn	Left horn			
1	2	3	4	5	6	7	8	9	10	11	12	13
5-1-66	..	..	5	5	..	..	1	2	7	..	10	15
6-1-67	..	..	2	2	..	..	..	..	8	..	8	10
15-1-66	..	..	2	2	..	..	..	..	6	..	6	8
19-1-67	..	..	2	2	..	..	..	3	3	..	6	8
28-1-66	..	..	..	..	..	..	..	..	1	..	1	1
10-2-65	..	..	8	8	..	..	2	4	6	..	12	20
12-2-66	..	..	3	3	..	..	..	2	11	..	13	16
16-2-65	..	..	4	4	..	..	1	4	6	..	11	15
23-2-66	..	..	4	4	..	..	1	..	10	..	11	15
28-2-67	..	..	4	4	..	..	..	5	4	..	9	13
2-3-65	..	..	5	5	..	..	..	3	4	..	7	12
7-3-65	..	..	7	7	..	..	1	3	3	..	7	14
12-3-65	..	..	..	..	..	..	..	4	6	..	10	10
15-3-66	..	..	1	1	..	..	..	2	8	..	10	11
17-3-65	..	..	6	6	..	..	1	4	7	..	12	18
17-3-66	..	..	2	2	..	..	1	5	..	..	6	8
24-3-66	..	..	3	3	..	..	..	2	3	..	5	8
7-4-65	..	..	1	1	..	..	..	..	8	..	8	9
9-5-65	..	..	6	6	..	..	..	7	7	..	14	20
24-5-66	..	..	..	..	2	..	..	2	2	2	8	8
29-5-65	..	..	2	2	1	..	..	1	3	1	6	8
29-5-66	..	..	1	1	..	..	..	3	..	..	3	4
11-6-65	3	..	1	4	3	..	..	..	..	5	8	12
18-6-65	2	1	..	3	3	4	..	..	1	10	18	21
24-6-66	6	1	2	9	1	2	..	1	1	11	16	25
15-7-65	..	3	2	5	..	3	2	..	..	3	8	13
15-8-65	..	4	2	6	..	1	2	..	..	5	8	14
27-9-65	..	..	2	2	..	..	4	..	..	..	4	6
25-10-65	..	..	9	9	..	..	9	..	..	..	9	18
23-11-65	..	..	7	7	..	..	..	2	8	..	10	17
28-11-66	..	..	2	2	..	..	2	..	7	..	9	11
22-12-65	..	..	3	3	..	..	..	2	6	..	8	11
24-12-65	..	..	5	5	..	..	..	..	2	..	2	7
25-12-65	..	..	1	1	..	..	..	..	1	..	1	2
25-12-66	..	..	1	1	..	..	2	3	5	..	10	11

Table II

Monthwise distribution of specimens

Month		Male	Female	Total
Jan.	..	11	31	42
Feb.	..	23	56	79
Mar.	..	24	57	81
Apr.	..	1	8	9
May	..	9	31	40
Jun.	..	16	42	58
Jul.	..	5	8	13
Aug.	..	6	8	14
Sep.	..	2	4	6
Oct.	..	9	9	18
Nov.	..	9	19	28
Dec.	..	10	21	31
Total	..	125	294	419

size, weight and the stage of development, would have been delivered in a day or two. No pregnant female was collected after this date. Evidently, this species has a long gestation period of about 190 to 200 days—calculating from about a week prior to the date when the first sign of pregnancy was noticed (23rd November) to the date on which the first delivered young were collected (24th May), and allowing a margin of a couple of days on either side.

The suckling young are constantly carried by their mothers at the breast. The first group of young ones, which had become free from their mothers, was collected on 18th June. Assuming that these were the young delivered in the first batch (that is, around 24th May), it is evident that the young are carried by their mothers for about 25 days. However, suckling of the young continues for some time after the young leave their mothers as indicated by the fact that the mammary glands of the mothers continued to be in full lactation until August and curdled milk was present in the stomach of several free flying young.

From the foregoing account of the breeding habits of the females of *Hipposideros ater ater* the annual life of the adult female of this species can be recognized into the following periods :—

(1) period of sexual quiescence from about the middle of August to about the second week of November.

(2) Copulation in about the second week of November.

(3) Pregnancy from about the middle of November until the last week of June.

(4) Parturition during the last week of May to the end of June.

(5) Lactation from about the last week of May until about the middle of August.

(6) Neither the commencement of pregnancy nor parturition take place synchronously in all the females in the colony. There is a span of about 30 days (between 15th November and 15th December), when all the females become pregnant, and there is similarly a span of 30 days (between 24th May and 24th June) when all deliveries occur.

(3) Number of young and symmetry of genitalia

Out of the 208 pregnant specimens collected, 144 had the pregnancy in the left cornu and 64 in the right. Microscopic examination of the ovaries of the pregnant females revealed that the corpus luteum was present invariably on the same side in which the uterine cornu carried the conceptus. It is not possible to determine if there is any alternation of the pregnancies between the two sides of the genitalia in successive cycles in this species. On the other hand it is very unlikely that there is such an alternation of the two sides of the genitalia in successive cycles as borne out by the following facts :—Pregnancies occurred on the left side more than on the right side during all the three successive breeding seasons when the collections were made. For example in 1965, 67 females had pregnancy in the left side and 34 in the right ; in 1966, 62 had pregnancy in the left side and 22 in the right ; in 1967 (collections made only during January and February), 15 had pregnancies in the left side and 8 in the right side. If physiological alternation occurs between the two sides of the genitalia, then the proportion of the pregnancies on the two sides should also alternate between the two sides in successive years. Evidently, there is a natural dominance of the left side of the genitalia in *Hipposideros ater ater*. The factors responsible for this are not known.

(4) Growth and maturity

Mention has already been made that the young ones are all delivered between the last

TABLE III

DISTRIBUTION OF FEMALES DURING THE BREEDING SEASON

Date		Pregnant		Non-pregnant	
		with mammary nipples and pubic teats	without mammary nipples and pubic teats	with mammary nipples and pubic teats	without mammary nipples and pubic teats
1		2	3	4	5
5-i-66	..	8	1	1	..
6-i-67	..	3	5	..	..
15-i-66	..	6	..	..	..
19-i-67	..	6	..	..	..
28-i-66	..	1	..	..	..
10-ii-65	..	9	1	1	1
12-ii-66	..	11	2	..	..
16-ii-65	..	9	1	..	1
23-ii-66	..	8	2	..	1
28-ii-67	..	7	2	..	..
2-iii-65	..	6	1	..	..
7-iii-65	..	6	..	..	1
12-iii-65	..	7	3	..	..
15-iii-66	..	3	7	..	..
17-iii-65	..	8	3	1	..
17-iii-66	..	4	1	..	..
24-iii-66	..	4	1	..	..
7-iv-65	..	8	..	..	..
9-v-65	..	14	..	..	..
24-v-66	..	4	..	..	..
29-v-65	..	4	..	..	..
29-v-66	..	3	..	..	..
11-vi-65	..	..	..	..	..
18-vi-65	..	1	..	..	..
24-vi-66	..	2	..	..	..
15-vii-65	..	..	..	2	..
15-viii-65	..	..	..	1	1
27-ix-65	..	..	..	4	..
25-x-65	..	..	..	5	4
23-xi-65	..	9	1	..	..
28-xi-66	..	7	..	1	1
22-xii-65	..	7	1	..	..
24-xii-65	..	2	..	..	..
25-xii-65	..	1	..	..	..
25-xii-66	..	7	1	1	1
Total	..	175	33	17	11

week of May and the last week of June. The new-born young weighs about 1.5 gm (the highest weight of the foetus is also about 1.5 gm). Immediately after birth the young one attaches itself to the breast of the mother, and is carried by the mother until it attains a body weight of about 3.5 gm, after which it leaves the mother, although it may continue to suck for a few more days. The first batch of independent young weighing 3.5 gm was collected on 18th June. It has already been mentioned that the young one is carried constantly by the mother for about 25 days. During this period the young one increases rapidly in weight from 1.5 gm to 3.5 gm. It is hardly possible to distinguish the weaned young from the adults on the basis of body size.

Table III shows the distribution of pregnant and non-pregnant females during the different months of the breeding season. Out of 220 females collected from November to June only 12 specimens were non-pregnant, and among the pregnant females 175 specimens had well-developed mammary nipples and pubic dugs and 33 had insignificant mammary nipples and pubic dugs. Among the 12 non-pregnant females 5 had well-developed mammary nipples, indicating that these are parous animals and the rest had insignificant mammary nipples and pubic dugs. The occurrence of very few non-pregnant females (some unquestionably parous) during the breeding season must be accidental either due to missed copulation or due to abortion. From the foregoing it is evident that the females reach sexual maturity within the year of their birth when they attain an age of about 6 months.

(5) Sex ratio

Out of a total of 419 specimens collected at random during a period of two years there were 294 (70%) females and 125 (30%) males. 21 young ones collected from the breasts of the mothers included 11 males and 10 females, and 19 free young ones included 9 males and 10 females. Evidently, there is a balanced sex ratio at birth and during early life, but there appears to be a preferential mortality of the males during the growth period resulting in an uneven female-dominant sex ratio in the adult stage.

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Miscellaneous Notes

1. LANGURS LIVING AT HIGH ALTITUDES

While carrying out a one year study of the social behaviour of a troop of langur monkeys (*Presbytis entellus*) living between 2440 and 3050 metres at Melemchigaon, in north-central Nepal, I observed a group of langurs at 4050 metres. Although this species has long been known to live at altitudes as high as 3660 metres in the Himalaya (Pocock 1939), this sighting is the highest published to date. The observations were made on August 18, 1972 at Routang, a high altitude pasture north of the village of Tarke Ghyang, Helambu valley, Nepal (28° 03′N, 85° 33′E). On the previous day, others observed this same group along the higher ridge at an altitude of 4250 metres.

Routang is a high pasture used during the summer monsoon by *dhzum*, a cow-yak hybrid commonly herded in the 2500-3700 metre altitude band in central Nepal. Two families occupied this pasture continually from mid June until mid August ; the langur troop was there throughout this time. During these months, there is daily rain, continual cloud cover except for brief periods in the morning, and by August 18, cold weather forced the herds to descend to lower pastures. The tree line here is at approximately 3500 metres, and above this there are only dwarf rhododendrons, wild rhubarb and a few alpine shrubs. Local hunters report that there are no longer any leopard in this area and the only large mammal regularly found there is musk deer (*Moschus moschiferus*).

Observations

The group of langurs was observed moving up a steep gully from their sleeping place at 1200 hours. Observation was possible for only a five minute period when the clouds lifted and we found ourselves facing each other at a distance of 30 metres. During this time, I counted 30 animals, including several large adult males and at least two infants (approximately six months old) being carried by their mothers. This is a *minimal* count—all three observers estimated a group size of at least 50 individuals. The animals barked at us and appeared nervous, as they hurried up the gorge and over the top of the ridge. The steepness and slipperiness of the rocks made it impossible to follow them.

Local herdsmen said this group sleeps under an overhanging rock at 3780 metres, and they move up the slopes from this rock every morning to forage. The sleeping rock itself is inaccessible to humans, so we were not able to look inside ourselves but were able to get an accurate altitude measurement. This group had been at Routang for at least the previous two months, foraging at altitudes as high as 4270 metres, but avoiding the *dhzum* herds. It is locally believed that the langurs descend to a potato field at 2900 metres, near Routang to spend the winter.

Discussion

This is the highest published sighting of *Presbytis entellus* ; the previous record height is *Presbytis entellus ajax* at 3960 metres in Kashmir (cited in Napier 1972). Furthermore, it places *Presbytis entellus* among the highest living nonhuman primates, along with the mountain gorilla (*Gorilla gorilla beringei*), the gelada baboon (*Theropithecus gelada*) and the barbary macaque (*Macaca sylvana*) of the Atlas mountains.

Altitude is meaningful only in relation to latitude, rainfall and the morphology of the mountains. In this case, the recorded altitude places these monkeys well above the tree line in the alpine zone for at least part of the year. The common langur of India, Sri Lanka and Nepal is a member of the Colobidae—the group of arboreal, leaf eating monkeys who are primarily adapted to life in the trees. The common langur is the most terrestrial of this family and in some areas spends a significant proportion of its time on the ground, but always near the safety of trees. In fact, langurs may be the most adaptable Asian primate, surpassing that more famous opportunist, the rhesus macaque (*Macaca mulatta*). At Routang, langurs sleep on cliffs and live without trees for safety.

Though possible, it is doubtful that these langurs stay year round at Routang, especially when food and shelter are available at lower altitudes. In fact these extremely high populations may be the only ones who actually do make seasonal migrations to different elevations. Long term observations of a different troop living at lower altitudes (2500-3100 metres) showed no migratory pattern ; the home range remained the same year round and within the range, there was no seasonal preference for higher or lower portions. This is in direct contradiction to local reports in both the Helambu and Trisuli vallyes. Local beliefs have become incorporated into the literature on this species (Hingston 1920 ; Pocock 1939 ; Vogel 1971) and may stem from the migratory patterns of local residents who move up to higher pastures in the summer. There they find groups which always live at that altitude but assume instead that the monkeys migrated with them. Evidence from Melemchigaon further indicates that snow itself is not a deterrant to langurs. It was observed that they will move along the ground in snow, even when it is possible to move through trees. The intensity of winter sun appears to compensate for the cold temperatures at night and langurs in the Himalaya are able to withstand night temperatures of —2°C with no observed ill effect. Food is no doubt the limiting factor here, and it is doubtful whether food sufficient to sustain a large langur troop is available as high as Routang in the winter.

The observations at Routang have implications for the consideration of mountain barriers to gene flow in the Himalaya. The langurs at Routang were observed to descend from that 4270 metre ridge in all four directions. These high and northern groups of langurs cannot be considered isolated from each other by mountain ridges and north-south flowing rivers. We observed langurs near Melemchigaon crossing rivers on bridges constructed for human traffic. And the group at Routang crossed with little apparent effort over the ridge at 4270 metres into the next valley to the east. The lower ranges of the Himalaya may not provide insurmountable barriers to east-west gene flow, especially for such an adaptable nonhuman primate as the langur monkey.

Acknowledgements

I would like to thank His Majesty's Government for permitting me to live and work in Nepal. Thanks also are due to Tribhuvan University and Vice-Chancellor Dr. T. N. Upraiti for extending me the courtesy of visiting scholar. These observations were made in the course of a one year study of the ecology and behaviour of langur monkeys carried out in Melemchigaon, Nepal between September 1971 and September 1972. This research was funded in part by a grant from the National Institutes of Health Training Grant, No. 1224.

Observations in Routang were made by Naomi H. Bishop, principal investigator, John M. Bishop and Mingma Tenzing Sherpa.

SYNOPSIS

A group of langurs (*Presbytis entellus*) was observed at 4270 metres in north-central Nepal in August 1972. This is the highest recorded sighting for this species and suggests that the lower ranges of the Himalaya do not provide insurmountable barriers to the exchange of genes between Himalayan groups of this species.

DEPARTMENT OF ANTHROPOLOGY,
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AT BOSTON,
BOSTON, MASSACHUSETTS 02125,
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February 7, 1977.

NAOMI H. BISHOP

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2. MIGRATORY BEHAVIOUR OF *MUS PLATYTHRIX* AT LUDHIANA (PUNJAB)

Little information is available on the migratory behaviour of Indian rodents. A study was undertaken from December, 1970 to November, 1972 at Ludhiana to know the movements of the Field Mouse, *Mus platythrix* (Bennett). Wonder traps were laid at 100 metres interval in a 53 ha cultivated area at the Ludhiana Farm of the Punjab Agricultural University. Mice were captured, marked and released at the point of capture. A mixture of husked rice, pearl millet and wheat was used as bait.

It appears that the mean range of migration of the field mouse within the crop fields, irrespective of sexes was significantly ($P = 0.01$) less than that from one crop to another (Table). Although there was no significant difference in range of movement of male and female mice in both the crop categories but the mean distance travelled by female *Mus platythrix* from crop to crop was significantly more ($P = 0.01$) than the mean distance covered by females within a crop.

With this limited data it is not possible to correlate the distance of movements of *Mus platythrix* with their preference of crop types or to explain the reason for greater ranges of movements from one crop to another.

ACKNOWLEDGEMENTS

I am thankful to the Director, Zoological Survey of India, Calcutta, for arranging identi-

TABLE

DISTANCE TRAVELLED BY *Mus platythrix* UNDER VARIOUS CROP TYPES

Crop type	Sex	No. of observations	Distance travelled (metres) mean ± S.E.	't' between
Within crop ..	Male ..	4	87.5 ± 12.5[a]	a & b = 0.81 NS
	Female ..	5	72.4 ± 13.9[b]	d & e = 1.98
	Total ..	9	79.1 ± 26.3[c]	c & f = 3.05**
Between crops ..	Male ..	8	109.5 ± 29.3[d]	a & d = 0.69 NS
	Female ..	10	195.5 ± 32.1[e]	b & e = 3.51**
	Total ..	18	157.3 ± 98.2[f]	

** Significant at 1 per cent level.

fication of the rodents and to Dr. O. S. Bindra, Professor and Head, Department of Entomology, for suggestions and for providing facilities.

DEPARTMENT OF ENTOMOLOGY,
PUNJAB AGRICULTURAL UNIVERSITY,
LUDHIANA,
July 25, 1977.

G. S. MANN

3. THE COMPOSITION AND FLUCTUATION OF POPULATION OF SYMPATRIC MURIDS IN PAU FIELDS

(*With two text-figures*)

INTRODUCTION

In Punjab, several species of rats and mice namely *Rattus meltada* (Gray), *Mus musculus bactrianus* (Blyth), *Mus booduga* (Gray), *Mus platythrix* Bennett, *Bandicota bengalensis* (Gray), *Tatera indica* (Hardwicke), *Golunda elliotí* (Gray) and *Nesokia indica* (Gray) have been reported to occur in the fields (Singh 1961 ; Anonymous 1970 ; Mann 1973 ; Bindra & Sagar 1975 ; Sood & Ubi 1975 and Sood *et al.* 1977). In the present paper an attempt has been made to determine the composition and fluctuation of these murids occurring in the fields of Punjab Agricultural University, Ludhiana, during the period of 1969-1974.

RESULTS AND DISCUSSION

The population analysis of sympatric murids occurring in an agro-ecosystem of PAU

Ludhiana reveals the co-existence of *Rattus meltada* (Gray), *Mus musculus bactrianus* (Blyth), *Mus booduga* (Gray), *Mus platythrix* Bennett, *Bandicota bengalensis* (Gray), *Tatera indica* (Hardwicke), *Golunda ellioti* (Gray) and *Nesokia indica* (Gray). The relative percentage occurrence of *R. meltada*, *M. m. bactrianus*, *M. booduga*, *M. platythrix*, *B. bengalensis*, *T. indica* and *G. ellioti* in all the crops available during the year 1974 in an area of 1.8 hectare was 38.36, 24.71, 15.33, 0.11, 9.76, 8.75 and 2.97 respectively (Sood & Ubi 1975). Out of the total number of 2016 rats and mice trapped from January, 1974 to December, 1974, the population density fluctuated within wide limits of 49.50 in January to 317.00 in October (Fig. 1). In the year 1970-71, Sagar (1972) reported 361 rats and mice from an area of 2 hectare and population density varied from 0 in January to 60 in May. Percentage

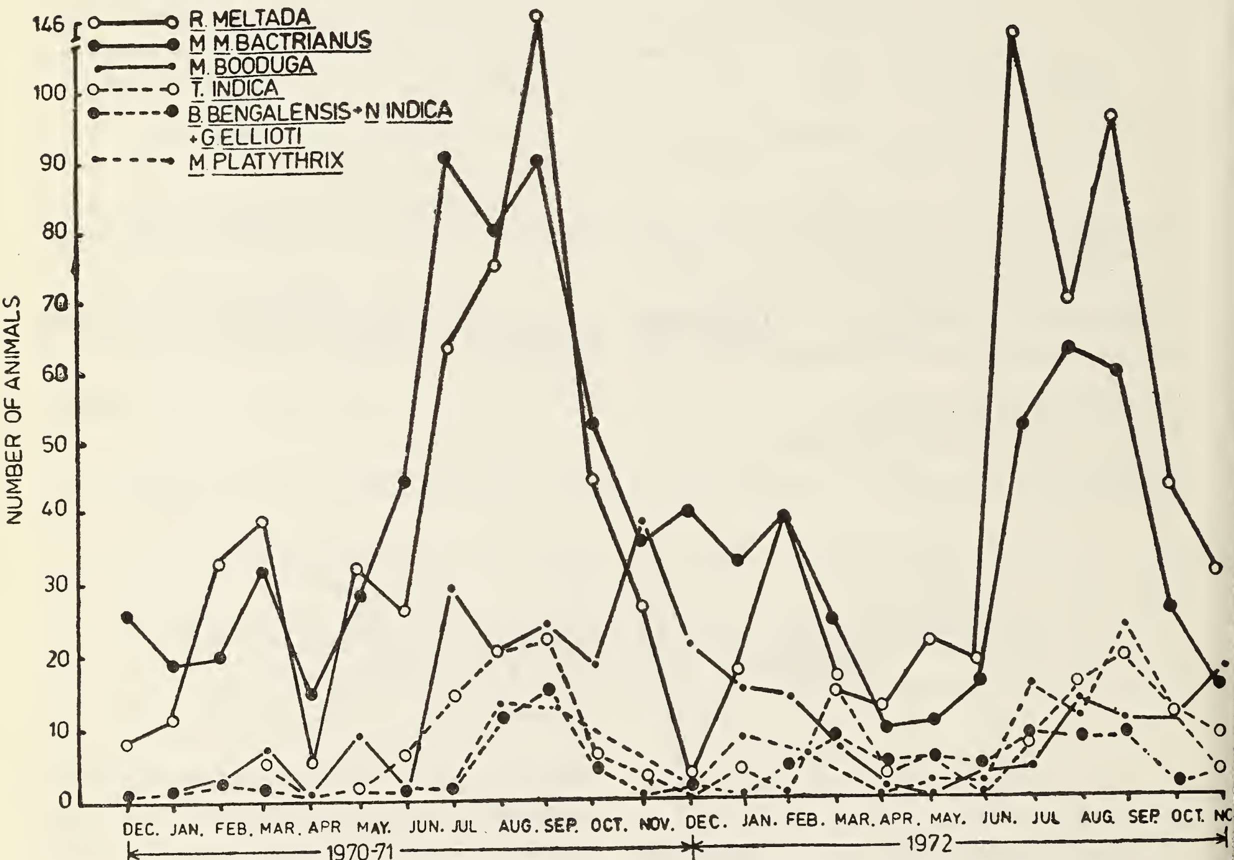

Fig. 1. Fluctuation in population of Field Rats and Field Mice in 53 ha cultivated area of P.A.U. farms, Ludhiana (after Mann, 1973).

occurrence of *R. meltada*, *M. m. bactrianus* and *M. booduga* was 46, 38 and 12 respectively of the total population while other species accounted only 4% of the total population. In 1969, Mann observed 229 rats and mice from 2 hectare area of fields while in 1970-71 and 1971-72, he observed total murid population of 1342 and 1183 per 53 hectare respectively. In 1969 composition of *R. meltada*, *T. indica*, *B. bengalensis*, *G. ellioti* and *Mus* spp. was 47, 30, 11, 1 and 21% respectively (Mann 1969) while in 1970-71 and 1971-72 percentage occurrence was *R. meltada*>*T. indica*>*B. bengalensis*>*M. m. bactrianus*>*M. booduga* (Mann 1973). Thus the population of these murids was much higher in 1974 as compared to those of earlier studies. The evident difference may be attributed to the pattern of arrangement of cages. Mann (1969, 1973) placed cages at a distance of 100 feet while Sood & Ubi (1975) placed them 15 metres apart.

Mus spp. (except *M. platythrix*) and *R. meltada* were predominant in all the crops available, while *B. bengalensis* and *T. indica* were mostly trapped in sugarcane and wheat fields. The trappability of these murids was *M. musculus*>*R. meltada*>*B. bengalensis*>*T. indica*>*M. booduga*>*G. ellioti*>*M. Platythrix* (Sood & Ubi 1975). These authors also noticed that most of the population was concentrated from July to October. The males were dominant in months of January, February and November to December while in other months males and females were almost in equal proportions. But, Sagar (1972) reported higher density during May-November than during December-April and Mann (1973) noted maximum population during July-September in 1970-72. In 1970-71, *R. meltada* and *Mus* spp. were predominant (Sagar 1972), while in 1970-71 population of *R. meltada* was more, this being followed by *T. indica*>*B. bengalensis*>*M. m. bactrianus*>*M. booduga* (Mann 1973) (Fig. 2). Higher density during July-September in the year 1971-72 while

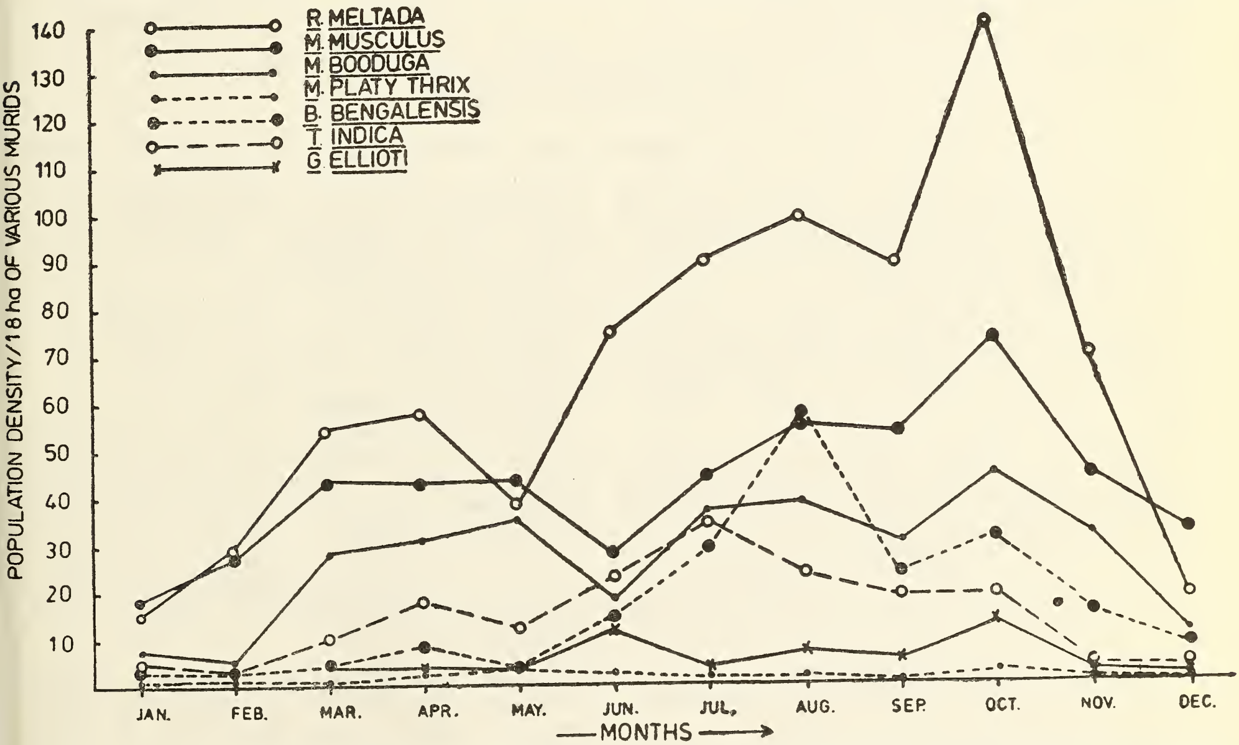

Fig. 2. Monthwise population fluctuation of sympatric murids in Agro-Ecosystem at P.A.U., Ludhiana (from Sood and Ubi, 1975).

low density in December, January and April (Sagar 1972 ; Mann 1973) may be associated with shortage of food and shelter in wake of harvesting of crops. It may also be due to the reduced breeding on account of lower temperature and shorter days (Pearson 1963 ; Schillar 1956 and Whitaker 1940).

The monthwise percentage density of murids fluctuated between 49.50 in January and 317.00 in October in 1974 (Sood & Ubi 1975). The probable reasons of the oscillating population may be due to biotic (food and shelter in form of crop and crop stages, predators, inter and intraspecific competition) and abiotic (atmospheric temperature, soil temperature and humidity) factors which have marked influence on the relative abundance of these murids (Sood & Ubi 1975 and Sood *et al.* 1977). The correlation coefficient between abundance of murids and environmental temperature and soil temperature is statistically significant while it is statistically insignificant between atmospheric humidity and murid population (Sood *et al.* 1977). Similarly population density in the crops shows that maximum number of murids occurred at maturity stage of crops. This population was 18.5/2.2 acres in sugarcane, 42.00/0.55 acres in groundnut, 83.22 acre in wheat and 29.00/0.5 acres in maize (Sood & Ubi 1975).

It is thus concluded that both biotic and abiotic factors have integrated multifarious suspected key influence on the fluctuating mechanism of the murid population in an agro-ecosystem.

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D. S. DILBER

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LUDHIANA,
June 8, 1977.

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4. HABITS OF MOUSE DEER

My son and I were out swimming in the river in the jungle only ten minutes walk from our bungalow. We had got too cold so were standing on a rock ledge warming ourselves in the sun and throwing sticks for our dog into the pool below. A little earlier my son had seen some small animal which he was not able to identify, swimming to escape the attentions of a group of jungle tribesmen, Panniars, and which had taken to the undergrowth by the river. As we threw a stick for our dog to retrieve to our horror it landed right beside the same small animal which I identified as a Mouse Deer, which was swimming to recross the river, this then dived and swam underwater. In fact, it remained submerged for so long that we thought it had drowned, until we spotted it as it emerged beside a rock in the pool. There it waited until the coast was clear then drifted down with the ripples in the cascade, looking like a bit of rotten wood until it was able to reach the other side and land in the undergrowth and make good its escape.

Sentinel Rock Estate,
Vellarmala-673 578,
S. Wynaad,
Kerala,
March 22, 1977.

(Mrs.) J. A. LAWRENCE

5. THE COOT *FULICA ATRA* LINNAEUS NESTING NEAR NASIK, MAHARASHTRA

While spending a long weekend at Nasik, I and my host Mr. J. D. Panday visited the small Khambhala village jheel a few miles out of Nasik on the Trimbak road. The embankment was totally hidden by rank monsoon vegetation and castor shrubs. On the water we saw several Coots and Little Grebes.

In the middle of the jheel among the floating aquatic vegetation we noted several mounds which we presumed were floating nests of grebes until on one mound we saw three full-grown coots but with very light underparts and an adult feverishly swimming to and fro adding more material to the mound. To the left of this nest I noticed a pair of coots with three small reddish chicks perhaps hatched shortly before. They could have, at a casual glance, been passed over as Little Grebes. A third pair with young in tow was noticed further away. The light was favourable from behind us and we also were able to compare the very young chicks with the grebes nearby and the fully fledged young with their lighter underparts contrasting with the black of the adults.

Though very common during the winter months throughout the subcontinent it is not that one comes commonly across nesting Coots and its exact distribution as a regular nesting bird needs to be determined over much of the country.

Bombay Natural History Society,
Hornbill House,
Shahid Bhagat Singh Road,
Bombay-400 023,
January 6, 1977.

LAVKUMAR KHACHER

6. AN ADDITIONAL RECORD OF THE WHITETAILED SEA EAGLE, *HALIAEETUS ALBICILLA* (LINNAEUS) IN NORTH-WESTERN INDIA

In their HANDBOOK Ali and Ripley (1968) listed the Whitetailed Sea Eagle (*Haliaeetus albicilla*) as a rare casual winter visitor to West Pakistan (Baluchistan, Sind, Northwest Frontier Province) with only one reliable record for India, this being from Punjab. Several records reported subsequent to this publication have served to further outline the range of this species within the Indian Region. Roberts & Savage (1969) reported sightings involving 10 birds in West Pakistan during the period 1966-1969, and Himmatsinhji (1970) submitted a previously unpublished record from Kutch made during 1949-50. Fleming *et al.* (1976) listed a single sight record from Nepal (1971, Pokhara) and recently Dukes *et al.* (1975) recorded the presence of two adult birds at Bharatpur, Rajasthan, during December, 1973. In light of this accumulating information an additional sighting made while I was travelling in northern India seems worth reporting.

On December 12, 1974, a single adult Whitetailed Sea Eagle was observed at Sultanpur Bird Sanctuary, less than 25 km from Delhi. This sanctuary is centred around a small jheel which also provided habitat for a variety of waterbirds at the time of the sighting. The eagle was closely examined in good light for over an hour as it perched motionless on the edge of a mound in the centre of the lake, approximately 100 m from my observation post on shore. The dark brown coloration of the body, the lighter coloured head and the short, pure white tail were all noted as the bird was at rest ; the characteristic wedge shape of the tail and the broad wings were further noted when it eventually left its perch and slowly flew out of sight over the water. Identification was confirmed the same day from the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali & Ripley 1968). According to descriptions in Brown and Amadon (1968) no other eagle has the same combination of characteristics, and the shape and colour of the tail are considered diagnostic (Ali & Ripley 1968).

Although a total of four days were spent at Sultanpur this is my sole observation, leading me to believe that the bird was only a temporary visitor. This species breeds locally throughout much of the Palaearctic Region (from Greenland to Japan, and between 28° and 75° N latitude ; Brown and Amadon (1968), and occurs only casually south of the breeding range during winter. Outside of this range birds associate primarily with coastal areas but are also known to wander to jheels and inundations inland (Ali & Ripley 1968). It is noteworthy that both the Bharatpur and Sultanpur observations occurred in association with interior wetlands, each approximately 800 km from the nearest seacoast. These two recent observations, the previous record from Punjab, and the proximity of all three to other records in West Pakistan suggest that the Whitetailed Sea Eagle may be a somewhat more common winter visitor to lakes in northwestern India than was previously thought. This is all the more likely when it is considered that adults, or groups of birds containing adults, are more liable to be noticed and identified than are birds in immature plumage.

DEPARTMENT OF ANIMAL SCIENCE,
UNIVERSITY OF ALBERTA,
EDMONTON, ALBERTA,
CANADA,
January 27, 1977.

R. E. SALTER

(A pair of adults was again sighted at the Keoladeo Ghana Bird Sanctuary, Bharatpur, by Dr. Sálim Ali and Mrs. Dilnavaz Variava on 11th January 1977. The species would thus appear to be a regular winter visitor to this wetland, possibly overlooked earlier until once definitely identified.—Eds.)

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7. OCCURRENCE OF GREY JUNGLEFOWL AND RED JUNGLEFOWL TOGETHER

In the Nawegaon National Park (Bhandara District) of E. Maharashtra State, both Grey Junglefowl (*Gallus sonneratii*) and Red Junglefowl (*G. gallus*) occur together. The natural vegetation in this area primarily conforms to the 'Southern tropical dry deciduous' mixed type, and the flora is fairly rich and diverse. The species commonly met with are *Terminalia tomentosa*, *Pterocarpus marsupium*, *Anogeissus latifolia*, *Lagerstroemia parviflora*, *Butea monosperma*, *Diospyros melanoxylon*, *Bombax ceiba*, *Ougeinia oojeinensis*, *Cassia fistula* and *Adina cordifolia*. Teak occurs scattered among these species. Bamboo forms a dense undergrowth.

Sub-Divisional Forest Officer,
Nawegaon Bandh,
Dist. Bhandara,
Maharasthra State,
January 6, 1977.

M. B. CHITAMPALLI

8. OCCURRENCE OF AND SOME OBSERVATIONS ON THE PURPLE WOOD PIGEON IN MAHARASTHRA (BHANDARA DISTRICT)

During the survey of salt-licks surrounding Itiadoh Lake of Bhandara district (N. E. Maharashtra), I found three Purple Wood Pigeons (*Columba punicea*) descending to the ground to pick up earth pellets at a salt-lick at the time of sunrise. Later I saw them descending to a salt-lick late in the afternoon also. I enquired with the local fishermen and two shikaris who reported that the Purple Wood Pigeon (locally known as *Kharmat*) visits this salt-lick regularly in the morning and late afternoon during winter. Although the above habit has been recorded in the case of green pigeons, no such observation has been made about the Purple Wood Pigeon.

I found these birds gorging on berries of *Litsaea monopetala* which is distributed in the forest.

Since this species has not been included in the chapter on Fauna in the MAHARASHTRA STATE GAZETTEER, 1974, it represents an addition to the birds of Maharashtra.

M. B. CHITAMPALLI

SUB-DIVISIONAL FOREST OFFICER,
NAWEGAON BANDH,
BHANDARA DISTRICT,
MAHARASHTRA STATE,
January 6, 1977.

9. DEAD NILGIRI HOUSE SWALLOW IN A NEST

My friend and I went to Hotel Hampton, Coonoor (11° 21′N., 76° 49′E., 1750 metres above mean sea level) in South India, to ring nestlings of Dusky Crag Martin *Hirundo concolor concolor* (Sykes), on 10th September, 1976. Within 10 m of Crag Martin's nests there was another, similar, nest from which the tail of a bird was projecting out. It seemed that the bird was incubating (although at the time of incubation swallows, usually, face outward). We tried to photograph the bird from close by and the bird remained immobile which made me doubt whether it was alive. My doubts grew stronger when Mrs. Adige, the owner of the hotel, told me that she had seen the bird sitting in almost the same position a couple of days earlier. We managed to reach the bird with the help of a ladder and found it dead. It was a Nilgiri House Swallow *Hirundo tahitica domicola* Jerdon. The bird was absolutely dried up and as I held it the feathers started slipping.

There was no sign of physical injury or deformity in the body of the dead swallow. Only its dried up tongue was projecting out of the bill. The claws of one leg were slightly entangled with the nest materials, perhaps as a result of contraction at the time of death. The nest was attached to a ceiling beam and wall of a passage between two sections of the hotel, and was about 4 m from the ground. The nest seemed to be old and might have been used as a roosting place by the bird.

As far as available literature is concerned there is no mention of such death in swallows which build saucer-like nest with open top. But Dr. Sálim Ali found two Redrumped Swallow *Hirundo daurica erythropygia* (Sykes) dead in a tubular nest (Himmatsinhji 1959). Himmatsinhji says, ' it appears that the birds had completed the nest, and one of them was incubating the eggs while the other one must have been busy putting the finishing touches to the structure. The only plausible explanation for this rather unusual mishap seems to be that one of the birds must have taken the last few pellets of mud late in the evening, and therefore on entering the nest to roost it must have tried to complete the days work. The result of this last-minute constructional alteration was that the entrance hole became too narrow and the birds thus unwittingly entrapped themselves, where they finally starved to death'.

Above explanation of swallows' death cannot be applied to the present case because the nest was not a tubular one and death occurred in non-breeding season (breeding season in South India chiefly March to May according to Ali & Ripley 1972). I have discussed this matter with Dr. Sálim Ali and others. The cause of death in this case could not be ascertained. The probable explanation seems to be that there was some sort of non-functioning of internl organs of this particular swallow which may have resulted from exhaustion or food poisoning.

It may be noted that there was no change in weather factors like relative humidity, rainfall and temperature during September, 1976 in relation to previous ten years record obtained from Coonoor.

RESEARCH FELLOW,
BOMBAY NATURAL HISTORY SOCIETY,
BOMBAY-400 023, INDIA,
January 6, 1977.

MOHAMMAD ALI REZA KHAN[1]

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10. MALABAR JUNGLE BABBLER, *TURDOIDES STRIATUS MALABARICUS* (JERDON) AND WHITEHEADED BABBLER *TURDOIDES AFFINIS AFFINIS* (JERDON) JOINTLY CARING FOR THE CHICKS OF THE LATTER

In the course of a comparative study of the biology of the above-mentioned two species which co-exist in the Calicut University campus (10°-12°N., 75°-77° E.) we came across the following incident. In our campus the two species live together without much conflict even though their home ranges and food overlap considerably. On the 31st March 1976 V. J. Zacharias found a nest of the Whiteheaded Babbler with three nestlings situated at a spot where the home ranges of a flock of the Jungle Babbler with ten birds and one of the Whiteheaded Babbler with four members overlapped. This nest was built on a woody creeper *Calicopteris floribunda* at a height of 8 m from the ground. Six Jungle and three Whiteheaded Babblers fed the nestlings and at night one Jungle Babbler stayed with the nestlings. The rest of the birds of both species roosted separately within distances of 36 to 40 m from the nest. The food given to the nestlings by both species consisted of orthopterans like *Gryllus* sp. Very often the two species moved together peacefully and would sit on adjacent branches to preen. In about 14 hours of observation spread over two weeks 6 clashes were observed between the two species and every time the Jungle Babblers managed to drive away the Whiteheaded Babblers but the latter never deserted the chicks totally. The dominant Jungle Babblers defended the nestlings more often. The fledglings followed the Jungle Babblers but the Whiteheaded Babblers also fed and defended them whenever they got the opportunity. In spite of vigorous defensive displays by both species a Rat snake (*Ptyas mucosus*) took one fledgling on the 3rd April. By the 4th one more fledgling and by the 16th April the last of them disappeared. To the last both species of babblers attended to the young.

The exact reason for this behaviour of the babblers is not known. The two species differ in size, colour and vocalizations. The Whiteheaded Babbler is more often seen in open areas with little or no cover of trees and shrubs, but both species often forage together and we have observed a Whiteheaded Babbler foraging with a flock of Jungle Babbler continuously for six months. In our study area both species of birds are constantly disturbed by the construction of new buildings and by firewood gatherers, and the home ranges of both species of babblers change from time to time.

In the present case we could not spot the nest at the time of building. It is possible that the Jungle Babblers also had built a nest at about the same time as the other species and at a spot close by and lost it. They may then have forced the Whiteheaded Babblers out of their nest and taken possession. Both species build similar nests and their eggs have the same colour. Both are parasitised by cuckoos and thus conditioned to accept alien chicks. In the coming months we hope to shift eggs from one species of babbler to the other to study their response.

Acknowledgement

V. J. Zacharias is supported by the Sálim Ali-Loke Wan Tho Ornithological research fund of the Bombay Natural History Society, Bombay.

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January 6, 1977.

V. J. ZACHARIAS
D. N. MATHEW

11. PURPLERUMPED SUNBIRDS AS FOSTER PARENTS

In the second week of August 1976, in an open plot in Vithalwadi, about 3 km from the centre of Poona City, a nest of a Purplerumped Sunbird was seen hanging from a twig of a *Caesalpinia sepiaria* bush. The nest was at a height of about 5 ft from the ground.

When the nest was first located, it contained two eggs. The eggs were white speckled with brown and in size equivalent to Redvented Bulbul's eggs. The female sunbird was seen incubating the eggs.

A chick was first seen inside the nest on 26th August. It was dark brown in colour and appeared rather big for a sunbird's chick. The shape of its beak was also different. How the other egg was disposed off was not known ; neither did we find the shell of the hatched egg. The possibility of brood parasitism had not occurred to us then.

On 16th September it was observed that the entrance hole was enlarged and the chick was not inside the nest. On an adjacent acacia (babul) tree the female sunbird was seen feeding the chick which was now of the size of a redvented bulbul minus tail. Its colour was dark grey with brown spots on the chest. The gape was rich scarlet red. Wings were short and tail feathers undeveloped. It was weakly calling *chee, chee*, the call becoming harsher on the arrival of the foster parents. Almost every five minutes it was being fed by the female sunbird. The female was seen picking up something from near the acacia blossom. Evidently it could not be nectar for there is none in babul flowers. She was, however, observed to be bringing in nectar from the loranthus flowers. The female would sit by the side of the chick and feed it by inserting its beak into the open mandibles of the chick. The chick would quiver its wings and tail during feeding. The chick was seen flying from one tree to another within a radius of 10 to 15 feet from the nest. As the chick and the parents were not coming back to the nest, it was removed by us.

In the last week of September both the parents were seen feeding the chick ; the frequency of feeding had increased to about every two minutes. Again, the sunbirds were seen pecking at tender twigs of babul. The tail of the young bird had become long and its colour lighter. The chest had become cross-barred with dark brown. The tail was also lightly barred with white and brown. It had become more active and could fly over a greater distance.

The chick was last seen on 30th September. In size it was bigger than a redvented bulbul. In colour it was grey with a lighter chest cross-barred with dark brown. Tail feathers were long and barred with white and dark grey. Its flight was like a large grey babbler's quick wing beats followed by a glide. It was low and silent. The sunbirds were still engaged in feeding it. The chick could not be located again in the same area after 30th September.

Other birds seen nesting in the same open plot were : Ashy Wren Warbler, Tailor Bird, Whitethroated Munia, Baya Weaver Bird, and Redvented Bulbul.

The following parasitic cuckoos were seen in the vicinity of the nest : Koel (quite common), Pied Crested Cuckoo, Hawk-cuckoo (uncommon) and Plaintive Cuckoo. The last was seen perching on the bush bearing the sunbirds' nest, only once, i.e. on 23rd September.

In the second week of October a member of the Nature Club in National Defence Academy, Khadakwasla, also recorded a sunbird feeding a large bird. The NDA is situated across the river at a distance of six to seven miles from Vithalwadi.

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S. INGALHALLIKAR
SANJAY KOTHARI

12. ASSISTED MIGRATION OF BIRDS BY SHIPS

On 18th September 1975, I sailed for England from Cochin as a passenger on board an Indian cargo ship. Two days out at sea from Cochin, I noticed two pairs and a single Little Brown Dove (*Streptopelia senegalensis*) on the mast of the ship. At times, the birds flew away from the ship apparently in search of land, but returned back always. Thinking that the birds will thirst and starve to death, I put out grain and water but was told by the sailors that there was no need to do so. There were enough pickings on the aft deck outside the kitchen where I saw the birds occasionally, and they could get fresh water from rain and dew collected in various depressions on the deck. Seven days later, when we reached Aden, the birds were still very much there. As we sighted land at dawn they flew to it but perhaps they found the treeless landscape too bleak because when we sailed from Aden the same afternoon, at least three of them were back on board. After crossing the Suez canal, the ship picked up a number of other local birds with which I was not familiar. The doves were also there but I could not get a correct tally of their number as they had numerous hide-outs on the ship : on the masts, in the crates of cargo and the machinery on the forward and aft decks. After Gibralter it turned cold and I was not out on deck much. Even so, I noticed another addition to our floating aviary—the Robin redbreasts, but I cannot say if the doves were still on board.

At that time, I had not taken serious notice of the passage of these birds as I was told by sailors that ships often carried birds from one continent to another in this manner. At times, these birds were blown off by storms, but in good weather they travelled quite well. After reading the question raised by Mr. Horace Alexander in his note ' What leads to increases in range of certain birds ' [*J. Bombay nat. Hist. Soc.* 71 (3)] I suspect there is every possibility that birds carried in this manner can find a niche in a distant land and build up a local population. Before Suez reopened, Indian cargo vessels used to go from Indian ports direct to U.K. with just two refuelling stops of a few hours each, and some of these ships could have carried Collared doves mentioned by Mr. Alexander. This could equally explain the sudden appearance of the Blackthroated thrush in Norfolk reported in the June 1976 issue of the *Newsletter* for birdwatchers published from Bangalore.

On 26th May 1976, I revisited the exact port area in Cochin from where I had sailed the previous year. Despite a thorough scanning of the trees and gardens in the port area, I failed to see doves of any kind though numerous Rock pigeons had congregated over a grain godown. Later, a resident of Fort Cochin which is across the harbour told me of occasionally seeing *Streptopelia senegalensis* in her garden.

A sailor friend who is a keen bird-watcher has agreed to keep a log of passage of birds on board his ship, and I hope some more data will become available of migration of birds in this manner.

ASHOKE KUMAR

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Calcutta-700 017,
January 1, 1977

[There are a number of instances of assisted passage of different species recorded in literature. Hugh Whistler noted the House Crow (*Corvus splendens*) travelling by ss. *City of Exter* on 26 April 1926 from Bombay, and leaving the ship after passing Perim on 2nd May (*J. Bombay nat. Hist. Soc.* 32 : 598).

Dr. C. B. Ticehurst (*The Ibis* 1923 : 466) recorded four or five of the Little Brown Dove coming aboard his ship quite exhausted on March 25th, 1918, when the ship was about 10 miles off Karachi, and remaining until she reached harbour. He suggested that they may have been oversea migrants of the race *ermanni*. The recoveries of birds of the species ringed during the Society's banding programme lends support to this view—a little Brown Dove (Ring B-1062) ringed on 15.iii.1961 near Bhuj (Kutch, *c.* 23° 10′N., 69° 50′E.) was recovered on 27.ii.1964 near Hyderabad (Pakistan, *c.* 25° 20′N., 68° 25′E.), *c.* 200 km north of the ringing place.

Derek Goodwin in the *Pigeons and Doves of the World* (Brit. Mus. 1967) gives the distribution of *Streptopelia senegalensis* as ' Africa, Arabia, India, Afghanistan and Turkestan. Also locally in Palestine, Syria, the Lebanon, Turkey and Malta, in all these places probably as a result of human introduction as in parts of Western Australia where it is now well established '. In addition to actual ' human introduction ' it appears that the Little Brown Dove has transported itself to many of these regions and has ' become adapted to a man-altered environment '.—Eds.]

13. NOTE ON THE BAYA WEAVER BIRD *PLOCEUS PHILIPPINUS* (LINN.)

Quite frequently we tend to take many of the goings on of birds and animals around us as common place and requiring no comments, and it is only years later that we find a note in a scientific journal that what we took for granted is something which ought to have been recorded ! And it is precisely this sort of reporting which has made the earlier journals such mines of information and so interesting to read.

While ruminating over Vol. 71 No. 3 of the *Journal* I read T. Anthony Davis's account on selection of Nesting Trees, etc., by this common and notoriously polygamous little bird.

Quite naturally I know this ubiquitous bird best in the Saurashtra region. My impression has been that the Baya prefers to site its nest in a tree above tall grass or rushes. The trees invariably are babools *Acacia nilotica* or wild Date Palms *Phoenix* sp. However *Prosopis spicigera* is also used. Other favoured locations are cliffs over river pools or wells with over-hanging Neem *Azadirachta indica* or any of the other common trees found growing from crevices down the side of wells. Electricity lines passing over stands of sugarcane are also used and a line of pendent nests along these makes a remarkable sight. With the clearing of trees and consequent reduction in potential breeding sites a very interesting development appears to have taken place, at least around Rajkot. In June, flocks of Bayas, still in plain and sparrow-like plumage, invade the city. They draw attention as the yellow starts becoming more prominent, for these urban flocks are all males. Very soon, they begin to construct nests on trees and shrubs along compound walls. Decorative palms in the vicinity soon have their fronds torn to shreds as the exuberant architects start collecting material.

These attempts at developing *bastis* do not seem to be approved by the hens and, as yet not a single urban colony has progressed beyond the ' helmet ' stage. By the middle of July, the birds leave the city and are not seen again with the sparrows feeding in the courtyards till the following May.

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
S. BHAGAT SINGH ROAD,
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January 6, 1977.

LAVKUMAR KHACHER

14. STUDIES ON THE INDIAN GHARIAL *GAVIALIS GANGETICUS* (GMELIN) (REPTILIA, CROCODILIA) CHANGE IN TERRESTRIAL LOCOMOTORY PATTERN WITH AGE

(*With two text-figures*)

Quadrupedal locomotion is common with gharial juveniles measuring less than 75 cm long and weighing about 1.5 kg. Larger juveniles perform a locomotion by synchronous pushing of all four limbs.

For ten month old gharias (*Gavialis gangeticus*) Singh & Bustard (in press) have reported high walk in relation to suspicious circumstances and belly run and gallop as a response to sudden fright. The high walk and gallop for the gharial are difficult locomotions due to their weak limbs, inefficient to carry the body on land.

The most common method of normal locomotion in hatchling gharials is the quadrupedal pattern (Bourliere 1955 and Romer 1955). Two diagonally opposite limbs are synchronously moved forward and when these two touch the ground the other two (diagonally opposite) limbs move forward. Between these two movements the body makes an undulatory pushing to front (Fig. 1).

During gharial's quadrupedal movement the head is held upward at an angle and the limbs are held almost in a sprawling posture, whose positions mark the limit through which the push of body undulations may be exerted on the ground. The hind limbs fall almost close to or over the print of the fore limbs. When a gharial performs this type of locomotion, it is often not possible to see a good print of the fore limbs.

Large gharials seldom move far from the water's edge (Singh & Bustard, in press). Typically, after haul-out and completion of basking they perform a short ' U '-turn so as to face the water. During haul-out and return to the water, when undisturbed, the gharial moves forward by simultaneous pushing movement of all four limbs, progressing by a series of jerks. The limb positions are shown in Fig. 2. This limb action is similar to that shown by green turtle *Chelonia mydas* on land (Bustard 1972).

Unlike quadrupedal locomotion, here the head is held almost parallel and touching to the ground and the limbs give more support to the body and they actually aid in pushing the body forward.

During forward movement of the limbs, the tip of the toes always touch the ground and draw outwardly directed lines subsequently bending inward to the body axis. To minimise expenditure of energy during muscular effort in helping the body pushed forward, the limbs always come closer before the body-push commences.

The adult pattern of simultaneous pushing movement is more common after the hatchlings attain a weight of about 1.5 kg when they measure approximately 75 cm in total length. This size can be attained at an age of about eight to nine months. This change in locomotory pattern provides a further parallel to green turtle hatchlings which likewise use normal quardupedal gait. Furthermore, *C. mydas* change to the adult pattern at similar age and weight as the gharial.

Hendrickson (1958) noted that whereas *C. mydas* and *Dermochelys coriacea* show this form of locomotory pattern, *Caretta caretta* continues to use normal quadrupedal gait throughout life. He postulated that increasing weight might have resulted in a changed locomotory pattern in the foregoing genera.

The locomotory pattern adopted by the gharial is here described for the first time for any crocodilian. Many other crocodilians,

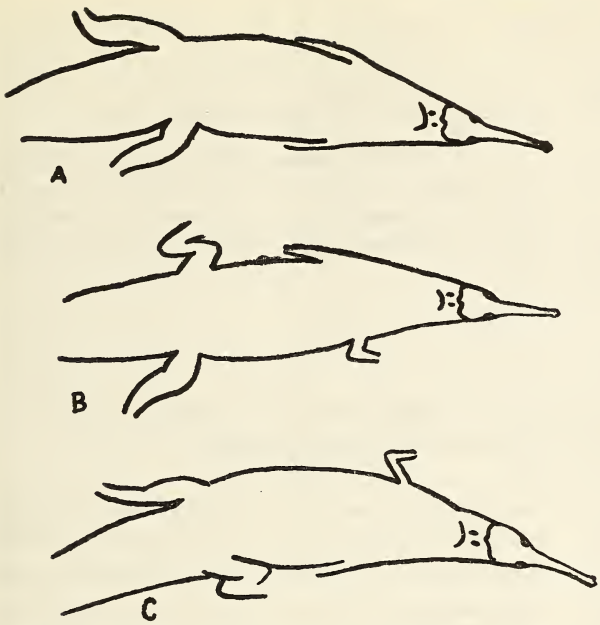

Fig. 1 Quadrupedal locomotion in gharial. A, resting position. Position B during locomotion is followed by an undulatory forward pushing of the body which is then followed by position C.

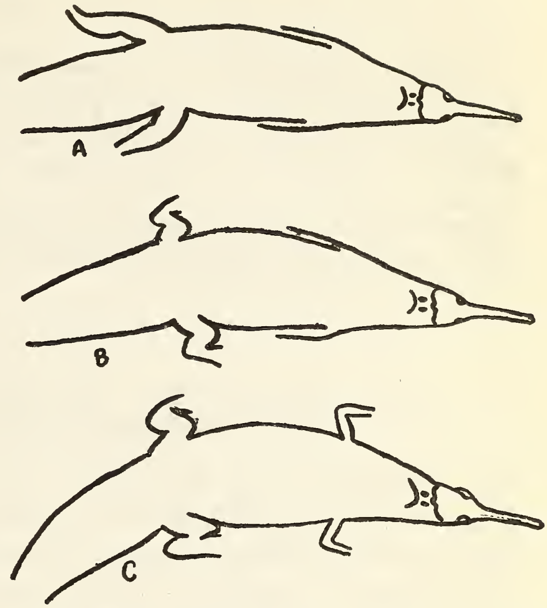

Fig. 2. Synchronous locomotion in gharial. A, resting position. B, hind limbs are brought forward. C, fore limbs are brought forward followed by a synchronous pressing of the limbs to the ground and simultaneous pushing of the body to front.

including *Crocodylus porosus* and probably *Crocodylus palustris* in India, attain similar adult weights to the gharial but this form of locomotion has not been described. Specifically, it was absent from yearling *Crocodylus palustris* used in studies of locomotory pattern (Bustard and Choudhury, in preparation).

The synchronous locomotory pattern of the gharial greatly restrict terrestrial locomotion in this species, since, as in those sea turtles where it is observed, it is a markedly inefficient locomotory method as compared to the norm.

The habits and habitats of the gharial may have contributed to this locomotory pattern. Gharials inhabit deep, flowing rivers which never dry up. They have little reason to leave the water except for basking and nesting. Evolutionary implications should also be taken into consideration. The gharial belongs to the oldest living crocodilian family. It could be that this locomotory pattern is primitive.

Acknowledgements

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15. A NOTE ON THE PROTUBERANCE OR KNOB ON THE SNOUT OF MALE GHARIAL [*GAVIALIS GANGETICUS* (GMELIN)]

The protuberance or the knob at the end of snout of adult male gharial is so prominent that it is popularly named as 'gharial' from its resemblance of a 'ghara' a word of north Indian origin, meaning an earthen pot. An adult male is easily distinguished by this character from a female but young male and female gharials are not distinguishable. Though the gharial young are now (April 1977) more than one year old at the Gharial Research and Conservation Unit at Tikerpada, Orissa the sex differentiation by the knob is not yet possible. One male gharial was received at Nandankanan Biological Park, Orissa on 22.iii.1963

Date of measurement	Length of male	Age	Size of the knob
22nd March 1963 ..	.. 135 cm	.. 20 months taking. July, 1961 as the probable hatching month.	Nil
January 1973 ..	.. 2.5 metres	.. 11 years 6 months	visible
January 1974 ..	.. 2.56 metres	.. 12 years 6 months	Slightly more developed. Now the male could be distinguished from the female.
February 1976 ..	.. 2.70 metres	.. 14 years 7 months	Well developed
February 1977 ..	.. 2.70 metres	.. 15 years 7 months	Very well developed; 5 × 6, (4) × 3.5 cm.

when it measured 135 cm without any visible sign of the protuberance at the end of its snout. The estimated age on that date of it was 20 months taking July 1961 as the probable month of its hatching by comparison with Singh's (1976) record of average length 274 mm and weight 97 gm of a gharial young soon after hatching. The first visible knob appeared in the beginning of 1973 at the age about eleven and half years when its length was about 2.5 metres. When one of us visited the Park in January 1974 it measured 2.56 metres long (Acharjyo, Biswas & Misra 1975) and the knob was a little developed and the male was distinguishable. In February, 1976 this male measured 2.70 metres (Mohapatra, Acharjyo & Misra 1976) and during this time the knob was well developed. The knob was measured on 3.ii.1977 as: Length 5 cm, anterior width 4 cm, posterior width 6 cm, thickness from the upper base to the top of the knob 3.5 cm.

In our earlier note (loc. cit.) we have already recorded the sex play of the male when it was approximately 12 years 6 months old and 2.56 metres long with a developed nose knob and when the first author visited the Nandankanan in 1975 he observed the further development of nose knob in the same male gharial. Therefore it can be presumed that 13 or 14 years old gharial with nose knob developed is an almost mature male. The reproductive activity in captivity can be presumed to be the same in nature.

The knob or the 'Ghara' develops from the upper base of the nostril and grows over it in such a way that the nostrils come to lie ultimately underneath the knob. Therefore, when the male comes out of water usually a hissing sound is heard (Acharjyo, Biswas & Misra 1975) which is produced due to obstruction of the exhalation within the knob.

ZOOLOGICAL SURVEY OF INDIA,
34, A & B, SASHIBHUSAN DEY STREET,
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NANDANKANAN BIOLOGICAL PARK,
P.O. BARANG
CUTTACK.

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WILDLIFE CONSERVATION OFFICER,
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June 4, 1977.

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16. FIRST RECORD OF THE SKINK *MABUYA BEDDOMII* (JERDON) [SAURIA : SCINCIDAE] FROM ORISSA, INDIA

During the course of studies on some unnamed reptiles brought from Orissa Survey, 1975-76 by Shri D. P. Sanyal and party, we came across a well-preserved specimen of the Skink, *Mabuya beddomii* (Jerdon), in the collections of the Zoological Survey of India, Calcutta. According to authoritative literature it has not been earlier recorded from Orissa. Smith (1935)[1] recorded the occurrence of the species from Berar, Salem, Tirunelvelly, Malabar, Mysore, Sivagiri and the Annamalai Hills within the Indian limits. Elsewhere it is known from Punduloya, Sri Lanka. The present finding, is significant extension of its zoogeographical distribution to north-east of the peninsula.

Mabuya beddomii (Jerdon)

1870 *Euprepes beddomii* Jerdon, *Proc. Asiat. Soc. Bengal.* March, 1870, p. 73 [type loc. Mysore; B.M. (N.H.), London].

MATERIAL: 1 ex., ♂, INDIA: Orissa, Keonjhor District, Ghatgaon, December 22, 1975, coll. D. P. Sanyal (Z.S.I. Regd. No. 23265).

Measurements: Standard length 55 mm, total length 154 mm, and tail 99 mm.

Pholidosis & diagnosis: Head comparatively small; snout obtusely pointed, a pair of nuchals, post nasal absent. Lower eye-lid scaly; temporal scale smooth. Ear opening sub-circular, about as large as lateral scale, with 4 pointed lobules anteriorly. Dorsal and lateral scale sub-equal, dorsal with 3 feebly keeled scales. 32 scales round the body. Digits moderately long, 15 strongly keeled lamellae beneath fourth toe. Hind-limb not reaching the wrist.

Colour, in alcohol: A broad brownish band present along either side of head and upper part of flanks; it is edged above and below with a white streak, the lower part of which starts from upper lip and passes through the ear; in its turn it is edged below by brown; top of head with small longitudinal markings; whitish below.

ACKNOWLEDGEMENTS

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May 5, 1977.

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D. P. SANYAL

[1] SMITH, M. A. (1935): Fauna Brit. India including Ceylon and Burma, Amphibia and Reptilia, Taylor & Francis (London), 2 (Sauria), i-xiii—1-440.

17. COLLECTION OF A RARE SNAKE IN THE NILGIRIS

While driving on the ghat road between Coonoor and Ooty (*c.* 6000 ft) on December 15th 1975 at 5 p.m. when it was cold and rainy, we found a DOR (dead on road) specimen of a small dark snake, (apparently a burrower) which was later identified by Prof. Carl Gans as *Xylophis perroteti.* It was evidently active just after dark and we were surprised that a snake would be abroad in the cold rain.

A few days later on the Woodlands Estate (5-4000 ft) we found another adult DOR specimen of this species. Searching under rocks in a small shola between the tea and coffee fields we found 2 juvenile *Xylophis.* These were quite active and coiled around one's fingers while being handled. This is a genus rarely collected, perhaps because of its fondness for colder temperatures at which the average herpetologist would not consider collection worthwhile. It was interesting to note that Uropeltids of the genus *Plectrurus* were at this time plentiful in the same area under leaf debris at the edge of tea gardens. The optimum temperature requisites of these burrowers evidently determine their elevational distribution and periods of activity.

Serial No.	Scale Rows	Ventrals	Subcaudals	Anal	Length	Diameter	Sex
MSP-N-1	13	137	24 divided	Single	58 cm	13 mm	female
MSP-N-2	13	139	34 divided	Single	55 cm	15 mm	male
MSP-N-3	13	147	21 divided	Single	19 cm	7 mm	female
MSP-N-4	13	142	36 divided	Single	17 cm	5 mm	male
M. A. Smith	13	139-147	Male 27-28 Female 16-20	Single	55 cm		

MADRAS SNAKE PARK,
MADRAS-600 022,
May 26, 1977.

R. WHITAKER
Z. WHITAKER

18. OBSERVATION ON THE FEEDING HABIT OF THE TREE SNAKE, COMMON INDIAN BRONZE-BACK, *DENDRELAPHIS TRISTIS* (DAUDIN)

The following observations, were made on the feeding habits of a Bronze-back snake at Nandankanan Biological Park, Orissa in the natural condition. The snake was seen on 5.iii.77 on a tree at a height of about 2.5 metres from the ground. It came down to about 1.5 metres above the ground on seeing a garden lizard *Calotes versicolor* (Daudin) on a bush of about 0.75 m height near the tree. The snake jumped over accurately from the tree on to the lizard covering a distance of 0.75 m and caught hold of the middle of the lizard and climbed back on to the tree. There it gradually slipped its mouth hold towards the head of the lizard and started swallowing it head first. The process of swallowing is the same as described in the feeding habit of King Cobra by Biswas, Acharjyo & Misra (1976). The snake took about 10 minutes for catching and swallowing the lizard.

This observation explains two facts in case of the tree snake, that they have good eye sight so that the prey, a garden lizard of body length 60 mm, could be detected from a distance of more than 2 metres. The second fact is ability to jump in case of tree snakes which use a gliding movement from a great height to a lower height as has been pointed out by Shebbeare (1939-40) in respect of two species *Chrysopelia ornata* (Shaw) and *Dendrophis pictus* (Gmelin) [*Dendrelaphis tristis* (Daudin)] though Smith (1943) has doubted this ability in the present genus, 'That they can fly or plane as can *Chryopelea ornata*, has not yet been definitely established' and Wall (1910), 'So far as *tristis* is concerned, however, the evidence, though suggestive is not well authenticated'. It is generally accepted that the tree snakes which possess hinge type of ventrals are able to glide.

This snake is also known to feed in captivity (Wall 1910) on lizards and frogs but Shaw as mentioned by Shebbeare (loc. cit.) found it difficult to get them to feed in captivity and in another case Caldwell had to set free one because it refused to feed.

ZOOLOGICAL SURVEY OF INDIA,
34 A & B, SASHIBHUSAN DEY STREET,
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S. BISWAS

VETERINARY ASST. SURGEON,
NANDANKANAN BIOLOGICAL PARK,
P.O. BARANG, DIST. CUTTACK.

L. N. ACHARJYO

WILDLIFE CONSERVATION OFFICER,
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BHUBANESWAR-7,
June 4, 1977.

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19. THE LEATHER JACKET, *ALUTERA SCRIPTA* (OSBECK) FEEDING ON THE PORTUGUESE MAN-OF-WAR *PHYSALIA UTRICULUS* (LA MARTINIÈRE)

(*With a text-figure*)

The onset of monsoon in the eastern Arabian Sea is heralded by strong onshore winds in May-June. At Bombay, these winds result in the occurrence of swarms of the siphonophores *Porpita*, *Velella* (popularly known as 'by-the-wind sailor'), and *Physalia*. These animals are then invariably found drifting on the sea surface or washed ashore.

Two species of leather jackets or file fishes are occasionally collected in the intertidal regions of Bombay in this season. They are the scribbled leather jacket, *Alutera scripta* (Osbeck) and the yellow-finned leather jacket, *Alutera monoceros* (Linnaeus). Although the colour pattern on their bodies suggests a life among seaweeds, the fishes are caught in open waters. They are quite uncommon, only an occasional specimen or two turning up in fish catches. They are slow, inefficient swimmers, and one might wonder how they are able to catch their prey or escape being eaten by predators.

These fishes have occasionally been displayed at the Taraporevala Aquarium, Bombay, but have not lived long in captivity. They are very choosy in their feeding; their small mouth can take in only small particles of food, with the consequence that they soon become emaciated and die.

It was, therefore, a fortuitous circumstance that enabled us to learn about their natural food. Some leather jackets were released in an aquarium tank containing *Physalia*. Normally, with any other fish, this would have meant immediate death for the fishes, as a chance brush with the Portuguese man-of-war's deadly tentacles would have paralysed the fishes. It was surprising, therefore, to see that the fishes immediately went for the tentacles and nibbled them off. In a few minutes, a fish had eaten off all the tentacles of a dozen *Physalia*, until only the floats (pneumatophores) remained uneaten.

Both the Atlantic species of *Physalia*, *P. physalis* Linnaeus, and the Indo-Pacific species, *P. utriculus* (La Martinière) are known for their virulent venom. Among the casualties known to have been caused by Portuguese man-of-war in Indian seas are several cases, including one fatality, reported by Scott (1921). Surprisingly though, a few fishes, such as the man-of-war fish, *Nomeus gronovii*, and juvenile yellow jack, *Caranx bartholomaei*, associate with it, swimming among its tentacles. Although Panikkar & Prasad (1952) have described the association between the young of *Caranx kalla* Cuvier & Valenciennes and the medusa *Rhopilema hispidum* Maas, and Jones (1960) observed this fish under the 'umbrella' of the medusa *Mastigias papua* L. Agassiz, association of any fish with the Portuguese man-of-war in Indian waters has not been observed.

Quite a few animals make use of the Portuguese man-of-war's nematocysts (stinging cells). Thus the beautiful and delicate nudibranch, *Glaucus marinas* (Dupont) feeds on the nematocysts of *Physalia* and incorporates them into its cerata, to be utilized as a defence mechanism against its enemies. Jones (1963) found that the young of the octopus *Tremoctopus violaceus* Delle Chiaje picks up broken fragments of the tentacles of *Physalia* and holds them in its arms to be used against its enemies. The ocean sunfish, *Mola mola*, and the logger head turtle, *Caretta caretta*, have been reported to feed on *Physalia* (Halstead 1965, p. 312). Although the orange filefish, *Alutera schoepfi*, is known to feed on another dangerous jellyfish, the sea nettle (*Chrysaora quinquecirrha*), it is not known to feed on the Portuguese man-of-war.

The occurrence of outbreaks of Ciguatera poisoning in man is now well known. It is caused by eating marine fishes which are normally non-poisonous, but which sometimes, due to their having consumed obnoxious animals or plants, become temporarily poisonous, the poison being known as ciguatoxin. In addition, many fishes belonging to the Order Tetraodoniformes (or plectognathi), such as the puffer fishes are also poisonous. In this case, however, the poison—tetrodotoxin, is different. The flesh can be safely eaten, but the gut, liver, gonads and skin are deadly.

There is confusion regarding the toxicity of the two leather jackets. Thus Day (1958, page 693) quotes Osbeck that *Monacanthus monoceros* ' looks like a flounder at a distance and has almost the same taste, but is not so fat '. Munro (1955, page 275) has nothing to relate about these fishes except that *Alutera scripta* attains forty inches. Smith (1953, pp. 405, 406) states that *Alutera monoceros* ' is said to be excellent eating *when skinned*' (italics by the present author). Regarding *Osbeckia scripta*, Smith refers to its habit of standing on its head among weeds to escape detection, adding ' stated not to be edible '. But Halstead & Schall (1956), during their screening of fishes of the Cocos Islands for ciguatoxin, found *Aluteres monoceros* to be also toxic. Hashimoto *et al.* (1969) refer to a saying among the fishermen of Saipan that the viscera of *Alutera scripta*, when fed to pigs, might kill them, although the flesh is entirely non-toxic. Hashimoto *et al.* (1969*a*) have attributed the toxicity of this fish to its feeding on the zoantharian *Palythoa tuberculosa*, and call the toxin ' aluterin '.

The rarity of occurrence of leather jackets precludes the probability of the leather jackets being extensively used for human consumption, but present finding of their diet including an

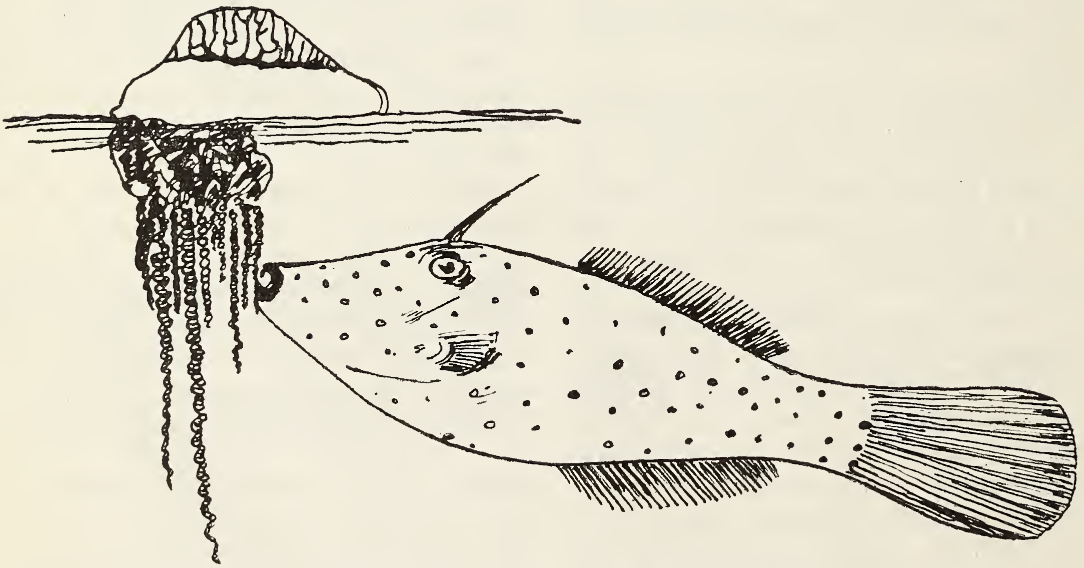

Fig. 1. Leather Jacket feeding on Portuguese Man-of-war.

extremely venomous animal may be connected to its flesh acquiring this toxicity, and due care should be taken in their consumption.

I am grateful to Shri A. M. Andhare, Assistant Curator, Taraporevala Aquarium, for his whole-hearted assistance.

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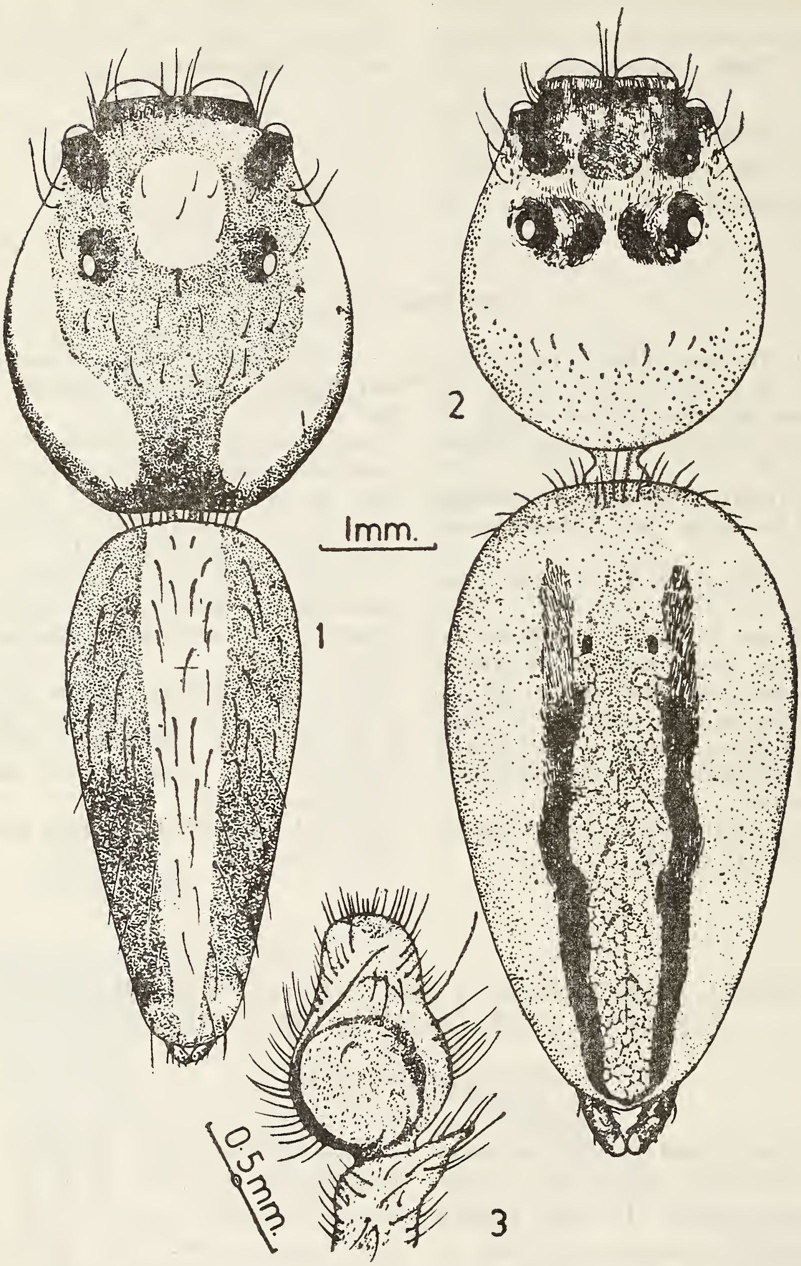
20. SEXUAL DIMORPHISM IN THE JUMPING SPIDER *PHIDIPPUS PATELI* TIKADER (FAMILY: SALTICIDAE)

(*With three text-figures*)

Though sexual dimorphism is very common among spiders of the family Araneidae, it is not so among salticid spiders. In some spiders of the genus *Araneus* sometimes the male is four to six times smaller than the female and very differently coloured. There are also many cases in thomisid spiders where males are much smaller and have different colour patterns than the female.

The salticid spider *Phidippus pateli* was described by Tikader (1974) on the basis of female specimen received from Gujarat. At that time the male was unknown. Subsequently females of this species were collected in good numbers from Poona also. But unfortunately none of the males. At the same time we collected many male jumping spiders whose females were not known. Recently



Figs. 1—3. *Phidippus pateli* Tikader

1. Dorsal view of male, legs omitted.
2. Dorsal view of female, legs omitted.
3. Left male palp, ventral view.

when we were collecting spiders in the Bund Garden, Poona, we came across many *P. pateli* females. In the vicinity of these females, the above-mentioned male jumping spiders were in abundance. This aroused our suspicion that these may be the males of *P. pateli* though their colour pattern was very much different. So we collected live female specimens of *P. pateli* and the particular males for further studies. In the laboratory we kept one mature female and one mature male in a jar and observed their behaviour. After sometime the male started showing courtship behaviour followed by copulation. Later on the male was devoured by the female. We reared this female and after some days it deposited eggs.

These observations confirmed that the males were of *P. pateli.* We have illustrated female and male specimens and the male palp. The marked degree of dimorphism is discussed below.

Dimorphism

Though there is very little difference in the size of male and female, but they are totally different as regards the colour patterns of abdomen and cephalothorax, colour and stoutness of legs. The cephalothorax of the female is pale except the orange brown and black patches at the base of eyes and a round patch at the centre of ocular area as in Fig. 2. Whereas in the case of males the eyes are surrounded by a continuous reddish brown thick patch which extends posteriorly to the middle of cephalothorax and subsequently narrows posteriorly upto the base of cephalothorax and then extends upwards laterally to the margins of carapace upto the clypeus as in Fig. 1. Contrary to the female at the centre of ocular area a round patch clothed with white pubescence is present in male. Posterior lateral region of carapace of male is also provided with broad elongated patches clothed with thick white pubescence. The first legs in the female are pale, weak and provided with short spines but those of the male are reddish brown, long, strong, and provided with long thick spines. Femora of first legs with long, thin, white spine like hairs and tibiae provided with thick brushes of black hairs on the dorsal, and ventral side of male. Other legs in male also reddish brown, hairy, longer and stronger than that of female and provided with longer and thicker spines than that of female. Sternum of female pale but in males sternum brown except the marginal pale patches. Labium of female pale but in males reddish brown except the distal pale margin. Maxillae in female pale except the blackish inner distal margin where as the maxillae of male reddish brown except the pale inner distal margins. Chelicerae pale in females and reddish brown in male.

Abdomen oval and narrowing behind in female and dorsally provided with a mid-longitudinal 'V' shaped dark brown band which is clothed with fine orange coloured pubescence as in Fig. 2. Whereas in male the mid-longitudinal dorsal area of abdomen is pale, clothed with white pubescence and on each side of it reddish brown longitudinal bands extend the whole length. Posterior dorsal half provided with long white spine-like hairs as in Fig. 1. Ventral side in female is uniform pale except three small black patches near the base of spinnerets but in male ventral side uniformly black and hairy.

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21. BUTTERFLY MIGRATIONS IN THE NILGIRI HILLS OF SOUTH INDIA (LEPIDOPTERA : RHOPALOCERA)

From 1954 to 1958 I lived in Kotagiri at 6500 feet in the Nilgiri Mountains (11°21′ N, 76°54′E) of Tamil Nadu State, then Madras State, attending boarding school and leaving at the age of 14. The remarkable seasonal migrations of many species of butterflies fascinated me so much that for the last two years I kept a notebook on my observations which has unfortunately been long since lost. However, the memories remained vividly etched in my mind. As far too little has been published on this interesting phenomenon in India, especially by observers resident for several years in the same spot, the well-known authority on insect migration, Dr. C. B. Williams, suggested that I publish as much as I could piece together. Aided by notes in the margin of my copy of Wynter-Blyth (1957) transferred from my notebook before it was lost, by specimens remaining in collections made by me and schoolmates at the time, and by the kind assistance of my former headmaster, Mr. Ejnar Jensen as well as the contents of a stream of letters which he goaded me into sending to my parents at the time, the total picture emerged much more precisely than I had dared hope for. The data may be of assistance in unravelling one of the most interesting natural phenomena among the Indian butterflies. However, it must be borne in mind that the observations were made by a boy between the age of 10 and 14 and that twenty years have since elapsed, so that although the total picture is valid enough the details must be treated with due caution.

Williams (1930) lists numerous recorded migrations from Sri Lanka while there are very much fewer from South India though the phenomenon should be equally important here. The most detailed observations are those made by Evershed at Kodaikanal in the Palni Hills (10°15′ N, 77°31′E) and his material will be used for comparison (Williams 1927). All known migrations in India were summarised in 1938 by Williams since when major studies in this field do not appear to have been published. However, as this is not intended to be a review article no careful literature search has been made.

The school was situated in the deciduous woodland zone of the South Indian mountains where a number of Palaearctic relict species survive separated from the closest neighbouring populations 3000 km to the north in the Himalayas. Typical representatives were *Pieris canidia*, *Colias erate*, *Vanessa indica* and *Argynnis hyperbius*. Many species of Oriental origin did not normally penetrate to this height and lower down on the Mettupalayam Ghat many species occurred which we never saw at Kotagiri.

Every year, probably in May, a prolonged migration lasting a month or more passed from the north towards south. The main components were the five Pierids *Appias albina*, *A. libythea*, *Catopsilia pomona*, *C. pyranthe* and *C. crocale crocale* as well as the Nymphalid *Phalanta phalanta*. These six must have accounted for three quarters of the total. *Hebomoia glaucippe* was a regular, but uncommon, member of the migrant stream. In addition at least the following species joined the main flight in smaller numbers : *Papilio crino*, *P. demoleus*, *Graphium nomius* (only 2 in 1957), *Euploea core*, *E. coreta*, *Euthalia nais* (very occasional), *E. lubentina* (occasional), *Ergolis ariadne*, *Cupha erymanthis*, *Cirrochroa thais* and *Precis almana*. Finally both the species of *libythea*, *lepita* and *myrrha*. On the whole the migrants behaved in the classical fashion, flying rather low, in a direct line, surmounting rather than avoiding obstacles, and rarely if ever settling to feed during the flight. Some of the *Catopsilia* and all the *Hebomoia* flew high. The direction of the spring flight was always the same. We used to collect in the school breaks on every sunny day and I remember never having been surprised on this count. It is perfectly clear that the direction of the flight cannot have been much modified by wind direction, though strong cross wind would lead to a considerable drift. On a good day one to four specimens would cross a 15 metre front every minute and although this is not an impressive density the migration was noticeable to the layman. How broad the total front was cannot be guessed at ; judging from walks to Sunday school and church or to other collecting grounds the belt certainly stretched at least three kilometres to either side of the school. While there were variations from day to day and from year to year in the density and composition of the flights the general impression was one of great regularity.

Once, almost certainly in October of 1957, there was a phenomenal migration of red-bodied swallowtails. Masses of *Atrophaneura hector* and *Pachlioptera aristolochiae* were flying south at a slightly different angle to that of the normal flight. The latter was slightly less abundant. The altitude of the migrants appeared to be 20-40 metres where they proceeded at a slow pace with hardly any movement of the wings. The visual effect was rather like that of bomber squadrons droning overhead on newsreels from the Second World War. The majestic procession stretched as far as the eye could see and lasted for at least five hours. Hundreds must have passed a hundred metre front every minute, and millions must have been involved. We were very keen to get some specimens, especially of *hector*, but not a single specimen descended from cruising altitude.

On the very same day there was a small migration of the Lycaenid *Jamides bochus* travelling towards the northeast. Though thin, the migratory movement was obvious since it was a butterfly which we rarely saw. On the same day there was a tremendous migration of dragonflies (Odonata, Anisoptera) travelling due south at a slight angle to that of the two swallowtails. Although dragonfly migrations were not very rare it is possible that the massive migratory movements of that day were prompted by some form of extraordinary metereological conditions.

Most of the species so far cited as migrants had no regular breeding populations at this height and some never bred at all. In this sense they resemble migrants crossing the sea as they traverse long stretches of land unsuitable for breeding. We had breeding populations of a number of species which although prone to migration elsewhere we never encountered in the main flights, e.g. *Eurema hecabe*, *Danaus* *limniace*, *Hypolimnas misippus*, *Vanessa cardui*, *Telchinia violae*, *Lampides boeticus* and others. Most of the *Precis* species have some migratory instincts, but apart from some *P. almana* I do not recollect them being associated with the flights.

I have little clear recollection of any autumn return flight. This does not necessarily mean it did not take place as we were attuned to the high density of the spring flights. The topography also would have made observations more difficult. However, I do remember collecting on a grassy slope from a stream of butterflies travelling towards the north or northeast on a few occasions and my notes say that there was a return movement of some *Appias* and *Catopsilia*. I have noted four species as having been encountered travelling in three or more directions at various times. They are *Euploea core*, *Euploea coreta*, *Jamides bochus* and *Cirrochroa thais* but the exact circumstances have been forgotten.

Compared to Evershed's observations on the Palni Hills the following points may be noted. Virtually all the species listed here were also encountered in the Palnis at the same time of the year, though *Precis* and *Danaus* species must have been under represented in the Nilgiris ; certainly they never migrated in large numbers. The direction of the flights was not identical in the two areas and in the Palnis the September and October movements were stronger than those in spring. Taking also Sri Lanka data into account (Williams 1930) we find that all the species listed have been known as migrants elsewhere with the exception of *Euthalia lubentina*. Although we only saw it rarely it was a bona fide migrant. Together with *E. nais*, a known migrant, *lubentina* has the largest distribution area of the *Euthalia* and it is natural to link this with its migratory capacity.

How far the species fly, from where they originate, to where they go, and what triggers such behaviour cannot be answered for the Nilgiris. It may be a movement from one flank of the mountains to the other to take advantage of seasonal rainfall but it is clear that a complex and substantial problem awaits a solution.

It may be appropriate to mention a few other unpublished migration records from other parts of India. Correspondence with a boyhood friend shows that he captured two female *Pieris brassicae* in Lodi Gardens in Delhi on 15 & 26.iv.1961. He caught a male *Argynnis hyperbius* in late March 1961 and I caught a few females in July, also in Lodi Gardens. Both species do not normally breed in Delhi but are restricted to the Himalayas where the breed above 3000 feet or so. They migrate towards the plains for hibernation. *P. brassicae* may breed on the plains, but *A. hyperbius* is most unlikely to find a suitable food plant as it appears restricted to violets. The presence of the latter in July in Delhi is doubly puzzling. Delhi is quite far south for both species to be found.

In April or May of 1958 on the plain just south of Mysore I encountered an enormous migration of *Euploea* (*core* and/or *coreta*) with a density high enough to make driving difficult. The direction of the flight was not determined. No other species were involved. Similar large migrations of *Euploea* have been recorded on other occasions on the plains.

Summary

In this paper I have attempted to sketch the pattern of butterfly migration as observed during four years in South India. The general picture is fairly correct, but as twenty years have passed since the observations were made details may be wrong. It is even possible that the timing of the two seasons is reversed. However, I hope the data are interesting enough

to stimulate more research into the fascinating problem of butterfly migration by long term residents in a given area. Even for Sri Lanka, where so much more information is on hand, the huge, annual flights remain for all practical purposes a mystery.

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22. ON THE OCCURRENCE OF DIMINUTIVE *POEKILOCERUS PICTUS* (FABR.) ADULTS IN NATURE

(*With two text-figures*)

Poekilocerus pictus (Fabr.) commonly known as painted or AK-grasshopper, occurs abundantly on *Calotropis* (' AK ' or Akwan) plants in the bed and banks of river Fulgu (Gaya and Bodh-Gaya localities). Though size variations in the adults of this grasshopper have been frequently observed interestingly enough during field collection as well as in laboratory rearings a few adults of both the sexes attracted our attention by virtue of their being of abnormally smaller size. They were hitherto referred as ' diminutive ' adults.

Among 235 adult specimens collected from the above localities in the month of June 1975, four diminutive adults were encountered. The sex ratio of these specimens was three males and one female. They had imaginal coloration but out of four only two (males) possessed fully formed fore and hind pairs of wings and the remaining two individuals (one male and one female) had rudimentary wings which more or less resembled the nymphal wing pads (Fig. 1). They were approximately of the size of a 5th instar nymph. The size of the body of these individuals (♂, 26.00-28.30 mm, ♀, 32.5 mm) compared well with those of the 5th instar nymphs (*see* Pruthi & Nigam 1939).

In the following year (1976) 250 adults were raised in the laboratory from a stock of 280 nymphs of 3rd to 5th instars collected in the month of June from the same localities. Seven diminutive adult males and one such female appeared among the normal sized adults. Interestingly enough one diminutive adult male and one female were of extremely small

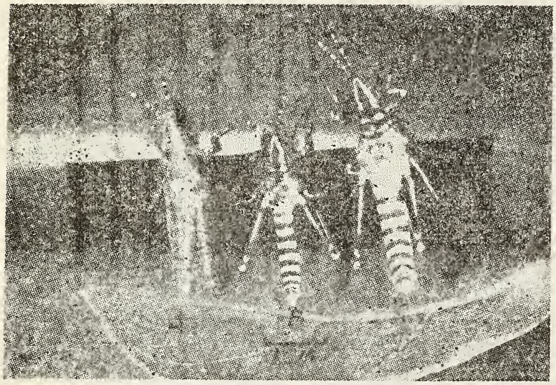

Fig. 1. Photograph showing the relative body size of a female 5th instar nymph (A), diminutive adults—male (B), and female (C). Note the rudimentary wings of the adults.

size ever observed by us (Fig. 2). The size of these two individuals (♂, 22.10 mm, ♀, 27.25 mm) were equal to the 4th instar nymphs (Pruthi & Nigam 1939). They had rudimentary wings. However, out of seven males six possessed

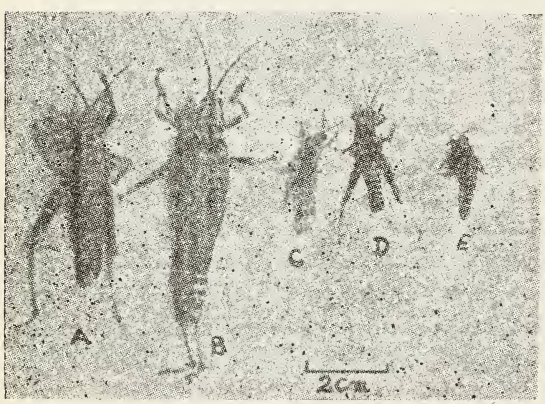

Fig. 2. Photograph showing the relative body size of a normal male (A), normal female (B), 4th instar female nymph (C), diminutive adults—female (D) and male (E). Note the rudimentary wings of the diminutive adults.

fully formed fore and hind pairs of wings and were comparable in size with the 5th instar nymphs.

Thus taking into account the numbers of individuals collected from the field and those reared in the laboratory we noted that in a total of 485 adult individuals, 12 were diminutive adults (approx. 2.5%).

The diminutive adult males with fully formed wings were the normal males in every respect but the adult males of the same category with rudimentary wings appeared to be imperfect or immature adults. The former displayed sexual behaviour and mated with the sexually mature females while the later neither exhibited sexual behaviour nor mated with females when kept under observation with females for twenty days. The normal adults of *P. pictus* become sexually mature and undergo mating within a week after fledging (Singh *et al.* 1975 ; Raziuddin *et al.* 1976). The diminutive adult females also did not undergo mating.

The various timely events occurring during the development of insects are regulated by a gradual change in the balance of the moulting hormone (ecdysone) secreted by prothoracic gland and juvenile hormone produced by corpora allata. If this hormonal balance is disturbed by various extrinsic and intrinsic factors abnormalities occur in metamorphosis. Temperature and food are the main factors which produce different effects on the production of hormones and consequently cause upsets in the hormonal balance. Low temperature causes 'metathetly' (juvenile changes) and high temperature 'prothetly' (adult characters) in the larvae of the bug *Rhodnius* (Wigglesworth 1951). In *Leucophaea* (Scharrer 1946) and *Dixippus* (Pflugfelder 1937) alletectomy in earlier instars leads to partial metamorphosis and the production of 'preadultoids' but in *Rhodnius* alletectomy of even first stage larvae led them to metamorphose into miniature adults having well developed adult characters. It is known that grasshoppers will not infrequently miss out a larval stage to produce small sized adults (Wigglesworth, personal communication) but *P. pictus* appear to omit one or more than one nymphal stages and undergo precocious metamorphosis during summer to produce diminutive adults. In fact the case of precocious metamorphosis in *P. pictus* reported in the present communication is very interesting as they were not produced by alletectomy in the laboratory but appear in nature on their own under the climatic conditions of hot summer months. The appearance of similar diminutive adults in laboratory reared stock is clearly a recurrence of the same phenomenon namely of precocious metamorphosis first observed in the field population. A thorough investigation of climatic and nutritional conditions in the field supported by experimental studies in the laboratory are needed to explain under what set or sets of climatic and nutritional conditions, precocious metamorphosis occurs in the population of *P. pictus* in nature.

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23. MIXED INFECTION OF LAC

The one problem for any living creature is that of food and in the case of parasites of plants, like the scale-insects, it means host-selection. But until we can rear the insects apart from the tree we shall never be able to know exactly what they feed upon. In view of the many technical difficulties enabling us to grow lac insects, so to say, in vitro, it was imagined that the symbiotic, yeast-like germ, that lives within the lac insect, would indirectly enable us to know what the insect really gets from the plant. In an article on lac cultivation (1919) I had suggested, supported by several preceding authorities, that probably gum constitutes the main source of food. I had, with my friend, Mr. Sreenivasaya (1928) grown the symbiotic germ on different culture media with the result that, as source of carbohydrate, gum-arabic gave the best result, and as that of nitrogen, uric acid. Uric acid is an excretory substance so that when the germ utilizes it there is a great economy in insect metabolism. Thus indirect evidence fully confirmed that lac insects feed on plant gums.

Now other scale-insects were also seen on the favourite host plants of lac insects. For instance, the lac insect, *Kerria communis*, was frequently found on the Champac tree, *Michelia champaca*, which also proved to be a host of the wax insect, *Ceroplastes cerriferus*. But it is possible that physiological conditions in two different plants of the same species may radically differ. Nothing would be better than to find a lac-insect and a wax insect growing close together so that, in this case, the foodstuff must necessarily be the same. There were two species of wax insects, in Bangalore, where the above observations were carried out. The other grew best on *Dodonaea viscosa* (1936). A new species named *Ceroplastes vayssierii* Madh., it was never found on *M. champaca*.

The species *K. communis* is found in Kerala, Tamilnadu, Andhra Pradesh, Karnataka, Goa, and Maharashtra, but nowhere is it exploited for cultivation. It tends to produce such a preponderance of males that it does not pay to cultivate it. On the contrary, in Karnataka, the species *K. mysorensis* is the lac insect cultivated on *Shorea talura*. Since this tree permits cultivation it was studied by preference. Yet few scale insects were found on it. The most common was a species of *Lecanium* which was propagated by the ant *Oecophyla smaragdina*, which is well known. But besides the symbiotic occurrence of that *Lecanium* species and, the ant the same scale insect was not conspicuous otherwise. However a species of *Monophlebius* was found occupying forked branches of *S. talura*. This insect I believe is not identical with *M. stebbingii* and probably is a new species.

Occasionally a species of *Cypticera* scale insect was found on the leaves of *S. talura*. I am grateful to the Commonwealth Bureau of Entomology for the probable identification of the coccid. In Sind the lac species *K. sindica* is cultivated on *Acacia arabica*. It has been found besides on *Albizzia lebbek*, *Zizyphus jujuba* and *Anona squamosa*. The same species of *Crypticera* was seen profusely growing all round a vertical stem of *A. squamosa* while a neighbouring stem supported *K. sindica*. Previous observations have shown that the predacious caterpillars of *Eublemma scitula* attacked other Coccids as also lac insects. No other parasite, chalcid or otherwise, have been found sharing as hosts, lac and other scale insects.

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24. OCCURRENCE OF *LEPTOCORISA ACUTA* FABR. (COREIDAE, HEMIPTERA) AS A PEST OF NUTMEG TREES

Large swarms of the rice earhead bug *Leptocorisa acuta* Fabr. adults were recorded on the nutmeg trees (*Myristica fragrans* Houtt.) in mixed plantations around newly transplanted rice fields in parts of Kalady in the Ernakulam District of the State of Kerala, during September-October, 1976. The population consisted exclusively of adults and the concenttration per leaf ranged from 15-40. The maximum concentration was found on tender foliage. In the absence of paddy crop in the susceptible stage, the nutmeg trees were very much preferred for adult congregation, possibly due to the dense leaf canopy of nutmeg trees which provide good shelter and due to the favourable micro climate in the irrigated plantations characterised by relatively high humidity.

The bugs which were comparatively inactive, fed on tender foliage causing minute slightly diffused yellowish-brown spots around the feeding punctures. This is the first record of *L. acuta* as a pest of nutmeg trees.

Foliar symptoms were reproduced when the bugs were confined in cages containing excised shoots. The mature leaves and fruits of varying degrees of development were not preferred for feeding. Though the bugs were present in large populations, the damage inflicted to the trees was found to be negligible.

L. acuta has been recorded on non-graminaceous alternate host crops such as mango (Sen 1961), Guava (Puttarudriah 1961), rubber (Green 1914 and Puttarudriah 1961) and tea (Corbett 1933).

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25. OCCURRENCE OF PEARL OYSTERS IN RATNAGIRI DISTRICT

In the Indian region pearl oysters exist in the Gulf of Mannar and in the Gulf of kutch. The following six species of pearl oysters have been reported (Rao 1970, Rao and Rao 1974).

1. *Pinctada fucata* (Gould), 2. *Pinctada margaritifera* (Linnaeus), 3. *Pinctada chemnitzii* (Philippi), 4. *Pinctada sugillata* (Reeve), 5. *Pinctada anomioides* (Reeve) and 6. *Pinctada atropurpurea* (Dunker).

Of these, *Pinctada fucata* is commercially most important species supporting a lucrative fishery in both the regions producing the 'Oriental pearls' or ' Lingah pearls '.

In the month of August, 1976 immediately after a storm, a number of pearl oysters were washed ashore on the Malvan beach. It was reported that at least over a thousand oysters were washed ashore which were subsequently picked up by local people for eating. A subsequent visit to the place yielded 27 shells of pearl oysters belonging to the species *Pinctada chemnitzii* (Philippi).

Pinctada chemnitzii was described by Philippi (1849) from the China sea and Prashad & Bhaduri (1933) first recorded its occurrence on the Indian coast. Along the Indian coast, the species is known to occur (Rao 1970) in Tranquebar, Madras Harbour, Tuticorin pearl beds in the Gulf of Mannar, in Palk Bay and off Balasore coast (Orissa). The Malvan Collection is the first record of this species from West Coast of India. Besides India, it has been recorded from Ceylon, Aden, Mergui Archipelago, Penang, Indonesian group of islands, Australia, Hong Kong, Philippines, China sea and Japan.

I am thankful to Dr. Alagarswami for kindly confirming the identity of the species.

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26. OCCURRENCE OF PEARLS IN THE INDIAN BACKWATER OYSTER *CRASSOSTREA MADRASENSIS* (PRESTON)

Although 22 species of marine bivalves are known to produce pearls (Bolman 1941; Alexander 1951; Cooke 1959; Alagarswamy 1965), formation of pearls in edible oysters appears to be rare. About 40 species of edible oysters occur in different parts of the world, but the only instance of pearl formation reported so far is in the European oyster *Ostrea edulis* (Bolman, loc. cit). This note reports the occurrence of pearls in the Indian backwater oyster, *Crassostrea madrasensis* (Preston).

During the course of an investigation on the biology of *C. madrasensis* from the Mulki estuary, South Kanara, three specimens of oysters were observed to have tiny pearls lodged in pearl sacs formed in the mantle. In the first specimen, 99 mm shell height, collected on 20-1-1976, a black pearl, 1 mm in diameter, was found in the pearl sac situated at the ventral edge of the right lobe of the mantle. The pearl sac was completely closed. The pearl was more or less spherical and nonlustrous. A second specimen, 150 mm shell height, collected on 19.vii.1976, revealed a cream coloured pearl, 1.1 mm in diameter, lodged in the completely closed pearl sac situated in the mantle at the umbo region. The pearl was almost spherical, non-lustrous and porcellanous. A third specimen, 142 mm shell height, collected on 11.i.1977, had three fully closed pearl sacs, two at the umbo region and one in the right lobe of the mantle immediately above the digestive gland. Each pearl sac contained one pearl. The first two pearls, 2.2 mm and 2.3 mm in diameter respectively, were white, while the third, 2.6 mm in diameter, was cream coloured and with a black marking on the side facing the right valve of the shell. All the three pearls were almost spherical and porcellanous.

From the seas around India, species of *Pinctada*, *Placuna* (Hornell 1909; Prashad & Bhaduri 1933), *Mytilus* (Jones 1950), *Gafrarium* and *Donax* (Alagarswamy 1965) were reported to produce pearls. Formation of pearls has been reported in the freshwater mussel *Lamellidens* (Hornell 1909) and the sacred chank *Xancus pyrum* (Hornell 1916). It is interesting to note that the formation of pearls in *C. madrasensis* is not very uncommon, as three speimens out of a total of 1,800 examined revealed the presence of pearls.

I am grateful to Dr. P. S. B. R. James for critical comments.

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27. FIRST REPORT OF *MESOCYCLOPS* (*THERMOCYCLOPS*) *MAHEENSIS* LINDBERG (COPEPODA-CYCLOPIDAE) FROM HIMACHAL PRADESH

Mesocyclops maheensis was described by Lindberg (1941) from Mahe in South India. Since then the species has not been recorded anywhere else. The present report from Himachal Pradesh is of great interest since it extends the distribution to the north.

Mesocyclops (Thermocyclops) maheensis Lindberg.

1941 *Mesocyclops* (*Thermocyclops*) *maheensis* Lindberg. *Rec. Indian. Mus.* 43 : 259.

Material: 1000 ex.; Cement tank, c. 1.75 m deep, Poanta Sahib, Sirmaur Distt.; alt. 400 m; 14. vii. 75. coll. R. C. Subbaraju. 10 ex.; Cement Tank, 2.3 m deep, Saproon, Solan Distt.; alt. 1500 m; 14. viii. 75; coll. R. C. Subbaraju, 12 ex.; Rain-water pool, 0.6 m deep; Saproon, Solan Distt.; alt. 1500 m; 4. ix. 75; coll. R. C. Subbaraju.

Remarks : The specimens from Himachal Pradesh agree well with the description of the species as given by Lindberg (1941) such as the elongated dorsal seta on the furca, connecting plate of 4th leg with small protruberences, elongated genital segment and the structure of the receptaculum seminis. However, it differs in some minor characters. The furca in the males is 3.01 times longer than broad (a mean of 12 examples) as against 3.78 (based on one example). In a collection from saproon, the females show a thick single spine at the distal end of second endopodite segment of 4th leg instead of 4 or 5 small setules in the specimens from Mahe.

Recently, Sewell (1957) while reviewing the various taxonomic characters of the subgenus *Thermocyclops* suggests that ratio of length to breadth of the genital segment might serve as a better basis for differentiating the species and species groups in the Cyclopoid taxonomy. Based on this feature, the present forms with an average of 1.4008 : 1 (length : breadth) are closer to *M. iwoyiensis* Onabamiro (1952) which have a value of 1.4 : 1.

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I am grateful to the Director, Zoological Survey of India for providing facilities to carry out these investigations. I am also thankful to Dr. Raj Tilak, Superintending Zoologist for encouragement. I thank Mr. J. R. Dhanze for help in collecting the material from Paonta Sahib.

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28. OCCURRENCE OF *LOPHOPODELLA CARTERI CARTERI* (HYATT) (LOPHOPODIDAE : ECTOPROCTA) IN LAKES IN WESTERN HIMALAYA

(*With three text-figures*)

During the recent faunistic surveys, colonies of a phylactolaematous bryozoan, namely *Lophopodella carteri carteri* (Hyatt) were collected from the Renuka Lake (about 30 km from Nahan, Distt. Sirmaur, Himachal Pradesh) and Mansar Lake (about 60 km from Jammu on Sambha-Udhampur road). Both the lakes are natural ones located at low altitude (650-720 m) and mainly rain-fed. The pH of the water is 7. The water is clear with submerged vegetation in the littoral region.

Lophopodella carteri (Hyatt) is known to occur in India, Java, Japan, China, Formosa, U.S.S.R., Africa, S. Australia and U.S.A. Rogick (1934) recognizes three varieties of this species, namely *carteri* (Hyatt), *himalayana* (Annandale) and *davenporti* (Oka) on the basis of form and number of processes on each end of the statoblast. These processes are about 3-9 of indefinite form or absent in *himalayana*, 6-17 with recurved hooks in *carteri* and 18-20 recurved hooks in *davenporti*. Of the three varieties, only *himalayana* and *carteri* are found in India, the former in the Kumaon Hills at Malwa Tal, Bhim Tal, Sat Tal and Naini Tal (Annandale 1911, 1912) and the latter at Bombay, Madras (Annandale 1911) and Ambala City (Vasisht & Sofet, in press). The statoblasts found in the specimens from Renuka and Mansar Lakes agree well with those of the variety *carteri*. The present discovery of *Lophopodella carteri carteri* extends its geographic range to the northernmost parts of the country.

Lophopodella carteri carteri (Hyatt)

1859. *Lophopus* sp. Carter, *Ann. Nat. Hist.*, (3) **3** : 335. (Bombay).

1866. *Pectinatella carteri* Hyatt, *Comm. Essex Inst.*, **4** : 203.

1911. *Lophopodella carteri*, Annandale, Fauna Brit. India, Freshwater sponges, hydroids and Polyzoa : 232.

1934. *Lophopodella carteri* var. *typica*, Rogick, *Trans. Amer. microsc. Soc.*, **53** : 417.

Material examined :

(i) One colony; Renuka Lake, H.P.; alt. 650 m; 17. vii. 76; Raj Tilak. (ii) Several colonies; Mansar Lake, Jammu & Kashmir; alt. 720 m; 4-10. ii. 77; Raj Tilak. (iii) Several colonies; Renuka Lake, H.P.; alt. 650 m, 20, 22. iii. 77; J.M. Julka (from submerged roots and stems of reeds).

Description

Colony: Colony is a lobulate gelatinous mass of yellowish colour and attached to the substratum by a hyaline substance. The zooids arise from a common stalk (Fig. 1).

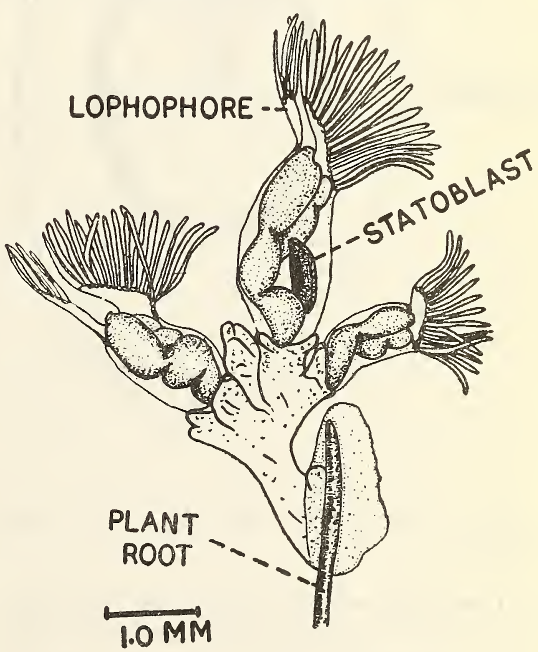

FIG. I

Fig. 1. A part of the colony of *Lophopodella carteri carteri* (Hyatt).

Zooid: Lophophore horseshoe-shaped, fringed with a row of 76-82 tentacles; the two arms of the lophophore project freely. Tentacles connected basally by a thin and transparent intertentacular membrane, fully retractile into zooecial tube. Mouth overhung by a projecting epistome. Anus outside tentacular crown. Digestive tract brownish, somewhat V-shaped; stomach attached to the body wall by a strong funiculus.

Statoblast: (Figs. 2, 3): Length 0.89-0.95 mm. Width 0.62-0.67 mm. Each statoblast deeply brownish in colour, broadly ellipsoidal

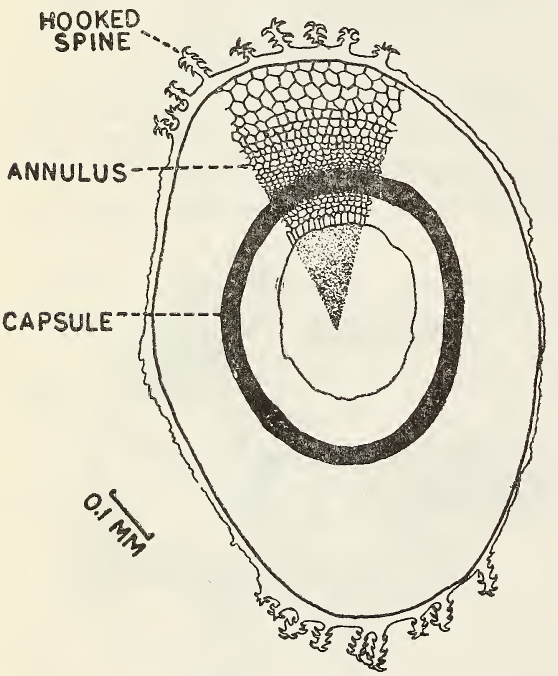

FIG. 2

Fig. 2. Statoblast of *Lophopodella carteri carteri* (Hyatt).

with extremities subtruncate; capsule somewhat circular to elliptical and darker in colour; annulus with air-filled cells which decrease in size towards the capsule; length of capsule 0.43-0.47 mm, width of capsule 0.4-0.42 mm.

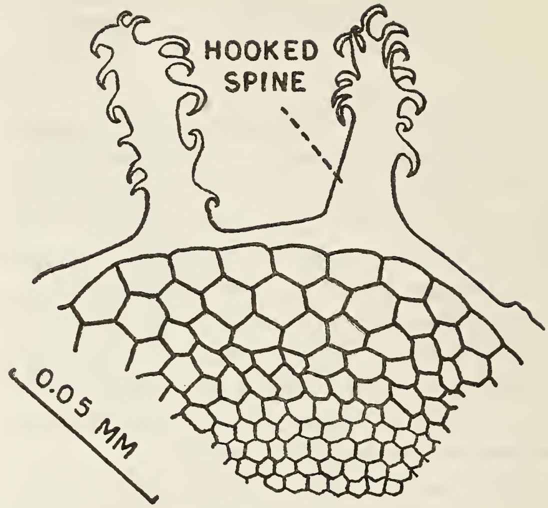

FIG. 3

Fig. 3. An enlarged view of a portion of the Statoblast.

Each extremity of statoblast with 8-10 spines; central spines longer than the lateral ones. Spines furnished with 4-17 recurved hooks.

Remarks: The presence of *Lophopodella carteri carteri* in Renuka and Mansar Lakes of Himachal Pradesh and Jammu and Kashmir respectively can be attributed to the successful transportation of its statoblasts to these lakes, their germination and eventual colonisation. The freshwater bryozoans have a tendency to spread to various parts of the world by transportation of their statoblasts, which in dry state, could be blown to long distances or carried away along with plants and vertebrates. Brown (1933) found some statoblasts still viable and capable of germination after passing through the digestive tracts of amphibians, turtles and ducks. Hymen (1959) states that the statoblasts of *Lophopodella carteri* can germinate after being kept dry at room temperature for about 4½ years. According to Rogick (1959), the colonies of *Lophopodella carteri*, when crushed, are toxic to fish.

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29. *HODGSONIA HETEROCLITA*—AN OIL-RICH CUCURBIT
(*With two text-figures*)

The Cucurbitaceous plants are known for their oil-rich seeds, and there are reports on the possibilities of using seeds of perennial cucurbits as sources of vegetable fats and proteins (Curtis 1946). The small genus *Hodgsonia* of Asia assumes importance in this context (Burkill 1935; Hu 1964; Uphof 1968). Of its two species, only *H. heteroclita* Hook. f. & Thoms. occurs in India (Anonymous 1959; Chakravarti 1959) chiefly in the subtropical north-eastern hills with its extension towards cold sub-temperate-temperate east Himalayan region. During plant explorations to Manipur and Mizoram some information on the uses of this woody climber was collected, along with a collection of fruit/seed material (locally called *Khaum*) from Kolasib tract (Mizoram). This note deals with the fruit/seed characteristics of this plant and the native uses of the kernel which constitutes the edible part, besides presenting data on the oil-content/composition of the seed.

The fruit—a pomiform gourd (Fig. 1) does not exhibit much variation. It has brownish/yellowish colour, is pulpy inside holding 6 to 8 large mature seeds, each upto $10 \times 6 \times 2$ cm. Each seed or often a pair of seeds is wrapped in a hard covering and inside this is the seed proper (Fig. 2) with a thin, brittle tests, pithy, thick (2-4 mm) integument and the large cotyledons—the kernel comprising the oil-rich commercially exploitable part of the plant. It has been reported that the kernel which is approximately 33% of the whole seed has an oil content to the extent of 70-80% by weight (Hu 1964). The kernel is eaten after roasting and only occasionally taken raw. In roasted form, it is very much favoured by the natives as a nutritious food. Its flavour is more like lard, comparable to that of a pork scrap (Hu 1964). The mature seeds are collected from the wild and brought to the village markets for sale. It is a much esteemed product.

Fig. 1. Mature fruit (pomiform gourd) of *Hodgsonia heteroclita*.

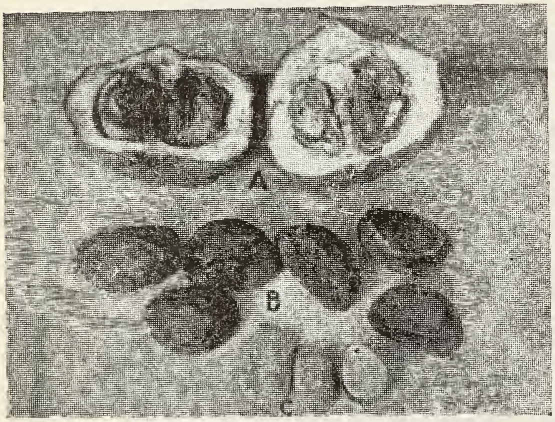

Fig. 2. (*A*) The fruit of *Hodgsonia* split into two halves;

B & C. The seeds with (*B*) and without (*C*) the hard bony covering.

To know the composition of the oil etc., the kernel was analysed through the Department of Chemical Technology, University of Bombay. The results are as follows:

I	Oil content on dry kernel basis :	53.7%
	Protein content ,, ,,	31.0%
	Carbohydrates ,, ,,	12.3%
	Fibres ,, ,,	3%
II	Fatty acid composition (by Gas-liquid Chromatography)	
	Palmitic	29.0
	Stearic	7.7
	Oleic	16.6
	Linoleic	46.7
III	Acid value of the oil :	2.3
	Iodine value of the oil :	95.1
	I.V. of mixed fatty acids derived from oil :	99.7

In north-eastern region the natives normally do not extract oil, but whenever this is done, it is used for cooking food and even for lighting purposes.

Efforts to study the potentialities of *Hodgsonia* as an economic plant were made in early part of this century and trials were conducted to grow it on an experimental basis (Hu 1964). This plant possesses desirable traits such as: good fruit bearing (40-100/plant) extended over a prolonged period, commencement of fruiting after 2 to 3 years' growth and a wide climatic adaptability. Its undesirable features are: difficulty of establishing a controlled population of male and female plants in the field, poor number of mature seeds per fruit, and large size of the hard shell or wrapping as compared to kernel size in seed, which have decidedly held up its coming into prominence.

Asexual propagation is possible in *Hodgsonia* and cutting and layering have been successfully tried (Hu 1964). A more meaningful effort to screen the existing populations to select fine quality strains of seeds to bring about higher yields is obviously necessary. In this context, it would be worthwhile to lay emphasis on the plants being grown by the natives in their courtyards, as some of these conscious domesticates may have desirable traits.

The oil content of seeds of *Hodgsonia* is quite high, and the percentage of unsaturated essential fatty acids in its composition is also very high. From the point of view of edibility, the undesirable component in the fatty acid composition of the oil is stearic acid which can be removed by refrigeration method. Although seeds are consumed by the local tribes in north-eastern India, it is essential to ascertain whether they contain any minute concentration of substances toxic to mammals by conducting feeding trials. The Iodine value also shows the degree of unsaturation which approximates the Iodine value of groundnut which is 106-115. Thus, there is possibility of locating better agrotypes of this plant in north-eastern region, as source of an oil which when processed with respect to elimination of stearic acid and toxic component, if any, will be comparable to groundnut oil in quality.

We are thankful to Dr. D. Rebello, Department of Chemical Technology, University of Bombay for help in the Chemical analysis of the seed material, and to Dr. K. C. Sikka, Division of Biochemistry, I.A.R.I., for the interpretation of this analysis.

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30. *DATURA INNOXIA*—A PERENNIAL HERB

(*With a text-figure*)

Datura innoxia Mill is an important medicinal plant of great pharmaceutical utility. Its seeds and young leaves contain the alkaloids, hyoscine, hyoscyamine and atropine, but commercially only scopolamine/hyoscine is extracted.

The plant, a native of Mexico (Dastur 1962), is reported as a coarse bushy annual of 1 to 1.25 m height. It now grows wild in the Western Himalayas, in the Western hills of Deccan peninsula and in other parts of the country by the sides of railway tracks, waste lands and near old dwellings. It has, however, not been reported from anywhere within the valley of Kashmir.

A number of years back Chopra *et al.* (1962) introduced this plant in Srinagar but there is no record of its having become naturalised to this region (Javed 1970; Kaul 1975). The plant was reintroduced by us during the year 1972 from Jammu, Bhubneshwar, Bangalore and other places of the country. During the course of its domestication at Srinagar three types of plants were observed on the basis of floral morphology the pin, the thrum, and the homostylous types. While the thrum and homostylous types proved to be annuals, a few of the pin types showed perennial behaviour. Avery *et al.* (1959) record the occasional perennial behaviour for the Bernhardi group of *Datura*, (in which *Datura innoxia* is also included) but no mention is made in particular about the behaviour of perennation in *Datura innoxia*. The present paper reports the behaviour of these perennial plants for the first time.

The seeds were washed with water to get rid of the inhibitor on the seed coat. After washing, these were sown on 7-3-1972 and 6-5-1972 in nursery beds of 0.50 m × 1.25 m size and seedlings were transplanted in the field on 16-6-72. The distances between plant-to-plant and row-to-row were kept as 0.75 and 1.00 m. respectively. Observations were recorded on all the three types of plants on October 5, 1972, but for sake of comparison the data for pin flowered plants only is reported in Table 1. The perennial plants which included only the pin types, totalling 36, were again studied in the fourth year of growth and the data were recorded on 1st October, 1975 (Table 1).

From the Table 1 and Fig. 1, it will be observed that the perennial plants are in no way different from the annual ones. Whatever little difference is noted in 1975, it is attributed

TABLE 1

AVERAGE PERFORMANCE OF PIN-EYED *D. innoxia* DURING 1ST AND 4TH YEAR OF GROWTH

Plant character	Year	
	1972	1975
Plant height (cm)	121.75	115.25
No. of capsules per plant ..	34.65	29.40
Fresh seed weight per plant (g) ..	200.00	170.00
% alkaloid in seed	0.29	0.23

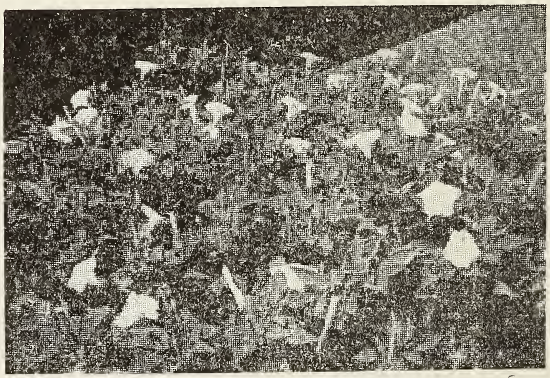

Fig. 1. Pin-eyed *Datura innoxia* during fourth year of growth.

to the lack of same field conditions as were prevailing in 1972. It may be pointed out that the root stock of these plants has been able to withstand severe winter conditions of Kashmir when the temperature drops down to 10 to −12°C. There is frost and snow right from late December to early March. In April-May fresh growth starts from the crown of these perennial root stocks. The herbarium specimen of these plants is deposited in Herbarium Section of RRL (Br.), Srinagar (Voucher No. 16443). Detailed investigation on the genetic make up of these plants is in progress.

Thanks are due to Dr. C. K. Atal, Director, Regional Research Laboratory, Jammu/Srinagar for suggestions and encouragement.

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31. THE HOST RANGE OF THE GENUS *CISTANCHE* HOFFM. & LINK IN INDIA

The genus *Cistanche* Hoffm. & Link, consisting about twenty-eight species, is represented by a single species *C. tubulosa* (Schenk) Wight in India (local name—Bhumiphor). It is found in Punjab, Gujarat, Maharashtra and Rajasthan in India and further extends westwards upto mediterranean region through Pakistan, Afghanistan, Persia and Arabia etc. The Plants are leafless, obligate root-parasites, bearing yellow flowers in dense, 15-20 cm long spikes and they, considerably, show a specificity in the selection of their hosts. They usually grow on the roots of deep-rooted, woody xerophytic plants of physically dry sandy soils. So far, *Calotropis procera* R. Br. and *Salvadora persica* Linn. are the most commonly known host species of this parasite in India. I have, during my studies on the Orobanchoid parasites of India, noted that the number of its hosts has markedly increased in recent years. The common hosts of *C. tubulosa* (Schenk) Wight in India are: *Balanites roxburghii* Planch., *Calligonum polygonoides* Linn., *Aerva javanica* (Burm. f.) Spreng., *Calotropis procera* (Ait.) R. Br., *C. gigantea* (Linn.) R. Br., *Leptadenia pyrotechnica* (Forsk.) Decne, *Lycium barbarum* Linn., *Salvadora persica* Linn., *S. oleoides* Decne, *Acacia leucophloea* Willd. and *Nopalia* sp. (see Bole in *JBNHS*, 61 (2): 472-473; 1964).

Further, it is interesting to note that most of the host species bear xerophytic characters like—fleshy leaves, leaves covered with cottony pubescence or modified into spines or all together absent and well developed chlorophyll in different tissues of the stem like—included phloem, chlorenchyma, pallisade etc. In Arabian region, besides the above-mentioned hosts, it is also reported on the roots of *Tamarix* species. Such association has not so far been reported from any part of India. *C. tubulosa* (Schenk) Wight is much used in increasing lactation in Buffaloes and as a cure for scorpion sting and snake-bite in Rajasthan and Gujarat.

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BOTANICAL SURVEY OF INDIA,
ARID ZONE CIRCLE,
D-7, SHASTRI NAGAR, JODHPUR,
(RAJASTHAN),
March 30, 1976.

32. TWO LITTLE KNOWN OR RARE PLANTS FROM EASTERN INDIA

During identification and scrutiny of some collections of plants from Eastern Himalayas, we came across some specimens of two interesting members of Asclepiadaceae and Liliaceae respectively. The former species was identified as *Dittoceras andersonii* Hk. f. (*Asclepiadaceae*) a species uncommonly recorded from Sikkim and Upper Burma (Hooker 1883) and hitherto unrecorded from Bengal and W. Bengal too. Hence it appears to be a new record for W. Bengal as well as previously undivided Bengal. The latter species has been identified as *Tofieldia yunnanensis* Franch. (Liliaceae), a chinese species hitherto unrecorded in Indian region and as such it is a new record for the Indian Subcontinent.

Dittoceras andersonii : Hk. f. in Hook. Ic. Pl. t. 1422.

A stout pubescent twining shrub with opposite long-petioled, elliptic leaves. Flowers dark-purple with rotate corolla, corona-5-lobed large lying flat on the corolla; column depressed; stigma-pentagonal. Fruit Subcylindric follicles.

Specimens examined : Sikkim ; Rongbi, 3-6-1909-Lepcha collector Reh (CAL) : Mongpoo. 9-5-1884-G. King s.n. (CAL). UPPER BURMA : Phyet. Jan. 1912-Capt. S. M. Toppin R.A. 6254 (CAL). W. BENGAL : Jalpaiguri, Buxa. 20-2-34. Biswas. K. P. 1536 (CAL).

Distribution : Sikkim Himalayas, Upper Burma, Buxa (West Bengal).

Tofieldia yunnadnensis: Franch., in Journ. De. Bot. 12 (15-16) : 225-230, 1898.

Roots fibrous, rusty hairy, weak stem 60-120 mm leaves 20-40 long, 1.5-2 mm wide, 3-5 nerved margins scabrous. Racemes ovate 10-25 mm before anthesis, lax flowered specially below. Pedicels spreading or erect, equal to flowers, bracts at base of pedicel, obliquel truncate, scaly, membranous, epicalyx 1-2 mm, hyaline, glabrous, turbinate, obliquely & delicately trilobed ; perianth 4-5 mm long, open, campanulate. Segments 2-3 mm wide, 5 mm long, glabrous, hyaline, broadly oblong, obtuse. Stamens longer than perianth, anthers ovate, violet, versatile. Ovary oblong a little or scarcely, shorter than style. Follicle beaked, beak 2-3 mm long.

Specimens examined : *F. Ludlow, G. Sherriff & J. H. Hicks* 14302, Deyang La, Kongbo, Bhutan, alt. 4408 m dt. 10.8.1947, 'Spikes pale straw colour. Habitat Midst grass & stones in alpine zone' (CAL).

Distribution : China (Yunnan), Bhutan.

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HOWRAH,
March 12, 1976.

33. NOMENCLATURAL NOTES ON SOME BOMBAY PLANTS—V

(*Continued from Vol.* **69**:449)

During the course of the study on the flora of Gujarat State, we came across changes in the names of some of the plants in Hooker's Flora of British India (**FBI** 1872-1897) and Cooke's Flora of the Presidency of Bombay (C. 1958 reprinted). The name changes are consistent with the rules of International Code of Botanical Nomenclature (1972). Since this nomenclature is not published in Indian Works including those of Santapau & Janardhanan in *Bull. bot. Surv.* of *India* 8 (Suppl. 1) : 7-58, 1967 (S & J) and Rau *ibid.* 10 (Suppl. 2) : 7-87. 1969, the information is compiled here.

Elatinaceae

Bergia suffruticosa (Del.) Fenzl, Denskschr, Bot. Ges. 3:1 83. 1841; Verdcourt in Milne-Redhead & Polhill, Fl. Trop. East Afr. 3 00.1968 *Lancreta suffruticosa* Del. Fl. Egypte 69 (213). t. 25/1. 1813. *Bergia odorata* Edgew. Journ. As. Soc. Beng. 7:765. 1838; FBI 1: 251; C 1:77; S & J 10.

Celastraceae

Cassine glauca (Rottb.) O. Ktze. Rev. Gen. Pl. 1:114. 1891; D. Hou, Fl. Males, 6 (2): 286. 1962. *Mangifera glauca* Rottb. Nye Samml. Vid. Selsk. Skrift. 2:534. t. 4. f. 1. 1805.

Elaeodendron glaucum (Rottb.) Pers. Syn. 1:241. 1805; FBI 1:623; C 1:248; Wealth of India 3:141. f. 88. 1952.

Elaeodendron roxburghii Wt. & Arn. Prodr. 152. 1834; Santapau in Rec. bot. Surv. India 16 (1) (ed. 3) : 41. 1967.

There has been some disagreement about the status of *Cassine* L. and *Elaeodendron* Jacq. Loesner (1892) reduced *Elaeodendron* to *Cassine* and distinguished the two taxa as two different sections of *Cassine*, subgenus *Elaeodendron*, section *Elaeodendron* with scalariform, rarely simple perforations and section *Cassine* with simple, round or elliptic, perforations. Davison (*Bothalia* 2:289. 1927) merged *Elaeodendron* Jacq. on the grounds that there are no generic differences between them. Metcalfe and Chalk (Anatomy of dicotyledons 1:393, 1950) also concluded that in absence of any anatomical distinctions of vessels to keep the two genera apart, the recognition of only one genus *Cassine* seems, therefore, to be final. This view is also accepted by Blacklock (*Kew Bull.* 1956:556. 1956) and Ding Hou [*Fl. Males.* 6 (2): 284-285. 1962]. Airy Shaw (A dictionary of flowering plants and ferns 223, 1973) considered *Elaeodendron* Jacq. f. as conspecific with *Cassine* Loes. [See Engler & Prantl. Pflanzenfam. (ed. 2) 206:110. 1942] accepting the later name as distinct from *Cassine* L. Even if it is assumed that *Cassine* L. and *Cassine* Loes. are distinct, the later name is illegitimate being a later homonym (Art. 64 of the Code). The only correct name is, then, *Cassine* L. (Sp. Pl. 268. 1753) as adopted by Ding Hou (1962) and others.

Fabaceae (Papilionaceae)

Some of the species names appearing under the genera *Dolichos* L. and *Phaseolus* L. in the Indian floras have been changed by Verdcourt (*Kew Bull.* 24 : 1-70, 235-307, 380-447, 507-569. 1970 & 25 : 65-169. 1971). According to him, the genera *Dolichos* L. and *Lablab*

Adans. differ in morphology of style and pollen.

Style conspicuously laterally flattened and blade-like throughout its length forming an angle of just less than 90° with the ovary ; style with a line of hairs along the inner margins ; stigma penicellate ; pollen grains tricolporate with very fine structure ..... *Labla.*

Style not conspicuously flattened, hairy or glabrous but stigma penicellate ; pollen grains tricolporate or triporate, very finely to strongly reticulate ..... *Dolichos.*

Further he has merged the old world species of *Phaseolus* L. into *Vigna* L. on the grounds that the spirally twisted keel in *Phaseolus* is not a diagnostic character to separate it from *Vigna* as done in most of our Indian floras, because in certain species of *Vigna* also beaks of the keels are twisted. The Palynological and cytological data also do not offer any diagnostic information to retain them as separate genera. In WEALTH OF INDIA (8 : 3. 1969), it is also remarked, ' Recent studies of the seeds and seedling species of *Phaseolus* and *Vigna* appear to confirm that the Asiatic species of *Phaseolus* are quite distinct from the American species and their assignment to *Vigna*, seems more logical '.

Again *Phaseolus mungo* L. (Udad ; black gram) and *Phaseolus radiatus* L. (Mung ; green gram) have been variously taxonomically treated by different taxonomists. Santapau [*Rec. bot. surv.* India 16 (1) (ed. 3) : 69. 1967] considers the Indian species unidentical with the Linnaean species, and that they are conspecific with *Phaseolus angularis* (Willd.) W.F. Wight, accepting the later name. However, Verdcourt (1970), under *Vigna*, treats *P. angularis* W.F. Wight, *P. mungo* L. and *P. radiatus* L. as distinct.

Dolichos trilobus L. Sp. Pl. 726. 1753 ; Verdcourt in Taxon 17 : 170. 1968 & Kew Bull. 24 : 422. 1970. *Dolichos falcatus* Klein ex Willd. Sp. Pl. 3 : 1047. 1802 ; FBI 2 : 211 ; S & J 18.

Lablab purpureus (L.) Sw. Hort. Brit. (ed. 1), 481. 1827 ; Verdcourt in Kew Bull. 24 : 410. 1970. *Dolichos lablab* L. Sp. Pl. 725. 1753 ; FBI 2 : 209 ; C 1 : 406. *Dolichos purpureus* L. Sp. Pl. 1021. 1763. *Lablab niger* Medik. in Vorles Charpf. Thys. Ges. 2 : 354. 1787. *Lablab vulgaris* Savi, Diss. 19. 1821 & Obs. Phas. & Dol. 19. 1822. (Bean).

Vigna aconitifolia (Jacq.) Marechal in Bull. Jard. Bot. Nat. Belge 39 : 160. 1969 ; Verdcourt in Kew Bull. 23 : 469. 1969 & 24 : 557. 1970. *Phaseolus aconitifolius* Jacq. Obs. Bot. 3 : 2. f. 52. 1768 ; FBI 2 : 202 ; C 1 : 403 ; S & J 19. (Math).

Vigna mungo (L.) Hepper in Kew Bull. 11 : 128. 1956 ; Verdcourt in Kew Bull. 24 : 558. 1970. *Phaseolus mungo* L. Mant. 1 : 101. 1767 ; FBI 2 : 203 p.p. ; C 1 : 403 ; *Phaseolus angularis* Sensu Santapau in Rec. bot. Surv. Ind. 16 (1) (ed. 3) : 69. 1967. (Udad ; Black Gram).

Vigna dalzelliana (O. Ktze.) Verdcourt in Kew Bull. 24 : 558. 1970. *Phaseolus pauciflorus* Dalz. in Hook. Journ. Bot. 3 : 209. 1851 (non G. Don 1832, nec Bth. 1837) ; FBI 2 : 202. *Phaseolus dalzellianus* O. Ktze. Rev. Gen. Pl. 1 : 202. 1891 ; *Phaseolus dalzellii* Cooke, Fl. Pres. Bombay 1 : 376. 1902 & 1 : 401. 1958 (reprinted) ; S & J 19.

Vigna khandalensis (Santapau) Bole & Shah, Comb. nov. *Phaseolus khandalensis* Santapau in Kew Bull. 1948 ; 276. 1948 & Rec. bot. Surv. Ind. 16 (1) (ed. 3) : 68. 1967. *Phaseolus grandis* Dalzell & Gibson, Bombay Fl. 72. 1861 ; FBI 2 : 202 ; Cooke 1 : 400 (*Omne non* Wall. Cat., 5602 & Benth. in Moq. Pl. Jungh. 239. 1852 *in nota*) *Vigna grandis* Dalzell & Gibson) Verdcourt in Kew Bull. 23 : 464. 1969 & 24 : 558. 1970.

Vigna radiata (L.) Wilczek var. **radiata** ; Verdcourt in Kew Bull. 24 : 559. 1970. *Phaseolus radiatus* L. Sp. Pl. 725. 1753 ; C 1 : 403.

Phaseolus aureus Roxb. Fl. Ind. 3 : 297. 1832. *Phaseolus mungo* L. var. *radiatus* (L.) Baker in Hk. f. FBI 2 : 203. 1876. (Mung).

Vigna radiata L. var. **sublobata** (Roxb.) Verdcourt in Kew Bull. 24 : 559. 1970. *Phaseolus sublobatus* Roxb. Fl. Ind. 3 : 288. 1832 ; C 1 : 402. *Phaseolus trinervius* Wt. & Arn. Prodr. 1 : 245. 1834 ; FBI 2 : 203. *Phaseolus radiatus* Auct. mult. non L. 1753 (*S. S.*) ; Santapau in Rec. bot. Surv. India 16 (1) (ed. 3) : 69. 1967 ; S & J 19. (Jangli Mung).

Vigna trilobata (L.) Verdcourt in Taxon 17 : 172. 1968 & Kew Bull. 24 : 560. 1970. *Dolichos trilobatus* L. Mant. 1 : 101. 1767. *Phaseolus trilobus* auct. non *Dolichos trilobus* L. ; *sensu* Ait. Hort. Kew. 3 : 30. 1789 ; FBI 2 : 201 ; C 1 : 401 ; S & J 19.

Vigna unguiculata (L.) Walp. subsp. **cylindrica** (L.) van Eseltine in Hendrick, Vegetables of New York 1 (2) : 11. 1931. Verdcourt in Kew Bull. 24 : 544. 1970. *Phaseolus cylindricus* L. Herb. Amb. 23. 1754 & Amoen. Acad. 4 : 132. 1759. *Dolichos catjang* Burm. f. Fl. Ind. 161. 1768. *Vigna catjang* (Burm. f.) Walp. in Linnaea 13 : 533. 1839 ; FBI 2 : 205 ; C 1 : 405. *Vigna unguiculata* (L.) Walp. Rep. 1 : 779. 1842 ; Santapau in Rec. bot. Surv. India 16 (1) (ed. 3) : 70. 1967 (*Omne p.p.*). (Choli).

Vigna unguiculata (L.) Walp. subsp. **unguiculata** Verdc. in Kew Bull. 24 : 543. 1970. *Dolichos unguiculatus* L. Sp. Pl. 725. 1753. *Dolichos biflorus* L. Sp. Pl. 727. 1753. FBI 2 : 210 ; C 1 : 407 ; S & J 18. (Kulith).

Convolvulaceae

Merremia turpethum (L.) Shah & Bhatt, comb. nov. *Convolvulus turpethum* L. Sp. Pl. 155. 1753. *Ipomoea turpethum* R. Br. Prodr. 485. 1810 ; FBI 4 : 212. *Operculina turpethum* (L.) Silva-Manso, Enum. Subst. Bras. 16 & 49. 1836 ; C 2 : 309 ; Ooststroom in Fl. Males. 456. f. 32 a-b. 1954 ; Wealth of India 7 : 96. f. 41. 1966 ; S & J 35.

The genus *Merremia* Dennst. ex Endl. is conserved over *Operculina* Silva-Manso by the International Code of Botanical Nomenclature (1972 p. 377).

Solanaceae

Lycopersicon lycopersicum (L.) Karst. ex Farwell, Annual Report Commissioners Parks Boulevards Detroit 11 : 83. 1900 ; S & J 35. *Solanum lycopersicum* L. Sp. Pl. 185. 1753. *Lycopersicon esculentum* Mill. Gard. Dict. ed. 8. No. 2. 1768 ; FBI 4 : 237 ; C 2 : 345. (Tomato).

Airy Shaw (Willis, *Dict. Fl. Pl.* 194. 1973, revised) attributes the authority of the combination *Lycopersicon lycopersicum* to Karsten but *Lycopersicum lycopersicum* (L.) Karsten, Deuts. Fl. 966. 1882 is invalid being a tautonym. Santapau, therefore, published the correct nomenclatural combination (See S & J 1967) ; but from the rule of priority Farwell has the credit for it (See *Taxon* 24 : 171-177. 1975).

Nyctaginaceae

Pisonia mitis L. Sp. Pl. 1026. 1753 ; Burm. f. Fl. Ind. 224. 1768 (excl. cit. Rheede). *Pisonia grandis* R. Br. Prodr. 422. 1810 ; Wealth of India 8 : 119. 1969. *Pisonia morindifolia* R. Br. in Wall. Cat. no. 7130. 1828 (*nomen*) ; C 2 : 566 ; S & J 42. *Pisonia alba* Span. in Linnaea 25 : 342. 1841 ; FBI 4 : 711.

Stemmeric [*Fl. Males.* 6 (4) : 464. ff. 11, 13. 1964] considered *Pisonia alba* Span., *Pisonia morindifolia* R. Br. and *Pisonia grandis* R. Br, conspecific, accepting the last name. However. Hooker in FLORA OF BRITISH INDIA (4 : 711. 1885) cites *Pisonia mitis* L. as an unambiguous synonym of *Pisonia alba* Span. Therefore *Pisonia mitis* Linn. has priority.

AMARANTHACEAE

Aerva javanica (Burm. f.) Juss. ex J. A. Schultes, Syst. Veg. (ed. 15) 5 : 565. 1819 ; FBI 4 : 727 ; C 2 : 577 ; Townsand in Nasar & Ali, Fl. West Pakistan no. 71 : 26. 1974. *Celosia lanata* L. Sp. Pl. 205. 1753 [non *Aerva lanata* (L.) Juss. ex J. A. Schultes 1819]. *Iresine javanica* Burm. f. Fl. Ind. 212. 1768. *Iresine persica* Burm. f. Fl. Ind. 212. 1768. *Illecebrum javanica* (Burm. f.) Murr. Syst. Veg. (ed. 13) 206. 1774. *Aerva tomentosa* Forsk. Fl. Aegypt.-Arab. Cxxii & 170. 1775 ; S & J 42. *Achyranthes javanica* (Burm. f.) Pers. Syn. 1 : 259. 1805. *Aerva persica* (Burm. f.) Merrill in Philip. Journ. Sci. 19 : 348. 1921 ; Santapau in Rec. Bot. Surv. Ind. 16 (1) (ed. 3) : 223. 1967.

This species is variously named in our Indian floras and some even consider *Aerva tomentosa* Forsk. and *A. javanica* Juss. taxonomically distinct. However, Jackson (*Index Kewensis* 1 : 49. 1895) cites the species under consideration conspecific and Townsand (1974) has adopted a similar taxonomic treatment.

CYPERACEAE

Fimbristylis dichotoma (L.) Vahl var. **pluristriata** (Cl.) Napper in Kew Bull. 25 (3) : 437. 1971. *Fimbristylis podocarpa* Nees in Wt. Contrib. India 98. 1834 ; FBI 6 : 638. *Fimbristylis diphylla* Retz. var. *podocarpa* (Nees) Kuekenth. Engl. Bot. Jahrb. 69 : 257. 1838. *Fimbristylis diphylla* Retz. var. *pluristriata* Cl. in Hk. f. FBI 6 : 637. 1893. *Fimbristylis dichotoma* (L.) Vahl subsp. *podocarpa* (Nees) Koyama in Micronesia 1 : 89. 1964.

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May 25, 1976.

34. OCCURRENCE OF STROPHIOLATE SEEDS IN *CAJANUS*

(*With a text-figure*)

The strophiolate character relates to the occurrence of an appendage on the hilum of some seeds. The presence or absence of this—strophiolate *vs* estrophilate seed, has been used as a key character by taxonomist in delimiting different species (*Rhynchosia*) and genera (*Atylosia* and *Cajanus*) particularly in the Papilionaceous taxa. Both *Atylosia* and *Cajanus* belong to Phaseoleae and are botanically much related : leaves gland-dotted underneath, pods with depressed lines between the seeds, ovules 3 or more ; the presence of strophiolate seed type in *Atylosia* distinguishing this genus from the estrophiolate type characterising *Cajanus*.

During plant exploration to Mizoram, about 20 collections of *Cajanus cajan* were made and interestingly some of these local types possessed strophiolate seeds of dull whitish colour (Fig. 1). One of the collections even possessed brown testa with specks of black. Further screening of *Cajanus* germplasm being maintained by the Division of Plant Introduction at Amravati pointed out that such raised-hilum types are represented in collections made earlier from Maharashtra, Tamil Nadu, Bihar and Madhya Pradesh ; the tribal pockets having more of this material.

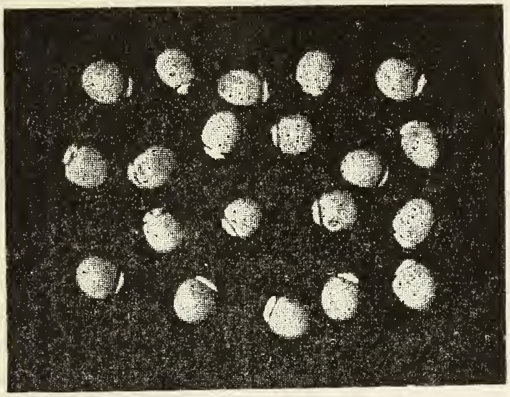

Fig. 1. Strophiolate seeds of *Cajanus cajan*.

In the light of the above, the presence of such strophiolate seed types in *Cajanus* should assume importance and will obviously have a bearing on the origin/relationship between these two genera ; in fact between the cultivated forms of *Cajanus* and their wild progenitor *Atylosia lineata*.

I am thankful to Shri M. W. Hardas, Head, Division of Plant Introduction, I.A.R.I., New Delhi for going through this note. My thanks are also due to Shri Bhagmal, Jr. Botanist, Plant Introduction Station, Amravati (Maharashtra) for screening the *Cajanus* seed material.

Division of Plant Introduction,
I.A.R.I., New Delhi-110 012,
February 20, 1976.

R. K. ARORA

35. SOME NEW RECORDS OF TROPICAL PLANTS FROM THE TEMPERATE KASHMIR VALLEY

The Valley of Kashmir forms a transitional region of diverse physical features between the weak monsoon zone of the Punjab and cold dry belt of Tibet, but shows little affinity with the climatic types prevalent in these adjoining areas. The Valley itself has a temperate-cum-Mediterranean climate of the continental type and therefore the vegetation is mostly temperate. However, there has been invasion of tropical and subtropical weeds from the adjoining areas by way of human agency. These elements have acclimatized and formed a part of the local vegetation. In the present communication some of these new elements are reported for record. The voucher specimens have been deposited in the Kashmir University Herbarium.

Amaranthaceae

Amaranthus spinosus L., Sp. Pl. 991 (1753).

Common in waste lands ; University Campus, GNJ 1051.

Alternanthera sessilis (L.) DC., Cat. Hort. Monsp. 77 (1813).

A common weed of warm countries ; Srinagar : along drains, GNJ 1563.

LYTHRACEAE

Rotala indica (Willd.) Koehne in Engl. Bot. Jahrb. 1 : 172 (1888).

A weed of rice fields ; Chandmari (Srinagar), GNJ 601.

R. leptopetala Koehne in Engl. Bot. Jahrb. 4 : 388 (1883) et Pfl-reich Heft 17 : 35 (1903).

Harwan ; rice fields, GNJ 822.

Both species are weeds of rice fields and it appears that they have been introduced with the paddy seeds from warm countries.

EUPHORBIACEAE

Chrozophora obliqua A. Juss. Tent. Euph. 28 (1824).

A weed of waste land ; Jawahir Nagar : GNJ 909.

CONVOLVULACEAE

Evolvulus alsinoides L., Sp. Pl. ed. 2, 392 (1762).

University Campus : waste land, GNJ 1040.

SCROPHULARIACEAE

Limnophila indica (L.) Druce in Rep. Bot. Exch. Cl. Brit. Isles 3 : 420 (1914). *L. gratioloides* R. Br., Prodr. 442 (1810).

Weed of rice fields, Shaliamar : GNJ 1036.

G. N. JAVEID

POSTGRADUATE DEPT.
OF BOTANY,
UNIVERSITY OF KASHMIR,
SRINAGAR,
February 2, 1976.

36. AN UNUSUAL RED-FLOWERED VARIANT OF *EUCALYPTUS TERETICORNIS* SM.

In the course of selective breeding and hybridization of eucalypts at this Institute for increased wood yields, we have come across an unusually red-flowered tree of *Eucalyptus tereticornis* ; an exotic species of Australian origin which is now well acclimatized and widely planted in India. The tree under discussion is one of a pair of even-aged 11 year old trees of the species planted near a hedge on the New Forest estate. One of these has consistently borne red flowers whereas in the other, the flowers are cream-coloured as is usual for this species. Further, although of the same age and growing only a metre of each other, the red-flowered tree is suppressed in height growth but has longer internodes, a more pronounced drooping habit, larger and thicker leaves with wavy margin. It appears therefore to be a deviant of the species and deserves further study. A herbarium specimen of this tree was sent to the Director, Royal Botanic Gardens, Sydney, Australia, for expert opinion. While confirming its botanical identity as *E. tereticornis* Sm. he observes that pink flowering forms of this species are known to occur as rare natural variants in Australia.

As is well known, a unique feature of the eucalypt flower is the lid or operculum which seals it and is cast off during the process of opening. Having no petals thereafter, the flower colour of this genus depends largely on the colour of the numerous stamen filaments. Comparatively few species of this very large Australian genus have pink, red, scarlet or yellow stamen filaments the vast majority have white or cream filaments which is generally also the case with *E. tereticornis*. However, in the exceptional tree of the species reported here, only newly opened flowers are of a cream colour. But as they get duly exposed to sunlight, their stamen filaments and styles turn permanently carmine red in colour, somewhat recalling in this respect those of the Bottle Brush tree (*Callistemon*), another ornamental of our gardens which, incidentally, is also a native of Australia and belongs to the same botanical family as *Eucalyptus*. Further, since within the 5-7 flowered cluster, the odd terminal flower is generally the first to open, it is also usually the first to thus change colour. Other flowers of the cluster follow suit in quick succession. Consequently, in early stages of blooming, both cream and red flowers can be seen within the same cluster. Such double coloration serves to enhance the beauty of the tree rendering it highly ornamental. The tree blooms during September-October which is the usual time of flowering of the species in Dehra Dun.

For some reason the variant red-flowered tree described above does not set seed unlike its normal neighbour, even in spite of hand pollination of its flowers with a pollen mixture. Controlled crossings using it as the pollen parent also failed to give any viable seed. While the exact cause of this sterility is under investigation, attempts are also being made simultaneously to propagate this tree vegetatively because of its potential horticultural value.

In conclusion, the photo-sensitive reddening, only upon exposure to light, of the stamen filaments of this unusual eucalypt is reminiscent of a similar development of the 'sun red' pigmentation on the anthers, glumes and husks of certain varieties of corn (Srb & Owen 1958).[1] It can serve as a simple and straight forward example for demonstrating to students the impact of environment on the expression of hereditary traits.

FOREST GENETICS BRANCH,
FOREST RESEARCH INSTITUTE,
NEW FOREST, DEHRA DUN-248 006,
March 25, 1976.

C. S. VENKATESH
V. K. SHARMA

[1] Srb, A. M. & OWEN, R. D. (1958): General Genetics. W.H. Freeman & Co., San Francisco, U.S.A.

37. A PRELIMINARY OBSERVATION ON THE FERNS OF THE GARO HILLS IN ASSAM

INTRODUCTION

There are few publications on the pteridophytic flora of the Eastern region of the Himalayas. Clarke (1880) reported only 269 species from 'Himalaya East of Nepal' and 258 from Assam to Chittagong. Recently Kachroo (1953) made a 'list of Ferns of Assam' and Panigrahi (1960) enumerated the pteridophytes of Eastern India (Orissa, Bihar, Assam and N.E.F.A.). The present observations are based on the collection of ferns made by J. Marten and T. D. Srinivasan who visited Garo Hills.

The Garo Hills are bounded on the north and west by the district of Goalpara, on the south by the Bangladesh district of Mymensingh and on the east by the district of the Khasi and Jaintia Hills. It lies between 25°2′ and 26°1′N and 89°49′ and 91°2′E and covers an area of 3140 square miles. Tura, the main range runs through the district from North-west to south-east.

The station of Tura is situated on a spur of the main range, and as it is only about 1300 feet above the level of the sea, the temperature at certain seasons of the year is fairly high. March and April are usually warm. November to February are the cold months in the year. Rainfall in Tura usually varies from 300-3125 cm.

Enumeration of the Species

The list of the pteridophytes given in the following pages is based on the collection of J. Marten and T. D. Srinivasan during the year 1903 and 1929, 1933-1935. The arrangement of the families of ferns is according to the phylogenetic scheme proposed by Mehra (1961). In the enumeration of each species, citation of references, basinym and synonym and place of collection are given followed by herbarium collection number, if any, of the previous authors. The species cited are all deposited in Herb (CAL).

Family : Cryptogrammaceae

Genus : *Onychium* Kaulf.

Onychium siliculosum (Desv.) C. Chr. Index Fil. 469. 1906 Garo Hills, June 1903, J. Marten.

Basinym : *Pteris siliculosum* Desv. in Ges. Freunde. Berlin. Mag. **5** : 324. 1811.

Synonym : *Onychium auratum* Kaulf. Enum. 144. 1824 Garo Hills, June 1903, J. Marten, s.n.

Family : Pteridaceae

Genus : *Pteris* Linn.

Pteris ensigormis Burm. Fl. Ind. 230. 1768.

Synonym : *Pteris crenata* Seo. Schard. Journ. 1800/2 : 5. 1801 Garo Hills, June 1903. J. Marten.

Pteris quadriaurita Retz. in Obs. Bot. **6** : 38. 1791 (sensu lato) : Clarke in Trans. Linn. Soc. Lond. II. Bot. 1 : 465. 1880 (Pro parte).

Garo Hills, Assam, T. D. Srinivasan 131.

Family : Dennstaedtiaceae

Genus : *Microlepia* Presl.

Microlepia strigosa (Thbg.) Presl. Epim. Bot. 95. 1849.

Basinym : *Trichomanes strigosum* Thbg. Fl. Jap. 339. 1784.

Synonym : *Davallia strigosa* Sw. Adnot. 69. 1829. *D. polypodioides* Don var. *strigosa* Clarke in Trans. Linn. Soc. Lond. II. Bot. 1 : 448. 1880.

Garo Hills, June 1903, J. Marten, s.n.

Microlepia trapeziformis (Roxb.) Kuhn, Chaetopt. 347. 1882.

Basinym : *Davallia trapeziformis* Roxb. Calc. Journ. **4** : 516. 1844.

Synonym : *Davallia rhomboidea* Wall. cat. (nom. nud.) Kze, Bot. Zeit. 8 : 158, 1850.

Microlepia rhomboidea Presl. Tent. Pterid. 125. 1836.

M. polypodioides Bedd. Ferns. S. Ind. t. 15. 1865.

Garo Hills, June 1903, J. Marten, s.n.

Microlepia speluncae (L.) Moore, Index. Fil. xciii. 1857.

Basinym : *Polypodium speluncae* Linn. spec. Pl. 2 : 1093, 1753.

Garo Hills, June 1903, J. Marten.

Microlepia hirta (Klf.) Pr. Tent. 125. 1836.

Basinym : *Davallia hirta* Klf. Enum. 223. 1824.

Synonym : *D. villosa* Don, Prod. Fl. Nepal 10. 1825.

Micr olepia speluncae L. var. **hirta** Bedd. Ferns Brit. Ind. & Ceylon. 68. 1969 (Reprint. Ed.)

Garo Hills, Assam, T. D. Srinivasan 172.

Microlepia marginata (Hoult.) C. Chr. Index Fil 212. 1905.

Basinym : *Polypodium marginatum* Hoult. Pfl. S,yst 13. 199. 1786.

Synonym : *Davallia marginata* Bak. Synop. Fil. 452, 1868.

Garo Hills, June 1903, J. Marten, s.n.

Family : Lindsayaceae

Genus : *Lindsaya* Dryander

Lindsaya stricta (Sw.) Dry. Tr. Linn. Soc. **3** : 42. 1797.

Basinym : *Adiantum strictum* Sw. Prod. 135. 1788.

Synonym : *Lindsaya lucida* Bl. Enum. Pl. Jav. 216. 1828. *L. gracilis* Kl. Linn. **18** : 549. 1844.

Garo Hills, Assam, T. D. Srinivasan, 264.

Genus : *Sphenomeris* Maxon

Sphenomeris chusana (L.) Copel. Bishop. Mus. Publ. **59** : 69. 1929 var. *tenuifolia* (Sw.) C. Chr. Pterid. Madag. 78. Pl. 27. 1932.

Synonyms : *Davallia tenuifolia* Sw. Schrad. Journ. 1800/2 : 88. 1801.

Stenoloma tenuifolia Fee. Gen. Fil. 330. 1850-52.

Garo Hills, June 1903. J. Marten, s.n.

Family : Davallinaceae

Genus : *Davallia* J. Smith

Davallia trichomanoides Bl. Enum. Pl. Jav. 238. 1828.

Synonym : *D. bullata* Wall. cat. No. 258 (nom. nud.) Hook. Spec. Fil. **1** : 169. t. 506. 1846.

Garo Hills, June 1903, J. Marten, s.n.

Family : Gleicheniaceae

Genus : *Dicranopteris* Bernh.

Dicranopteris linearis (Burm.) Underwood in Bull. Torrey Bot. d. **34** : 250. 1907.

Basinym : *Polypodium lineare* Burm. Fl. Ind. 235. t. 67. 1768.

Synonym : *Gleichenia linearis* (Burm.) Clarke Trans. Linn. Soc. Lond. II. Bot. **1** : 428, 1880.

G. dichotoma Hk. spec. Fil. **1** : 12. 1844.

Garo Hills, Assam, J. D. Srinivasan, 105.

Family : Cyatheaceae

Genus : *Cyathea* Smith

Cyathea andersoni Copel. Phil. Jour. Sci. **4c** : 56, 1909.

Synonym : *Alsophila andersoni* J. Scott. in Bedd. Ferns. Brit. Ind. t. 310, 1869.

Garo Hills, June 1903, J. Marten, s.n.

Family : Athyriaceae

Genus : *Diplazium* Swartz

Diplazium spectabile (Wall. ex Mett.) Bir. Res. Bull. Punjab Univ. (N.S.) **12** : 130, 1961.

Basinym : *Asplenium spectabile* Wall. ex Mett. Abhandh. Senck. Naturf. Gesell. **3** : 240. 1860.

Synonyms : *Diplazium umbrosum* var. *multiicaudatum* Bedd. Handb. Ferns. Brit. Ind. 190, 1883.

Asplenium multicaudatum Wall. List. no. 229, 1828. Clarke in Trans. Linn. Soc. Lond. II Bot. **1** : 502, 1880.

Garo Hills, Assam, T. D. Srinivasan. s.n.

Diplaziopsis javanica (Bl.) C. Chr. Index Fil. 227. 1905.

Basinym : *Asplenium javanicum* Bl. Enum. Pl. Jav. 175, 1828.

Synonym : *Allantodia javanica* Trevis, Nu. Giarn. Bot. Jt. 159. 1875.

Garo Hills, Assam, T. D. Srinivasan, 1773.

Family : Thelypteridaceae

Genus : *Thelypteris* Schmilel

Thelypteris decipiens (Clarke) Ching, Bull. Fan. Mem. Just. Biol. Bot. **6** : 325. 1936.

Basinym : *Nephrodium gracilescens* var. *decipiens* Clarke, Trans. Linn. Soc. Lond. II Bot. **1** : 514, 1880.

Synonym : *Lastraea gracilescens* var. *decipiens* Bedd. Handb. Ferns, Brit. Ind. Suppl. 51. 1892.

Garo Hills, Assam, June 1903, J. Marten, s.n.

Thelypteris semisagittata (Roxb.) Morton, Contrib. U.S. Nat. Herb. **38** (7) : 360. 1974.

Basinym : *Polypodium semisagittatum* Roxb. Cal Journ. Nat. Hist. **4** : 491, 1844.

Garo Hills, June 1903, J. Marten, s.n.

Genus : *Cyclosorus* Link

Cyclosorus crinipes (Hook.) Ching, Bull. Fan. Mem. Inst. Biol. **8** : 199, 1938.

Basinym : *Nephrodium crinipes* Hk. Spec. Fil. **4** : 71, 1862.

Synonym : *Dryopteris crinipes* (Hk.) O. Ktze, Rev. Gen. Pl. **2** : 812, 1891.

Garo Hills, June 1903, J. Marten, s.n.

Cyclosorus dentatus (Forsk.) Ching, in Bull. Fan. Mem. Inst. Biol. **8** : 206, 1938.

Basinym : *Polypodium dentatum* Forsk. Fl. Aegypt. 185, 1775.

Synonym : *Nephrodium molle* Bedd. Ferns. Brit. Ind. 277, 1883.

Garo Hills, Assam, June 1903, J. Marten, s.n.

Cyclosorus parasiticus (L.) Farwell in Amer. Midl. Naturalist **12** : 259, 1931.

Basinym : *Polypodium parasiticum* Linn. Spec. Plant. **2** : 1090, 1753.

Synonym : *Nephrodium parasiticum* Clarke in Trans. Linn. Soc. Lond. II. Bot. **1** : 533, 1880.

N. molle R. Br. Prodr. Fl. N. Holl. 149, 1810.

Dryopteris parasitica (L.) O. Ktze. Rev. Gen. Plant. **2** : 811, 1891.

Garo Hills, Assam, June 1903, J. Marten, s.n.

Cyclosorus latipinna (Hk.) Jardin—Blot. Not. Syst. **7** : 73, 1938.

Basinym : *Nephrodium latipinna* Hk. Syn. Fil. 292, 1867.

Synonym : *Dryopteris latipinna* O. Ktze, Rev. Gen. Pl. **2** : 813, 1891.

Garo Hills, Assam, June 1903, J. Marten, s.n.

Family : ASPLENIACEAE

Genus : *Asplenium* Linn.

Asplenium unilaterale Lamk. Encyc. **2** : 305, 1786.

Synonym : *Asplenium resectum* J. Sm. Jc. Pl. **3** : t. 72, 1791 ; Bedd., Ferns. South Ind. t. 132, 1863.

Garo Hills, Assam, T. D. Srinivasan, 171.

Asplenium nidus Linn. Spec. Pl. **2** : 1079, 1753.

Synonym : *Thamanopteris nidus* Presl. Epim. Bot. 68. 1849.

Garo Hills, Assam, T. D. Srinivasan, 256.

Asplenium simonsianum Hk. Jc. Pl. t. 925, 1854.

Synonym : *Thamanopteris simonsiana* Moore, Ind. L. 1857.

Garo Hills, Assam, June 1903, J. Marten, s.n.

Family : POLYPODIACEAE

Genus : *Pyrrosia* Mirbd.

Pyrrosia adnascens (Forst.) Ching, Bull. Chin. Bot. Soc. **1** : 45, 1935.

Basinym : *Polypodium adnascens* Forst. Prodr. 81. 1786.

Synonym : *Cyclophorus adnascens* Desv. Berl. Mag. **5** : 300, 1811.

Garo Hills, Assam, June 1903, J. Marten, s.n.

Pyrrosia nummularifolia (Sw.) Ching, Bull. Chin. Bot. Soc. **1** : 47, 1935.

Basinym : *Acrostichum nummularifolium* Sw. Syn. Fil. 191, 419, 1806.

Synonym : *Niphobolus nummularifolius* J. Sm. JOB. **3** : 396, 1841.

Cyclophorus nummularifolius (Sw.) C. Chr. Ind. Fil. 200. 1905.

Garo Hills, Assam, June 1903, J. Marten, s.n.

Pyrrosia stigmosa (Sw.) Ching, Bull. Chin. Bot. Soc. **1** : 67, 1935.

Basinym : *Polypodium stigmosum* Sw. Schrod. Journ. 1800, **2** : 21, 1801.

Synonym : *Niphobolus stigmosus* Moore, in Bedd. Handb. Ferns. Brit. Ind. 328, 1883.

Garo Hills, Assam, June 1903, J. Marten, s.n.

Genus : *Pseudodrynaria* C. Chr.

Pseudodrynaria coronaus (Wall.) Ching, Sunyatsenia **5** : 357, 1940 and **6** : 10, 1941, and Ic. Fil. Sinica **5** : Pl. 201, 1958.

Basinym : *Polypodium coronans* Wall., List No. 288, 1828 (nom. nud.)

Synonym : *Drynaria coronans* J. Smith, Jour. Bot. **4** : 61, 1841.

Garo Hills, Assam, June 1903, J. Marten, s.n.

Genus : *Leptochilus* Kaulfuss.

Leptochilus scalpturatus (Fee) C. Chr. Ind. Fil. **17** : 1905.

Basinym: *Heteroneuron scalpturatum* Fee Acrost. 95 t. 56. 1845.

Synonym : *Gymnopteris costata* Bedd. Ferns. Brit, Ind. Suppl. 27. 1876.

Garo Hills, Assam, June 1903. J. Marten, s.n.

ACKNOWLEDGEMENTS

We are grateful to Dr. J. K. Maheshwari, Director-in-charge, Botanical Survey of India for encouragment in the work and Dr. R. S.

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CENTRAL NATIONAL HERBARIUM,
BOTANICAL SURVEY OF INDIA,
SIBPORE, HOWRAH,
March 19, 1976.

R. B. GHOSH
M. C. BISWAS

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38. TWO NEW RECORDS OF FUNGI-IMPERFECTI FROM INDIA[1]

(*With two text-figures*)

During our investigations on the ecology of forest fungi, two rare forms were collected from the forests of Varandha Ghat and Raireshwar (Maharashtra) recently, which were identified as belonging to the form-genera: *Spilodochium* Syd. (Ellis 1971) and *Tetranacrium* Hds. & Sutton (Hudson and Sutton 1964). The present paper briefly describes these two fungi:

Spilodochium indicum sp. nov. (Fig. 1)

Coloniae effusae, fusce-brunnea, pseudo-parenchymatibus, pallide-brunnea, mycelio immersa; Conidiophora stromatibus; Conidia orientalis ex cellulis stromatis; Conidia (blastosporae) productae terminaliter vel lateraliter ex cellula blastosporae apicali, ovoidia vel ellipsoidia, magnit 4-8 × 4-6 μ: blastospora cellulae apicem fertilis, arida, acropleurogena, simplicia, ellipsoidia vel ovoidia, brunnea, levia, uni-septata vel raro bi-septata 8-10 × 4-8 μ.

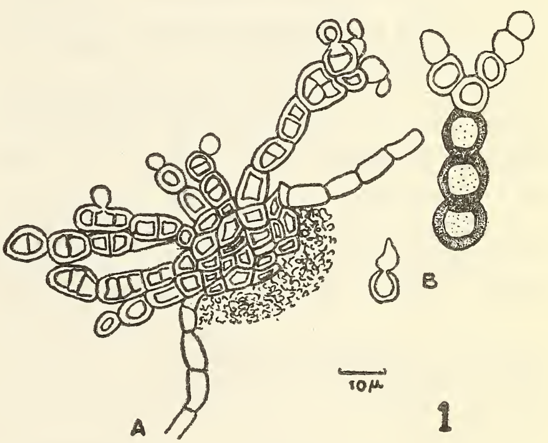

Fig. 1. *Spilodochium indicum* sp. nov.
A. Sporodochium.
B. Conidia.

Matrix: On living leaves of *Machilus macrantha* Nees, (Fam. Sapindaceae) Leg.

[1]Contribution No. 573 from the Dept. of Mycology & Plant Pathology.

A.W.S. (4-12-1974) ad Varandha Ghat (Maharashtra State) No. AMH 2743 (Holotypus).

The genus *Spilodochium* Syd. is monotypic with *S. vernoniae* Syd. (Ellis 1971) as type. On comparison with the type species, the writer's collection differed significantly in respect of dimensions of pseudostroma and conidia and hence the same has been accommodated here as a new species.

This genus—*Spilodochium*—constitutes a new addition to the fungi of India (Mukerji & Juneja 1975).

Tetranacrium eugeniae sp. nov. (Fig. 2)

Pycnidia brunnea, immersa, hysteriformia, magnit 128-305 × 226-370 μ ; Conidiophora erecta 3-5 μ longa, non-ramosa, aseptata, hylina excellulis interiorbus prarietis pycnidiorum composita ; Conidia singula, acrogena, pallidebrunnea, ramosa, composita ex quarter ramis equalibus vel fere aequalibus, divergentibus ex medio primordio globoro orientibus, 3-5 septatis, plerumque quarter, apicem versus attenuatis basefortiter constrictis ramo principali elongato ramis secundariis elongatis, triverticillatis ex primordio globoro orientibus, magnit 20-60 × 2-3.5 μ.

Matrix : On stems of *Eugenia jambolana* Lamk. (Fam : Myrtaceae) Leg. A.W.S. (20-1-1976) ad Raireshwar (near Poona) No. AMH 2868 (Holotypus).

T. eugeniae is distinct from the type species, *T. graminum* Huds. & Sutton (Hudson & Sutton 1964) in possessing smaller pycnidia and larger conidia. The form-genus *Tetranacrium* has not been reported so far in the lists of Indian fungi (Mukerji & Juneja 1975).

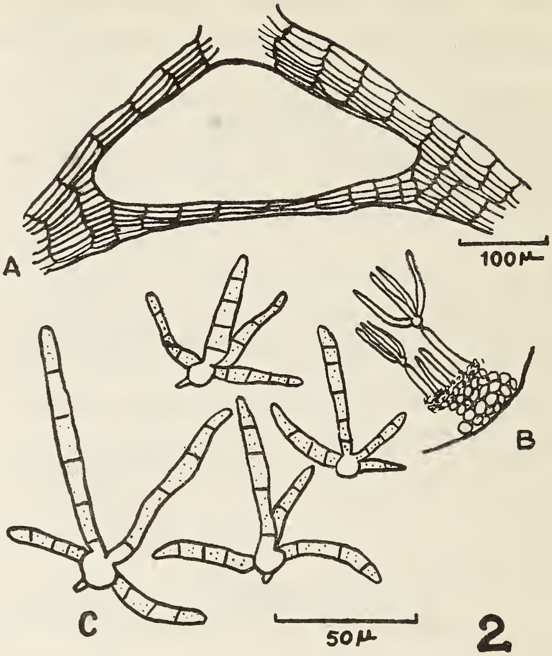

Fig. 2. *Tetranacrium eugeniae* sp. nov.
A. Pycnidium in V. S.
B. Conidiophores with conidia.
C. Conidia.

We are thankful to Prof. M. N. Kamat for his valuable advice, to the Director for the laboratory facilities and to the Ministry of Education, Govt. of India for the award of Research Scholarship to the Senior Author.

M.A.C.S. Research Institute,
Pune 4, (India),
May 25, 1976.

A. W. SUBHEDAR
V. G. RAO

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39. DESMIDS OF NAGPUR, MAHARASHTRA

So far only one desmid *Cosmarium reinschii* Arch. has been recorded from the cultures of the paddy field soils of Nagpur by Kamat & Patel (1973). Here forty-four desmids belonging to eight genera of Mesotaeniaceae and Desmidiaceae are recorded for the first time. These have been collected from a few places during July 1973 to May 1974. The pH of the water of the collection spots was determined by using B.D.H. Universal indicator and was found to range between 7.5 to 8.7.

Nagpur, a centrally situated city in India, is 307 metres above m.s.l. The average rainfall is 110 cm. The average minimum and the maximum temperatures are 7°C in January and 46°C in May respectively.

The desmids commonly occur in waters having pH between 5 and 6. However Croasdale (1955) and Kamat (1965) found them common even in waters with pH 7.6 to 8.5. The newly constructed cisterns in Nagpur usually contain *Cosmarium* spp. in large numbers. It is also worth recording that the desmids and in particular Closterias were abundant in the big earthen pots specially maintained for the algal cultures in the Botany garden of the Institute of Science, Nagpur. At other collection spots they were rather rare.

Mesotaeniaceae

Mesotaenium mirificum Arch.

In a puddle, Seminary hills (27-7-73).

Gonatozygon montaenium De Bary

In a small pond, Amraoti road (28-7-73).

G. pilosum Wolle

In a pool, Dharampeth (28-8-73).

Cylindrocystis brebissonii Menegh.

In a puddle, Dharampeth (24-7-73).

C. brebissonii Menegh. v. **minor** W. et G. S. West

In a pool, Ravinagar (29-7-73).

C. pyramidatum W. et G. S. West

In a puddle, Hingana road (4-8-73).

The present alga is longer (up to 39 μ long) than the type.

Roya cambrica W. et. G.S. West

In a puddle, Seminary hills (25-7-73).

The alga (6-9 μ broad and 90-96 μ long) is slightly smaller than the type.

Desmidiaceae

Closterium dianae Ehrenberg

Common in puddles, earthen pots (July to May).

C. gracile Breb.

In a puddle, Kamathi road (12-8-73).

C. kolhapurense Kamat forma

In a puddle, Seminary hill (30-7-73). In earthen pots (August-May).

The alga is slightly smaller than the type.

C. lanceolatum Kuetzing

Common in puddles, earthen pots (August-September).

C. leibleinii Kuetzing

Floating mucilaginous masses in earthen pots (August-February).

C. littorale Gay

Along with other desmids in earthen pots (August-May).

C. moniliferum Menegh. v. **concavum** Klebs

Floating along with other desmids in earthen pots (October-May).

C. strigosum Breb.

In a puddle, Sitabuldi (28-9-73).

C. venus Kuetzing

In a pond, Ramnagar (13-7-73).

C. venus Kuetzing v. **incurvum** (Breb.) Krieger

In a puddle, Dharampeth (24-7-73).

A form, 81-90 μ long was found in earthen pot (May).

Cosmarium angulosum Breb.

In puddles, Seminary hills (24-7-73).

C. binodulum Reinsch

In a puddle, Ravinagar (23-8-73).

C. botrytis Menegh.

In a puddle, Dharampeth (23-7-73).

C. clepsydra Nordst.

In an earthen pot (August).

C. cucurbitinum (Biss.) Luetkem. v. **minor** (West) Luetkem.

In a puddle, Seminary hills (27-7-73).

The alga is smaller (22-24 μ broad, 44-46 μ long) than the type.

C. curtum Breb.

In a puddle, Ravinagar (12-8-73).

C. lundellii Delp. v. **ellipticum** West

Floating along with other algae in earthen pots (August-May).

C. minutum W. et G.S. West v. **rotundatum** Messik.

In earthen pots (August-September).

C. moniliformae (Trub.) Ralfs forma

Rare. In a puddle, Ravinagar (27-8-73).

The present alga is much bigger (56-58 μ broad, 99-105 μ long) than the type.

C. nitidulum De Not v. **subundatum** Schmidle

Planktonic in an earthen pot (August-February).

C. pandreforme Turner

In a puddle, Sitabuldi (12-8-73).

C. pseudopyramidatum Lund

Rare. In a puddle, Ravinagar (27-9-73).

C. pseudopyramidatum Lund v. **corniolicum** Luetkem.

In an earthen pot (August-January).

C. quandrum Lund

In a puddle, Amraoti road (21-8-73).

C. raciborskii Lagerheim

In a rainwater pool, Dharampeth (24-7-73). In an earthern pot (20-8-73).

C. retusum (Perty) Rabenh. v. **angustatum** W. et G.S. West

In a puddle, Dharampeth (24-8-73).

C. sexangulare Lund v. **minima** Nordst.

Floating along with other algae in earthen pots (August-October).

C. sikhimense Turner

Along with other algae in an earthen pot (September).

C. subcostatum Nordst.

In a pool, Sitabuldi (17-7-73).

C. subtumidum Nordst. v. **klebsii** W. et G. S. West

In a puddle, Seminary hills (29-9-73).

C. undulatum Corda

Common in puddles (August-September).

C. wittrockii Lund

Floating along with other algae in earthen pots (August-October).

Euastrum spinulosum Delp.

In puddles, pools, ponds (July-September).

Staurastrum lapponicum (Schmidle) Gronbald

Along with other algae in earthen pots (August-May).

S. muticum Breb.

In a puddle, Ravinagar (23-8-73).

S. polymorphum Breb.

Along with other algae in earthen pots (August-February).

S. punctulatum Breb.

In a puddle, Amraoti road (21-9-73).

BOTANY DEPARTMENT,
INSTITUTE OF SCIENCE,
AURANGABAD.

N. D. KAMAT

SINDHU VIDNYAN MAHAVIDYALAYA,
NAGPUR,

S. R. TIWARI

January 7, 1976.

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JOURNAL
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Vol. 74 SUPPLEMENTARY ISSUE

Hydrozoa from the coastal waters of Maharashtra

Part I. Hydromedusae[1]

JACOB THOMAS[2]
AND
B. F. CHHAPGAR[3]

(*With three plates*)

Nineteen species of hydromedusae were collected from inshore waters of Maharashtra, but mainly from Bombay. Earlier authors have recorded only six species of these hydromedusae from Bombay.

One medusa, *Aglauropsis vannuccii*, was found to be new to science. Four species—*Aequorea australis*, *Eutonina indicans*, *Phialidium malayense* and *Podocoryne ocellata*, are recorded for the first time from India.

Eight other medusae are recorded for the first time from Maharashtra.

Marine hydroids and hydromedusae, though of common occurrence in the coastal waters of Maharashtra, have not been given the attention they deserve. They are considered to be of relatively little importance, since they do not comprise an item of human diet or otherwise contribute to economic value. Previous studies on hydromedusae from Indian coasts have mainly been restricted to the south. Thus, M. A. S. Menon (1945), Nair (1951), George (1953), and Vannucci and Santhakumari (1969) have studied these animals from Kerala. Taxonomic accounts of these forms from Madras are by K. S. Menon (1931) and M. G. K. Menon (1932). The only other work on the east coast is that of Ganapati & Nagabhushanam (1958) from Visakhapatnam. The collection of hydromedusae in the Indian Museum (from the Nicobar Islands, Visakhapatnam, Orissa, Mergui Archipelago, and Burma) was studied by Kramp (1958).

Browne (1916) pioneered the study of hydromedusae from western Indian coast, with his description of two forms, namely, *Amphogona*

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apsteini and *Solmundella bitentaculata* together with the siphonophore (*Dichyopsis chamissonis* and the scyphomedusa *Cassiopea andromeda* var. *maldivensis*) from Okhamandal, Gujarat State. The only other study, albeit sparse, of medusae from western Indian coasts is by Lele & Gae (1935) who recorded six species from Bombay harbour. Bal & Pradhan (1952) could not add any more species to Lele and Gae's list.

During taxonomic study of the hydromedusae collected from the coastal waters of Maharashtra, 19 species, belonging to 16 genera and five Orders, were identified. One of these turned out to be new to science, and has been described in detail earlier (Thomas & Chhapgar 1975). Four species are new records for India, while eight species have been collected for the first time from Maharashtra. All the 19 species recorded from Maharashtra were found at Bombay.

The hydromedusae, obtained by horizontal hauls with a plankton net, were preserved by adding 12.5 ml formaldehyde (40%) to about 100 ml of sea water containing the animals. Places other than Bombay could not be visited frequently, but collections in the Bombay harbour were made once every fortnight. It was found that the hydromedusae were apparently absent in the harbour during monsoon (June-September). The largest numbers of medusae were collected during the pre-monsoon period, but in post-monsoon period their number was considerably reduced. This is because the coastal waters, especially in semi-enclosed places like the Bombay harbour, are subjected to heavy monsoon rains which results in dilution from a normal salinity of 36‰ to as low as 13‰. Bhattacharya (1971), in laboratory studies on the salinity tolerance of hydromedusae from Bombay, concluded that these animals are intolerant of such dilutions. Even in a 40% dilution of sea water, no species of hydromedusae could survive for 48 hours.

Order ANTHOMEDUSAE

Family TUBULARIIDAE

Genus **Euphysa** Forbes

Euphysa aurata Forbes

Plate I (a)

Euphysa aurata Forbes, *Monogr. Brit. naked-eyed medusae* : 71 (1848) ; Kramp, *J. Mar. biol. Ass. U.K.* 40 : 36 (1961) ; Vannucci & Santhakumari, *J. Mar. biol. Ass. India* 11 : 40 (1969).

Steenstrupia aurata Mayer, *Medusae of the world* : 35 (1910).

Corymorpha aurata Ostenfeld, *Publ. circ. cons. Explor, Mer.* **70** : 42 (1916).

Steenstrupia virgulata Bigelow, *Pap. Boston Soc. nat Hist.* 7 : 5 (1914).

Umbrella bell-shaped with rounded apex, without apical canal. Tentacle moniliform with nematocyst rings and devoid of a large terminal knob. Three non-tentacular, perradial marginal bulbs present. Stomach large, tubular, extending up to the velar opening, with a circular, simple mouth. Lips and oral tentacles absent. Four narrow radial canals join the ring canal at the margin. Gonads simple and encircle almost the whole of the stomach, leaving only the upper end of the stomach and mouth free. Excretory papillae ocelli and sense organs absent.

The species can be distinguished by the presence of one tentacle and three non-tentacular perradial marginal bulbs, rounded apex, and absence of apical canal. The tentacle is moniliform and devoid of a large terminal knob. Nematocyst rings are present on the tentacle.

28 specimens, including 11 young, were collected. The adults measure up to 4 mm in height and a little less in width.

This species was first recorded in the Indian Ocean by Vannucci & Santhakumari (1969) from Kerala. This is the first record from the coasts of Maharashtra.

It has been recorded from the coastal waters of Chile, China, Philippines, and the east coast of Malacca in the Pacific Ocean. It also occurs along both the coasts of the Atlantic Ocean as well as in the Mediterranean and Adriatic Seas.

Genus **Euphysora** Maas

Euphysora bigelowi Maas

Plate I (b)

Euphysora bigelowi Maas, *Siboga Exped. Monogr.* **10** : 71 (1905) ; Nair, *Bull. Cent. Res. Inst., Univ. of Travancore* **2** : 50 (1951) ; Ganapati & Nagabhushanam, *Mem. Oceanogr. Andhra Univ.* **2** : 92 (1958) ; Kramp. *Rec. Ind. Mus.* **53** : 340 (1958) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 39 (1961).

Steenstrupia bigelowi Mayer, *Medusae of the world* : **39** (1910) ; Lele & Gae, *J. Univ. Bombay* **3** : 91 (1935) ; Bal & Pradhan, ibid. **20** : 76 (1952).

This species can be distinguished by the presence of single long tentacle with adaxial nematocyst knobs, and three short tentacles without nematocyst knobs. Apex pointed but without apical canal. The gonad encircles the peduncle.

It is a strictly neritic, epipelagic medusa. 33 specimens, of which 8 are young, are in the present collection. A typical medusa measures 13 mm in height and 5 mm in width.

This species has been previously recorded from Bombay waters by Lele & Gae (1935) and by Bal & Pradhan (1952) as *Steenstrupia bigelowi*. It is quite common in the Indo-Malayan region, coasts of Africa, southern Japan, China, and off north-eastern Australia.

Family Pandeidae

Genus **Merga** Hartlaub

Merga tergestina (Neppi & Stiasny)

Plate I (c)

Tiara tergestina Neppi & Stiasny, *Zool. Anz. Leipzig* **39** : 556 (1912).

Merga tergestina Kramp, *J. Mar. biol. Ass. U.K.* **40** : 107 (1961) ; Vannucci & Santhakumari, *J. Mar. biol. Ass. India* **11** : 40 (1969).

non Kramp, *Atlantide Rep.* **3** : 250 (1955).

Top of the umbrella pointed and without an apical canal. Manubrium about two-thirds as high as the bell cavity, with faintly crenulated lips, without nematocyst knobs. The 4 to 8 tentacles have large conical basal bulbs, each of them having ocelli, but there are a few very small rudimentary bulbs without ocelli. Gonads adradial, mesenteries short.

Three specimens were collected, about 7mm high and 4 mm wide.

This is the first record of this species from Maharashtra. Vannucci & Santhakumari (1969) have previously recorded it from Cochin waters. It also occurs in the Gulf of Guinea, at Trieste and Naples and in Adriatic Sea.

Family Hydractinidae

Genus **Podocoryne** Sars

Podocoryne ocellata (Agassiz & Mayer)

Plate I (e)

Lymnorea ocellata Agassiz & Mayer, *Mem. Mus. comp. zool. Harv.* **26** : 144 (1902) ; Mayer, *Medusae of the world* : 153 (1910).

Podocoryne ocellata Kramp, *J. Mar. biol. Ass. U.K.* **40** : 70 (1961).

Medusa with deep, bell-shaped umbrella with flat top and thin walls. Manubrium half as long as the bell cavity, with four branched oral tentacles. Four, narrow, straight, unbranched radial canals with four interradial gonads.

There are 30-40 short, solid, stiff marginal tentacles with quite prominent basal bulbs, each with a prominent adaxial ocellus.

Marginal and lateral cirri and sense organs absent.

This species can be distinguished by the manubrium being half as long as the bell cavity, the oral arms divided four times, presence of four interradial gonads, and about 40 short, stiff tentacles, each with a prominent adaxial ocellus.

Nine specimens were collected, measuring 2-3 mm in height as well as width.

This is the first record of this species from Indian seas. It has earlier been recorded from Paumotus, in the South Pacific Ocean.

Order LEPTOMEDUSAE

Family AEQUOREIDAE

Genus **Aequorea** Peron & Lesueur

Aequorea conica Browne

Plate I (d)

Aequorea conica Browne, *Rep. Pearl Oyst. Fish. Mannar* **27** : 145 (1905) ; Nair, *Bull. Cent. Res. Inst. Univ. Travancore* **2** : 68 (1951) ; Ganapati & Nagabhushanam, *Mem. Oceanogr. Andhra Univ.* **2** : 92 (1958) ; Kramp, *Rec. Ind. Mus.* **53** : 360 (1958) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 206 (1961).

Gelatinous substance in the high, conical umbrella very thick in the central part, the ridge being thin with a narrow velum. Subumbrellar side convex. Gastric peduncle absent. Stomach broad, flat—half as wide as the umbrella diameter, with 16 crenulated, long, slender lips. These latter have a furrow continuing along the inside of the stomach to the 16 simple (undivided) narrow radial canals. The 16 laterally compressed, smooth gonads are situated on the proximal half of the radial canals.

From 26 to 30 hollow, small tentacles, with conical basal bulbs and excretory pores. Statocysts twice as many as tentacles, each with two concretions between the marginal bulbs and the tentacles. Cordyli, marginal or lateral cirri, ocelli and excretory papillae absent.

This species can be distinguished by its high, conical umbrella, with gonads at the proximal half of the 16 radial canals, a mouth with long and slender lips, and about 30 tentacles (twice the number of radial canals).

29 specimens were collected. Average height is 12 mm and width 9 mm.

This is the first record of the species from Maharashtra. The species is quite common in the coastal waters of India. Nair (1951) recorded it from Trivandrum, Ganapati & Nagabhushanam (1958) from Visakhapatnam and Kramp (1958) from the Mergui Archipelago. Outside India, it is common in the Malayan Archipelago, Mozambique Channel, China and in north Australian coastal waters.

Aequorea australis Uchida

Plate I (g)

Aequorea australis Uchida, *J. Fac. Sci. Hokkaido Univ.* **9** : 307 (1947) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 205 (1961).

Aequorea forskalea Vanhcffe, *Zoologica Stuttgatr* **67** : 24 (1913).

Distinguished from *A. conica* by its low umbrella, up to 35 mm in diameter, concave sub-umbrella. Lips present but very small and highly frilled. Tentacles as many as radial canals. Basal bulbs with excretory papillae. Gonads more than half as long as the radial canals and situated nearer the margin than the stomach.

11 specimens are in the present collection, with the umbrella measuring 10-20 mm in diameter.

This is the first record of this species from the coasts of India. It occurs in the coastal waters of the Indo-west Pacific region, from East Africa to Tahiti, northwards to China and southwards to north-eastern Australia.

Family EIRENIDAE

Genus **Eirene** Eschscholtz

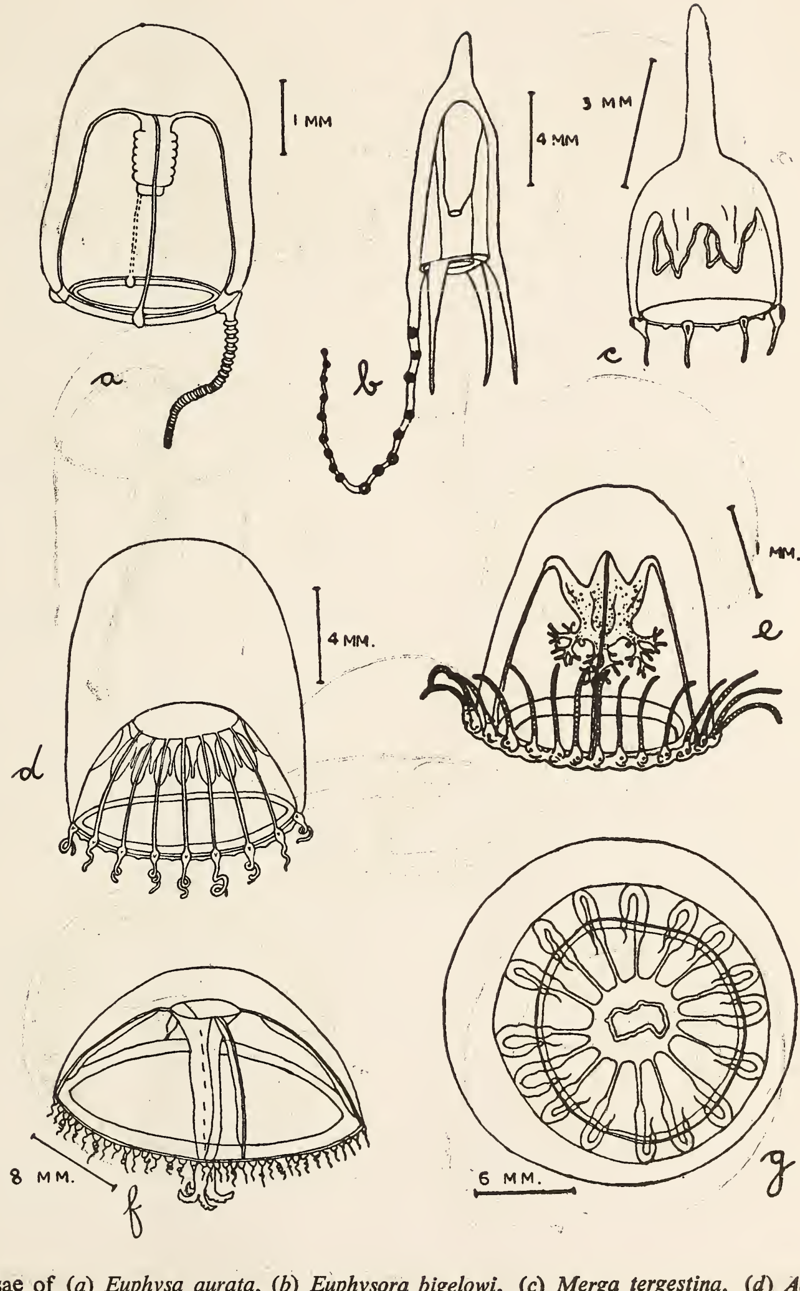
Eirene ceylonensis (Browne)

Plate I (f)

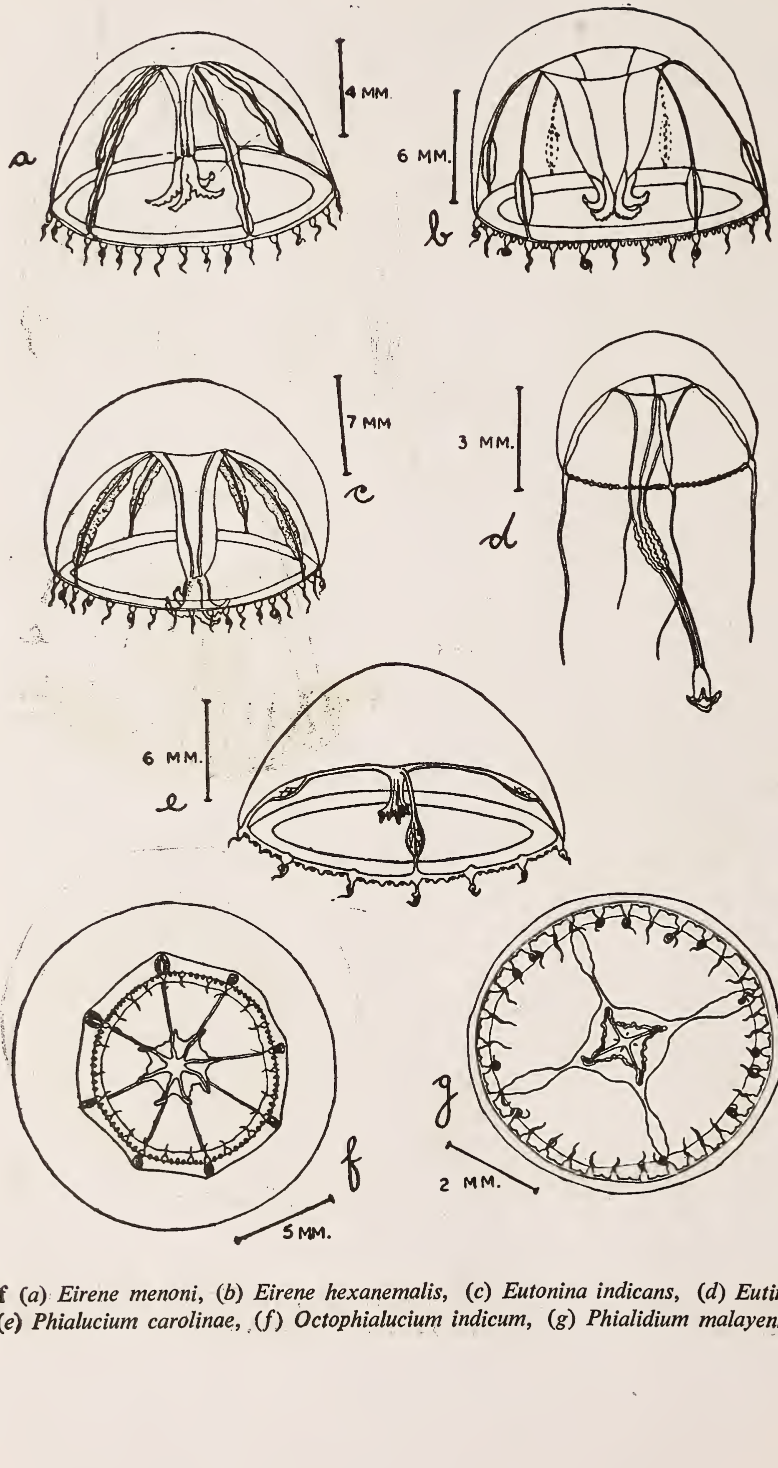
Irene ceylonensis Browne, *Rep. Pearl Oyst. Fish. Gulf of Mannar* **27** : 140 (1905).

Eirene ceylonensis Bigelow, *Mem. Mus. Comp. Zool. Harvard* **37** : 160 (1909) ; Nair, *Bull. Cent. Res. Inst., Univ. Travancore* **2** : 64 (1951) ; Kramp, *Rec. Ind. Mus.* **53** : 352 (1958) ; Ganapati & Nagabhushanam, *Mem. Oceanogr. Andhra Univ.* **2** : 92 (1958) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 187 (1961).

Phortis ceylonensis Lele & Gae. *J. Univ. Bombay* **3** : 92 (1935) ; Bal & Pradhan, ibid. **20** : 76 (1952).



Medusae of (*a*) *Euphysa aurata*, (*b*) *Euphysora bigelowi*, (c) *Merga tergestina*, (*d*) *Aequorea conica*, (*e*) *Podocoryne ocellata*, (*f*) *Eirene ceylonensis*, (*g*) *Aequorea australis*.



Medusae of (*a*) *Eirene menoni*, (*b*) *Eirene hexanemalis*, (*c*) *Eutonina indicans*, (*d*) *Eutima orientalis*, (*e*) *Phialucium carolinae*, (*f*) *Octophialucium indicum*, (*g*) *Phialidium malayense*.

Umbrella flat, with a thin wall. Four straight, narrow, unbranched radial canals. The four, very much folded, gonads are restricted to the sub-umbrellar portion of the radial canals. Over 100 short, slender, hollow, tapering marginal tentacles present.

The medusa is 15 to 25 mm wide.

The species, already recorded from Indian waters including Bombay, occurs in the coastal waters of the Indo-west Pacific, from East Africa to New Zealand and China.

Eirene menoni Kramp

Plate II (a)

Eirene menoni Kramp, *Sci. Rep. Great Barrier Reef Exped.* **6** : 286 (1953) ; Kramp, *Rec. Ind. Mus.* **53** : 353 (1958) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 189 (1961).

Irene ceylonensis Annandale, *J. Asiat. Soc. Bengal* **3** : 79 (1907).

Eirene ceylonensis Nair, *Bull. Cent. Res. Inst., Univ. Travancore* **2** : 64 (1951).

Phortis sp. Menon, *Rec. Ind. Mus.* **33** : 503 (1931) ; Menon, *Bull. Madras Govt. Mus.* **1** : 18 (1932).

Umbrella evenly rounded. Four linear gonads, highly variable in length, and restricted to the umbrellar portion of the radial canal. There are 46 hollow marginal tentacles. Between each pair of tentacles are two rudimentary bulbs. Tentacles are all of nearly the same length but distance between them variable.

The umbrella of a typical specimen in the present collection is 12 mm wide and 5 mm high.

Annandale (1907) and Nair (1951) had recorded this species under the trivial name *ceylonensis* from Bengal and Trivandrum respectively. K. S. Menon (1931) and M. G. K. Menon (1932) had recorded it as *Phortis* sp.

This is the first record of this species from Maharashtra. It occurs in the Indo-west Pacific region, from East Africa to Polynesia.

Eirene hexanemalis (Goette)

Plate II (b)

Irenopsis hexanemalis Goette, *S. B. Preuss. Akad. wiss.* **7** : 832 (1886).

Irene hexanemalis Menon, *Bull. Madras Govt. Mus.* **3** : 19 (1932).

Eirene hexanemalis Kramp, *Vidensk. Medd. dansk. naturh. foren. Kbh.* **99** : 248 (1936) ; Nair, *Bull. Cent. Res. Inst., Univ. Travancore* **2** : 63 (1951) ; Ganapati & Nagabhushanam, *Mem. Oceanogr. Andhra Univ.* **2** : 92 (1958) ; Kramp. *Rec. Ind. Mus.* **53**: 354 (1958) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 188 (1961).

Radial canals six. Stomach small and mounted on a wide peduncle. Mouth with six long, thin lips, with folded margins. From 30 to 50 tentacles present with a large basal bulb. Between each pair of tentacles three rudimentary bulbs and four marginal vesicles are present. There is an excretory pore at the base of each tentacle bulb and rudimentary bulb.

The gonads are confined to the distal portions of the radial canals, and are less than half as long as the radial canals.

10 specimens are in the present collection, measuring from 10-15 mm in diameter and slightly less in height.

This is the first record of this species from Maharashtra. It occurs in the coastal waters of the Indo-west Pacific region, from South-East Africa to Australia and Melanesia, and off southern China and Japan.

Family Eutimidae

Genus Eutonina Hartlaub

Eutonina indicans (Romanes)

Plate II (c)

Tiaropsis indicans Romanes, *J. Linn. Soc. (Zool.)* **12** : 525 (1876).

Eutimalphes indicans Haeckel, *Erster. Theil. einer Monogr. der medusen* : 195 (1879).

Eutimium socialis Mayer, *Medusae of the world* : 306 (1910).

Eutonina socialis Hartlaub, *Wiss. Meeres. Abt. Helgoland* : 506 (1897).

Eutonina indicans Bigelow, *Proc. U.S. Nat. Mus.* **44** : 34 (1913) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 200 (1961).

Bell walls thick at the middle and thin at the margin. Stomach short, with the conical peduncle extending up to the level of the velar opening. Mouth with four folded, broad lips. There are eight marginal vesicles, with 12 concretions.

The four linear gonads, sinuous along nearly the whole length of the subumbrellar portion of the four radial canals, extend from the base of the peduncle almost to the ring canal. There are about 100 short tentacles, with conical bases, without ocelli and excretory pores. Cirri and marginal warts absent.

Only two specimens represent the present collection. The larger one is 22 mm in diameter, with slightly more height.

This is the first record of this species from Indian waters. It is common in the Atlantic Ocean and also occurs off Japan and in the North Pacific.

Genus **Eutima** McCrady

Eutima orientalis (Browne)

Plate II (d)

Octorchis orientalis Browne, *Rep. Pearl Oyst. Fish. Gulf of Mannar* **27** : 139 (1905).

Octorchis gegenbauri Russel, *Medusae of the British Isles* : 367 (1953).

Eutima mira Vanhoffen, *Zoologica Stuttgart* **67** : 23 (1913) ; Menon, *Bull. Madras Govt. Mus.* **1** : 18 (1932) ; Nair, *Bull. Cent. Res. Inst., Univ. Travancore* **2** : 63 (1951) ; Ganapati & Nagabhushanam, *Mem. Oceanogr. Andhra Univ.* **2** : 92 (1958).

Eutima orientalis Mayer, *Medusae of the world* **1** : 299 (1910) ; Menon, *Rec. Ind. Mus.* **33** : 503 (1931) ; Kramp, ibid. **53** : 357 (1958) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 198 (1961).

An easily identifiable species because of its characteristic hemispheric shape and eight gonads, four on the subumbrella and four on the peduncle. It has a very long, narrow, prismatic peduncle with a broad, dome-like base, extending far beyond the umbrellar margin.

The gonads, borne on the four radial canals, extend from the base of the peduncle almost to the ring canal and are much folded. Four perradial tentacles with lateral cirri and 60-80 marginal warts with lateral cirri. Eight closed marginal vesicles present. Excretory pores and cordyli absent.

Four specimens were obtained, measuring 5-6 mm in diameter and slightly more in height.

This is the first record of this species from Maharashtra. It has been recorded from the coasts of India, Ceylon, Nicobar Islands, Vietnam, China, Amboina, New Zealand, Philippines and Madagascar.

Family PHIALUCIIDAE

Genus **Phialucium** Maas

Phialucium carolinae (Mayer)

Plate II (e)

Oceania carolinae Mayer, *Bull. Mus. Comp. Zool. Harv.* **37** : 7 (1900).

Phialucium carolinae Nair, *Bull. Cent. Res. Inst., Univ. Travancore* **2** : 62 (1951) ; Kramp, *Rec. Ind. Mus.* **53** : 346 (1958) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 185 (1961).

Phialucium virens Lele & Gae, *J. Univ. Bombay* **3** : 94 (1935) ; Bal & Pradhan, ibid. **20** : 76 (1952).

Octocanna polynema Kramp, *Atlantide Rep.* **3** : 260 (1955).

Pseudoclytia longleyi Burkenroad, *Biol. Bull. Woods Hole* **61** : 118 (1931).

Phialidium heptactis Vanhoffen, *Wiss. Ergebn.* ' *Valdivia* ' **19** : 225 (1911).

Phialidium phosphoricum Vanhoffen, *Dtsch. supol Exped.* **13** : 19 (1912).

Phialucium mbenga Bigelow, *Bull. U.S. Nat. Mus.* **1** : 293 (1919).

Peduncle absent. Umbrella watch-glass shaped. Mouth with four simple, folded lips. Usually four radial canals present, but up to eight radial canals may be seen in some specimens. Gonads, at the distal half of the radial canals, hang down vertically from these canals. About 30 tentacles are present; between successive tentacles there are usually three rudimentary bulbs. The rudimentary marginal bulbs are knob-like and the median one between each pair of tentacles, is larger than the other two and is provided with an excretory papilla. The portions of the margin between adjacent tentacles are not equal. Ocelli absent.

More than 60 specimens are in the present collection. It was found in large numbers in some pre-monsoon plankton hauls.

This species has been previously recorded from Bombay as *Phialucium virens*. It is widely distributed from the Straits of Malacca and the Gulf of Thailand, Philippines, Australia, China and Africa. It was originally described from North Carolina and Florida on the east coast of America.

Genus **Octophialucium** Kramp

Octophialucium indicum Kramp

Plate II (f)

Octophialucium indicum Kramp, *Rec. Ind. Mus.* **53**: 347 (1958); Kramp, *J. Mar. biol. Ass. U.K.* **40** : 184 (1961).

Octocanna polynema Menon, *Bull. Madras Govt. Mus.* **3** : 23 (1932); Nair, *Bull. Cent. Res. Inst., Univ. Travancore* **2**: 63 (1951); George, *J. Zool. Soc. India* **5**: 82 (1953); Ganapati & Nagabhushanam, *Mem. Oceanogr. Andhra Univ.* **2** : 92 (1958).

Umbrella disc-like and of very thick gelatinous consistency; frequently lenticular. Peduncle absent and stomach about one-sixth the diameter of the umbrella. There are eight pointed lips with crenulated margins. Usually eight radial canals present but some specimens have 6 to 11. Radial canals continued inwards, almost up to the centre of the stomach.

Gonads about one-fifth as long as the radial canals, and situated very near the bell margin along the radial canals. There are about 20 to 28 tentacles without marginal or lateral cirri. Tentacles spirally coiled and slightly flattened with broad, conical basal bulbs with excretory papillae. Between two successive tentacles there are 3-5 (usually four) rudimentary marginal bulbs with an excretory papilla on each tentacle bulb. A closed marginal statocyst between each successive pair of marginal bulbs irrespective of whether they carry a tentacle or not.

The species can be distinguished by the number of tentacles, 3 to 5 rudimentary bulbs between successive tentacles, and marginal vesicles in the same number as tentacles plus rudimentary bulbs.

17 specimens of this species are in the present collection. The largest measures 15 mm in diameter.

This is the first record of this species from Maharashtra. Distribution Indo-west Pacific tropical waters from Madagascar to Tahiti.

Family Companulariidae

Genus **Phialidium** Leuckart

Phialidium malayense Kramp

Plate II (g)

Phialidium malayense Kramp, *J. Mar. biol. Ass. U.K.* **40** : 170 (1961).

Phialidium pacificum Mayer, *Medusae of the world* **i** : 273 (1910).

Bell hemispherical. Stomach large and globular, without a peduncle. Mouth with four prominent, pointed, much folded lips.

Four gonads, borne on the middle one-third of the four narrow, straight radial canals, are oval in shape. The 32 or more tentacles equally spaced on the umbrellar margin. Basal bulbs large but devoid of ocelli or brown pigment; rudimentary bulbs absent. Two statocysts present between each successive pair of tentacles.

This species can be distinguished by its large, globular stomach with four prominent lips, hollow tentacles without brown pigment spot, narrow velum, numerous vesicles, and lack of irridescence of the subumbrella.

15 specimens are in the present collection. An average specimen measures 6 mm in diameter.

This is the first record of this species from Indian waters. It occurs in the waters of North Australia, Amboina, Vietnam and China.

Order LIMNOMEDUSAE

Family OLINDIADIDAE

Genus **Aglauropsis** Fr. Muller

Aglauropsis vannuccii Thomas & Chhapgar

Plate III (a)

Aglauropsis vannuccii Thomas & Chhapgar, *J. Bombay nat. Hist.* Soc. 72 (3) : 809 (1975).

This species was described in 1970 (Thomas & Chhapgar 1975). It can be distinguished by the presence of 28 tentacles with nematocyst rings, small stomach, mouth with four small folded lips, radial canals of average width, smooth sac-like gonads extending nearly three-fourths of the radial canal and with pendant distal ends, and numerous statocysts (one between every two tentacles). Rudimentary tentacles are lacking.

Nine specimens are in the present collection ; the largest measures 8 mm in diameter and 6 mm in height.

This species was first collected from Bombay. Subsequently, it has also been found to occur off Goa.

Order TRACHYMEDUSAE

Family GERYONIIDAE

Genus **Liriope** Lesson

Liriope tetraphylla (Chamisso & Eysenhardt)

Plate III (b)

Geryonia tetraphylla Chamisso & Eysenhardt, *Nova Acta Phys. Medd. Acad. Leopold Carol.* **10** : 357 (1821).

Liriope tetraphylla Gegenbaur, *Z. Wiss. Zool.* **8** : 257 (1856) ; Menon, *Rec. Ind. Mus.* **33** : 503 (1931) ; Menon, *Bull. Madras Govt. Mus.* **3** : 28 (1932) ; Lele & Gae, *J. Univ. Bombay* **3** : 97 (1935) ; Menon, *Proc. Ind. Acad. Sci.* **22** : 41 (1945) ; Nair, *Bull. Cent. Res. Inst., Univ. Travancore* **2** : 70 (1951) ; Bal & Pradhan, *J. Univ. Bombay* **20** : 76 (1952) ; Kramp, *Rec. Ind. Mus.* **53** : 368 (1958) ; Ganapati & Nagabhushanam, *Mem. Oceanogr. Andhra Univ.* **2** : 93 (1958) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 238 (1961).

This species is easily distinguished by its four leaf-shaped gonads situated on the four radial canals. Centripetal canals are present.

This is the only species of the genus and the most abundant and widely distributed oceanic medusa ; it is a valuable indicator of sea currents. 82 mature specimens and 20 young, measuring from 10 to 30 mm, are in the present collection.

It occurs in the warm parts of all the oceans and Mediterranean Sea. In the Pacific, it occurs between 40°S and 40°N, in the Indian Ocean down to 40°S. In the Atlantic it likewise occurs between these degrees of latitude, but in eastern parts it penetrates somewhat further north, into the English Channel.

Family RHOPALONEMATIDAE

Genus **Amphogona** Browne

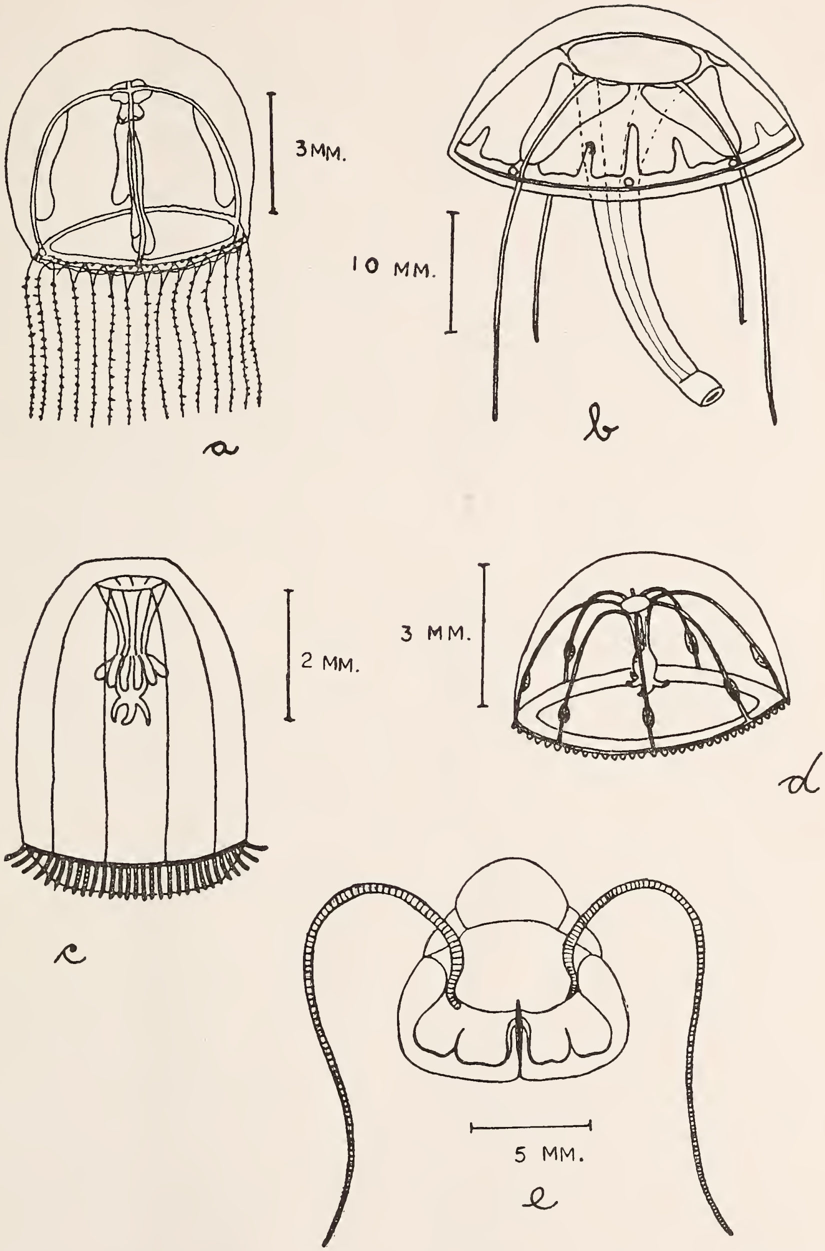
Amphogona apsteini (Vanhoffen)

Plate III (d)

Pantachogon apsteini Vanhoffen, *Wiss. Ergebn. Valdivia* **3** : 65 (1902).

Amphogona apsteini Browne, *Fauna Geog. Maldive Laccad. Archipel.* **11** : 740 (1905) ; Browne, *Rep. mar. Zool. Okhamandal* **2** : 152 (1916) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 252 (1961).

Umbrella almost hemispherical, without apical projection, lateral walls thin. Velum very broad. Stomach small, on a small gelatinous peduncle as long as one-third of the height of the umbrella cavity. Four short pointed lips, eight radial canals and eight oval gonads present. Gonads are of unequal size, being alternately very small and somewhat larger. Numerous (almost 60) small tentacles (8 per octant). Statocysts 16 to 24, club-shaped. Lateral or marginal cirri absent.



Medusae of (*a*) *Aglauropsis vannuccii*, (*b*) *Liriope tetraphylla*, (*c*) *Aglaura hemistoma*, (*d*) *Amphogona apsteini*, (*e*) *Solmundella bitentaculata*.

This species can be distinguished by its small stomach, ellipsoidal gonads of unequal size, and 16-24 statocysts. The tentacles, numbering from 50 to 70, are all alike and are not densely crowded.

About 60 specimens are in the present collection. Of these, 43 are with mature gonad and the rest immature. They measure up to 6 mm in diameter and 5 mm in height.

This species has been previously recorded, in India, from Okha in Gujarat State. It is an epipelagic medusa found in the tropical parts of the eastern and western Pacific oceans, in the Malayan Archipelago, in the Indian Ocean, N.E. Australia, Palao Islands, Japan, Vietnam, Sumatra, the Maldive Islands and north of Madagascar. It has also been recorded from the Gulf of Guinea on the Atlantic coast of Africa and from the Galapagos Islands.

Genus **Aglaura** Peron & Lesueur

Aglaura hemistoma Peron & Lesueur

Plate III (c)

Aglaura hemistoma Peron & Lesueur, *Ann. Mus. Hist. nat.* **14** : 351 (1809) ; Lele & Gae. *J. Univ. Bombay* **3** : 95 (1935) ; Nair, *Bull. Cent. Res. Inst., Univ. Travancore* **2** : 69 (1951) ; Bal & Pradhan, *J. Univ. Bombay* **20** : 76 (1952) ; Ganapati & Nagabhushanam, *Mem. Oceanogr. Andhra Univ.* **2** : 93 (1958) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 251 (1961).

Aglaura elongata Vanhoffen, *Zool. Jahrb.* **11** : 428 (1913).

Aglantha globuligera Ranson, *Bull. Inst. Oceanogr. Monaco* 593 : 1 (1932).

Peduncle shorter than bell cavity. Stomach small, mouth with four small, simple lips. From 45 to 85 solid, stiff tentacles present, with free, club-shaped, marginal (eight) statocysts. Eight, narrow, straight, unbranched radial canals present.

Eight sausage-shaped, long, pendant gonads situated on the peduncle at the juncture of the eight radial canals with the stomach.

68 specimens are in the present collection ; however, these animals are difficult to preserve, and 18 specimens turned inside out after preservation. Very few young were seen in the plantkon hauls. The average size is 5 mm high and 4 mm wide.

This species has already been recorded from Bombay ; it was quite common in the collections throughout the year. It is widely distributed in the warm and temperate parts of all oceans.

Order NARCOMEDUSAE

Family AEGINIDAE

Genus **Solmundella** Haeckel

Solmundella bitentaculata (Quoy & Gaimard)

Plate III (e)

Charybdea bitentaculata Quoy & Gaimard, *Zoologica* **4** : 295 (1833).

Solmundella bitentaculata Mayer, *Medusae of the world* **1** : 455 (1910) ; Browne, *Rep. mar. Zool. Okhamandal* **2** : 152 (1916) ; Menon, *Rec. Ind. Mus.* **33** : 503 (1931) ; Menon, *Bull. Madras Govt. Mus.* **3** : 28 (1932) ; Lele & Gae, *J. Univ. Bombay* **3** : 99 (1935) ; Menon, *Proc. Indian Acad. Sci.* **22** : 41 (1945) ; Nair, *Bull. Cent. Res. Inst., Univ. Travancore* **2** : 70 (1951) ; Bal & Pradhan, *J. Univ. Bombay* **20** : 76 (1952) ; George, *J. Zool. Soc. India* **5** : 82 (1953) ; Ganapati & Nagabhushanam, *Mem. Oceanogr. Andhra Univ.* **62** : 93 (1958) ; Kramp, *J. Mar. biol. Ass. U.K.* **40** : 270 (1961).

The gelatinous substance of this conical medusa is thick at the aboral surface and bell cavity, but becomes thin at the margin of the bell. Stomach flat, very broad, lenticular, with eight inter-radial, divided stomach pouches.

There are four peronia, but only two primary, perradial, opposite tentacles. Bell keeled along the axis leading to the tentacles. The two tentacular peronia are in deep grooves.

From 8 to 16, but sometimes as many as 32, statocysts, are present. There are no peripheral canals, octoporpae or secondary tentacles.

This species has been previously recorded from Bombay. It is very widely distributed in the Pacific, extending from Japan to southern

California ; in the Atlantic it is common everywhere south of 20°N, while there are only a few scattered records from the North Atlantic further north, as far as 40°N. It is very common in the Mediterranean Sea, and is circumpolar in Antarctic seas.

Key to the Identification of the Hydromedusae of Bombay[4]

1 Sense organs exclusively ectodermal..........2
Sense organs (statocysts and tentaculocysts) with an endodermal axis.........................15[4]

2(1) Medusae tall, bell-like, with ocelli but without statocysts, gonads borne on the manubrium or stomach (Acanthomedusae) 3
Medusae flatter, bowl or saucer shaped, usually with statocysts (or cordyli or marginal vesicles), gonads borne on the radial canals (Leptomedusae) 6

3(2) Mouth simple and tubular (Tubulariidae)......4
Mouth with four lips........................5

4(3) Three short or rudimentary tentacles and one long tentacle differing from the others in structure . . .. *Euphysora bigelowi*
One to four unequally developed tentacles but of uniform structure .... *Euphysa aurata*

5(3) Lips with clusters of nematocysts (Hydractiniidae) .... *Podocoryne ocellata*
Lips without clusters of nematocysts (Pandeidae) .... *Merga tergestina*

6(2) Medusae with a distinct gastric peduncle...... 7
Medusae without a distinct gastric peduncle....11

7(6) Numerous marginal vesicles, gonads restricted to umbrellar portion of radial canals, tentacle bulbs usually with excretory pores (Eirenidae : *Eirene*) 8
Marginal vesicles usually eight ; if more, the gonads extend from the bell margin down along the peduncle almost to the stomach ; no excretory pores (Eutimidae)......................... 10

8(7) Peduncle wide............*Eirene hexanemalis*
Peduncle slender 9

9(8) Medusa with distinct excretory papillae........ .... *Eirene ceylonensis*
Medusae without excretory papillae.......... .... *Eirene menoni*

10(7) Medusa without marginal warts and cirri (*Eutonina*) .... *Eutonina indicans*
Medusa with lateral cirri on marginal warts, usually also at the base of tentacles (*Eutima*).. .... *Eutima orientalis*

11(6) Stomach very broad with many radial canals, tentacle bulbs with excretory pores (Aequoreidae : *Aequorea*) 12
Stomach narrow with (normally) four to eight radial canals.............................. 13

12(11) About 16 radial canals and twice as many tentacles ; umbrella high, conical, 9 mm wide, gonads in proximal half of radial canals............. .... *Aequorea conica*
16 to 32 radial canals and as many tentacles, umbrella low, up to 45 mm wide, gonads in distal half of radial canals........*Aequorea australis*

13(11) Tentacle bulbs with excretory pores, four to eight radial canals (Phialuciidae)................14
Tentacle bulbs without excretory pores, four radial canals (Companulariidae : *Phialidium*).... ....*Phialidium malayense*

14(13) Medusa with normally four radial canals (*Phialucium*)........... *Phialucium carolinae*
Medusa with normally eight (6 to 11) radial canals (*Octophialucium*).................. .... *Octophialucium indicum*

15(1) Umbrella margin smooth ; tentacles solid, springing from umbrella margin, or solid and hollow ; radial and ring canals invariably present ; gonads borne on radial canals ; sensory clubs free or enclosed (Trachymedusae) 16
Umbrella margin scalloped by tentacle bases ; tentacles solid, springing from exumbrella, some distance above umbrella margin (sometimes small secondary tentacles on margin) ; no radial canals, with or without peripheral canal system ; gonads on stomach walls ; sense organs free (Narcomedusae : Aeginidae : *Solmundella*)......... .... *Solmundella bitentaculata*

[4] The Order Limnomedusae cannot be fitted in this key as it is comprised of predominantly freshwater medusae intermediate between the Trachymedusae and Narcomedusae, in which gonads may be borne either on the stomach wall, with or without perradial lobes extending along the radial canals, or only on the radial canals. Tentacles are hollow, Statocysts are sometimes present, and are internal, being in the form of enclosed sensory clubs. *Aglauropsis vannuccii* Thomas & Chhapgar, falling in the family Olindiadidae, belongs to this Order.

16(15) Medusa with centripetal canals (Geryoniidae : *Liriope*)................. *Liriope tetraphylla*
Medusa without centripetal canals (Rhopalonematidae) 17

17(16) Medusa with short, conical gastric peduncle, with eight globular or oval gonads (*Amphogona*) .... *Amphogona apsteini*
Medusa with long, slender gastric peduncles; gonads sausage-shaped, pendant, attached to peduncle (*Aglaura*)..........*Aglaura hemistoma*

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Additions to the flora of Kolhapur District[1]

A. R. Kulkarni[2] and A. N. Thite

The luxuriant vegetation of Kolhapur district has not received much attention. Mahajan & Divan (1968) and Mahajan & Vaidya (1969) have dealt with the forest resources of Radhanagari and the vegetation of grasslands around Kolhapur respectively. Kulkarni & Mudgal (1971) and Kulkarni & Desai (1972) have revised the family Commelinaceae and Eriocaulaceae respectively of this area. Kulkarni (1971) has reported the occurrence of *Sesamum mulayanum* Nair in this region. *Eriocaulon tuberiferum* Kulkarni et Desai (1972) has been described from Panhala—a fort near Kolhapur. On the basis of data available in the herbarium of the Botanical Survery of India, Western circle, Poona, Singh, Malhotra & Mudaliar (1972) have published an account of the flora of Kolhapur district in which they have enumerated 301 species including Pteridophytes. The aim of the present note is to add to this list whatever information we have gathered on the Angiosperm flora during our six years botanical explorations in different parts of this district. The plants already recorded from this region are excluded from the present list except those where more information is added on the distribution in the district. Cultigens have also been excluded. The account on Cyperaceae will be published at a later date. Necessary changes in the nomenclature of identified taxa have been made. The herbarium specimens are deposited in the herbarium of Shivaji University, Botany Department, Kolhapur.

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Menispermaceae

Tinospora cordifolia (Willd.) Miers. A common climber, Kolhapur, Panhala ; often cultivated (122, 125).

Cocculus hirsutus (Linn.) Diels. In open grassland. Kolhapur, Panhala (135-37).

Cissampelos pereira Linn. A climber in forests or forest edges. Katyayani, Panhala, Gaganbavada (139-43).

Nymphaeaceae

Nymphaea stellata Willd. Both red and white flowered forms. Rankala and Shiruli talaeo, Kolhapur (149).

Nelumbo nucifera Gaertn. Laxmi talaeo, Kolhapur.

Papaveraceae

Argemone mexicana Linn. A weed in waste land and in disturbed soils. Kolhapur, Panhala (171-73).

Brassicaceae

Cardamine trichocarpa Hochst. ex Rich. In moist places, often on walls. Panhala (176).

Coronopus didymus (Linn.) Sm. A garden weed; rare. University campus, Kolhapur (191).

Capparaceae

Cleome simplicifolia Hook. f. and Thoms. Pretty common in open grassland. Kolhapur, Panhala (205, 210).

C. viscosa Linn. In waste land. Kolhapur (215).

C. chelidonii Linn. In puddles and along streams during mid monsoon. Kolhapur, Katyayani (222-226).

Crataeva religiosa Forst. Only one tree near Kokhale College hostel, Kolhapur (235).

Cadaba indica Lam. Along bunds of sugarcane field opposite Rankala talao, Kolhapur (246).

FLACOURTIACEAE

Flacourtia indica (Burm. f.) Merrill. In open forests. Katyayani, Panhala (285-292).

POLYGALACEAE

Polygala chinensis Linn. In pasture lands. Kolhapur, Panhala (305-307).

P. persicariaefolia DC. In moist shady places. Katyayani, Panhala (314-317).

CARYOPHYLLACEAE

Saponaria vaccaria Linn. Escape from cultivation, University campus, Kolhapur (326).

Polycarpon prostratum (Forsk.) Aschers and Schweins. Forms carpet in wet land zones of Rankala talao, Kolhapur (335).

PORTULACACEAE

Portulaca oleracea Linn. Quite common along road sides and other open places. Kolhapur, Panhala (344-347).

Portulaca grandiflora Linn. Grows as escape along margins of Rankala talao, Kolhapur (354).

ELATINACEAE

Bergia ammannioides Heyne ex Roth. Common hygrophyte of a number of tanks at Kolhapur (373-376).

MALVACEAE

Abutilon indicum (Linn.) Sweet. In grasslands and waste land. Kolhapur, Panhala (420-423).

Malachra capitata Linn. Rare weed ; University campus, Kolhapur.

Sida spinosa Linn. In grasslands. Kolhapur (413).

BOMBACACEAE

Bombax ceiba Linn. In open forests. Panhala, Kolhapur.

STERCULIACEAE

Helicteres isora Linn. Forest margins and forest clearings. Panhala, Gaganbavada (479-482).

Eriolaena quinquelocularis Wight. Katyayani and Radhanagari forests (490-493).

TILIACEAE

Corchorus olitorius Linn. In waste land. Kolhapur (535).

Triumfetta bartramia Linn. Forest edges and in open places. Panhala (526).

MALPIGHIACEAE

Hiptage benghalensis (Linn.) Kurz. Climber with beautiful flowers. Katyayani ; Near Amberkhana, Panhala (546, 548).

ZYGOPHYLLACEAE

Tribulus terrestris Linn. In open dry land ; not common, Kolhapur (553).

OXALIDACEAE

Oxalis corniculata Linn. In moist land ; a weed in gardens. Kolhapur, Panhala (561-64).

Biophytum sensitivum DC. In moist land. Kolhapur (569).

BALSAMINACEAE

Impatiens balsamina Linn. Gregarious and most conspicuous middle monsoon herb in grassland. Kolhapur, Katyayani, Panhala (596-598).

I. inconspicua Benth. In pasture lands during monsoon. Radhanagari, Gaganbavada (586-589).

I. pulcherrima Dalz. In shades ; worthy of cultivation. Panhala (610), Ambaghats.

RUTACEAE

Atalantia racemosa Wight and Arn. In forests of Panhala, Ambaghats (644-648).

Aegle marmelos (Linn.) Correa. Often planted near temples. Kolhapur, Katyayani (653).

Glycosmis pentaphylla (Retz.) Correa. In forests. Panhala, near Gaganbavada, Ambaghats (629-632).

Murraya koenigii (Linn.) Spreng. Very common in forest shades. Panhala, Ambaghats (634-636).

MELIACEAE

Cipadessa baccifera (Roth.) Mig. Along forest edges near Gaganbavada (701).

Heynea trijuga Roxb. Forests of Ambaghats, often in cleared forests near Gaganbavada (719, 722).

SIMARUBIACEAE

Balanites roxburghii Planch. Drier parts of Kolhapur district ; along Miraj road (674).

OPILIACEAE

Cansjera rheedii Gmel. Open forests Katyayani ; along forest slopes, Ambaghats (735-737).

Nothopodytes foetida (Wight) Sleumer. Common in open forests. Panhala, Ambaghats (745, 748).

Sarcostigma kleinii Wight and Arn. A climber ; in forests between Amba and Vishalghar.

CELASTRACEAE

Celastrus paniculata Willd. A common straggler along forest margins and open areas. Katyayani, Panhala (771-776).

Gymnosporia montana Benth. In scrubs. Katyayani, Panhala (778-782).

HIPPOCRATEACEAE

Pristimera grahamii (Wight) A. C. Smith. Along fort slopes near Baji Prabhu point, Panhala (788).

RHAMNACEAE

Zizyphus mauritiana Lamk. Several trees are seen on the outskirts of Kolhapur, Katyayani and Panhala but not in actual forest areas (799).

Z. rugosa Lamk. A common climber in the forests of Katyayani, Panhala, Gaganbavada and Ambaghats (809-816).

Z. oenoplia Mill. In grasslands of Kolhapur (805).

VITACEAE

Cayratia elongata (Roxb.) Suessery. Very common climber in forests of Panhala and Gaganbavada (825-830).

Cissus pallida Planch. In rocky areas towards the base of Panhala fort (843).

Leea macrophylla Roxb. ex Horneum. Quite common in cleared forests of Katyayani (848).

L. indica (Burm.) Merrill. Very common shrub in forests and forest margins, Panhala, Gaganbavada, Radhanagari and Ambaghats (860-866).

Sapindaceae

Allophyllus serratus (Roxb.) Radlk. Scandent shrub in forest shade. Panhala, Gaganbavada (887-869).

Cardiospermum halicacabum Linn. In grassland. Kolhapur, Katyayani and Panhala (882, 883).

Schleichera oleosa (Laur.) Oken. In forests of Katyayani, not common (890).

Sapindus laurifolius Vahl. Very few trees specially near human dwellings (895).

Anacardiaceae

Mangifera indica Linn. Abundant in Panhala and Amba (907-915).

Lannea coromandelica (Houtt.) Merrill. Small tree. Katyayani, basement of Panhala fort (922).

Semicarpus anacardium Linn. A few trees near Katyayani temple (927).

Holigarna grahmi (Wight) Hook. f. In forests of Ambaghats (934, 936).

Nothopegia colebrookiana Blume. In forests of Ambaghats and Radhanagari (940).

Fabaceae

Goniogyna hirta (Willd.) Ali. Very common in pasture lands of Kolhapur and Panhala ; June-April (963-968).

Crotalaria filipes Benth. var. *trichocarpa* (Benth. ex Baker) Cooke. Pasture lands of Kolhapur, Panhala (975, 978).

C. juncea Linn. Escape from cultivation. University campus, Kolhapur (1030).

C. lutescens Dalz. Grasslands. University campus, Kolhapur (1015).

C. nana Burm. Grasslands, University campus, Kolhapur, Panhala (996).

C. orixensis Willd. University campus, Kolhapur (1046).

C. prostrata Roxb. Amongst grasses. Panhala (1050).

C. spectabilis Roth. Grass lands. Katyayani (1019-1022).

C. vestita Baker. Along forest margins and grassland. Panhala (982).

Indigofera cordifolia Heyne ex Roth. In grass land ; June-April, Kolhapur (1085).

I. dalzellii Cooke. In moist rocky places. Panhala (1089).

I. linnaei Ali. In grasslands. Kolhapur (1096).

I. hendecaphylla Linn. In moist open places and grass lands. Along margins of Rankala Talao, Kolhapur. Panhala (1108).

I. linifolia Retz. In pasture lands, Kolhapur (1079).

I. pulchella Roxb. A shrub in grasslands. Panhala, Katyayani (1143-1146).

I. tinctoria Linn. In waste land. Kolhapur, Panhala. Rare (1132-1135).

I. trita Linn. Grassy places. Kolhapur, Katyayani, Panhala (1113-1116).

Tephrosia coccinea Wall. A shrub in open land. Radhanagari (1154).

T. pumila Pers. Grasslands of Kolhapur, rare (1165).

T. purpurea Pers. A shrub of grasslands. Kolhapur, Panhala (1158).

T. strigosa (Dalz.) Santapau. In grassland, Kolhapur (1150).

Geissaspis cristata Wight and Arn. Grasslands, Panhala (1185).

Zornia diphylla Pers. Common amongst grass land. University campus, Kolhapur, Panhala (1190).

Smithia bigemina Dalz. Very common and attractive middle monsoon herb in grasses. Ambaghat, Panhala (1217, 1220.)

S. blenda var. *racemosa* Baker. Kolhapur, Panhala (1225, 1227).

S. co ferta Sm. University campus, Kolhapur and Panhala (1199).

Smithia setulosa Dalz. Grassy places. Kolhapur (1209-1212).

Aeschynomene indica Linn. Middle monsoon herb in moist places. Kolhapur (1235).

A. aspera Linn. Along marshes of Vadanige lake near Kolhapur.

All species of *Alysicarpus* noted below are found in grasslands.

Alysicarpus belgaumensis Wight. Radhanagari (1275).

A. bupleurifolius DC. Kolhapur (1256).

A. pubescens Law. Very conspicuous because of pubescence and elegant inflorescences. Kolhapur (1270).

A. rugosus DC. Kolhapur (1261-1263).

A. rugosus DC. var. *heyneanus* Baker. Kolhapur (1265).

A. tetragonolobus Edgew. Kolhapur, Panhala (1268).

A. vaginalis DC. Kolhapur, Panhala (1250-1254).

Desmodium diffusum DC. Amongst grass. Kolhapur (1297).

D. gangeticum (Linn.) DC. A shrub in open places and forest clearings. Panhala, Gaganbavada, Radhanagari (1317-1322).

D. latifolium DC. An undershrub with spreading branches. Panhala (1325).

D. laxiflorum DC. Undershrub. Kolhapur-Panhala (1286).

D. polycarpum DC. Often in shades of forest trees. Gaganbavada, Radhanagari (1290, 1293).

D. rotundifolium Baker. Spreading herb in grasses. Katyayani, Panhala (1330).

D. triflorum (Linn.) DC. Very common in rocky areas. Panhala, Radhanagari (1305-1309).

D. triquetrum DC. Panhala (1312).

Abrus precatorius Linn. A climber in forests or along forest margins. Gaganbavada, Radhanagari (1338).

Teramnus labialis Spreng. A twiner along forest edges (1348-1351).

Mucuna prurita Hook. Forest edges. Gaganbavada.

Erythrina variegata Linn. var. *orientalis* (Linn.) Merr. Some trees are seen at Panhala (1359).

Butea monosperma (Lamk.) Taub. Saplings of this tree are seen all over the rocky areas around Kolhapur. In forests of Katyayani.

Pueraria lobata (Willd.) Ohwi. Amongst grass. Kolhapur (1368).

Clitoria ternata Linn. In hedges ; often cultivated. Kolhapur, Panhala (1387-1389).

Atylosia scarabaeoides Benth. Twiner in forests of Radhanagari (1400).

Moghania strobilifera (Linn.) St. Hil. ex Jacks. In forests and edges of forests. Panhala, Radhanagari (1425-1430).

Dalbergia latifolia Roxb. A few trees are seen at basement of Panhala fort with heavy infection of *Viscum angulatum* (1439).

Dalbergia sympathetica Nimmo ex Grah. Hooked climber; very common in forests of Panhala, Radhanagari and Ambaghats (1448-1451).

Derris indica (Lamk.) Bennet. [*Pongamia pinnata* (Linn.) Pierre.] Common in forests of Panhala ; around Kolhapur (1465).

Caesalpinaceae

Caesalpinia sepiaria Roxb. Along bunds of Sugarcane fields. Kolhapur-Panhala road ; Panhala fort near Tabak bag (1493).

Wagatea spicata Dalz. In forests of Panhala, Ambaghats (1505-1510).

Cassia fistula Linn. Panhala, Radhanagari (1512).

C. sophera Linn. In waste land. Katyayani ; near Phule wadi, Kolhapur (1516).

C. tora Linn. In waste land. Kolhapur (1522).

C. auriculata Linn. Along road sides. Katyayani (1528).

C. absus Linn. Among grass. Katyayani, Kolhapur (1538).

Cassia pumila Lamk. In pasture lands. Kolhapur, Katyayani (1545-1548).

MIMOSACEAE

Entada scandens Benth. In dense forests of Radhanagari and Ambaghats.

Dichrostachys cinera Wight and Arn. In rocky open areas. Kolhapur (1589).

Mimosa pudica Linn. Weed in moist places and in gardens. Kolhapur (1592).

M. hamata Willd. In rocky open areas. University campus, Kolhapur (1598).

Acacia concinna DC. Common. Panhala (1605).

CRASSULACEAE

Bryophyllum pinnatum (Lamk.) Oken. In moist places. Panhala, Ambaghats (1651).

DROCERACEAE

Drocera burmanni Vahl. Along margins of temporary ponds near Amba village (1673).

D. indica Linn. In moist places. Near Nimajgah, Panhala ; amongst grasses, Kolhapur (1679).

RHIZOPHORACEAE

Carallia brachiata (Laur.) Merrill. In dense forests of Radhanagari and Ambaghats (1689).

COMBRETACEAE

Terminalia bellirica (Gaertn.) Roxb. Panhala (1762).

T. chebula Retz. Very common in Ambaghats ; also in Panhala and Gaganbavada forests (1768-1772).

T. crenulata Roth. Panhala and Radhanagari (1775).

MYRTACEAE

Syzygium cuminii (Linn.) Skeels. Abundant in Panhala (1791).

LECYTHIDACEAE

Careya arborea Roxb. Common in Panhala, Radhanagari and forests near Gaganbavada (1805).

MELASTOMACEAE

Osbeckia truncata D. Don. In grasslands and rice fields. Moist situations. Gaganbavada (1815).

LYTHRACEAE

Rotala densiflora (Roth.) Koehne. In moist places along margins of ponds and puddles. Around Nimajgah, Panhala (1845).

Ammania baccifera Linn. In marshes. Kolhapur (1855).

Woodfordia fruticosa (Linn.) Kur. In forest clearings Radhanagari, Gaganbavada, sometimes on old fort walls, Panhala (1864-1869).

ONAGRACEAE

Ludwigia perennis Linn. In marshy places. Kolhapur (1881).

CUCURBITACEAE

Trichosanthes bracteata (Lamk.) Voigt. Very common climber of Panhala ; Gaganbavada (1899).

T. cucumerina Linn. Rare twiner. Panhala (1905).

Bryonopsis laciniosa Naud. Often on hedges ; Katyayani (1922).

Melothria maderaspatna Cogniaux. Very common in grassy places in Kolhapur (1932).

BEGONIACEAE

Begonia crenata Dryand. Pretty common in moist places. Panhala, Gaganbavada, Ambaghats, Radhanagari (1943-1949).

B. trichocarpa Dalz. In dense jungles in shades of forest trees. Gaganbavada (1961).

CACTACEAE

Opuntia dillenii Haw. In dry localities, often as weed. Kolhapur, Panhala.

MOLLUGINACEAE

Glinus lotoides O. Kze. In moist clayey soils (1976).

Mollugo pentaphylla Linn. Common in moist places along gutters and margins of Talaeos. Kolhapur, Panhala (1980-1982).

M. pentaphylla var. *rupestris* Cooke. In moist rocky places around Nimajgah, Panhala (1984-1986).

AIZOACEAE

Trianthema portulacastrum Linn. Along road sides. University campus, Kolhapur (1972).

APIACEAE

Centella asiatica (Linn.) Urban. Along margins of Talaeos in Kolhapur (1992).

Pimpinella adscendens Dalz. In grass lands. Panhala, Gaganbavada (1998-2001).

P. lateriflora Dalz. and Gibs. In forest clearings on way to Gaganbavada (2015).

Peuced num dhana Ham. In grasslands of Kolhapur (2022).

RUBIACEAE

Anotis foetida (Dalz.) Benth. and Hook. Herb in rocky moist areas. Gaganbavada fort (2096).

A. lancifolia (Dalz.) Hook. f. Very abundant and conspicuous monsoon herb in grasses. Jotiba, Panhala (2108-2112).

A. montholoni Hook. f. Amongst grasses. University campus, Kolhapur (2123).

A. rheedei Benth. and Hook. Jotiba, Panhala (2115-2117).

Borreria hispida (Linn.) Schum. Rocky places, University campus, Kolhapur (2226).

Canthium parviflorum Lamk. Not common. Near Rankala, Kolhapur ; Panhala (2172).

C. dicoccum (Gaertn.) Merrill. Forests of Ambaghats (2176).

Dentella repens (Linn.) Forst. Mat forming hygrophyte. Kagal lake ; Rajaram Tank, Kolhapur (2070).

Hamiltonia suaveolens Roxb. Amongst stone crevices of Sadoba tank, Panhala (2223).

Hymenodictyon obovatum Wall. Along slopes towards fort, Gaganbavada ; along Rajdindi road, Panhala ; towards Vishalghar, Ambaghats. Nowhere very common (2056-2058).

Ixora arborea Roxb. ex Sm. Common shrub in forests of Panhala (2198).

I. elongata Heyne. Behind Katyayani temple, Katyayani (2195).

Meyna laxiflora Robyns. In rocky grasslands. Kolhapur.

Oldenlandia crystallina Roxb. In moist rocky places. Panhala (2089).

O. corymbosa Linn. Pasture lands. Panhala (2082).

O. herbacea (Linn.) Roxb. Panhala (2086).

Pavetta indica Linn. Edges of forests and along cleared areas. Panhala, Gaganbavada, Radhanagari (2205-2209).

Randia uliginosa DC. Behind Katyayani temple, a few trees.

Rubia manjith Roxb. ex Flem. Panhala in Tabak Udyan area (2231).

Wendlandia thyrsoidea Steud. Along forest edges and clearings. Panhala (2064-2066).

Xeromphis spinosa (Thumb.) Keay. Very common on Panhala fort plateau (2145).

ASTERACEAE

Acanthospermum hispidum DC. Weed. Kolhapur (2410).

Artemisia vulgaris Linn. Along edges of Tabak Udyan, Panhala (2338).

Bidens biternata (Lour.) Merr. and Sherff. Weed. Gopaltirth, Panhala. Kolhapur (2329).

Blumea malcolmii Hook. f. Densely hairy herb in open areas ; post-harvest weed in rice fields. Kolhapur, Panhala (2278).

B. membranacea DC. In dry areas amongst grasses. Panhala (2270).

Caesulia axillaris Roxb. Common in marshy places. Kolhapur (2312).

Cyathocline purpurea (D. Don) O. Ktze. Weed in rice fields (2254).

Elephantopus scaber Linn. In shades of forest trees. Sometimes in forest clearings. Panhala, Ambaghats (2252).

Eclipta prostrata (Linn.) Linn. Common in grasses, along road sides, Kolhapur (2320).

Echinops echinatus Roxb. Dry rocky places. Kagal (2360).

Flaveria contrayerba Pers. Weed in waste places, Kolhapur (2396).

Gynura angulosa DC. Edges of Ghat slopes. Ambhaghats (2347).

Gnaphalium indicum Linn. Moist and marshy places. Rajaram Tank, Kolhapur (2295).

Lactuca runcinata DC. Weed in cultivated fields. Katyayani (2360).

Lagasca mollis Cav. Quite common and gregarious in waste places, on road sides. Kolhapur (2315).

Parthenium hysterophorus Linn. A rapidly spreading weed, Kolhapur (2415).

Pulicaria wightiana C. B. Clarke. In open areas amongst grasses. Panhala (2305).

Senecio grahami Hook. f. Often on old walls. Panhala (2352).

Sphaeranthus africanus Linn. Forest edges, Panhala (2290).

Tridax procumbens Linn. In rocky dry places, along road sides. Kolhapur, Panhala (2335).

LOBELIACEAE

Lobelia alsinoides Lamk. In pasture lands. Panhala, Gaganbavada (2420-2425).

L. heyneana Roem. and Sch. Pasture lands. Amba village (2430).

L. nicotianaefolia Heyne. In dense forests and forest edges. Panhala, Ambaghats (2435, 2438).

PLUMBAGINACEAE

Plumbago zeylanica Linn. In dry open areas. Kolhapur (2447).

PRIMULACEAE

Anagallis arvensis Linn. Along road sides. Kolhapur (2449).

A. pumila Swart. Monsoon herb in pasture lands. Basement of Panhala fort (2452, 2456).

MYRSINACEAE

Maesa indica Wall. Along forest edges. Panhala rare ; Radhanagari, common (2460, 2462).

Embelia tsjariam-cottam A. DC. Rare ; Katyayani (2469).

Sapotaceae

Xantolis tomentosa (Roxb.) Raf. Common in Panhala on way to Tin Darwaja from Sadoba darga (2474).

Mimusops elengi Linn. Very common on Panhala plateau (2483).

Ebenaceae

Diospyros montana Roxb. Generally in association with *Xantolis tomentosa*. Panhala (2505).

Oleaceae

Jasminum malabaricum Wight. Katyayani, Panhala, Gaganbavada, Ambaghats. Very common at all places (2510).

Schrebera swietenioides Roxb. This was collected only once (26/9/1968) near Gaganbavada village on way to fort.

Apocynaceae

Carrisa congesta Wight. Very common often gregarious. Panhala, Katyayani (2535, 2538).

Rauwolfia canescens Linn. A rare weed in waste places of Kolhapur (2543).

Catharanthus pusillus (Murr.). G. Don. A weed in gardens. Kolhapur (2548).

Alstonia scholaris (Linn.) R. Br. Near Amba village towards tannin factory.

Holarrhena antidysenterica Wall. Common in forests of Katyayani, Panhala and Gaganbavada (2556).

Tabernaemontana heyneana Wall. Along road sides between Amba village and rest house (2560).

Vallaris solanacea (Roth.) Kuntze. On way to Pusati point along fort wall, Panhala (2562).

Periplocaceae

Hemidesmus indicus R. Br. Common in forests and forest clearings. Panhala, Gaganbavada (2581).

Cryptolepis buchanani Roem. and Schult. Common. Kolhapur, Katyayani, Panhala (2585-2587).

Asclepiadaceae

Asclepias curasavica Linn. Around temporary pond near Phule wadi, Kolhapur (2714).

Calotropis gigantea R. Br. Along road sides and in waste places. Kolhapur, Panhala (2591, 2593).

Ceropegia attenuata Hook. In grasslands. Katyayani (2693).

C. tuberosa Roxb. In forests of Panhala.

C. huberi Ansari. Along fort slopes in Gaganbavada and slopes of Ambaghats (2698).

Dregea volubilis Benth. ex Hook. Near Rajaram Tank, Kolhapur, Ambarkhana border, Panhala (2678).

Gymnema sylvestre (Ret.) R. Br. Near Baji Prabhu point, Panhala (2667).

Hoya pendula Wight and Arn. In forests of Ambaghats (2686).

Leptadenia reticulata Wight and Arn. Forest edges. Panhala, Gaganbavada (2689).

Pergularia daemia (Forsk.) Blatt. and McC. Often in hedges. Kolhapur ; on way to Gaganbavada (2660).

Tylophora dalzellii Hook. f. Common in Panhala above Sadoba darga and in Ambarkhana (2670, 2674).

Loganiaceae

Strychnos colubriana Linn. Forests near Gaganbavada (2720).

Menyanthaceae

Nymphoides indicum (Linn.) O. Kuntze. Rankala Talaeo, Kolhapur, Kagal lake, Kagal (2727).

N. cristatum (Roxb.) O. Kuntze. Rankala Talaeo, Kolhapur ; Kagal lake, Kagal (2730).

Gentianaceae

Canscora diffusa R. Br. In moist places often along slopes. Katyayani, Gaganbavada, Ambaghats (2750).

Centaurium roxburghii (G. Don) Druce. In moist places ; University campus, Kolhapur (2745).

Exacum bicolor Roxb. On way to Katyayani along nala ; pasture lands, Panhala (2734).

E. lawii Clarke. In pasture lands. Kolhapur. Panhala, Gaganbavada (2740).

E. petiolare Griseb. In pasture lands. Kolhapur, Panhala, Gaganbavada (2737).

Ehretiaceae

Cordia dichotoma Forst. f. Common. Panhala, Katyayani (2761, 2763).

Boraginaceae

Adelocaryum coelestinum (Lindl.) Brand. Along slopes of Ambaghats (2805).

Coldenia procumbens Linn. Gregarious. Rajaram Tank, Kolhapur (2778).

Cynoglossum meeboldii Brand. Forest edges. Panhala, Radhanagari (2797, 2800).

Heliotropium ovalifolium Forsk. In grassy places. Kolhapur (2787).

Trichodesma amplexicaule Roth. A weed in fields ; often in waste places and grasslands. Kolhapur (2793).

Cuscutaceae

Cuscuta reflexa Roxb. Common specially on hedge plants—*Clerodendrum*, *Duranta*, *Vitex* ; Kolhapur, Panhala (2813).

Convolvulaceae

Argyreia hookeri Clarke. Common in forests of Panhala, Ambaghats (2884, 2888).

A. elliptica Choisy. Panhala, behind Moro-plant library (2894).

Convolvulus arvensis Linn. Weed of cultivated fields. Kolhapur (2835).

Erycibe wightiana Graham. Forests of Ambaghats (2817).

Evolvulus alsinoides Linn. In grass lands. Kolhapur, Panhala (2823, 2825).

Ipomoea aquatica Forsk. Common in all Talaeos of Kolhapur, Vadanige and Kagal near Kolhapur (2857, 2859).

I. cairica (Linn.) Sweet. Extensively cultivated ; often runs wild (2845, 2846).

I. longiflora R. Br. Along hedges. Stem with prominent subspinous tubercles. Near Rankala, Kolhapur (2872).

I. obscura Ker.-Gawl. Ambaghats (2863).

Merremia hastata Hallier. In dry rocky areas of Kolhapur (2841).

Solanaceae

Datura metal Linn. Common weed of waste places. Kolhapur, Panhala (2958).

Nicandra physaloides (Linn.) Gaertn. Weed. Panhala (2975).

Physalis minima Linn. Weed. Not common. Kolhapur, Panhala (2950).

Solanum nigrum Linn. Weed. Kolhapur, Panhala (2905, 2910).

S. surattense Burm. F. In dry rocky areas and along road sides, Kolhapur (2922).

S. indicum Linn. Very common throughout Panhala Plateau and also in Katyayani (2930).

S. torvum Swart. Opposite Rankala along bunds of sugarcane fields ; probably escape (2940).

S. seaforthianum Andr. Escape from cultivation. Opposite Rankala, Kolhapur; Near Mayur Udyan, Panhala (2945).

Withania somnifera (Linn.) Dunal. Weed in waste places. Kolhapur (2954).

Schrophulariaceae

Artanema longifolia (Linn.) Merrill. In grasslands of Gaganbavada, Radhanagari and Amba (3032).

Bacopa monnieri (Linn.) Pennell. Common in damp places and ditches. Kolhapur, Radhanagari (2998).

Dopatorium junceum (Roxb.) Buch.—Ham. Marshy places. Kolhapur, Katyayani (3024).

Kickxia ramosissima (Wall.) Janchen. In crevices of fort walls and other old buildings. Kolhapur, Panhala, Gaganbavada (2990, 2992).

Limnophila sessiliflora Blume. Very common in many Talaeo's around Kolhapur (3017, 3020).

Lindernia anagallis (Burm.) Pennell. Moist and marshy places ; a weed in rice fields. Kolhapur (3088).

L. ciliata (Colsm.) Pennell. Monsoon herb in moist places. Gaganbavada, Amba (3088).

L. crustacea (Linn.) F. Mueller. Moist places, often along road sides. Panhala, Malkapur (3035).

L. parviflora (Roxb.) Haines. Herb in marshes. Kolhapur, Katyayani, Kadamwadi, Gaganbavada (3039).

Mimulus strictus Benth. Kolhapur, Katyayani, Gaganbavada (3102, 3105, 3107).

Pelpidium maritimum (Linn.) Wettst. Marshes of Vadanige lake near Kolhapur.

Rhamphicarpa longiflora (Arn.) Benth. Moist places, Pasture lands. Gaganbavada, Radhanagari.

Sopubia delphinifolia (Roxb.) G. Don. Grasslands. Panhala (3071, 3073).

Stemodia viscosa Roxb. In hygrophytic places. Kolhapur, Radhanagari (3010, 3029).

Striga densiflora Benth. Weed in jawar and sugarcane fields. Kolhapur, Tandulwadi, Gaganbavada (3056, 3057).

S. euphrasioides (Vahl) Benth. Grasslands. Kolhapur (3058).

S. gesneroides (Willd.) Vatke. Panhala and Ambaghats (3050, 3055).

S. sulphurea Dalz. and Gibs. Amongst grasses. Kolhapur, Gaganbavada (3062).

Verbascum chinense Santapau. Along road sides. Kolhapur, Malkapur, Radhanagari (2980, 2985).

Orobanchaceae

Aeginetia indica Linn. Total root parasite in dense forests. Gaganbavada, Ambaghats (3091, 3094).

Christisonia calcarata Wight. Parasitic on roots of *Carvia callosa*. On way to fort top, Gaganbavada (3099).

Gesneriaceae

Klugia notoniana (Wall.) A. DC. In moist places ; in wall crevices. Panhala, Gaganbavada (3118, 3120).

Rhynchoglossum obliquum Blume var. *parviflora* Clarke. On forest slopes ; in cleared areas, gregarious. Gaganbavada (3122, 3125).

Bignoniaceae

Heterophragma quadriloculare (Roxb.) K. Schum. Common on Panhala plateau and Katyayani (3142, 3145).

Tecoma stans (Linn.) H.B.K. In dry places around Kolhapur; Basement of Panhala fort. Not very common (3138).

Pedaliaceae

Sesamum laciniatum Klein ex Willd. Common around Kolhapur and near Kagal in dry rocky soils amongst grasses (3179, 3185).

Martyniaceae

Martynia annua Linn. In waste places. Kolhapur, on way to Panhala, Kagal (3215).

Acanthaceae

Adhatoda vasica Nees. Gregarious in open places. Panhala, Gaganbavada (3392, 3394).

Andrographis paniculata (Burm. f.) Wall. ex Nees. Along forest edges, rarely in open areas. Jotiba, Panhala (3282).

Asteracantha longifolia (Linn.) Nees. Along sewage canals. Kolhapur (3240, 3242).

Asystasia dalzelliana Santapau. Near Tin Darwaja, and Tabak Udyan, Panhala (3326, 3328).

A. lawiana Dalz. Behind Katyayani temple, Katyayani (3332).

Barleria cristata Linn. In hedges, sometimes cultivated. Panhala, Katyayani (3303, 3305).

B. gibsoni Dalz. Grasslands. Katyayani (3320).

B. prionitis Linn. Common in hedges. Panhala, Kolhapur (3293, 3295).

Blepharis asperrima Nees. In shade of forest trees. Panhala, Ambaghats (3229, 3235).

Carvia callosa (Wall.) Brem. Thickets along slopes on way to Gaganbavada (3275).

Eranthemum roseum R. Br. In shade. Panhala, Gaganbavada (3257, 3260).

Haplanthus verticillatus (Roxb.) Nees. Along forest edges in shade. Panhala (3286).

Justicia betonica Linn. Tabak Udyan, Panhala (3376).

Lepidagathis cristata Willd. On rocky ground amongst grasses. Kolhapur, Kagal, Panhala (3337).

Peristrophe bicalyculata (Ret.) Nees. Near Tin Darwaja, Panhala, Jotiba. Not common (3398).

Rostellularia crinita Nees. Along road sides. Kolhapur (3388).

Rungia elegans Dalz. and Gibs. Along road sides, in grasses. Kolhapur (3367).

R. pectinata (Linn.) Nees. Amongst grasses. Panhala (3358).

Verbenaceae

Calicarpa tomentosum (Linn.) Murray. Forest edges. Panhala, Ambaghats (3428).

Clerodendrum fragrans (Vent.) R. Br. Mostly cultivated but grows as escape in Panhala (3463).

C. viscosum Vent. Very common in forest clearings. Panhala, Gaganbavada, Radhanagari (3450-3455).

C. serratum (Linn.) Moon. In grass lands; specially in forest clearings. Katyayani, Panhala, Radhanagari, Gaganbavada (3457-3459).

Duranta repens Linn. Extensively cultivated as hedge in Panhala, often grows as escape (3480, 3482).

Lantana camera Linn. var. *aculeata* (Linn.) Moldenke. Very common in Panhala, gregarious (3411).

Phyla nodiflora (Linn.) Green. Very common in moist places. Kolhapur, Panhala (3415).

Stachytarpheta jamaicensis (Linn.) Vahl. Rare. Near Tabak Udyan & Tin Darwaja, Panhala (3423).

Vitex negundo Linn. Very common. Usually around dwellings. Kolhapur, Panhala, Katyayani, Gaganbavada (3440-3443).

Lamiaceae

Anisochilus carnosus Wall. Very common in rainy season specially on tile roofs. Kolhapur, Panhala, Gaganbavada (3507-3509).

Colebrookea oppositifolia Sm. Gregarious in cleared forests. Panhala, Radhanagari, Ambaghats (3540-3543).

Dysophylla stellata Benth. Around the puddles and marshes. Kolhapur, Panhala, Gaganbavada (3532, 3535).

Hyptis suaveolens (Linn.) Poit. Gregarious in waste places. Kolhapur (3604).

Lavandula burmanni Benth. Amongst grasses. Kolhapur, Panhala (3524, 3526).

Leonurus sibirius Linn. Behind Jotiba temple in waste places. Jotiba (3549).

Leucas aspera Spreng. Amongst grass. Kolhapur (3458).

L. biflora R. Br. Amongst grass. Kolhapur (3577).

L. ciliata Benth. In grass lands and forest clearings. Panhala, Gaganbavada (3582-3584).

L. stelligera Wall. ex Benth. In grasslands and forest clearings. Panhala, Gaganbavada (3586, 3587).

L. urticifolia R. Br. Kadamwadi near Kolhapur (3554-3556).

Plectranthus incanus Link. Katyayani ; basement of Panhala fort (3498).

Pogostemon plectranthoides Desf. Gregarious in Panhala ; in forest clearings, Radhanagari (3524-3526).

Plantaginaceae

Plantago major Linn. Along Panchaganga river beds, Kolhapur (3610).

Nyctaginaceae

Boerhaavia diffusa Linn. Pretty common in Kolhapur. Plants are better developed in shade than in sunny areas (3619, 3625).

Amaranthaceae

Achyranthes aspera Linn. Amongst grasses. Kolhapur, Panhala (3676-3677).

Aerva sanguinolenta (Linn.) Blume. Forest edges. Panhala (3668).

Alternanthera pungens H.B. & K. In dry rocky places; sometimes along road side. Kolhapur, Panhala (3693).

A. sessilis (Linn.) DC. Weed in damp and waste land. The species shows remarkable variation in vegetative characters (3688).

Amaranthus spinosus Linn. In waste places. Kolhapur, Panhala (3647-3649).

Celosia argentea Linn. Weed in fields. Kolhapur (3637-3639).

Digera alternifolia (Linn.) Aschers. In grasses and road sides ; rare. University campus, Kolhapur.

Gompherena celosioides Mart. In waste places and along road sides. Kolhapur, Panhala (3696).

G. globosa Linn. Often found as escape from cultivation in waste land. University campus, Kolhapur (3698).

Chenopodiaceae

Chenopodium ambrosioides Linn. Weed in gardens. Kolhapur (3704).

POLYGONACEAE

Antigonon leptopus Hook. and Arn. Cultivated but runs wild in Panhala (3759).

Polygonum chinense Linn. Very common in Panhala, Gaganbavada (3749-3751).

P. glabrum Willd. Marshes of Kolhapur, Shiroli talaeo, Vadanige talaeo near Kolhapur (3732-3735).

P. plebejum R. Br. Very common in all marshes and damp localities. Kolhapur, Panhala Radhanagari (3727-3729).

PODOSTEMACEAE

Terniola zeylanica (Gardn.) Tul. In streams of Ambaghat and Radhanagari.

Griffithella hookeriana (Tul.) Warming. Near Gaganbavada in stream.

PIPERACEAE

Piper hookeri Miq. In forests of Ambaghats (3782).

P. longum Linn. In shady places along the bunds of sugarcane fields near Rankala (3785).

LAURACEAE

Cinnamomum zeylanicum Blume. Gohlna area of Radhanagari forests (3805-3806).

Alseodaphne semicarpifolia Nees. Ambaghats (3813).

THYMELAEACEAE

Lasiosiphon eriocephalus Deine. Very common along forest margins and forest clearings. Panhala, Radhanagari, Gaganbavada, Katyayani and Ambaghats (3827-3835).

ELAEAGNACEAE

Elaeagnus conferta Roxb. Ambaghats on way to Pratapnagar (3840).

LORANTHACEAE

Dendrophthoe falcata (Linn. f.) Ettings. Very common on *Mangifera indica* and *Melilotus philippiensis* at Panhala (3856, 3859).

D. falcata Ettings var. *coccinea* (Talb.) Santapau. Radhanagari on *Terminalia crenulata*.

VISCACEAE

Viscum angulatum Heyne ex DC. On *Dalbergia latifolia*, Panhala ; on *Terminalia chebula*, Radhanagari (3879, 3880).

SANTALACEAE

Osyris wightiana Wall. ex Wight. In forests. Katyayani, Panhala (3893-3897).

Santalum album Linn. Panhala, Kolhapur. Possibly cultivated (3886-3888).

EUPHORBIACEAE

Acalypha ciliata Forsk. Often grows in wall crevices. Kolhapur (4204).

Bridelia squamosa (Lamk.) Gehrm. Common at Panhala, Katyayani and Gaganbavada (4067-4069).

Chrozophora rottleri (Geis.) Juss. ex Spr. Weed in cultivated fields and puddles. Kolhapur (4193).

Croton bonplandianum Baill. Weed of waste land. Kolhapur (4179).

Emblica officinalis Gaertn. Radhanagari forests (4112).

Euphorbia geniculata Orteg. In waste places. Kolhapur, Panhala (4053-4058).

E. hirta Linn. Throughout plains of Kolhapur and Panhala (4034, 4036).

E. neriifolia Linn. On rocky slopes. Ambaghats. Gaganbavada.

E. rothiana Spreng. Amongst grasses in forest clearings. Gaganbavada (4009).

E. thymifolia Linn. Very common throughout plains of Kolhapur and Panhala (4043).

Glochidion hohenackeri Bedd. Panhala, Radhanagari (4087).

G. malabaricum Bedd. Katyayani, Panhala (3879).

Jatropha curcas Linn. Near habitation. Kolhapur, Panhala (4148, 4153).

J. gossypifolia Linn. In waste land in Rajarampuri, Kolhapur (4158).

Kirganelia reticulata (Poir.) Baill. In open places. Kolhapur, Panhala (4108).

Macaranga peltata (Roxb.) Muell.-Arg. Radhanagari, Ambaghats (4238).

Melanthesa turbinata (Koen. ex Roxb.) Wight. In forests and along forest edges. Panhala, Gaganbavada (4102).

M lilotus philippiensis (Lamk.) Muell.-Arg. Very common. Panhala, Katyayani, Gaganbavada, Ambaghats (4222).

Phyllanthus asperulatus Hutch. In grassland, Kolhapur, Panhala (4117-4119).

P. urinaria Linn. Grass land. Kolhapur (4123).

Sapium insigne Trimen. Forest margins and clearings. Rajdindi road, Panhala ; forests near Gaganbavada ; Along streams near Amba tannin factory, Amba (4255).

Securinega leucopyrus (Willd.) Muell.-Arg. Common in open areas. Kolhapur, Katyayani, Panhala (4098).

Tragia muelleriana var. *unicolor* (Muell.-Arg.) Pax and Hoffm. Under shades of forest trees. Panhala, Gaganbavada (4248).

Ulmaceae

Celtis cinnamomea Lindl. Very common in Panhala but not in other areas of Kolhapur district. Panhala (4272).

Trema orientalis (Linn.) Blume. Common. Panhala, Kolhapur (4276, 4280).

Moraceae

Ficus asperrima Roxb. Quite common shrub of Panhala Plateau.

F. glomerata Roxb. Kolhapur, Panhala, Radhanagari ; often cultivated.

F. rumphii Blume. Common along fort walls, Panhala.

F. tsiela Roxb. All over Panhala Plateau. Possibly cultivated.

Urticaceae

Boehmeria scabrella (Roxb.) Gaud. Stinging herb in shades. Panhala Gaganbavada (4304-4306).

Flurya interrupta (Linn.) Gaud. Common on old walls. Kolhapur, Panhala, Gaganbavada (4285-4288).

Girardinia zeylanica Decne. In waste land during rainy season. Panhala, Gaganbavada (4292).

Lecanthus peduncularis (Wall.) Wedd. Succulent in moist localities and in wall crevices. Panhala, Gaganbavada (4298).

Pilea microphylla (Linn.) Liebm. Naturalized ; in damp places. Kolhapur, Panhala (4322).

Pouzolzia zeylanica (Linn.) Benn. In rocky moist areas on Gaganbavada fort (4311).

P. pentandra Benn. Along streams. Kolhapur (4314).

Salicaceae

Salix tetrasperma Roxb. Along river beds and streams. Kolhapur, Malkapur (4330).

Ceratophyllaceae

Ceratophyllum demersum Linn. Common in all lakes and ponds of Kolhapur (4336).

Hydrocharitaceae

Blyxa octandra (Roxb.) Planch. ex Thw. Submerged herb with purplish tufted leaves. Kagal lake, Kagal.

Hydrilla verticillata (Linn. f.) Royle. All lakes, ponds and puddles of Kolhapur, Kagal lake (4661-4664).

Vallisneria spiralis Linn. Common in all water spreads (4668).

Burmanniaceae

Burmannia pusilla (Wall. ex Miers.) Thew. In pasture lands during September-October. Gaganbavada (4681-4684).

Orchidaceae

Dendrobium barbatulum Lindl. Common in forests of Panhala, Radhanagari and Ambaghats (4714-4716).

D. microbulbon A. Rich. Near Gohlna, Radhanagari (4706).

Eria dalzellii Lindl. Radhanagari, Ambaghats. (4758-4761).

Eulophia pratensis Lindl. Marshes of Kagal lake (4776).

E. nuda Lindl. In shades of forest trees. Ambaghats (4779).

Habenaria commelinifolia Wall. ex Lindl. Grasslands. Radhanagari (4892).

H. grandiflora Lindl. In grasslands ; earliest *Habenaria* to flower in monsoon. Very common. Kolhapur, Katyayani, Kagal, Panhala, Gaganbavada, Radhanagari, Ambaghats. Throughout the district (4852-4857).

H. longecalcarata A. Rich. Grasslands. An attractive species because of its long spur. Kolhapur (4859).

H. marginata Coleb. In rice fields. Kolhapur, Panhala (4901-4906).

Oberonia recurva Lindl. Panhala, Gaganbavada, Radhanagari and Ambaghats (4693-4696).

Vanda parviflora Lindl. Panhala, Radhanagari (4852-4857).

Zingiberaceae

Curcuma inodora Grah. Very common along forest edges and in forest clearings. Panhala, Gaganbavada, Radhanagari (4936).

Curcuma sp. Under growth in dense forests and along forest edges. Panhala, Radhanagari.

Hedychium coronarium Koen. Only one patch of it was seen along margin of temporary pond behind Shalini palace, Kolhapur (4929).

Zingiber cernuum Dalz. Under growth in dense forests. Near Gaganbavada (4959).

Costaceae

Costus speciosus (Koenig.) Smith. Common along forest edges. Panhala, Gaganbavada, Radhanagari, Ambaghats (4971-4973).

Cannaceae

Canna indica Linn. Escape. Along stream near Rankala, Kolhapur ; behind Tin Darwaja, Panhala.

Musaceae

Ensete superbum (Roxb.) Cheesman. Along Ghat slopes. Ambaghats, Gaganbavada.

Hypoxydaceae

Curculigo orchioides Gaertn. In open grasslands and forest clearings. Kolhapur, Gaganbavada, Radhanagari (5041-5C46).

Hypoxis aurca Laur. Common in pasture lands. Kolhapur, Panhala (5032-5038).

Amaryllidaceae

Crinum latifolium Linn. Along streams. Kolhapur; on way to Katyayani.

Agaveaceae

Agave vera-cruz Mill. Escape. Panhala.

Dioscoriaceae

Dioscoria bulbifera Linn. Common. Katyayani, Panhala, Gaganbavada, Radhanagari (5132-5136).

D. pentaphylla Linn. In all forests. (5122-5128).

Liliaceae

Asparagus racemosus Willd. var. *javanica* Baker. Katyayani, Panhala, Gaganbavada, Ambaghats. Forest margins and clearings (5142).

Asphodelus tenuifolius Cav. Weed in cultivated fields. Kolhapur (5238).

Chlorophytum glaucum Dalz. Gaganbavada, Radhanagari. Rare.

C. laxum R. Br. Pasture lands of Kolhapur, Panhala (5238).

Gloriosa superba Linn. In forest clearings. Katyayani, Panhala, Ambaghats (5175-5178).

Iphigenia indica (Linn.) A. Grey. In grass lands, Panhala, Radhanagari; Plants with 4-5 perianth segments and 4-5 stamens are not rare in fields (5181-5186).

I. pallida Baker. Common in pasture lands. Kolhapur (5188).

Ledebouria hyacinthiana Roth. In pasture lands. Kolhapur, Radhanagari (5198-5208).

There are two populations of this species: Population collected from Radhanagari has larger lanceolate-oblanceolate nonblotched leaves which regularly end in bulbils at tips: The flowering in this population is rare and flowers wither away without forming fruits. The main reproduction is by bulbils. The other population commonly seen in the plains of Kolhapur has smaller lanceolate blotched or faintly blotched leaves rarely terminating in bulbils. The main reproduction is by seeds which germinate as soon as they are ripe. The roots in this population are often tuberous. Both the populations have remained distinct under uniform conditions of cultivation at Kolhapur.

Smilax zeylanica Linn. Common. Katyayani, Panhala, Gaganbavada (5161-5165).

Urginea indica (Roxb.) Kunth. Common in pasture lands of Kolhapur, Kagal (5212-5215).

Pontederiaceae

Monochoria vaginalis (Burm. f.) Presl. ex Kunth. Along marshes of Vadanige lake near Kolhapur. Rare (5269).

Eichhornia crassipes (Mart.) Solms. Common along Panchaganga river, Rankala Talaeo, puddles at Kolhapur (5272-5278).

Arecaceae

Phoenix sylvestris Roxb. Along nalas at Kolhapur.

Caryota urens Linn. In forests of Panhala, Gaganbavada and Ambaghats.

Pandanaceae

Pandanus odoratissimum Linn. f. Kagal stream near Kolhapur, Katyayani; Radhanagari, along streams.

Typhaceae

Typha angustata Bory and Chaub. Common in marshes. Kolhapur, Kagal, Shiruli (5491-5498).

ARACEAE

Ariopsis peltata Nimmo. Generally epiphytic, sometimes in rock crevices; abundant at Panhala and Radhanagari (5541-5546).

Arisaema murrayi Hook. Katyayani, Panhala, Gaganbavada (5541-5546).

Colocasia esculenta (Linn.) Schott. Escape. In ponds and ditches. Kolhapur (5776).

Pothos scandens Linn. Gohlna forests of Radhanagari (4561).

LEMNACEAE

Lemna paucicostata Hegalmaier. In stagnant waters and ponds. Kolhapur.

Spirodella polyrrhiza (Linn.) Schleid. Kolhapur.

POTAMOJETONACEAE

Potamojeton nodosus Poir. In all talaeos of Kolhapur, Shiruli, Vadanige and Kagal (5796-5799).

P. pectinatus Linn. Kagal lake, Kagal (5815).

NAJADACEAE

Najas graminea Del. Common in ponds and lakes. Kolhapur, Kagal (5825).

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List of type specimens of the species, varieties, and forma deposited in Blatter herbarium, Bombay[1]

P. V. Bole[2] and M. R. Almeida[3]

(*Continued from vol. 74 (2) : 232*)

Liliaceae

111. **Iphigenia stellata** Blatter, in Journ. Bombay nat. Hist. Soc. 32 (4) : 734, 1928.

Lectotype : E. Blatter—Panchgani-P-1 (June, 1927),

Syntypes : E. Blatter—Panchgani P-1 A-C (June, 1927).

There were a number of unmounted specimens in newspapers with a common number P-1. They are now mounted on four herbarium sheets and one of them is retained with no. P-1 and is herein selected as the lectotype and remaining three are marked with P-1A, P-1B and P-1C and designated as syntypes.

112. **Scilla viridis** Blatter, in Journ. Indian Bot. 2 : 52-3, 1921.

Holotype : C. McCann—Khandala-14500 (Sept., 1918).

113. **Urginia polyantha** Blatter, in Journ. Bombay nat. Hist. Soc. 32(4) : 735, 1928.

Lectotype : E. Blatter & McCann—Panchgani-101 (Apr., 1926),

Syntypes : E. Blatter & McCann—Panchgani-101 A-G (Apr., 1926).

The lectotype no. 101 is one of the unmounted specimens found in a common folder in McCann's herbarium. The remaining duplicates have been marked 101A, 101B, 101C, 101D, 101E, 101F and 101G and designated as syntypes.

Linaceae

114. **Hugonia bellii** Sedgwick, in Indian Forester, 10(6) : 424, 1920.

Lectotype : T. R. D. Bell—Coorg-5457 (Feb., 1919),

Syntypes : T. R. D. Bell—Coorg-5457A (Feb., 1919),

T. R. D. Bell—Coorg-3916 (May, 1918).

In the original publication the author has given no. 5457 as the type of this species. There are however two herbarium sheets under this number in Blatter Herbarium. One of them is selected herein as the lectotype under the same number and the other specimen is designated as syntype of the species.

[1] Accepted December 1975.

[2] Blatter Herbarium, St. Xavier's College, Bombay-400 001

[3] Presently at CIBA-GEIGY Research Centre, Bombay-400 063.

Lythraceae

115. **Ammania senegalensis** forma **indica** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1) : 214, 1918.

Lectotype : Blatter & Hallberg—Poona-19866 (Aug., 1895).

Syntypes : Blatter & Hallberg—Poona-3352 (Dec., 1917),
Blatter & Hallberg—Khandala-3350 (Nov., 1916).

In the original publication authors have mentioned three specimens as types. No. 19866 is herein selected as the lectotype of the species and other two are kept as syntypes.

Malvaceae

116. **Abutilon fruticosum** var. **chrysocarpa** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1) : 227, 1918.

Holotype : Blatter & Hallberg—Jaisalmer-5660 (Nov., 1917).

117. **Abutilon indicum** var. **major** Blatter et Hallberg, in Jour. Bombay nat. Hist. Soc. 26(1) : 226, 1918.

Holotype : Blatter & Hallberg—Jaisalmer-5644 (Nov., 1917).

118. **Althaea villosa** Blatter, in Journ. Indian Bot. Soc. 9(4) : 201, 1930.

Holotype : J. Fernandez—Miranshah-804 (16-4-1927).

119. **Althaea villosoides** Blatter et Hallberg, in Journ. Indian Bot. Soc. 9(4) : 202, 1930.

Holotype : J. Fernandez—Miranshah-805 (16-4-1927),

Paratype : J. Fernandez—Miranshah-1622 (16-4-1927).

120. **Malva waziristanensis** Blatter, in Journ. Indian Bot. Soc. 9(4) : 202, 1930.

Holotype : J. Fernandez—Miranshah-493 (12-4-1927).

121. **Pavonia arabica** var. **glutinosa** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1) : 227, 1918.

Lectotype : Blatter & Hallberg—Jodhpur-5669 (Oct., 1917).
(See Santapau, 1959 B).

Orchidaceae

122. **Dendrobium mabalae** Gammie, in Journ. Bombay nat. Hist. Soc. 16 : 567, 1905.

Holotype : G. A. Gammie—Castle Rock-15782 (29-10-1902).

123. **Eria minima** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 35 : 274, f. 2, 1931.

Holotype : L. J. Sedgwick—Anmode, N. Kanara-3260 (December),

Paratypes : L. J. Sedgwick-Jog-7170 (Oct., 1918),
T. R. D. Bell—Anmode-4443 (Oct., 1918),
M. Ezekiel—Mahabaleshwar-2670 (17-2-1917).

124. **Eria rupestris** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 35(2) : 270, 1931.

Isotypes : May Langham—Panchgani-228-9 (June, 1925).

125. **Habenaria cerea** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2) : 21, t. 6, 1932.

Holotype : E. Blatter—Panchgani-73 (August, 1925), Isotype : E. Blatter—Panchgani-P-76 (August, 1925),

Paratypes : L. J. Sedgwick—Panchgani-7568 (Oct., 1920),

L. J. Sedgwick—Panchgani-7907 (Aug., 1921).

126. **Habenaria grandifloriformis** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 36 : 17, 1932.

Paratypes : L. J. Sedgwick—Panchgani-7900 (Feb., 1921),

L. J. Sedgwick—Dharwar-2601 (July, 1917).

127. **Habenaria multicaudata** Sedgwick, in Rec. Bot. Surv. India, 6 : 352, 1919.

Holotype : T. R. D. Bell—Gudehalli-3045 (Sept., 1917).

128. **Habenaria spencei** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 36 : 17, t. 3, 1932.

Isotype : C. McCann—Mahabaleshwar-3027 (28-8-1930).

129. **Habenaria variabilis** Blatter, in Journ. Bombay nat. Hist. Soc. 36 : 19-20, tt. 4-5, 1932.

Paratypes : E. Blatter—Panchgani-201, 204-6 (July, 1925),

E. Blatter & M. Isaacs—Panchgani-26494 (July, 1925),

L. J. Sedgwick—Panchgani-7908 bis (Aug., 1921).

130. **Liparis flavo-viridis** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 35(2) : 260, 1931.

Paratype : Mr. Spooner—Londa-s.n. (20-8-1905).

131. **Luisia macrantha** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 35 : 492, t. 10, 1932.

Lectotype : T. R. D. Bell—N. Kanara-5400 (1907),

Syntypes : T. R. D. Bell—N. Kanara-5397A, 5414 (1907),

L. J. Sedgwick—Anmode, N. Kanara-3224 (Dec., 1917).

132. **Luisia pseudotenuifolia** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 35 : 492, t. 11, 1932.

Isotype : T. R. D. Bell—N. Kanara-5411 (1907).

133. **Nervillea monantha** Bell et Blatter, in Journ. Bombay nat. Hist. Soc. 35 : 724, 1932.

Holotype : T. R. D. Bell—Yellapur, N. Kanara-5428 (1907),

Isotype : T. R. D. Bell—Yellapur, N. Kanara-5429 (1907),

Paratypes : T. R. D. Bell—Yellapur, N. Kanara-2522-4 (May, 1917),

L. J. Sedgwick—Karwar-4071 (June, 1900),

L. J. Sedgwick—Nagargali-2635 (July, 1917).

134. **Oberonia lingmalensis** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 35(2) : 255, 1931.

Paratypes : L. J. Sedgwick—Mahabaleshwar-7755 (1920),

T. R. D. Bell—Thana-3973 (Feb., 1918).

135. **Oberonia sedgwickii** Blatter et McCann, in Journ. Bombay nat. Hist. Soc 35(2) : 257, 1931.

Paratype : L. J. Sedgwick—Castle Rock-5540 (March, 1919).

136. **Peristylis xanthochlorus** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 35 : 733, 1932.

Paratypes : E. Blatter—Panchgani P-81 (Oct., 1925),

L. J. Sedgwick—Panchgani-7566 (Dec., 1920),

L. J. Sedgwick—Panchgani-7596 bis (Dec., 1920),

L. J. Sedgwick—Mahabaleshwar-7622 bis (Dec., 1920),

L. J. Sedgwick—Mahabaleshwar-7642 (Dec., 1920).

137. **Sacrochilus flabelliferum** Blatter et McCann, in Journ. Bombay nat. Hist. Soc. 35(4) : 722, 1932.

Holotype : L. J. Sedgwick & T. R. D. Bell—Devimane, N. Kanara-6951 (Oct., 1919),

Paratypes : L. J. Sedgwick—Sirsi, N. Kanara-7078 (Oct., 1919),

T. R. D. Bell—N. Kanara-5413 (1907).

138. **Tropidia bellii** Blatter, in Journ. Bombay nat. Hist. Soc. 35(4) : 730, 1932.

Holotype : T. R. D. Bell—Gudehalli-2992 (Sept., 1917).

Orobanchaceae

139. **Aeginetia indica** var. **alba** Santapau, in Kew Bull. 1948 : 491-2, 1949.

Holotype : H. Santapau—Khandala-2412 (21-8-1943),

Paratype : H. Santapau—Khandala-4812 (8-9-1944).

140. **Christisonia flamea** Sedgwick, in Journ. Indian Bot. 2: 123, 1921.

Lectotype : Hallberg & McCann-Gersoppa falls-34663 (Oct., 1919).

In the original publication, Sedgwick does not specify the type specimen. According to him the type material was collected by Sedgwick, Bell, Hallberg and McCann, in Nov., 1919. The date of type collection does not agree with the material available in Blatter Herbarium. Since no. 34663 is the only specimen available, which also happens to be collected earlier than the type mentioned, it is selected herein as the lectotype of this species.

Papilionaceae

141. **Alysicarpus monilifer** var. **venosa** Blatter et Hall., in Journ. Bombay nat. Hist. Soc. 26(1) : 240, 1918.

Lectotype : E. Blatter—Jaisalmer-7226 (Nov., 1917).

142. **Argyrolobium mucilagineum** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2) : 481, 1933.

Holotype : E. Blatter & J. Fernandez—Waziristan-870 (5-4-1930),

Paratype : E. Blatter & J. Fernandez—Waziristan-657 (5-4-1930).

143. **Argyrolobium purpurascens** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2) : 480, 1933.

Holotype : E. Blatter & J. Fernandez—Waziristan-1642 (19-4-1930).

144. **Aegyrolobium strigosum** Blatter, in Journ. Bombay nat. Hist. Soc. 39(4) : 205, 1936.

Holotype : J. Fernandez—Saragorha-163 (20-5-1927),

Paratypes : J. Fernandez—Waziristan-359 (4-4-1927),

J. Fernandez—Waziristan-4046 (21-6-1927),

J. Fernandez—Miranshah-363 (14-4-1927).

145. **Astragalus fernandezianus** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2) : 482, 1933.

Holotype : J. Fernandez—Razmak-3278 (5-5-1927),

Isotypes : J. Fernandez—Razmak-3113, 3174, 3179 (5-5-1927),

Paratypes : E. Blatter & J. Fernandez—Waziristan-1261 (14-4-1930).

146. **Astragalus lasius** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2) : 480, 1933.

Holotype : E. Blatter & J. Fernandez—Waziristan-754 (2-4-1930),

Paratype : E. Blatter & J. Fernandez—Waziristan-261 (23-4-1930).

147. **Caragona spinosissima** Blatter, in Journ. Indian Bot. Soc. 9(4) : 205-6, 1930.

Holotype : E. Blatter—Boya-910 (27-3-1927),

Isotype : E. Blatter-Boya 907 (27-3-1927).

148. **Calophaca tomentosa** Blatter et Hallberg, in Journ. Indian Bot. 1 : 19, 1919.

Holotype : J. E. B. Houston—Paharechi-322 (18-9-1917).

149. **Dorychnium vilosum** Blatter et Hallberg, in Journ. Indian Bot. 1 : 18, 1919.

Lectotype : J. E. B. Houston—Ispikan-M-89 (7-3-1918),

Syntype : J. E. B. Houston—Ispikan-M-89A (7-3-1918).

In original publication authors have mentioned both specimens as types. M-89 is herein selected as the lectotype of the species.

150. **Indigofera acanthinocarpa** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2): 482, 1933.

Holotype : J. Fernandez—Durgai post-4066 (22-6-1927),

Isotype : J. Fernandez—Durgai post-4075 (22-6-1927),

Paratype : J. Fernandez—Tenai-4030 (21-6-1927).

151. **Indigofera articulata** var. **monosperma** Santapau, in Proc. Nat. Inst. Sci. India, 24B (3) : 135-7, 1958.

Holotype : H. Santapau—Dwarka-16771 (16-10-1953),

Isotype : H. Santapau—Dwarka-16784 (16-10-1953),

Paratypes : H. Santapau—Dwarka-4625-6 (20-8-1952).

152. **Indigofera oreophila** Santapau et Panthaki, in Journ. Bombay nat. Hist. Soc. 54(1) : 221-3, 1956.

Holotype : D. P. Panthaki—Waghai-2350 (23-10-1955),

Paratypes : D. P. Panthaki—Pimpri-2415 (26-10-1955),
H. Santapau—Waghai-19995 (22-10-1955),
H. Santapau—Waghai-20081 (22-10-1955).

153. **Indigofera paucifolioides** Blatter et McCann, in Journ. Indian Bot. 1 : 19, 1919.

Holotype : J. E. B. Houston—Wad-226B (2-10-1917).

154. **Medicago monantha** Blatter, in Journ Bombay nat. Hist. Soc. 26 : 969, 1933.

Holotype : E. Blatter & J. Fernandez—Waziristan-839 (14-1-1930),

Paratype : E. Blatter & J. Fernandez—Waziristan-660 (14-1-1930).

155. **Moghania gracilis** Mukherjee, in Bull. Bot. Soc. Bengal, 6(1) : 22-4, 1953.

Isotype : T. R. D. Bell—Castle Rock-4343 (Sept., 1918),

Paratype : H. Santapau—Khandala-949 (14-9-1930).

156. **Moghania praecox** var. **robusta** Mukherjee, in Bull. Bot. Soc. Bengal, 6(1) : 19-20, 1953.

Paratype : T. R. D. Bell—Thana-3634 (Feb., 1918).

157. **Psoralea odorata** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1) : 238, 1918.

Lectotype : Blatter & Hallberg—Jodhpur-7035 (Nov., 1917).

(See Santapau, 1959 A).

158. **Rhynchosia arenaria** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1) : 243, 1918.

Lectotype : Blatter & Hallberg—Jaisalmer-6942 (Nov., 1917).

(See Santapau, 1959 A).

159. **Rhynchosia rhombifolia** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1) : 242, 1918.

Lectotype : Blatter & Hallberg—Jaisalmer-6948 (Nov., 1917).

(See Santapau, 1959 A).

160. **Tephrosia incana** var. **horizontalis** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1) : 239, 1918.

Lectotype : E. Blatter—Jodhpur-6977 (Oct., 1917).

(See Santapau, 1959 A).

161. **Tephrosia jamnagarensis** Santapau, in Proc. Nat. Inst. Sci. India, 24 B (3) : 133-5, 1958.

Holotype : H. Santapau—Jamnagar-7522 (16-10-1945).

162. **Tephrosia multiflora** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1): 239, 1918.

Lectotype : E. Blatter—Jaisalmer-6974 (Oct., 1917).

(See Santapau, 1959 A).

163. **Tephrosia petrosa** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1) : 239, 1918.

Lectotype : Blatter & Hallberg—Jaisalmer-6969 (Nov., 1917).

(See Santapau, 1959 A).

164. **Trigonella dimorpha** Blatter, in Journ. Bot. Soc. 9(4) : 204, 1930.

Holotype : J. Fernandez—Razmak-3306 (5-5-1927).

165. **Trigonella laesia** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2) : 479, 1933.

Holotype : J. Fernandez—Razmak-1883 (6-5-1927),

Isotypes : J. Fernandez—Razmak,1841, 1853 (6-5-1927),

Paratype : J. Fernandez—Razmak-2320 (7-5-1927).

166. **Trigonella longepedunculata** Blatter, in Journ. Indian Bot. Soc. 9(4) : 204-5, 1930.

Holotype : J. Fernandez—Razmak-2376 (2-5-1927),

Isotypes : J. Fernandez—Razmak-2439, 3023, 3025, 3041, 3044 (2-5-1927),

Paratypes : J. Fernandez—Razimi-2165 (23-4-1927).

167. **Trigonella psylorhynchos** Blatter, in Journ. Bombay nat. Hist. Soc. 36(2) : 479, 1933.

Holotype : E. Blatter & J. Fernandez—Razmak-1721 (24-4-1930).

PRIMULACEAE

168. **Androsace croftii** var. **scaposa** Santapau et Banerji, in Proc. Nat. Inst. Sci. India, 24B(3) : 137, 1958.

Holotype : M. L. Banerji—E. Nepal-686 (8-5-1952).

RANUNCULACEAE

169. **Ranunculus echinatissimus** Blatter, in Journ. Indian Bot. Soc. 9(4) : 200, 1930.

Holotype : J. Fernandez—Razimi-2912 (19-4-1927).

170. **Ranunculus fernandezii** Blatter, in Journ. Indian Bot. Soc. 9(4) : 199, 1930.

Holotype : J. Fernandez—Saragorha-21 (18-5-1927),

Isotype : J. Fernandez—Saragorha-33 (18-5-1927).

171. **Ranunculus hirtellus** var. **minor** Santapau et Banerji, in Proc. Nat. Inst. Sci. India 24B (3) : 138, 1958.

Holotype : M. L. Banerji—E. Nepal-798 (28-5-1953).

172. **Ranunculus nanus** Blatter, in Journ. Indian Bot. Soc. 9(4) : 199, 1930.

Holotype : J. Fernandez—Waziristan-2934 (19-4-1927).

173. **Ranunculus pseudomuricatus** Blatter et Hallberg, in J. Ind. Bot. Soc. 1 : 54, 1919.

Holotype : J. E. B. Houston—Nag-M-54A (7-4-1918).

174. **Thalictrum obovatum** Blatter, Journ. & Proc. Asiat. Soc. Bengal (New Series) 26(1) : 339-340, 1930.

Lectotype : Ankadi, Mahabaleshwar-P-26 (12-7-1925),

Syntype : Ankadi, Mahabaleshwar-P-26A (12-7-1925).

There were two unmounted specimens in a folder under no. P-26. One of them is selected herein as a lectotype and other is designated a syntype under P-26A.

RHAMNACEAE

175. **Ventilago madraspatana** var. **fructifida** Santapau, in Kew Bull. 1949 : 340, 1949.

Isotype : L. D. Garade—Khandala-s.n. (22-3-1905).

ROSACEAE

176. **Prunus leucophylla** Blatter, in Journ. Indian Bot. Soc. 9(4) : 206, 1930.

Holotype : E. Blatter—Boya-425 (8-4-1927),

Isotype : E. Blatter—Boya-424 (8-4-1927),

Paratype : E. Blatter—Razimi-2751 (19-4-1927).

177. **Pyrus parvifolia** Blatter, in Journ. Indian Bot. Soc. 9(4) : 207, 1930.

Holotype : E. Blatter—Razimi-2158 (23-4-1927),

Paratype : E. Blatter—Razmak-3344 (5-5-1927).

RUBIACEAE

178. **Gailonia macrantha** Blatter et Hallberg, in Journ. Indian Bot. Soc. 1 : 27, 1919.

Holotype :———, Quetta-s.n. (Aug., 1918).

179. **Oldenlandia maheshwarii** Santapau et Merchant, in Journ. Indian Bot. Soc. 42A : 213-5, 1963.

Holotype : Y. A. Merchant—Mahabaleshwar-1267 (20-9-1952),

Paratype : H. Santapau—Mahabaleshwar-14963 (20-9-1952).

180. **Oldenlandia sedgwickii** Blatter, in Journ. & Proc. Asiat. Soc. Bengal (New Series) 26(1) : 344, 1930.

Holotype : L. J. Sedgwick—Karwar-6653 (Oct., 1919).

SCROPHULARIACEAE

181. **Anticharia glandulosa** var. **caerulea** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26 : 549, 1919 (nom. nud.), ex Santapau, in Journ. Bombay nat. Hist. Soc. 56(2) : 280, 1959.

Lectotype : Blatter & Hallberg—Jaisalmer-10284 (Nov., 1917).

(See Santapau, 1959 A).

182. **Bonnaya bracteoides** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 25(3) : 416, 1918.

Lectotype : Blatter & Hallberg—Mount Abu-1514 (Oct., 1916).

In the original publication, the authors have mentioned three specimens (nos. 1514, 1515 & 1516) as types of this species. Only one specimen out of the three is located in Blatter Herbarium and is herein selected as the lectotype of this species.

183. **Bonnaya micrantha** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 25(3) : 417, 1918.

Lectotype : Blatter & Hallberg—Igatpuri-1735 (Sept., 1917).

In the original paper, the authors have mentioned four specimens (nos. 1734, 1735, 1736 & 1765) as types. Out of these four only no. 1735 is located in the Blatter Herbarium and is selected herein as the lectotype of the species.

184. **Bonnayodes limnophyloides** Blatter et Hallberg, in Journ. Indian Bot. 2: 46-7, 1921.

Holotype : Blatter & Hallberg—Londa-9450 (Oct., 1918).

185. **Dopatrium junceum** var. **multiloba** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 25(3) : 426, 1918.

Holotype : Blatter & Hallberg—Igatpuri-1597 (Jan., 1917).

186. **Limnophila polystachyoides** Blatter, in Journ. & Proc. Asiat. Soc. Bengal (New Series) 26(1) : 352, 1930.

Lectotype : Marole, Salsette-2 (1840) (Dec., 1916).

Syntype : Marole, Salsette-2 (1837) (Dec., 1916).

The original publication mentions ' Locality: Bombay Presidency, Salsette, near Marole (McCann & Blatter no. 12345, type)—flowered and fruited in December, 1916 '.

In the Blatter Herbarium, there are two herbarium sheets with nos. 1837 and 1840, collected from Marole, Salsette Island, during December, 1916. Herbarium label of specimen no. 1840 gives, ' *Limnophila* sp. nov. no. 2, type species '. It is presumed here that no. 1840 is the corresponding no. 2 specimen from nos. 1, 2, 3, 4 & 5 which are misprinted in the original paper as no. 12345. Therefore no. 2 (1840) is selected herein as the lectotype of the species.

187. **Mazus mccannii** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 25(3) : 423-4, 1918.

Lectotype : C. McCann—Igatpuri-1720 (Sept., 1917),

Syntype : C. McCann—Igatpuri-1721 (Sept., 1917).

Out of the six specimens mentioned under types for this species only two are available in Blatter Herbarium. Specimen no. 1720 is selected herein as the lectotype of the species and specimen no. 1721 is designated as syntype.

188. **Striga gesneroides** var. **minor** Santapau, in Kew Bull. 1948 : 491, 1949.

Holotype : H. Santapau—Khandala-3072 (6-11-1943),

Isotype : H. Santapau—Khandala-3073 (6-11-1943),

Paratypes : H. Santapau—Khandala-3417 (24-12-1943),

H. Santapau—Khandala-3451 (27-12-1943),

H. Santapau—Khandala-3438 (26-12-1943),

H. Santapau—Khandala-5262 (2-11-1944).

189. **Torenia indica** C. Saldanha, in Bull. Bot. Surv. India 8(2) : 126-8, 1966.

Holotype : C. Saldanha—Waghai, Dangs-6733 (26-8-1961),

Isotypes : C. Saldanha—Waghai, Dangs-6730, 6732, 6735 (26-8-1961),

Paratypes : H. Santapau—Waghai, Dangs-19166 (3-9-1954),

H. Santapau—Pimpri, Dangs-19332 (7-9-1954).

190. **Torenia lindern'oides** C. Saldanha, in Bull. Bot. Surv. India 8(2) : 129-30, 1966.

Holotype : L. J. Sedgwick—Kali nadi-Dandeli-2511 (May, 1917),

Paratypes : L. J. Sedgwick—Yellapur-2433 (May, 1917),

H. Santapau—Londa-10828 (21-4-1950),

C. Saldanha—Wynad-7509-10 (11-10-1961).

191. **Veronica anagallis** var. **bracteata** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 25(3) : 427, 1918.

Holotype : Blatter & Hallberg—Mount Abu-1633 (Oct., 1933).

Solanaceae

192. **Solanum mccannii** Santapau, in Journ. Bombay nat. Hist. Soc. 47 : 654, 1948.

Lectotype : H. Santapau—Khandala-2972 (18-10-1943),

Syntype : H. Santapau—Khandala-2973 (18-10-1943).

In the original publication both the above mentioned specimens are given as types. No. 2972 is herein selected as the lectotype of the species.

Sterculiaceae

193. **Melhania magnifolia** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1): 228, 1918.

Lectotype : E. Blatter—Jodhpur-7285 (Oct., 1917).

(See Santapau, 1959 A).

194. **Melhania tomentosa** var. **major** Blatter et Hallberg, in Journ. Bombay nat. Hist. Soc. 26(1) : 228, 1918.

Lectotype : Blatter & Hallberg—Barmer-7286 (Nov., 1917).

(See Santapau, 1959 A).

Tamaricaceae

195. **Reumuria punjgurica** Blatter et Hallberg, in Journ. Indian Bot. 1 : 9, 1919.

Holotype : J. E. B. Houston—Punjgur-M-321 (12-5-1918).

196. **Tamarix longepedunculata** Blatter et Hallberg, in Journ. Indian Bot. 1 : 9, 1919.

Holotype :———, Kalat-228 (2-9-1917).

Umbelliferae

197. **Pimpinella clarkeana** Watt. ex Banerji, in Journ. Bombay nat. Hist. Soc. 50(1) : 88, 1951.

Paratype : M. L. Banerji—E. Nepal-446 (21-5-1948).

198. **Pimpinella multiradiata** Santapau, in Kew Bull. 1948 : 485, 1949.

Holotype : H. Santapau—Khandala-8054 (25-11-1945),

Isotype : H. Santapau—Khandala-8053 (25-11-1945).

Verbenaceae

199. **Clerodendrum serratum** var. **pubescens** Moldenke, in Phytologia 6(6) : 324, 1958.

Holotype : S. K. Wagh—Vizag. Dt.-2592 (11-5-1956).

200. **Clerodendrum villosum** var. **macrocalyx** Moldenke, in Phytologia 6(6) : 325, 1958.

Holotype : P. V. Bole—Dandeli, N. Kanara-1457 (25-12-1955).

Violaceae

201. **Viola oblonga** Blatter, in Journ. Indian Bot. Soc. 9(4) : 200-201, 1930.

Holotype : J. Fernandez—Razmak-2017 (30-4-1927).

Paratypes : J. Fernandez—Razmak-1550 (10-5-1927),

J. Fernandez—Razmak-2332 (7-5-1927).

Zingiberaceae

202. **Curcuma inodora** Blatter, in Journ. & Proc. Asiat. Soc. Bengal (New Series) 26 : 357-8, 1930.

Holotype : Hallberg—Moolgaon-12724 (June, 1917).

Zygophyllaceae

203. **Fagonia spinosissima** Blatter et Hallberg, in Journ. Indian Bot. 1 : 12, 1919.

Holotype : J. E. B. Houston—Punjgur-M-8E (23-5-1918).

204. **Zygophyllum trialatum** Blatter et Hallberg, in Journ. Indian Bot. 1 : 90, 1919.

Lectotype : ———, Baluchistan-s.n. (Aug., 1917).

According to the authors, the type specimen of this species was collected from Quetta in July, 1918. There is no specimen in the Blatter Herbarium, identified by E. Blatter, which is collected from Baluchistan in August, 1917. Since the specimen from Quetta is not located, the specimen from Baluchistan is selected herein as the lectotype of the species.

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Bio-spectral analysis of Ladakh vegetation[1]

B. L. SAPRU[2] AND P. KACHROO

(*With a text-figure*)

The paper includes brief information on the climate and vegetation of Ladakh region. The life-forms reveal a geo-chamaephytic phytoclimate with a high proportion of therophytes. The spectrum is in good agreement with the prevailing climate and therefore with Raunkiaer's system. Therophytes reflect the aridity of the region whereas geophytes-chamaephytes the cold winter.

INTRODUCTION

Ladakh, a constituent part of Jammu and Kashmir State is designated as the 'cold desert of India'. It has a distinct climate, geological history and topography which is hardly akin to any other part of the state and this distinction is very well reflected in its vegetation. Much work has been done regarding the floristic (Stewart 1917 and Sapru *et al.* 1975) and phyto-sociological studies (Durani *et al.*, 1974) in the area. As a part of the study completed recently by us in various districts of Ladakh, it was thought worthwhile to analyse the vegetation according to the classification proposed by Raunkiaer 1934, in order to assess the percentage distribution of the various life-forms and to work out its validity in determining the phyto-climate of the region.

GEOGRAPHY AND CLIMATE

Ladakh, with a geographical area of 97,782 sq. km. which is more than the combined area of Jammu and Kashmir provinces, is represented by mountain chains upto 6,600 m high enveloping rugged terrain and sandy valleys drained by the river Indus. It has a marine origin, because of its having been under a sea in the past (Burrand & Heydon 1907) which piled up huge sedimentary deposits until late Tertiary period.

The most remarkable point about the climate of Ladakh is that the dryness is of two kinds, one is physical due to the paucity of precipitation during the summer and autumn, and the second is physiological caused by the temperature below 0°C inhibiting absorption of water by the roots, in the winter and early spring when precipitation occurs. The ombrothermic diagram of Leh (Fig. 1a) reveals a cold desertic (eremic) bioclimate according to the classification of Bagnouls & Gaussen (1957). November to March is the period with negative mean temperatures, the mean of minimum being as low as −14°C. April to October is the physically dry period when the mean monthly rainfall is less than twice the mean, temperature, although the latter is above 0°C. Thus the total of the cold months and dry months comes to 12. However, April and probably even May, may be excluded from the category of dry months considering the fact that the snow accumulated during the cold season would melt in these months with the rising temperatures. Thus the short spring and the summer when there are occasional showers is the only time favourable to the plants.

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At Kargil (Fig. 1b), conditions are little better than at Leh. The cold period extends from November to March but April is not physically dry; precipitation is less than twice the mean temperature from May to October but the melting of snow would compensate dryness of May and probably June too. The bioclimate may be considered as cold sub-desertic (hemi-eremic).

Drass (Fig. 1c) in spite of a relatively high rainfall of 650 mm has a climate more or less similar to Leh and Kargil with 11 months either physically or physiologically dry.

The soils are mainly sandy or sandy-loam with appreciable quantities of clay at some places. The pH ranges between 7-11 (Bhat 1965).

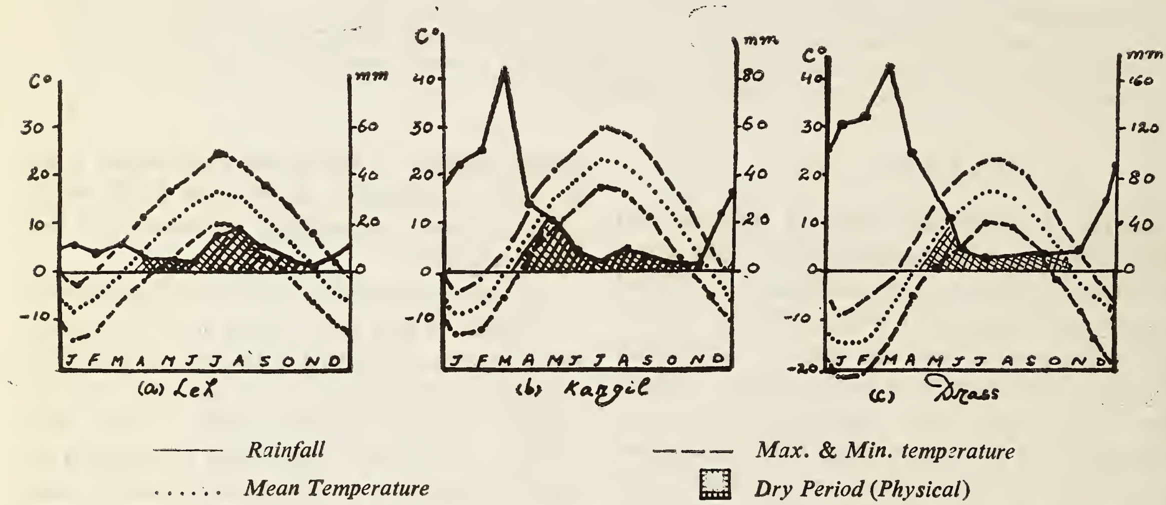

Fig. 1. Ombrothermic Diagrams for Ladakh.

Vegetation

Ladakh supports scanty vegetation due to the various odd factors operating in the region. From forestry point of view the entire area from Zojila to Chushul has rightly been classified under 'Alpine scrub zone' (Champion & Seth 1965) because trees are few in number and these grow only in some specific pockets covering roughly an area of about 2.75 sq. km.

The herbaceous element comprising some annual and few perennial weeds are commonly met with in places that have escaped erosion or are located within crevices and pockets that retain some amount of moisture. Areas near banks of lakes and nallah beds are amongst the sites conducive for the growth of forbes, and or rare shrubs. The plants are able to grow up to an elevation of 4,800 m above sea level wherever some moisture is available.

The alpine, desert and oasis elements are the representative features of Ladakh vegetation. The alpine element is mostly confined to narrow belts which receive part of the melted snow water and the upper beds of mountain streams. The desert flora which is very prominent in the upper reaches and the valleys is most closely related to the Tibetan and Turkish floristic elements. The oasis element comprises of a variety of exotics intermixed with some indigenous plants.

Across Zojila, which acts as a barrier between Ladakh and Kashmir transition in vegetation is prominent upto Suru valley. On way to Drass after a gradual descent from Zojila, one comes across barren and eroded mountain slopes with some green patches in shaded moist places. Along the transition zone almost an; plant of Kashmir that can survive above 3,300 m may be found growing, wherever a small quantity of moisture is readily available. Most such plants are alpine mesophytes as for instan e the species of *Delphinium*, *Potentilla*, *Leontopodium*, *Taraxacum*, *Aster* etc., along with the representatives of typical Kashmir element like *Podophyllum emodi*, *Lavatera kashmiriana*, *Impatiens glandulifera*, *Lotus corniculatus*, *Astragalus rhizanthus*, *Indigofera* sp., *Rosa moschata*, *Verbasacum thapsus* etc. Along the river courses and in depressions, stunted *Salix daphnoides* and *Morus alba* trees are found growing with *Myricaria elegans* scrub. Along the sandy banks of the Drass river and its side streams there is a rich growth of *Phragmites karka* thriving in close association with *Equisetum* sp. and *Sonchus oleraceus*. At Minamarg and Gumri where the mountain tops are under perpetual snow, the slopes are covered with plants like *Polygonum affine*, *Potentilla bifurca*, *Pedicularis siphonantha*, *Parnassia palustris*, *Geranium pratense*, *Bupleurum longicaule*, *Stachys sericea*, *Origanum vulgare*, *Gentiana decumbens*, *Anaphalis nubigena*, *Swertia thomsoni*, *Agrostis canina* etc. Eastward of Rupshu, plant life is scanty because of high altitude and little rainfall. Only some hardy species like *Carex nivalis*, *Oxyria digyna*, *Polygonum corydalis*, *Draba lasiophylla*, *Sedum ewersii*, *Saxifraga sibirica*, *Allardia tomentosa*, *Dianthus anatolicus* etc. thrive. In Rupshu area the predominent floristic element is represented by those Tibetan species which can thrive up to a height of 5,000 m. In this area the common species are *Oxytropis lapponica*, *Potentilla multifida*, *Nepeta tibetica*, *Plantago minima*, *Delphinium brunonianum*, *Lychnis macrorhiza*, *Atriplex crassifolia*, *Polygonum sibiricum*, *Sedum tibeticum*, *Arabis tibetica*, *Brava alpina* etc.

At Nubra and Leh, *Acantholimon lycopodioides*, *Myricaria elegans*, *Lindelofia anchusoides*, *Scopolia prealta*, *Tanacetum artemesioides*, *Nepeta floccosa*, *Arnebia tibetiana*, *Potentilla nivea*, *Euphorbia tibetica*, *Lancea tibetica*, *Iris ensata*, *Carum carvi*, *Lepidium apetalum*, *Elaeaganus angustifolia*, *Potentilla anserina*, *Astragalus ciliolatus*, *Draba fladnitzensis*, etc. grow along with the tree species like *Salix alba*, *S. daphnoides*, *Populus deltoides*, *Juglans regia*. The trees are a recent introduction in the area while the herbaceous cover is an admixture of Tibetan, alpine mesophytes and desertic elements.

Life-Forms

During the investigation, 662 plant species were recorded from the various ecological nitches in the area. These are scattered through 51 families with maximum representation of species in the families Compositae, Cruciferae, Labiatae, Polygonaceae, Papilionaceae and Graminae. Following the system proposed by Raunkiaer (1934), the species were grouped into the following life-forms : Phanerophytes (Ph) Nanophanerophytes (N), Chaemephytes (Ch), Hemicryptophytes (H), Geophytes (G), Hydrophytes (HH), Therophytes (Th), Lianas (L), Epiphytes (E) and Parasites (P).

The number of species from each of the fifty-one families that fit into the various life form classes are indicated in Table 1. From the tabulated values it is evident that maximum number of species (219) are therophytes that mainly reproduce through seeds, followed in descending order by chaemephytes (178) and geophytes (141). There are no lianas and epiphytes.

TABLE 1

LIFE-FORM DISTRIBUTION FOR LADAKH REGION, FAMILY-WISE

S. No.	Family	No. of species in each life-form class							
		Ph	N	Ch	H	G	HH	Th	P
1.	Ranunculaceae	x	5	6	2	4	2	6	x
2.	Berberidaceae	x	2	x	x	1	x	x	x
3.	Papaveraceae	x	x	2	x	x	x	x	x
4.	Fumariaceae	x	x	x	x	x	x	10	x
5.	Brassicaceae	x	x	12	7	x	x	35	x
6.	Caryophyllaceae	x	x	11	2	xx	xx	21	x
7.	Geraniaceae	x	x	1	1	3	x	3	x
8.	Papilionaceae	xx	x	22	1	5	x	15	x
9.	Rosaceae	2	4	14	1	x	c	3	x
10.	Saxifragaceae	x	2	x	x	9	x	x	x
11.	Crassulaceae	x	x	x	x	6	x	1	x
12.	Haloragaceae	x	x	x	x	x	1	x	x
13.	Onagraceae	x	x	4	x	x	x	x	x
14.	Umbelliferae	x	x	13	x	x	x	9	x
15.	Caprifoliaceae	x	5	1	x	x	x	x	x
16.	Rubiaceae	x	x	1	x	x	x	6	x
17.	Valerianaceae	x	x	3	x	x	x	x	x
18.	Dipsacaceae	x	2	x	x	x	x	x	x
19.	Compositae	x	1	41	2	6	x	41	x
20.	Campanulaceae	x	x	4	x	x	x	2	x
21.	Plumbaginaceae	x	x	x	1	x	x	2	x
22.	Primulaceae	x	x	x	x	7	x	x	x
23.	Androsaceae	x	x	x	x	6	x	x	x
24.	Apocynaceae	x	x	x	x	x	x	1	x
25.	Gentianaceae	x	x	x	x	13	x	3	x
26.	Boraginaceae	x	x	13	4	1	x	5	x
27.	Cuscutaceae	x	x	x	x	x	x	x	4
28.	Solanaceae	x	x	1	x	x	x	2	x
29.	Scrophulariaceae	x	x	x	5	2	x	10	x
30.	Orobanchaceae	x	x	x	x	x	x	x	2
31.	Lentibulariaceae	x	x	x	x	x	1	x	x
32.	Selaginaceae	x	x	x	2	x	x	x	x
33.	Lamiaceae	x	x	7	3	1	x	16	x
34.	Chenopodiaceae	x	x	6	x	x	x	17	x
35.	Euphorbiaceae	x	x	3	1	x	x	x	x
36.	Polygonaceae	x	x	10	9	x	x	9	x
37.	Urticaceae	x	x	2	x	x	x	1	x
38.	Moraceae	1	x	x	x	x	x	x	x
39.	Ulmaceae	1	x	x	x	x	x	x	x
40.	Juglandaceae	1	x	x	x	x	x	x	x
41.	Betulaceae	1	x	x	x	x	x	x	x
42.	Salicaceae	12	4	x	x	x	x	x	x
43.	Gnetaceae	x	x	x	x	1	x	x	x
44.	Pinaceae	x	3	x	x	x	x	x	x
45.	Orchidaceae	x	x	x	x	2	x	x	x
46.	Iridaceae	x	x	x	x	2	x	x	x
47.	Liliaceae	x	1	x	x	11	x	2	x
48.	Capparidaceae	x	3	1	x	x	x	x	x
49.	Juncaceae	x	x	x	x	7	x	x	x
50.	Graminae	x	x	x	23	41	x	x	x
51.	Cyperaceae	x	x	x	x	12	x	x	x
	Total in each class	18	32	178	64	140	4	220	6

The biological spectrum worked out for the region on a percentage basis is enumerated in Table 2, along with the normal spectrum (Raunkiaer 1934).

The phytoclimate of a region, according to Raunkiaer, is characterised by the life-form (or forms) which in the biological spectrum of that region exceeds the percentage of the same life-form in the normal spectrum. He further divided the phytoclimate of the world into four distinct classes, i.e. (i) Phanerophytic climate in the tropics, (ii) Therophytic climate in the deserts, (iii) Hemicryptophytic climate in the greater part of cold temperate region and (iv) Chaemephytic with a fair proportion of geophytes in cool climates.

It will be noted from Table 2 that phanerophytes, nanophanerophytes and hydrophytes are quite negligible in the Ladakh spectrum compared to the normal spectrum ; hemicryptophytes fare better with 9.6% but are yet almost three times lesser than the normal. The life-forms whose percentages exceed the normal values are (1) geophytes, more than five times higher than in the normal spectrum (2) chamaephytes, almost three times higher, (3) therophytes nearly two and a half times higher, (4) parasites only about 1% more.

From these observations, the phytoclimate of the Ladakh region may be designated as geo-chamaephytic with a high proportion of therophytes. This is quite in agreement with the climate prevailing in the region. Whereas the therophytes reflect the desertic to sub-desertic conditions, the dominance of geophytes and chamaephytes corresponds to the low temperatures of the winter-spring months.

Table 2

Biological spectrum for Ladakh region

Region	Per cent number/Life-form class									
	PH	N	Ch	H	G	HH	Th	L	E	P
Ladakh ..	2.62	4.84	26.83	9.61	21.31	0.62	33.18	0.0	0.0	0.9
Normal spectrum ..	28	15	9	26	4	2	13	0	3	0

Discussion

The validity of the vegetational criterion for assessing the aridity or humidity of a region has been broadly elucidated by Meher-Homji (1964). Although different systems were proposed by several ecologists (Humboldt 1805, Warming 1909, Drude 1913, Pound *et al.* 1898 and Raunkiaer 1934) for the classification of vegetation in different regions, only Raunkiaer's has a universal applicability mainly because his system is based on properly designated life-forms classified on the basis of perennating organs, reflecting two important parameters of the climate, namely, precipitation and temperature.

Ladakh region is mainly arid with cold winters, the annual average precipitation varying between 80 mm (Leh) and 650 mm (Drass). As already stated, most of the precipitation received in the region is in the form of snow during winter and early spring and is not readily available to the plants in view of the low temperatures. Most of the plants complete their life-cycles during the short spring when the snow melts and during the summer when there are sporadic showers. For the rest of year, the soil remains dry and almost devoid of vegetation imparting an arid landscape.

The biological spectrum of the region is quite in conformity with the local geophysical conditions which have favoured therophytic populations. If the trend of cultivation of suitable trees under the aforestation programme is implemented in full vigour, the increase in the phanerophytic element would result in a change not only in the spectral composition but probably also in the amelioration of the local eco-climatic conditions.

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Contribution to the botany of Lahaul[1]

B. K. KAPAHI[2] AND Y. K. SARIN

(*With two text-figures*)

Lahaul comprises an area of 2820 sq. km lying between lat. 30° 8′ and 32° 59′N and 76° 49′ E in the district of Lahaul and Spiti in Himachal Pradesh. The adjoining areas are Ladakh in the north, Kulu and Bara Bhangal in the south, Spiti sub-division on the east and Chamba district on the west (Fig. 1). The area has peculiar climatic and physical features and

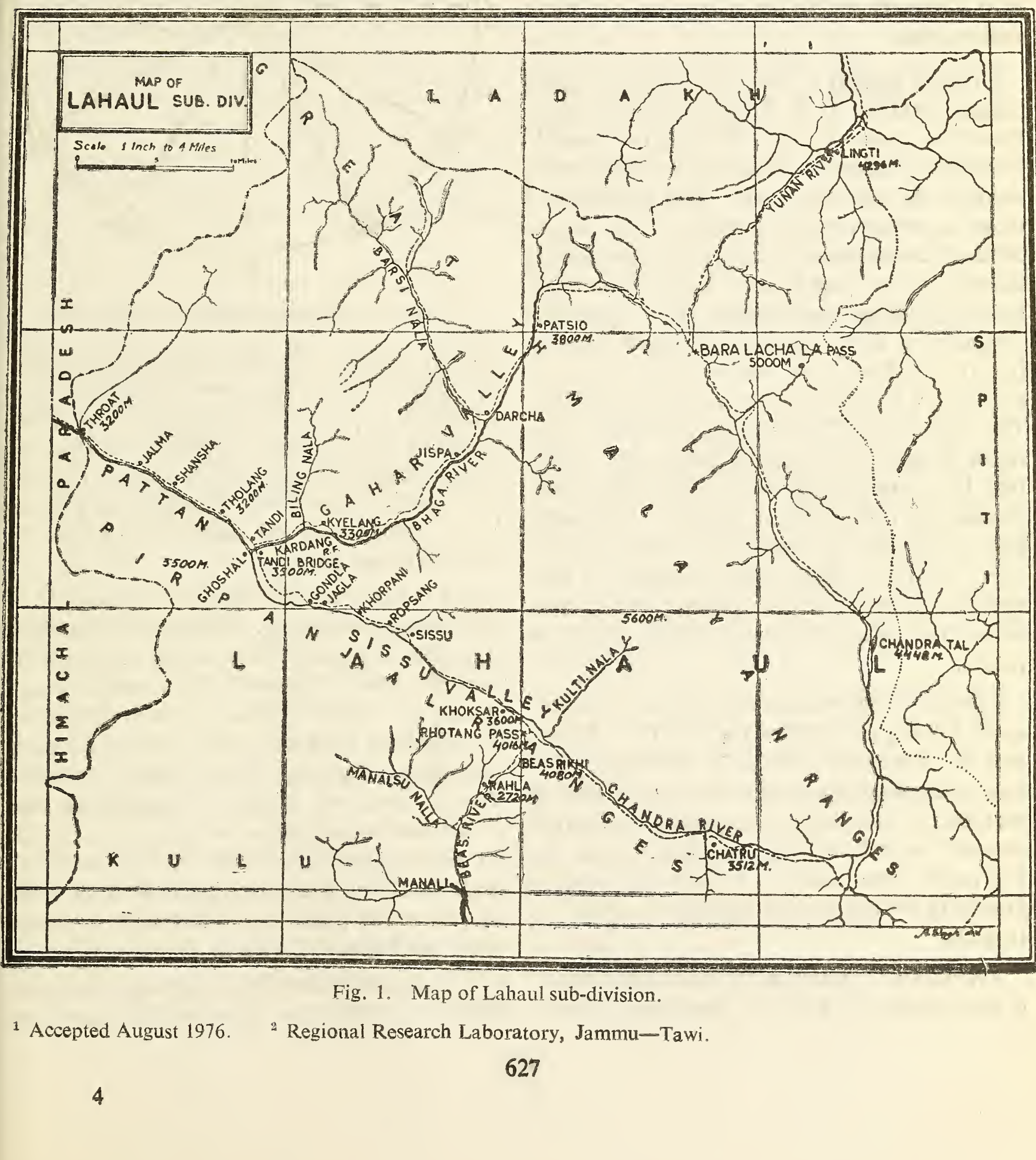

Fig. 1. Map of Lahaul sub-division.

[1] Accepted August 1976. [2] Regional Research Laboratory, Jammu—Tawi.

is of great botanical interest. The area was earlier explored by Aitchison (1868) and Watt (1881) who published short accounts of the botany of the western parts. In recent years, Joshi (1952), Rau (1960) and Nair (1964) published tour notes on various parts of the valley. As a part of a planned programme of study of the vegetation, particularly economic plants of the area it was surveyed during 1964, 1970 and 1973. This paper presents the results of these explorations.

Physical aspects : The tract has a highly rugged terrain. It is bounded by the main Himalayan axis in the north, the middle Himalayan ranges in the south and connecting links in the east and west. The elevation of these mountains range between 4187 m and 7000 m above mean sea level. The area is drained by the river Chenab and its two tributaries Chandra and Bhaga. The tributaries originate at Baralacha pass at about 5050 m (a.s.l.) and flow in a south-westerly direction enclosing a triangular mass of lofty mountains. The main axis of the central mass lies from north to south with a branch going west. These two lines are fringed with lateral spurs, the intervening valleys having glaciers. The major part of the area is barren with highly precipitous mountain slopes and glaciers. Cultivation is restricted to the lower parts of river valleys having an altitude of 3100 m to 3800 m (a.s.l.).

Climate : The maximum temperature recorded at Kelong (alt. 3600 m) is 23.1°C in August and the minimum—10.3°C in February. The enormous mountain ranges act as a barrier to monsoon currents and consequently the average summer rainfall hardly exceeds 15 cm. On the other hand there is heavier precipitation averaging 294 cm per year during winter months (Fig. 2).

Vegetation : A low rainfall during summer, a long period of gelation, precipitous physiognomy, shallow soil cover and high intensity of lopping and grazing have resulted in poor vegetation cover. The tree element is represented by *Betula utilis* and *Juniperus macropoda*, a high altitude conifer. A few trees of *Quercus semi-carpifolia* and *Pinus wallichiana* are sometimes encountered in sheltered localities in Chandrabhaga Valley.

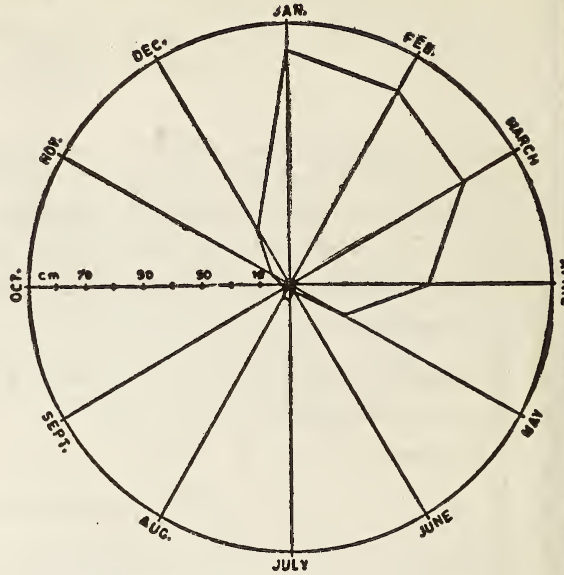

Fig. 2. Total precipitation pattern of Lahaul.

The shrubby element consists of a number of semi-zerophytic species. *Hippophe rhamonides*, an armed straggling shrub, along with *Berberis vulgaris*, *Ribes grossularia*, *Rosa webbiana* and species of *Rubus*, *Cotoneaster* and *Crataegus* form isolated thickets in the valley of Chandra and Bhaga and upto Jalma Kothi in Patten Valley. *Juniperus recurva*, *J. wallichiana* and *Rhododendron anthopogon* are the main shrubs on higher slopes. *Ephedra gerardiana* grows gregariously on southern aspects between Jispa and Baralacha pass on both the banks of Bhaga river and beyond Chatru in Chandra Valley.

The ground vegetation is greatly influenced by the soil conditions. The habitat ranges from typical dry sandy or rocky on high precipitous slopes to water logged depressions. The major constituents under varying habitat conditions are as follows :

1. Dry slopes with loose sandy soil : The main herbs are *Artemisia maritima*, *A. dracunculus*, *A. vestita*, *Phlomis bracteosa*, *Cicer soongaricum*, *Lotus corniculatus*, *Lychnis fimbriata*, and species of *Astragalus*, *Verbascum*, *Origanum*, *Lotus* and *Cnicus*.

2. Moist slopes with water seeping from above : *Iris kumaonensis*, *Lagotis glauca*, *Picrorhiza kurrooa*, *Anemone obtusiloba*, *Geum elatum*, *Adonis chrysocyathus*, *Primula sibirica*, *Polygonum chinensis*, *Anaphalis nubigena*, *A. cinnamomoea* and *Ranunculus* spp.

3. 'Dangs' (fallow land near cultivated fields) : *Chaerophym villosum*, *C. reflexum*, *Eremurus himalaicus*, *Aconitum heterophyllum*, *Bunium bulbocastanum*, *Heracleum candicans*, *Phlomis bracteosa*, *Thlaspi arvense*, *Capsella bursa-pastoris*, *Verbascum thapsus*, *Bupleurum falcatum* and species of *Ranunculus*, *Arabis*, *Artemisia* and *Caltha* species.

4. Organic dumps near road sides and villages : *Datura stramonium*, *Physochalaina praealta*, *Hyoscyamus niger*, *Physalis minima*, *Verbena officinalis* and species of *Papavar*, *Ranunculus*, *Lychnis*, *Amaranthus* and *Chenopodium*.

5. Crevices of moist rocks : *Onosma echiodes*. *Rheum palmatum*, *Bergenia ligulata* and a number of *Sedum* species.

The majority of plants flower during May to August and fruits mature by the month of October and dormancy sets in most of the species by first or second week of November.

Cereal and cash crops : The vegetative season being limited to about seven months between April and October only one crop per year is harvested. 'Grisham' or naked barley (*Hordeum vulgare*) is the only cereal grown in the area, though cultivation of rice has been taken up recently in some low lying areas of Chandrabhaga Valley. Potato, Tobacco, Lentils, Buckwheat and Kuth (*Saussurea lappa*) are the main cash crops. Very large quantities of seed potato are produced in the area and exported to all parts of India. Lahaul has a monopoly in Kuth roots, large quantities of which are exported from India every year. Cultivation of hops (*Humulus lupulus*) has also been taken up recently.

Ethnobotanical observations : The local inhabitants, cutoff from the world during six months in a year and faced with the vagaries of climate depend on wild plants for many of their daily needs. During the survey, the following observations were made regarding the use of wild plants for various purposes by the local people.

1. *Plants used as substitutes for flour :* The chief food of Lahaul is potato and buckwheat. These are occasionally supplemented by the indigenously produced naked barley. Among the wild plants used for similar purposes are the tap roots of *Codonopsis ovata* (Ludut) and *Chaerophyllum villosum* (Meetha patis). These are dried, ground into flour and mixed with flour of buckwheat, barley or wheat.

2. *Wild plants used as pot herb and vegetable :*

Allium victorialis Linn. (Linchi)
Young leaves, bulbs & young roots.

Bunium cylindricum Grossheim (Shingo)
Flowering tops.

Cicer soongaricum Steph.
Seeds & herb.

Codonopsis ovata Bentha. (Ludut)
Roots & leaves.

Eremurus himalaicus Baker (Boe)
Young leaves.

Morchella sp. (Mpksha)
Fructification.

Polygonum polystachyum Watt. (Mushutzi)
Flowering spikes.

Rheum palmatum Linn. (Ravandchini)
Young stems.

Sedum rhodiola DC. (Shrolo)
Tender shoots.

Sedum tibeticum Hook. f. (Kindut)
Young roots.

Taraxacum officinalis Wigg. (Ganiathal)
Whole herb.

Tragopogon major Jacq. (Dudhi)
Whole herb.
(Local name is given in parantheses.)

3. *Fruits :* Cultivated fruit trees are few. Apple, Pear and Walnut have been introduced recently in Chandrabhaga Valley. The fruits of the following wild plants are commonly used by the local people.

Cotoneaster disticha Lange
Fragaria vesca Linn. (Paljoo)
Hippophae rhamonides Linn. (Starboo)
Pyrus buccata Linn. (Litsee)
Pyrus malus Linn. (Kushoo) local apple.
Ribes grossularia Linn. (Kuchshoo)

4. *Plants used in local medicines :*

Aconitum heterophyllum Wall. (Bonga) The roots are used as febrifuge and are given in decoction or boiled with tea.

Bergenia ligulata Wall. Rhizomes are made into a paste and applied over ulcers and bruises.

Chaerophyllum villosum Wall. (Meetha patis). The dried roots are used as carminative.

Gentiana tenella Rottb. Whole herb used as febrifuge in decoction.

Hippophae rhamonides Linn. (Starboo). Jelly made from the fruit is used in lung complaints.

Myricaria germanica Desv. The leaves are used as emollient applications to bruises, swollen joints and bruises.

Pedicularis hookeriana Wall. Roots are used in powder form for gastric troubles.

Rheum palmatum Linn. (Lacchu). Fresh herb juice used as purgative.

5. *Miscellaneous products :*

In gompas and temples a great amount of incense is burnt. The major item used for this purpose is roots of *Saussurea lappa*. The roots of *Delphinium brunonianum* and *Morena brevifolia* (Boi) and fruits of *Juniperus macropoda* are also employed for this purpose. Roots of *Polygonatum cirrifolium* and *Saponaria* spp. are used for washing woollen clothes. Spices obtained from wild plants are, seeds of *Bunium cylindricum* and flowering tops of *Allium stracheyi.*

For fodder all sort of herbs, shrubs and trees are used. Chief among these being *Chaerophyllum villosum* (herb), *Cicer soongaricum* (herb), *Indigofera* sp. (leaves), *Phlomis bracteosa* (herb), *Salix* sp. (bark and leaves), *Populus* sp. leaves and a large number of alpine grasses.

Enumeration of the flowering plants :

275 species belonging to 152 genera and 46 families of Angiosperms and Gymnosperms have been collected from the area during a series of field exploration trips. The plants collected are enumerated in the following list. The specimens are kept in the Herbarium of the Regional Research Laboratory, Jammu—Tawi.

RANUNCULACEAE

Aconitum heterophyllum Wall.
Koksar, YKS; 8972.

Anemone obtusiloba D. Don
Rhotang Road, YKS; 8721. BKK; 12611.

A. polyanthes D. Don
Rhotang jot, BKK; 12612.

A. rupicola Camb.
Gondla, YKS ; 8963.

Aquilegia vulgaris Linn.
Jisparoad, YKS; 8857. Tandi, BKK; 12680.

Caltha palustris Linn.
Rhotang, YKS; 8717. Sissue, BKK; 12671.

Isopyrum thalictroides Linn.
Keylong (Biling area), YKS ; 8794.

Delphinium cashmerianum Royle
BKK; 12728, Rhotang.

D. vestitum Wall.
BKK; 12727; Billing Nallah.

Ranunculus affinis R.Br.
Rhotang, BKK ; 12743.

R. hirtellus Royle
Tandi-Shansha, YKS ; 8887.

R. laetus Wall.
Sissue, BKK ; 12669.

R. lobatus Jacq.
Rhotang, YKS ; 8981.

R. munroanus J. R. Drum
Tandi-Shansha, YKS ; 8887.

R. muricatus Linn.
Sansha village and throughout BKK; 12729

Thalictrum cultratum Wall.
Morung (Ka 34a), BKK ; 12816.

T. foliolosum DC.
Gramphoo, Shansha; 127230.

T. minus Linn.
Kaza, BKK; 12751.

Trollius acaulis Lindl.
Rhotang top, YKS ; 8741.

Papaveraceae

Corydalis cachemiriana Royle
Rhotang jot, BKK ; 12613.

C. govaniana Wall.
Rhotang-Mari, YKS ; 8738.

C. ramosa Wall.
Keylong, YKS ; 8792. Keylong ; BKK ; 12646.

C. ramosa Wall. var. *vaginans*
Keylong, YKS ; 8871.

C. tibetica Hook. f. & Thoms.
Sisso, YKS ; WN.

Meconopsis acul ata Royle
Rhotang, BKK ; 12726.

Cruciferae

Arabis alpine Linn.
Keylong—Jaloma, YKS ; 8873.

A. amplexicaulis Edgew.
Tandi Village, YKS ; 8881.

A. auriculata Lamk.
Jalma, BKK; 127240.

A. tibetica Hook. f. & Thoms.
Jalma, BKK; 12738.

Capsella bursa-pastoris Moench
Kardang. R.F., YKS ; 8812.
Koksar, BKK ; 12632.

Cardamine hirsuta Linn. var. *sylvatica* Link.
Tandi Village, YKS ; 8882.

C. impatiens Linn.
Rhotang Pass, BKK ; 8750.

Descurainia sophia (Linn.) Webb.
(= *Sisymbrium sophia* Linn.)
Keylong, BKK ; 12653.

Draba lanceolata Royle
Rhotang top, YKS ; 8743.

Lepidium latifolium Linn.
Keylong, BKK ; 127132.

L. ruderale Linn.
Keylong, BKK ; 12733.

Megacarpaea polyandra Benth.
Mari, BKK ; 12380.

Thalaspi arvense Linn.
Keylong, BKK ; 12654.

Caryophyllaceae

Arenaria kashmirica Edgew.
Gondla. BKK ; 12690.

A. orbiculata Royle
Koksar, YKS ; 8762.
Keylong, BKK ; 12619.

A. serpylifolia Linn.
Koksar, BKK ; 12734.

Cerastium trigynum Villars.
Koksar-Keylong, YKS ; 8770.

Gypsophila cerastoides D. Don
Koksar, BKK ; 12618.

Sagina saginoides (Linn.) Karsten
(= *S. procumbens* Linn.)
Rhotang, YKS ; 8733.

Silence venosa (Gibb.) Aschers.
(= *S. inflata* Smith.)
Keylong, BKK ; 12742.

Tamaricaceae

Myricaria germanica Desv.
Gondla village, BKK ; 12676.

M. elegans Royle
Near Chandra river, BKK ; 12741.

Malvaceae

Malva rotundifolia Linn.
Tandi village, YKS ; 8906
Koksar, BKK ; 12624.

M. verticillata Linn.
Gondla, BKK ; 12737.

Geraniaceae

Geranium nepalense Sweet.
Sissue, YKS ; 8777.

G. wallichianum D. Don
Grampho (Koksar), BKK ; 12617.

Impatiens amphorata Edgew.
Gondla-Sissue, BKK ; 12698.

I. amphorata Edgew. var. *umbrosa* Edgew.
Keylong, YKS ; 8950.

Sapindaceae

Acer caesium Wall. ex Brand.
Rhotang (South aspect), YKS ; 8712.

Leguminosae

Astragalus adesmiaefolium Benth. ex Bunge
Kaza, BKK ; 12750.

A. cicerifolius Royle ex Bunge
(= *A. oplites* Benth. ex Baker.)
Kaza, BKK ; 12760.

A. chlorostachya Lindl.
Keylong, BKK ; 12662.

A. himalayanus Klotz.
Kunzum, BKK ; 12759.

Cicer arietinum Linn.
Keylong, BKK ; 12951.

Indigofera pulchella Roxb.
Rhotang top, BKK ; 8970.

Lotus corniculatus Linn.
Koksar, BKK ; 12628.

Medicago sativa Linn.
Sissue, YKS ; 8775. Keylong, BKK ; 12655.

Melilotus parviflora Desf.
Pattan valley, YKS ; 8940.

Oxytropis thomsoni Benth.
Koksar-Keylong, YKS ; 8767.

Pisum sativum Linn.
Keylong, BKK ; 12663.

Thermopsis barbata Benth.
Mari, BKK ; 12382.

Trifolium repens Linn.
Koksar, BKK ; 12639.

Rosaceae

Cotoneaster microphylla Wall. ex Lindl.
Rhotang pass, YKS ; 8736.

Cotoneaster racemiflora Koech & May
(= *C. nummularia* Fisch.)
Keylong. Jisparoad, YKS ; 8930.

Fragaria vesca Linn.
Mari, BKK ; 12754.

Geum elatum Wall.
Rhotang top, YKS ; 8995.
BKK ; 12610.

G. urbanum Linn.
Rahla, YKS ; 8706.

Malus sylvestris Mill.
(= *Pyrus malus* Linn.)
Pattan valley, YKS ; 8942.

Potentilla ambigua Camb.
Tandi-Shansha, YKS ; 8885.

P. argyrophylla Wall. var. *argyrophylla* Proper.
Rhotang, BKK ; 12389.

P. argyrophylla Wall. var. *atrosanguinea* Lodd.
Mari, YKS ; 8992. Rhotang, BKK ; 12700.

P. bifurca Linn.
Tandi village, YKS ; 8889.

P. gelida C. A. Mey
Chotadara, BKK ; 12752.

P. multifida Linn.
Kunzum, BKK ; 12753.

Potentilla nivea Linn.
Rhotang, YKS; 8973. Keylong, BKK; 8839.

Potentilla sibbaldi Hall. f.
Billing nallha, YKS ; 8827.
Rhotang, BKK ; 8980.

Prunus armeniaca Linn.
Pattan Valley, BKK ; 12761.

P. padus Linn.
(= *P. cornuta* Wall.)
Keylong, YKS ; 8782.

Pyrus foliolosa Wall.
Billing nallha, YKS ; 8856.

Rosa webbiana Wall.
Jispa, YKS; 8927 ; Koksar. Keylong, BKK ; 12645.

Spiraea canescens D. Don
Kothi, BKK ; 12379.

S. vestita Wall. ex G. Don
Pattan Valley, YKS ; 8941.

Saxifragaceae

Bergenia ligulata (Wall.) Engl.
(= *Saxifraga ligulata* Wall.)
Mari, BKK ; 12758.

Ribes grossularia Linn.
Gondla. Keylong, YKS ; 8799.
Jispa, BKK ; 12801.

R. rubrum Linn. Tinu bridge, BKK ; 8860.

Saxifraga diversifolia Wall.
Koksar, BKK ; 12755.

S. flagellaris Willd. ex Sternb.
Batal, BKK ; 12755.

S. imbricata Royle
Keylong, YKS ; 8781.

Crassulaceae

Sedum adenotrichum Wall.
Randi nallha, YKS ; 8984.

S. crenulatum Hk. f. & T.
Rhotang near Rani nallha, BKK ; 8739.

S. ewersii Ledeb.
Mari, YKS ; 8988. Koksar, BKK ; 12621.

S. quadrifidum Pall.
Rhotang top, YKS ; 8748.

S. rhodiola DC.
Koksar, Keylong, YKS ; 8769.

S. tibeticum Hk. f. & Thoms.
Rhotang Jot, BKK ; 12608.

Umbelliferae

Bupleurum falcatum Linn.
Tandi. Shansha, YKS ; 8888.

B. falcatum Linn. var. *marginata* Wall.
Gondla village, BKK ; 12678.

B. jucundum Koch.
Thlong, BKK ; 12656.

B. longicaule Wall.
Keylong, YKS ; 8953.

B. longicaule Wall. var. *himalensis*. Klotz.
Kardang R.F., YKS ; 8810.

B. maddeni C. B. Clarke
Koksar, BKK ; 12636.

Carum bulbocastanum Koch.
Gondla, BKK ; 12675.

C. carvi Linn.
Sissue-Gondla, BKK ; 12686.

Chaerophyllum acuminatum Lindl.
Gondla, YKS ; 8965.

C. villosum Wall.
Sissue, YKS ; 8774. Rhotang Jot, BKK ; 12605.

Ferula jaeschkaeana Vatke
Keylong, YKS ; 8948.

Heracleum candicans Wall.
Keylong, BKK ; 12652.

H. thomsoni C. B. Clarke
Tandi, BKK ; 12684.

Selinum tenuifolium Wall.
Mari, BKK ; 12778.

S. vaginatum C. B. Clarke
Rhotang, YKS ; 8715.

Vicatia coniifolia DC.
Shashoor R.F., YKS ; 8854.

Caprifoliaceae

Lonicera quinquelocularis Hardw.
Keylong, BKK ; 12810.

Viburnum cotinifolium D. Don.
Pattan village, BKK ; 12777.

Rubiaceae

Galium aparine Linn.
Koksar, BKK ; 12631.

G. boreale Linn.
Tinu-Keylong, YKS ; 8863.
Glabotop, BKK ; 12383.

G. verum Linn.
Tandi, BKK ; 12683.

Valerianaceae

Valeriana hardwickii Wall.
Keylong, YKS ; 8807.

V. wallichii DC.
Rhotang, YKS ; 8710.

Dipsacaceae

Morina coulteriana Royle
Sissue-tandi, BKK ; 12682.

Scabiosa speciosa Royle
Koksar & Chatruo, BKK ; W.N.

Compositae

Achillea millifolium Linn.
Gondla, YKS ; 8798. Keylong, BKK ; 14821.

Anaphalis contorta Hook. f.
Koksar, YKS ; W.N.

A. nubigena DC.
Rhotang, YKS ; 8998. Koksar, BKK ; 12634.

A. virgata Thoms.
Chhatruo, BKK ; 12819.

Arctium lappa Linn.
Sissue, BKK ; 12670.

Artemisia dracunculus Linn.
Koksar-Keylong, YKS ; 8761, Jispa, BKK ; 12644.

A. falconeri C. B. Clarke
Kazya, BKK ; 12811.

A. laciniata Willd.
Kaza, BKK ; 12756.

A. maritima Linn.
Jalma-Pattan, YKS ; 8935.
Sissue-Keylong, BKK ; 12642.

A. moorcroftiana Wall.
Kaza, BKK ; 12770.

A. sacrorum Ledeb.
Between Chhatru & Chotodara, BKK ; 12769.

A. scoparia Waldst. & Kit.
Throat (Udaipur Valley), BKK ; 12659.

A. siversiana Ehrh. ex Willd.
Jispa, BKK ; 12749.

A. vestita Wall.
Keylong-Throat, BKK ; 12666.

Carduus nutans Linn.
Pattan Valley, YKS ; 8920.

Carpesium abrotanoides Linn.
Tandi, BKK ; 12809.

Cirsium arvense (Linn.) Scop.
(= *Cnicus arvensis* Hoffm.)
Keylong, BKK ; 12658.

Cnicus wallichii DC.
Billing Pingpa, YKS ; 8832.

Cousinia thomsoni C. B. Clarke
Koksar, YKS ; 8759.

Echinops cornigerus DC.
Koksar, BKK ; 12748.

Erigeron alpinus Linn.
Tandi, BKK ; 12805.

E. multiradiatus Benth. & Hook f.
Rhotang, YKS ; 8709. Gondla, BKK ; 12685.

Inula racemosa Hook. f.
Jalma, BKK ; 12768.

I. royleana DC.
Pattan Valley, YKS ; 8919.

Koelpinia linearis Pall.
Kardang R.F., YKS ; 8803.

Lactuca dissecta D. Don
Pattan Valley, YKS ; 8945.

L. tatarica C. A. Meyer
Chokhung (Throat), BKK ; 12764.

Leontopodium alpinum Cass.
Pattan Valley, YKS ; 8894.

Myriactis nepalensis Less.
Mari, YKS ; 9132.

Saussurea lappa C. B. Clarke
Keylong, YKS ; 3368, Thlong, BKK ; 12657.

S. jacea C. B. Clarke
Rhotang, YKS ; W.N.

S. sorocephala Hook. f. & Thoms. ex C. B. Clarke
Morung ; BKK ; 12763.

S. taraxacifolia Wall.
Jispa Kothi ; BKK ; 12767.

Senecio chrysanthemoides DC.
Keylong, BKK ; 12667.

S. pedunculatus Edgew.
Tandi, YKS ; 8905.

Sonchus arvensis Linn.
Tandi-Keylong, YKS ; 8787.
Koksar, BKK ; 12627.

Sonchus oleraceus Linn.
Keylong, BKK ; 12649.

Tenacetum gracile Hook. f. & Thoms. ex Hook. f.
Tandi, YKS ; W.N.

Taraxacum officinale Wigg.
Koksar, YKS ; W.N.

Tragopogon gracilis D. Don
Sissue, BKK ; 12692.

CAMPANULACEAE

Codonopsis ovata Benth.
Tandi-Gondla, BKK ; 12689.

ERICACEAE

Cassiope fastigiata D. Don
Rhotang top, YKS ; 8746.

Rhododendron campanulatum D. Don
Rhotang, YKS ; 8138.

R. hypanthum Hook. f.
Rhotang top, YKS; 8996.

Primulaceae

Androsace rotundifolia Hardw.
Keylong, YKS ; 8788.

A. sarmentosa Wall.
Mari-Rahla ; BKK ; 8989.

A. sarmentosa Wall. var.
primuloides D. Don
Rhotang South slopes, YKS; 8718.

A. sempervivoides Jacq. ex Duby.
Rhotang, YKS ; 9000. BKK ; 12609.

Primula denticulata Smith
Rhotang top, YKS ; 8740.

P. involucrata Wall.
Koksar-Keylong, YKS ; 8764.

P. macrophylla D. Don
Mari-Rhotang ; YKS; 8708.

P. minutissima Jacq.
Rhotang, YKS ; 8744.

P. nivalis Pall.
(= *P. stuartii* Wall.).
Rhotang, BKK ; 12606.

P. sibirica Jacq.
Rhotang Jot, BKK ; 12615.

Oleaceae

Fraxinus xanthoxyloides Wall.
Jisparoad—Baralacchapass, YKS ; 8922.

Gentianaceae

Gentiana kurroo Royle
Rhotang, BKK ; 12776.

G. moorcroftiana Wall.
Chokhung, BKK ; 12775.

G. tenella Rottb.
Chhatru, BKK ; 12774.

Swertia chirata Wall.
Mari, YKS ; 8553.

S. purpurascens Wall.
Rhotang top, YKS ; 12735.

Boraginaceae

Cynoglossum denticulatum A. DC.
Tandi, BKK ; 12806.

C. micranthum Desf.
Throat, BKK ; 12731.

Eritrichium strictum Decne.
Tandi-Gondla, BKK ; 12691.

Lindelofia angustifolia A. Brand.
Tandi, YKS ; 8911.

L. spectabilis Lehm. var. *falconeri*
Keylong, YKS ; 8780.

Myosotis sylvatica Hoffm.
Tandi-Gondla, BKK ; 12385.

M. stricta Link
Kardang Reserve forest, YKS ; 8814.
Tandi, BKK ; 12687.

Onosma echioides Linn.
Koksar, YKS ; 8750.

Convolvulaceae

Convolvulus arvensis Linn.
Keylong, YKS ; 8913. Istingri, BKK ; 12648.

Cuscuta reflexa Roxb.
Koksar, BKK ; 12762.

Solanaceae

Hyoscyamus niger Linn.
Koksar, YKS ; 8771. Keylong, BKK ; 12620.

Solanum tuberosum Linn.
Keylong throughout, BKK ; 12664.

Physochlaina praealta Miers
Tandi, BKK ; 12829.

Scrophulariaceae

Digitalis lanata Ehrh.
Cultivated, BKK ; W.N.

D. purpurea Linn.
Glaboo ; BKK ; 10595.

Euphrasia officinalis Linn.
Pattan Valley, YKS ; 8900, Gondla, BKK ; 12674.

Lancea tibetica Hook. f. & Thoms.
Koksar, BKK ; 12747.

Pedicularis pectinata Wall.
Billong longpa, YKS ; 3838. Thiong, BKK; 12660.

P. pectinata Wall. var. *pyramidata*
Pattan Valley, YKS ; 3944.

Picrorhiza kurrooa Royle ex Benth.
Rhotang, YKS ; 8723.

Scrophularia calycina Benth.
Koksar, BKK ; 12765.

S. lucida Linn.
(= *S. decomposita* Royle ex Benth.)
Koksar, BKK ; 12625.

Verbascum thapsus Linn.
Koksar-Keylong, BKK ; 12641.

Veronica anagallis Linn.
Koksar, BKK ; 12780.

V. biloba Linn.
Kardang R.F., YKS ; 8816.
Pattan Valley, BKK ; 8899.

Wulfenia amherstiana Benth.
Rhotang, BKK; 12779.

Orobanchaceae

Orobanche epithymum DC.
Keylong, YKS ; 8913.

Selaginaceae

Lagotis glauca Gaertn. var. *cashmeriana* Royle.
Rhotang, BKK ; 12607.

L. glauca Gaertn. var. *kunawarensis*
Rhotang, YKS ; 8742.

Gymnandra stolonifera Koch.
(= *Lagotis stolonifera* Koch.)
Rhotang, YKS ; 8982.

Labiatae

Calamintha clinopodium Benth.
Gondla, BKK ; 12673.

Elsholtzia cristata Willd.
Throat, BKK ; 12802.

Lamium album Linn.
Mari-Glabolop, BKK ; 12388.

Mentha longifolia Huds.
(=*M. sylvestris* Linn.)
Sissue, BKK ; 12693.

Nepeta discolor Royle ex Benth.
Keylong, YKS ; 12253.

N. eriostachys Benth.
Keylong, YKS ; 8869.
Gondla, BKK ; 12672.

N. spicata Benth.
Keylong, YKS ; 8912. BKK ; 12681.

Origanum vulgare Linn.
Tandi-Gondla, BKK ; 12681.

Phlomis bracteosa Royle ex Benth.
Rhotang, BKK ; 12614.

Prunella vulgaris Linn.
(= *Brunella vulgaris* Linn.)
Gondla. Sissue, BKK ; 12697.

Thymus serpyllum Linn.
Koksar, BKK ; 12626.

Plantaginaceae

Plantago brachyphylla Edgew. ex Decne
Rhotang (South slopes), YKS ; 8714.

P. major Linn.
Sissue, BKK ; 12694.

P. tibetica Hook. f. & Thoms. ex Hook. f.
Kardang R.F., YKS ; 8818.

Chenopodiaceae

Chenopodium album Linn.
Keylong, BKK ; 12643.

C. botrys Linn.
Keylong, YKS ; 8947.
Pattan, BKK ; 8898.

C. foliosum (Moench.) Aschers.
Koksar, BKK ; 12629.

C. murale Linn.
Keylong, YKS ; 8843.

Corispermum hyssopifolium Linn.
Kunzum ; BKK ; W.N.

Salsola kali Linn.
Morung ; BKK ; W.N.

Polygonaceae

Fagopyrum cymosum Meissn.
Kothi-Mari, YKS ; 9129.

F. tataricum (Linn.) Gaertn.
Pattan Valley, BKK ; 12736.

Oxyria digyna Hill.
Rhotang, YKS; 8716. Koksar, BKK; 12635.

Polygonum affine D. Don.
Billing nallha, YKS ; 8844, Koksar, BKK ; 12633.

P. alpinum All.
Keylong, YKS ; 8797. Sissue, YKS ; 8776.

P. paronychioides C. A. Mey
Tandi, YKS ; 8883. Koksar, BKK ; 12622.

P. polystachyum Wall.
Chhatruo, BKK ; 12817.

P. vacciniifolium Wall.
Chhatruo, BKK ; W.N.

P. viviparum Linn.
Keylong, YKS ; 8952.

Rheum emodi Wall.
Keylong, YKS ; 8789.

R. palmatum Linn.
Rhotang top, YKS ; 8732.

Rumex nepalensis Spreng.
Koksar, BKK ; 12630.

Elaeagnaceae

Hippophe rhamnoides Linn.
Keylong-Jispa, YKS ; 8931. BKK ; 12647.

H. salicifolia D. Don
Kardang R. F., YKS ; 8811.

Urticaceae

Cannabis sativa Linn.
Keylong, YKS ; 8929.

Urtica dioica Linn.
Keylong, BKK ; 12650.

Juglandaceae

Juglans regia Linn.
Pattan Valley, YKS ; 8925.

Cupuliferae

Betula utilis D. Don
Billing Nallha area, YKS ; 8828.

Quercus semicarpifolia Smith
Rhotang (South slopes), YKS ; 8713.

Salicaceae

Salix elegans Wall.
Gondla-Sissue ; YKS ; 8958.

S. flabellaris Anderss.
Rhotang, YKS ; 12745.

S. fruiticulosa Anderss.
Billing langpa, YKS ; 8822.
Rhotang, BKK ; 8745.

S. wallichiana Anderss.
Gondla-Sissue, YKS ; 8962.

S. lindleyana Wall.
Rani nallha, YKS ; 8985.

GNETACEAE

Ephedra intermedia Schrenk. & C. A. Mey
Tandi, BKK ; 12746.

E. vulgaris Rich.
(= *E. gerardiana* Wall.)
Tinue bridge, YKS ; 8867. Sissue, BKK ; 12693.

CONIFERAE

Juniperus communis Linn.
Shashoor R. F. (Keylong), YKS ; 8850.

J. macropoda Boiss.
Kardang R. F., YKS ; 8848. Keylong Lehroad, BKK ; 12651.

J. recurva Buch.-Ham. ex D. Don
Kardang R. F., YKS ; 8851.

IRIDACEAE

Iris hookeriana Foster
Rhotang road, YKS ; 8722.

I. kaumaonensis Wall.
Mari-Rhotang, BKK ; 12603.

DIOSCORIACEAE

Dioscorea deltoidea Wall.
Glaboo-Kothi, YKS ; 9152.

LILIACEAE

Allium sikkimense Baker
Tandi-Gondla, BKK ; 12688.

A. stracheyi Baker
Tinu-Keylong, YKS ; 8865.

Paris polyphylla Smith
Rhotang, YKS ; W.N.

Smilax parviflora Wall.
Mandi-Kothi, YKS ; 9111.

Trillium govanianum Wall.
Koksar, YKS ; 8753.

JUNCACEAE

Juncus bufonius Linn.
Koksar, BKK ; 12766.

J. himalensis Klotz.
Kothi-Mari, YKS ; 5785.

J. membranaceus Royle ex D. Don
Tinue bridge, YKS ; 8861.

CYPERACEAE

Carex atrata Linn.
Morung, YKS ; 12773.

Abbreviations : W.N. = Without Number.

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Ferns of Kedarnath, Madhyamaheshwar and Tungnath[1]

Prakash Chandra[2]

(*With a map*)

The paper describes the Fern flora of Madhyamaheshwar and Tungnath hills, regions hitherto not botanically surveyed. This is the first record of Ferns from these areas. The paper also includes the Ferns of Mandakini valley and a survey of ecological distribution of Ferns in the altitudinal range of 1200-4200 m.

Introduction

Fern flora of Western Himalayas has been studied by a number of botanists through many botanical excursions during the past one hundred years (Clarke 1880 ; Blanford 1888 ; Beddome 1892 ; Hope 1899-1904 ; Mehra 1939 ; Stewart 1942, 1945 ; Rau 1961 ; and Bir 1963). However, Madhyamaheshwar and Tungnath hills have not been botanised yet and there is no record of Fern flora of these areas. Though a few ferns have been reported from Kedarnath (Rau 1961), there is no comprehensive information about ferns of Mandakini valley. During August-September 1974 and September-October 1975, I led two joint botanical expeditions comprising a team of research workers from four C.S.I.R. laboratories namely R. R. L. Jammu, R. R. L. Jorhat, CIMPO and National Botanic Gardens, Lucknow to the above localities and made an extensive collection of ferns and plants of other groups. The present communication deals with the ferns of these localities and their ecology, distribution and altitudinal range.

During the first expedition, collection was made from Mandakini valley starting from Guptakashi to Kedarnath *via* Sonprayag, Gaurikund and Garunchatti. At Kedarnath a general survey was made upto an altitude of 4250 m. After covering this valley, the collection was made from Madhyamaheshwar region. During the second expedition, in addition to the resurvey of Madhyamaheshwar valley, a survey was also made from Budha Madhyamaheshwar which is about one kilometre away from Madhyamaheshwar and situated at an altitude of 3500 m. In the second phase of this expedition, the Tungnath hills and adjoining areas were covered.

Physiography

Madhyamaheshwar is an alpine meadow situated at an altitude of 3100 m, surrounded by lofty snow clad mountains on three sides. About 35 Km long, the green and fertile valley extending from Guptakashi to Gaundar is situated between Mandakini valley on the one hand and the valley of flowers on the other. The route for Madhyamaheshwar bifurcates from Nalachatti, a village about 4 Km beyond Guptakashi on Kedarnath route and passes through Kalimath, Raolank, Ransi and Gaundar. The 9 Km climb, starting from Gaundar the last village *en route*, is very steep and exhausting and the non-availability of drinking water througout the route up to Madhyamaheshwar, makes the climb more difficult and tiresome. However, for the encouragement of exhausted and discouraged visitors, a board about midway reads ' Do not get disappointed

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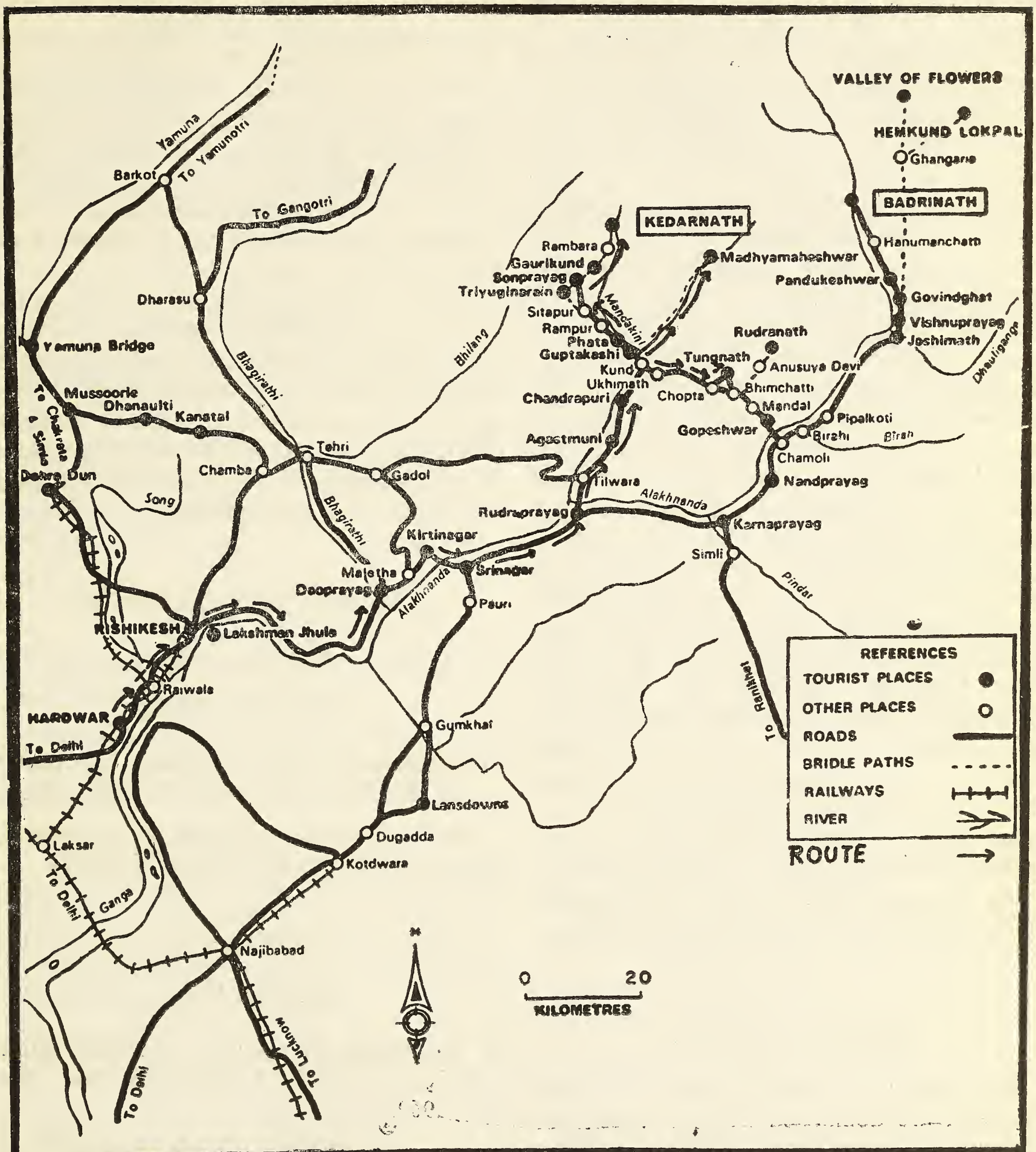

Map of the collection area

by the exhausting climb as a panorama abounding in natural beauty awaits you at Madhyamaheshwar'. At Madhyamaheshwar, there is a majestic old temple of Lord Shiva to which is attached the same religious importance as that of Kedarnath but due to difficult terrain and lack of facilities *en route*, hardly 200 to 250 pilgrims visit this shrine in a year. Tillman, the famous mountaineer in his book THE ASCENT OF NANDA DEVI has written 'I have in mind which is not often accomplished to visit Madhyamaheshwar which lies up a valley that few plains men would care to penetrate'.

Like Kedarnath and Madhyamaheshwar, Tungnath is one of the 'Panch Kedars' and attaches much religious importance. There is an all weather metalled road which bifurcates from 'Kund' about 4 Km before Guptakashi and passes *via* Ookhimath, Mastura, Duggalbitta and Chopta, from where Tungnath is hardly two and half kilometres away. However, due to irregular and uncertain Bus service on this route, the entire distance of 45 Km from Ookhimath to Tungnath was covered on foot. Tungnath is situated at an altitude of 3400 m and there is an old temple of Lord Shiva which is architecturally more or less similar to that of Madhyamaheshwar temple. About one kilometre away from Tungnath is a place called 'Chandra Shila' which is the highest point (3750 m) on Tungnath hills. From Chandra Shila one gets an excellent panoramic view of the snows of the Himalayas.

General Vegetation

The forests of Madhyamaheshwar and Tungnath are dominated by four species of *Quercus*. At lower altitude (600 m) *Q. glauca* and *Q. incana* were encountered whereas between the range of 600 m-3600 m, *Q. dilata* and *Q. semicarpifolia* were the dominant species. Duggalbitta forest (between 2400-2700 m), one of the richest encountered *en route* to Tungnath, comprised of *Populus ciliata*, *Acer* species, *Ilex odorata*, *Rhododendron arboreum*, *R. companulatum* and *Buxus sempervirens*, in addition to 3-4 species of Oaks. *Pinus roxburghii* occupied the open grassland on forest slopes along the river and its stream. *Pinus wallichiana* (Blue Pine) was conspicuous by its absence in the Madhyamaheshwar and Tungnath forests, though this is recorded from Kedarnath hills.

All the specimens collected are kept in the herbarium of National Botanic Gardens, Lucknow and the number in brackets (as given in the list) refer to the collection number. The genera here are arranged according to Copeland (1947) system of classification and all the species under each genus are arranged alphabetically with their latest nomenclature.

ENUMERATION OF SPECIES

Ophioglossaceae

BOTRYCHIUM Swartz.

B. lanuginosum (Wall. ex Hook. et Grev.) Nishida, Journ. Jap. Bot., 27 : 276, 1952.

Quite common, occurring at Gaurikund, Ransi and Mastura to Pothibasa, (104447).

Osmundaceae

OSMUNDA Linn.

O. claytoniana L., Spec. Pl., 2 : 1066, 1753. Panigrahi et Dixit, J. Indian bot. Soc., 48 : 98, 1969.

Very common, high altitude (upto 3500 m) species, growing densely between Ghanauriapani to Kedarnath, Madhyamaheshwar to Budha Madhyamaheshwar and Tungnath to Chandra Shila, (106030).

SCHIZAEACEAE

LYGODIUM Swartz.

L. flexuosum (L.) Sw., Schrad. Journ. Bot. 1800/2 : 106, 1801.

Common at lower altitudes (1200 m). Growing abundantly at Guptakashi, Kalimath, Ookhimath and Mastura, (104936).

PTERIDACEAE

PTERIDIUM Scopoli

P. aquilinum (L.) Kuhn, v. Decken Reise ostafr., 3/3 : 11, 1879.

Very common at exposed, dry places between Guptakashi to Gaurikund, Kalimath to Gaundar and Ookhimath to Duggalbitta, (104442, 106034).

PTERIS Linn.

P. aspericaulis (Wall.) J. G. Agardh, Recens. spec. Gen. Pteridis, 22, 1839.

Sparsely occurring in the forests of Guptakashi, Gaurikund, between Raolank to Gaundar and in Duggalbitta forest, (104442, 106034).

P. cretica L., Mantissa Pl. Alt., 130, 1767.

A very common species growing between 1200-2700 m, forming large, dense patches at somewhat exposed places. The species is very distinct in possessing narrow fertile fronds and broad sterile ones, (104422).

P. pellucida Presl., Rel. Halnk., 1 : 55, 1825.

Not common, met in the forest of Gaurikund, between Gaundar to Madhyamaheshwar and in Duggalbitta forest, (104416).

P. quadriaurita Retz., Obs. Bot., 6 : 38, 1791.

Quite common species growing at moist and shady places between 1200-2400 m, (104416).

P. vittata Linn., Spec. Pl. , 2 : 1074, 1753 ; Hieron, Hedwigia 54 : 290, 1914.

A very common lower altitude species occurring between 600-1500 m, at Guptakashi, Gaurikund, Kalimath and Ookhimath to Mastura. The plants of this species occur in small patches at comparatively exposed places, (104415).

P. wallichiana J. G. Agardh, Recens. Spec., Gen. Pteridis 69, 1839.

This is a very distinct species having three partite fronds and condensed tuberous rhizome. Commonly occurring in small colonies throughout the Mandakini valley, Madhyamaheshwar valley and on the Tungnath route upto 2400 m, (104421).

CRYPTOGRAMMA R. Br.

C. crispa (L.) R. Br. ex Hook., Gen. Fil., t. 115 B, 1842.

Not common, occurring between 2400-3300m. Growing in small protected crevices near Garunchatti and Kedarnath, Madhyamaheshwar and between Chopta to Tungnath, (104116).

CHEILANTHES Swartz.

C. albomarginata Clarke, Trans. Linn. Soc. Ser. 2 Bot., 1 : 456, t 52, 1880.

A very common species growing in rock crevices throughout the Mandakini and Madhyamaheshwar valleys and from Ookhimath to Tungnath, (104415).

C. belangeri (Bory) C. Chr., Index Fil., 172, 1905.

Quite a common species growing at extremely shady and moist places between Sonprayag to Gaurikund, Bantoli (foothill of Madhyamaheshwar) to Madhyamaheshwar, (104110, 104440).

C. bullosa Kunze, Linnaea, 24 : 274, 1851; Nayar, Bull. Bot. Gard. No. 68 : 27, 1962.

Not common, occurring in Gaurikund and Duggalbitta forests, (104493).

C. dubia Hope, in Journ. Bombay nat. Hist. Soc. 12 : 528, t 2, 1899.

A rare species occurring between Sonprayag and Gaurikund (2400 m) at extremely moist and shady places, (104472).

C. rufa D. Don., Prodr. Fl. Nepal. 16, 1825.

Very common, growing at comparatively shady places in rock crevices. The species is conspicuous by the extremely hairy nature of the fronds.

CONIOGRAMME Fee

C. fraxinea (Don) Diels, Nat. Pflanzen, 1/4 : 262, 1899.

A very distinct species commonly occurring upto an altitude of 2400 m, growing densely between Ghanauriapani to Garunchatti, from Kalimath to foothill of Madhyamaheshwar and between Mastura to Duggalbitta, (104114).

ADIANTUM L.

A. caudatum L., Mantissa Pl. Alt., 308, 1771; Nayar, Bull. Natl. Bot. Gdns. No. 52, 1961.

A very common species growing throughout the valleys at lower altitudes, (104409).

A. capillus-veneris L., Spec. Pl., 2 : 1096, 1753; Nayar, Bull. Natl. Bot. Gdns. No. 52 : 25, 1961.

Quite common fern growing at marshy and shady places, sometimes forming extensive patches by the side of streams. Occurring profusely between Sonprayag to Ghanauriapani, Guptakashi to Bantoli and all along the route from Ookhimath to Chopta, (104444).

A. philippense L., Spec. Pl. 2 : 1094, 1753; Nayar, Bull. Natl. Bot. Gdns. No. 52 : 5, 1961.

This species is very common between Guptakashi to Kalimath and Mastura to Pothibasa, (104408).

A. venustum Bon., Prodr. Fl. Nepal, 17, 1825; Nayar, Bull. Natl. Bot. Gdns., No. 52 : 16, 1961.

A very common species growing usually in rock crevices throughout the Mandakini and Madhyamaheshwar valleys, Pothibasa to Chopta upto an altitude of 3100 m, (104484, 106048).

GYMNOPTERIS Bernhardi

G. vestita (Wall.) Und., Bull. Torrey Bot. Club, 29 : 627, 1902.

A rare species occurring between 2400-3300 m, usually growing in exposed rock crevices. This species was met between Gaurikund to Kedarnath, Raolank to Madhyamaheshwar and Duggalbitta to Tungnath, (104439).

ONYCHIUM Kaulfuss.

O. contiguum (Wall.) Hope, Journ. Bombay nat. Hist. Soc. 13 : 444, 1901.

Common species, occurring profusely in Gaurikund forest, between Kalimath to Gaundar and Mastura to Chopta, (104476).

O. siliculosum (Desv.) C. Chr., Index Fil, 20, 1905; 469, 1906.

This is a very common species growing in patches at semiexposed places. Quite common between Guptakashi to Ghanauriapani, Kalimath to Gaundar and Ookhimath to Chopta, (106084).

O. japonicum (Thbg.) Kze., Bot. Zeit., 6 : 507, 1848.

Quite common at Gaurikund, between Gaundar to Bantoli and Pothibasa to Chopta, (104453, 106046).

NOTHOLAENA R. Br.

N. marantae (L.) R. Br., Prodr. Fl. Nov. Holl., 146, 1810, Desv ; Journ. de Bot. appl., 1 : 92, 1813.

A very rare species of fern occurring at Ghanauriapani and Garunchatti ; usually growing between 2100-4500 m. This species was not collected from Madhyamaheshwar valley and Tungnath hills, (104107).

MICROLEPIA Presl.

M. strigosa (Thbg.) Pr., Epim. Bot., 95, 1849 ; Nayar et Kaur, Bull. Natl. Bot. Gdns. No. 79: 16, 1963.

A very distinct species, forming dense patches at shady and moist places between Sonprayag to Gaurikund, Kalimath to Gaundar and Pothibasa to Duggalbitta, (104464).

DAVALLIACEAE

LEUCOSTEGIA Presl.

L. immersa (Wall.) Pr., Tent Pterid., 95, t 4, f 11, 1836.

A very common epiphyte on tree trunks, growing profusely between Sonprayag to Gaurikund, Kalimath to foothill of Madhyamaheshwar and between Mastura to Duggalbitta, (104473).

L. pulchra J. Sm., London Journ. Bot., 1 : 426, 1842.

The most common epiphyte on tree trunks and wooden logs at Sonprayag, Gaurikund, Lakarmandi, between Gaundar to Madhyamaheshwar and Pothibasa to Chopta, (104470).

L. delavayi (Bedd. ex Clarke et Bak.) Ching, in C. Chr., Index fil., Suppl. 3 : 120, 1934.

A rare species, growing sparsely on tree trunks between Gaurikund, Ghanauriapani, and at Madhyamaheshwar. This species was not collected from Tungnath area, (104127).

ASPIDIACEAE

POLYSTICHUM Roth.

P. bakerianum (Atkins.) Diels, Nat. Pflanzen., 14 : 191, 1899.

A high altitude species occurring at 3000 m, very common at Kedarnath and Madhyamaheshwar, (104113).

P. discretum (Don) Diels, Nat. Pflanzen, 1/4, 199, 1899.

Not common, a very distinct species characterised by densely hairy nature of the fronds. Occurring in Duggalbitta forest on Duggalbitta-Pothibasa short cut route, (106056).

P. lentum (D. Don) Moore, Index Fil., 86, 1858.

A very common species growing at somewhat exposed places throughout the valleys upto 2400 m, (104429).

P. nepalense (Sprengel) C. Chr., Index Fil., 84, 1905.

A large species, growing between 2400 to 3000 m at comparatively shady places. Quite common at Duggalbitta on Duggalbitta-Pothibasa short cut route, (106079).

P. nepalense var. **subbipinnatum** C. Chr. in Contr. U.S. Nat. Herb. 20 : 284, 1931.

Not a common fern, growing on Pothibasa-Duggalbitta short cut route, (106050). Not collected from other localities.

P. neolobatum Nakai, Fl. Himal. 480, 1966.

Not a common species, occurring at moist and shady places at Madhyamaheshwar, (106078).

P. prescottianum (Wall. ex Mett.) Moore, Index Fil., 101, 1858.

Very common at high altitude (between 2400-3600 m), growing profusely at Gaurikund, Kedarnath, Madhyamaheshwar, and Tungnath hills, (104117).

P. setiferum (Forsk.) Moore ex Woynar, Mitt. Naturw. ver. Steiermark, 49 : 181, 1913.

Common fern, growing between Gaurikund to Kedarnath, Kalimath to Madhyamaheshwar and Mastura to Chopta, (104102).

P. squarrosum (D. Don) Fee, Gen. Fil., 278, 1852.

A very common fern occurring throughout both the valleys and Ookhimath to Chopta, (104443, 106049).

P. stimulans Pr., Tent. Pterid., 83, 1836.

Quite common fern growing at shady places in rock crevices between Gaurikund to Kedarnath, Ransi to Madhyamaheshwar and Duggalbitta to Chopta, (104478).

P. thomsoni (Hook. f) Bedd., Ferns Brit. India, 1 : 5 126, 1866.

A rare species occurring at extremely shady, humid and marshy places in rock crevices between 2100-3000 m. This species was collected between Gaurikund to Rambara and at Chopta, (104104).

HYPODEMATIUM Kunze

H. crenatum (Forsk.) Kuhn, v. Decken Reise Ostafr., 3/3 : 37, 1879.

A common ornamental species growing at lower altitudes throughout the Mandakini valley, Madhyamaheshwar valley and Ookhimath to Duggalbitta, (104404).

THELYPTERIS Schmidel

T. auriculata (J. Sm.) K. Iwat., Acta. Phytotax. Geobot. 19 : 11, 1961.

Quite common at Guptakashi, Gaurikund, Ransi to Gaundar and Mastura to Pothibasa, (104466).

T. ochthodes (Kunze) Ching, Bull. Fan. Mem. Inst., Biol. Bot., 6 : 300, 1936.

A tall distinct species, quite common between Guptakashi, to Sonprayag, Kalimath to Gaundar and Mastura to Duggalbitta, (104411).

T. repens (Hope) Ching in Bull. Fan. Mem. Inst. Biol. 6 : 304, 1936.

A very common species growing at shady and moist places between 1200-1500 m, (104449).

GLAPHYROPTERIDOPSIS Ching

G. erubescens (Wall. ex Hook.) Ching, Acta. Phytotax. Sin. 8 : 319, 320, 1963.

Very common in shady and moist clefts at Gaurikund, Raolank to Gaundar and Mastura to Duggalbitta. It is a tall growing species characterised by the presence of distinct aerophore at each base of costae underneath and naked sori, (104459).

PSEUDOPHEGOPTERIS Ching

P. levingei (Clarke) Ching, Acta. Phytotax. Sinica 8 : 314, 1963.

A tall, exindusiate species, growing at extremely shady and moist places at Gaurikund, foothill of Madhyamaheshwar and between Pothibasa to Duggalbitta, (106080).

DRYOPTERIS Adanson

D. barbigera (Hook.) O. Ktze., Rev. Gen. Pl., 2 : 812, 1891.

Quite common at Guptakashi, Sonprayag to Gaurikund, Kalimath to Gaundar and Mastura to Duggalbitta, (106081).

D. cochleata (Don) V. Chr., Index Fil., 258, 1905.

Quite common growing at dry and exposed places between Guptakashi to Sonprayag, Kalimath to foothill of Madhyamaheshwar and Mastura to Pothibasa, (104445).

D. deparioides O. Ktze., Rev. Gen. Pl., 2 : 812, 1891.

Not common, occurring sparsely at Gaurikund and Raolank to Gaundar, (104461).

ATHYRIUM Roth.

A. duthiei (Bedd.) Bedd., Handb. Suppl, 34, 1892.

Quite common species occurring at shady and moist places throughout the valleys between 1500-2000 m, (104413).

A. pectinatum (Wall.) Pr., Tent Pterid. 98, 1836.

A rather low altitude fern, growing commonly between 600-1300 m. Quite common at Guptakashi, Kalimath to Raolank and Ookhimath to Pothibasa, (106082).

DIPLAZIUM Swartz.

D. bellum (Clarke) Bir., J. Indian bot. Soc. 43 : 571, 1964.

Not a common species, collected from Gaurikund, Bantoli, and Pothibasa to Duggalbitta, (106083).

D. esculentum (Retz.) Sw. ex Schrad. in Journ. Bot. 1, 1801/2 : 312, 1803.

This is one of the commonest species throughout the valleys and Ookhimath to Chopta, (104424).

D. polypodioides Bl., Enum. Pl. Jav., 194, 1828.

Not common, growing sparsely between Gaurikund to Garunchatti, 5000 m, (104475).

WOODSIA R. Br.

W. alpina (Dalton) Gray, Nat. arr. br. pl., 2 : 17, 1821.

Very common, growing in moist and shady places between Guptakashi to Rambara, Gaundar to Madhyamaheshwar and Pothibasa to Chopta, (104427).

CYSTOPTERIS Benth.

C. fragilis (L.) Bernh., Schard. Neu. Journ. 1/2 : 26, 52, f 9, 1806.

Quite common fern, growing in shady places from Sonprayag to Ghanauriapani, throughout the Madhyamaheshwar valley and Pothibasa to Chopta, (104413).

TECTARIA Cav.

T. cicutaria (L.) Copel., Philip. Jour. Sci., 2C : 410, 1907.

A very common species at Guptakashi, Kalimath and Ookhimath, (104417).

LEPTOGRAMMA J. Sm.

L. totta (Schlecht.) J. Sm., Hook. Journ. Bot., 4 : 52, 1841.

Not common, occurring in Duggalbitta forest in shady and moist places, (106062).

BLECHNACEAE

WOODWARDIA Smith

W. radicans (L.) Smith, Mem. Acad. Turin, 5 : 412, 1793.

Quite common at Gaurikund, Gaundar and between Pothibasa to Duggalbitta, (104438, 106063).

Aspleniaceae

asplenium L.

A. dalhousiae Hook., Icones Pl., t 105, 1837.

A very common species occurring throughout the valley upto 2700 m, (104495).

A. ensiforme Wall., Cat. no. 200, 1828 (nom. nud.); Hook. et Grev., Icones Fil., 1 : t 71, 1829.

Not common, an epiphytic species growing on tree trunks at Gaurikund and Duggalbitta, (104482).

A. exiguum Bedd., F.S. India, t 146, 1863.

A rare fern, occurring in damp moist caves between Lakarmandi and Ghanauriapani near Kedarnath, (104126).

A. laciniatum D. Don, Prodr. Fl. Nepal, 8, 1825.

Sparsely occurring in the forest of Guptakashi and Raolank and between Pothibasa to Duggalbitta, (104410).

A. trichomanes Linn., Spec. Pl., 2 : 1080, 1753.

A very common species growing at extremely moist and shady places between Gaurikund to Rambara, foothill of Madhyamaheshwar and Duggalbitta to Chopta, (104483).

Polypodiaceae

phymatodes Presl.

A. stracheyi Ching in Contr. Inst. Bot. nat. Acad. Peiping 2 : 83, 1933.

Quite common at Duggalbitta (2400 m) and on the way to Chopta, (106068).

crypsinus Presl.

C. ebenepes (Hook.) Copel.

A very common species growing on moist rocks and in rock crevices at Chopta, 3000 m, (106066).

C. hastatus (Thunb.) Copel. Gen. Fil., 206, 1947.

One of the commonest species at Guptakashi, Gaurikund and Kalimath to Gaundar, (104423).

C. malacodon (Hook.) Copel. Gen. Fil., 206 : 1947.

A high altitude species (upto 3500 m) commonly growing at Kedarnath and Madhyamaheshwar, (104124).

lepiosorus J. Sm.

L. excavatus (Bory) Ching, Bull. Fan. Mem. Inst. Bot., 4 : 68, 1933.

Very common species at Guptakashi, Sonprayag to Rambara, Kalimath to Gaundar and on Tungnath route, (104481).

L. kashyapii (Mehra) Mehra in Bir, Res. Bull. Punjab Univ. (n.s.) 13 : 23, 1962.

Quite common epiphyte on tree trunks at Madhyamaheshwar and Chopta (2700-3000 m), (106069).

L. pseudonudus Ching., Bull. Fan. Mem. Inst. Biol. 4 : 83, 1933.

Quite common at Duggalbitta and Chopta, (106070).

L. thunbergianus (Kaulf.) Ching, Bull. Fan. Mem. Inst. Biol., Bot. 4 : 88, 1933.

One of the commonest epiphyte throughout the valleys, (104402).

L. ussuriensis (Regal and Maack) Ching in Bull. Fan. Mem. Inst. Biol. 4 : 91, 1933.

A quite common high altitude (3000 m) epiphyte, growing on logs and tree trunks at Chopta, (106077).

ARTHROMERIS (Moore) J. Sm.

A. wallichiana (Spr.) Ching, Contr. Inst. Bot. Nat. Acad. Peiping, 2 : 92, 1933.

Very common species at Guptakashi, Kalimath, and Pothibasa to Duggalbitta, (104431, 106047, 106065).

LOXOGRAMMA (Bl.) Presl.

L. involuta (D. Don) Presl., Tent. Pterid., 215, 1836.

Not common, sparsely occurring at Kalimath, Gaurikund and Duggalbitta, (104432).

POLYPODIUM L.

P. amoenum Wall., Cal. no. 290, 1828 (nom. nud.) ; Mett., *Polypodium*, 80 n. 131, 1857.

A very common epiphyte throughout the valleys, occurring densely at Gaurikund, foothill of Madhyamaheshwar and Mastura to Chopta, (106067).

P. argutum Wall., Cat. no. 308, 1828 (nom. nud.) ; Hook., Spec. Fil., 5 : 32, 1863.

Common throughout the Mandakini valley upto Ghanauriapani, Kalimath to Gaundar and Mastura to Chopta, (106072).

P. lachnopus Wall., Cat. no. 310, 1828 (nom. nud.), Hook., Icones. Pl., t 952, 1854.

A very common fern at Gaurikund, Gaundar to Madhyamaheshwar and between Duggalbitta to Chopta, 2400-3000 m, (106074).

MICROSORIUM Link

M. membranaceum (D. Don) Ching, Bull. Fan. Mem. Inst. Biol, Bot. 4 : 309, 1933 ; Nayar, Bull. Natl. Bot. Gdns. no. 58 : 17, 1961.

A very common species growing at moist and shady places, forming dense patches throughout the valley from Rampur to Ghanauriapani, Nalachatti to Gaundar and Pothibasa to Chopta, (104403).

DRYNARIA (Bory) J. Sm.

D. propinqua (Wall. ex Mett.) J. Sm., Hook. Journ. Bot., 4 : 61, 1842 ; Nayar, Bull. Natl. Bot. Gdns., no. 56 : 9, 1961.

One of the commonest epiphyte covering entire trees and logs at Gaurikund, foothill of Madhyamaheshwar, and Duggalbitta to Chopta, (106075).

PLEOPELTIS (H. & B.)

P. macrocarpa (Bory ex Willd.) Klf., Berlin. Jahrb. Pharm., 21 : 41, 1820 ; Pichi. Sermoli, 20 : Webbia, 353, 1965.

Not common, sparsely occurring at Gaurikund, (104481).

PYRROSIA Mirbel.

P. adnascens (Sw.) Ching, Bull. Chin. Bot. Soc., 1 : 45, 1945 ; Nayar et Chandra, Bull. Natl. Bot. Gdns., no. 117 : 48, 1965.

A rare epiphyte in this area. One specimen was collected near Sonprayag on way to Kedarnath, (104120).

VITTARIACEAE

VITTARIA Smith

V. flexuosa Fee, Mem. Fam. Foug., 3 : 16, 1851-52.

Not common, collected only from Chopta on way to Tungnath, 3100 m, (106053). No specimen was collected from Madhyamaheshwar valley.

ACKNOWLEDGEMENT

I am grateful to Dr. T. N. Khoshoo, Director, National Botanic Gardens, Lucknow, for the keen interest evinced by him in organising the two expeditions.

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Grasses of Bhubaneswar and neighbourhood[1]

B. N. Behera, C. B. S. R. Sharma and S. K. Dash[2]

(*With a text figure*)

INTRODUCTION

Owing to the meagreness of floristic reports on Orissa State after the works of Haines (1924), Mooney (1950) and Gamble and Fischer (1928) the necessity of plant exploration has been felt. Since hardly an area exists without graminaceous populations, a preliminary survey of grasses in and around the capital city of Bhubaneswar has been taken up.

Bhubaneswar is situated at 20° 3′N and 85° 8′E the ground sloping towards east. The western part of the city is therefore higher with hard soil and the eastern part is alluvial and low suitable for agriculture. Average annual rainfall is 152 cm, heaviest being in July. Annual mean maximum temperature is about 32°C with relative humidity around 70%.

Grasses are generally found in open areas, damp fields and edges of paddy fields. Some are found in sandy soils and even in hard rocky substratums. The kind of species and their distribution therefore differs regionally and seasonally, the rainy season supporting maximum.

The areas surveyed are given in Fig. 1. Collections were made all the year round by the senior author and were identified with aid of Bor's treatise (Bor 1960) and confirmed by the Botanical Survey of India, Calcutta. The voucher specimens are handed over to the Botany Department, Utkal University, Bhubaneswar.

[1] Accepted August 1976.

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The salient features of the recorded species are given in the text arranged according to Bor's system (Bor 1960) of classification. The chromosome reports are the findings of the authors (Sharma *et al.* 1976).

The following is the enumeration of the species collected in the present survey with collection number, short notes on previous reports, morphology, and cytology.

GROUP : PANICOIDEAE

TRIBE : ANDROPOGONEAE

1. **Arthraxon sikkimensis** Bor, BNB 444.

   A new report for Orissa. Spikelets laterally compressed and pedicelled, 2-nate, one sessile and another pedicelled, similar, on the articulate fragile rachis, glumes equal, lemma awned, 9 bivalents at meiosis (2n = 18).

2. **Bothriochloa intermedia** (R.Br.) A. Camus, BNB 415.

   Syn. *Amphilophis glabra* (Roxb.) Stapf. Reported from Sijimali and Indragiri of Kalahandi district (Mooney 1950). Occurs in the rice fields opposite to the Regional Research Laboratory, Panicles with short primary axis.

3. **B. pertusa** (Willd.) A. Camus, BNB 448.

   Syn. *Andropogon pertusus* (Linn.) Willd. A new report from Orissa. Occurs in the Rice fields. Water loving perennial

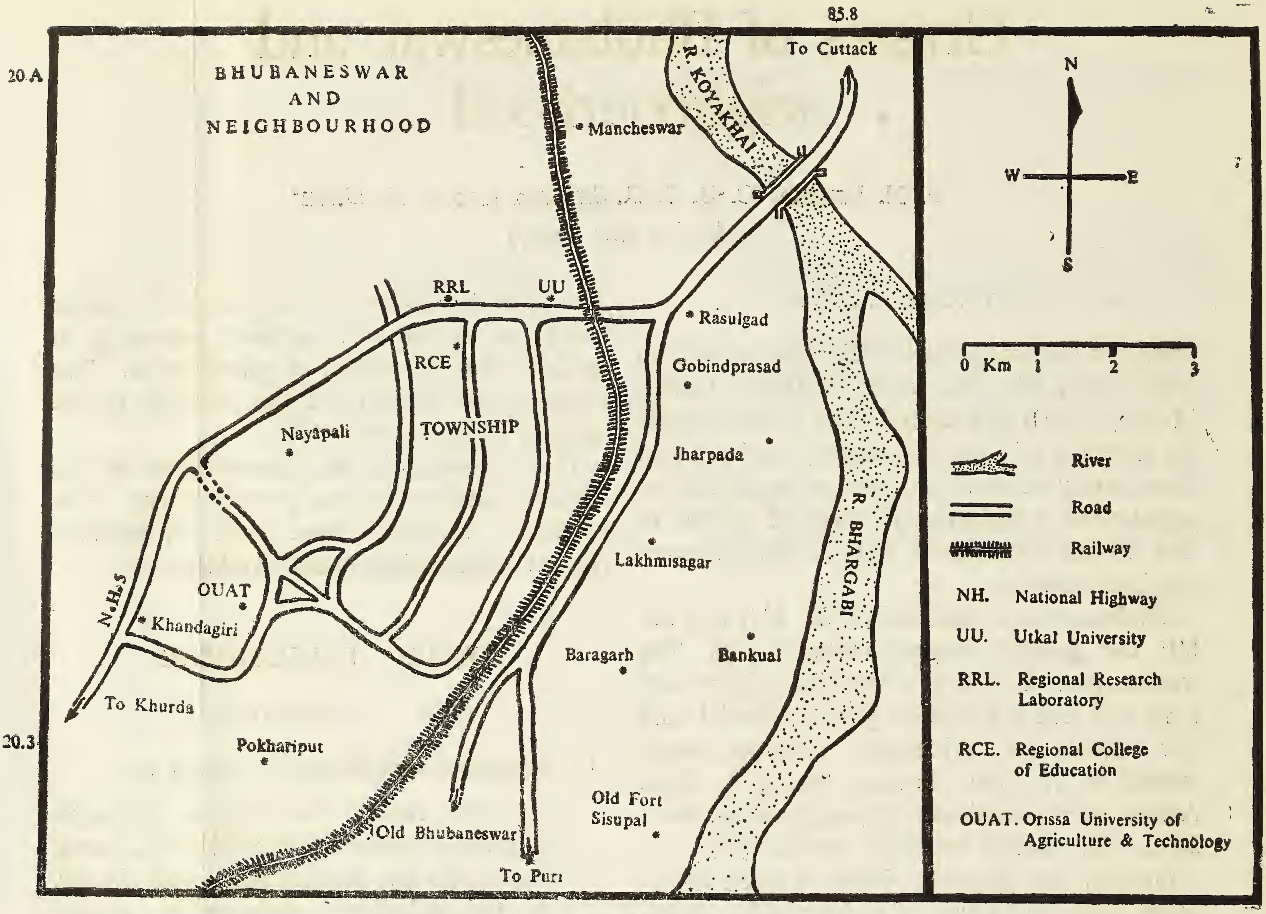

Fig. 1. Map of Bhubaneswar and its neighbourhood showing the Surveyed Areas.

herbs. Stems tufted and creeping all around. Leaves aggregated at the base of the stem and the flowering branches ascend from a geniculate base. Inflorescence consists of digitate spikes. An aneuploid ($2n = 4 \times = 36$) deficient by 2 chromosomes at haploid level, a variation from earlier reports.

4. **Chrysopogon aciculatus** Trin., BNB 424.

A new report from Orissa. Collected from the waste lands around the Utkal University and as weeds from rice fields. Perennials characterized by the spikelets being arranged in groups of three at the ends of the branches of the panicle. Each group consists of one sessile and awned and two pedicelled but unawned spikelets.

5. **Pogonatherum paniceum** (Lamk.) Hack., BNB 464.

Syn. *P. saccharoideum* P. Beauv., New report from Orissa. Slender grasses with suberect narrow leaves and very slender peduncles with solitary terminal spikes.

6. **Vetiveria zizanoides** Nash., BNB 462.

Reported from Puri, Anugul and Sambalpur (Haines 1924). Densely tufted perennials with erect and rigid leaves. Inflorescence is an erect conical panicle with reddish brown spikelets covered with thick based spines.

TRIBE : PANICEAE

7. **Alloteropsis cimicina** (Linn.) Stapf, BNB 431.

Reported from Sambalpur, Puri, Gunupur (Mooney 1950, Gamble & Fischer 1928). This species is characterised by 2-flowered spikelets in digitate spikes. Spikelets awned. A natural tetraploid with 18 (2x) bivalents.

8. **Brachiaria eruciformis** (J.E.S.) Griseb., BNB 459.

Reported from Champua of Keonjhar (Mooney 1950). It has one-sided racemose inflorescence and the position of the spikelet is adaxial. A natural tetraploid with 18 (2x) bivalents.

9. **B. kurzii** (Hook. f.) A. Camus, BNB 463.

A new report from Orissa. Stems weak and slender, leaves lanceolate and acuminate, ciliate and cordate base. One-sided racemose inflorescence with adaxial spikelets. An aneuploid ($2n = 4x = 32$) deficient by 2 chromosomes at haploid level which is a new report.

10. **B. ramosa** comb. nov. (Linn.) Stapf, BNB 422.

Syn. *Panicum ramosum* Linn. A new report for Orissa. Stems branched, nodes pubescent, leaves lanceolate. Inflorescence a panicle with erect spikes, spikelets pubescent.

11. **Digitaria adscendens** (H.B.K.) Henr., BNB 450.

New report for Orissa. Possess binate awnless spikelets jointed on the pedicels in digitate spikes. New octoploid report. Aneuploid ($2n = 8x = 68$) with 2 chromosomes deficient at haploid level.

12. **Echinochloa colonum** (Linn.) Link., BNB 451.

Reported from Orissa (Gamble & Fischer 1928). Culms erect with spikelets secund on dense racemes with triquetrous rachis, nodes glabrous, leaf sheath up to 15 cm long, spikes 8-15, 1.3 to 2.5 cm long, spikelets yellowish white and 2 to 2.5 mm long.

13. **Hymenachne pseudointerrupta** C. Muell., BNB 461.

Reported from Kasipur and Kalahandi (Mooney 1950). Aquatic stout grasses with linear leaves. Panicles with lanceolate acuminate spikelets which articulate on their minute pedicels. 18 bivalents (2x) at meiosis which is a new report.

14. **Panicum austroasiaticum** Ohwi., BNB 416.

New report from Orissa. Spikelets symmetrical, pedicellate, pedicel much divided, new spikelets are continuously growing on the axis, herbaceous and membraneous glumes, grains pale, and tightly enclosed by hardened glumes.

15. **P. miliare** Lamk., BNB 423.

A new report from Orissa. Cultivated species for its edible grain, leaves linear gradually tapered to the apex, glabrous, compound panicles suddenly acute, glumes amplexicaul.

16. **P. paludosum** Roxb., BNB 414.

Syn. *P. proliferum* Hook. f. non Lamk. Reported from Ganjam District (Gamble & Fischer 1928).

17. **P. psilopodium** Trin., BNB 465.

Reported from Ranpur of Puri District and Junagar of Kalahandi District

(Mooney 1950). A tufted grass, leaves linear, acuminate, sheaths with spreading hairs, panicles spreading, spikelets narrowly elliptic, glumes amplexicaul, spikelets are very commonly inhabited by an insect larva and then they became hypertrophied. A natural tetraploid with 18 bivalents.

18. **P. repens** Linn. BNB 443.

Reported from the sandy tracts of Puri (Haines 1924). Stems creeping and stoleniferous, leaves glabrous, linear to lanceolate, spikelets mostly paired and unequally pedicelled, glumes hyaline, amplexicaul and membraneous.

19. **Paspalidium flavidum** (Stapf) A. Camus, BNB 409.

Syn. *Panicum flavidum* Retz. Reported from Khurda of Puri Dist. (Haines 1924). Stems ascending, leaf sheaths inflated and compressed, leaves linear, spikelets ovoid, single terminal spike in case of small specimens, spikelets awnless, pale and glabrous.

20. **Paspalum scorbiculatum Linn.**, BNB 454.

Reported from Kalahandi, Khariar (Mooney 1950) at 2700 ft. Annuals with erect tufted culms, leafy from the base to upwards. Inflorescence panicle, consisting of two false spikes with elliptic spikelets, in two rows on the under surface of the glabrous rachis. An aneuploid ($2n = 4x = 42$) with 1 extra chromosome at haploid level.

21. **Setaria, pallidefusca** (Schumach.) Stapf et Hubb., BNB 656.

A new report from Orissa. Terminal panicles often cylindrical with solitary spikelets seated on stunted branches which are more or less produced into bristles.

GROUP : POOIDEAE

TRIBE : ARISTIDEAE

22. **Aristida depressa** Retz., BNB 460.

Syn. *A. adscencionnis* Linn. Reported from Sambalpur (Mooney 1950). Common weed on sandy ground, leaves filliform and glabrous, inflorescence a panicle consisting of slender awnless spikelets.

TRIBE : CHLORIDEAE

23. **Chloris barbata** Sw., BNB 417.

Reported from Puri (Haines 1924). Inflorescence of digitate spikes seated at the top of the peduncle, spikelets awned and secund.

24. **Cynodon dactylon** (Linn.) Pers., BNB 447. Syn. *Chloris cynodon* Trin. Cosmopolitan.

Distribution in Orissa ; wide spread. Creepers, some are ascending, leaves subulate, glabrous, spreading and linear. Inflorescence constitutes a group of spikes. Plant grows mostly on damp soil of drier parts.

TRIBE : ERAGROSTEAE

25. **Dactyloctenium aegyptium** (Linn.) Beauv., BNB 453.

Syn. *Eleusine aegyptiaca* Desf. Reported from Parlakimedi of Ganjam District (Srinivasan & Subbarao 1961). Annual with culms glabrous. Inflorescence of digitate spikes, radiating from the top of the culm. The rachis of the spike is sharply pointed. Spikelets many at right angles to rachis. An aneuploid ($2n = 4x = 52$) with 2 extra chromosomes at the haploid level.

26. **Eleusine coracana** (Linn.) Gaertn., in Cultivated.

27. **E. indica** (Linn.) Gaertn., BNB 455.

Reported from Puri (Haines 1924) Spikelets awned, 2-3 seriate, on digitate capitate spikes, compressed with their sides to the rachis, flowering glumes several, unawned and greyish green.

28. **Eragrostis ciliaris** Link., BNB 407.

A new report from Orissa. Slender herbs with many ascending portions originate from a horizontal root stock. Leaves flat ascending.

29. **E. interrupta** Beauv. var. **diplachnoides** Stapf, BNB. 435.

Reported from Puri (Haines 1924). Stems stout and branched, panicles long.

30. **E. maderaspatana** Bor, BNB 449.

A new record from Orissa. Group of spikes constitute the panicle. Each spike consists of 4 to 5 spikelets. Each spikelet with 5/6 florets. The glumes are mid-veined and serrate margined. The lemma is three veined with veins ascending in obtuse awns, palea and stigma both feathery. A natural hexaploid ($2n = 6x = 60$) which is a new report.

31. **E. tenella** (Linn.) Roem. & Sch., BNB 457. Reported from Puri (Haines 1924), Parlakimedi of Ganjam Dist. (Srinivasan & Subbarao 1961). Slender grass with leaves convolute and accuminate, spikelets not very spongy, compressed, grains long ovoid and polished.

32. **E. unioloides** (Retz.) Nees ex Steud. BNB 442.

Cosmopolitan in distribution (Gamble & Fischer 1927), Parlakimedi (Srinivasan & Subbarao 1961). Spikelets ovate much compressed, branches spreading, lemma and palea fallen from the base to the upwards, grains ellipsoid.

TRIBE : ORYZEAE

33. **Oryza sativa** Linn.
Cultivated.

TRIBE : PEROTIDEAE

34. **Perotis indica** (Linn.) O. Ktze., BNB 418.

Reported from Nayagarh, Keonjhar and Sambalpur (Mooney 1950). Slender annuals occurring in waste lands, leaves short, spikes feathery, spikelets narrow, awned and glumes unequal.

TRIBE : SPOROBOLEAE

35. **Sporobolus indicus** auctt. non (Linn.) R.Br., BNB 458.

New report for Orissa. Leaves flat, small and minute, spikelets in effuse spiciform panicles.

TRIBE : TRITICEAE

36. **Triticum aestivium** Linn.
Cultivated.

Discussion

Haines (1924) reported 214 species of grasses belonging to 90 genera and Mooney (1950) added 42 species more. Only a fraction of the 385 species reported by Gamble and Fischer (1928) from Madras Presidency have been collected from Ganjam District of Orissa. Out of the 36 species reported currently including the three cultivated grasses, belonging to 24 genera, 13 are new reports to Orissa state as they have not been reported by earlier workers (Haines 1924; Mooney 1950; Gamble and Fischer 1928; Srinivasan & Subbarao 1961). The tribe Paniceae is dominant with 15 species followed by Eragrosteae with 8 species. Among the genera, however, both *Panicum* and *Eragrostis* are represented by 5 species each. It is interesting to note that a considerable number of the investigated species exhibit cytotypic differentiation (Sharma, Behera & Dash 1976).

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A contribution to the flora of Bari-Bareli range (Raisen District), M.P.[1]

V. B. Gupta[2]

Introduction

Bari-Bareli range lies in the Raisen District east of Hoshangabad, between the longitude 77° 15′-79° east and latitude 22° 46′-23° 45′ north at a distance of 19 Km from Bareli town. The forest land covers an area of 1849.67 Sq. Km. The study of the area was all the more important since a dam is proposed to be built (which has recently been inaugurated in the month of October 1975) at Bari on Barna river in which considerable area of the forest is going to be submerged.

Physiography and Geology :

The tract is covered by southern tropical dry deciduous forest and at places by dry deciduous scrub forest (Champion 1936).

The tract varies in configuration at different places. The whole area is situated on the Malwa plateau. The area is bounded by Vindhyan sand-stones and the Deccan traps. The altitude of the hills vary from 319.2-608.3 m above m.s.l.

The area is traversed by numerous nalas, streams and a few rivers, of them the Barna is the only perennial river. It is a tributary of Narbada joining it near Samarighat.

[3]*Climate :*

The average rainfall is 1196.6 mm. The average maximum temperature is in the month of May (35.2°C) and average minimum temperature in the month of January (19.8°C). Relative humidity is maximum in the month of September (92%) and minimum in the month of May (19%). Average velocity of wind is minimum in the month of December (1.80 Km per hour) and maximum in the month of July (12.95 Km per hour).

Previous Work :

On the whole very scanty work has been done on the flora of Madhya Pradesh State. And no work is available for Bari-Bareli range. Those who have contributed to the study of Madhya Pradesh flora are—Bhattacharya (1955), Biscoe (1910), Brandis (1874), Maheshwari (1958, 1961), Sebastine and Bala Krishnan (1963), Tiwari and Maheshwari (1965).

The collection is located in Botany Department, Holkar Science College, Indore. The various species collected during the present work are listed below.

(i) Pteridophyta

Actinopteris australis (L. fil.) Link.

Common on walls, rock crevices and in forest during 9-12. V.B.G. 738.

Adiantum incisum Forst

Common in the ground flora and on the hills during 7-9. V.B.G. 741.

Adiantum lunulatum Burm. f.

In the ground flora and lower slopes of the hills during 7-9. V.B.G. 737, 739.

[1] Accepted August 1976.

[2] Lecturer in Botany, Holkar Science College, Indore, M.P.

[3] The climatic data have been obtained from tehsil office Bareli and Barna Dam Office, Bari and pertains for the period 1956-65.

Aleuritopteris farinosa (Forsk.) Fee.

Found common on damp soil along river stream in the forest area in the month of September. V.B.G. 742.

Ampelopteris prolifera (Retz.) Copel.

Found along the river banks, spore formation during 2-4. V.B.G. 740.

Azolla pinnate R. Br.

Commonly floating in ditches during 9-11. V.B.G. 1605.

Ceratopteris thalictroides (Linn.) Brongn.

Common in tanks, ditches, swampy places, even on dry grounds during rains. V.B.G. 1181.

Cheilanthes tenuifolia (Burm.) Sw.

In rock crevices and in ground flora during September. V.B.G. 743.

Equisetum diffusum Don.

Found in thickets along banks of Barna river. Cone formation during October-November. V.B.G. 1604.

Marsilea minuta Linn.

Found along the ditches and other water formations during rainy season. Remains alive till ditches dry up. V.B.G. 1603.

Selaginella ciliaris (Retz.) spr.

Found on damp shady places during the month of September. V.B.G. 1601.

(ii) **Angiospermae**

ANNONACEAE

Annona squamosa Linn.

Common in forest, also cultivated. Fl. 4-8. Fr. 10-11. V.B.G. 233, 915.

MILIUSEAE

Miliusa tomentosa (Roxb.) Sinclair

In river ravines, not common. Fl. 4. Fr.7. V.B.G. 162.

MENISPERMACEAE

Cissampelos pareira Linn.

Not common, found on the hill slopes. Fl. & Fr. 8-12. V.B.G. 294, 436, 1039-1041.

Cocculus hirustus (Linn.) Diels.

Abundant in the fields, along river side, on the hedges and trees. Fl. & Fr. 2-3. V.B.G 4,29, 1036-1038.

Tinospora cordifolia (Willd.) Miers.

Common in hedges and on trees.

NYMPHAEACEAE

Nymphaea stellata Willd.

Abundant in the ditches in the forest area. Fl. & Fr. 9. V.B.G. 381.

PAPAVERACEAE

Argemone mexicana Linn.

It is found in fields, waste lands, recently disturbed and eroded soil. Fl. 1-12.

CRUCIFERAE

Brassica juncea (Linn.) Czern. & Coss.

Found growing in the courtyards. Fl. & Fr. 10-1. V.B.G. 965.

Cardamine hirusta Linn.

Found in ground flora and as weed in the fields. Fl. & Fr. 11-2. V.B.G. 1183.

Rorippa indica (Linn.) Hiren.

It is common along the river banks in damp moist places. Fl. & Fr. 10-2. V.B.G. 964.

CAPPARIDACEAE

Capparis zeylanica Linn. non Hook. f. & Th.

Common in ground flora. Fl. & Fr. 12-4. V.B.G. 966.

Cleome viscosa Linn.

Found as weed in cultivated fields, also on hill slopes and in ground flora. Fl. & Fr. 7-10. V.B.G. 210, 211, 872, 967.

Gynandropsis gynandra (Linn.) Briq.

Common as weed in cultivated fields, also in the ground flora and along river banks. Fl. & Fr. 7-11. V.B.G. 571, 873.

VIOLACEAE

Hybanthus enneaspermus (Linn.) F. V. Muell.

Common in ground flora and on hill slopes. Fl. & Fr. 8-10. V.B.G. 232, 264, 747, 1043, 1044.

BIXACEAE

Cochlospermum religiosum (L.) Alston.

Found on hill slopes and tops, not common. Fl. & Fr. 2-4. V.B.G. 158, 184 A.

FLACOURTIACEAE

Flacourtia indica (Burm. f.) Merr.

Found on hill slopes and in river ravines Fl. & Fr. 3-6.

POLYGALACEAE

Polygala chinensis Linn.

Common in ground flora and in grass fields. Fl. & Fr. 7-10. V.B.G. 284, 949, 950.

Polygala elongata Klein ex Willd.

Found as undergrowth in the forest area. Fl. & Fr. 8-11. V.B.G. 363.

Polygala erioptera DC.

Common in ground flora and fields. Fl. & Fr. 8-10. V.B.G. 947, 948.

CARYOPHYLLACEAE

Polycarpaea corymbosa Linn.

Not common, found on hill tops and slopes. Fl. & Fr. G.

Polycarpon prostratum (Forsk.) Asch. & Sch.

Common in forest, fields, and along ditches. Fl. & Fr. 5-10. V.B.G. 1185.

PORTULACACEAE

Portulaca oleracea Linn.

Common as weed in the cultivated fields, and near the kitchens. Also cultivated as pot herb. Fl. & Fr. G. V.B.G. 69.

Portulaca quadrifida Linn.

Weed in the fields, common in courtyards and near Kitchens. Fl. & Fr. G.

TAMARICACEAE

Tamarix dioica Roxb. Not common, found on the sandy banks of the river and low lying moist ground. Fl. & Fr. 5-9. V.B.G. 746.

MALVACEAE

Abelmoschus monihot (Linn.) Medik.

Found in grassfields and in ground flora, not common. Fl. & Fr. 8-9. V.B.G. 1186.

Abutilon indicum (Linn.) Sweet.

Common as weed in cultivated fields, waste grounds, grass fields, fallowlands and ground flora. Fl. & Fr. G. V.B.G. 569, 1031.

Azanza lampas (Cav.) Alef.

Found on the hill slopes and in ground flora Fl. & Fr. 9-1. V.B.G. 351.

Hibiscus gibsoni Stocks ex Harv. & Sond.

Found in ground flora and in fields. Fl. 8-9. V.B.G. 1167.

Hibiscus lobatus (Murr.) Kuntze

On hill slopes, ground flora, in the fields. Fl. & Fr. 9-11. V.B.G. 1033.

Hibiscus mutabilis Linn.

In the ground flora and hill slopes. Fl. 1. V.B.G. 351, 1024.

Hibiscus panduraeformis Burm. f.

Common in grass fields and ground flora. Fl. & Fr. 11-2. V.B.G. 3, 8, 1020, 1032.

Kydia calycina Roxb.

In ground flora, on foot and slopes of the hills. Fl. 9-11, Fr. 12-5. V.B.G. 472, 1023 1030.

Malvastrum coromandelianum (Linn.) Garcke

As common weed in cultivated fields. Fl. & Fr. G. V.B.G. 234.

Sida acuta Burm. f.

Common along nalas in the fields and forest. Fl. & Fr. 10-11. V.B.G. 537.

Sida spinosa Linn.

Common in grassfields, cultivated fields and, in ground flora. Fl. & Fr. 10-3. V.B.G. 35,100, 546, 1025, 1026.

Sida rhombifolia Linn. var. *retusa* Linn.

Common in waste lands, fields, along the river banks. Fl. & Fr. 9-10. V.B.G. 261.

Sida veronicaefolia Lamk.

Common in fields and forest. Fl. & Fr. 9-1. V.B.G. 1017, 1019, 1021, 1022.

Urena labata Linn.

Common in ground flora, waste places, fields etc. Fl. & Fr. 6-11. V.B.G. 519, 553, 1018, 1027-28.

Bombacaceae

Bombax ceiba Linn.

Common in ground flora and lower hill slopes. Fl. 1-3. Fr. 3-5.

Sterculiaceae

Helicteres isora Linn.

Common on hill slopes as undergrowth. Fl. 4-12. Fr. 10-1. V.B.G. 279, 723.

Melhania futteyporensis Munro ex Mast.

In ground flora and fields. Fl. 12-1. V.B.G. 1187.

Sterculia urens Roxb.

Found on the hill slopes associated with *Boswellia serrata*. Fl. & Fr. 1-3. V.B.G. 1187.

Waltheria indica Linn.

Common on hill slopes and in ground flora. Fl. & Fr. 8-11. V.B.G. 284, 394, 494, 1006-1008.

Tiliaceae

Corchorus aestuans Linn.

Common in waste lands, grass fields and, in ground flora. Fl. & Fr. 8-10. V.B.G. 338, 365.

Corchorus capsularis Linn.

Common in ground flora. Fl. & Fr. 8-10. V.B.G. 1001, 1002.

Corchorus trilocularis Linn.

Common in fields. Fl. & Fr. 8-12. V.B.G. 997, 998.

Grewia asiatica Linn.

Common in ground flora and foot of the hills. Fl. 5-7. Fr. 9-11. V.B.G. 169, 193, 1005.

Grewia flavescens Juss.

Found on hill slopes and in ground flora as undergrowth. Fl. & Fr. 8-10. V.B.G. 1189, 1207.

Grewia hirusta Linn.

Common on hill slopes and ground flora as undergrowth. Fl. & Fr. 7-10. V.B.G. 434, 1003.

Grewia tiliaefolia Vahl

Common throughout the forest. Fl. 5-8. Fr. 9-10. V.B.G. 198.

Triumfetta pentandra Guill. & Perr.

Common in ground flora, hill slopes, grass fields and waste lands. Fl. & Fr. 7-10. V.B.G. 403, 999, 1000.

Triumfetta rotundifolia Lamk.

Found in ground flora and fields. Fl. & Fr. 7-12. V.B.G. 1004.

Zygophyllaceae

Tribulus terrestris Linn.

Rare, in the foot of the hills and in ground flora. Fl. & Fr. 7-8. V.B.G. 178.

Oxalidaceae

Biophytum sensitivum DC.

Common in ground flora. Fl. & Fr. 8-10. V.B.G. 330, 1045-1047.

Oxalis corniculata Linn.

Found on damp moist soils as weed in the fields and gardens. Fl. & Fr. G. V.B.G. 694.

Balsaminaceae

Impatiens balsamina Linn.

As an escape in ground flora and on hill slopes. Fl. & Fr. 7-9.

Rutaceae

Aegle marmelos (Linn.) Correa

Common on hill slopes and in ground flora. Fl. 3-5. Fr. 1 year.

Feronia limonia (Linn.) Swingle

Common in ground flora and fields. Fl. 2-4. Fr. 10. V.B.G. 714.

Simaroubaceae

Ailanthus excelsa Roxb.

Along roads, not common. Fl. & Fr. 1-3. V.B.G. 1010.

Balanites roxburghii Planch.

Common in river ravines and deforested soil, rarely, on hills. Fl. & Fr. 4-5. V.B.G. 20, 1009.

Burseraceae

Boswellia serrata Roxb. ex Colebr.

Common on hill slopes and in ground flora. Fl. & Fr. 1-6. V.B.G. 183, 953.

Meliaceae

Azadirachta indica A. Juss.

Common in habitation areas and to some extent wild. Fl. 3-5. Fr. 7-8.

Chloroxylon swietenia DC.

Common in ground flora and on hill slopes. Fl. 3-4. Fr. 5-8.

Melia azedarach Linn.

Planted along the roads. Fl. 3-5. Fr. 12. V.B.G. 1036.

Celastraceae

Celastrus paniculata Willd.

Common in river ravines and ground flora. Fl. & Fr. 4-6. V.B.G. 189, 982, 983.

Maytenus senegalensis (Lamk.) Exell.

Found common in ground flora, on deforested soil, small hillocks and, outskirts of the forest. Fl. & Fr. 11-1. V.B.G. 578, 984.

Rhamnaceae

Ventilago calyculata Tulsane

Common in ground flora. Fl. & Fr. 2-4 V.B.G. 74, 584, 717, 722.

Zizyphus glaberrima Sant.

Common on hill slopes and in ground flora as undergrowth. Fl. & Fr. 7-8. V.B.G. 205, 220, 353.

Zizyphus mauritiana Lamk.

Common in ground flora and also cultivated. Fl. 4-10. Fr. 10-3. V.B.G. 157, 715, 716.

Zizyphus nummularia (Burm. f.) Wt. & Arn.

Common in waste land, river ravines, grass-fields. Fl. 3-6. Fr. 12. V.B.G. 719.

Zizyphus oenoplia Mill.

Common all over the forest area. Fl. 4-5 Fr. 6-9. V.B.G. 475, 524, 718, 721.

Zizyphus xylopyrus Willd.

Common on hill slopes and in ground flora. Fl. 2-4. Fr. 12-1. V.B.G. 95.

Ampelidaceae

Ampelocissus latifolia (Roxb.) Planch.

Common on the hill slopes. Fl. & Fr. 4-7. V.B.G. 188, 427, 876.

Ampelocissus tomentosa Planch.

Found on hill slopes. Fl. & Fr. 3-4. V.B.G. 295, 877.

Leea edgeworthii Santapau

Rare, on hill slopes. Fl. & Fr. 8-11. V.B.G. 297.

Vitaceae

Cayratia carnosa Gagnep.

Found climbing on trees, shrubs, on hill slopes and in ground flora. Fl. & Fr. 8-9. V.B.G. 1190.

Sapindaceae

Cardiospermum helicacabum Linn.

Common in hedges and bushes. Fl. & Fr. 8-10. V.B.G. 371, 1014.

Sapindus laurifolius Vahl

Common in ground flora. Fl. 12-2. Fr. 2-4. V.B.G. 1015, 1016.

Schleichera oleosa (Lour.) Oken.

Common in the forest. Fl. 2-3. Fr. 6-8.

Anacardiaceae

Buchanania lanzan Spreng.

Abundant on hills and in ground flora. Fl. 1-3. Fr. 4-5. V.B.G. 22, 99, 885.

Lannea coromandelica (Hoult.) Merr.

Usually on lower slopes of the hills and in ground flora. Fl. 3-4. Fr. 5-7. V.B.G. 93, 103, 692, 693.

Mangifera indica Linn.

As an escape in the forest area. Under cultivation and along the roads. Fl. 3-4. Fr. 5-6.

Rhus paniculata Wall.

Common in the ground flora. Fl. 2-3. Fr. 3-4. V.B.G. 1191.

MORINGACEAE

Moringa oleifera Lamk.

Cultivated, along the hedges. Fl. 1-4. Fr. 5-6.

PAPILIONACEAE

Abrus precatorius Linn.

Common climber in ground flora. Fl. & Fr. 8-10. V.B.G. 649.

Aeschynomene indica Linn.

Found along water ditches. Fl. & Fr. 8-10. V.B.G. 314, 390, 454, 651, 652.

Alysicarpus bupleurifolius DC.

Abundant in grass fields. Fl. & Fr. 8-10. V.B.G. 643.

Alysicarpus glumacens (Vahl) DC. var. *styracifolius* DC.

Common in moist places and in fields. Fl & Fr. 9-11. V.B.G. 648.

Alysicarpus monilifer DC.

Common in grass fields. Fl. & Fr. 8-10. V.B.G. 640.

Alysicarpus rugosus DC.

Common in fields and grass fields. Fl. & Fr. 8-9. V.B.G. 641, 664.

Alysicarpus vaginalis DC.

Common in grass fields. Fl. & Fr. 8-10. V.B.G. 407, 441, 645, 646.

Atylosia scarabaeoides Benth.

Common on hedges and small trees. Fl. & Fr. 8. V.B.G. 642, 644.

Butea monosperma (Lamk.) Taub.

Common on hills, in ground flora, on deforested soil. Fl. 2-3. Fr. 3-4. V.B.G. 653.

Butea superba Roxb.

Found on the hills and in ground flora. Fl. 3-4.

Clitoria ternatea Linn.

Not common, on hedges. Fl. & Fr. 10-11. V.B.G. 486, 654, 655.

Crotalaria albida Heyne.

Common in grass fields. Fl. & Fr. 8-9. V.B.G. 657, 658.

Crotalaria hirta Willd.

Found wild in the fields and along the river banks. Fl. & Fr. 10-12. V.B.G. 5, 663, 665.

Crotalaria orixensis Willd.

Common in fields and ground flora. Fl. & Fr. 10-11. V.B.G. 544.

Crotalaria prostrata Roxb.

Found common in fields and forest flora. Fl. & Fr. 9-11. V.B.G. 523, 1109.

Crotalaria sericea Retz.

Not common, in ground flora. Fl. & Fr. 11-1. V.B.G. 659, 660, 661.

Cyamopsis tetragnoloba Linn.

Wild in grassy fields as an escape. Fl. & Fr. 8-10. V.B.G. 662.

Dalbergia lanceolaria Linn .f.

Common in the forest in ground flora and on hills. Fl. 5-6. V.B.G. 1, 72, 90, 671.

Dalbergia paniculata Roxb.

Common in ground flora and lower slopes of the hills. Fl. 4-5.

Desmodium cephalotes Wall.

Rare, at the foot of the hills. Fl. & Fr. 9-10. V.B.G. 473.

Desmodium diffusum DC.

Found in the ground flora and foot of the hills. Fl. & Fr. 9. V.B.G. 543.

Desmodium gangeticum DC.

Common in ground flora. Fl. & Fr. 8-10. V.B.G. 393, 448, 673.

Desmodium latifolium DC.

Common in ground flora, and on hill slopes. Fl. & Fr. 7-9. V.B.G. 139.

Desmodium triflorum (Linn.) DC.

Found in the courtyards where the soil is moist and under shade, and in fields. Very common. Fl. & Fr. 9-10. V.B.G. 388, 669, 670.

Eleiotis sororia DC.

Found in fallow lands, grass fields and in ground flora. Fl. & Fr. 8-9. V.B.G. 364.

Erythrina suberosa Roxb.

Common on hills and in ground flora. Fl. 3-4. V.B.G. 154.

Heylandia latebrosa DC.

Common in fields and ground flora. Fl. & Fr. 11-12. V.B.G. 501, 705.

Indigofera astragalina DC.

Common on hill slopes and in ground flora. Fl. & Fr. 9-11. V.B.G. 362, 446, 529, 667.

Indigofera cassioides Rottl. ex DC.

Not very common in ground flora and forest valley. Fl. & Fr. 10-12. V.B.G. 16, 665.

Indigofera glandulosa Willd.

Common on deforested soil and also hill slopes. Fl. & Fr. 9-10. V.B.G. 398, 449.

Indigofera linifolia Retz.

Common in fields. Fl. & Fr. 10-11. V.B.G. 487, 668.

Indigofera linifolia Retz. var. *campbelii* Wight.

Not very common, in fields. Fl. & Fr. 9-11. V.B.G. 548.

Indigofera tinctoria Linn.

Common in ground flora. Fl. & Fr. 10-12. V.B.G. 506, 666.

Indigofera trita Linn. f.

Common in ground flora. Fl. & Fr. 8-9. V.B.G. 315.

Melilotus alba Desr.

Wild in fields and in damp places even during March-April. Fl. & Fr. 12-3. V.B.G. 145.

Melilotus indica All.

A common weed in the fields. Fl. & Fr. 11-1. V.B.G. 1192.

Mucuna prurita Hook.

In ground flora and hill slopes, not common. Fl. 2-3. V.B.G. 505, 704.

Ougeinia oojeinensis (Roxb.) Hoch.

Found common on deforested soil and on hill slopes. Fl. & Fr. 3-4. V.B.G. 139, 1196.

Phaseolus adenanthus Meyer.

Common throughout the forest. Fl. & Fr. 9-11. V.B.G. 581.

Phaseolus aureus Roxb.

Common on hill slopes and in ground flora. Fl. & Fr. 9-11. V.B.G. 530.

Phaseolus trilobus Ait.

Common along river banks, in grassfields and in ground flora. Fl. & Fr. 9-10. V.B.G. 410, 674, 675.

Psoralea corylifolia Linn.

Found on waste lands and along the river banks. Fl. & Fr. 9-2. V.B.G. 483, 677, 678.

Pterocarpus marsupium Roxb.

Common on hill slopes and in ground flora. Fl. 10. Fr. 12-1. V.B.G. 11, 588.

Rhyncosia minima (Linn.) DC.

Found growing wild in grass fields and turning over the hedges. Fl. & Fr. 2-10. V.B.G. 679, 680, 681.

Sesbania bispinosa (Jacq.) Fawcett & Rendle

Abundant in waste and crop fields and also in swampy places. Fl. & Fr. 8-10. V.B.G. 699.

Sesbania sesban (Linn.) Merr.

Common on moist soil and along the ditches. Fl. & Fr. 8-10. V.B.G. 480, 698, 701.

Smithia conferata Sm.

Common in ground flora. Fl. & Fr. 10-12. V.B.G. 581.

Tephrosia pumila Pers.

Common on hills, along river banks, and in grassfields in wet places. Fl. & Fr. 7-9. V.B.G. 60.

Tephrosia purpurea (Linn.) Pers.

Common in fields, river, ravines and ground flora. Fl. & Fr. 9-1. V.B.G. 373, 392.

Tephrosia strigosa (Dalz.) Sant. & Mahesh.

As weed in crop fields. Fl. & Fr. 2-5. V.B.G. 686.

Teramnus labialis (Linn. f.) Spreng.

All over the forest and hedges. Fl. & Fr. 9-12. V.B.G. 435, 474.

Uraria lagopoides Wall.

Common in ground flora. Fl. & Fr. 10-1. V.B.G. 346.

Uraria picta Desv.

Common in ground flora. Fl. & Fr. 10-1. V.B.G. 704.

Vicia hirsuta (Linn.) S. F. Gray

Abundant as weed in wheat fields. Fl. & Fr. 12-3. V.B.G. 444.

Vicia sativa Linn.

Common in moist places along the river banks, and as weed in wheat, sarson, fields. Fl. & Fr. 2-3. V.B.G. 53, 702, 703.

Zornia gibbosa Span.

Common in waste lands and grass fields. Fl. & Fr. 8-9. V.B.G. 625, 705.

Caesalpinaceae

Bauhinia malabarica Roxb.

Common on hill slopes and in ground flora. Fl. 9-11, Fr. 1-3. V.B.G. 638.

Caesalpinia sepiaria Roxb.

Not common, on hedges of crop fields. Fl. 9-2, Fr. 3-4. V.B.G. 123, 134, 637.

Cassia absus Linn.

Common on deforested soil. Fl. & Fr. 9-11. V.B.G. 447, 521.

Cassia fistula Linn.

Common throughout the forest. Fl. 3-6. V.B.G. 633, 634.

Cassia marginata Roxb.

Not very common, in ground flora. Fl. & Fr. 7-10. V.B.G. 192.

Cassia occidentalis Linn.

Common on deforested area and along the river banks. Fl. & Fr. 7-10. V.B.G. 573, 635, 636.

Cassia pumila Lamk.

Common on hill slopes and in ground flora. Fl. & Fr. 8-10. V.B.G. 639.

Cassia tora Linn.

Common weed on waste land. Fl. & Fr. 8-10. V.B.G. 384.

Poinciana pulcherrima Linn.

Planted for ornamental use, also in ground flora. Fl. & Fr. 4-12. V.B.G. 656.

Tamarindus indica Linn.

Not common, in ground flora. Fl. 7-9. Fr. 4-6. V.B.G.

MIMOSACEAE

Acacia catechu Willd.

Common throughout forest on hills and in ground flora. Fl. 3-4. Fr. 11-1. V.B.G. 172, 583, 631.

Acacia farnesiana (Linn.) Willd.

Rare, along the road. Fl. 1-3. Fr. 3-5. V.B.G. 94.

Acacia leucophloea (Roxb.) Willd.

Common in ground flora and along roads. V.B.G. 401, 589, 627.

Acacia nilotica (Linn.) Del. Found common in forest, along the roads, and on deforested soils. Fl. 7-10. Fr. 1-6. V.B.G. 269, 630.

Acacia pennata Willd.

Common in ground flora. Fl. & Fr. 6-9. V.B.G. 477, 585.

Albizzia lebbek (Linn.) Benth.

Common in ground flora. Fl. 4-5. Fr. 1. V.B.G. 632.

Albizzia odoratissima (Linn. f.) Benth.

Common on hill slopes and in ground flora. Fl. 5-6. Fr. 1. V.B.G. 528, 629.

Albizzia procera (Roxb.) Benth.

Found in ground flora, not common. Fl. 8-9. Fr. 1-5. V.B.G. 81, 552, 626.

Mimosa hamata Willd.

Common in river ravines and ground flora. Fl. & Fr. 8-10. V.B.G. 344, 628.

Pithecolobium dulce (Roxb.) Benth.

Cultivated in hedges. Fl. 2-7. Fr. 6-8. V.B.G. 625.

Prosopis juliflora (SW.) DC.

Planted in government building compounds. Fl. 2-9. Fr. 10.

ROSACEAE

Potentilla supina Linn.

Not common, on the moist river banks. Fl. & Fr. 3. V.B.G. 1193.

COMBRETACEAE

Anogeissus latifolia Wall.

Abundantly found throughout the forest. Fl. 4-6.

Anogeissus pendula Edgew.

Not common, in ground flora.

Combretum ovalifolium Roxb.

Common in ground flora. V.B.G. 1268.

Terminalia arjuna Bedd.

Common along river banks. Fl. 5-7. Fr. 3-4. V.B.G. 596, 970 ,996.

Terminalia bellerica (Gaertn.) Roxb.

Common on hills and in ground flora. Fl. 3-5. Fr. 1-2. V.B.G. 152, 994, 995.

Terminalia chebula Retz.

Common on hill slopes and in ground flora. Fl. 4-5. Fr. 10-2. V.B.G. 274, 275, 299.

Terminalia tomentosa Wt. & Arn.

Abundant in forest. Fl. 6. Fr. 2-3. V.B.G. 202, 993.

MYRTACEAE

Eugenia heyneana Duthie

Common along the river banks in the forest. Fl. 3-5. V.B.G. 191, 1167.

Syzygium cumini (Linn.) Skeels.

Planted in the villages, not common in forest. Fl. 3-4. Fr. 6-7.

Lythraceae

Ammannia baccifera Linn.

Common along water ditches and other moist habitats. Fl. & Fr. G. V.B.G. 112, 617, 618.

Ammannia multiflora Roxb.

Found common on damp and moist soil along the river banks. Fl. & Fr. 11-12. V.B.G. 559, 616.

Lagerstroemia parviflora Roxb.

Abundant in forest area. Fl. 4-5. V.B.G. 209.

Rotala indica (Willd.) Kochne.

Common in fields and other moist places. Fl. & Fr. 10-1. V.B.G. 1195.

Rotala tenuis (Wight) Kochne.

Found wild in isolated patches along the river banks. Fl. & Fr. 2-3. V.B.G. 85, 621.

Woodfordia fruticosa (Linn.) Kurz.

Common along the river banks and in the river ravines. Fl. & Fr. 1-4. V.B.G. 615.

Onagraceae

Jussiaea perennis (Linn.) Brenan

On moist places and around the ditches. Fl. 8. V.B.G. 397, 728.

Trapaceae

Trapa bispinosa Roxb.

Cultivated in temporary ponds and ditches. Fl. 9. Fr. 9-12.

Cucurbitaceae

Cucumis melo Linn.

Cultivated along river banks. In wild specimens the plant and fruit sizes are greatly reduced. Fl. & Fr. 8-9. V.B.G. 252, 985, 986.

Diplocyclos palmatus (Linn.) C. Jeffrey

Found on the hedges, fences and trees in forest area. Fl. & Fr. 9-12. V.B.G. 989.

Lagenaria vulgaris Ser.

Not common, on hill slopes and in ground flora. Fl. & Fr. 8-10. V.B.G. 987.

Luffa acutangula (Linn.) Roxb.

Not common, found on hedges and, in ground flora. Fl. & Fr. 8-10. V.B.G. 503.

Momordica charantia Linn.

On the hedges, and in ground flora, not common. Fl. & Fr. 10-1. V.B.G. 542, 988.

Momordica dioica Roxb. ex Willd.

Not common, on hill slopes and in ground flora. Fl. & Fr. 8-10. V.B.G. 340, 467.

Mukia scabrella Arn.

Common in grass fields and river ravines. Fl. & Fr. 8-10. V.B.G. 1197.

Trichosanthes cucumerina Linn.

Found in ground flora, not common. Fl. & Fr. 8-1. V.B.G. 28.

Trichosanthes dioica Roxb.

Not common, in ground flora. Fl. & Fr. 9-12. V.B.G. 400.

Cactaceae

Opuntia dillenii Haw.

Found on the hill slopes, ground flora and fields. Fl. & Fr. 3-5. V.B.G. 1145.

Molluginaceae

Glinus lotoides Linn.

Common along the river side and in fields. Fl. & Fr. 10-12. V.B.G. 749, 750.

Mollugo pentaphylla Linn.

In fields and forest. Fl. & Fr. 7-9. V.B.G. 748.

Cornaceae

Alangium salvifolium (Linn. f.) Wang.

Common in forest on deforested soil. Fl. & Fr. 2-4. V.B.G. 1198.

Rubiaceae

Adina cordifolia (Roxb.) Hook. f. ex Brandis.

Common throughout the forest. Fl. 6-7. Fr. 2-5. V.B.G. 83.

Borreria articularis (Linn. f.) Will.

Found in fields and ground flora, and at foot of the hills. Fl. & Fr. 8-9. V.B.G. 48, 734, 735.

Borreria stricta (Linn. f.) K. Schum.

On hill slopes in rock crevices. Fl. & Fr. 10-12. V.B.G. 334.

Gardenia latifolia Ait.

Common on hills. Fl. 4-5. Fr. 12-6. V.B.G. 97, 184.

Hymenodictyon excelsum Wall.

Not common, on hill slopes and in ground flora. Fl. 6-8. V.B.G. 298.

Hymenodictyon obovatum wall.

Found on the hill slopes. Fl. 7-9. V.B.G. 1256.

Ixora parviflora Vahl

Common on hills and in ground flora. Fl. 7-9 & 3-5. Fr. 5-6. V.B.G. 126, 258, 735, 737.

Mitragyna parviflora (Roxb.) Korth.

Common in the ground flora. Fl. 5-7. Fr. 12-1. V.B.G. 207, 736.

Oldenlandia corymbosa Linn.

Common on hill slopes and in ground flora. Fl. & Fr. 10-12. V.B.G. 734, 735.

Oldenlandia umbellata Linn.

Found in forest. Fl. & Fr. 8-12. V.B.G. 1200.

Pentas lanceolata (Forsk.) K. Schum.

Found in ground flora. Fl. 7-10. V.B.G. 425.

Vangueria spinosa Roxb.

Found common in ground flora. Fl. 4-6. Fr. 12-1. V.B.G. 227.

Compositae

Acanthospermum hispidium DC.

Found in the fields and in ground flora. Fl. 3-12. V.B.G. 1201.

Ageratum conyzoides Linn.

Abundant along the river banks. Fl. & Fr. 1-2. V.B.G. 1202.

Bidens biternata (Lour.) Merr. & Sherff.

Common on hill slopes and in ground flora. Fl. & Fr. 7-8. V.B.G. 866.

Blainvillea acmella (Linn. f.) Phil.

Common in ground flora. Fl. & Fr. 8-9. V.B.G. 865, 866.

Blumea mollis (D. Don) Merr.

Common in fields and in ground flora. Fl. & Fr. 2-5. V.B.G. 1203.

Blumea oxyodonta DC.

Common in fields and ground flora. Fl. & Fr. 3-5. V.B.G. 1204.

Blumeopsis falcata (D. Don) Merr.

Found in fields and ground flora. Fl. & Fr. 1-4. V.B.G. 1205.

Caesulia axillaris Roxb.

Common in marshy fields. Fl. & Fr. 9-1. V.B.G. 491, 862, 863.

Chrysanthemum indicum DC.

Abundant in wet sandy ground. Fl. 9-2. V.B.G. 1206.

Cyathocline purpurea (Don) Kuntze

In moist habitats and along streams. Fl. & Fr. 11-3. V.B.G. 865.

Echinops echinatus Roxb.

Common throughout the area but more frequently in the fields. Fl. & Fr. 2-4.

Eclipta prostrata Linn.

Common in fields, ground flora, and along ditches. Fl. & Fr. G. V.B.G. 245.

Elephantopus scaber Linn.

Found in ground flora under the shade of the trees, common. Fl. & Fr. 11. V.B.G. 1207.

Eupatorium coeletinum Linn.

In the fields. Fl. & Fr. 2-3. V.B.G. 1163. 1164, 1208.

Emilia sonchifolia DC.

Abundant in fields and ground flora. Fl. & Fr. G. V.B.G. 429.

Glossogyne bidens (Retz.) Alston.

On hill slopes, not common. Fl. & Fr. 9-10. V.B.G. 859.

Gnaphalium indicum Linn.

Common along river banks. Fl. & Fr. 11-2. V.B.G. 854-857.

Gnaphalium luteo-album Linn.

Common along river banks. Fl. & Fr. 11-2. V.B.G. 851.

Gnaphalium pulvinatum Delile

Common along the river banks. Fl. & Fr. 11-2. V.B.G. 852, 853, 858.

Lagasca mollis Cav.

Common in ground flora. Fl. 1-12. V.B.G. 479, 551, 848.

Launaea nudicaulis Hook. f.

Abundant throughout the area. Fl. & Fr. 10-1. V.B.G. 828.

Sonchus oleraceus Linn.

Common in fields and ground flora. Fl. & Fr. 1-4. V.B.G. 1209.

Sphaeranthus indicus Linn.

Common on damp moist ground and along river banks. Fl. & Fr. 11-1. V.B.G. 847.

Tridax procumbens Linn.

Common in ground flora, fields, roadside grassy places, old walls. Fl. & Fr. G. G.V.B. 849, 850.

Veronica cinerea Linn.

All over the area. Fl. & Fr. 11-1. V.B.G 830.

Vicoa indica DC.

Common in fields, waste lands, grass fields and ground flora. Fl. & Fr. 11-2. V.B.G. 845, 846.

Volutarella ramosa (Roxb.) Santapau

Found common in fields, ground flora, waste lands. Fl. & Fr. 11-4. V.B.G. 844.

Xanthium strumarium Linn.

In ground flora, cultivated and fallow lands. Fl. & Fr. 9-4.

CAMPANULACEAE

Campanula canescens Wall. ex DC.

Found along river banks. Fl. & Fr. 2-3. V.B.G. 1209, 1210.

PLUMBAGINACEAE

Plumbago zeylanica Linn.

Common in river ravines of forest area. Fl. & Fr. 11-12. V.B.G. 567.

PRIMULACEAE

Anagalis arvensis Linn.

Common throughout the area as weed of cultivation and also in forest. Fl. & Fr. 10-1. V.B.G. 70, 938.

MYRSINACEAE

Embelia tsjeriam-cottam (Roem. & Schult.) DC.

Found in ground flora. Fl. & Fr. 8-11. V.B.G. 534.

SAPOTACEAE

Madhuca longifolia (Koenig) MacBride var. *latifolia* (Roxb.) Chevaliar

Common in ground flora and foot of the hills. Fl. 3-4. Fr. 6-7. V.B.G. 133.

Mimusops hexandra Roxb.

Found in the ground flora. Fl. 11-12. Fr. 1-3. V.B.G. 13.

EBENACEAE

Diospyros melanoxylon Roxb.

Abundant in forest area. Fl. 3-4. Fr. 6. V.B.G. 167, 194, 951.

APOCYNACEAE

Carissa spinarum Linn.

Common at the foot of the hills and in ground flora. Fl. 3-4. Fr. 12-1. V.B.G. 131, 155.

Catharanthus pusillus (Murr.) G. Don

Found in the fields, ground flora and hills. Fl. & Fr. 7-9. V.B.G. 221, 272.

Holarrhena antidysentrica (Linn.) Wall.

Found in ground flora. Fl. 5-6. Fr. 1-2.

Ichnocarpus frutescens (Linn.) Ait. & Ait.

Common in ground flora and river ravines. Fl. 8-12. Fr. 4. V.B.G. 499, 888.

Wrightia tinctoria R. Br.

Common on hill slopes and in ground flora. Fl. 3-4. Fr. 12. V.B.G. 175, 886.

ASCLEPIADACEAE

Calotropis procera (Ait.) R. Br.

Common on waste land and deforested soils. Fl. 3-5. Fr. 1-2. V.B.G. 881.

Cryptolepis buchanani Roem. & Schult.

Common in ground flora. Fl. 6-7. V.B.G. 197.

Dregea volubilis Benth. ex Hook. f.

Common on hedges and in ground flora. Fl. 4-7. Fr. 7-12. V.B.G. 224.

Dregea volubilis Benth. var. *lacuna* Hook. f.

Common in ground flora and fields. Fl. 7-8. V.B.G. 170.

Gymnema sylvestre R. Br.

Rare, in ground flora. Fl. 9-11. V.B.G. 395, 883.

Hemidesmus indicus (Linn.) Schult.

Common in ground flora. Fl. & Fr. G. V.B.G. 532, 882.

Marsdenia tenacissima Wight. & Arn.

On hill slopes, not common. Fl. & Fr. 7-12. V.B.G. 293.

Oxystelma secamone (Linn.) K. Schum.

Found twining on trees and herbs in the fields and forest. Not common. Fl. & Fr. 9-12. V.B.G. 480.

Pergularia daemia (Forsk.) Blatt. & McC.

Common on trees and shrubs on hill slopes and ground flora. Fl. & Fr. 8-1. V.B.G. 512, 884.

Telosma pallida (Roxb.) Craib.

Near the base of the hills not common. Fl. 5-8. Fr. 9-3. V.B.G. 230.

LOGANIACEAE

Mitreola oldenlandioides Wall.

At the foot of the hills. Fl. & Fr. 7-9. V.B.G. 440.

GENTINIACEAE

Canscora decussata Roem. & Sch.

Common on hills and in ground flora. Fl. & Fr. 8-9. V.B.G. 1049.

Canscora diffusa R. Br.

Common in ground flora. Fl. & Fr. 10-12. V.B.G. 587, 1047.

Centaurium roxburghii (Don) Druce.

Found common in forest fields. Fl. & Fr. 2-4. V.B.G. 1011.

Enicostema verticillatum (Linn.) Engl.

Common in ground flora on damp soil. Fl. & Fr. 7-10. V.B.G. 248, 1050.

Exacum pedunculare Arn.

Common along the river banks. Fl. & Fr. 1-3. V.B.G. 88, 1051.

Nymphoides cristatum (Roxb.) Kuntze

Abundant in temporary ditches during rainy season. Fl. & Fr. 7-10. V.B.G. 396.

HYDROPHYLLACEAE

Hydrolea zeylanica (Linn.) Vahl.

On drying mud and along the ditches. Fl. & Fr. 10-12. V.B.G. 525.

BORAGINACEAE

Heliotropium ovalifolium Forsk.

Along river banks and ditches. Fl. & Fr. 7-10. V.B.G. 214, 954.

Heliotropium strigosum Willd.

Common in variety of habitats ranging from hill slopes to river banks. Fl. & Fr. 7-11. V.B.G. 1212.

Heliotropium supinum Linn.

A weed of cultivation, ground flora, on drying ditches on the river side. Fl. & Fr. 11-3. V.B.G. 959, 960.

Trichodesma amplexicaule Roth.

Common by road side and in ground flora. Fl. & Fr. 8-1. V.B.G. 270, 956, 957.

Trichodesma zeylanicum R. Br.

Common in fileds and ground flora. Fl. & Fr. 12-3. V.B.G. 955.

EHRETIACEAE

Cordia dichotoma Forst. f.

Common in forest area. Fl. 3-4. Fr. 5-6. V.B.G. 1213.

Cordia macleodii Hook. f. and Thoms.

In ground flora, not common. Fl. 3-4. V.B.G. 151, 958.

Rotala aquatica Lour.

Abundant along the river banks. Fl. & Fr. 10-2. V.B.G. 25.

CONVOLVULACEAE

Aregyreia kleiniana (Roem. & Sch.) Raizada

Common on hill slopes and in ground flora. Fl. & Fr. 9-12. V.B.G. 974.

Argyreia setosa (Roth) Sant. & Patel

Found in ground flora. Fl. 9-12. V.B.G. 104.

Convolvulus arvensis Linn.

Common in cultivated fields. Fl. & Fr. 11-1. V.B.G. 422, 976.

Convolvulus microphyllus Sieb.

Wild in the fields. Fl. & Fr. G. V.B.G. 973, 978.

Evolvulus alsinoides Linn.

Very common in fields and forest ground flora and by river sides. Fl. & Fr. G. V.B.G. 277, 978.

Ipomoea angulata Lamk.

Found on the fences around houses and twining around the trees in the forest area. Fl. & Fr. 10-2. V.B.G. 1214, 1217.

Ipomoea eriocarpa R. Br.

Common in grass fields and hill slopes. Fl. & Fr. 7-10. V.B.G. 416.

Ipomoea fistulosa Mart. ex Chois.

Used for hedging the fields and houses. Fl. & Fr. 1-12. V.B.G. 1215.

Ipomoea muricata (Linn.) Jacq.

In ground flora and in habitation. Fl. & Fr. 9-11. V.B.G. 1216.

Ipomoea nil (Linn.) Roth.

Common on the hedges of forest villages. Fl. & Fr. 9-12. V.B.G. 71, 971.

Ipomoea pes-tigridis Linn.

Common on hill slopes and in ground flora. Fl. & Fr. 8-9. V.B.G. 981.

Ipomoea reptans (Linn.) Poir.

Common along and floating on the ditches and ponds. Fl. & Fr. 9-12. V.B.G. 464, 594.

Ipomoea sinensis (Desr.) Choisy.

Twines around the shrubs and trees. Fl. & Fr. 10. V.B.G. 511.

Merremia aegyptica (Linn.) Urban.

Occurs in ground flora and foot of the hills. Fl. & Fr. 9-10. V.B.G. 489.

Merremia emarginata (Burm. f.) Hallier. f.

Found wild in the fields. Fl. & Fr. 9-10. V.B.G. 975.

Merremia tridentata Hallier. f.

Not common, on hill tops. Fl. & Fr. 10-12. V.B.G. 496.

Operculia turpethum (Linn.) Silva-Monso

Common in fields. Fl. & Fr. 9-1. V.B.G. 1081, 1082.

Porana paniculata Roxb.

Common in ground flora. Fl. & Fr. 10-1 V.B.G. 977.

Rivea hypocrateriformis Chois.

Common in forest area. Fl. & Fr. 8-10. V.B.G. 1217.

Cuscutaceae

Cuscuta hyalina Roth.

Common in fields and along road side on a number of undershrubs, shrubs and trees. Fl. & Fr. 8-1. V.B.G. 9, 385.

Solanaceae

Datura innoxia Mill.

Common in forest and fields. Fl. & Fr. 11-2. V.B.G. 1218.

Nicotiana tabacum Linn.

In the river ravines. Fl. & Fr. 1-2. V.B.G. 1013.

Physalis minima Linn.

Occurs in the fields and waste grounds, not common. Fl. & Fr. 8-10. V.B.G. 295, 676.

Solanum incanum Linn.

Found in fields, not common. Fl. & Fr. 1-5. V.B.G. 575.

Solanum indicum Linn.

Common in grass fields. Fl. & Fr. 2-3. V.B.G. 59.

Solanum nigrum Linn.

Found wild in the fields. Fl. & Fr. 12-4. V.B.G. 129, 1011.

Solanum surattense Burm. f.

Common in fields, waste lands and, recently eroded places. Fl. 1-12.

SCROPHULARIACEAE

Dopatrium junceum (Roxb.) Buch.-Ham. ex Benth.

Common along the ditches in the forest area. Fl. & Fr. 7-9. V.B.G. 1219.

Limnophila heterophylla Benth.

Common in ditches. Fl. & Fr. 7-9. V.B.G. 592.

Limnophila indica (Linn.) Druce.

Common along the river banks. Fl. 11-1. V.B.G. 1220.

Lindenbergia indica (Linn.) Kuntze

Common in the crevices of walls and river banks. Fl. & Fr. 1-4. V.B.G. 727.

Lindernia ciliata (Colsm.) Pennell

Found on damp and moist places near the river banks, ponds, ditches etc. Fl. & Fr. 9-11. V.B.G. 343, 730.

Lindernia crustacea (Linn.) F. V. Muell.

Common in grassy fields and on moist places. Fl. & Fr. 8. V.B.G. 731.

Lindernia multiflora (Roxb.) Mukherjee

In ground flora, not common. Fl. & Fr. 10-12. V.B.G. 1221.

Sopubia delphinifolia G. Don

On hill slopes and in ground flora. Fl. & Fr. 7-11. V.B.G. 352, 729.

Striga densiflora Benth.

Common on hills and in ground flora. Fl. & Fr. 7-8. V.B.G. 405.

Striga euphrasioides (Vahl) Benth.

Common in ground flora and on hill slopes. Fl. & Fr. 8-2. V.B.G. 80, 319.

Striga gesneroides (Willd.) Vatke. ex Engel.

On hill slopes, not common. Fl. & Fr. 8-9. V.B.G. 358.

Sutera dissecta Walp.

Common along the river banks. Fl. & Fr. 11-2. V.B.G. 577, 732.

Verbascum chinense (Linn.) Santapau

Found along the river banks, common. Fl. & Fr. 12-4. V.B.G. 36, 37.

Veronica anagalis Linn.

Common along river banks. Fl. & Fr. 11-1. V.B.G. 940.

LENTIBULARIACEAE

Utricularia exoleta R. Br.

Common in ditches and rivers. Fl. & Fr. 2. V.B.G. 590.

PEDALIACEAE

Sesamum indicum Linn.

Common on hill slopes. Fl. & Fr. 8-10. V.B.G. 339.

MARTYNIACEAE

Martynia annua Linn.

Common along road side, waste places, hills, ground flora. Fl. & Fr. 8-10. V.B.G. 1222.

Acanthaceae

Adhatoda vasica Nees

Common on waste lands, base of the hills and deforested area. Fl. & Fr. 11-1. V.B.G. 899.

Andrographis echioides (Linn.) Nees

Common in river ravines and ground flora. Fl. & Fr. 8-12. V.B.G. 379, 890.

Barleria cristata Linn.

Common along river side and in ground flora. Fl. & Fr. 11-1. V.B.G. 576, 906.

Barleria gibsoni Dalz.

Common in ground flora. Fl. & Fr. 11-1. V.B.G. 905.

Barleria prionitis Linn.

Common in deforested soil. Fl. & Fr. 10-1. V.B.G. 566.

Blepharis maderaspatensis (Linn.) Heyne. ex Roth.

Common in ground flora and on hill slopes. Fl. & Fr. 8-1. V.B.G. 596, 907.

Daedalacanthus purpurascens T. Anders.

Found in ground flora, not common. Fl. & Fr. 11-1. V.B.G. 900-902.

Dipteracanthus prostratus (Poir.) Nees

Common in ground flora and fields. Fl. & Fr. 6-9. V.B.G. 537.

Elytraria acaulis (Linn. f.) Lindan.

Common in ground flora and hill slopes. Fl. & Fr. 12-6. V.B.G. 186, 981.

Haplanthus verticillaris Nees

Common on hill slopes. Fl. & Fr. 12-1. V.B.G. 1098.

Hemigraphis latebrosa Nees var. *heyneana* Braun.

Found in ground flora, hill slopes, fields, and along road side. Fl. & Fr. 11-1. V.B.G. 907.

Hygrophila auriculata (Schumach.) Heine.

Common along the ditches and in the fields. Fl. & Fr. 9-2. V.B.G. 893-895.

Lepidagathis trinervis Nees

Common on hills. Fl. & Fr. 10-1. V.B.G. 896.

Justicia prostrata Gamble

Found in forest and fields. Fl. & Fr. 9-11. V.B.G. 24, 897, 898.

Justicia simplex D. Don

Common in ground flora, in fields, along road side. Fl. & Fr. 11-2. V.B.G. 904.

Justicia tranquebariensis Linn. f.

Found in ground flora and on hills. Fl. & Fr. 9-11. V.B.G. 204.

Petalidium barleroides Nees

In fields. Fl. & Fr. 2-4. V.B.G. 121.

Peristrophe bicalyculata (Retz.) Nees

Common along river side and in ground flora. Fl. & Fr. 10-12. V.B.G. 30, 563.

Ruellia tuberosa Linn.

Common on forest. Fl. & Fr. 8-9. V.B.G. 903.

Rungia pectinata (Linn.) Nees

In ground flora, field and along road side. Fl. & Fr. 11-1. V.B.G. 908-913.

Rungia repens (Linn.) Nees

Common in grass fields and forest area. Fl. & Fr. 9-12. V.B.G. 516, 912, 914.

Verbenaceae

Clerodendrum indicum (Linn.) Kuntze

Common in open grassy places. Fl. & Fr. 11-12. V.B.G. 712, 713.

Clerodendrum phlomidis Linn .f.

Common in the ground flora. Fl. & Fr. G. V.B.G. 711.

Lantana camara Linn. var. *aculeata* (Linn.) Moldenke

Common as undergrowth in ground floor. Fl. 6-9. Fr. 12-2. V.B.G. 708.

Nyctanthes arbor-tristis Linn.

Abundant as undergrowth on hill slopes and in ground flora. Fl. 8-10. Fr. 12-1. V.B.G. 370, 539.

Tectona grandis Linn. f.

Abundant all over the forest area. Fl. & Fr. 6-8. V.B.G. 1223.

Vitex negundo Linn.

Common in ground flora. Fl. & Fr. 3-4. V.B.G. 33, 223.

LABIATAE

Anisochilus carnosus Wall.

Found common on hill slopes and in ground flora. Fl. & Fr. 9-10. V.B.G. 1224.

Anisomeles indica (Linn.) Kuntze.

Common in fields. Fl. & Fr. 11-1. V.B.G. 612.

Hyptis suaveolens (Poir.) Jacq.

Found in ground flora. Fl. 10-11. V.B.G. 614.

Leucas aspera Spreng.

Found in fields and forest. Fl. & Fr. 7-4. V.B.G. 1225.

Leucas cephalotes Spreng.

Found common in fields. Fl. & Fr. 8-10. V.B.G. 1226.

Leucas mollissima Wall.

Grows on the eroded margins of the river and also in fields. Fl. & Fr. 11-12. V.B.G. 18, 610.

Leucas nutans Spreng.

Found on hills, forest, river, ravines and fields. Fl. & Fr. 8-9. V.B.G. 262.

Leonitis nepetaefolia R. Br.

In dried, nallas. Fl. & Fr. 9-2. V.B.G. 1227.

Nepeta hindostana (Roth.) Haines

Found along river banks. Fl. & Fr. 2. V.B.G. 82, 89, 613.

Ocimum americanum Linn.

Found common in fields, grassy fields and at foot of the hills. Fl. & Fr. 9-1. V.B.G. 601, 604.

Ocimum basilicum Linn.

Wild in fields and on deforested soil. Fl. & Fr. 10-12. V.B.G. 602.

Orthosiphon pallidus Royle ex Benth.

Common in fields. Fl. & Fr. 6-8. V.B.G 196, 609.

Pogostemon benghalensis (Burn. f.) Ktze.

Rare, in ground flora. Fl. & Fr. 1-2. V.B.G. 20, 33, 76.

Salvia plebeia R. Br.

Common as weed in the fields. Fl. 8-4. V.B.G. 1228.

NYCTAGINACEAE

Boerhaavia diffusa Linn.

Common in fields and ground flora. Fl. & Fr. G. V.B.G. 291, 507, 935.

AMARANTHACEAE

Achyranthes aspera Linn.

As weed on waste grounds, grassfields, cultivable land and forest. Fl. & Fr. 8-12. V.B.G. 452, 557, 916.

Aerva lanata (Linn.) Juss.

Common in fields, waste land, ground flora. Fl. & Fr. 10-2. V.B.G. 58, 558, 919.

Aerva sanguinolenta (Linn.) Bl.

Found in ground flora. Fl. & Fr. 1. V.B.G 1229.

Alternanthera paronychoides St. Hil.

Not common, in the fields and along the river banks. Fl. & Fr. 9-1. V.B.G. 1230.

Alternanthera sessilis R. Br.

Common along river banks, a weed in crop fields and on deforested soil. Fl. & Fr. G. V.B.G. 247, 923, 929.

Amaranthus gracilis Desf.

Common as weed in cultivated fields, grass fields and in ground flora. Fl. & Fr. 7-1. V.B.G. 927, 932.

Amaranthus hybridus Linn. sub. sp. *cruentus* Thell. var. *paniculatus* Thell.

Along the river banks. Fl. & Fr. 10-1. V.B.G. 56, 922.

Amaranthus spinosus Linn.

Common in grass fields, waste places, and in round flora. Fl. & Fr. 9-10. V.B.G. 430, 924.

Celosia argentea Linn.

Common in grassfields, hill slopes and in ground flora. Fl. & Fr. 8-11. V.B.G. 329, 921, 922.

Digera muricata (Linn.) Mart.

Common in fields and along river side. Fl. & Fr. 7-11. V.B.G. 303, 928.

Gomphrena celosioides Mart.

Common in fields and in ground flora. Fl. & Fr. 7-9. V.B.G. 235.

Nothosaerva brachiata (Linn.) Wt.

Common in forest and fields. Fl. & Fr. 11-12. V.B.G. 1231.

Pupalia lappacea (Linn.) Moq.

Common in ground flora and along the river banks. Fl. & Fr. 9-11. V.B.G. 443.

CHENOPODIACEAE

Chenopodium album Linn.

A common weed throughout the area in cultivated fields and waste places. Fl. & Fr. 12-4. V.B.G. 968.

POLYGONACEAE

Polygonum barbatum Linn.

Abundant along the river banks. Fl. & Fr. 10-3. V.B.G. 568.

Polygonum plebeium R. Br.

Common on recently exposed soil by digging in fields, along river banks. Fl. & Fr. 11-3. V.B.G. 940-946.

Rumex dentatus Linn.

Along river banks. Fl. & Fr. 11-3. V.B.G. 944, 945.

ARISTOLOCHIACEAE

Aristolochia indica Linn.

Common on hill slopes and in ground flora. Fl. & Fr. 8-11. V.B.G. 1232.

LORANTHACEAE

Dendrophthoe falcata (Linn. f.) Ettings.

Not common, grows on *Buchanania lanzan* and *Madhuca longifolia* var. *latifolia* etc. Fl 1-3. V.B.G. 624.

Viscum nepalense Spreng.

Found growing on a number of hosts like *Buchanania lanzan, Schleichera oleosa* and *Terminalia arjuna*, etc., scattered all over the forest. Fl. 7-11. V.B.G. 138.

EUPHORBIACEAE

Acalypha indica Linn.

Common in grassfields, ground flora and waste land. Fl. & Fr. G. V.B.G. 404, 424.

Baliospermum montanum Muell.

Common in ground flora and fields. Fl. & Fr. 1-12. V.B.G. 1060, 1070.

Bridelia sqamosa Gehrm.

Common in ground flora. Fl. & Fr. 5-10. V.B.G. 78, 476.

Chrozophora prostrata Dalz.

Common in ground flora and waste fields. Fl. & Fr. 11-2. V.B.G. 574, 1059.

Emblica officinalis Gaertn.

Common on hill slopes and in ground flora. Fl. 3-5. Fr. 12-1. V.B.G. 159.

Euphorbia bombaiensis Santapau

Common all over the area. Fl. & Fr. 1-12. V.B.G. 1065.

Euphorbia elegans Spreng.

Found in river, ravines and fields, not common. Fl. & Fr. 1-3. V.B.G. 143.

Euphorbia geniculata Orteg.

As a weed in gardens, in fields. Fl. & Fr. 10-2. V.B.G. 1055, 1066.

Euphorbia hypericifolia Linn.

Common all over the area. Fl. & Fr. 1-12. V.B.G. 283, 1058.

Euphorbia neriifolia Linn.

Found in ground flora and at the foot of the hills. Fl. 3-5. V.B.G. 146.

Euphorbia parbracteata Gage.

As weed in cultivated fields, near and along the river banks. Fl. & Fr. 1-3. V.B.G. 1063.

Euphorbia parviflora Roxb.

Abundant all over the area. Fl. & Fr. 1-12. V.B.G. 1054, 1057, 1068.

Euphorbia thymifolia Linn.

Very common in the area in all habitats. Fl. & Fr. 1-12. V.B.G. 1064.

Euphorbia tirucalli Linn.

In ground flora, in the fences of cultivated fields, not common. V.B.G. 140.

Jatropha curcas Linn.

Found in semi-wild condition in vicinity of villages and also planted in hedges. Fl. & Fr. 9-1. V.B.G. 1062.

Mallotus philippinensis (Lamk.) Muell.

Common along river banks. Fl. & Fr. 11-1. V.B.G. 1056, 1069.

Phyllanthus debilis Ham.

Found in ground flora. Fl. & Fr. 7-9. V.B.G. 278.

Phyllanthus maderaspatensis Linn.

Common in fields. Fl. & Fr. 1-12. V.B.G. 415.

Phyllanthus simplex Retz.

Found in ground flora and fields. Fl. 8-11. V.B.G. 263.

ULMACEAE

Holoptelea integrifolia Planch.

Common on hills and in ground flora. Fl. 3-4. Fr. 4-5. V.B.G. 868.

Trema orientalis Blume.

Found common along river and river ravines during its course in the forest. Fl. G. V.B.G. 72, 514, 869.

MORACEAE

Ficus benghalensis Linn.

Occurs as planted tree near habitation. Receptacles 3-4.

Ficus gibbosa Blume.

Common in ground flora. Receptacles 3-5. V.B.G. 73, 1233.

Ficus glomerata Roxb.

Common along river banks. Receptacles 7-9. V.B.G. 867.

Ficus hispida Linn. f.

In ground flora and along river banks. Receptacles 7-6. V.B.G. 870, 871.

Ficus lacor Benth-Ham.

Rare, around Bari village.

Ficus religiosa Linn.

Rare in forest, planted in local habitation. Receptacles 4-5.

Ficus tomentosa Roxb. ex Willd.

Not common on the hills and in ground flora. Receptacles 7-7. V.B.G. 203.

HYDROCHARITACEAE

Blyxa auberti Rich.

In Barna river, common. Fl. & Fr. 9-11. V.B.G. 600.

Hydrilla verticillata (Linn. f.) Royle

Abundant in river Barna. Fl. & Fr. 11-12. V.B.G. 591.

Vallisneria spiralis Linn.

Common in Barna river. Fl. & Fr. 1-4. V.B.G. 1042.

ORCHIDACEAE

Habenaria plantaginea Lindl.

Found in ground flora on damp shady places. Fl. & Fr. 3-4. V.B.G. 1235.

Vanda tesselata Hook. ex G. Don.

Found common on number of plants like *Mangifera indica*, *Buchanania lanzan* etc. Fl. & Fr. 4-7. V.B.G. 187, 933.

Zeuxine strateumatica (Linn.) Schlt.

Rare, along small streamlets which join Barna River. Fl. & Fr. 2-3. V.B.G. 113, 934.

MUSACEAE

Globba orixensis Roxb.

Not common, in ground flora. Fl. & Fr. 7-9.

AMARYLLIDACEAE

Crinum defixum Ker.-Gawl.

Amphibious, along river banks. Fl. & Fr. 8-11. V.B.G. 562, 878.

Curculigo orchioides Gaertn.

Common on lower hill slopes and in ground flora. Fl. & Fr. 7-10. V.B.G. 201, 879.

TACCACEAE

Tacca leontopetaloides (Linn.) Kuntze

Rare, in the ground flora. Fl. & Fr. 8-9. V.B.G. 345.

AGAVACEAE

Agave mexicana Dr. & Prain

Planted as hedges of the cultivable fields and gardens. Fl. 1-6. V.B.G. 1140.

DIOSCOREACEAE

Dioscorea bulbifera Linn.

In ground flora and on hills. Fl. & Fr. 8-10. V.B.G. 1246.

Dioscorea hispida Dennst.

On shrubs and trees in ground flora. Fl. & Fr. 8-11. V.B.G. 206.

Dioscorea pentaphylla Linn.

Found on hills. Fl. 9-10. V.B.G. 536, 1104.

LILIACEAE

Asparagus racemosus Willd.

Common in ground flora. Fl. & Fr. 8-11. V.B.G. 1236.

Chlorophytum arundinaceum Baker

Common on hills. Fl. & Fr. 7-8. V.B.G. 199.

Gloriosa superba Linn.

Found on hills and in ground flora. Fl. & Fr. 6-10. V.B.G. 622.

Scilla hyacinthina (Roth.) Macbr.

On hill tops, rare. Fl. & Fr. 7. V.B.G. 180.

Urginea indica Kunth.

On hills, rare. Fl. & Fr. 4. V.B.G. 156.

SMILACEAE

Smilax zeylanica Linn.

Found in ground flora, not common. Fl. & Fr. 8-9. V.B.G. 300, 623.

PONTEDERIACEAE

Monocharia vaginalis (Burm. f.) Presl. ex Kunth.

Common in and along the ditches. Fl. & Fr. 8-10. V.B.G. 317.

COMMELINACEAE

Commelina attenuata Koen. ex Vahl.

Found on lower slopes and in ground flora. Fl. & Fr. 8. V.B.G. 1237.

Commelina benghalensis Linn.

Abundant in fields and in ground flora. Fl. & Fr. 7-10. V.B.G. 372, 941.

Commelina hasskarlii Clarke

Common at foot of the hills and in ground flora. Fl. & Fr. 10-11. V.B.G. 522.

Commelina paludosa Blume.

Common on the hill slopes and in ground flora. Fl. & Fr. 7-8. V.B.G. 218.

Cyanotis cucullata Kunth.

Common in the ground flora and foot hills. Fl. & Fr. 7-10. V.B.G. 1238.

Cyanotis fasciculata Schult. f.

Common on hill slopes and in ground flora. Fl. & Fr. 8-9. V.B.G. 310.

Murdannia malabarica (Linn.) Brueckner

Common on lower slopes and in ground flora. Fl. & Fr. 9. V.B.G. 1239.

Murdannia spiratum (Linn.) Brueckner

Found in fields on hills and in ground flora. Fl. & Fr. 7-9. V.B.G. 386.

Zygomenes axillaris (Linn.) Salis.

Common in ground flora. Fl. & Fr. 7-8. V.B.G. 392.

Zygomenes cucullata (Roth.) R. et Kam.

On the hill slopes and in ground flora. Fl. & Fr. 8-9. V.B.G. 992.

PALMAE

Phoenix sylvestris Roxb.

Common throughout the area in and outside the forest on moist ground along banks and beds of the streams. Fl. 1-2.

TYPHACEAE

Typha angustata Bory. & Chaub.

Common along the river banks and in the shallow waters of the river. Fl. 8.

ARACEAE

Amarphophallus purpurascens Kurz.

Found in the ground flora. Fl. 4-5. V.B.G. 1115.

Arisaema decipiens Schott.

Found in ground flora. Fl. 7-9. V.B.G. 471, 540.

Cryptocoryne retrospiralis Kunth.

Along the river banks and in the water stream. Fl. 8. V.B.G. 1039.

Plesmonium margaritiferum Schott.

Not common, at the base of the hills. Fl. & Fr. 9. V.B.G. 182.

LEMNACEAE

Lemna paucicostala Hege.

Common on ponds and in shallow sluggish streams. Fl. 10.

ALISMATACEAE

Sagittaria sagittifolia Linn.

Common along river banks and in the river bed also. Fl. & Fr. 1-4. V.B.G. 880.

NAIDACEAE

Naias graminea Del.

Found in ponds and river beds. Fl. 8-9. V.B.G. 1240.

Naias minor All.

Found in ditches and river ponds. Fl. 9. V.B.G. 593.

POTAMOGETONACEAE

Potamogeton nodosus Poir.

Found submerged in the river. Fl. & Fr. 3. V.B.G. 1242.

ERIOCAULACEAE

Eriocaulon sexangulare Linn.

Found in ground flora on damp deforested soil where grasses have come up. Fl. & Fr. 7-9. V.B.G. 1052.

Eriocaulon turncatum Buch.-Ham.

Found on moist shady places in ground flora. Fl. & Fr. 8-9. V.B.G. 442.

CYPERACEAE

Cyperus brevifolius (Rottl.) Endl.

Common in ditches. Fl. & Fr. 8-10. V.B.G. 1106.

Cyperus compressus Linn.

A common weed in fields and along river banks. Fl. & Fr. 7-9. V.B.G. 870.

Cyperus cyperoides (Linn.) Kuntze

Found along the ditches and on moist places. Fl. & Fr. 7-8. V.B.G. 246, 882.

Cyperus difformis Linn.

Abundant in the mud, in and along the ditches. Fl. & Fr. 9-10. V.B.G. 459, 875.

Cyperus exaltatus Retz.

Common on damp soil and in the ditches. Fl. & Fr. 9. V.B.G. 450.

Cyperus iria Linn.

Common on damp soil, in and along water ditches. Fl. & Fr. 9-10. V.B.G. 273, 880, 881.

Cyperus maritimus Linn.

Common, in the river bed and along the banks. Fl. & Fr. 2. V.B.G. 37.

Cyperus niveus Retz.

Found in fields, along river banks and in ground flora. Fl. 11. V.B.G. 1137.

Cyperus pangorei Rottlb.

Common along the banks and in the river. Fl. & Fr. 2. V.B.G. 38, 877, 888.

Cyperus pumilus Linn.

Found in ground flora and along the ditches. Fl. 9. V.B.G. 1243.

Cyperus rotundus Linn.

In ditches, on damp soil, in ground flora, in and along river banks. Fl. & Fr. 1-12. V.B.G. 216, 238, 872.

Cyperus triceps (Rottb.) Endl.

Common in fields, ground flora, along river banks. Fl. & Fr. 8-11. V.B.G. 39, 215.

Eleocharis palustris R. Br.

Common in the river stream and in ditches. Fl. & Fr. 8-4. V.B.G. 63, 268, 871.

Fimbristylis dichotoma Vahl

Common on moist soils, along river banks. Fl. & Fr. 10-4. V.B.G. 1244.

Fimbristylis dichotoma Vahl var. *paucispiculata* Linn.

Common along the river banks, ditches. Fl. & Fr. 11-4. V.B.G. 1245.

Fimbristylis diphylla Vahl

Common in streams and along the river banks. Fl. & Fr. 10-3. V.B.G. 873, 874.

Fimbristylis miliacea Vahl

Common on damp soil in ground flora and along river banks. Fl. & Fr. 8-11. V.B.G. 458.

Scirpus lacustris Linn.

Found in and along the margins of the ditches. Fl. & Fr. 7-8. V.B.G. 242.

Scirpus littoralis Schrad.

Common in the ditches. Fl. & Fr. 9-11. V.B.G. 1074.

Conclusions

The pteridophytes are represented by 11 species covered by 10 genera. Whereas the dicotyledons are represented by 401 species covered by 270 genera and 79 families. Monocotyledons are represented by 21 families comprising of 87 genera and 139 species, of which gramineae is represented by 49 genera and 73 species (papers on grasses is already under submission to Bulletin Botanical Survey of India). Thus in all 551 species have been found in the area.

Abbreviations :

Numbers from 1-12 have respectively been used to denote the months from January-December. 'G' denotes greater part of the year.

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Some plants new to the Flora of Punjab Plains[1]

M. Sharma[2]

During the last thirteen years, I have been collecting plants from Punjab Plains. A critical and comparative perusal of the literature dealing with the plants of Punjab and the contiguous areas (Stewart 1869, Hooker *et al.* 1872-97, Collett 1902, Bamber 1916, Parker 1918, Sabnis 1940-41, Stewart 1945, Duthie 1960, Nair & Nair 1963-66, Rau 1968, Singh 1971, Bor 1973) has revealed that the 75 species belonging to 67 genera and 37 families enumerated below have not been reported previously from Punjab plains. The voucher herbarium specimens have been deposited in the herbaria of Panjab University Chandigarh (collected during July 1963 to April 1966 and indicated by a single asterisk), Punjab Agricultural University, Ludhiana (collected during May 1966 to September 1968 and indicated by double asterisks) and Punjabi University, Patiala (collected ever since October 1968, devoid of any asterisk mark). But for the minor modifications, the arrangement of the families adopted here is the same as in Hookee *et al.* (1872-97).

Cruciferae

Brassica campestris L. var. **sarson** Prain. In waste places and fields. Fl. & Fr. Nov.-Mar. M. Sharma 458**, 750, 4514.

B. juncea Czern. & Coss. Rare in waste places and fields. Fl. & Fr. Dec.-May. M. Sharma 441**, 4526, 4550.

Descurainia sophia Prantl. Common weed in waste places at Kapurthala. Fl. & Fr. Feb.-Apr. O. P. Sharma 4214.

Violaceae

Hybanthus enneaspermus F. Muell. Among grasses, rare to common. Fl. & Fr. June-Oct. M. Sharma 2052, 2843, 3979, 4284.

Caryophyllaceae

Cerastium glomeratum Thuill. Rare. Fl. & Fr. Feb.-Mar. M. Sharma 2554.

Malvaceae

Abutilon grandifolium Sweet. Rare. Fl. & Fr. Jan.-May. M. Sharma 3795, 3796.

Pavonia zeylanica Cav. Rare. Fl. & Fr. Aug.-Oct. M. Sharma 1495, 2944.

Sterculiaceae

Melochia corchorifolia L. Common in moist waste places. Fl. & Fr. July-Oct. M. Sharma 1577, 2158, 3577, 4039.

Tiliaceae

Triumfetta pentandra A. Rich. Very common in waste places. Fl. & Fr. Aug.-Oct. M. Sharma 211**, 528, 1626, 2166, 4042, 4330.

Geraniaceae

Geranium rotundifolium L. Very common near Pathankot. Fl. & Fr. Feb.-Apr. M. Sharma 3854.

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VITACEAE

Ampelocissus latifolia Planch. Occasional. Fl. & Fr. July-Nov. M. Sharma 1463, 2936.

PAPILIONACEAE

Lotus corniculatus L. Fairly common in Ludhiana. Fl. &. Fr. Mar.-May. M. Sharma 638**.

Rhynchosia rothii Aitchis. Rare. Fl. & Fr. Aug.-Nov. M. Sharma 2959, 4037, 4371.

Trigonella incisa Benth. Very common weed. Fl. & Fr. Dec.-Apr. M. Sharma 2387*, 446**, 225, 2017, 3876, 3904.

MIMOSACEAE

Mimosa himalayana Gamble. Rare. Fl. & Fr. July-Oct. M. Sharma 2222, 2264, 3568.

ONAGRACEAE

Epilobium hirsutum L. Rare. Fl. & Fr. Aug.-Oct. M. Sharma 3792, 4036.

Hartmannia rosea G. Don. Rare. Fl. & Fr. Mar.-May. M. Sharma 3497, 4224.

CUCURBITACEAE

Blastania fimbristipula Kotschy & Peyr. Very rare. Fl. Sept. M. Sharma 4364.

UMBELLIFERAE

Apium graveolens L. Common near Budha Nala, Ludhiana. Fl. & Fr. Mar.-May. M. Sharma 641**, 1898, 2682.

Torilis japonica DC. Common at Manimajra, Chandigarh. Fl. & Fr. Feb.-Apr. M. Sharma 1679*.

RUBIACEAE

Oldenlandia brachiata Hook. f. Common among grasses. Fl. & Fr. Aug.-Oct. M. Sharma 2792*, 776**, 589, 1465, 1518, 1544.

COMPOSITAE

Acanthospermum hispidum DC. Rare to common and gregarious. Fl. & Fr. Aug.-Oct. M. Sharma 1662, 2516, 3557, 4306.

Ageratum houstonianum Mill. Common. Fl. & Fr. Sept.-Apr. M. Sharma 941**, 1743, 3457.

Cirsium wallichii DC. var. **fasciculata** (Hook. f.) M. Sharma Comb. nov. *Cnicus wallichii* Hook. f. var. *fasciculata* Hook. f. in Fl. Brit. India 3 : 364, 1881.

Fairly common in Bir Chhatt, Patiala. Fl. & Fr. Mar.-May. M. Sharma 3520.

Galinsoga parviflora Cav. Very rare. Fl. & Fr. Jan.-Feb. M. Sharma 2418.

Lactuca dissceta D. Don. Common weed in waste places and orchards. Fl. & Fr. Feb.-Apr. M. Sharma 1684*, 569**, 1783, 2014, 2555, 2698, 3233, 3445, 3937.

L. serriola L. Fairly common in shady waste places. Fl. & Fr. Apr.-June. M. Sharma 39**, 2042, 3964.

Lagascea mollis Cav. Very rare. Fl. & Fr. Sept.-Dec. M. Sharma 2500*.

Launaea resedifolia Druce. On sand dunes. Fl. & Fr. Apr.-June. M. Sharma 4542.

Parthenium hysterophorus L. Rare to abundant. Fl. & Fr. Apr.-Oct. M. Sharma 2701, 2724 3106, 3216, 3977.

OLEACEAE

Jasminum auriculatum Vahl. Rare in hedges. Fl. & Fr. July-Sept. M. Sharma 2683*, 2072, 2122.

APOCYNACEAE

Catharanthus pusillus G. Don. Fairly common in fields and waste places. Fl. & Fr. Augs-Oct. M. Sharma 2246*, 332**, 540, 2113. 3550, 3748.

EHRETIACEAE

Ehretia aspera Roxb. Common in waste place and hedges. Fl. & Fr. Mar.-Nov. M. Sharma 2458*, 86**, 1785, 1713, 1851, 3925.

CONVOLVULACEAE

Ipomoea cairica Sweet var. **indica** Hall. f. Naturalized among hedges and forests. Fl. & Fr. Almost throughout the year. M. Sharma 2077*, 232**, 2046, 4239, 4275.

I. fistulosa Choisy. Naturalized in watery places. Fl. & Fr. Mar.-Dec. M. Sharma 2353*, 31**, 960, 1470, 3467, 4345.

I. pes-tigridis L. var. **capitellata** Cl. Fairly common weed. Fl. & Fr. Aug.-Oct. M. Sharma 2783*, 354**, 506, 1354, 1612.

Merremia dissecta Hall. f. Among hedges. Fl. & Fr. Apr.-Nov. M. Sharma 339**, 1674, 2292, 2806, 3791.

SOLANACEAE

Datura stramonium L. Rare. Fl. & Fr. Aug.-Oct. M. Sharma 2498*, 1348, 2523.

Nicotiana plumbaginifolia Viv. Widespread weed. Fl. & Fr. Feb.-July. M. Sharma 1690*, 633**, 921, 2079, 2679, 3262.

SCROPHULARIACEAE

Lindernia verbenifolia Pennell. Rare. Fl. & Fr. Aug.-Sept. M. Sharma 2710.

Verbascum thapsus L. Rare but scattered. Fl. & Fr. Sept.-Nov. also Mar.-May. M. Sharma 778**, 2524, 2704, 3527.

PEDALIACEAE

Pedalium murex L. Rare. Fl. & Fr. July-Sept. M. Sharma 1369.

ACANTHACEAE

Blepharis maderaspatensis Roth. Rare. Fl. & Fr. Mar.-May. M. Sharma 2215*, 2803, 3472.

Dicliptera verticillata Christens. Rare. Fl. Mar.-Apr. M. Sharma 1799.

Hemigraphis hirta T. Anders. Common in Patiala district. Fl. & Fr. Mar.-June. M. Sharma 1803, 1845, 2010, 2628.

Lepidagathis cuspidata Nees. Rare. Fl. & Fr. Mar.-Apr. M. Sharma 2444*, 4240.

VERBENACEAE

Premna barbata Wall. ex Schau. Common in Bir Chhatt, Patiala. M. Sharma 4308.

LABIATAE

Ocimum canum Sims. Rare. Fl. & Fr. July-Oct. M. Sharma 2226*, 768*, 1410, 3565.

PLANTAGINACEAE

Plantago pumila Willd. Rare. Fl. & Fr. Feb.-Apr. M. Sharma 855, 3281.

AMARANTHACEAE

Achyranthes aspera L. var. **porphyristachya** Hook f. Fairly common in Patiala district. Fl. & Fr. July-Nov. M. Sharma 1637, 2989, 3081, 3757.

Alternanthera ficoidea Griseb. Rare to abundant. Fl. & Fr. Almost all the year round. M. Sharma 3107, 3222, 3230, 4248.

EUPHORBIACEAE

Croton bonplandianum Baill. Very common in waste places. Fl. & Fr. Mar.-Nov. M. Sharma 2198*, 118**, 142, 1397, 3505, 3959.

Euphorbia serpens H.B. & K. Common in Punjabi University Campus. Fl. & Fr. Mar.-Nov. M. Sharma 3540, 3556, 3785, 4279.

Kirganelia reticulata Poir. Rare. Fl. & Fr. Mar.-May. M. Sharma 4206, 4237.

URTICACEAE

Pouzolzia pentandra Benn. Rare to very common. Fl. & Fr. July-Nov. M. Sharma 2051*, 760**, 962, 1338, 2890, 3989.

ORCHIDACEAE

Eulophia hormusjii Duthie. Rare to common. Fl. Mar.-Apr. M. Sharma 1691*, 562**, 3487, 3872.

DIOSCOREACEAE

Dioscorea bulbifera Linn. Common in Bir Chhatt, Patiala. Fl. & Fr. July-Nov. M. Sharma 3763, 4299.

PONTEDERIACEAE

Eichhornia crassipes Solms. Very common in ponds. Fl. Aug.-Nov. also Apr.-May. M. Sharma 389**, 2114, 2651, 4379.

COMMELINACEAE

Commelina forskalaei Vahl. Rare. Fl. & Fr. July-Sept. M. Sharma 2103.

C. undulata R. Br. Fairly common. Fl. & Fr. July-Oct. M. Sharma 1472, 2151, 2270, 2996, 3079.

ALISMATACEAE

Alisma plantago L. Rare. Fl. Mar. M. Sharma 3866.

POTAMOGETONACEAE

Potamogeton perfoliatus L. Fairly common. Fl. & Fr. Jan.-Apr. M. Sharma 2538, 2550, 3280.

CYPERACEAE

Cyperus alulatus Kern. Very common weed. Fl. & Fr. Aug.-Oct. M. Sharma 2277*, 278**, 343, 941, 3732, 4013, 4334.

C. atkinsonii Cl. Rare. Fl. & Fr. July-Oct. M. Sharma 2992, 3073, 3102.

Eleocharis acutangula Schult. Rare. Fl. & Fr. Aug.-Oct. M. Sharma 3548, 3775.

GRAMINEAE

Chloris montana Roxb. Rare to common. Fl. & Fr. July-Oct. M. Sharma 359, 1365, 1493.

C. virgata Sw. Common in Patiala district. Fl. & Fr. July-Oct. M. Sharma 995, 1572, 2534, 3086.

Chrysopogon fulvus Chiov. Rare. Fl. & Fr. Aug.-Oct. M. Sharma 2302*, 3765, 4305.

Cymbopogon parkeri Stapf. Very rare. Fl. & Fr. July-Sept. M. Sharma 2513.

Digitaria longiflora Pers. Rare. Fl. & Fr. Aug.-Oct. M. Sharma 2721, 3213.

D. stricta Roem. & Schult. Common. Fl. & Fr. July-Oct. M. Sharma 2748*, 1429, 1481, 2297, 3087, 4380.

Dinebra retroflexa Panz. Fairly common in Patiala district. Fl. & Fr. Aug.-Oct. M. Sharma 2705, 3208.

Eriochloa nubica Thell. Common. Fl. & Fr. July-Oct. M. Sharma 2081, 2115, 2706, 2726, 2951, 3108, 3206, 3582.

Lasiurus sindicus Henr. On sand dunes. Fl. & Fr. Apr.-June. M. Sharma 4543.

Leersia hexandra Sw. Rare. Fl. & Fr. Aug.-Nov. also Apr.-May. M. Sharma 393**, 2893, 3452.

Panicum maximum Jacq. Common in Bir Mehas, Patiala. Fl. & Fr. Aug.-Nov. M. Sharma 1372, 2288, 4356.

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Introduced weeds in the Vegetation of Mysore District[1]

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AND

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Introduction

Karnataka has no flora of its own, though parts of the state are covered by the floras of Madras (Gamble 1915-36), Bombay (Cooke 1901-1908), Bangalore (Ramaswamy & Razi 1973) and Hassān (Saldanha 1976). Flora of Mysore district (Rao 1973) is one more step towards the ultimate achievement of the flora of the state of Karnataka.

During the course of preparation of a flora of Mysore district, a large number of 'weedy species' which have not been mentioned or mentioned only as a casual reference in many of the South Indian floras were encountered; and some of these are of recent introductions—(Ramaswamy *et al.* 1972-73).

The flora of Mysore district is now fairly well-known mainly through the works of Barnes (1944), Naithani (1966), Kammathy *et al.* (1967), Razi & Rao (1971), Rao (1971-72, 1973), Rao & Razi (1973-74), Bhaskar & Razi (1973). But a systematic study on introduced elements has not been made hitherto, though Ramaswamy *et al.* (1972-73) have published a small note on the adventive species in the district. Elsewhere, in the country similar studies have been carried out and have received much attention (Prain 1890; Brühl 1908; Kashyap 1924; Biswas 1934; Raizada 1935, 1936; Mooney 1950; Srivastava 1954, 1964; Maheshwari 1960, 1962). The present study from Mysore district is to fill such a lacuna and is hoped that this will induce others also towards such studies in other parts of the country.

Exotic weeds have been established in our country eversince the time of Portuguese settlement in India (15th century). They introduced economically important plants brought from Brazil, Mexico, parts of Africa and other places on their commercial route. Later, many British Officers and travellers interested in gardening also introduced many ornamental as well as medicinal plants from other countries to India; along with these useful plants, seeds of many of the obnoxious weeds also got introduced by some way or other and thus got established on the new soil.

Calcutta, eversince the establishment of the Royal Botanic Garden (now Indian Botanic Garden) in 1787 has been the active centre for introduction and acclamatisation of many useful plants; and thus is also a source for spread of many foreign weeds from this garden.

India being a vast country has a varied type of climate, topography, soil types and other factors, which are suitable for the growth of plants from practically all regions of the world. Though, this is beneficial in a way to introduce

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any economically important plants, at the same time provides a congenial habitat for the growth of ' nature selected weeds '.

Thus, these foreign weeds once introduced have acclamatised on the new soil and naturalised themselves in such a way that they now seem to be part of the native flora. These weeds after their introduction have spread to all parts by various factors, man being the only major biotic factor. Some of the important factors responsible for the spread of these weeds are shifting cultivation, deforestation, faulty pasturage methods, methods of harvesting, sale and introduction of impure seeds, sowing impure seeds on cultivated and uncultivated lands, construction of roads and railway lines, etc. (Maheshwari 1962). While weeds like *Croton bonplandianum*, *Acanthospermum hispidum*, *Alternanthera* sp. are accidental introductions; *Eupatorium odoratum*, *Lantana camara*, *Eichhornia crassipes*, *Datura metel* and others are species introduced as ornamentals or for their medicinal value.

Mysore district is the southernmost portion of the state of Karnataka, and lies between 11° 36′-12° 42′ N lat. and 76° 55′-77° 45′ E long. The vegetation of the district is interesting with a variety of forest types (Rao & Razi 1973-74). In Mysore district majority of the weeds thus established are from Tropical America or Africa and a few from Europe and Australia (Table 2).

There are 184 introduced species in the present vegetation of Mysore district spread over 49 families and 128 genera ; and this approximately constitutes 11.5% of the introduced flora as against 40% recorded for India (Maheshwari 1962).

Asteraceae tops the list of introduced species both in the number of species as well as in their abundance in the district. Another noteworthy observation is that this is one of the families to establish very quickly, thereby becoming adventive in nature. There are many reasons for the quick establishment and spread of these Asteraceae species. The main features being the production of enormous amount of seeds and secondly their effective mode of dispersal. *Eupatorium odoratum* for example was introduced to India when the FLORA OF BRITISH INDIA (Hooker 1872-1897) was being written. It is said that this plant was somehow got introduced in to Kerala state from Assam region by the labourers returning from the Assam front about 15 years ago. By 1973 when Flora of Mysore (Rao 1973) was explored this was the most dominant weed all round Karapura, Kakanakote and Heggadadevanakote forests replacing all other weedy species, including *Lantana camara*. This is indicative of the adventive nature of the species. Another species of the family having a similar history is *Parthenium hysterophorus*. This species was recorded for the first time in India in 1951 from Poona (Rao 1956). In Mysore district this was recorded for the first time on 23-11-1971, when only two individual plants were seen (Ramaswamy *et al.* 1972-73). Though these plants were uprooted and burnt, today however this has become a dominant weed in many parts of the district. Within a short span of 25 years this weed has established itself to such an extent all over the state of Karnataka, that it is the only dominant weed now.

Papilionaceae, Poaceae, Amaranthaceae, Euphorbiaceae, Solanaceae, Cyperaceae, Malvaceae, Scrophulariaceae and Convolvulaceae are some other families with a large number of introduced weeds in the district (Table 1).

Maheshwari (1962) has discussed in detail about the route in which these weeds have migrated with reference to India ; and Srivastava (1964) has discussed the way in which some of these weeds probably might have been introduced. In the present account an

TABLE 1

FAMILIES SHOWING THE NUMBER OF INTRODUCED GENERA AND SPECIES

Family		Number of genera	Number of Species
Asteraceae	..	24	27
Papilionaceae	..	11	18
Poaceae	..	13	17
Amaranthaceae	..	8	12
Euphorbiaceae	..	6	12
Solanaceae	..	5	9
Cyperaceae	..	2	8
Malvaceae	..	4	7
Tiliaceae	..	1	6
Caesalpiniaceae	..	2	5
Convolvulaceae	..	2	5
Scrophulariceae	..	4	4
Cactaceae	..	1	3
Caryophyllaceae	..	3	3
Lamiaceae	..	3	3
Polygonaceae	..	2	3
Rubiaceae	..	2	3
Verbenaceae	..	2	3
Acanthaceae	..	2	2
Boraginaceae	..	1	2
Chenopodiaceae	..	1	2
Cleomaceae	..	1	2
Hydrocharitaceae	..	2	2

Rest 26 families with one genus and one species in each.

enumeration of all the introduced weed species of Mysore district with their probable native countries is given in tabular form (Table 2). However, no effort is made to give their years of introduction and establishment, since many of them have been repeatedly brought and introduced in different parts at different times.

All the specimens enumerated are deposited in the Herbarium, Manasagangotri, University of Mysore, Mysore (MGM).

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TABLE 2

ENUMERATION OF INTRODUCED WEEDS OF MYSORE DISTRICT

No.	Species	Family	Native Country Region	Remarks
1.	*Abelmoschus moschatus* Medic. (*Hibiscus abelmoschus* L.)	Malvaceae	Paleotropical	Rare ; often cultivated.
2.	*Abrus precatorius* L.	Papilionaceae	Pantropical	Common all over the district ; not abundant.
3.	*Acalypha ciliata* Forsk.	Euphorbiaceae	Paleotropical	Common in shady moist places.
4.	*Acanthospermum hispidum* DC.	Asteraceae	Brazil	Common all over on fallow fields.
5.	*Achyranthes aspera* L.	Amaranthaceae	Trop. America	Common in plains.
6.	*Adathoda vasica* Nees	Acanthaceae	Trop. Asia	Cultivated for its medicinal uses ; but fairly run wild also.
7.	*Adenostemma lavenia* (L.) Ktz. (*A. viscosum* Forst.)	Asteraceae	South America	Frequent.
8.	*Aeschenomene americana* L.	Caesalpiniaceae	Trop. America	Common.
9.	*Ageratum conyzoides* L.	Asteraceae	South America	Escape, very abundant all over.
10.	*Allamanda cathartica*	Apocynaceae	Trop. America	Escape ; mostly cultivated.

No.	Species	Family	Native Country Region	Remarks
11.	*Alternanthera ficoidea* (L.) R. Br.	Amaranthaceae	Trop. America	Common in ponds and ditches.
12.	*A. pungens H. B. & K.* (*A. echinata* Sm.)	,, ,,	,,	Common in open grassy soils.
13.	*A. sessilis* (L.) R. Br. (*A. paronychioides* St. Hil.)	,, ,,	,,	Frequently associate with other Amaranthaceae members.
14.	*Amaranthus gracilis* Desf. (*A. viridis* Hk. f. *non* L.)	,, ,,	Pantropical	Common weed in vegetable gardens.
15.	*A. spinosus* L.	,, ,,	,,	Common near human habitations.
16.	*Anagallis arvensis* L.	Primulaceae	Europe	Rare, in B.R. Hills.
17.	*Antigonon leptopus* Hk. & Arn.	Polygonaceae	South America	Cultivated but runs wild in some places.
18.	*Argemone mexicana* L.	Papaveraceae	Cent. America	Common and abundant in some fallows.
19.	*Asclepias curassavica* L.	Asclepiadaceae	South America	Rare, near water margins.
20.	*Bacopa monnieri* (L.) Penn.	Scrophulariaceae	Cosmop-Trop.	Common all over in marshy places.
21.	*Barleria cristata* L.	Acanthaceae	Paleotropical	Frequent, not abundant.
22.	*Biophytum sensitivum* DC.	Geraniaceae	Pantropical	Common in shades.
23.	*Blainvillea acmella* (L.) Philipson (*B. latifolia* DC.)	Asteraceae	,,	Common.
24.	*Boerhaavia diffusa* L.	Nyctaginaceae	,,	Very common all over the waste lands.
25.	*Borreria articularis* (L.f.) F.N. Will. (*B. hispida* Schum.)	Rubiaceae	Paleotropical	Common in agricultural fields.
26.	*B. stricta* (L.f.) Schum.	,,	,,	Common in agricultural fields.
27.	*Brachiaria mutica* (L.) Stapf	Poaceae	Europe	Occasional.
28.	*Brugumontia suaveolens* Bracht. & Presl. (*Datura suaveolens* H.B.K.)	Solanaceae	Mexican	Common in Higher elevations of B. R. Hills.
29.	*Calceolaria mexicana* Benth.	Scrophulariaceae	Mexico	Recent; abundant only in coffee estates.
30.	*Canscora diffusa* R. Br.	Gentianaceae	Paleotropical	Common in marshy places.
31.	*Cardiospermum halicacabum* L.	Sapindaceae	Pantropical	Isolated in bushes and plains. (waste lands).
32.	*Cassia occidentalis* L.	Caesalpiniaceae	South America	Common all over the district.
33.	*C. pumila* Lamk.	,,	Pantropical	Rare ; common in B.R. Hills.
34.	*C. sophera* L.	,,	South America	Common.
35.	*C. tora* L.	,,	,,	Common.
36.	*Celosia argentea* L.	Amaranthaceae	Pantropical	Weed of sorghum and maize fields.
37.	*Ceratophyllum demersum* L.	Ceratophyllaceae	Trop. America	Not common.
38.	*Chenopodium album* L.	Chenopodiaceae	Paleotropical	Weed of vegetable gardens.
39.	*C. ambrasioides* L.	Chenopodiaceae	Mexico	Weed of vegetable gardens.
40.	*Chloris barbata* Sw.	Poaceae	Trop. America	Common all over the district.
41.	*Cleome gynandra* L. (*Gynandropsis pentaphylla* (L.) DC.	Cleomaceae	Pantropical	Common all over the district.
42.	*C. monophylla* L.	Cleomaceae	Afro-asian	Frequent.
43.	*Clitoria ternatea* L.	Papilionaceae	Paleotropical	Common.
44.	*Convolvulus arvensis* L.	Convolvulaceae	European	Common climber.

ENUMERATION OF INTRODUCED WEEDS OF MYSORE DISTRICT

TABLE 2—(*Contd.*)

No.	Species	Family	Native Country Region	Remarks
45.	*Corchorus aestuans* L.	Tiliaceae	Trop. America	Weed of waste lands and cultivated fields, common all over the plains.
46.	*C. capsularis* L.	Tiliaceae	Trop. America	Weed of waste lands and cultivated fields, common all over the plains.
47.	*Corchorus fascicularis* Lamk.	Tiliaceae	Paleotropical	Weed of open places and cultivated lands; common throughout the district.
48.	*C. olitorius* L.	Tiliaceae	Pantropical	Weed of open places and cultivated lands; Common throughout the district.
49.	*C. tridens* L.	Tiliaceae	Pantropical	Weed of open places and cultivated lands; Common throughout the district.
50.	*C. trilocularis* L.	Tiliaceae	Paleotropical	Weed of open places and cultivated lands; Common throughout the district.
51.	*Coronopus didymus* (L.) Sm. (*Senebiera pinnatifida* DC.)	Brassicaceae	Trop. America	Common in marshy shady places.
52.	*Crossocephalum crepidioides* (Benth.) S. Moore	Asteraceae	Trop. Africa	Common in fallow fields and near marshy places.
53.	*Crotalaria medicaginea* Lamk.	Papilionaceae	Austro-asian	Common.
54.	*Croton bonplandianum* Baill. (*C. sparsiflorus* Morong.)	Euphorbiaceae	South America	Dominant weed in the district.
55.	*Cymbopogon martinii* (Roxb.) Wats.	Poaceae	Afro-asian	Common in higher elevations.
56.	*Cynodon dactylon* (L.) Pers.	Poaceae	Trop. America	Common.
57.	*Cyperus alopecuroides* Rottb.	Cyperaceae	Paleotropical	Frequent in marshy and muddy soils; common all over the district.
58.	*C. flabelliformis* Rottb.	Cyperaceae	Trop. Africa	Frequent in marshy and muddy soils; common all over the district.
59.	*C. iria* L.	Cyperaceae	Paleotropical	— do —
60.	*C. pumilus* L.	Cyperaceae	Paleotropical	— do —
61.	*C. pygmaeus* Rottb.	Cyperaceae	Pantropical	— do —
62.	*C. rotundus* L.	Cyperaceae	Pantropical	— do —
63.	*C. triceps* (Rottb.) Endl.	Cyperaceae	Paleotropical	— do —
64.	*Dactyloctenium aegyptium* (L.) Beauv.	Poaceae	Pantropical	Weed in rice fields and open marshy places.
65.	*D. metel* L.	Solanaceae	Trop. America	On fallow fields.
66.	*Datura stramonium* L.	Solanaceae	Paleotropical	On fallow fields.
67.	*Desmodium parviflorum* DC.	Papilionaceae	Austro-Asian	Not common.
68.	*D. triflorum* (L.) DC.	Papilionaceae	Pantropical	Common on moist gravelly soils.
69.	*Digera muricata* (L.) Mart.	Amaranthaceae	Afro-asian	Weed of cultivated fields.
70.	*Digitaria adscendens* (H.B. & K.) R. & S.	Poaceae	Trop. America	Common.

No.	Species	Family	Native Country Region	Remarks
71.	*Drymaria cordata* (L.) Willd. ex Roem.	Caryophyllaceae	Paleotropical	Common weed in coffee plantations in Biligirirangan hills.
72.	*Eclipta prostrata* L.f.	Asteraceae	Pantropical	Common in marshy places.
73.	*Eichhornia crassipes* (Mart.) Solms.	Pontederiaceae	Brazil	Dominant free floating water weed in tanks.
74.	*Elephantopus scaber* L.	Asteraceae	Pantropical	Rare.
75.	*Emilia sonchifolia* (L.) DC.	Asteraceae	Afro-asian	Frequent.
76.	*Eragrostis cilianensis* (All.) Vignolo-Lutari	Poaceae	Afro-asian	Common.
77.	*E. plumosa* P. Beauv.	Poaceae	Afro-asian	Common.
78.	*Erigeron asteroides* Roxb.	Asteraceae	Trop. America	Common in higher elevations.
79.	*E. canadensis* L.	Asteraceae	South America	Dominant in higher elevations.
80.	*E. mucronatus* DC.	Asteraceae	Mexico	Common all over at higher elevations.
81.	*Eupatorium adenophorum* Spreng. (*E. glandulosum* H.B. & K.)	Asteraceae	Mexico	Common at higher elevations.
82.	*E. odoratum* L.	Asteraceae	Trop. America	Abundant near Karapura, Heggadevana kote and Kakanakote.
83.	*Euphorbia geniculata* Ort.	Euphorbiaceae	Pantropical	Weed in open fields.
84.	*E. hirta* L.	Euphorbiaceae	Pantropical	Weed in open fields, Common.
85.	*E. prostrata* Ait.	Euphorbiaceae	West Africa	Weed in open soils ; Commonly seen with other species.
86.	*E. pulcherrima* Willd.	Euphorbiaceae	Mexico	Recent ; under cultivation ; rarely escape.
87.	*Fimbristylis littoralis* Gaud. (*F. miliacea* (L.) Vahl)	Cyperaceae	Pantropical	Common in marshy places.
88.	*Flaveria australasiaca* Hook.	Asteraceae	Australian	Common.
89.	*Galinsoga ciliata* (Rafn.) Blake	Asteraceae	South America	Common all over, but confused with the next species.
90.	*G. parviflora* Cav.	Asteraceae	South America	Abundant weed along road sides.
91.	*Glinus oppositifolius* (L.) DC.	Aizoaceae	Paleotropical	Common.
92.	*Gomphrena celosioides* Mart. (*G. decumbens* Jack.)	Amaranthaceae	South America	Weed in plains.
93.	*Hackelochloa granularis* (L.) O. Ktz.	Poaceae	Pantropical	Common in higher elevations.
94.	*Heliotropium indicum*	Boraginaceae	South America	Weed in open fields.
95.	*H. ovalifolium* Forsk.	Boraginaceae	Pantropical	Common in dry open soils.
96.	*Hibiscus panduraeformis* Burm f.	Malvaceae	Paleotropical	Common weed in gardens and hedges.
97.	*H. vitifolius* L.	Malvaceae	Paleotropical	Common weed in gardens and hedges.
98.	*Hypericum japonicum* Thunb.	Hypericaceae	Paleotropical	Rare in higher elevations.
99.	*Hyptis sauveolens* (L.) Poir.	Lamiaceae	South America	Weed in waste lands.
100.	*Indigofera astragalina* DC.	Papilionaceae	Paleotropical	— do —
101.	*I. cordifolia* Heyne ex Roth.	Papilionaceae	Paleotropical	— do —
102.	*I. linifolia* Retz.	Papilionaceae	Paleotropical	— do —
103.	*I. linnaei* Ali	Papilionaceae	Austro-asian	— do —
104.	*I. prostrata* Willd.	Papilionaceae	Austro-asian	— do —

ENUMERATION OF INTRODUCED WEEDS OF MYSORE DISTRICT

TABLE 2—(*Contd.*)

No.	Species	Family	Native Country Region	Remarks
105.	*I. trita* L.f.	Papilionaceae	Austro-asian	Weed in waste lands.
106.	*Ipomoea fistulosa* Mart. (*I. carnea* Jacq.)	Convolvulaceae	South America	Common near villages; Occasionally cultivated.
107.	*I. eriocarpa* R. Br.	Convolvulaceae	Paleotropical	Common in plains.
108.	*I. pestigridis* L.	Convolvulaceae	Paleotropical	Common in plains and in cultivated fields.
109.	*I. reptans* (L.) Poir. (*I. aquatica* Forsk.)	Convolvulaceae	Paleotropical	Common along the water margins and muddy soils.
110.	*Iseilema laxum* Hack.	Poaceae	Trop. America	Rare.
111.	*Jatropha curcas* L.	Euphorbiaceae	Trop. America	In hedges.
112.	*J. glandulifera* L.	Euphorbiaceae	Afro-asian	In waste lands.
113.	*J. gossypifolia* L.	Euphorbiaceae	Trop. America	Weed of waste lands.
114.	*Kalanchoe pinnata* (Lamk.) Pers.	Crassulaceae	Trop. America	Common along river bank in paschimavahini and often cultivated.
115.	*Laggera aurita* (Willd.) Sch.-Bip.	Asteraceae	Afro-asian	Aromatic weed in open waste lands.
116.	*Lantana camara* L.var. *aculeata* (L.) Moldenke	Verbenaceae	Cent. America	Common all over.
117.	*L. indica* Roxb.	Verbenaceae	South America	Common at higher elevations.
118.	*Legascea mollis* Cav.	Asteraceae	Mexico	Common in plains.
119.	*Leucas lavendulaefolia* Rees. (*L. linifolia* Spreng)	Lamiaceae	West Asia	Common; often associated with *L. aspera*.
120.	*Malvastrum coromandelianum* (L.) Garcke	Malvaceae	South America	Abundant in waste lands.
121.	*Martynia annua* L.	Martyniaceae	Mexico	Common in waste lands.
122.	*Mecardonia dianthera* (Sw.) Penn. (*Herpestris chamaedryoides* H.B. & K.)	Scrophulariaceae	Trop. America	Common from plains to higher elevations.
123.	*Mikania micrantha* H. B. & K.	Asteraceae	Trop. America	Very abundant along the cauvery river bank.
124.	*Mimosa pudica* L.	Mimosaceae	Brazil	Frequent.
125.	*Mucuna prurita* HK.	Papilionaceae	Pantropical	Rare.
126.	*Murdannia dimorpha* (Dalz.) Bruck.	Commelinaceae	Pantropical	Occasional.
127.	*Nicotiana plumbaginifolia* Viv.	Solanaceae	Mexico	Recent, occasional in betel leaf garden.
128.	*Nothosaerva brachiata* (L.) Wt.	Amaranthaceae	Trop. Africa	In marshy places soon after rains.
129.	*Ocimum canum* Sims. (*O. americanum* L.)	Lamiaceae	Afro-asian	Weeds in fallow fields.
130.	*Oenothera rosea* (Soland.) Ait.	Oenotheraceae		Rare, only in higher elevations.
131.	*Oldenlandia corymbosa* L.	Rubiaceae	Pantropical	Occasional in marshy places.
132.	*Opuntia coccinellifera* Mill.	Cactaceae	Mexican	Occasional near villages.
133.	*O. dillenii* Haw.	Cactaceae	South America	Occasional near villages.
134.	*O. elatior* Mill.	Cactaceae	South America	Occasional near villages.
135.	*Ottelia alismoides* (L.) Pers.	Hydrocharitaceae	Austro-asian	Common in tanks and ponds.

No.	Species	Family	Native Country Region	Remarks
136.	*Oxalis latifolia* H.B. & K.	Oxalidaceae	Mexico	Common.
137.	*Parthenium hysterophorus* L.	Asteraceae	Trop. America	One of the recent adventives to the district.
138.	*Passiflora foetida* L.	Passifloraceae	South America	Rare climber.
139.	*Pennisetum purpureum* Schum.	Poaceae	Trop. Africa	Occasional in gardens.
140.	*Peperomia pellucida* H.B. & K.	Piperaceae	Cent. America	Weed in gardens specially in shady green houses.
141.	*Phyllanthus asperulatus* Hutch.	Euphorbiaceae	Trop. America	Common weed in gardens.
142.	*Physalis minima* L.	Solanaceae	Paleotropical	Common on open fields.
143.	*P. peruviana* L.	Solanaceae	Trop. Africa	Common on open fields.
144.	*Plumbago zeylanica* L.	Plumbaginaceae	Geront Trop.	In hedges, occasional in plains.
145.	*Polycarpaea corymbosa* Lamk.	Caryophyllaceae	Pantropical	In open grassy fields.
146.	*Polygonum barbatum* L.	Polygonaceae	Paleotropical	In marshy places.
147.	*P. hydropiper* L.	Polygonaceae	Temperate	In marshy places.
148.	*Portulaca oleracea* L.	Portulacaceae	Paleotropical	Common all over the district.
149.	*Potamogeton nodosus* poir.	Potamogetonaceae	Temperate	Rare in tanks.
150.	*Pupalia lappacea* (L.) Juss.	Amaranthaceae	Afro-asian	Rare in the district.
151.	*Rhynchosia minima* DC.	Papilionaceae	Pantropical	Common in open fallow fields.
152.	*Rivina humilis* L.	Phytolacaceae	South America	Rare weed in betel gardens.
153.	*Saccharum spontaneum* L.	Poaceae	Paleotropical	Occasional.
154.	*Scoparia dulcis* L.	Scrophulariaceae	South America	Common.
155.	*Sebastiania chamalea* (L.) Muell.-Arg.	Euphorbiaceae	Paleotropical	Common.
156.	*Sesbania bispinosa* (Jacq.) Faw. & Rendle (*S. aculeata* Pers.)	Papilionaceae	Pantropical	Weed in gardens occasionally cultivated.
157.	*Setaria glauca* P. Beauv.	Poaceae	Eurasian	Occasional in plains.
158.	*S. verticillata* (L.) P. Beauv.	Poaceae	Austro-asian	Occasional in plains.
159.	*Sida alba* L. (*S. spinosa* L.)	Malvaceae	Pantropical	Common.
160.	*S. cordifolia* L.	Malvaceae	Pantropical	Common.
161.	*S. veronicaefolia* Lamk.	Malvaceae	Trop. America	Common.
162.	*Solanum elaegnifolium* Cav.	Solanaceae	Mexico	Rare.
163.	*S. seaforthianum* Andr.	Solanaceae	Trop. America	Occasional in hedges.
164.	*S. surattense* Burm. f. (*S. xanthocarpum* Schrad & Wendl.)	Solanaceae	Paleotropical	Frequent.
165.	*Sonchus oleraceus* L.	Asteraceae	Paleotropical	Common throughout the district.
166.	*S. wightianus* DC. subsp. *wightianus* Boulos (*S. arvensis* L.)	Asteraceae	European	Common.
167.	*Sphaeranthus indicum* L.	Asteraceae	Africa	Common in marshy places.
168.	*Sporobolus diander* (Retz.) Beauv.	Poaceae	Austro-asian	Common.
169.	*Stachytarpheta jamaicensis* (L.) Vahl (*S. indica* Vahl)	Verbenaceae	Paleotropical	Common in fallows.
170.	*Stellaria media* Cyr.	Caryophyllaceae	European	Rare.
171.	*Synadenium grantii* Hk. f.	Euphorbiaceae	Trop. Africa	Plants all over the district.
172.	*Synedrella nodiflora* (L.) Gaertn.	Asteraceae	Trop. America	Frequent.
173.	*Tephrosia purpurea* Pers.	Papilionaceae	Pantropical	Common all over on waste lands.

TABLE 2—(*Contd.*)

No.	Species	Family	Native Country Region	Remarks
174.	*Teramnus labialis* Spr.	Papilionaceae	Pantropical	Not a common plant in the district.
175.	*Tithonia diversifolia* A. Gray	Asteraceae	Mexican	Rare.
176.	*Tribulus terrestris* L.	Zygophyllaceae	Pantropical	Prostrate weed on open fields.
177.	*Tridax procumbens* L.	Asteraceae	Mexico	Common in open places among grasses.
178.	*Urochloa panicoides* P. Beauv.	Poaceae	Geront Trop.	Common in open places.
179.	*Vallisneria spiralis* L.	Hydrocharitaceae	Pantropical	Common in streams.
180.	*Vernonia cinera* (L.) Juss.	Asteraceae	Pantropical	Common.
181.	*Vigna trilobata* (L.) Verdc. (*Phaseolus trilobus* L.)	Papilionaceae	Afro-asian	Occasional in open soils.
182.	*Wedelia calendulacea* less.	Asteraceae	Austro-asian	Rare, in marshy places.
183.	*Xanthium strumarium* L.	Asteraceae	South America	Common all over in fallow fields.
184.	*Zornia diphylla* Pers. (*Z. gibbosa* Span.)	Papilionaceae	Pantropical	Common in plains on open grassy soils.

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