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Vol. 80 (Parts 3 & 4) 1982 Pages : 251—549

CONTENTS

Rec. zool. Surv. India, 80 : 251-263, 1983

THE CALCUTTA COLLECTION OF ASIAN RHINOCEROS

By

COLIN P. GROVES[1] AND S. CHAKRABORTY[2]

The rarity of preserved skulls of the three living Asian species of rhinoceros is most annoying for a mammalian taxonomist, especially when one considers the thoughtless slaughter of these animals by so-called sportsmen in the last century. Pollok (in Pollok and Thom, 1900) massacred forty-four rhinos in Assam, one in Burma ; Thom (loc. cit.) three in Burma ; Baker (1881) killed three in the Sundarbans (protesting that the rhino was rarely disturbed and 'must be multiplying fast' there. Rhinos became extinct in the Sundarbans not long after Baker wrote). And so on. Of the authors mentioned, a single skeleton was presented by Pollok to the Indian Museum; the remains of the others either rotted where they fell, or are cluttering up some obscure attic. From any point of view, the slaughter is a tragedy ; had it resulted in some specimens being made available for science, there would have been some slim compensation, but even this cold comfort is denied us.

It is, therefore, of great importance to seek full documentation in those specimens that actually are preserved in museums. According to the list published long ago by Sclater (1891), the Indian Museum, Calcutta, should have one of the largest collections in the world, fairly well documented, and from a taxonomic point of view are very valuable as many of them are from localities—especially Lower Burma—not well represented in any other collection. Sclater lists the following number of specimens (skulls unless otherwise specified) :

Rhinoceros unicornis — 17 (6 with locality), including 5 complete or incomplete skeletons, 2 stuffed skins and 3 hoofs.

Rhinoceros sondaicus — 19 (9 with locality), including 9 skeletons, all said to be complete, and 2 stuffed.

Rhinoceros (now **Dicerorhinus) sumatrensis** — 18 (10 with locality), including 7 full or partial skeletons ; but two of the skulls fragmentary ; 3 skins (2 stuffed) ; and a pair of horns.

1. *Australian National University, Canberra, Australia*
2. *Zoological Survey of India, Calcutta, India*

The nucleus of the Indian Museum collection was that of the Asiatic Society of Bengal. In 1863, this latter collection contained (Blyth, 1863) :

Rhinoceros sondaicus — 9 (6 with locality), one being a nearly complete skeleton, one stuffed skin.

'Rhinoceros sumatranus' (=D. sumatrensis) — 7 (5 said to have locality data) and the remaining two, one complete skeleton and one stuffed headskin also said to have locality data according to Blyth (1862).

R. unicornis=R. indicus'—No specimen, although 'skulls immediately expected' (as stated in a footnote).

In 1865, the Asiatic Society's collection, according to Anderson (1881) 'practically became the property of the Government of India, although the legal transfer was not completed until 1876'. With the birth of the Zoological Survey of India in 1916, all these collections were vested with that institution. The collection remained in the Indian Museum until the Second World War (1942) when, in anticipation of possible Japanese bombing raids on Calcutta, the ZSI headquarters were transferred to Benares (Varanasi) ; but the osteological collection was left in a room in the Indian Museum in Calcutta. Calcutta remained free of bombs, but the uncurated collection suffered loss and damage, and many labels got mixed up ; it was a much depleted collection to which the ZSI returned to Calcutta in 1948-49. There was a move to a rented building some $2\frac{1}{2}$ km away in Bhowanipore, Calcutta, in 1964 ; and there was a further move into the present quarters of the Zoological Survey of India at 8 Lindsay Street (Calcutta) in 1966. Thus, the collections were subjected to the rigours of transfers and retransfers on several occasions. Today, the rhinoceros collection (now newly registered with ZSI numbers) is as follows.

R. unicornis : 8 skulls (4 with locality), 1 skeleton

R. sondaicus : 9 skulls (5 with locality), 1 lower jaw, 1 stuffed skin

D. sumatrensis : 9 skulls (4 with locality), 1 headskin, 2 fragmentary postcranial specimens.

Loss of specimens seems to have taken place from the very beginning. Blyth (1863) notes that some whose earlier accession was recorded were lost even before his curatorship ! In Sclater's (1891) catalogue, only 5 specimens of *R. sondaicus* are recorded as 'ASB'—some had evidently

been lost. In some cases, of course, it may have been the information about the specimen which was lost, not the specimen itself.

Thanks to the assistance of Dr. B. Biswas., Emeritus Scientist, Zoological Survey of India, Mr P. K. Das, and Mr T. P. Bhattachariya (Mammal Section, Zoological Survey of India). All the rhino specimens still in the collection of the ZSI and the Indian Museum have been examined and measured by one or both of us. By rubbing off the accumulated dust and mud, italic letters can be detected written in black indelible ink on the forehead of most of the skulls corresponding to the letters of Sclater's catalogue.

Identification of the material

Wherever the Sclater catalogue letter is given without qualification, it means that the letter can be discerned written on the skull. Listing of these specimens, and commentary upon them, follows.

R. unicornis

1. 19262. Mounted skeleton on display in the Indian Museum. This is probably Sclater's catalogue No. *b*. Mounted skeleton of a female from Barrackpore park, received from the Calcutta Medical College Museum in 1879. A different specimen (see below) is at present labelled as from Barrackpore, but as there was only one mounted skeleton then and is only one now, and no record that more than one from Barrackpore was preserved, there may have been a switching of labels.

2. 2735. Skull on display in the Indian Museum. The label in front of it identifies it as a female presented by Maddock in 1863. However, no *unicornis* skull appears to have been presented by Maddock ; according to Sclater one, according to Blyth two, *sondaicus* skulls were presented by Maddock (from Tenasserim). Another case of label switching is indicated, but to which *sondaicus* skull the label should belong is undertain. The *unicornis* skull in question is probably Sclater's *h*, an old male from the Nepal terai presented by Sir E. Baring.

3. 2736/19243, Sclater's *j*. A juvenile skull, from the Nepal terai, presented by Baring.

4. 17948. Sclater's *r*. Juvenile skeleton, ASB. No locality.

5. 7306/19263. Juvenile skull on display in museum, Sclater's *o* (from ASB).

6. 10437. From Nepal, presented by Watts & Co. in 1907.

7. 10438. This is not a Sclater specimen ; it was presented by Watts & Co. in 1907 and is from Nepal, like 10437.

8. 20387. Skull, no data.

9. 19240. On display in museum ; stated to be Sclater's *b* from Barrackpore, but see under (1) above. The skull is in fact probably Sclater's *1* presented by Raja R. Mullick in 1871 ; the animal probably died in Raja Mullick's private zoo in Calcutta.

R. sondaicus

1. 3521. Female skull, Chillichang Creek, Sundarbans. Capt. Charling. Sclater's *t*.

2. 19241. Skull, Sundarbans. W. W. Shepperd, 1867. Sclater's *q*. Lacks mandible.

3. 17685. Skull, young adult, no locality. Dr. N. Wallich, ASB. Sclater's *1*. Lacks mandible. Pearson (1840) recorded that 'Dr. Wallich presented five crania of the Rhinoceros' ; Blyth (1863) could find only one in the ASB collection in his day, so presumably this is the one. Nathaniel Wallich (1786-1854) was a Danish Botanist who entered the East India Company's service in 1813 ; he explored Nepal in 1820, northwestern India in 1825, and Lower Burma and Ava (Mandalay district) in 1826-27. He was invalided home in 1828, and returned to explore Assam—in search of the wild tea plantin 1832. As there is no question of this skull's identification as *R. s. sondaicus* it must be from Lower Burma (unless it is true that, as Pollock (1900) asserts, this species formerly occurred in Assam).

4. 17684. Skull, juvenile (Stage 4 of Groves, 1967). Tenasserim, Sir T. H. Maddock. Probably Sclater's *m*. Blyth (1863) records two skulls (one minus lower jaw) presented by Maddock ; Sclater, only one. All the other skulls in Sclater's lists seem satisfactorily documented, so the skull itself must have been lost. Blyth (1862, pl. II, fig. 2) figures dorsal view of a skull from Tenasserim which he does not otherwise identify ; it is in fact the present one, recognisable by a healed fracture on the left zygomatic arch. The skull may at one time have been on exhibition, as there is a label which might apply to it (see above, *unicornis* (No. 2)).

5. 17144. Skull, adult. No identification.

6. 17688. Skull, male, adult. Sclater's *s*, from Mathabhanga R. Barisal district, Sundarbans.

7. 17693. Skull, adult, on display in the Indian Museum. Sclater's *p*, from Java, presented by the Batavian Society.

8. 19378. Badly damaged skull, male, juvenile. Sclater's *j* ; W. Rutledge, 1875. Rutledge was an animal dealer in Calcutta (B. Biswas,

pers. comm.) ; evidently this animal died in captivity, but its origin is impossible to locate.

9. 20386. Mandible. Sclater's *v* ; no history.

D. sumatrensis

1. 2707/17691. Skull, young adult (Stage 5) ; on display in the Indian Museum. Donated by W. Rutledge in 1875 ; imported from Singapore. Though there is no identifying mark on the skull, Sclater (1891) lists only two skulls from Singapore, Nos. *a* and *o*. As skull *o* is available (see below), the present skull is surely *a*. Its origin is likely to have been Malaysia.

2. 17686. Skull, aged ; nasals hacked off ; lacking mandible. Sclater's *n*. This skull in Sclater's catalogue is said to have 'no history' ; but it is unquestionably Blyth's (1862) plate III, fig 1, which is stated to be from Tenasserim. In Blyth's figure, the nasals are present but connected to the rest of the cranium by the merest point of bone, quite contrary to the law of gravity ; for the photograph (from which the figure was made) an assistant must have held them in place. The jagged front edge of the maxilla is exactly similar in the figure and in 17686 ; but the skull at present lacks a mandible. It is noteworthy that in the same paper (1862 p. 163) Blyth briefly catalogues the Asiatic Society rhinos, mentioning 'the skulls of an old male and of an adult female of SUMATRANUS, [and] the skin of the head of the latter... presented to the Society by E. O' Reilly, Esq. (then of Amherst) in 1847' ; but in his 1863 catalogue he mentions only the old male as being presented by O'Reilly, while the collector of the adult female skull (and the headskin) is not given. Sclater (1891) follows Blyth's catalogue in attributing only a single (male) skull to O'Reilly ; no headskin is even mentioned. Headskin there is, nonetheless, on display today in the Indian Museum ; while the acknowledged O'Reilly skull is far from being 'old'—it is, in fact, a juvenile—and probably a female. The present skull thus actually increases the number of documented specimens by giving a locality and collector to a 'no history' skull in Sclater's catalogue.

3. 17687. Skull, juvenile (Stage 3), with associated limb bones registered 450. ASB. Sclater's *g*. Tenasserim, collected by E. O'Reilly, 1847, supposedly male (but see above). This is certainly Blyth's (1862) plate III, fig. 3 and plate IV, fig. 2 (not fig. 4, as incorrectly stated by Blyth on p. 157), and is the same individual as the mounted head (in the Indian Museum), as recorded by Blyth. Despite Blyth's characterisation of it as 'adult', it is clearly far from mature.

4. 17692. Skull, young adult male. Sclater's *h*. Tenasserim, presented by Sir T H. Maddock, 1842, ASB. This is an edentulous skull, probably not one of those figured by Blyth.

5. 17689. Skull, young adult female. Sclater's *o*, presented by W. Rutledge, 1885, who imported it from Singapore. It is therefore most likely to be from Malaya like No. 1 above.

6. 17690. Skull, adult. The extreme breadth and long toothrow make it likely to be one of the ASB skulls of no history to which Sclater (1891 p. 205) draws attention, i.e. *k* or *l* ; *k* being present in the collection, it is doubtless *l*.

7. 19313. Skull with horns and mandible. There is no entry in either Blyth or Sclater corresponding to this description.

8. 17942. Skull, adult. No history or identifying marks.

9. 17949. Sclater's *k*, adult from ASB, no history. See under 6 above.

10. No number. Scapula and long bones of forelimb. Male, Tenasserim, presented by E. O'Reilly. ASB. Blyth's (1863) cat. No. 450D.

11. No number. Limb bones and some vertebrae. Female, no locality ; ASB. Blyth's (1863) cat No. 450B.

Significance of the material

R. unicornis

Although four of the Calcutta skulls of this species are of known locality, (Nepal in each case) the species appears at present to be monotypic. One of us (C. P. G) is investigating this proposition at present in collaboration with C. Guerin.

R. sondaicus

As can be seen from Table I, the differences between the five geographic isolates of *R. sondaicus* are not great ; the differences between the Javan, Sumatran and Malayan populations are not worth recognising at subspecific level, while the Vietnam and Bengal (Sundarbans) populations are somewhat more distinct and can be retained as subspecies (Guerin & Groves, 1980). *R. s. inermis*, Bengal, has a shorter basal length and so a less inclined occipital plane than *R. s. sondaicus* from Sundaland ; the toothrow is longer ; the occiput is broader and higher ; the skull is generally broader. (Face height and dorsal concavity depth, which also tend to distinguish this race, were not taken on many of the Calcutta skulls and so will not be included here). *R. s. annamiticus*, from Vietnam, has a remarkably short occipitonasal length,

so that the occipital plane is more forwardly inclined (contrary to *inermis*) ; the occiput (indeed the cranium as a whole) is rather narrow, but the zygomatic arches are comparatively flared.

Among the Calcutta skulls, as the premaxillae have not been retained in any skull, basal length is difficult to estimate ; although it has been attempted in a few cases (premaxilla length is generally about 60mm), basal to occipitonasal length ratios cannot be securely worked out. All three Sundarbans skulls (Table Ia) do, however, have rather less inclined occipital planes than the others ; the toothrow is long in all. Occiput breadth is very great in 19241, the only one of the three Sundarbans skulls for which this measurement is available ; occipital height is very great in two of the known Sundarbans skulls but not in 17688. The three skulls known to be from the Sundarbans, therefore, fit very well into the pattern previously established ; one (17688) not as well as the other two.

The Java skull is very like those previously examined from Java : relatively short occipitonasal length ; narrow ; small teeth ; low occiput.

It is perhaps the Tenasserim skull which is of most interest here, as previously only a single skull—and that a juvenile—has been known from this area. The Tenasserim population was perhaps continuous with that in Malaya, but the most northerly *sondaicus* until Vietnam to the northeast and the Sundarbans to the northwest. There is thus interest in seeing whether the Tenasserim skulls shown an approach to those from more northerly regions.

In Table Ia, skull 17685 (not absolutely certainly from Tenasserim, although very probably so) is compared with the previously analysed data. The skull is nearly adult but still rather small, so recalling *annamiticus* ; but its basal length is short compared to occipitonasal—an *inermis*-like feature, as is the long toothrow. The occiput is narrow like *annamiticus*, but not especially low, so being more like *sondaicus*. For its narrow skull the zygomatic arches are flared, again resembling *annamiticus*.

The only skull that is beyond question from Tenasserim is 17684, which is juvenile (Stage 4). Unfortunately no skulls of this developmental stage are known from Vietnam ; but the British Museum specimen from Tenasserim is of this age. The measurements of a Malayan skull of this age have been kindly sent by Dr. David Wells, of the Zoology Department, Kuala Lumpur.

It is to be noted (Table Ib) that the occipitonasal/basal ratio and broad occiput so characteristic of adult *R. s. inermis* has not developed by Stage 4. Evidently the occiput expands and grows backwards

TABLE. Ia. Cranial measurements of *R. sondaicus*: adults

	R. s. sondaicus										*R. s. annamiticus*				*R. s. inermis*				Calcutta Specimens				
	Java				Sumatra				Malaya				Vietnam				Bengal				p	l	s	q	t
																					17693	17685	17688	19241	3521
																					Java	Lower	Sund-	Sund-	Sund-
	$\bar{x}$	s	d	n	$\bar{x}$	s	d	n	$\bar{x}$	s	d	n	$\bar{x}$	s	d	n	$\bar{x}$	s	d	n		Burma	arbans	arbans	arbans
Occipitonasal l.	518.5	22.0		17	528.6	20.1		5	532.7	24.0		3	499.3	30.1		3	527.3	16.8		7	532	501	499	545	546
Basal l.	580.3	19.2		12	578.4	16.0		5	581.8	31.3		4	581.3	39.8		4	560.4	18.4		5	—	(531)	—	(573)	—
Toothrow l.	225.6	8.5		15	233.0	6.0		5	226.8	4.7		4	230.1	7.4		4	238.5	5.9		7	222	237	237	235	230
Zygomatic br.	346.2	13.2		16	350.4	16.2		5	361.8	3.3		4	343.5	15.3		4	359.1	9.8		7	337	355	338	374	370
Bimastoid br.	295.0	13.5		15	284.6	6.4		5	291.3	14.4		4	282.5	8.6		4	296.3	16.9		6	283	273	—	315	—
Occipital ht.	158.5	9.9		15	161.8	4.4		5	170.5	12.9		4	157.3	12.0		4	179.3	7.5		4	172	166	162	180	171
M^1br	54.8	1.6		10	56.9	2.8		7	58.6	2.2		4	56.0	3.4		4	57.4	2.3		6	—	60.5	57.0	59.0	—
M^2br	55.3	1.8		11	58.3	2.8		5	60.0	3.4		3	58.7	3.7		4	59.2	2.4		6	(64)	61.0	60.0	62.5	—
M^3br	48.0	2.7		12	54.3	2.0		3	45.8	4.3		3	53.1	3.3		3	50.2	1.8		7	51.0	52.0	51.0	53.3	51.0

TABLE IIa. Cranial measurements of *D. sumatrensis* : adults (stages 5-6).

	D. s. harrissoni			*D. s. sumatrensis*						*Subsp.*		*D. s. lasiotis*			Calcutta Specimens			
	Borneo			Sumatra			Malaya			Pegu		N. Burma			o 17689	a 17691	h 17692	n 17686
	$\bar{x}$	s d	n	$\bar{x}$	s d	n	$\bar{x}$	s d	n	$\bar{x}$	n	$\bar{x}$	s d	n	? Malaya	? Malaya	Tenas-serim	Tenas-serim
Occipitonasal l.	471.0	19.8	9	530.1	29.2	3	525.0	13.9	6	519.0	2	549.7	40.2	3	519	533	542	—
Basal l.	475.6	12.3	10	508.6	18.9	8	503.7	17.0	6	508.5	2	505.5	—	2	517	500	—	507
Toothrow l.	194.4	6.3	10	198.3	12.0	7	193.5	3.5	4	206.5	2	209.7	2.9	3	192	—	—	191
Zygomatic Br.	261.1	14.1	11	288.6	11.3	8	295.5	10.4	6	282.0	1	304.3	17.9	3	282	272	282	292
Occipital br.	116.9	8.6	11	127.5	5.5	10	120.3	9.9	6	141.0	2	156.0	10.2	3	121	117	133	139
Occipital ht.	114.0	5.1	9	114.9	3.9	8	119.4	4.5	6	128.3	2	126.7	3.1	3	123	121	127	122
M^1br.	48.7	1.8	14	49.0	2.2	18	50.9	1.8	6	47.3	2	54.0	2.0	3	50.0	48.5	—	53.0
M^2br.	48.7	1.9	8	51.0	2.4	13	52.3	2.2	4	50.8	2	54.6	0.8	3	53.0	49.5	—	53.5
M^3br.	42.4	2.7	5	45.6	2.8	8	47.3	0.6	3	48.0	1	48.3	—	2	41.0	—	—	47.0

relatively rapidly towards maturity. The two juvenile Tenasserim skulls are narrow compared to their size, the occiput being relatively narrow. The other characteristics—occiput height, skull breadth—vary so markedly between the two specimens that nothing can really be said about them.

In conclusion, then, it is probably most convenient to classify the Tenasserim population in *R. s. sondaicus* but the evidence—meagre as it is—suggests that there is some variation in the direction of the two more northerly subspecies.

D. sumatrensis

The subspecies of *Dicerorhinus sumatrensis* are much more clear-cut than those of *Rhinoceros sondaicus* (Groves, 1967). The fairly respectable sample sizes of *D. s. harrissoni* and *D. s. sumatrensis* amply confirm their distinctiveness ; since 1967 no further skulls of *D. s. lasiotis* have come to light but the differences from the other two remain quite large. Dr. G. G. Musser has kindly supplied the measurements of an adult female from Pegu (in the American Museum of Natural History, New York), which like those of the British Museum skull with this locality (Groves, 1967) are mainly intermediate between the races *sumatrensis* and *lasiotis* (toothrow length, occipital breadth) ; in occipital height the Pegu skulls resemble *lasiotis*.

The Calcutta skulls supposedly from Malaya (Table IIa) are in no way different from those previously measured. Again, it is the skulls from Tenasserim that are of special interest. The only available toothrow length (of 17686) falls in the range of *D. s. sumatrensis* ; its molar widths are however large like *lasiotis*. The occiput of 17686 is broad like Pegu but low ; that of 17692 fairly broad, but high like Pegu and *lasiotis*. Thus the two Tenasserim skulls show decided tendencies towards *lasiotis*—perhaps less markedly so than the two Pegu skulls, as one would expect from their more southerly origin. Whether the relationship between *D. s. sumatrensis* and *D. s. lasiotis* is clinal, or whether the Pegu-Tenasserim population as a whole represents a hybrid swarm, is difficult to say on the evidence of so few specimens ; some characters, especially the molar breadth measurements, suggest increased variability which would support the second hypothesis. For convenience, as in the analogous case of *R. sondaicus*, the Tenasserim (and Pegu) populations of *D. sumatrensis* are probably best classified in the southern subspecies, *D. s. sumatrensis*. However, cranial features of Z S I specimen of stage 3 from Tenasserim have been compared with that of Borneo and Sumatra and found to be somewhat different (Table IIb).

TABLE Ib. Cranial measurements of *R. sondaicus* : stage 4.

	R. s. sondaicus Java	*R. s. inermis* Bengal	Kuala Lumpur Skull C Perak	*BM* 1921 5.15.1 Tenasserim	*m* ZSI 1768 Tenasserim
Occipitonasal l.	508.8 (4)	486.5 (2)	490	503	499
Basal l.	547.3 (3)	552.5 (2)	(559)	(569)	(556)
Zygomatic Br.	342.0 (5)	326.0 (2)	(322)	345	317
Bimastoid Br.	281.5 (4)	251.5 (2)	244	252	254
Occipital ht.	153.8 (4)	164.5 (2)	—	150	171
M^1 br.	54.8 (10)	57.4 (6)	58.0	54.1	55.5

TABLE IIb. Cranial measurements of *D. sumatrensis* stage 3.

	D. s. harrissoni Borneo	*D. s. sumatrensis* Sumatra	*g* ZSI 17687 Tenasserim
Occipitonasal l.	443.4 (5)	490.0 (2)	451
Basal l.	461.7 (3)	484.5 (2)	—
Zygomatic br.	254.1 (5)	273.5 (2)	277
Bimastoid br.	105.8 (4)	114.0 (2)	120
Occipital ht.	115.0 (3)	115.0 (2)	128
M^1 br.	48.7 (14)	49.0 (18)	45.0

Types in the Calcutta collection

As noted above, three specimens of *D. sumatrensis* (as well as certain other specimens) were figured by Blyth (1862) : one of these (plate III, fig. 1) is definitely 17686, the second (plate III, fig. 3, also Plate V, fig. 2) is almost certainly 17687, while the third (Plate III, fig. 2, also Plate IV, fig. 3) appears no longer to be in the collection.

In 1873 Gray commented on the figures in Plate III. He noted the contrasts in their ages (fig. 1, the oldest ; fig. 2, 'half-grown' (nearly adult) ; fig. 3, the youngest), and the fact that the occiput in fig. 2 is more produced backward than the other two, while the hinder end of the mandible shelves in figs. 2 and 3 instead of being expanded and rounded on the lower edge. 'It may turn out', he wrote, 'that more than one species of two-horned rhinoceros inhabit Tenasserim'. The oldest skull, fig. 1, resembled the type skull (also aged !) of his recently-described species *Ceratorhinus* (=*Dicerorhinus*) *niger* whereas 'the lower jaw in the two younger specimens does not agree in form with the lower jaw of *C. niger* and therefore I should provisionally name them *C. blythi*'.

It is difficult to be sure from Gray's description exactly which of the three skulls is meant to represent his new race, and which is not; most likely, 'the two younger specimens,' i. e. figs., 2 & 3. The skull depicted by fig. 2 is lost, as noted above; fig. 3 is 17687, which is accordingly hereby designated lectotype of *Ceratorhinus blythi* Gray.

It is almost superfluous to add that a species named on the evidence of ageinfluenced characters is unlikely to withstand the test of time. As has been shown above, Tenasserim skulls do show some deviation, on average, from *D. s. sumatrensis*, in the direction of *lasiotis*; but it would be nonsensical to dignify this with a subspecific name. So *Ceratorhinus blythi* Gray, 1873, falls as a junior synonym of *D. s. sumatrensis*.

Summary

The paper deals with the documentation of the osteological collection of the Asian species of rhinoceros present in the Zoological Survey of India. Altogether 31 specimens have been documented. The skulls of the rhinoceros present in the Zoological Survey of India have been taxonomically compared with those present in the other museums of the world. It has been found that the difference between the five geographic isolates of *R. sondaicus* are not great; the differences between the Javan, Sumatran and Malayan population are not worth recognizing at subspecific level, while the Vietnam and Bengal population are somewhat more distinct.

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Rec. zool. Surv. India, 80 : 265-290,

A CHECK-LIST OF LEECHES OF INDIA

By

MAHESH CHANDRA

High Altitude Zoology Field Station, Zoological Survey of India
Solan (H. P.).

INTRODUCTION

In the Fauna of British India-Hirudinea, Harding and Moore (1927) have recorded 38 species and 6 subspecies of leeches from the present geographical limits of India (excluding Pakistan, Sri Lanka, Bangladesh and Burma). Since then, 16 more species have been added to the Indian leech fauna by Bhatia (1930, 1934 and 1939), Chelladurai (1934), Sanjeeva Raj (1951 and 1974) and Baugh (1960) ; and the distribution of a number of species have been extended to various parts of the country by them. The two species, *viz.*, *Glossiphonia complanata* Linnaeus and *Glossiphonia weberi* Blanchard are reduced to subspecific level by Soos (1969). Recently Soota (1956), Chandra (1966, 1976a, b, c and 1977) and Julka and Ghosh (1976) have considerably increased the distributional records of a number of species from Kashmir Valley ; Maharashtra ; Rajasthan ; Himachal Pradesh and Chhota Nagpur (Bihar) and Indian Coasts.

The present check-list deals with 52 species and 8 subspecies so far known from the Indian region. The species are arranged in the systematic order. The original and the latest references along with important synonyms have been mentioned under each species. The type-locality and type-depository has also been given. The distribution of each species in India as well as outside India has been mentioned. The works of Harding & Moore (1927), and Soos (1966, 1967a, 1967b, 1967c, 1969) have been followed for the preparation of keys for identification.

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KEY TO THE IDENTIFICATION OF INDIAN LEECHES

KEY TO INDIAN ORDERS

A.	Jawless : proboscis present ; strictly parasitic ; freshwater and marine forms. ...	RHYNCHOBDELLAE
B.	Jawed ; without proboscis ; sanguivorous ; freshwater and terrestrial forms. ...	ARHYNCHOBDELLAE

KEY TO THE INDIAN FAMILIES OF RHYNCHOBDELLAE

A.	Body cylindrical of flattened ; usually divided into distinct anterior and posterior regions ; anterior sucker generally cupuliform or discoid distinct from the body ; sometimes with paired lateral branchiae or pulsating vesicles. ...	PISCICOLIDAE
B.	Body ovate and flattened ; Anterior sucker ventral and fused with the body ; lateral branchiae and pulsating vesicles absent. ...	GLOSSIPHONIDAE

KEY TO THE INDIAN SPECIES OF FAMILY PISCICOLIDAE

1.	Eyes absent ; lateral branchiae and pulsating vesicles absent. ...	...	2
	Eyes present ; lateral branchiae or pulsating vesicles present. ...	...	4
2.	Body divided into distinct regions. ...	...	3
	Body not divided into distinct regions ...	*Piscicola caeca*	
3.	Body divided into three distinct regions of which anterior two are provided with fin-like processes, tubercles absent. ...	*Pterobdella amara*	
	Body divided into two distinct regions ; lateral fin-like processes absent, tubercles present. ...	*Pontobdellina macrothela*	
4.	Eyes one pair. ...	...	5
	Eyes 2 pairs. ...	*Piscicola olivacea*	
5.	Lateral branchiae present, pulsating vesicles absent. ...	...	6
	Lateral branchiae absent, pulsating vesicles present. ...	*Zeylanicobdella arugamensis*	
6.	Posterior region with less than eleven pairs of branchiae. ...	...	7
	Posterior region with eleven or more than eleven pairs of branchiae. ...	...	8
7.	5 pairs of branchiae. ...	*Ozobranchus margoi*	
	7 pairs of branchiae. ...	*Ozobranchus branchiatus*	
8.	Branchiae more than 20 pairs. ...	*Branchellion plicobranchus*	
	Branchiae 20 or less than 20 pairs. ...	...	9

9.	11 pairs of branchiae. ...	*Ozobranchus shipleyi*	
	20 pairs of branchiae. ...	*Ozobranchus polybranchus*	

KEY TO THE INDIAN SPECIES OF FAMILY GLOSSIPHONIDAE

1.	Eyes less than four pairs. ...	...	2
	Eyes four pairs. ...	...	18
2.	Mouth opening subterminal in the anterior sucker. ...	...	3
	Mouth opening in the middle of the anterior sucker. ...	...	8
3.	Eyes one pair. ...	...	4
	Eyes three pairs. ...	...	6
4.	Eyes on ring three. ...	*Placobdella emydae*	
	Eyes on ring two. ...	...	5
5.	Male gonopore between rings 24 and 25 ; total number of rings. 66. ...	*Placobdella horae*	
	Male gonopore between rings 25 and 26 ; total number of rings 70. ...	*Placobdella indica*	
	Male gonopore between rings 26 and 27 ; total number of rings 71. ...	*Placobdella undulata*	
6.	Crop with seven pairs of lateral diverticula. ...	*Placobdella ceylanica*	
	Crop with more than seven pairs of lateral diverticula. ...	...	7
7.	Eyes on rings 3, 4 and 7 ; male gonopore between rings 29 and 30. ...	*Paraclepsis praedatrix*	
	First two pairs of eyes on ring 2, third pair on ring 5 ; male gonopore between rings 27 and 28. ...	*Paraclepsis vulnifera*	
8.	Eyes one pair. ...	...	9
	Eyes more than one pair. ...	...	10
9.	Dorsal scute between ring 12 and 13 present ; eyes on ring 3 ; male gonopore between rings 24 and 25. ...	*Helobdella stagnalis*	
	Dorsal scute absent ; eyes on ring 4 ; male gonopore between rings 28 and 29. ...	*Helobdella nociva*	
10.	Crop with 6 or 7 pairs of lateral diverticula. ...	...	11
	Crop with 9 or more than nine pairs of lateral diverticula. ...	...	15
11.	Crop with 6 pairs of lateral diverticula. ...	...	12
	Crop with 7 pairs of lateral diverticula. ...	...	13

12.	First and second pairs of eyes on ring three, third pair on ring four.	...*Glossiphonia complanata complanaa*
	First and second pairs of eyes on ring four, third pair on ring five. ...	*Glossiphonia annandalei*
	First, second and third of eyes on ring 3, 4 and 5. ...	*Glossiphonia cruciata*
	First, second and third pair of eyes on ring 5, 7 and 8. ...	*Glossiphonia heteroclita*
	First, second and third pair of eyes on ring 6, 7 and 8. ...	*Glossiphonia weberi weberi*
13.	Head separated from body by necklike constriction ; Gonopores separated by two rings ; eye two pairs. ...	... 14
	Head not separated from body by necklike constriction ; gonopores separated by one and half ring ; eyes three pairs. ...	*Batracobdella hardingi*
14.	First pair of eye between ring 2 and 3 and second pair on ring 5. ...	*Batracobdella lobata*
	First pair of eye on ring 2 and second pair on ring 3. ...	*Batracobdella mahabiri*
	First pair of eye on ring 4 and second pair on ring 5. ...	*Batracobdella reticulata*
15.	Three pair of eyes ; cephalic region not dialated. ...	... 16
	Two pair of eyes ; cephalic region dialated. ...	... 17
16.	Eyes on ring 2, 3 and 5 ; gonopores separated by one and a half rings. ...	*Hemiclepsis bhatiai*
	Eyes on ring 3, 4 and 6 ; gonopores separated by two rings. ...	*Hemiclepsis viridis*
17.	Total number of rings 67. ...	*Hemiclepsis marginata marginata*
	Total number of rings 72. ...	*Hemiclepsis marginata asiatica*
18.	Eyes on ring 2, 4, 7 and 10. ...	*Theromyzon sexoculata*
	Eyes on ring 3, 5, 8 and 11. ...	*Theromyzon mathai*

KEY TO THE INDIAN FAMILIES OF ORDER ARHYNCHOBDELLAE

1.	Eyes never arranged in a regular arch on contiguous somites. ...	ERPOBDELLIDAE
	Eyes forming always a regular arch on contiguous somites. ...	... 2
2.	Third and fourth pair of eyes on contiguous annuli ; terrestrial forms. ...	HAEMADIPSIDAE
	Third and fourth pair of eyes separated by an annulus ; aquatic. ...	HIRUDIDAE

KEY TO THE INDIAN SPECIES OF FAMILY ERPOBDELLIDAE

1.	No dorsal canal from stomach to exterior. ...	...	2
	Dorsal canal from stomach to exterior present. ...	*Foraminobdella heptamerata*	
2.	No accessory post-cephalic eyes. ...	...	3
	Accessory post-cephalic eyes present. ...	...	5
3.	Eyes four pairs. ...	...	4
	Eyes three pairs. ...	*Barbronia weberi*	
4.	Gonopores separated by three rings. ...	*Erpobdella octoculata*	
	Gonopores separated by four rings. ...	*Erpobdella indica*	
5.	First pair of eyes on somite three ; gonopores separated by two to three rings. ...	*Herpobdelloidea laterоculata*	
	First pair of eyes on somite four ; gonopores separated by five rings. ...	*Nematobdella indica*	

KEY TO THE SPECIES OF FAMILY HIRUDIDAE

1.	Jaws small and week. ...	...	2
	Jaws well developed. ...	...	4
2.	Head not attenuated, stomach caecate, somite imperfectly 5 annulate. ...	*Myxobdella annandalei*	
	Head attenuated, stomach caecate, somite perfectly 5 annulate. ...	...	3
3.	Teeth coarse and all distichous. ...	*Haemopis indica*	
	Teeth imperfect in two series. ...	*Whitmania laevis*	
4.	Teeth absent or vestigial. ...	...	5
	Teeth well developed. ...	...	6
5.	Caudal sucker equal or exceeding body width....	*Dinobdella ferox*	
	Caudal sucker muchless than body width. ...	*Dinobdella notata*	
6.	Salivary papillae on jaws absent or rarely a few very small ones ; median ventral fissure on lip absent. ...	...	7
	Salivary papillae on jaws numerous and large ; median ventral fissure on lip present. ...	...	8
7.	Colour uniform ; no metameric spots. ...	*Hirudo asiatica*	
	Colour pattern longitudinally striped ; metameric spots present. ...	*Hirudo birmanica*	

8.	Vaginal stalk absent.	...	... 9
	Vaginal stalk well-developed.	...	... 10
9.	Gonopores separated by seven annuli.	...	*Poecilobdella javanica*
	Gonopores separated by five annuli.	...	*Poecilobdella manillensis*
10.	Vaginal stalk about equal in length to caecum.	...	*Poecilobdella granulosa*
	Vaginal stalk about twice the length of caecum.	...	*Poecilobdella viridis*

KEY TO THE INDIAN SPECIES OF FAMILY HAEMADIPSIDAE

1.	Somite VII 3-annulate and VIII 4-annulate.	...	2
	Somite VII 4-annulate and VIII 5-annulate.		*Haemadipsa dussumieri*
2.	Furrow pits obscure, when present on IX to XII ; Prehensile papilla on caudal sucker well developed.	...	... 3
	Furrow pits evident, on VIII to XI ; prehensile papilla on caudal sucker little developed.	...	... 5
3.	Eyes 3 and 4 on contiguous annuli.	...	... 4
	Eyes 3 and 4 separated by a complete or partial annulus.	...	*Haemadipsa montana*
4.	Colour pattern mottled with black above and below ; a black or dark stripe constant, no paler median dorsal field.	...	*Haemadipsa zeylanica cochiniana*
	A median dorsal yellow or greenish yellow line, colour reddish brown or orange mottled with black.	...	*Haemadipsa zeylanica zeylanica*
	A median dorsal black or dark line in paler median field ; ground colour variable with dark blotched spots.	...	*Haemadipsa zeylanica agilis*
	A median dorsal black or dark-line in a paler median field ; ground colour variable, dark spots or blotches absent or obscure.	...	*Haemadipsa zeylanica montivindicis*
5.	Colour brown with usually three black dorsal stripes ; sucker rays usually 74-76.	...	*Haemadipsa sylvestris*
	Colour velvety black alternating with cream or pale yellow stripes ; venter red ; sucker usually 86-94.	...	*Haemadipsa ornata*

CHECK LIST

Class : HIRUDINEA

Order : RHYNCHOBDELLAE

Family : PSCICOLIDAE

Genus : **Ozobranchus** de Quatrefagus, 1852

Ozobranchus shipleyi Harding

1909. *Ozobranchus shipleyi* Harding, *Proc. Camb. Phil. Soc.* **25** : 233. (Type-Locality : Sri Lanka ; Type-Deposited : Not known).

1921. *Ozobranchus jantseanus* Kaburaki, *Mem. Indian Mus.*, **5** (9) : 661.

1921. *Ozobranchus papillatus* Kaburaki, *Rec. Indian Mus.*, **22** (5) : 689.

1958. *Ozobranchus shipleyi*, Sanjeeva Raj, *J. Bombay nat. Hist. Soc.*, **52** : 476.

Distribution : India : Sambalpur (Orissa) ; River Ganges (West Bengal). Out side India : Pakistan.

Habitat : Marine and freshwater forms, parasitic on turtle and tortoises.

Ozobranchus polybranchus Sanjeeva Raj

1951. *Ozobranchus polybranchus* Sanjeeva Raj, *J. zool. Soc. India*, **3** (1) : 1-5. (Type-Locality : Porto Novo, Tamil Nadu ; Type-Deposited : Z. S. I.).

1954. *Ozobranchus polybranchus* Sanjeeva Raj, *J. Bombay nat. Hist. Soc.*, **52** : 477.

Distribution : India : Porto-Novo (Tamil Nadu).

Habitat : Marine form, parasitic on turtles.

Ozobranchus margoi (Apathy)

1890. *Pseudobranchellion margoi* Apathy, *Orvos-terres-zettud Ertesitte*, **15** : 110-113, 122-127 (Type-Locality : Bay of Naples ; Type-Deposited : Not known).

1974. *Ozobranchus margoi*, Sanjeeva Raj, *J. Mar. biol. Ass. India*, **16** (2) : 381-397.

Distribution : India : Bay of Bengal at Ennore (Tamil Nadu). Outside India : Japan and South America.

Habitat : Marine form ; parasitic on fishes.

Ozobranchtus branchiatus (Manzies)

1869. *Eubranchella branchiatus* Baird, *Proc. Zool. Soc. Lond.* 310-318. (Type-Locality and Type-Deposited : Not Known).

1974. *Ozobranchus branchiatus* Sanjeeva Raj, *J. mar. biol. Ass. India*, **16** (2) : 381-397.

Distribution : India : Pirotan Island, Gulf of Kutch (Gujarat) ; Pulicate Lake, Bay of Bengal (Tamil Nadu). Outside India : South China seas and Florida.

Habitat : Parasitic on fishes.

Genus : **Branchellion** Savigny, 1822

Branchellion plicobranchus Sanjeeva Raj

1953. *Branchellion plicobranchus* Sanjeeva Raj, *Curr. Sci.*, **22** : 310 (Type-Locality : Assumption Island, Bay of Bengal (Tamil Nadu) ; Type deposited : Not known).

1974. *Branchellion plicobranchus* Sanjeeva Raj, *J. Mar. biol. Ass. India*, **16** (2) : 381-397.

Distribution : India : Assumption Island, Bay of Bengal and fish market, Madras (Tamil Nadu) ; Vizagapatam (Andhra Pradesh) ; Quillon (Kerala) and Bombay (Maharashtra).

Habitat : Parasitic on marine fishes.

Genus : **Pontobdellina** Harding, 1927

Pontobdellina macrothela Schmarda

1861. *Pontobdella macrothela* Schmarda, *Neue Wirbellose Thiere*, **1** : 2, Fol. Leipzig. (Type-Locality : Kignston, Jamaica ; Type-Deposited : Not known).

1927. *Pontobdellina macrothela*, Harding, *Fauna Brit. India*, Hirudinea, 45-48.

Distribution : India : Off Gopalpur (Orissa). Outside India : Sumatra, Australia, Jamaica and New South Wales.

Habitat : Marine form ; parasitic on fishes.

Genus : **Piscicola** de Blainville, 1818

Piscicola olivacea Harding

1920. *Piscicola olivacea* Harding, *Mem. Indian Mus.*, **5** : 510. (Type-Locality ; Chilka Lake, Orissa ; Type-Deposited : Not known).

1927. *Piscicola olivacea* Harding, *Fauna Brit. India*, Hirudinea, 48-52.

Distribution : Chilka Lake (Orissa). Outside India ; China.

Habitat : Brackish-water form ; parasitic on fishes.

Piscicola caeca Kaburaki

1921. *Piscicola caeca* Kaburaki, *Mem. Indian Mus.*, **5** : 661. (Type-Locality : Chilka Lake, Orissa ; Type-Deposited : Not known).

1927. *Piscicola caeca*, Harding, *Fauna Brit. India*, Hirudinea, 52-53.

Distribution : India : Chilka Lake (Orissa).

Habitat : Brackish-water form, parasitic on fishes.

Genus : **Pterobdella** Kaburaki, 1921

Pterobdella amara Kaburaki

1921. *Pterobdella amara* Kaburaki, *Mem. Indian Mus.*, **5** : 668. (Type-Locality : Chilka Lake, Orissa ; Type-Deposited : Not known).

1927. *Pterobdella amara*, Harding, *Fauna Brit. India*, Hirudinea, 54-56.

Distribution : India : Chilka Lake (Orissa).

Habitat : Brackish-water form, parasitic on fishes.

Genus : **Zeylanicobdella** De Silva, 1963

Zeylanicobdella arugamensis De Silva

1963. *Zeylanicobdella arugamensis* De Silva, *Spolia zeylan*, **30** (1) : 47-53. (Type-Locality : Sri Lanka ; Type-Deposited : Ceylon Museum).

1974. *Zeylanicobdella arugamensis*, Sanjeeva Raj. *J. Mar. biol. Ass. India*, **16** (2) : 381-397.

Distribution : India : Pulicate Lake, Bay of Bengal (Tamil Nadu). Outside India : Sri Lanka and Malaysia.

Habitat : Brackish-water forms, parasitic on fishes.

Family : GLOSSIPHONIDAE

Genus : **Glossiphonia** Johnson, 1816

Glossiphonia annandalei Oka

1922. *Glossiphonia annandalei* Oka, *Rec. Indian Mus.*, **24** (4) : 521. (Type-Locality : Inle Lake, Burma ; Type-Deposited : Not known).

1927. *Glossiphonia annandalei*, Harding, *Fauna Brit. India*, Hirudinea, 65-68.

1969. *Glossiphonia annandalei*, Soos, *Acta. zool. hung.*, **15** : 397-454.

1976. *Glossiphonia annandalei*, Chandra, *Rec. zool. Surv. India*, **69** : 325-328.

Distribution : India : Jaisalmer (Rajasthan) ; Satara, Kolhapur (Maharashtra) ; Chilka Lake (Orissa). Outside India : Burma.

Habitat : Freshwater form ; occurs in lakes, tanks and pools, attached to submerged articles parasitic on molluscs.

Glossiphonia complanata complanata (Linnaeus)

1758. *Hirudo complanata* Linnaeus, *Systema Naturae*, 10th. ed. 650. (Type-Locality and Type-Deposited : Not known).

1816. *Glossiphonia tuberculata* Johnson, *Treatise On the Medicinal* Leech, 8, London.

1822. *Clepsine complanata* Savigny, *Systema des Annelides.*

1872. *Clepsine pallida* Verrill, *Rept. US. Fish Commissioner for* 1872-1873, **2** : 667.

1900. *Glossiphonia elegans* Castle, *Bull. Mus. Comp. zool. Harv.* **36** (2) : 667.

1927. *Glossiphonia complanata* Harding, *Fauna Brit. India*, Hirudinea, 57-60.

1969. *Glossiphonia complanata complanata*, Soos, *Acta zool. hung.*, **15** : 397-454.

Distribution : India : Srinagar (Jammu and Kashmir). Outside India : Japan, U. S. A. and Europe.

Habitat : Freshwater forms, occurs in tanks, ponds and slow moving streams, parasitic on molluscs.

Glossiphonia cruciata Bhatia

1930. *Glossiphonia cruciata* Bhatia, *Annls. Parasit. hum. comp.*, **8** : 344-348. (Type-Locality : Achabal, Kashmir ; Type-Deposited ; Not known).

1966. *Glossiphonia cruciata*, Soos, *Annls hist. -nat. Mus. natn. hung.*, **58** : 271-279.

Distribution : India : Achabal (Jammu and Kashmir).

Habitat : Lakes and ponds, free-living or attached to submerged articles.

Glossiphonia heteroclita (Linnaeus)

1761. *Hirudo heteroclita* Linnaeus, *Fauna Suecica, 2nd. ed.* (Type-Locality and Type-Deposited : Not known).

1805. *Hirudo pappillosa* Brawn, *Systematische Beschreibung Egelarten*, 40, Berlin.

1826. *Clepsine carenae* Moquin-Tandon, *Monographie de la famille des Hirudinees*, 40, Montpellier.

1894. *Glossiphonia heteroclita*, Blanchard, *Boll. Mus. Zool.*, Torino, 9 (192).

1927. *Glossiphonia heteroclita*, Harding, *Fauna Brit. India*, Hirudinea, 60-62.

1976. *Glossiphonia heteroclita* Mahajan & Chandra, *Rec. zool. Surv. India*, **71** : 143-148.

Distribution : India : Nagaur (Rajasthan) ; Monghyr (Bihar). Outside India : North America, Europe and Burma.

Habitat : Lakes and ponds, free living or attached to submerged articles, parasitic chiefly on molluscs.

Glossiphonia weberi weberi Blanchard

1897. *Glossiphonia weberi* Blanchard, *Zool. Ergeb. einer Reise in Niederlandische Ost-Indian*, Max Weber, **4** : 332. (Type-Locality : Sumatra ; Type-Deposited : Not known).

1927. *Glossiphonia weberi*, Harding. *Fauna Brit. India*, Hirudinea, 62-65.

1969. *Glossiphonia weberi weberi*, Soos, *Acta. zool., hung.* **15** : 397-454.

1977. *Glossiphonia weberi*, Chandra, *Rec. zool. Surv. India*, **73** (1-4) : 189-195.

Distribution : India : Harwan (Jammu and Kashmir) ; Sirmour, Solan, Bilaspur (Himachal Pradesh) ; Bhim Tal, Gurud Tal, Naini Tal

(Uttar Pradesh) ; Jodhpur, Bikaner (Rajasthan) ; Hoshangabad (Maharashtra) ; Bangalore (Karnatak) ; Bushampur, Sangur (Madhya Pradesh) ; Chhota Nagpur (Bihar) ; Diamond Harbour, Calcutta, Hooghly (West Bengal) ; Mangaldai (Meghalaya) ; Loktak Lake (Manipur) ; Cuttack, Puri, Chilka Lake (Orissa).

Out side India : Pakistan, Nepal, Burma and Sumatra.

Habitat : Lakes, tanks, pools and slow moving streams, free-living or attached to sub-merged, parasitic on molluscs and aquatic beetles.

Genus : **Batracobdella** Viguer, 1879

Batracobdella hardingi Baugh

1960. *Batracobdella hardingi* Baugh, *Parasitology*, **50** : 287-301. (Type-Locality : Monghyr, Bihar ; Type-Deposited : Z. S. I.).

1966. *Batracobdella hardingi*, Soos, *Annls hist.-nat. Mus. natn. hung.*, 58 : 271-279,

Distribution : India : Monghyr (Bihar).

Habitat : Pools ; attached to stones.

Batracobdella lobata (Bhatia)

1934. *Glossiphonia lobata* Bhatia, *Annls Parasit. hum. comp.*, **12** : 121-129. (Type-Locality ; Srinagar, Kashmir ; Type-Deposited : Not known).

1936. *Batracobdella lobata*, Autrum, *Bronns Klassen und Ordnungen des Tierreichs*, Teil 1, Lief 1, 1-95.

Distribution : India : Srinagar (Jammu and Kashmir).

Habitat : Lakes and tanks ; attached to submerged articles.

Batracobdella mahabiri Baugh

1960. *Batracobdella mahabiri* Baugh, *Zool. Anz.*, **165** : 468-477. (Type-Locality : Rewa, Madhya Pradesh ; Type-Deposited : Z. S. I.).

1966. *Batracobdella mahabiri*, Soos, *Annls hist.-nat. Mus. natn. hung.*, **58** : 271-279.

Distribution : India : Rewa (Madhya Pradesh).

Habitat : Tanks and pools ; attached to submerged articles.

Batracobdella reticulata (Kaburaki)

1921. *Glossiphonia reticulata* Kaburaki, *Rec. Indian Mus.*, **22**(5) : 689. (Type-Locality : Jullundhur, Punjab ; Type-Deposited : Z. S. I.).

1927. *Glossiphonia reticulata*, Harding, *Fauna Brit. India*, Hirudinea, 65.

1966. *Batracobdella reticulata*, Autrum, *Bronns Klassen und Ordnungen des Tierreichs.* Teil 1, Leifl ; 1-95.

1966. *Batracobdella reticulata*, Soos, *Annls hist.-nat. Mus. natn. hung.*, **58** : 271-279.

Distribution : India : Jullundhar (Punjab) ; Sirmour, Bilaspur, (Himachal Pradesh) ; Satara, Kolhapur (Maharashtra).

Habitat : Tanks, pools and slow moving streams, attached to submerged articles ; parasitic on molluscs.

Genus : **Helobdella** Blanchard, 1896

Helobdella nociva Harding

1924. *Helobdella nociva* Harding, *Ann. Mag. nat. Hist.*, Ser. 9, **14** : 489 (Type-Locality and Type-Deposited : Not known).

1927. *Helobdella nociva* Harding, *Fauna Brit. India*, Hirudinea, 70-72.

1977. *Helobdella nociva* Chandra, *Rec. zool. Surv. India*, **73** (1-4) : 189-195.

Distribution : India : Solan (Himachal Pradesh) ; Calcutta (West-Bengal) ; Puri (Orissa).

Habitat : Tanks and pools ; attached to submerged articles.

Helobdella stagnalis (Linnaeus)

1758. *Hirudo stagnalis* Linnaeus, *Systema Naturae*, 10th ed. (Type-Locality and Type-Deposited : Not known).

1826. *Clepsine bioculata* Moquin-Tondon, *Monographie de la famille des Hirudinees*, 40, Montpellier.

1896. *Helobdella stagnalis*, Blanchard, *Boll. Mus. Zool. Torino*, **11** (263) : 4.

1927. *Helobdella stagnalis*, Harding, *Fauna Brit. India*, Hirudinea, 68-70.

1977. *Helobdella stagnalis*, Chandra, *Rec. zool. Surv. India*, **73** (1-4) : 189-195.

Distribution : India : Srinagar (Jammu and Kashmir) ; Solan, Sirmour (Himachal Pradesh).

Outside India : Canada, U. S. A. and Paraguay.

Habitat : Tanks, ponds, slow moving streams ; attached to submerged articles, parasitic on molluscs, frogs and fishes.

Genus : **Placobdella** Blanchard, 1893

Placobdella ceylanica (Harding)

1909. *Glossiphonia ceylanica* Harding, *Proc. Camb. Phil. Soc.*, **15** : 233 (Type-Locality : Sri Lanka ; Type-Deposited : Not known).

1924. *Placobdella ceylanica*, Moore, *Proc. Acad. nat. Sci. Philad.*, **75** : 343-388.

1927. *Placobdella ceylanica*, Harding, *Fauna Brit. India*, Hirudinea, 73-74.

Distribution : India : Buldana (Madhya Pradesh) ; Chilka Lake (Orissa).

Outside India : Pakistan and Sri Lanka.

Habitat : Lakes and tanks, parasitic on molluscs, frogs and turtles.

Placobdella emydae Harding

1920. *Placobdella emydae* Harding, *Mem. Indian Mus.*, **5** : 510. (Type-Locality and Type-Deposited : Not known).

1927. *Placobdella emydae* Harding, *Fauna Brit. India*, Hirudinea, 74-76.

1977. *Placobdella emydae*, Chandra, *Rec. zool. Surv. India*, **73** (1-4) : 189-195.

Distribution : India : Solan (Himachal Pradesh) ; Chhota Nagpur (Bihar) : Calcutta, Hooghly (West Bengal) ; Sambalpur, Chilka Lake (Orissa) ; Hoshangabad, Nagpur, Satara (Maharashtra).

Outside India : Burma.

Habitat : Lakes, Tanks, pools ; attached to submerged articles, parasitic on turtles.

Placobdella fulva Harding

1924. *Placobdella fulva* Harding, *Ann. Mag. nat. Hist.*, Ser. **9, 14** : 489 (Type-Locality and Type-Deposited : Not known).

1927. *Placobdella fulva* Harding, *Fauna Brit. India*, Hirudinea, 78.

Distribution : India : Chhota Nagpur, Manbhum (Bihar)

Habitat : Lakes, Tanks, pools ; attached to submerged articles, parasitic on turtles.

Placobdella horai Baugh

1960. *Placobdella horai* Baugh, *Parasitology*, **50** : 287-301. (Type-Locality : Purulia, Bihar ; Type-Deposited ; Z. S. I.)

Distribution : India : Purulia (Bihar).

Habitat : Stream ; attached to dead *Unio* shell.

Placobdella indica Baugh

1960. *Placobdella indica* Baugh, *Zool. Anz.*, **165** : 468-477. (Type-Locality : Sitkundi (Monghyr), Bihar ; Type-Deposited : Z. S. I.).

Distribution : India : Monghyr (Bihar).

Habitat : Pools ; attached to submerged articles.

Placobdella undulata Harding

1924. *Placobdella undulata* Harding, *Ann. Mag. nat. Hist.*, Ser. **9, 14** : 489. (Type-Locality and Type-Deposited : Not known).

1927. *Placobdella undulata* Harding, *Fauna Brit. India*, Hirudinea, 78-81.

1977. *Placobdella undulata*, Chandra, *Rec. zool. Surv. India*, **73** (1-4) : 189-195.

Distribution : India : Jodhpur (Rajasthan) ; Solan (Himachal Pradesh).

Outside India : Sri Lanka.

Habitat : Tanks, pools and lakes, free-living or attached to submerged articles, parasitic on fish.

Genus : **Theromyzon** Philippi, 1867

Theromyzon sexoculata (Moore)

1898. *Protoclepsine sexoculata* Moore, *Proc. U. S. natn. Mus.*, **21** (1160) : 543-563. (Type-Locality : Siberia ; Type-Deposited : Not known).

1902. *Protoclepsis meyeri* Livanow, *Veid. zool. Jahrb.*, **27** : 339-362.

1927. *Theromyzon sexoculata*, Harding, *Fauna Brit. India* Hirudinea, 82-83.

Distribution : India : Loktak Lake (Manipur).

Outside India : Russia, Sweden and France.

Habitat : Lakes and small streams, attacks waterfowls.

Theromyzon mathai Bhatia

1939. *Theromyzon mathai* Bhatia, *Bull. Punj. Univ. Zool.*, 2 : 1-17. (Type-Locality : Srinagar, Kashmir ; Type-Deposited : Not known).

Distribution : India : Srinagar (Jammu and Kashmir).

Habitat : Lakes and tanks ; attached to submerged articles.

Genus : **Hemiclepsis** Vejdovsky, 1883

Hemiclepsis bhatiai Baugh

1960. *Hemiclepsis bhatiai* Baugh, *Parasitology*, **50** : 287-301. (Type-Locality : Kalipahar, Bihar ; Type-Deposited : Z. S. I.).

Distribution : India : Kalipahar (Bihar).

Habitat : Pools ; attached to submerged articles.

Hemiclepsis marginata asiatica Moore

1924. *Hemiclepsis marginata asiatica* Moore, *Proc. Acad. nat. Sci., Philad.* **76** : 243-388. (Type-Locality : Srinagar, Kashmir ; Type-Deposited : Z. S. I).

1927. *Hemiclepsis marginata asiatica* Harding, *Fauna Brit. India*, Hirudinea, 87-88.

1977. *Hemiclepsis marginata asiatica*, Chandra, *Rec. zool. Surv. India*, **73** (1-4) : 189-195.

Distribution : India : Srinagar (Jammu and Kashmir) ; Sirmour (Himachal Pradesh).

Habitat : Slow running streams ; attached to submerged articles.

Hemiclepsis marginata marginata (Müller)

1778. *Hirudo marginata* Müller, *Vermium terrestrium et fluviatiluem* **1** Pars 2.4° Havniel et Lipsie, 1773-1774. (Type-Locality and Type-Deposited : Not known).

1887. *Haemocharis marginata* de Fillippi, *Memonia sugli Annellidi della famiglia delle Sanguisughe*, Milano, 26.

1921. *Hemiclepsis marginata marginata*, Kuburaki, *Rec. Indian Mus.*, **22** : 694-695.

1927. *Hemiclepsis marginata marginata*, Harding, *Fauna Brit. India*, Hirudinea, 83-86.

1976. *Hemiclepsis marginata marginata*, Chandra, *Rec. zool. Surv. India*, **69** : 325-328.

Distribution : India : Kumaon (Uttar Pradesh) ; Murshidabad (West Bengal) ; Jodhpur (Rajasthan) ; Igatpur, Satara (Maharashtra) ; Hoshangabad (Madhya Pradesh). Outside India : Europe, Western Asia and Nepal.

Habitat : Lakes, tanks, pools ; free-living or attached to submerged articles, attacks certain molluscs.

Hemiclepsis viridis Chelladurai

1984. *Hemiclepsis viridis* Chelladurai, *Rec. Indian Mus.*, **36** : 345-352. (Type-Locality : Travancore, Kerala : Type-Deposited ; Z. S. I.).

Distribution : India : Travancore (Kerala).

Habitat : Tanks and pools ; attached to submerged articles.

Genus : **Paraclepsis** Harding, 1924

Paraclepsis praedatrix Harding

1924. *Paraclepsis praedatrix* Harding, *Ann. Mag. nat. Hist.*, Ser. 9, **14** : 489. (Type-Locality and Type-Deposited : Not known).

1927. *Paraclepsis praedatrix* Harding, *Fauna Brit. India*, Hirudinea, 88-90.

1976. *Paraclepsis praedatrix*, Chandra, *Rec. zool. Surv. India*, **69** : 325-328.

Distribution : India : Sirmour, Solan, Bilaspur (Himachal Pradesh) ; Kalka (Haryana) ; Purulia, Chhota Nagpur (Bihar) ; Mangaldai (Assam) ; Jodhpur, Nagaur, Jaisalmer, Jaipur Bikaner, Sikar (Rajasthan) ; Igatpuri, Kolhapur, Satara (Maharashtra).

Habitat : Lakes, tanks, pools, small streams ; free-living or attached to submerged articles, attacks molluscs amphibians and reptiles.

Paraclepsis vulnifera Harding

1924. *Paraclepsis vulnifera* Harding, *Ann. Mag. nat. Hist.*, Ser. 9, **14** : 489. (Type-Locality : Tanjore, Tamil Nadu ; Type-Deposited ; Not known).

1927. *Paraclepsis praedatrix* Harding, *Fauna Brit. India*, Hirudinea, 91-92.

1976. *Paraclepsis praedatrix*, Chandra, *Rec. zool. Surv. India*, **69** : 325-328.

Distribution : India : Bilaspur (Himachal Pradesh) : Nagaur, Bikaner (Rajasthan) ; Satara (Maharashtra) ; Tanjore (Tamil Nadu).

Habitat : Tanks and pools ; free-living or attached to submerged articles.

Order : ARHYNCHOBDELLAE

Family : ERPOBDELLIDAE

Genus : **Erpobdella** de Blainville, 1818

Erpobdella indicus Bhatia

1939. *Erpobdella indicus* Bhatia, *Bull. Punj. Univ. zool.*, **2** : 1-17. (Type-Locality : Srinagar, Kashmir ; Type-Deposited : Not known).

Distribution : India : Srinagar (Jammu & Kashmir).

Habitat : Tanks and pools ; attached to submerged stones.

Erpobdella octoculata (Linnaeus)

1758. *Hirudo octoculata* Linnaeus, *Systema Naturae*, 10th ed. (Type-Locality and Type-Deposited : Not known).

1894. *Herpobdella atomaria* Blanchard, *Boll. Musei. Zool. Anat.comp. R. Univ. Torino*, **9** (192) : 56.

1910. *Herpobdella atomaria*, Oka, *Annotnes. zool. jap.*, **7** (3) : 117.

1927. *Erpobdella octoculata*, Moore, *Fauna Brit. India*, Hirudinea, 130-135.

Distribution : India : Srinagar (Jammu & Kashmir).

Habitat : Tanks, small streams ; attached to stones.

Genus : **Barbronia** Johansson, 1918

Barbronia weberi (Blanchard)

1897. *Dina weberi* Blanchard, *Zool. Ergeb. Riese in Neiderlandisch Ost-India*, **4** : 332-355. (Type-Locality ; Java ; Type-Deposited : Not known).

1918. *Barbronia rouxi* Johansson, *Sarasin V. Roux*, Nova Calendonia, Zoologie, **2** (3) : 373-396.

1921. *Herpobdella hexoculata* Kaburaki, *Mem. Indian. Mus.*, **5** : 662-675.

1927. *Barbronia weberi*, Moore, *Fauna Brit. India*, Hirudinea, 135-140.

1976. *Barbronia weberi*, Chandra, *Rec. zool. Surv. India*, **69** : 325-328.

Distribution : India : Srinagar (Jammu and Kashmir) ; Sirmour, Solan, Simla, Bilaspur (Himachal Pradesh) ; Hoshangabad (Madhya Pradesh).

Outside India : Pakistan, Nepal, Java and Sumatra.

Habitat : Lakes, Tanks, pools and small streams ; attached to submerged articles.

Genus : **Nematobdella** Kaburaki, 1921

Nematobdella indica Kaburaki

1921. *Nematobdella indica* Kaburaki, *Rec. Indian Mus.*, **18** : 689-719. (Type-Locality : Dharampur, Himachal Pradesh ; Type-Deposited : Z. S. I.).

1927. *Herpodelloidea indica* Moore, *Fauna Brit. India*, Hirudinea, 144-148.

1970. *Nematobdella indica*, Soos, *Opusc. zool., Bpest*, **10** (2) : 313-324.

1976. *Herpobdelloidea indica*, Chandra, *Rec. zool. Surv. India*, **69** : 325-328.

Distrib ution : India : Nagaur, Jodhpur (Rajasthan) ; Bhushampur, Saugor (Madhya Pradesh) ; Satara (Maharashtra) ; Loktak Lake (Manipur).

Habitat : Tanks, pools and lakes ; free-living or attached to submerged articles.

Genus : **Herpobdelloidea** Kaburaki, 1921

Herpobdelloidea lateroculata Kaburaki

1921. *Herpobdelloidea lateroculata* Kaburaki, *Rec. Indian Mus.*, **18** : 689-719. (Type-Locality : Saugor, Madhya Pradesh ; Type-Deposited : Z. S. I.).

1927. *Herpobdelloidea lateroculata*, Moore, *Fauna Brit. India*, Hirudinea, 141-143.

1976. *Herpobdelloidea lateroculata*, Mahajan & Chandra, *Rec. zool. Surv. India*, **71** : 143-148.

Distribution : India : Jodhpur, Nagaur (Rajasthan) ; Bushampur, Saugor (Madhya Pradesh) ; Satara (Maharashtra) ; Loktak Lake (Manipur).

Habitat : Tanks, pools and lakes ; free-living or attached to submerged articles.

Family : TREMATOBDELLIDAE

Genus : **Foraminobdella** Kaburaki, 1921

Foraminobdella heptamerata Kaburaki

1921. *Foraminobdella heptamerata* Kaburaki ; *Rec. Indian Mus.*, **18** : 689-719. (Type-Locality : Nedurattan, Tamil Nadu ; Type-Deposited : Z. S. I.).

1927. *Foraminobdella heptamerata*, Moore, *Fauna Brit. India*, Hirudinea, 149-151.

Distribution : India : Nilgiri (Tamil Nadu).

Habitat : Small streams ; amphibious and burrowing in nature.

Family : HIRUDIDAE

Genus : **Myxobdella** Oka, 1917

Myxobdella annandalei Oka

1917. *Myxobdella annandalei* Oka, *Mem. Asiat. Soc. Beng.*, **6** : 159-176. (Type-Locality : Hong Kong ; Type-Deposited : Z. S. I.).

1927. *Myxobdella annandalei*, Moore, *Fauna Brit. India*, Hirudinea, 161-168.

Distribution : India : Yercaud (Tamil Nadu).

Outside India : Burma and Hong Kong.

Habitat : Small streams ; attached to submerged articles ; attacks cattles and human beings.

Genus : **Whitmania** Blanchard, 1887

Whitmania laevis (Baird)

1869. *Hirudo laevis* Baird, *Proc. zool. Soc. Lond.*, 310-318. (Type-Locality : Japan ; Type-Deposited : British Museum).

1884. *Microstoma pigrum* Whitman, *Proc. Am. Acad. Arts Sci.*, **20** : 76-87.

1896. *Whitmania laevis*, Blanchard, *Me'm. Soc. zool. Fr.*, **9** : 316-330.

1927. *Whitmania laevis*, Moore, *Fauna Brit. India*, Hirudinea, 169-175.

Distribution : India : Pagla Nadi (Manipur). Outside India : Burma, China, Formosa and Japan.

Habitat : Hill streams, ponds and ditches ; attached to submerged articles.

Genus : **Dinobdella** Moore, 1927

Dinobdella ferox (Blanchard)

1896. *Whitmania ferox* Blanchard, *Me'm. Soc. zool. Fr.*, **9** : 316-330. (Type-Locality : Not known ; Type-Deposited : British Museum).

1921. *Haemopis birmanica* Kaburaki, *Rec. Indian Mus.*, **28** : 689-719.

1927. *Dinobdella ferox*, Blanchard, *Fauna Brit. India*, Hirudinea, 175-185.

1977. *Dinobdella ferox*, Chandra. *Rec. zool. Surv. India*, **73** : (1-4) : 189-195.

Distribution : India : Bilaspur (Himachal Pradesh) ; Muktesar, Nainital (Uttar Pradesh) ; Darjeeling (West Bengal) ; Sikkim and Manipur.

Outside India : Sri Lanka and Siam.

Habitat : Ponds, paddy fields ; attacks cattles.

Dinobdella notata Moore

1927. *Dinobdella notata* Moore, *Fauna Brit. India*, Hirudinea, 185-189 (Type-Locality : Palni Hills, Tamil Nadu ; Type-Deposited : Z. S. I.).

Distribution : India : Kodaikanal, Ootacamund (Tamil Nadu).

Habitat : Marshy land : under stones, attacks cattles.

Genus : **Hirudo** Linnaeus, 1758

Hirudo asiatica Blanchard

1896. *Hirudo asiatica* Blanchard, *Me'm. Soc. zool. Fr.*, **9** : 316-330 (Type-Locality : Afghanistan ; Type-Deposited : British Museum).

1927. *Hirudo asiatica*, Moore, *Fauna Brit. India*, Hirudinea, 190-192.

Distribution : India : Kanpur (Uttar Pradesh).

Outside India : Afghanistan.

Habitat : Tanks and pools ; sometimes as ectoparasites on frogs or free-living.

Hirudo birmanica (Blanchard)

1894. *Haemopis birmanica* Blanchard, *Annali. Mus. civ. Stor. nat. Giacomo Doria*, 2 (14) : 113-118 (Type-Locality : Karenni Mountains, Burma ; Type-Deposited : Genova Museum).

1924. *Hirudo nipponica fuscolineata* Moore, *Proc. Acad. nat. Sci. Philad.*, **81** : 343-388.

1927. *Hirudo birmanica* Moore, *Fauna Brit. India*, Hirudinea, 192-199.

Distribution : India : Nagaur, Jodhpur (Rajasthan) ; Allahabad, (Uttar Pradesh) ; Sonali, Solmari (Bihar) ; Nilgiri Hills, Kilakaria (Tamil Nadu) ; Satara (Maharashtra) ; West Bengal.

Outside India : Pakistan, Sri Lanka and Burma.

Habitat : Rivers, streams, tanks and ponds ; free-living, attacks humanbeing and cattles.

Haemopis indicus Bhatia

1939. *Haemopis indicus* Bhatia, *Bull. Punj. Univ. zool.*, **2** : 1-17. (Type-Locality : Srinagar, Kashmir ; Type-Deposited : Not known).

Distribution : India : Srinagar (Jammu & Kashmir).

Habitat : Lakes and tanks.

Genus : **Poecilobdella** Blanchard, 1893

Poecilobdella javaniea (Wahlberg)

1856. *Sanguisuga javanica* Wahlberg, *Ofversigt Kongl. vet. Akad ; Forth*, 233-234. (Type-Locality : Java ; Type-Deposited : Not known).

1886. *Hirudinaria javanica*, Whitman, *Q. Jl. microsc. Sci.*, **26** : 373-376.

1897. *Limnatis* (*Poecilobdella*) *javanica*, Blanchard, *Zool. Ergeb. Reise in Neiderlandisch Ost. Indian*, **4** : 349-351.

1927. *Hirudinaria javanica*, Moore, *Fauna Brit. India*, Hirudinea, 210-218.

1970. *Poecilobdella javanica*, Soos, *Opusc. zool., Bpest*, **10** (2) 313-324.

Distribution : India : West Bengal ; Sikmai Turail (Assam) ; Manipur.

Outside India : Sri Lanka, Burma, Java, Sumatra, Malaysia and Phillippines.

Habitat : Paddy fields, tanks and pools ; attacks cattles and humanbeings, used for medicinal purposes.

Poecilobdella manillensis (Lesson)

1824. *Hirudo manillensis* Lesson, *Revue Zoologique Societe Curierieme*, **8** (Type-Locality : Luzon, Phillippines Islands ; Type-Deposited : Not known).

1861. *Hirudo multistriata* Schmarda, *Neue Turbellarien, Rotatorien und Anneliden*, Leipzig, 2te Halfte, Leeches, 2-7.

1893. *Limnatis* (*Poecilobdella*) *granulosa* Blanchard, *Boll. Musei. Zool. Anat. comp. R. Univ. Torino*, **7** (145) : 32.

1924. *Limnatis* (*Poecilobdella*) *manillensis*, Moore, *Proc. Acad. nat. Sci. Philad.* **81** : 343-388.

1927. *Hirudinaria manillensis*, Moore, *Fauna Brit. India*, Hirudinea, 218-226.

1970. *Poecilobdella manillensis*, Soos, *Opusc. zool., Bpest*, **10** (2) : 313-324.

Distribution : India : Landaur (Uttar Pradesh) ; Darjeeling, Calcutta (West Bengal) ; Cachar (Assam) ; Karnataka ; Cochin (Kerala).

Outside India : Pakistan, Sri Lanka, Burma, Borneo, Malaysia, Phillippines and China.

Habitat : Paddy fields, tanks and pools, rivers ; attacks cattles and humanbeings, used for medicinal purposes.

Poecilobdella granulosa (Savigny)

1820. *Sanguisuga granulosa* Savigny, *Systeme des Annelides,* Paris. (Type-Locality : Pondicherry ; Type-Deposited : Not known).

1846. *Hirudo granulosa* Moquin-Tandon, *Monograhie de la femille des Hirudinees,* 2nd ed., Paris.

1898. *Limnatis* (*Poecilobdella*) *granulosa,* Blanchard, *Boll. Musei Zool. Anat. comp. R. Univ. Torino,* **8** : 26.

1921. *Limnatis* (*Poecilobdella*) *granulosa,* Kaburaki, *Mem. Indian Mus.,* **5** : 673-675.

1927. *Hirudinaria* (*Poecilobdella*) *granulosa,* Moore, *Fauna Brit. India,* Hirudinea, 226-238.

1970. *Poecilobdella granulosa,* Soos, *Opusc. zool., Bpest,* **10** (2) : 313-324.

1977. *Hirudinaria granulosa,* Chandra, *Rec. zool. Surv. India,* **73** (1-4) : 189-195.

Distribution : India : Patiala (Punjab) ; Bilaspur (Himachal Pradesh) ; Kumaon, Mathura, Agra, Bahraich (Uttar Pradesh) ; Ahmedabad (Gujarat) ; Almanabad (Maharashtra) ; Berar (Madhya Pradesh) ; Madras (Tamil Nadu).

Outside India : Sri Lanka, Nepal and Burma.

Habitat : Rivers, marshes, swamps, tanks and pools ; attacks cattles, highest altitudinal record is 3,000 mts.

Poecilobdella viridis Moore

1927. *Hirudinaria* (*Poecilobdella*) *viridis* Moore, *Fauna Brit. India,* Hirudinea, 239-243. (Type-Locality : Travancore, Kerala ; Type-Deposited : Z. S. I.).

1966. (1970). *Hirudinaria viridis,* Chandra, *Rec. zool. Surv. India,* **64** (1-4) : 107-110.

1970. *Poecilobdella viridis,* Soos, *Opusc. zool., Bpest,* **10** (2) : 313-324.

Distribution : India : Bilaspur (Himachal Pradesh) ; Varanasi (Uttar Pradesh) ; Etakare (Tamil Nadu) ; Travancore (Kerala).

Habitat : Paddy fields and ponds ; attacks cattles.

Family : HAEMADIPSIDAE

Genus : **Haemadipsa** Tennant, 1859

Haemadipsa zeylanica zeylanica (Moquin-Tandon)

1826. *Sanguisuga zeylanica* Moquin-Tandon, *Monographie de la famille des Hirudinees,* Montpellier. (Type-Locality : Sri Lanka ; Type-Deposited : Not known).

1846. *Hirudo zeylanica* Moquin-Tandon, *Monographe de la famille des Hirudinees* 2nd. ed., Paris.

1866. *Haemadipsa ceylanica*, Whitman, *Q. Jl. microsc. Sci.*, **24** : 317-416.

1894. *Haemadipsa zeylanica*, Blanchard, *Mus. zool. Anthr. Etch. du Dresden*, No. 4., 5.

1927. *Haemadipsa zeylanica*, Moore, *Fauna Brit. India*, Hirudinea, 255-264.

1967. *Haemadipsa zeylanica zeylanica*, Soos, *Acta zool., hung.*, **13** (3-4) : 417-432.

1977. *Haemadipsa zeylanica*, Chandra, *Rec. zool. Surv. India*, **73** (1-4) : 189-195.

Distribution : India : Sirmour (Himachal Pradesh) ; Ankaling Village (Arunachal Pradesh).

Outside India : Sri Lanka.

Habitat : Deep dampy forests ; upto 3500 mts. height, attacks cattles and humanbeings.

Haemadipsa zeylanica cochiniana Moore

1927. *Haemadipsa zeylanica cochiniana* Moore, *Fauna Brit. India*, Hirudinea, 265-266. (Type-Locality : Cochin, Kerala ; Type-Deposited : Z. S. I.).

1932. *Haemadipsa cochiniana* Moore, *Rec. Indian Mus.*, **34** (1) : 1-6.

1967. *Haemadipsa zeylanica cochiniana*, Soos, *Acta zool., hung.*, **13** (3-4) : 417-432.

Distribution : India : Nilgiri Hills (Tamil Nadu) ; Cochin (Kerala) ; N. Kanara (Maharashtra).

Habitat : Deep dampy forests ; attacks cattles and humanbeings.

Haemadipsa zeylanica agilis Moore

1927. *Haemadipsa zeylanica agilis* Moore, *Fauna Brit. India*, Hirudinea, 266-267. (Type-Locality : Naini Tal, Uttar Pradesh ; Type-Deposited : Z. S. I.)

1967. *Haemadipsa zeylanica agilis*, Soos, *Acta. zool., hung.*, **13** (3-4) : 417-432.

1977. *Haemadipsa zeylanica agilis*, Chandra, *Rec. zool. Surv. India*, **73** (1-4) : 189-195.

Distribution : India : Sirmour, Chamba (Himachal Pradesh) ; Naini Tal, Almora, Kumaon, Landour, Muktsar, (Uttar Pradesh) ; Arunachal Pradesh.

Outside India : Nepal.

Habitat : Grassy lands and jungles : attacks cattles and humanbeings.

Haemadipsa zeylanica montivindicis Moore

1927. *Haemadipsa zeylanica montivindicis* Moore, *Fauna Brit. India*, Hirudinea, 267-268. (Type-Locality : Darjeeling, West Bengal ; Type-Deposited : Z. S. I.).

1966. (1970). *Haemadipsa zeylanica montivindicis*, Chandra, *Rec. zool. Surv. India* **64** (1-4) : 107-110.

Distribution : India : Darjeeling (West Bengal) ; Ghumti (Assam) ; Kalimpong (Sikkim) ; Arunachal Pradesh.

Habitat : Damp ravines and drippy forests ; upto 3000 mts. height, attacks cattles and human beings.

Haemadipsa montana Moore

1927. *Haemadipsa montana* Moore, *Fauna Brit. India,* Hirudinea, 269-276. (Type-Locality : Palni Hills, Tamil Nadu ; Type-Deposited : Z. S. I.).

1966. (1970) *Haemadipsa montana,* Chandra, *Rec. zool. Surv. India,* **64** (1-4) : 107-110.

Distribution : India : Darjeeling (West Bengal) ; Makaibari, Aplane, Gey, Gangtok (Sikkim) ; Moshing, Chug, Shergaon (Arunachal Pradesh) ; Palni Hills (Tamil Nadu).

Habitat : Deep dampy forests ; upto 3000 mts. height, attacks cattles and humanbeings.

Haemadipsa sylvestris Blanchard

1894. *Haemadipsa sylvestris* Blanchard, *Annali Mus. civ. Stor. nat.* Giacomo Doria, 2 (14) : 113-118 (Type-Locality : Carin, Burma ; Type-Deposited : Not known).

1927. *Haemadipsa sylvestris,* Moore, *Fauna Brit. India,* Hirudinea, 276-284.

1966. (1970) *Haemadipsa sylvestris,* Chandra, *Rec. zool. Surv. India,* **64** (1-4) : 107-110.

Distribution : India : Naini Tal, Bahraich (Uttar Pradesh) ; Darjeeling, Calcutta (West Bengal) ; Amatula, Padamchen (Sikkim) ; Shillong, Cachar, Cherrapungi (Assam) ; Jhumla, Moshing, Donkochu, Shergaon, Sangloo, Domkho (Arunachal Pradesh).

Outside India : Burma, Java and Sumatra.

Habitat : Swamps and dampy places ; upto 1500 mts. height ; attacks cattles and human beings.

Haemadipsa ornata Moore

1927. *Haemadipsa ornata* Moore, *Fauna Brit. India,* Hirudinea, 284-289. (Type-Locality : Darjeeling, West Bengal ; Type-Deposited ; Z. S. I.).

Distribution : India : Darjeeling (West Bengal) ; Kamrup (Assam).

Habitat : Drippy forests ; upto 1000 mts. height ; attacks cattle and human beings.

Haemadipsa dussumieri Blanchard

1917. *Haemadipsa dussumieri* Blanchard, *Bull. Soc. Path. exot.* **10** : 640-675 (Type-Locality : South India ; Type-Deposited : Paris Museum).

1927. *Haemadipsa dussumieri,* Moore, *Fauna Brit. India,* Hirudinea, 289-290.

Distribution : South India.

SUMMARY

The Present paper deals with 52 species and 8 subspecies of leeches belonging to 25 genera and 5 families so far known from India within the present geographical limits. The Type-Locality and Type-Depository and their distribution outside India has also been mentioned under each species.

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NOTES ON THE BIOGEOGRAPHY OF NEUROPTERA : PLANIPENNIA FROM CERTAIN AREAS OF THE NORTH-WEST HIMALAYAN AND NORTHERN PENINSULAR SECTORS OF INDIA

By

S. K. Ghosh

Zoological Survey of India, Calcutta.

The present paper is an endeavour to highlight a few important aspects on both the inland and exotic patterns of distribution related to the taxonomical studies of certain species of the Neuropteran suborder Planipennia from the less explored areas of two states in India and to establish new locality records for some of them. Besides, taxonomic annotations are also provided for some of the species, as and when required.

The material for study were available from the different surveys made by various parties and also from the old named collections at Zoological Survey of India. These comprise 23 species belonging to 19 genera under 5 families occuring at variable altitudes between *ca* 560 and 3340 metres in the areas surveyed. Our knowledge of the fauna from Uttar Pradesh of the North-West Himalayan and both Uttar Pradesh and Madhya Pradesh of the Northern Peninsular sectors of India is rather far from complete. Hence, the scientific results of more extensive explorations of the fauna from these areas are likely to augment further knowledge of the group concerned. It is not out of place to mention here that 11 species were already reported from Himachal Pradesh in the North-Western Himalayas by the author (*vide* Ghosh, 1977). Majority of the species are known to occur in the identical ranges of both the aforesaid states and also in other parts of India. Amongst the species examined, 17 are known from Uttar Pradesh, out of which 14 are endemic and the rest are exotic in distribution ; most of the species, however, occur in the Himalayan sector. Of the 9 species from Madhya Pradesh, all but one are confined to the Indian subregión. Only four species are mutually common in both the states. Besides, 10 other species from Madhya Pradesh and 3 species from Uttar Pradesh have not been reported at all from the areas under consideration. For the relevant synonymy list of majority of the species dealt with here, the check-list of Indian Planipenna (*vide* Ghosh & Sen, 1977) may be consulted. The precise locality data of

several species were not provided by the earlier workers and the areas as given in the original literature, have been put in the "Inverted Commas" under the distributional column of such species. All the forms endemic in India, those constituting new locality records and also those mutually common in both the states, are respectively marked with asterisk (*), dagger (†) and triangle (△) in the text.

I. Family Osmylidae

1. * † **Parosmylus prominens** Needham

1909. *Parosmylus prominens* Needham, *Rec. Indian Mus.*, 3 : 209.

Material examined : Uttar Pradesh : Garhwal : 4 exs., Ghangria, alt. *ca* 3040m., 13-14. vi. 1958 ; 1 ex., Pavelor, 17. vi. 1958 (*B. S. Lamba* coll.).

Distribution : India : Uttar Pradesh ; Himachal Pradesh.

Remarks : Kuwayama (1962) merged the genus *Parosmylus* Needham with *Osmylus* Latreille without assigning proper reasons. Therefore, the author agrees with the Needham's views in so far as the placement of the species under the genus is concerned. The species, originally described from Kulu and Lahoul of Himachal Pradesh, is for the first time reported from Uttar Pradesh and exhibits endemic distribution in India.

2. * **Parosmylus belaae** Ghosh and Sen

1968. *Parosmylus belaae* Ghosh and Sen, *Zool. Anz.*, Bd. **180**, Heft 1/2 : 107.

Material examined : Uttar Pradesh : Garhwal : 1 ex., Ukhal, alt. *ca* 2720m., 16. v. 1958 (*B. S. Lamba* coll.).

Distribution : India : Uttar Pradesh.

Remarks : The species is hitherto not known from any other state *cum* union territory of India.

3. † **Spilosmylus tuberculatus** (Walker)

1853. *Osmylus tuberculatus* Walker, *Cat. Brit. Mus. Neur.*, 2 : 255.

1914. *Spilosmylus tuberculatus*, Nakahara, *Annotnes zool. jap.*, 8 : 502.

Material examined : Madhya Pradesh : Balaghat : 7 exs., Muki, 12-16. ix. 1957 ; 1 ex., Baihar, 10. ix. 1957 (*B. Biswas* coll.).

Distribution : Taiwan ; India (Maharashtra ; Madhya Pradesh) ; Indo-Malayan subregion ; Japan.

Remarks : Walker (1853) recorded the species from "East Indies" and Banks (1937), from "Malay Peninsula" and "Sunda Islands" of the Indo-Malayan subregion but none of them mentioned any specific locality for the species. Ghosh (1978) recorded the species for the first time from Maharashtra.

4. * **Hyposmylus punctipennis** (Walker)

1859. *Osmylus punctipennis* Walker, *Trans. R. ent. Soc. Lond.*, 5 : 183.

1870. *Hyposmylus punctipennis*, MacLachlan, *Entomologist's mon. Mag.*, 6 : 200-201.

Material examined : Uttar Pradesh : Garhwal, (Kalidhang Expedition), Lanka, alt. *ca* 2800m., 13. vii. 1974 (*H. C. Ghosh* coll.).

Distribution : INDIA : Uttar Pradesh ; "India Septentrional" and 'Kunawur'.

Remarks : The author agrees with MacLachlan's (1870) view regarding the placement of the species under his genus *Hyposmylus*.

II. Family CHRYSOPIDAE

5. * † **Chrysopa (Chrysoperla) sanandensis** Ghosh

1977. *Chrysopa (Chrysoperla) sanandensis* Ghosh, *Entomon*, 2 (no. 1) : 103.

Material examined : Madhya Pradesh : Bastar survey, 1978-1979 : 2 exs., Kanker rest house, 4. i. 1979 ; 1 ex., Bodhghat, Jagdalpur, 13. xii. 1978 ; 3 exs., Dongaghat, Jagdalpur, 12. xii. 1978 (*M. S. Shishodia and party* coll.).

Distribution : INDIA : Gujarat ; Madhya Pradesh.

6. * **Tumeochrysa indica** Needham

1909. *Tumeochrysa indica* Needham, *Rec. Indian Mus.*, 3 : 204.

Material examined : Uttar Pradesh : Garhwal, Dhakwania, alt. *ca* 3340 m., 4. vii. 1958 (*B. S. Lamba* coll. : On the Indo-Swiss expedition, 1958).

Distribution : INDIA : Himachal Pradesh ; Uttar Pradesh.

Remarks : The author has casually come across this species from the North-Eastern Himalayas, but it was hitherto restricted to the North-Western Himalayas, as on record.

III. Family NEMOPTERIDAE

7. * † △ **Croce filipennis** (Westwood)

1841. *Nematoptera filipennis* Westwood, *Proc. zool. Soc., Lond.*, p. 13.

1909. *Croce filipennis*, Needham, *Rec. Indian Mus.*, **3** : 196.

Material examined : Uttar Pradesh : 6 exs., Lucknow, 7. iv. 1908 (*R. H.* coll.) ; Madhya Pradesh : 1 ex., Jabalpur, Ghamapur, 24. iii. 1964 (*J. S. Bhatti* coll.).

Distribution : INDIA : Uttar Pradesh ; Gujarat ; Maharashtra ; Madhya Pradesh ; Bihar : Orissa ; West Bengal.

Remarks : The species is a new record for Madhya Pradesh.

IV. Family MYRMELEONIDAE

8. * † Stiphroneura inclusa (Walker)

1853. *Myrmeleon inclusus* Walker, *Cat. Brit. Mus., Neur.*, **2** : 327.

1909. *Stiphroneura inclusa*, Needham, *Rec. Indian Mus.*, **3** : 200.

Material examined : Madhya Pradesh : 1 ex., Balaghat, Muki, alt. *ca* 560m., 17. ix. 1957 (*B. Biswas* coll.).

Distribution : INDIA : Sikkim ; Madhya Pradesh.

Remarks : The species, hitherto confined to the North-Eastern Himalayas, constitutes a new locality record for Northern Peninsular India, as mentioned above.

9. † * △ **Creoleon griseus** (Klug)

1834. *Myrmeleon griseus* Klug, *Symb. Phys.*, IV, t. 36.

1972. *Creoleon griseus*, Holzel, *Beitr. naturk. Forsch. SüdwDtl.*, **1** : 61.

Material examined : Madhya Pradesh : Bastar Survey, 1978-1979 : 2 exs., Gidam, 20. xii. 1978 ; Kanker, 2. i. 1979 (*M. S. Shishodia and party* coll.) ; Uttar Pradesh : 1 ex., Allahabad, 2. v. 1978 (coll. nil).

Distribution : EGYPT ; SUDAN ; ISRAEL ; IRAN ; INDIA (Maharashtra ; "North India" ; Madhya Pradesh ; Bihar ; West Bengal ; Orissa ; Tamil Nadu).

Remarks : The species is distributed in Ethiopian, Palaearctic and Oriental regions of the globe. The species is a new record for Madhya Pradesh.

10. * **Distoleon verendus** (Walker)

1853. *Myrmeleon verendus* Walker, *Cat. Brit. Mus. Neur.*, **2** : 342.

Material examined : Uttar Pradesh : 1 ex., Tehri, Kay, alt. *ca* 1530 m., 5. iv. 1958 ; 2 exs., Almorah, Loharkhet, alt. *ca* 1660 m., 19. x. 1958. (*B. S. Lamba* coll.) ; 1 ex., Tehri Garhwal, Sayanacheti, alt. *ca* 1900 m., 31. viii. 1979 (*S. K. Gupta and party* coll.).

Distribution : INDIA : Himachal Pradesh ; Uttar Pradesh ; "North India".

Remarks : The species has been considered under *Distoleon* Banks after Holzel (1972), who treated *Formicaleon* Banks as a congener of the former.

11. * **Macronemurus nefandus** (Walker)

1853. *Myrmeleon nefandus* Walker, *Cat. Brit. Mus. Neur.*, **2** : 357.

1868. *Macronemurus nefandus*, MacLachlan, *J. Linn. Soc.*, **9** : 278.

Material examined : Uttar Pradesh : 1 ex., Dehra Dun ; date & coll. nil.

Distribution : INDIA : Himachal Pradesh ; Uttar Pradesh.

12. * † **Myrmeleon tenuipennis** Rambur

1842. *Myrmeleon tenuipennis* Rambur, *Hist. nat. Ins. Neur.*, p. 405.

Material examined ; Madhya Pradesh : Bastar Survey, 1978-1979 : 4 exs. Gidam, P. W. D. Rest house, 21. xii. 1978 (*M. S. Shishodia and party* coll.).

Distribution : INDIA : Maharashtra ; Madhya Pradesh, "North India".

13. **Myrmeleon** sp.

Material examined : Uttar Pradesh : 1 ex., Garhwal, (Indian Kalidhang Expedition), Lanka, 13. vii. 1974 (*H. C. Ghosh* coll.).

Remarks : The identification of the material upto species is not possible due to the lack of male specimen at hand. The species, however, seems to be allied to *M. circumcinctus* Tjeder from Israel.

14. **Hagenomyia sagax** (Walker)

1853. *Myrmeleon sagax* Walker, *Cat. Brit. Mus. Neur.*, **2** : 382.

1913. *Hagenomyia sagax*, Esben-Petersen, *Ent. Mitt.*, **2** : 223.

Material examined : Uttar Pradesh : Garhwal : 1 ex., Topoban, 11. viii. 1958 ; 1 ex., Birahi, alt. *ca* 2130 m., 15. viii. 1958 ; 1 ex., Rini,

alt. *ca* 2130 m., 27. viii. 1958 ; 2 exs., Joshimath, alt. *ca* 2130 m., 31. viii. 1958 ; 1 ex., Ghat, alt. *ca* 1160 m., 17. viii. 1958 ; Almorah : 1 ex., Loharkhet, alt., *ca* 1660 m., 19. ix. 1958 (*B. S. Lamba* coll.).

Distribution : TAIWAN ; INDIA (Himachal Pradesh ; Uttar Pradesh ; Assam ; West Bengal).

Remarks : The species was formerly placed under the genus *Myrmeleon* Linn. by Walker (1853). But later it was transferred to the genus *Hagenomyia* Banks by Nakahara (1971). The species, formerly recorded from the Kumaon Himalayas by Needham (1909), extends also to the Garhwal Himalayas as has been presently observed. It is hitherto confined to the Oriental region.

15. * † **Nesoleon perpunctatus** Banks

1931. *Nesoleon perpunctatus* Banks, *Psyche*, **38** : 60.

Material examined : Madhya Pradesh : 1 ex., Balaghat, Muki, 26.viii. 1957 (*B. Biswas* coll.).

Distribution : INDIA : Andhra Pradesh ; Madhya Pradesh.

16. * † △ **Palpares pardus** (Rambur)

1842. *Myrmeleon pardus* Rambur, *Hist. nat. Ins. Neur.*, p. 375.

1868. *Palpares pardus*, Mac Lachlan, *J. Linn. Soc.*, **9** : 275.

Material examined : Uttar Pradesh : 1 ex., Dehra Dun, New forest, viii. 1952 (*O. Singh* coll.) ; 2 exs., Almorah, alt. *ca* 1070 m., 25. ix. 1958 (*B. S. Lamba* coll.) ; Madhya Pradesh ; Balaghat : 2 exs., Baihar, 23-24. viii. 1957 ; 4 exs. Muki, 28. viii. 1957, 18-19. ix. 1957 ; 1 ex., Muki, Banjar valley, alt. *ca* 560 m., 25. viii. 1957 ; 2 exs., Supkhar Hallon valley, alt. *ca* 690 m., 26-27. ix. 1957 (*B. Biswas* coll.).

Distribution : INDIA : North-Western Himalayas ; Madhya Pradesh ; Sikkim ; West Bengal ; Bihar ; Orissa ; Maharashtra, Southern Peninsula.

Remarks : The species seems to exhibit a rather cosmopolitan distribution in India. It is a new record for Madhya Pradesh.

V. Family ASCALAPHIDAE

17. * **Idricerus decrepitus** (Walker)

1859. *Ascalaphus decrepitus* Walker, *Trans. R. ent. Soc. Lond.*, (2) **5** : 197.

1871. *Idricerus decrepitus*, Mac Lachlan, *J. Linn. Soc.*, **9** : 240.

Material examined : Uttar Pradesh : Garhwal : 1 ex., Dhak, alt. *ca.* 2440 m., 5. viii. 1958 (*B. S. Lamba* coll.) ; Nainital : 1 ex.,—v-vi. 1893 (Lucknow Mus. coll.).

Distribution : INDIA : Jammu & Kashmir (North) ; Uttar Pradesh ; Assam ; Meghalaya, Arunachal Pradesh.

Remarks : The species, formerly recorded from the Kumaon Himalayas by Needham (1909), extends to the Garhwal Himalayas, too, as has been presently observed.

18. * † **Ogeogaster segmentator** (Westwood)

1848. *Ascalaphus* (*Ogcogaster*) *segmentator* Westwood, *Cabinet Oriental ent.*, t. 34.

1871. *Ogcogaster segmentator*, Mac Lachlan, *J. Linn. Soc.*, **11** : 265.

Material examined : Uttar Pradesh : Almorah : 2 exs., Nail, alt. *ca* 1530 m., 4. ix. 1958 ; 1 ex., Bamrari, alt. *ca* 920 m., 24. ix. 1958 ; 1 ex., Baijnath, alt. *ca* 1070 m., 25. ix. 1958 (*B. S. Lamba* coll.).

Distribution : INDIA : Jammu & Kashmir ; Himachal Pradesh ; Uttar Pradesh ; Maharashtra ; Karnataka.

19. **Ogcogaster tessellata** (Westwood)

1848. *Ascalaphus* (*Ogcogaster*) *tessellatus* Westwood, *Cabinet Oriental ent.*, p. 69.

1908. *Ogcogaster tessellata*, Weele, *Cat. Coll. Selys*, 8 : 253.

Material examined : Uttar Pradesh : Kumaon, 1 ex., Kousanie, alt. *ca* 1850 m.,-viii. 1914 (*Tytler* coll.).

Distribution : PAKISTAN ; INDIA (Himachal Pradesh ; Uttar Pradesh ; Gujarat ; Bihar).

Remarks : The species is hitherto restricted to the Oriental region of the globe.

20.* **Siphlocerus nimius** (Walker)

1853. *Ascalaphus nimius* Walker, *Cat. Brit. Mus. Neur.*, 2 : 429.

1871. *Siphlocerus nimius*, Mac Lachlan, *J. Linn. Soc.*, **11** : 261.

Material examined : Uttar Pradesh : 3 exs., Allahabad ; date nil (Mus. coll.).

Distribution : INDIA : Uttar Pradesh ; Punjab ; Bihar ; West Bengal.

21. * † △ **Glyptobasis dentifera** (Westwood)

1848. *Ascalaphus* (*Ogcogaster*) *dentifera* Westwood, *Cabinet Oriental ent.*, p. 69.

1871. *Glyptobasis dentifera*, Mac Lachlan, *J. Linn. Soc.*, **11** : 278.

Material examined : Uttar Pradesh : 1 ex., Almorah, alt. *ca* 1530 m., 4. vii. 1958 (*B. S. Lamba* coll.) ; Madhya Pradesh : 9 exs., Balaghat :

Muki, 13-19. ix. 1957 ; 1 ex., Muki, Banjar Valley, alt. *ca* 560 m., 23. ix. 1957 ; 1 ex., Muki, Bhaisangarth Hills, alt. *ca* 760 m., 19.ix. 1957 ; 7 exs., Supkhar, Hallon valley, alt. *ca* 700 m., 24-25. ix. 1957 (*B. Biswas* coll.).

Distribution : INDIA : Punjab ; Uttar Pradesh ; Maharashtra ; Madhya Pradesh ; Orissa ; West Bengal ; Kerala ; Karnataka.

Remarks : The species is for the first time recorded from Madhya Pradesh.

22. † **Ascalaphus dicax** Walker

1853. *Ascalaphus dicax* Walker, *Cat. Brit. Mus. Neur.*, **2** : 423.

Material examined ; Uttar Pradesh : 1 ex., Nainital, 5. v. 1908 (Mus. coll.).

Distribution : ASIA MINOR ; BEIRUT ; IRAQ ; SAUDI ARABIA ; South-east Asia including CHINA, INDIA (Himachal Pradesh ; Uttar Pradesh ; West Bengal), BANGLADESH (Sylhet), SRI LANKA, the PHILLIPPINES, SULAWESI, SUMATRA, Western JAVA and other islands of the INDO-MALAYAN area ; PAPUA and NEW-GUINEA ; MOLLUCUS.

Remarks : The species is known from the broad localities of the Palaearctic, and Australo-Oriental regions of the globe including Insulinde which comprises the Malayan and Papuan archipelagos after Weele (1909). It is not out of place to mention here that Tjeder (1972) strongly opined for the replacement of the genus *Helicomitus* MacLachlan by *Ascalaphus* Fabricius as per "The rules for settling of generic type-species——". The author also agrees with this view that the species *dicax* Walker should no longer belong to the genus *Helicomitus* MacLachlan but to *Ascalaphus* Fabricius.

23.† **Ascalaphus sinister** Walker

1853. *Ascalaphus sinister* Walker, *Cat. Brit. Mus. Neur*,. **2** : 424.

Material examined : Madhya Pradesh : Bastar Survey, 1978-1979 : 1 ex., Kanker, 18. xii. 1978 (*M. S. Shishodia and party* coll.).

Distribution : INDIA : (Maharashtra ; Madhya Pradesh and other area of North India ; West Bengal) ; SRI LANKA.

Remarks : The species is hitherto restricted in the Oriental region of the globe. As for the preceding species, *Helicomitus* MacLachlan should be changed to *Ascalaphus* Fabricius after Tjeder (1972).

SUMMARY

The paper incorporates a brief review of geographical distribution of Neuroptera comprising 23 species in 5 families from Uttar Pradesh and Madhya Pradesh coupled with relevant comments on some of them. About 60% of the present fauna from both the states constitute new locality records, while 70% are hitherto known to be endemic in India. Over 17% of the material are observed to be mutually common in both the states. Attempts have also been made to correlate the distribution of the Indian fauna with that known from the other Zoogeographical regions of the world, if any.

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Rec. zool. Surv. India, 80 : 301-307, 1983

SOME NEW RECORDS OF PHYTOSEIIDAE FROM INDIA (ACARINA : MESOSTIGMATA)

By

SABITA RAY

M. B. B. College, Agartala, Tripura

AND

S. K. GUPTA

Zoological Survey of India, Calcutta

(With 4 Text-figures)

Recently, the authors had the opportunity to examine a small collection of Phytoseiidae from different parts of India. Out of those, four species were found to be quite interesting and not hitherto recorded from India. Those are redescribed here in the light of modern taxonomic concepts and are also illustrated to help the future workers in easily recognising those species.

The material treated here are deposited in the collection of the Zoological Survey of India. The measurements given in the text are in microns. The setal nomenclature as of Rowell *et al.*, (1878) is followed.

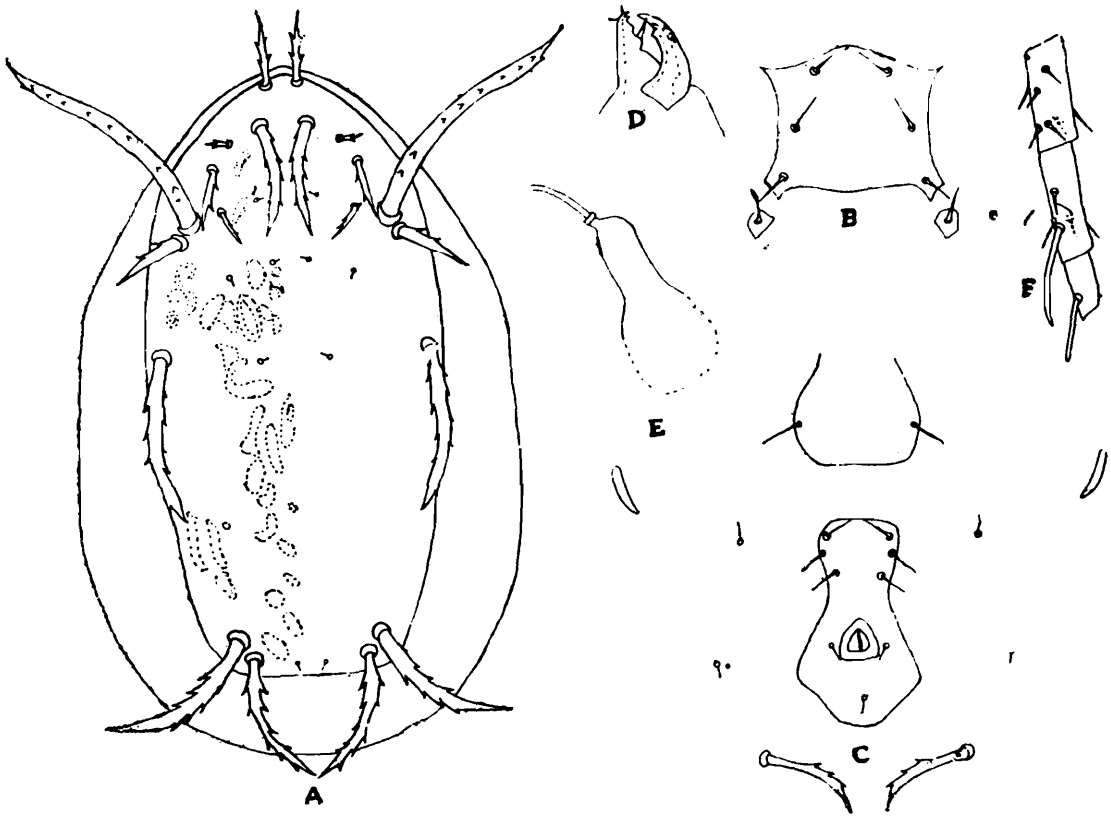
Phytoseius (Phytoseius) mixtus Chaudhri

(Text-fig. 1)

Phytoseius (*Phytoseius*) *mixtus* Chaudhri, 1973, *Pakist. J. Zool.*, 5 : 83-85.

Female : Dorsal shield rugose, 280 long, 134 wide, with 15 pairs of setae and a few pairs of pores. Setae j3, s4, s6, Z5, j1, r3, Z4 long, thick and serrate, other setae minute. Measurements of setae : j1—29, j4—j6, J5—4-5 each, j3—56, z2—16, z3—36, z4—20, s4—130, s6—78, Z5—72, z5—5, Z4—95, r3—52 ; Z4 much thicker than Z5. Sternal shield wider (85) than long (67) with 3 pairs of moderately long setae ; metasternal plate distinct with seta. Genital shield normal with setae. Ventrianal shield much longer (90) than wide (42) with a conspicuous constriction little below the level of 3rd. preanal seta, para- and post-anal setae present as usual ; 3 pairs of setae present

around ventrianal shield, JV5 56 long, serrate ; metapodal plate single paired, moderately long ; transverse striation present between genital and ventrianal shields. Chelicera with 2 teeth anterior to *pilus dentilis*, on the fixed digit, movable digit with one tooth. Spermatheca with a tubular cervix and a knobbed atrium, major duct long. Leg IV with maceosetae on tibia-56, basitarsus-31, distitarsus-31 ; macroseta absent on genu.



Text-fig. 1 (A-F) : *Phytoseius* (*Phytoseius*) *mixtus* Chaudhri (♀) : A—dorsal shield, B—sternal shield, C—posterior ventral surface, D—chelicera, E—spermatheca, F—leg IV.

Male : Unknown.

Material examined : 1 ♀, INDIA ; U. P., Barkot, 3. ix. 1976, ex grass. (Coll. *S. K. Gupta*) (Z. S. I. Reg. No. 3178/17).

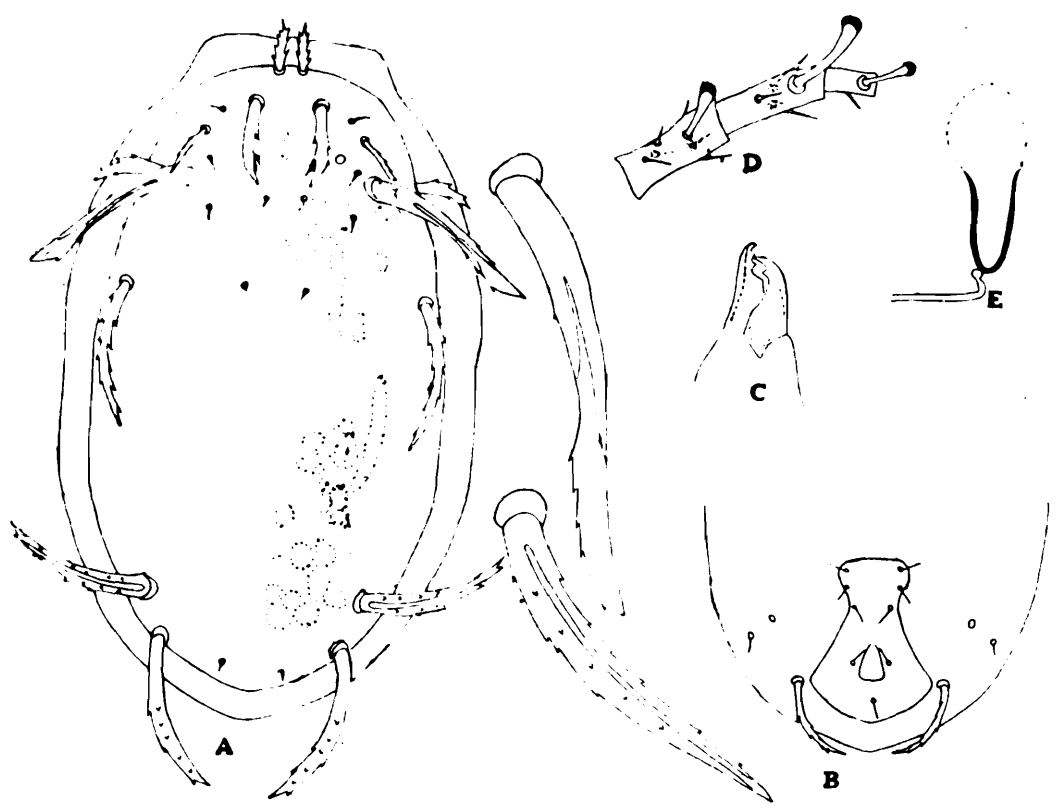
Remarks : The present specimen agrees well with description provided by Chaudhri (1973) except that the notocephalic pore associated with z5 is lacking in the specimen examined by the authors. Besides, the number of small platelets present around genital and ventrianal shields are also absent in the specimen. Inspite of these differences, the present specimen is considered to be same as *mixtus* while the characters lacking here are regarded as variations. This species was earlier described from Pakistan and the present one is the first record from India.

Phytoseius (Phytoseius) crinitus Swirski & Shechter

(Text-fig. 2)

Phytoseius (*Dubininellus*) *crinitus* Swirski and Shechter, 1961, *Israel J. agric. Res.*, **11** (2) : 102-104.

Female : Dorsal shield 280 long, 168 wide with 15 pairs of setae, of those, 7 pairs in lateral series, 2 pairs in median series, 5 pairs in dorsocentral series, in addition, r3 also present on dorsal shield. Besides setae j4—j6, J5, z2, z4, all other setae being long, thick and serrate ; s4 and Z4 appear to be divided. Measurements of setae :



Text-fig. 2 (A-E) : *Phytoseius* (*Phytoseius*) *crinitus* Swirski and Shechter (♀) A—dorsal shield, B—posterior ventral surface, C—chelicera, D—leg IV, E—spermatheca.

j1—29, j4—j6, z5, J5— 4-5 each, j3—40, z2-18, z3-31, z4-11, s4-101, s6-67, Z5-65, Z4-83, r3-38. Ventrally, sternal and genital shields not discernible. Ventrianal shield much longer (90) than wide (56) with 3 pairs of preanal setae, preanal pores appear to be absent, 3 pairs of setae present around ventrianal shield, JV5 36 long. Chelicera with 2 teeth on fixed digit and one tooth on movable digit. Macrosetae on leg IV : genu-31, tibia-50, basitarsus-27, distitarsus-22, all being spatulate. Spermatheca as figured.

Male : Unknown.

Material examined : 1 ♀, INDIA : ASSAM, Jorhat, January, 1980, ex undetermined host (Coll. *A. Saha*). (Z. S. I. Reg. No. 3183/17)

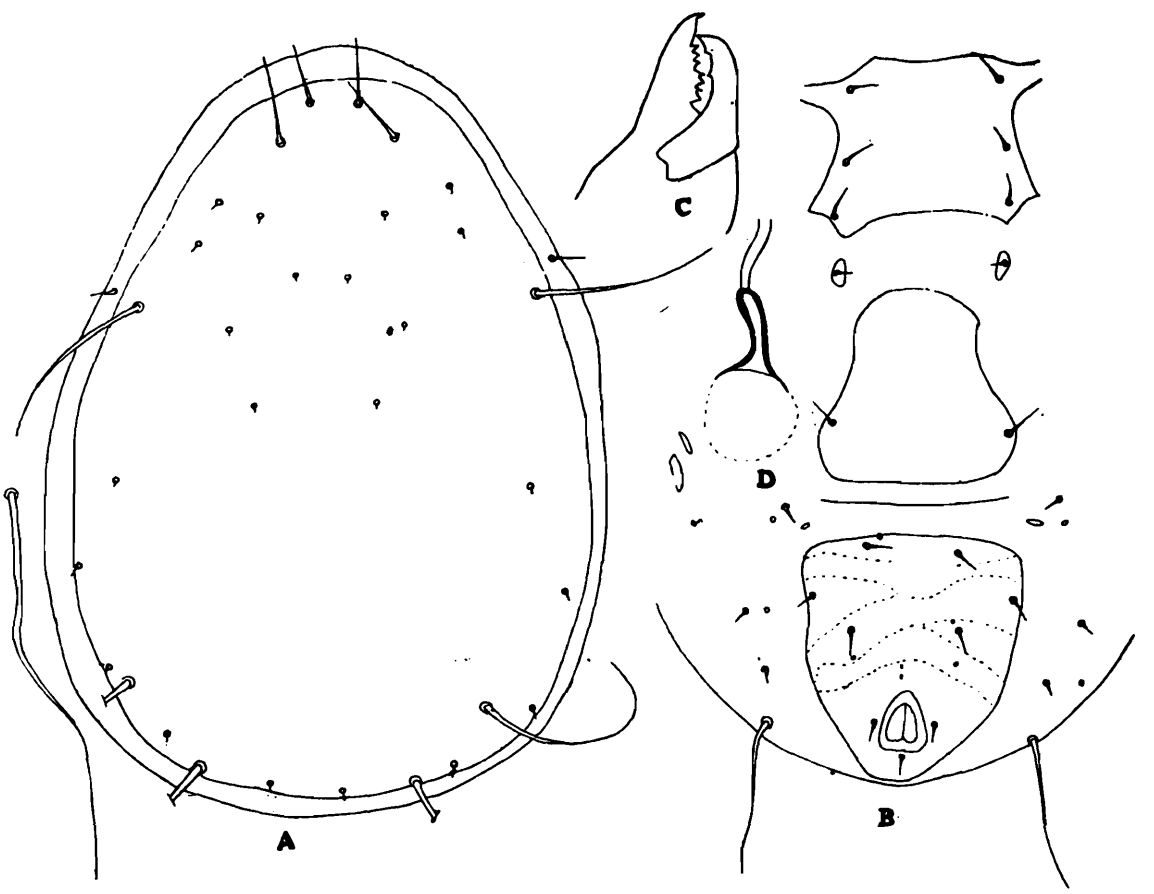
Remarks : This species was described by Swirski & Shechter in 1961 from Hong Kong and since then it has been recorded from number of places. The specimen examined by the present authors mostly conform with re-description of Denmark (1966) but differs from that in having macroseta on genu IV longer than that of basitarsus IV. This is the first record of this species from India.

Amblyseius (Amblyseius) rhabdus Denmark

(Text-fig. 3)

Amblyseius rhabdus Denmark, 1965, *Florida Ent.*, **48** (2) : 95.

Female : Dorsal shield 403 long, 247 wide, smooth with 17 pairs of setae, of those, j1, j3, s4, Z4, Z5 long or moderately long while the



Text-fig. 3 (A-D) : *Amblyseius* (*Amblyseius*) *rhabdus* Denmark. (♀) : A—dorsal shield, B—ventral surface, C—chelicera, D—spermatheca.

other setae being short and simple. Measurements of setae : j1—27, j4—j6— 5-6 each, j3—47, s4—103, Z5— 319, Z4— 156, the rest of the setae measure between 5-6 each. Ventrally, the sternal shield 78 long, 112 wide with 3 pairs of setae, metasternal plate distinct with a seta. Genital shield normal with a pair of setae, a distinct fold present between genital and ventrianal shields. Ventrianal plate shield shaped, reticulate (more prevalent in the region anterior to anal pore while

it is absent beyond that region) with 3 pairs of preanal setae and a pair of preanal pores ; 4 pairs of setae present around ventrianal shield, ventrianal shield 134 long, 125 wide. Fixed digit of chelicera multidentate while 2 teeth present on movable digit. Spermatheca as figured.

Male : Unknown.

Material examined : 2 ♀ ♀, INDIA : TAMIL NADU, Coimbatore, 1978-1979 (no definite collection date mentioned) ex tea (Coll. *R. L. N. Murthy & R. Chandrasekharan*). (Z. S. I. Reg. No. 3180/17)

Remarks : This species was originally described by Denmark (1965) basing on material collected in Florida. The present material agree well with description of Denmark (1965) as well as with that of Muma & Denmark (1970). This material possess teeth on the movable digit while as per the description of the earlier workers the same was lacking. In addition to this, the setae on the dorsocentral series are smaller in the material examined by the present workers. This is the first record of the species from India.

Amblyseius (Amblyseius) deleoni Muma and Denmark

(Text-fig. 4)

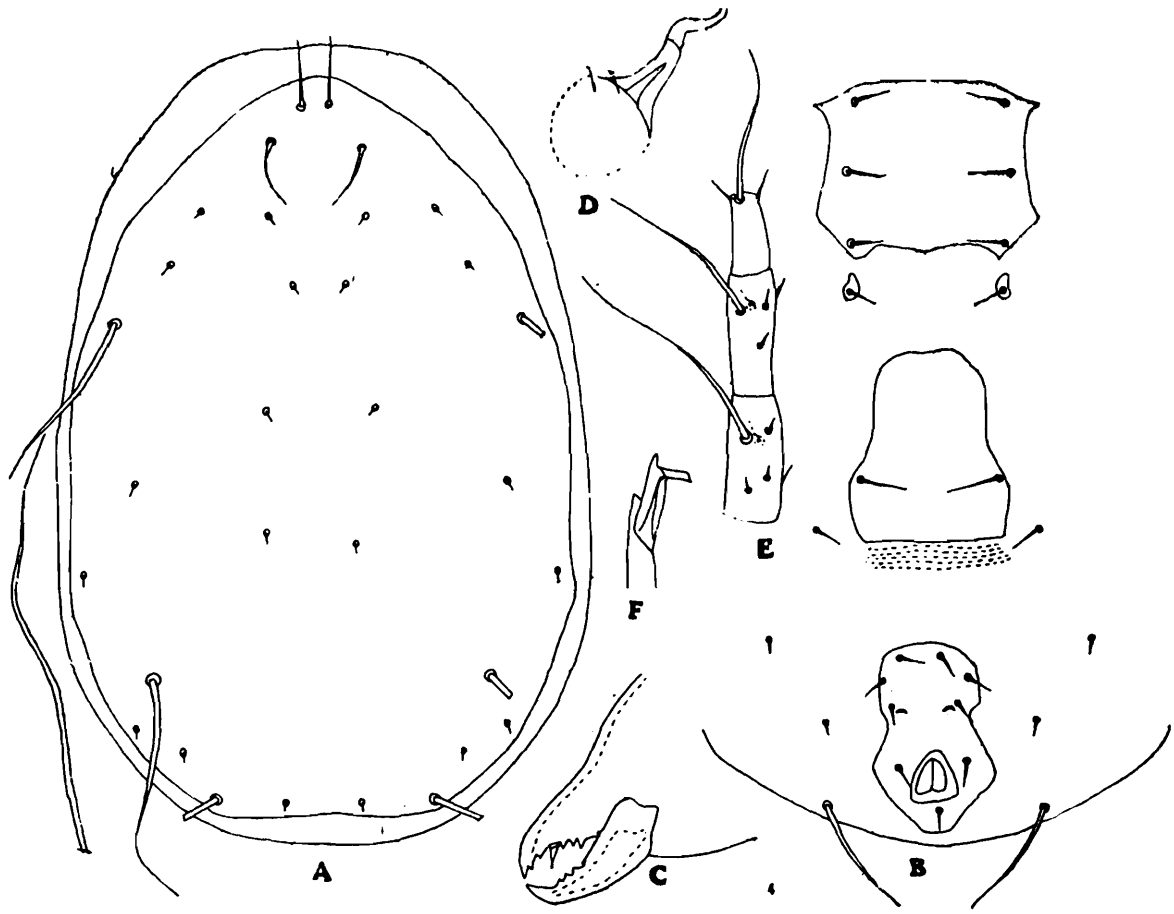
Amblyseius (*Amblyseialus*) *largoensis* Muma, Muma, 1961, *Bull. Fla St. Mus.*, **5** (7) : 287.

Amblyseius deleoni Muma & Denmark, 1970, *Fla Dept. Agr. Con. Serv.*, **6** 68-69.

Female : Dorsal shield smooth, 357 long, 255 wide with 17 pairs of setae. Setae j1, j3, s4, Z5, Z4 being long, other setae minute. Measurements of setae : j1—35, j4—j6, J2, J5— 4-5 each, J3— 33, z2—9, z4—11, s4—107, Z1—9, S2—13, S4—9, S5—13, Z5—205, z5-6, Z4—125, r3—11, R1—7. Ventrally, sternal shield 81 long, 94 wide with 3 pairs of sternal setae, metasternal plate present with a seta. Genital shield 78 wide with a pair of setae. Ventrianal shield 116 long, 67 wide with 3 pairs of preanal setae, single pair of preanal pores present at the base of 3rd pair of preanal setae ; one pair of preanal and a postanal seta present ; 4 pairs of setae present around ventrianal shield, JV5 67 long, 2 pairs of metapodal plates present, primary one— 21 long, secondary one —14 long. Peritreme extends anteriorly upto the base of j1. Fixed digit of chelicera with 5 strong teeth and a *pilus dentilis*, movable digit with 3 minute teeth. Spermatheca as figured. Macrosetae on legs : genu II— 35, genu III— 51, tibia III— 40, genu IV— 129, tibia IV— 90, basitarsus IV— 76.

Male : Spermatophoral process as figured.

Material examined : 3 ♀ ♀, INDIA : TRIPURA, Kumarghat, 19. x. 1979, ex *Aegle marmelos* (Coll. *S. Ray*) ; 2 ♀ ♀, U. P., Barkot, 3. ix. 1979, ex undetermined host (Coll. *S. K. Gupta*). (Z. S. I. Reg. No. 3181/17).



Text-fig. 4 (A-E) : *Amblyseius* (*Amblyseius*) *deleoni* Muma and Denmark (♀). A—dorsal shield, B—ventral surface, C—chelicera, D—spermatheca, E—leg IV. (F) : *A* (*A.*) *deleoni* (♂) spermatophoral process.

Remarks : This species is often confused with *A. largoensis* (Muma) but is distinguished from it by its fundibuliform spermathecal cervix. This mite has been recorded earlier from North America, South Ameriea, S. Africa, Madagascar, Taiwan and Thailand. This is the first record of this species from India.

ACKNOWLEDGEMENTS

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Rec. zool. Surv. India, 80 : 309-314, 1983

ADDITION TO THE RECORDS OF SEXUALES OF APHIDS (HOMOPTERA : APHIDIDAE) FROM INDIA

By

D. N. RAYCHAUDHURI, D. RAYCHAUDHURI, BASANT K. AGARWALA AND S. K. DAS

Department of Zoology, University of Calcutta, Calcutta

(With 4 Text-figures)

INTRODUCTION

Through the works of Basu and Raychaudhuri (1980), Singh *et al.* (1980) and Raychaudhuri *et al.* (1980) sexuales of 93 aphid species have been known to occur in India. These sexuales are represented either by male or oviparous female or by both the morphs.

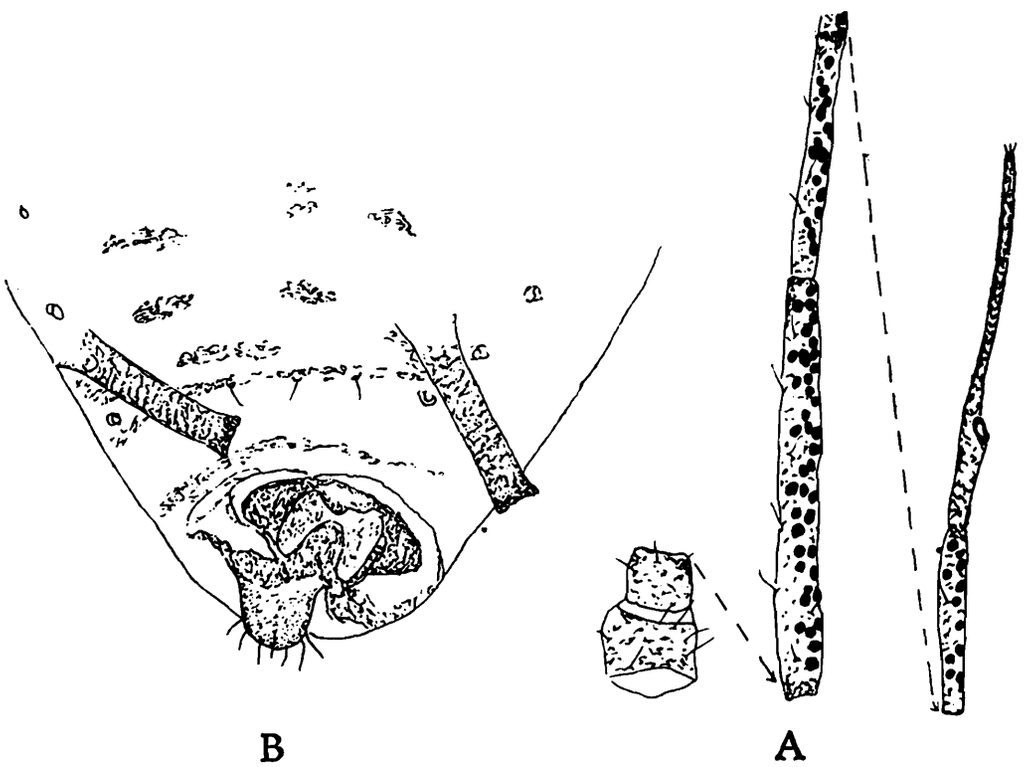
Further studies on the sexuales of Indian aphids have revealed the existence of males and/or apterous oviparous females of 3 more aphid species, viz. *Eumyzus darjeelingensis* Basu and Raychaudhuri, *Neomyzus circumflexus* (Buckton) and *Eulachnus thunbergii* (Wilson). Of these, alate males and apterous oviparous females of *Eumyzus darjeelingensis* Basu and Raychaudhuri and *Neomyzus circumflexus* (Buckton) were so far unknown. Apterous oviparous female of *Eulachnus thunbergii* (Wilson) was hitherto unknown from India. Find of sexuales of these species, besides parthenogenetic morphs suggests chances of completion of holocyclic life-cycle by these species under Indian climate. Sexuales of *Eumyzus darjeelingensis* and *Neomyzus circumflexus* are being described. Apterous oviparous female of *Eulachnus thunbergii* is also described because of lack of such description based on Indian material.

The material are deposited in the Aphid Research Unit, Entomology Laboratory, Zoology Department, Calcutta University.

Eumyzus darjeelingensis Basu and Raychaudhuri, 1974

Alate male : Body 1.50—1.83 mm long with 0.60—0.78 mm as its maximum width. Antennae (Text-fig. 1A) 6-segmented, 0.87—1.14× body ; segment III, IV and V respectively with 36—40, 17—22 and 9—22 circular secondary rhinaria distributed over their entire length. Ultimate rostral segment bearing 2 secondary hairs. Dorsal abdominal hairs on tuberculate bases, the longest one on anterior, 7th and 8th tergites about 0.81—1.0, 0.70—0.72 and 0.80—0.90×basal diameter of antennal segment III respectively. Siphunculi 0.12—0.16 × body

and 2.60—3.0 × cauda bearing 7 hairs. Male genitalia well developed (Text-fig. 1B). Other characters as in alate viviparous female (Basu and Raychaudhuri, 1974).



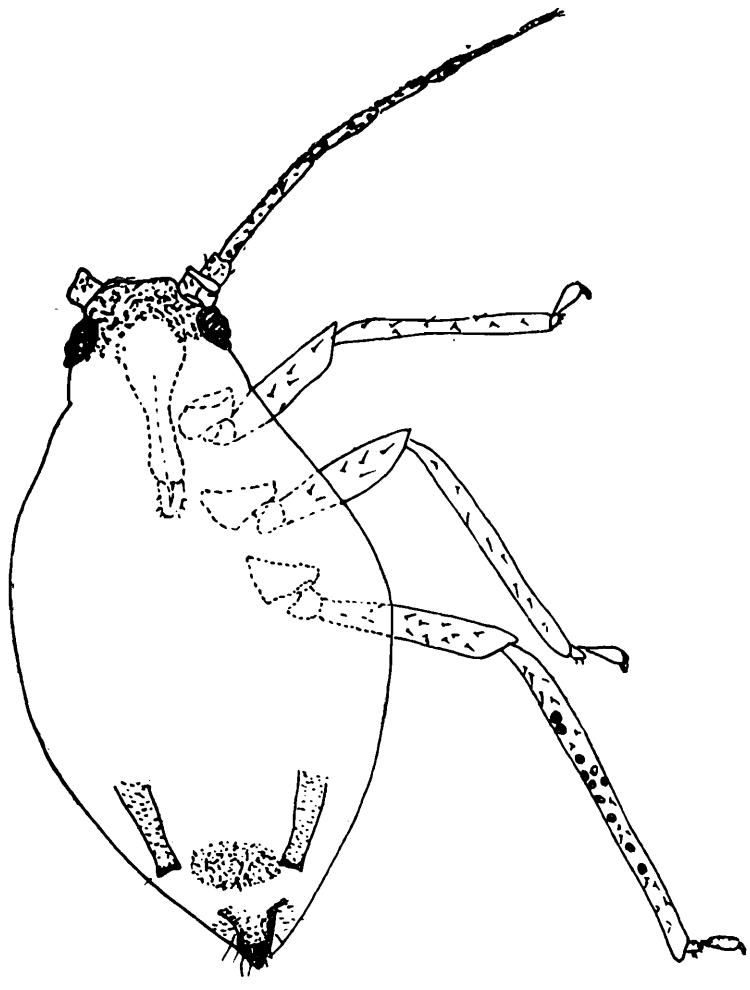
Text-fig. 1. *Eumyzus darjeelingensis* Basu and Raychaudhuri : Alate male
A. Antenna
B. Posterior portion of abdomen showing male genitalia

Measurements of one alate male in mm : Length of body 1.80, width 0.79 ; antenna 1.77, segments III : IV : V : VI 0.52 : 0.36 : 0.22 : 0.13+0.36 ; ultimate rostral segment 0.11 ; second-segment of hind tarsus 0.11 ; siphunculus 0.22 ; cauda 0.07.

Apterous oviparous female : Body 1.63-1.87 mm long with 0.82-1.0 mm as its maximum width. Antennae 6-segmented, 0.64—0.70 × body ; flagellum without any secondary rhinaria. Ultimate rostral segment 0.90—1.03 × second segment of hind tarsus and bears 2 secondary hairs. Dorsum of abdomen pale and scabrous ; dorsal hairs on tuberculate bases ; the longest one on anterior, 7th and 8th tergites about 1.0—1.11, 0.88—1.42, 1.28—1.57 × basal diameter of antennal segment III respectively. Siphunculi 0.12—0.13 × the body and 1.54—1.66 × cauda bearing 7—11 hairs. Hind tibiae bearing 6-15 pseudosensoria distributed on middle portion only (Text-fig. 2). Otherwise as in apterous viviparous famale (Basu and Raychaudhuri, 1974).

Measurements of one apterous oviparous female : Length of body 1.80, width 0.97 ; antenna 1.26, segments III : IV : V : VI 0.39 : 0.21 : 0.15 : 0.10+0.25 ; ultimate rostral segment 0.10 ; second segment of hind tarsus 0.10 ; siphunculus 0.22 ; cauda 0.15.

Collection data : 3 alate viviparous ♀ ♀, 1 apterous oviparous ♀, 2 **alate** ♂ ♂ and 14 nymphs from indet host plant, India : West Bengal : **Kalimpong** : Monsung, 8. iv. 71, coll. *M. R. Ghosh* ; 25 apterous ♀ ♀, 2 **alate** ♂ ♂ and 4 nymphs from an indet host plant, India ; West Bengal : **Darjeeling**, 17. iv. 70, coll. *M. R. Ghosh.*



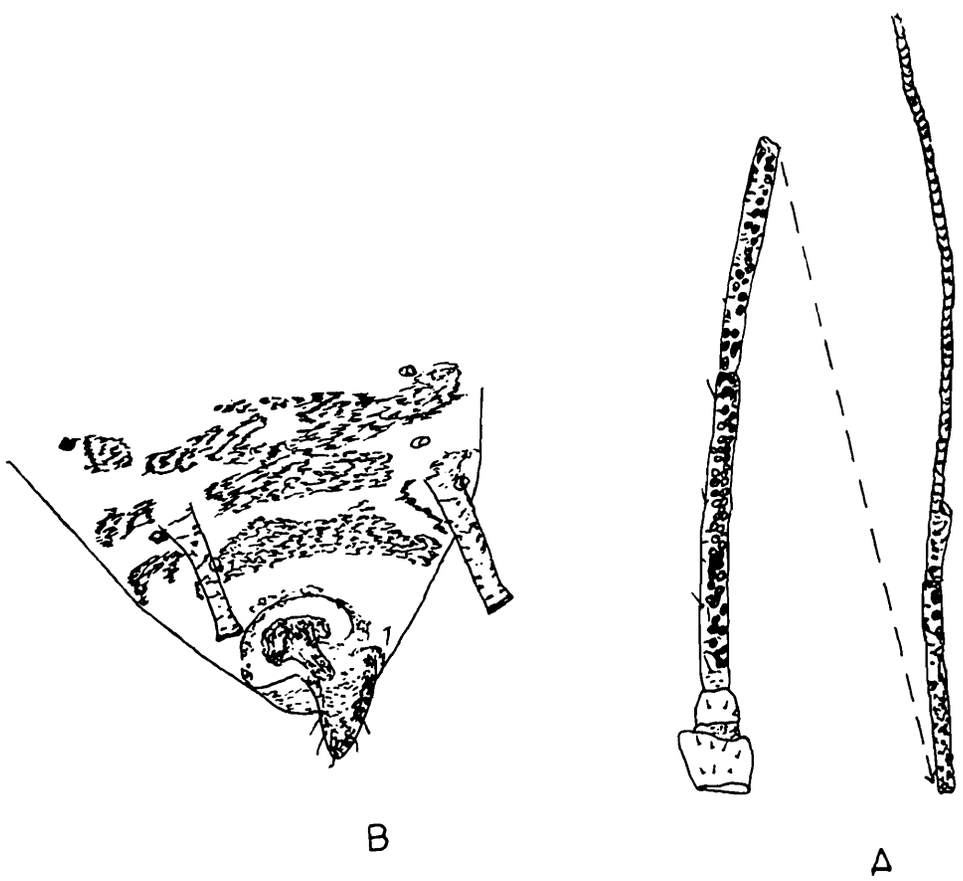
Text-fig. 2. *Eumyzus derjeelingensis* Basu and Raychaudhuri : Apterous ovipara Whole body with hind tibiae showing pseudosensoria

Note : Basu and Raychaudhuri (1974) while describing the species **by** apterous and alate viviparous females collected at Darjeeling, West **Bengal** stated that the species infested *Hydrangea paniculate.* Unfortunately the host plant of the sexuale morphs collected at Kalimpong and **Darjeeling**, West Bengal could not be determined.

Neomyzus circumflexus (Buckton, 1876)

Alate male : Body 1.75-2.25 mm long with 0.61-0.93 mm as its **maximum** width. Head dark brown, spinulose, with well developed **lateral** frontal tubercles. Antennae 6-segmented (Text-fig. 3A), 0.99-1.44× **the body**, dark brown except the very base of segment III which is pale

brown ; flagellum very sparsely imbricated except on segment VI which with normal imbrications, segments III, IV and V respectively with 34-64, 15-43 and 6-14 small, circular secondary rhinaria distributed irregularly over entire length ; processus terminalis 3.50-6.50 × the base of segment VI. Ultimate rostral segment 1.08-1.34 × second segment of hind tarsus and bears 2-3 secondary hairs. Dorsum of abdomen with pleural and marginal sclerotic patches on tergites 2-6, those on tergite 7 fuse to form a transverse band, tergite 8 with only a faint spinal



Text-fig. 3. *Neomyzus circumflexus* (Buckton) : Alate male

A. Antenna

B. Posterior portion of abdomen showing male genitalia

band ; dorsal hairs short, longest one on anterior and 8th tergites about 0.33-0.45 and 0.63-1.0 × basal diameter of antennal segment III respectively. Siphunculi cylindrical, about 0.13-0.15 × the body and 1.99-2.37 × cauda bearing 4-6 hairs. Male genitalia as in Text-fig. 3B.

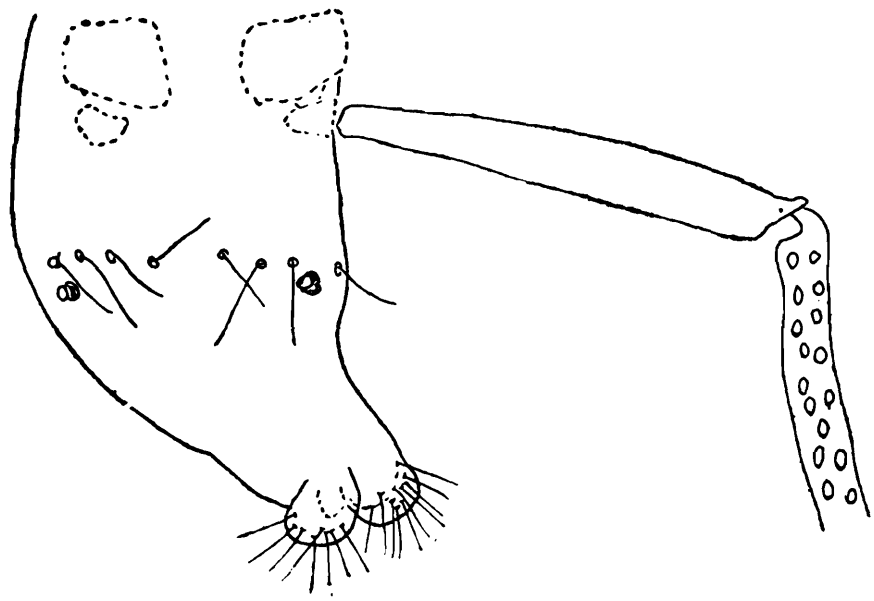
Measurements of one alate male in mm : Length of body 2.25, width 0.93 ; antenna 3.25, segments III : IV : V : VI 0.70 : 0.64 : 0.46 : 0.18+ 0.99 ; ultimate rostral segment 0.13 ; second segment of hind tarsus 0.09 ; siphunculus 0.31 ; cauda 0.16.

Collection data : 1 apterous viviparous ♀, 2 alate viviparous ♀♀, 2 alate ♂♂ and 8 nymphs from *Zanthoxylum oxiphyllum* (Rutaceae), India : West Bengal : Kalimpong : Algarha, 6. xi. 70, coll. *M. R. Ghosh.*

Note : *Neomyzus circumflexus* (Buckton) is a widely distributed species. Hille Ris Lambers (1949) and Eastop (1966) are of the opinion that the species reproduces anholocycally. But the find of alate males along with viviparous females on a plant of Rutaceae suggests that the species may produce sexuales under certain condition.

Eulachnus thunbergii (Wilson, 1919)

Apterous oviparous female : Body 2.40 mm long with 0.78 mm as maximum width. Head pale brown, smooth ; frons weakly convex ; dorsal cephalic hairs long, fine and arising from sclerotic bases, longest one being about 3.63 – 3.81 × basal diameter of antennal segment III. Antennae 6—segmented, 0.53× body ; segments I and II concolorous with head ; flagellum pale, sparsely imbricated, less so on segments III and IV, without secondary rhinaria ; flagellar hairs like those on cephalic dorsum. Ultimate rostral segment about 0.55 × second segment of hind



Text-fig. 4. *Eulachnus thunbergii* (Wilson) : Apterous ovipara Posterior portion of body with hind tibia (partly broken) showing pseudosensoria.

tarsus bearing 2 secondary hairs. Dorsum of abdomen pale, smooth, bearing numerous long hairs arising from sclerotic bases, the longest one on anterior and 8th tergites being 3.50 and 3.80 × basal diameter of antennal segment III respectively. Siphunculi ring like, without hairs. Cauda semilunar, bearing numerous hairs. Hind tibiae partly broken bearing numerous pseudosensoria (Text-fig. 4). Other characters as in apterae viviparae.

Measurements of the apterous oviparous female : Length of body 2.40, width 0.78 ; antenna 1.29, antennal segments III : IV : V : VI 0.40 : 0.21 : 0.25 : 0.18+0.6 ; ultimate rostral segment 0.09 ; second segment of hind tarsus 0.16 ; siphuncular pore 0.02.

Collection data : 3 apterous viviparous ♀ ♀ and 1 apterous oviparous ♀ from *Pinus* sp. (Abietaceae), India : Meghalaya : Shillong : Umpling : 10. xii. 70, coll. *R. C. Basu.*

Note : The oviparous female is reported for the first time from India. In view of non-availability of a good description of the ovipara detailed description of the same is provided here.

Summary

This paper reports hitherto unknown alate male and apterous oviparous female of *Eumyzus darjeelingensis* Basu and Raychaudhuri and alate male of *Neomyzus circumflexus* (Buckton). Besides, apterous oviparous female of *Eulachnus thunbergii* (Wilson) is reported for the first time from India.

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Rec. zool. Surv. India, 80 : 315-329, 1983

A REVIEW OF THE INDIAN SPECIES OF THE GENUS *RETICULITERMES* HOLMGREN (ISOPTERA : RHINOTERMITIDAE)

By

O. B. CHHOTANI AND B. C. DAS

Zoological Survey of India, Calcutta

(With 6 Text-figures and 3 Tables)

INTRODUCTION

The genus *Reticulitermes* in the Indian region is restricted to North-eastern India and Bhutan. Only two species *viz.*, *assamensis* Gardner and *saraswati* Roonwal & Chhotani were so far reported. The species *assamensis* was treated as a synonym of *chinensis* by Snyder (1949) and Roonwal and Chhotani (1962), but more recently Thakur (1977) and Roonwal and Chhotani (1977) have recognised *assamensis* as a distinct species.

A number of surveys of this part of the country have been undertaken by the Zoological Survey in the recent years and while going throught the collections of the genus the authors have come across another two species, these are *chinensis chinensis* Snyder and a new species *tirapi*. Thus, in all four species of the genus are now known from India. In this present contribution all the species have been reviewed giving their descriptions, the distribution and the keys for identification.

Abbreviations used : coll., collected by ; Im., imago ; S., soldier ; W., worker ; Z. S. I., Zoological Survey of India.

II. SYSTEMATIC ACCOUNT

(A). KEY TO THE SPECIES

Imago :

The imagos of the two species known are separated as follows :—

1 (2) Ocelli separated from eyes by long diameter of ocellus ; pronotum yellow ; tibia basally one fourth brownish, rest yellowish. ... *assamensis* Gardner

2 (1) Ocelli separated from eyes by less than short diameter of ocellus ; pronotum dark brown ; tibia yellowish. ... *chinensis chinensis* Snyder

Soldier :

1 (2)	Smaller species. Head-length without mandibles 1.53 mm ; head-width 1.00 mm. ...	*saraswati* Roonwal & Chhotani
2 (1)	Larger species : Head-length without mandibles 1.75-2.32 mm ; head width 1.05-1.25 mm.	
3 (4)	Labrum with a sharply pointed tip ; frontal protuberances absent or ill developed. ...	*chinensis chinensis* Snyder
4 (3)	Labrum with a blunt tip ; frontal protuberances well developed.	
5 (6)	Head thinner and narrower ; head-width 1.05-1.12 mm (mean 1.07 mm), head-height 0.90-0.95 mm (mean 0.93 mm). Pronotum narrower, (width 0.80-0.87 mm, mean 0.82 mm). ...	*tirapi* sp. n.
6 (5)	Head thicker and wider ; head-width 1.07-1.32 mm, (mean 1.17 mm), head-height 0.87-1.10 mm (mean 1.01 mm). Pronotum wider (width 0.77-0.92, mean 0.84 mm). ...	*assamensis* Gardner

(B) DESCRIPTION OF SPECIES

1. **Reticulitermes assamensis** Gardner

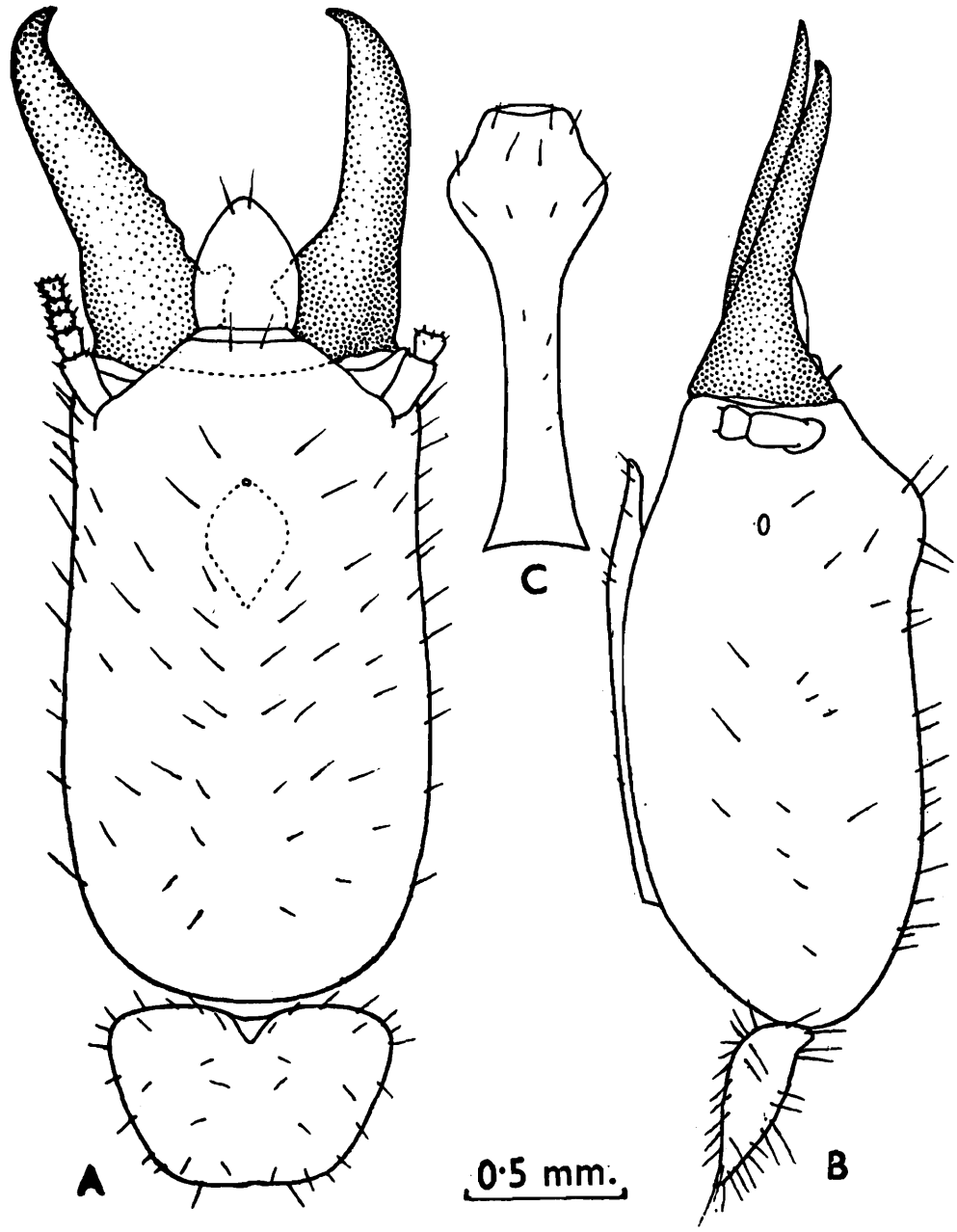
(Text-fig. 1 ; Tables 1 & 2)

1944. *Reticulitermes assamensis* Gardner, *Indian J. Ent.*, **6** : 105-106. Type locality : Sadiya, Assam, India ; 1977. Roonwal and Chhotani, *Ent. Basil.*, **2** : 46-48 ; 1977. Thakur, *J. Bombay nat. Hist. Soc.*, **74** (1) : 191-195.

1949. *Reticulitermes chinensis* Snyder, *Smithson. misc. Collns.*, **112** : 71 ; 1953. Roonwal and Pant, *Indian Forest Leafl.* (*Ent.*). No. 121, pt. 9 : 54 ; 1962. Roonwal and Chhotani, *Proc. natn. Inst. Sci. India*, (B) 28 (4) : 301-302 ; 1962. Mathur and Thapa, *Indian Forest Leafl.* (*Ent.*), No. 167 ; 27 [Indian records only].

Material : The following material from India and Bhutan was examined :—INDIA : Imagos, soldiers and workers, Shaitan Bridge. Kameng District, Arunachal Pradesh, coll. *A. N. T. Joseph*, 23. iv. 1966 (1 vial) and Mawphlong, Meghalaya, coll. *G. K. Srivastava*, 18. v. 1979 (1 vial). Soldiers and workers as follows :—*Meghalaya* : Shillong, coll. *A. P. Kapur*, 21. xii. 1958 (1 vial) and 6. iv. 1959 (1 vial). *Assam* : Sadiya, 14. xii. 1933 (Lectotype and Paralectotype). *Arunachal Pradesh* : Kameng District : Rupa, *K. C. Jayaramakrishna* coll., 2. v. 1961 ; Siggon village, *K. C. Jayaramakrishna* coll., 4. v. 1961. Subansiri District : Subansiri river Nacho, coll. *J. M. Julka*, 28. xi. 1971 ; Didi Camp, Chukru, *A. N. T. Joseph* coll., 22. v. 1966 ; Pabin, J. M. Julka coll., 17. i. 1975. Siang District : Tappi Dulla, 12. x. 1966 ; Tashidoni, 24. x. 1966 ; Kambong, 16 & 17. x. 1966, all *S. K. Tandon*

and *G. S. Arora* coll. *Sikkim* : *A. G. K. Menon* coll. as follows :— Pechrek, 2. iv. 1959 ; Naga, 2. viii. 1959 ; Singhik, 6. viii. 1959. BHUTAN : Sampa-Kothoka, coll. *W. Wittmer* and *C. Baroni-Urbani*, 9. vi. 1972.



Text-fig. 1. *Reticulitermes assamensis* Gardner. Soldier (Paralectotype). A, Head and pronotum, dorsal view ; B, Head and pronotum, side view ; C, Postmentum, ventral view.

Distribution : INDIA (Assam, Meghalaya, Arunachal Pradesh, Sikkim, West Bengal) and BHUTAN (Sampa-Kothoka).

Remarks : The Imago (Roonwal & Chhotani, 1977) and Soldier (Thakur, 1977) of this species have been described in detail recently as such their descriptions are not given here again. The figures and measurements are, however, given for comparison with the other species. The species is restricted to eastern India and Bhutan.

2. **Reticulitermes chinensis chinensis** Snyder

(Text figs. 2 & 3 ; Tables 1 & 2)

1923. *Reticulitermes chinensis* Snyder, *J. Wash. Acad. Sci.*, **13** : 107-109. Type locality : Suifu, Szechuan Province, China ; 1931. Light, *Lignan Sci. J.*, **7** : 583-584, 589-590 ; 1962. Roonwal & Chhotani, *Proc. natn. Inst. Sci. India*, (B) **28** (4) : 301-303 (Records from China only) ; 1962. Mathur and Thapa, *Indian Forest Leafl.*, No. 167 : 27 (Records from China only) ; *R. chinensis chinensis* : 1968. Hsia and Fan, *Acta ent. Sin.*, **14** (4) : 2.

Material : Imagos, soldiers and workers as follows were examined :— CHINA : *Szechuan Prov.* : Suifu, 2 imagos and one soldier, paratypes. Soldiers and workers from : INDIA : *Arunachal Pradesh* : Kameng District : Kalaktang and Rupa, *K. C. Jayaramakrishna* coll., 17. iii. and 2. iv. 1961 ; Siggon village, *S. Biswas* coll., 27. viii. 1961. *Assam* : Shantipur, *S. K. Tandon* coll., 2. iii. 1969.

Description : There has been some confusion in respect of the species *assamensis* Gardner and *chinensis* Snyder. The former species was till recently regarded as a synonym of the latter until Roonwal & Chhotani (1977) and Thakur (1977) treated them as two distinct species. The imago and soldier of *assamensis* have been described in details (Roonwal and Chhotani, 1977 ; Thakur, 1977) while those of *chinensis chinensis* need redescription. As such they are being described here in some detail.

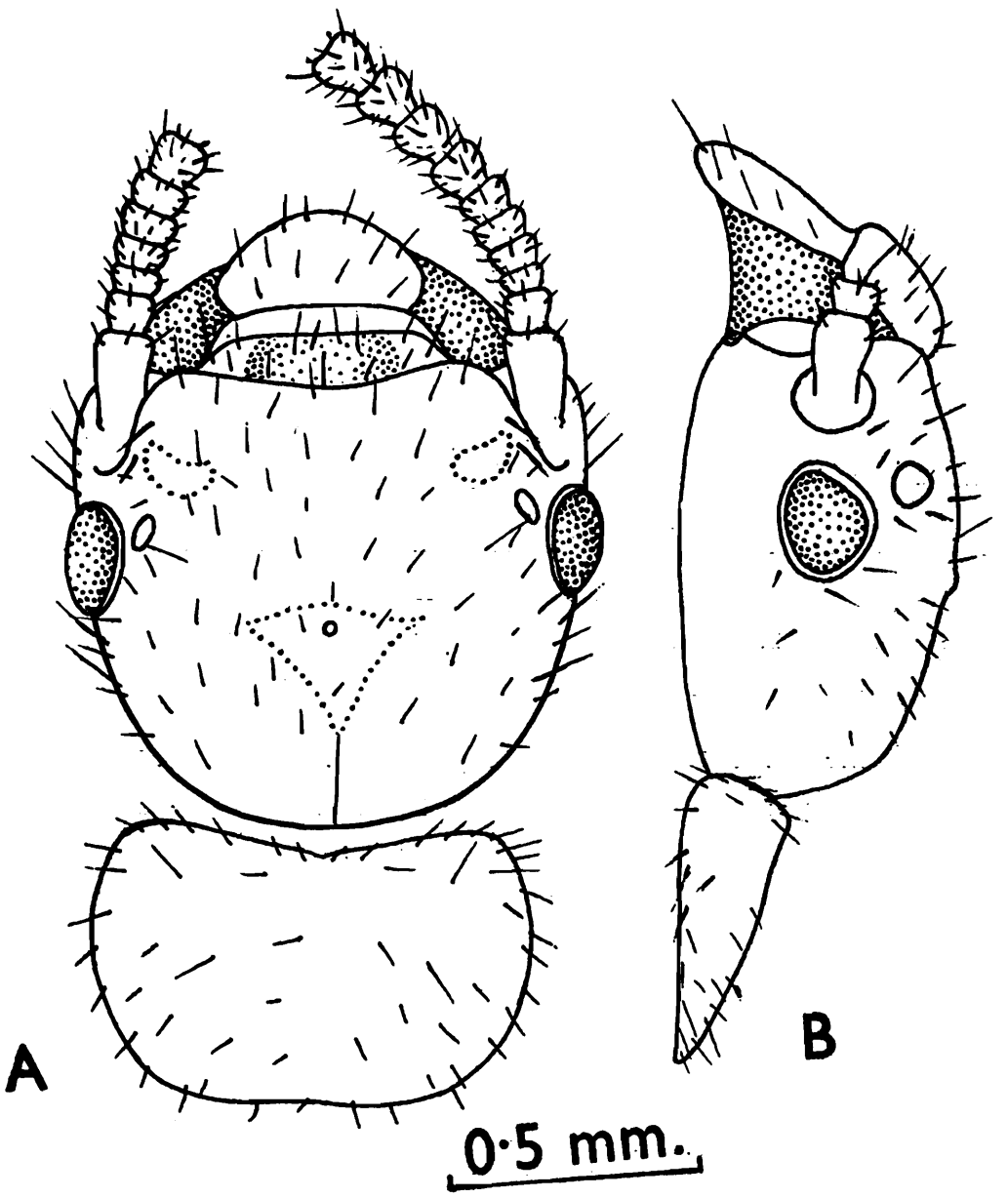
TABLE 1. Measurements (mm.) of imagos of *Reticulitermes assamensis* Gardner and *R. chinensis chinensis* Snyder. L, length ; W, width.

	Body parts	*assamensis* (range 3 exs)	*chinensis chinensis* (range 2 exs)
1.	Total body-length without wings *c*	5.30-6.40	4.50-5.20
2.	Head-length to tip of labrum	1.43-1.50	1.23
3.	Head-length to base of mandibles	1.10-1.17	0.97-1.00
4.	Max. head-width with eyes	1.10	1.05
5.	Max. head-height	0.62-0.70	0.53-0.55
6.	Occipito-fontanelle distance	0.50-0.55	0.45
7.	Postclypeus L × W	0.17 × 0.50	0.10 × 0.50
8.	Labrum L × W	0.33 × 0.40	0.33-0.35 × 0.40
9.	Max. diameter of eyes	0.23-0.27	0.22-0.23
10.	Eye-lateral margin distance	0.18-0.20	0.15
11.	Max. diameter of ocelli	0.07-0.10	0.08-0.10
12.	Min. eye-ocellus distance	0.07-0.075	0.05-0.055
13.	Pronotum L × W	0.60-0.67 × 0.90	0.55-0.58 × 0.84-0.87
14.	Length of forewing scale	0.62-0.69	0.75-0.80
15.	Length of hindwing scale	0.55-0.58	0.45-0.50

IMAGO (Text-fig. 2 ; Table 1) :

Only two paratype imagos were available for study and the following description and measurements are given from these specimens. The colour of the specimens seems to have run somewhat, since they appear to be paler than what is mentioned in the original description. The colouration, etc. of the various parts as mentioned by Snyder (1923) are given within parentheses.

Head dark brown (dark castaneous brown (dark finished mahogany)) ; postclypeus, coxae, meso- and metathorax yellowish brown ; antennae pale brown (grey-brown) ; pronotum brown slightly paler than head (about same color as head) ; femora yellowish brown (greyish brown) ; tibiae and tarsi yellowish ; abdominal tergites pale brown (slightly lighter colored (more grey) than head) ; wings pale brownish. Head



Text-fig. 2. *Reticulitermes chinensis chinensis* Snyder. Imago (Paratype). A, Head and pronotum, dorsal view ; B, Head and pronotum, side view.

and body fairly densely hairy with light yellowish hairs. Total body-length without wings c 4.5-5.2 mm.

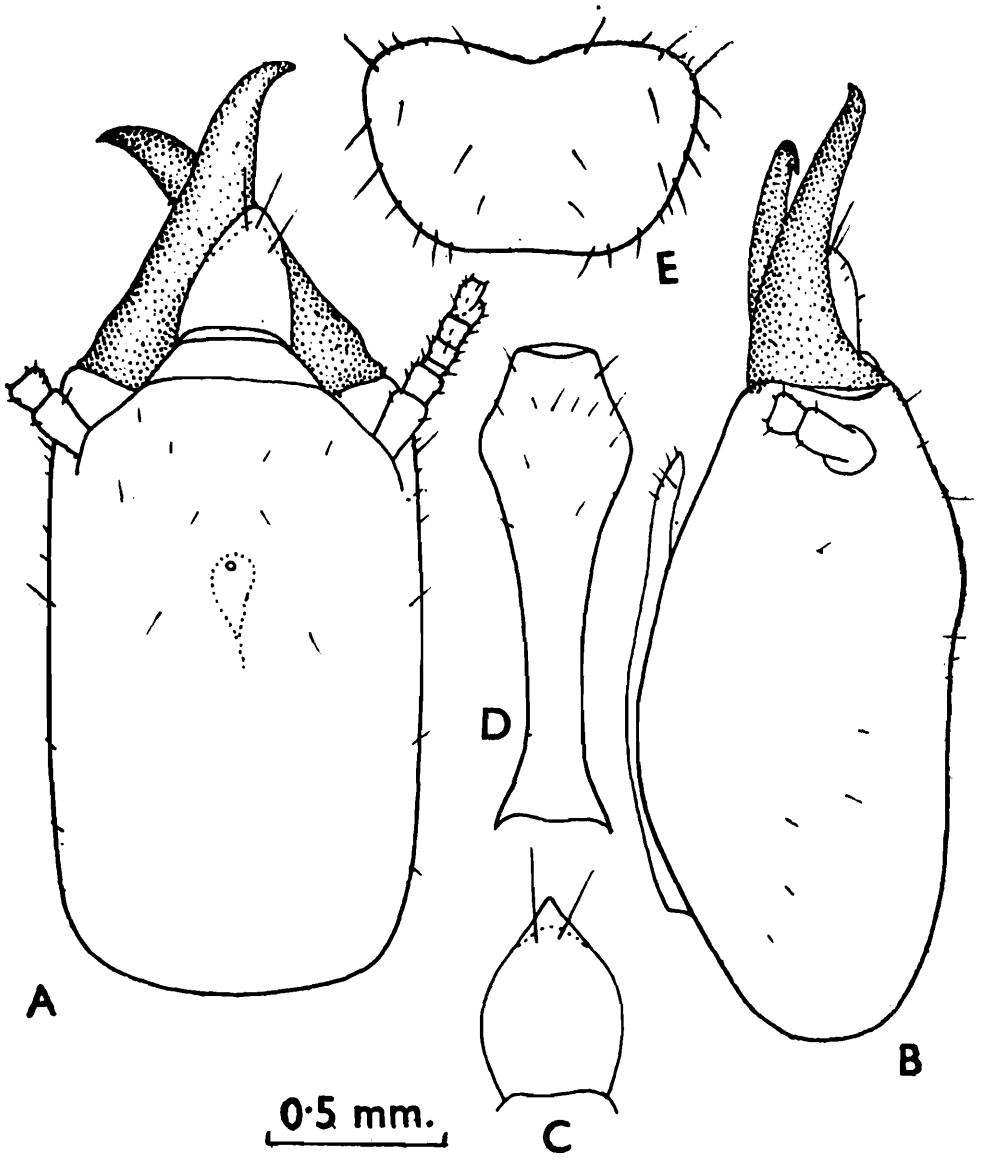
Head oval, head-capsule subsquarish, slightly narrowed posteriorly, length to base of mandibles subequal to width with eyes ; epicranial suture faint. Fontanelle minute, slightly raised. Eyes small, broadly oval, slightly buldging, anteriorly straighter ; from lower margin of head separated by nearly 2/3rds of their long diameter. Ocelli small, subcircular ; separated from the eyes by little less than short diameter, and by their diameter from antennae. Antennae broken, maximum of ten segments (17-18 segments) present in one of the specimens ; segment 1 long, cylindrical ; 2 shorter than 1, cylindrical ; 3 shortest, ring-like ; 4 onwards gradually increasing in length. Labrum broad, tongue-shaped, yellowish brown ; wider than long ; with a few hairs anteriorly and medially on body. Postclypeus weakly swollen, length less than half of width, hairy. Anteclypeus flat, apilose, hyaline. Pronotum flat, subrectangular, narrower than head-width with eyes ; anterior margin incurved and with a weak median notch ; posterior margin with a faint, median incurving. Legs elongate, hairy, fairly stout ; apical tibial spurs 3 : 2 : 2 ; tarsi 4-segmented. Wings broken in the specimens examined, a few fragments available ; membrane with minute granular spots. Abdomen elongate ; cerci 2-segmented ; styli present in male, single-jointed.

SOLDIER (Text-fig. 3 ; Table 2) :

Head-capsule straw yellow to yellowish brown ; mandibles reddish brown ; antennae, labrum, abdomen and legs yellowish white. Head-capsule sparsely and thorax and abdomen moderately, hairy. Total body-length c 5.90-7.10 mm.

Head-capsule subrectangular, longer than wide, about 1.75 times as long as wide ; sides subparallel ; postero-lateral corners rounded ; frontal protuberance very ill developed or absent. Fontanelle minute, circular. Antennae 16 to 18 segmented, pilose ; in 18-segmented antennae segment 4 smallest, segment 3 subequal to 5 ; in 16 and 17-segmented antennae segment 3 smallest, ring-like ; segment 4 subequal to 2 ; rest of the segments progressively increasing in length, the last segment ovate. Clypeus trapezoidal ; anteclypeus narrow, hyaline, apilose ; postclypeus wider and pilose. Labrum oval, longer than broad, usually broadest near the base ; sides convex with hyaline margin and converging into thin and sharply pointed tip having 2 long bristles. In the paratype soldier tip of labrum not sharply

pointed, probably broken ; according to Snyder (1923) it is pointed at apex. Mandibles short and stout, with weakly incurved apices ; left mandible with 3-4 crenulations and a basal projection on inner margin ; right mandible with smooth inner margin, basally with a minute tooth-



Text-fig. 3. *Reticulitermes chinensis chinensis* Snyder. Soldier : drawings A—B from a paratype, C, D and E from a specimen from Arunachal Pradesh, India. A, Head, in dorsal view ; B, Head, in side view ; C, Labrum, in dorsal view, showing pointed tip ; D, Postmentum, in ventral view ; E, Pronotum, in dorsal view.

like projection. Postmentum club-shaped, more than three times as wide at widest point as at waist ; anterior margin substraight. Pronotum flat, narrower than head ; widest anteriorly ; anterior margin with a deep, median notch ; posterior margin weakly notched medially. Mesonotum narrower than pronotum. Metanotum slightly wider than pronotum. Legs long, slender, pilose ; tibial spurs 3 : 2 : 2 ; tarsi 4-segmented. Abdomen elongate, moderately hairy ; cerci 2-segmented ; styli one-segmented.

TABLE 2. Measurements (mm.), etc. of soldiers of *Reticulitermes assamensis* Gardner, *R. chinensis chinensis* Snyder and *R. saraswati* Roonwal & Chhotani. H, height ; L, length ; W, Width.

Body parts	*assamensis* (20 exs)	*chinensis chinensis* (20 exs)	*saraswati* (Holotype)
(a) Measurements			
1. Total body-length with mandibles c	5.30-6.50	5.90-7.10	4.0
2. Head-length with mandibles	2.60-3.47	2.65-3.49	2.30
3. Head-length to mandible-base	1.75-2.32	1.83-2.27	1.53
4. Max. head-width	1.08-1.30	1.08-1.32	1.00
5. Max. head-height	0.87-1.10	0.93-1.14	0.80
6. Labrum (median L × W)	0.30-0.45 × 0.27-0.38	0.35-0.47 × 0.32-0.42	0.30 × 0.27
7. Length of mandibles	0.95-1.15	0.95-1.22	0.86
8. Occipito-fontanelle distance	1.22-1.65	1.28-1.60	1.03
9. Median length of postmentum	1.00-1.52	1.30-1.50	1.08
10. Max. width of postmentum	0.42-0.52	0.43-0.52	0.40
11. Width of postmentum at waist	0.12-0.17	0.12-0.15	0.12
12. Pronotum (L × W)	0.42-0.62 × 0.77-0.97	0.50-0.55 × 0.82-0.95	0.40 × 0.67
(b) Indexes			
1. Head Index-I(W/L to mandible-base)	0.50-0.64	0.55-0.59	0.65
2. Head Index II (H/L to mandible-base)	0.47-0.50	0.40-0.50	0.52
3. Head Index III (H/W of head)	0.84-0.93	0.81-0.89	0.80
4. Mandible-head Index (Left mandible-length/Head-length)	0.48-0.60	0.51-0.55	0.56
5. Postmentum Index (W at waist/Max.W)	0.24-0.35	0.24-0.30	0.30

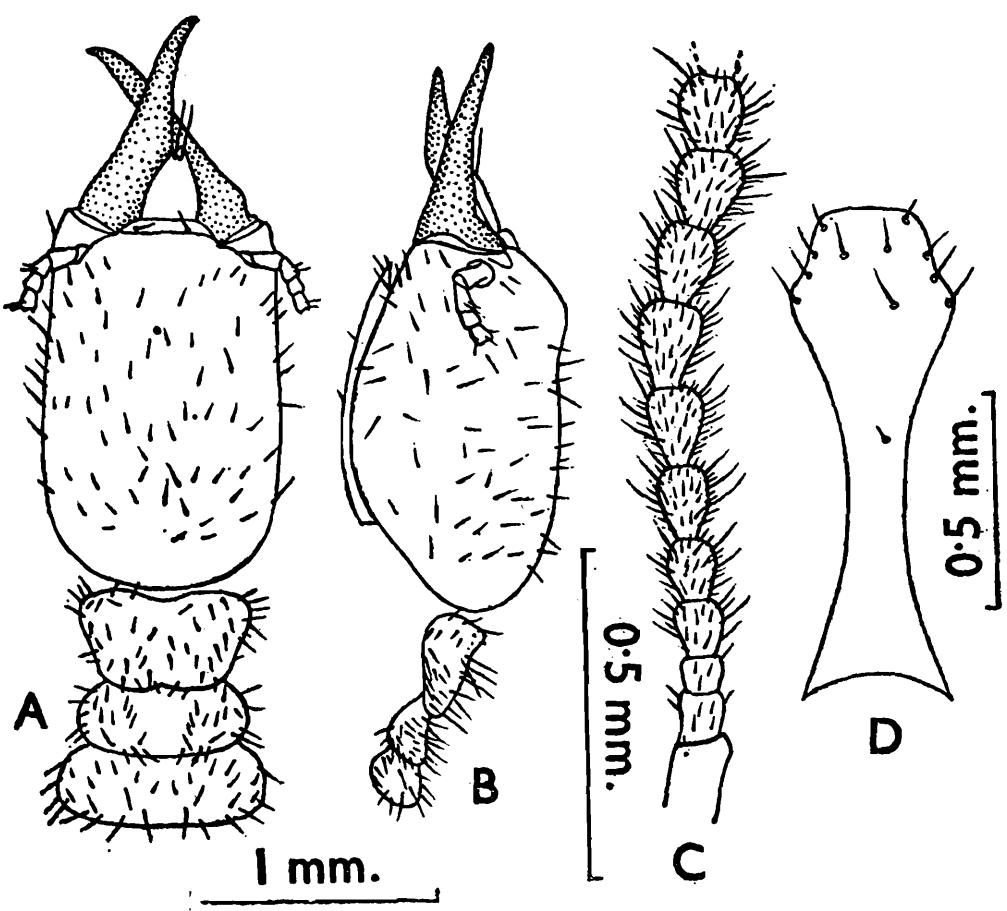
WORKER :

Head-capsule pale yellow ; antennae, legs and abdomen paler than head-capsule. Body less hairy than in *R. assamensis*. Total body-length c 3. 50-4.00 mm.

Head subsquarish (length to base of mandibles 1.05-1.07 ; max. width 1.17-1.22 mm), lateral and posterior margins rounded. Fontanelle indistinct. Antennae 15-segmented, segment 2 longer than 3, 4 shortest. Anteclypeus flat, apilose. Postclypeus slightly swollen, pilose, length less than half its width (length 0.12-0.15 ; width 0.45-0.50 mm). Labrum subsquarish, slightly wider than long, anterior margin convex. Mandibles typically *Reticulitermes*—type, each with an apical and three marginal teeth. Pronotum flat (max. length 0.42-0.50 ; max. width 0.77-0.85 mm) ; with a prominent, median notch at anterior margin. Mesonotum narrower and metanotum wider than pronotum. Legs and abdomen as in soldier.

Distribution : It is a widely distributed species in China and is recorded from a number of provinces (for details *vide* Hsia and Fan, 1968). From the Indian region it is reported here from Arunachal Pradesh (Kameng District) and Assam (Shantipur).

Remarks : The imago of *R. chinensis chinensis* is separated from that of *R. assamensis* for its darker pronotum, colour of tibiae and ocelli closer to eyes. The soldier of *chinensis chinensis* is separated from those of other closely allied species i. e., *assamensis* and *tirapi* sp. n. for its sharply pointed tip of labrum and weaker frontal protuberances. The paratype soldier before us has weak frontal protuberances but its labrum is not as sharply pointed as in the other specimens. According to Hsia and Fan (1968) the soldier of *chinensis chinensis* has low or slightly raised frontal protubrances and narrow and sharply pointed labrum ; our specimens correspond to the description and figures given by them as far as these characters are concerned. In the original description Snyder (1923) mentions labrum to be "pointed at apex", very probably the tip of the labrum in the paratype soldier is damaged.



Text-fig. 4. *Reticulitermes saraswati* Roonwal & Chhotani. Soldier (Holotype). A, Head and thorax, dorsal view ; B, Head and thorax, side view ; C, Antenna ; D, Postmentum, ventral view. After Roonwal & Chhotani, 1962.

3. **Reticulitermes saraswati** Roonwal & Chhotani

(Text-fig. 4 ; Table 2)

1962. *Reticulitermes saraswati* Roonwal and Chhotani, *Proc. natn. Inst. Sci. India*, (B) **28** (4) : 289, 295, 303-306, 393, 397.

Material examined : Holotype S. and paratype (Morphotype and paramorphotype) W., Shillong (Meghalaya, India), coll. *A. P. Kapur*, 20. xii. 1958.

Distribution : INDIA : Meghalaya : Shillong.

Remarks : Since this species has been described in detail by Roonwal & Chhotani (1962), it is not redescribed here. The soldier of this species is the smallest of all the known species from India. Measurements (Table 2) and figures of soldier (Text-fig. 4) are, however, given here for comparison with other species.

4. **Reticulitermes tirapi** sp. n.

(Text-fig. 5 ; Table 3)

Material : A vial with S. and W., Nampong, Tirap district, Arunachal Pradesh, coll. *C. B. Srivastava*, 2. ii. 62.

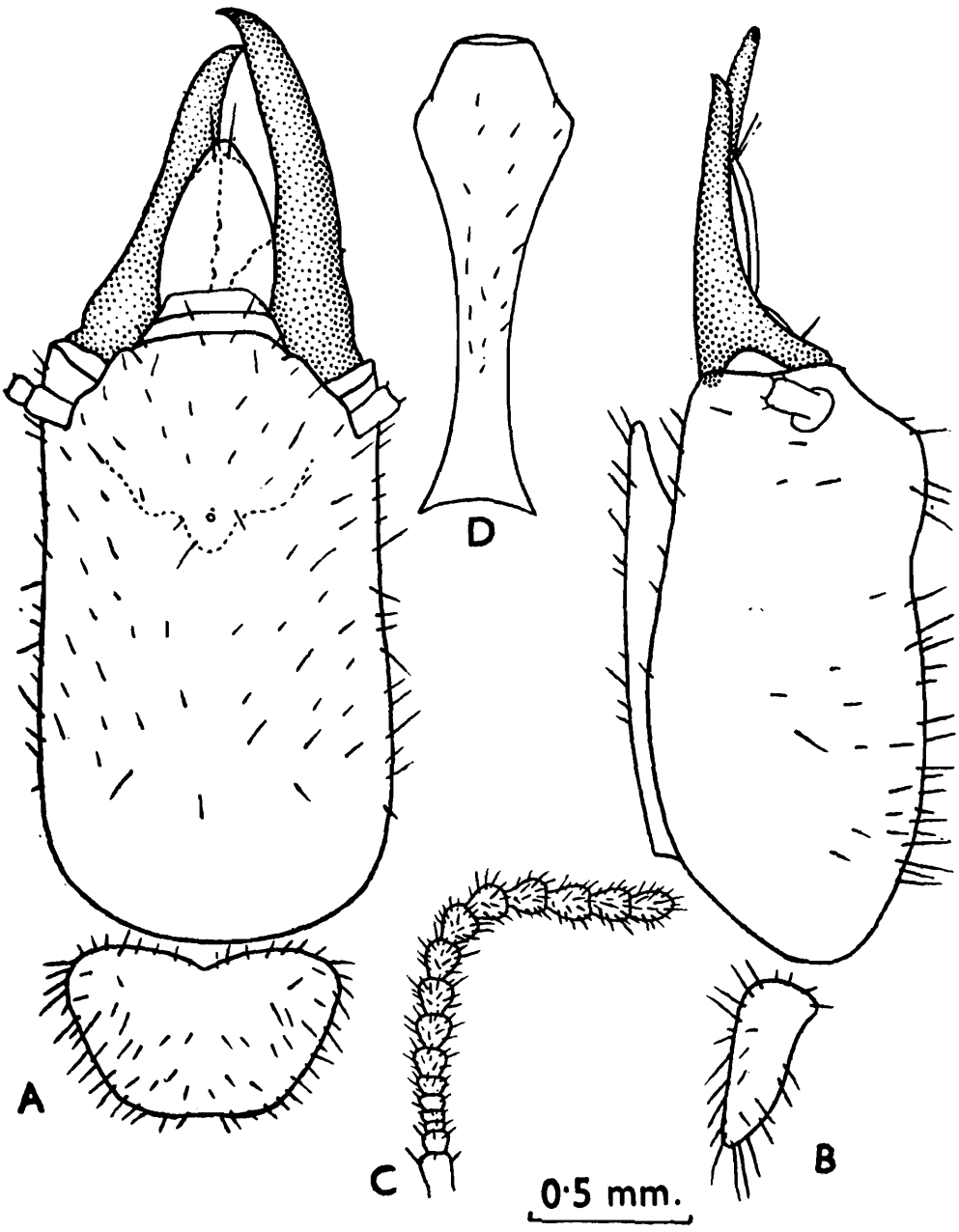
Description : IMAGO : Unknown.

SOLDIER (Text-fig. 5 ; Table 3) :

Head-capsule pale yellow, paler in frontal region ; mandibles dark brown, slightly paler basally ; antennae, labrum, thorax, abdomen and legs yellowish white. Head-capsule sparsely and thorax and abdomen rather densely, hairy. Total body-length 6.30-6.80 mm.

Head-capsule subrectangular, much longer than broad (index Width/ Length 0.54-0.58) ; sides subparallel, slightly narrowed posteriorly ; postero-lateral corners rounded, posterior margin weakly convex ; frontal region swollen and steeply sloping in front. Fontanelle minute, placed at base of swollen part of frons. Antennae with 15-16 segments, pilose ; in 15-segmented antenna segment 3 longer than 4 ; latter as long as 5 ; 6 onwards progressively increasing in length ; in 16-segmented—one 3 shortest, 4 onwards gradually increasing in length ; last ovate. Postclypeus subtrapezoidal, pale yellow ; anteclypeus whitish, subrectangular, narrower than postclypeus. Labrum oval, narrower anteriorly ; slightly longer than broad and broadest near base ; tip blunt and with two long hairs. Mandibles stout, weakly incurved anteriorly, length

half to slightly more than half of head length ; inner margin of left with 3 crenulations and a basal projection ; right mandible with straight inner margin except for a small tooth-like projection near base. Post-



Text-fig. 5. *Reticulitermes tirapi* sp. n. Soldier (Paratype). A, Head and pronotum, dorsal view ; B, Head and pronotum, side view ; C, Antenna ; D, Postmentum, ventral view.

mentum club-shaped ; at widest point more than twice as wide as at waist. Pronotum flat, narrower than head, widest anteriorly, antero- and postero-lateral corners rounded ; anterior margin with a distinct median notch ; posterior margin faintly incurved medially. Mesonotum narrower than pronotum, substraight at posterior margin. Metanotum as wide as pronotum, substraight posteriorly. Legs long, slender and pilose ; tibial spurs 3 : 2 : 2 ; tarsi 4-segmented. Abdomen elongate, hairy ; cerci 2-segmented ; styli finger-like, single-jointed.

TABLE 3. Measurements (mm.) etc. of soldiers of *Reticulitermes tirapi* sp. n. H, height ; L, length ; W, Width.

Body parts	Range (16 exs)	Holotype
(a) Measurements		
1. Total body-length with mandibles	6.30-6.80	6.50
2. Head-length with mandibles	2.80-3.08	2.80
3. Head-length to mandible-base	1.87-2.03	1.90
4. Max. head-width	1.05-1.10	1.075
5. Max. head-height	0.90-0.95	0.91
6. Labrum (median L × W)	0.37-0.45 × 0.30-0.35	0.45 × 0.33
7. Length of mandibles	1.00-1.05	1.03
8. Occipito-fontanelle distance	1.30-1.42	1.33
9. Median length of postmentum	1.30-1.43	1.40
10. Max. width of postmentum	0.45-0.50	0.45
11. Width of postmentum at waist	0.12-0.15	0.12
12. Pronotum (L × W)	0.45-0.55 × 0.80-0.87	0.50 × 0.85
(b) Indexes		
1. Head Index I (W/L to mandible-base)	0.54-0.58	0.56
2. Head Index II (H/L to mandible-base)	0.45-0.50	0.47
3. Head Index III (H/W of head)	0.83-0.88	0.85
4. Mandible-head Index (Left mandible-length/Head-length)	0.51-0.54	0.54
5. Postmentum Index (W at waist/Max. W)	0.24-0.31	0.26

WORKER :

Head-capsule pale yellow ; antennae, labrum, abdomen, and legs yellowish white. Head moderately and thorax and abdomen densely hairy. Total body-length 3.70-4.20 mm.

Head subsquarish (length to base of mandibles 0.87-1.00 ; max. width 1.00-1.10). Fontanelle indistinct. Antennae 16-segmented ; segment 2 longer than 3 ; 4 shortest. Postclypeus slightly swollen, pilose ; length less than half of its width (length 0.12 ; width 0.37 mm), medially divided into two halves ; anteclypeus apilose, flat, whitish. Labrum broad, tongue-shaped, longer than wide. Mandibles typically *Reticulitermes*-type ; each with an apical and three marginal teeth. Pronotum flat (max. length 0.30-0.37 ; max. width 0.55-0.65 mm), broadest at the anterior margin ; anterior margin with a weak median notch and posterior-one faintly emarginate medially. Abdomen and legs as in soldier.

Type specimens : Holotype soldier (Z. S. I. Reg. No. 2575/H_{11}), morphotype worker (Z. S. I. Reg. No. 2577/H_{11}) and paratype soldiers and paramorphotype workers (Z. S. I. No. 2576/H_{11}), in National Zoological

Collection, Zoological Survey of India. One paratype soldier and two paramorphotype workers each in Forest Research Institute, Dehra Dun (U. P., India) and American Museum of Natural History, New York (U. S. A.).

Type locality and distribution : INDIA : Arunachal Pradesh : Nampong (Tirap District) ; known only from the type locality.

Comparison : The soldier of *tirapi* sp. n. can be separated from that of *chinensis chinensis* for having blunt tip of labrum and prominent frontal protuberances, and is generally larger than that of *saraswati* Roonwal & Chhotani in size. It is closest to that of *assamensis* Gardner but can be separated for its narrower and slenderer head and thorax (head-width 1.05-1.12 vs. 1.07-1.32, mean value 1.07 vs. 1.17 mm ; head-height 0.90-0.95 vs. 0.87-1.10 mm, mean value 0.93 vs. 1.01 mm) and narrower pronotum (width 0.80-0.87 vs. 0.77-0.92, mean value 0.80 vs. 0.84 mm).

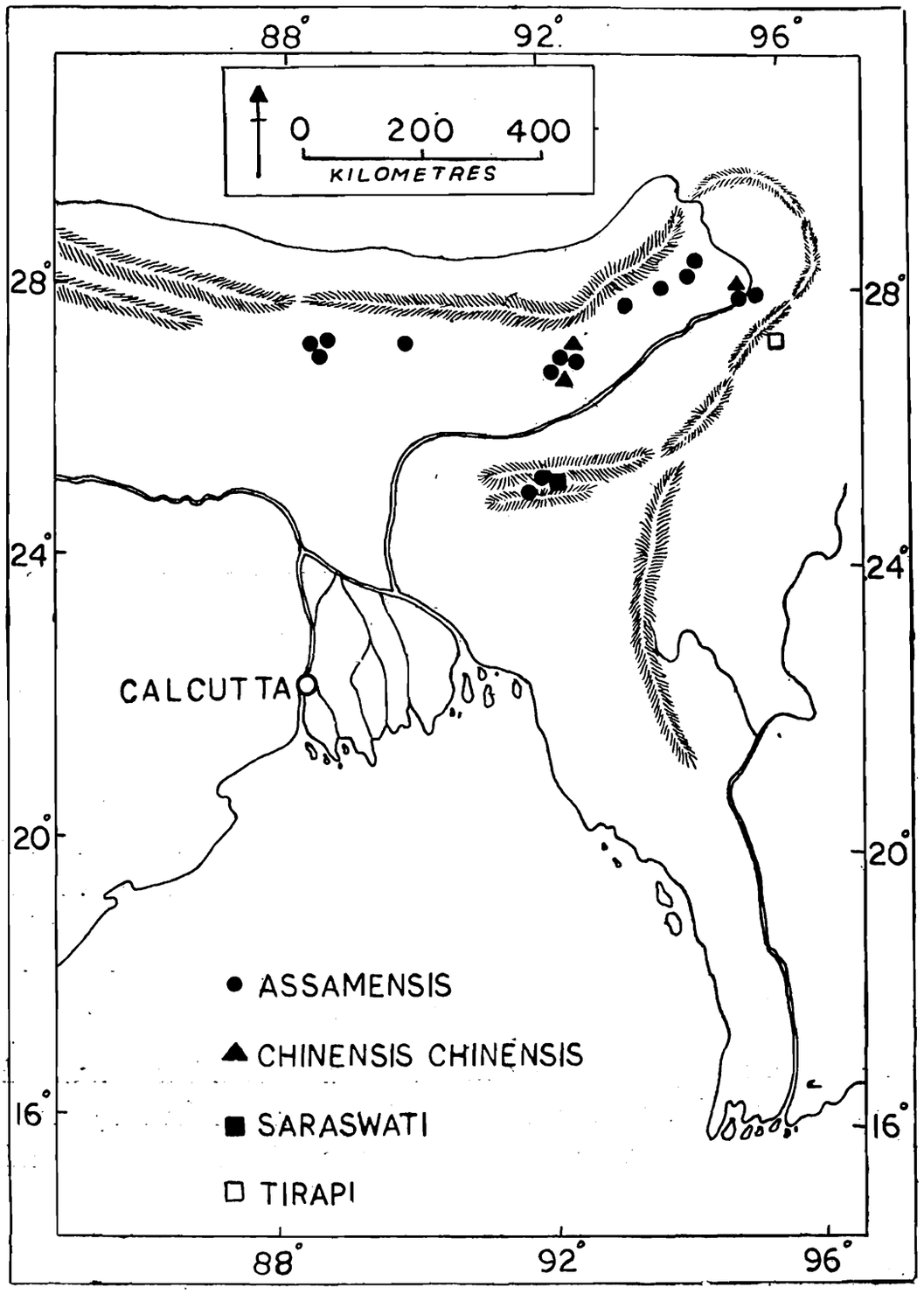
III. DISTRIBUTION OF ORIENTAL RETICULITERMES

The Holarctic genus *Reticulitermes* is mainly reported from the Palaearctic and Nearctic zoogeographical regions. Some of the species, however, extend into the adjoining parts of the Oriental region and some are endemic in this zoogeographical region.

In all 27 living species and subspecies of the genus are so far known from the world, of which eleven are from the Oriental region, thirteen from the Palearctic region (Europe and Asia) and six from the Nearctic region (North America). Six species are common between the Palaearctic and Oriental zoogeographical regions.

The Oriental species are known from North-East India, Bhutan Southern China, Formosa and Indo-China. The Indian species (Text-fig. 6) *assamensis* Gardner, *saraswati* Roonwal & Chhotani and *tirapi* Chhotani & Das are endemic to the Indian subregion ; *assamensis* having been reported from India (Sikkim, Assam, Meghalaya and Arunachal Pradesh) and Bhutan ; *saraswati* from Meghalaya, India ; and *tirapi* from Arunachal Pradesh, India. The species *chinensis chinensis* Snyder, reported here from Assam and Arunachal Pradesh in India, is mainly a Chinese species recorded from southern Oriental and Palaearctic parts of China. The species *affinis* Hsia & Fan, *grandis* Hsia & Fan, *chinensis leptomandibularis* Hsia & Fan and *fukiensis* Light are known from the southern Oriental and Palaearctic China and *flaviceps* (Oshima) from the Oriental Formosa and Oriental and Palaearctic

China. The species *megadalenae* Silvestri is reported only from the temperate altitudes of Indo-China and *longicephalus* Tsai & Chen from Fukien in southern China.



Text-fig. 6. Map showing distribution of the species of the genus *Reticulitermes* Holmgren in eastern India.

Summary

The genus *Reticulitermes*, in the Indian subregion, is known by four species which are restricted to North-eastern states of India and Bhutan.

Two species viz., *assamensis* Gardner and *saraswati* Roonwal & Chhotani were so far recorded from this subregion ; the species *chinensis chinensis* Snyder is reported here from India from Arunachal Pradesh and Assam states and a species new to science is described from Tirap District of Arunachal Pradesh.

Keys for the identification of the known imagos of two species and the soldiers of the four species are given. The species *chinensis chinensis* is redescribed and the new species *tirapi* is described in detail while *assamensis* and *saraswati* are not described as the detailed descriptions of these species have been published recently. Figures and measurements of all the species are given. The distribution of the species of the genus in the Oriental Region is discussed.

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Rec. zool. Surv. India, 80 : 331-340, 1983

NEMATODES FROM WEST BENGAL (INDIA) VIII. QUALITATIVE AND QUANTITATIVE STUDIES OF PLANT AND SOIL INHABITING NEMATODES ASSOCIATED WITH PADDY CROP IN BURDWAN DISTRICT

By

QAISER H. BAQRI, AMALENDU JANA, NASEEM AHMAD AND P. K. DAS

Zoological Survey of India, Calcutta 700 016

(With 1 Text-figure)

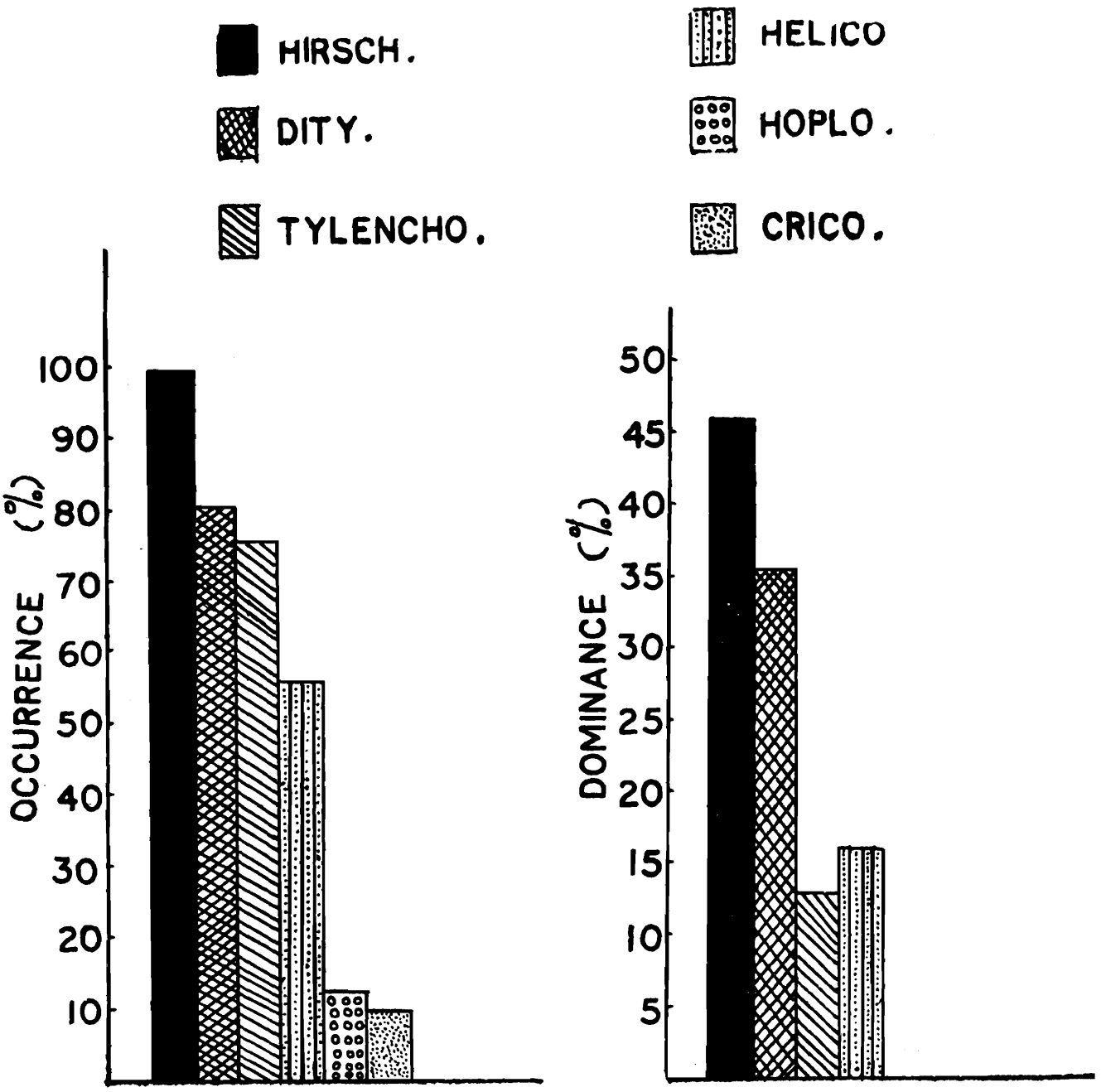
INTRODUCTION

This is the eighth paper of the series on "Nematodes from West Bengal (India)" which deals with the qualitative and quantitative studies of plant and soil inhabiting nematodes associated with paddy crop in Burdwan district of West Bengal. The present study was undertaken as a part of All India Co-ordinated Research Project on Nematode Pests of Crops and their Control, jointly sponsored by I. C. A. R. and D. S. T. during 1977-79. Since this type of studies provide useful informations regarding relative abundance and degree of dominance of different phytophagous nematodes, an intensive survey was therefore made during the month of December, 1977 at Memari, Jamalpur and Bursul Blocks of Burdwan district which is one of the major rice growing districts of West Bengal.

Despite an attempt to study the effect of soil texture on the occurrence and the dominance of different parasitic nematodes, their relationship could not be established in the present study. The results are being provided in the separate tables for each Block so that they may be helpful in future studies.

MATERIAL AND METHODS

The Head Quarter of each developmental block was made as centre and the survey was made in its North, South, West and East directions. In each direction, a village was selected and made centre. An attempt was made, subject to the availability of paddy crop, to take about 4 soil samples from each direction up to 2 Km from village centre. Several



Text-fig. 1

informations regarding management practices etc. were collected from the farmers to correlate these data in future studies.

For the quantitative study, the bulk of a sample was thoroughly mixed with hand and 100 gm of soil was taken separately for processing. This 100 gm soil was processed for the isolation of nematodes through the modified Baermann funnel technique. After 24 hours the counting was made thrice in a counting dish and the mean values were obtained. Only the commonly found nematodes were identified up to genera and counted separately under the stereoscopic microscope. The remaining nematodes were counted under the following groups ; other tylenchids, other dorylaimids and saprophagous.

DETAILS OF SURVEY

1. BLOCK : MEMARI

Village Centre	Adjoinig localities	Soil samples collected from different Soil texture				Total No. of samples collected
		Sandy-loam	Clayey-loam	Clayey	Loam	
(a) Balut	(i) Balut	—	7	—	—	7
	(ii) Garaghata	—	2	—	—	2
	(iii) Kanaidanga	1	—	—	—	1
	(iv) Palla	—	1	—	—	1
	(v) Navagram	—	1	—	—	1
	(vi) Dolui Bazar	—	1	—	—	1
	(vii) Rasulpur Stn.	—	1	—	—	1
(b) Saldah	(i) Saldah	5	7	—	—	12
	(ii) Mahes danga Camp.	—	—	1	—	1
(c) Radhakantapur						
	(i) Radhakantapur	2	5	—	—	7
	(ii) Diamagra	—	1	—	—	1
	(iii) Balidanga	—	—	2	—	2
	(iv) Kamalpur	—	—	2	—	2
	(v) Munshidanga	—	—	1	—	1
(d) Shyamnagar						
	(i) Shyamnagar	—	—	3	—	3
	(ii) Kantapur	1	—	—	—	1
	(iii) Kantanagar	—	1	—	—	1
	(iv) Chotkhanda	1	1	—	—	2
	(v) Maghlampur	1	—	1	—	2

2. BLOCK : JAMALPUR

(a) Abujhati						
	(i) Abujhati	1	4	3	—	8
	(ii) Seromani	1	2	—	—	3
	(iii) Amra	2	—	—	—	2
(b) Autpara						
	(i) Autpara	4	4	—	1	9
	(ii) Bartika	2	—	—	—	2
	(iii) Dakshnpara	2	—	—	—	2
	(iv) Amtara	1	—	—	—	1
(c) Manirambati						
	(i) Manirambati	1	—	—	1	2
	(ii) Basantabati	1	—	—	—	1
	(iii) Madhavpur	1	1	—	—	2

Village Centre	Adjoining localities	Soil samples collected from different Soil texture				Total No. of samples collected
		Sandy-loam	Clayey-loam	Clayey	Loam	
(d) Choubaria						
	(i) Masagram	2	—	2	—	4
	(ii) Choubaria	1	1	—	2	4
	(iii) Saranpur Bartala	2	—	—	—	2
	(iv) Mear Ban	—	1	—	—	1
	(v) Panchra	3	—	—	—	3
3. BLOCK : BURSUL						
(a) Majherpara						
	(i) Majherpara	1	2	—	2	5
	(ii) Sonakur	—	—	—	2	2
	(iii) Krishnapur	—	—	—	1	1
(b) Ryan						
	(i) Ryan	—	7	1	—	8
	(ii) Nari	—	1	—	—	1
(c) Pamra						
	(i) Pamra	8	—	—	2	10
	(ii) Nandur	1	—	—	—	1

A. Qualitative Study :

The samples upon analysis yielded 18 parasitic species belonging to 13 genera, 9 families of the order Tylenchida and Dorylaimida. Besides, 18 soil inhabiting species have also been identified. The following is the list of parasitic nematode species arranged according to their systematic position.

Order TYLENCHIDA Thorne, 1949

Superfamily TYLENCHOIDEA (Orley, 1880) Chitwood & Chitwood, 1937.

Family TYLENCHIDAE Orley, 1880

Genus **Tylenchus** Bastian, 1865

T. davainei Bastian, 1865

T. filiformis Butschili, 1873

Genus **Ditylenchus** Filipjev, 1936

D. mirus Siddiqi, 1963

Family TYLENCHORHYNCHIDAE (Elieva, 1964) Golden, 1971.

Genus **Tylenchorhynchus** Cobb, 1913

T. mashhoodi Siddiqi & Basir, 1959

Family HOPLOLAIMIDAE (Filipjev, 1934) Wieser, 1953

Genus **Hoplolaimus** Daday, 1905

H. indicus Sher, 1963

H. columbus Sher, 1963

Genus **Helicotylenchus** Steiner, 1945

H. crenacauda Sher, 1966

H. retusus Siddiqi & Brown, 1964

Family PRATYLENCHIDAE (Thorne, 1949) Siddiqi, 1963

Genus **Hirschmanniella** Luc & Goodey, 1963

H. oryzae (Soltwedel, 1889) Luc & Goodey, 1963

H. gracilis (De Man, 1880) Luc & Goodey, 1963

Superfamily HETERODEROIDEA (Filipjev, 1934) Golden, 1971.

Family NACOBBIDAE (Chitwood & Chitwood, 1950) Golden, 1971.

Genus **Rotylenchulus** Linford & Oliveira, 1940

R. reniformis Linford & Oliveira, 1940

Superfamily CRICONEMATOIDEA (Taylor, 1936) Geraert, 1966

Family CRICONEMATIDAE (Taylor, 1936) Thorne, 1949

Genus **Macroposthonia** de Man, 1880

M. onoensis (Luc, 1959) De Grisse & Loof, 1965

M. ornata (Raski, 1958) De Grisse & Loof, 1965

Genus **Hemicriconemoides** Chitwood & Birchfield, 1957

H. cocophillus (Loos, 1949) Chitwood & Birchfield, 1957

Family PARATYLENCHIDAE (Thorne, 1949) Raski, 1962

Genus **Paratylenchus** Micoletzky, 1922

P. dianthus Jenkins & Taylor, 1956

Genus **Gracilacus** Raski, 1962

*G. janai** Baqri, 1979

Superfamily APHELENCHOIDEA (Fusch, 1937) Thorne, 1949

Family APHELENCHIDAE (Fusch, 1937) Steiner, 1949

Genus **Aphelenchus** Bastian, 1865

A. avenae Bastian, 1865

Order DORYLAIMIDA (De Man, 1876) Pearse, 1942

Superfamily DORYLAIMOIDEA (de Man, 1876) Thorne, 1934

Family LONGIDORIDAE (Thorne, 1935) Meyl, 1961

Genus **Paralongidorus** Siddiqi *et al.*, 1963

P. citri (Siddiqi, 1959) Siddiqi *et al.*, 1963

Apart from these parasitic nematode species, the following soil inhabiting nematode species belonging to the order Dorylaimida have also been identified :

1. *Ischiodorylaimus* n. sp.
2. *Thornenema mauritianum* (Williams, 1959) Baqri & Jairajpuri 1967
3. *Sicaguttur sartum* Siddiqi, 1971
4. *Medalinema coomansi** Baqri & Jana, 1980
5. *Jairajpuria shamimi** Baqri & Jana, 1980
6. *Aporcelaimellus heynsi* Baqri & Jairajpuri, 1968
7. *Aporcelaimellus tropicus** Jana & Baqri, 1981
8. *A. coomansi* Baqri & Khera, 1975
9. *Tylencholaimus pakistanensis* Timm, 1964
10. *Proleptonchus clarus* Timm, 1964
11. *Dorylaimoides elaboratus* Siddiqi, 1965
12. *Dorylaimoides parvus* Thorne & Swanger, 1936
13. *D. arcuicaudatus* Baqri & Jairajpuri, 1969
14. *Morasia bengalensis** Jana & Baqri, 1982
15. *Dorylaimellus discocephalus* Siddiqi, 1964
16. *Dorylaimellus indicus* Siddiqi, 1964
17. *Dorylaimellus deviatus* Baqri & Jairajpuri, 1968
18. *Neoactinolaimus thornei* Chaturvedi & Khera, 1979

The species marked with asterisk in the list have been reported earlier as new (Baqri, 1979 ; Baqri and Jana, 1980 ; Jana & Baqri, 1980 ; Baqri & Jana, 1981 ; and Jana & Baqri, 1982.). The male specimens of *Sicaguttur sartum*, Siddiqi 1971 have been reported for the first time.

B. Quantitative Study of Nematodes

1. BLOCK : MEMARI

Soil samples examined : 49

Nematodes	Per 100 gm of soil
Ditylenchus	20—510
Tylenchorhynchus	20—700
Helicotylenchus	10—530
Hirschmanniella	10—360
Macroposthonia	10— 80
Other Tylenchids	20—370
Other Dorylaimids	30—630
Saprophagous	40—370

Nematodes found from different types of soil in the Block Memari (per 100 gm of soil)

Nematodes	Sandy-loam		Clayey-loam		Clayey	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Ditylenchus	20	410	30	510	20	290
Tylenchorhynchus	20	300	10	200	20	700
Helicotylenchus	10	280	10	530	20	60
Hirschmanniella	80	220	10	280	20	360
Macroposthonia	10	80	10	—	—	—
Other Tylenchids	20	130	10	370	—	—
Other Dorylaimids	30	560	40	630	40	380
Saprophagous	80	360	60	370	40	210

2. BLOCK : JAMALPUR

Soil samples examined : 46

Nematodes	Per 100 gm of soil
Ditylenchus	20—2270
Tylenchorhynchus	10— 610
Hoplolaimus	10
Helicotylenchus	20— 240
Hirschmanniella	10— 290
Macroposthonia	10— 40
Rotylenchulus	50— 100
Other Tylenchids	30— 130
Other Dorylaimids	20—1200
Saprophagous	30— 400

Nematodes found from different types of soil in the Block Jamalpur (per 100 gm of soil)

Nematodes	Sandy-loam		Clayey-loam		Clayey		Loam	
	Mini-mum	Maxi-mum	Mini-mum	Maxi-mum	Mini-mum	Maxi-mum	Mini-mum	Maxi-mum
Ditylenchus	20	2270	40	2050	80	1190	100	—
Tylenchorhynchus	10	610	10	100	20	110	70	—
Hoplolaimus	10	—	10	—	—	—	—	—
Helicotylenchus	20	240	10	40	40	70	—	—
Hirschmanniella	10	230	30	280	30	290	110	210
Macroposthonia	10	40	—	—	—	—	—	—
Rotylenchulus	50	100	—	—	—	—	—	—
Other Tylenchids	40	110	30	40	—	—	130	—
Other Dorylaimids	50	1200	110	410	20	700	160	270
Saprophagous	30	400	30	310	60	260	120	300

3. BLOCK : BURSUL (BURDWAN SADAR)

Soil samples examined : 29

Nematodes	Per 100 gm of soil
Ditylenchus	10—470
Tylenchorhynchus	20—290
Hoplolaimus	15—130
Helicotylenchus	20—240
Hirschmanniella	15—410
Macroposthonia	50
Paralongidorus	10
Other Tylenchids	10— 80
Other Dorylaimids	40—610
Saprophagous	20—230

Nematodes found from different types of soil in Block Bursul (per 100 gm of soil)

Nematodes	Sandy-loam		Clayey-loam		Clayey		Loam	
	Mini-mum	Maxi-mum	Mini-mum	Maxi-mum	Mini-mum	Maxi-mum	Mini-mum	Maxi-mum
Ditylenchus	10	180	20	330	470	—	50	190
Tylenchorhynchus	20	160	30	100	220	—	290	—
Hoplolaimus	15	130	—	—	—	—	—	—
Helicotylenchus	240	—	20	40	110	—	50	110
Hirschmanniella	50	410	20	325	130	—	15	250
Macroposthonia	50	—	—	—	—	—	—	—
Paralongidorus	—	—	10	—	—	—	—	—
Other Tylenchids	20	40	30	80	—	—	10	20
Other Dorylaimids	40	380	50	610	140	—	150	320
Saprophagous	20	180	40	230	90	—	30	120

Among the plant parasitic nematodes, species of *Hirschmanniella* Luc & Goodey, 1963 were most abundant and present nearly in all the samples. *Hirschmanniella gracilis* (de Man, 1880) Luc & Goodey, 1963 was found dominating over other parasitic species in 46% samples.

The occurrence of *Ditylenchus* spp., *Tylenchorhynchus mashhoodi* Siddiqi & Basir, 1959 and *Helicotylenchus crenacauda* Sher, 1966 has been noted in 81%, 76% and 56% samples respectively. The *Ditylenchus* spp. were dominating in 36% samples. *Tylenchorhynchus mashhoodi* and *Helicotylenchus crenacauda* were generally present in small numbers but dominating in 13% and 16% samples respectively. The species of the genus *Hoplolaimus* Daday, 1905 has been recorded in 13% samples. The species of *Macroposthonia* de Man, 1880 and *Hemicriconemoides* Chitwood & Birchfield, 1957 were quite numerous in 10% samples (Text-fig. 1). The other parasitic species are less abundant.

The effect of soil texture on the relative abundance and degree of dominance of different parasitic nematode species remained inconclusive at this stage, but more intensive surveys in future would be certainly helpful in this regard.

Summary

During the month of December, 1977 an intensive survey was made to study the relative abundance and degree of dominance of plant parasitic nematodes associated with paddy crop at Memari, Jamalpur and Bursul Blocks of Burdwan district in West Bengal. Upon analysis, 18 parasitic nematode species belonging to 14 genera and 9 families are being identified. In addition to these parasitic nematode species, 18 soil inhabiting nematode species have also been found. The list of species also includes the names of the following species and genera which have been found new to science in this collection : *Gracilacus janai* Baqri, 1979 ; *Ischiodorylaimus* n. sp., *Medalinema coomansi* Baqri & Jana, 1980 ; *Jairajpuria shamimi* Baqri & Jana, 1980 ; *Aporcelaimellus tropicus* Jana & Baqri, 1981 and *Morasia bengalensis* Jana & Baqri, 1982. The male specimens of *Sicaquttur sartum* Siddiqi, 1971 have been found for the first time. The present study also reveals that among the plant parasitic nematodes, *Hirschmanniella gracilis* (de Man, 1880) Luc & Goodey, 1963 is the most abundant species and dominates in 46% samples in the area surveyed.

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ON THE LOCATIONS OF THE OESOPHAGEAL GLAND NUCLEI IN THE ORDER MONONCHIDA (NEMATODA)

By

QAISER H. BAQRI

Zoological Survey of India, Calcutta

AND

SAMER Z. BAQRI

Department of Zoology, Aligarh Muslim University, Aligarh

INTRODUCTION

Loof & Coomans (1968, 70) were the first to give an exhaustive and systematic account of oesophageal glands and their orifices in many species of different genera and families of the suborder Dorylaimina. Their study also included five species of mononchs because they were considered under Dorylaimina. Since then Loof & Jairajpuri (1968), Baqri & Jairajpuri (1969), Coomans & Loof (1970), Siddiqi (1969), Loof & Coomans (1972), Baqri & Coomans (1973) and others have contributed informations on this aspect and noted the consistency of these structures in different groups.

In the present work, an attempt has been made to provide informations, wherever possible, about the locations of oesophageal glands and their orifices in the species of Mononchida present in the National Collection of Zoological Survey of India and Department of Zoology, Aligarh Muslim University, Aligarh (U. P.). A total of 20 species belonging to 11 genera and 6 families of two suborders (Mononchina and Bathyodontina) have been studied. Since the order Mononchida includes only about 30 genera, the present study gives a good account of informations on the distribution of oesophageal gland nuclei and their orifices.

OBSERVATIONS

The general plan of nuclei and orifices in mononchs : The oesophagus in its posterior half consists of five (one celled) glands of different size and shape, i.e., one gland in the dorsal sector and four arranged in two pairs in the ventro-sublateral sectors. The nucleus/nucleolus of each gland becomes visible upon careful examination of the oesophagus.

The dorsal gland (DN) is the anterior most of the five, except in the members of suborder Bathyodontina where it may be situated even below the first pair of subventral glands. It is comparatively larger in size. The orifice of the dorsal gland (DO) is always well visible in the lumen anterior to dorsal gland (DN). The first pair of subventral glands (S_1N) are smaller in size and situated far below their orifices (S_1O). These two glands (S_1N) are located almost at the same level. The second pair of subventral glands (S_2N) is situated near the base of oesophagus or at about 90% or more of the oesophageal from anterior extremity. The orifices of the second pair (S_2O) are very close and generally situated slightly posterior to their glands but may be either at the level of S_2N or even far anterior. The S_2N are comparatively bigger than S_1N.

The locations are given below in percentage calculated from the total oesophageal length.

Suborder MONONCHINA

Family : MONONCHIDAE Chitwood, 1937

1. Genus **Mononchus** Bastian, 1865

1. 1. **Mononchus truncatus** Bastian, 1865

(Text-fig. 1)

Specimens observed : Four females. Total oesophageal length 382-415 μm. Location as follows :

DO=59.0-60.9	S_1O=69-73	S_2N=90-93
DN=62.5-66.2	S_1N=80-83	S_2O=93-94
DO-DN=3.6-5.5	S_1N-S_1O=8.8-10.6	

2. Genus **Prionchulus** (Cobb, 1917) Wu & Hoeppli, 1929

2. 1. **Prionchulus muscorum** (Cobb, 1917) Wu & Hoeppli, 1229

(Text-fig. 2)

Specimens observed : Five females. Total oesophageal length 412-442 μm. Locations as follows :

DO=56.6-58.4	S_1O=72-77	S_2N=94-95
DN=60.7-62.7	S_1N=83-88	S_2O=95-96
DO-DN=3.9-4.8	S_1N-S_1O=10.1-10.9	

2. 2. **Prionchulus longus** (Thorne, 1929) Andrassy, 1958

(Text-fig. 3)

Specimens observed : Two females. Total oesophageal length 554-567 μm. Locations as follows :

DO=53.2-55.0	S_1O=70-71	S_2N=94
DN=57.7-60.1	S_1N=80-81	S_2O=96
DO-DN=4.5-5.1	S_1N-S_1O=9.9-11.4	

3. Genus **Clarkus** Jairajpuri, 1970

3. 1. **Clarkus papillatus** (Bastian, 1865) Jairajpuri, 1970

(Text-fig. 5)

Specimens observed : Three females. Total oesophageal length 281-354 μm. Locations as follows :

DO=58.9-60.8	S_1O=72-74	S_2N=94-95
DN=65.2-66.9	S_1N=83-85	S_2O=95-96
DO-DN=4.8-6.1	S_1N-S_1O=10.5-10.6	

3. 2. **Clarkus sheri** (Mulvey, 1967) Jairajpuri, 1970

(Text-fig. 4)

Specimen observed : One female. Total oesophageal length 487 μm. Locations as follows :

DO=59.7	S_1O=71	S_2N=97
DN=62.4	S_1N=81	S_2O=98
DO-DN=2.7	S_1N-S_1O=10.3	

Family : COBBONCHIDAE Jairajpuri, 1969

4. Genus **Cobbonchus** Andrássy, 1958

4. 1. **Cobbonchus indicus** Baqri, Baqri & Jairajpuri, 1978

(Text-fig. 6)

Specimens observed : One female and one male. Total oesophageal length 324-325 μm. Locations as follows :

DO=54.1-55.2	S_1O=73-74	S_2N=93-94
DN=61.7-62.6	S_1N=85	S_2O=97
DO-DN=6.5-8.5	S_1N-S_1O=10.2-11.4	

Family : MYLONCHULIDAE Jairajpuri, 1969

5. Genus **Mylonchulus** (Cobb, 1916) Altherr, 1953

5. 1. **Mylonchulus nainitalensis** Jairajpuri, 1970

(Text-fig. 8)

Specimens observed : Three females. Total oesophageal length 283-314 μm. Locations as follows :

DO=56.6-57.6	S_1O=71-72	S_2N=91-93
DN=61.4-63.1	S_1N=81-83	S_2O=92-93
DO-DN=4.8-5.6	S_1N-S_1O=9.9-10.6	

5. 2. **Mylonchulus agriculturae** Coetzee, 1967

(Text-fig. 9)

Specimens observed : Three females. Total oesophageal length 310-389 μm. Locations as follows :

DO=56.1-56.8	S_1O=70-73	S_2N=90-93
DN=59.3-60.3	S_1N=78-81	S_2O=92-93
DO-DN=3.3-3.5	S_1N-S_1O=8.0-9.0	

5. 3. **Mylonchulus mulveyi** Jairajpuri, 1970

(Text-fig. 10)

Specimens observed : Five females. Total oesophageal length 287-322 μm. Locations as follows :

DO=53.1-56.4	S_1O=66-70	S_2N=90-93
DN=58.2-62.0	S_1N=76-79	S_2O=93-95
DO-DN=4.9-6.4	S_1N-S_1O=9.1-11.0	

5. 4. **Mylonchulus lacustris** (N. A. Cobb in M. V Cobb, 1915) Andrássy, 1958

(Text-fig. 11)

Specimens observed : Four females. Total oesophageal length 321-390 μm. Locations as follows :

DO=50.1-55.3	S_1O=63-68	S_2N=90-93
DN=54.8-59.3	S_1N-74-78	S_2O=92-94
DO-DN=4.0-5.5	S_1N-S_1O=9.3-10.9	

5. 5. **Mylonchulus striatus** (Thorne, 1924) Andrássy, 1958

(Text-fig. 12)

Specimen observed : One female. Total oesophageal length 285 μm. Locations as follows :

DO=57.1	S_1O=70	S_2N=92
DN=63.5	S_1N=79	S_2O=92
DO-DN=6.4	S_1N-S_1O=8.7	

5. 6. **Mylonchulus brachyuris** (Butschili, 1873) Altherr, 1953

(Text-fig. 13)

Specimens observed : Two females. Total oesophageal length 338-342 μm. Locations as follows :

DO=58.7-59.0	S_1O=71	S_2N=90-91
DN=62.8-63.1	S_1N=79-84	S_2O=93
DO-DN=3.8-4.4	S_1N-S_1O=7.9-12.8	

6. Genus **Sporonchulus** (Cobb, 1917) Pennak, 1953

6. 1. **Sporonchulus ibitensis** (Carvalho, 1956) Andrassy, 1958

(Text-fig. 7)

Specimens observed : Four females. Total oesophageal length 261-294 μm. Locations of follows :

DO=58.9-62.2	S_1O=70-73	S_2N=91-94
DN=64.1-67.7	S_1N=82-87	S_2O=94-97
DO-DN=4.1-5.7	S_1N-S_1O= 9-15	

Family : ANATONCHIDAE Jairajpuri, 1969

7. Genus **Anatonchus** (Cobb, 1916) De Coninck, 1939

7. 1. **Anatonchus gynglymodontus** Mulvey, 1961

(Text-fig. 14)

Specimens observed : Two females and one male. Total oesophageal length 561-608 μm. Locations as follows :

DO=52.3-53.0	S_1O=69-71	S_2N=94
DN=56.1-57.1	S_1N=80-83	S_2O=95-96
DO-DN=3.1-4.8	S_1N-S_1O=10.2-13.0	

8. Genus **Miconchus** Andrássy, 1958

8. 1. **Miconchus thornei** Mulvey & Jensen, 1967

(Text-fig. 15)

Specimens observed : Two females. Total oesophageal length 439-516 μm. Locations as follows :

DO=49.6-52.1	S_1O=70-72	S_2N=93-94
DN=52.6-56.9	S_1N=80	S_2O=96
DO-DN=2.5-4.3	S_1N-S_1O=8-10	

Family : Iotonchidae Jairajpuri, 1969

9. Genus **Iotonchus** (Cobb, 1916) Altherr, 1950

9. 1. **Iotonchus longicaudatus** Baqri, Baqri & Jairajpuri, 1978

(Text-fig. 16)

Specimens observed : Four females. Total oesophageal length 259-305 μm. Locations as follows :

DO=52.5-55.4	S_1O=71-74	S_2N=92-94
DN=62.1-64.7	S_1N=82-84	S_2O=95-97
DO-DN=9.0-10.2	S_1N-S_1O=10.2-10.6	

9. 2. **Iotonchus brachylaimus** (Cobb, 1917) Andrassy, 1958

(Text-fig. 17)

Specimens observed : One female and two males. Total oesophageal length 547-647 μm. Locations as follows :

DO=47.2-50.5	S_1O=67-71	S_2N=91-93
DN=55.7-59.3	S_1N=79-84	S_2O=95-96
DO-DN=8.5-8.8	S_1N-S_1O=11-17	

9.3. **Iotonchus coomansi** Baqri, Baqri & Jairajpuri, 1978

(Text-fig. 18)

Specimens observed : Four females. Total oesophageal length 234-254 μm. Locations as follows :

DO=54.8-58.6	S_1O=70-71	S_2N=95-97
DN=62.1-64.1	S_1N=80-85	S_2O=96-97
DO-DN=6.0-7.5	S_1N-S_1O=12.8-15. 4	

The S_2N are either situated at the level of S_2O or slightly above.

10. Genus **Parahadronchus** Mulvey, 1978

10.1. **Parahadronchus shakili** (Jairajpuri, 1969) Mulvey, 1978

(Text-fig. 19)

Specimens observed : Three females and one male. Total oesophageal length 546-615 μm. Locations as follows :

DO=47.8-50.0	S_1O=66-69	S_2N=91-94
DN=56.3-58.6	S_1N=80-81	S_2O=94-96
DO-DN=6.3-9.2	S_1N-S_1O=11.7-13.3	

The species of the genera *Iotonchus* and *Parahadronchus* of the family Iotonchidae share a character that DN lies comparatively far behind DO, i.e., near about middle of DO-S_1O.

Suborder BATHYODONTINA

Family : MONONCHULIDAE (De Coninck, 1965)

11. Genus **Mononchulus** Cobb, 1918

11.1. **Mononchulus nodicaudatus** (v. Daday, 1901) Schneider, 1937

(Text-fig. 20)

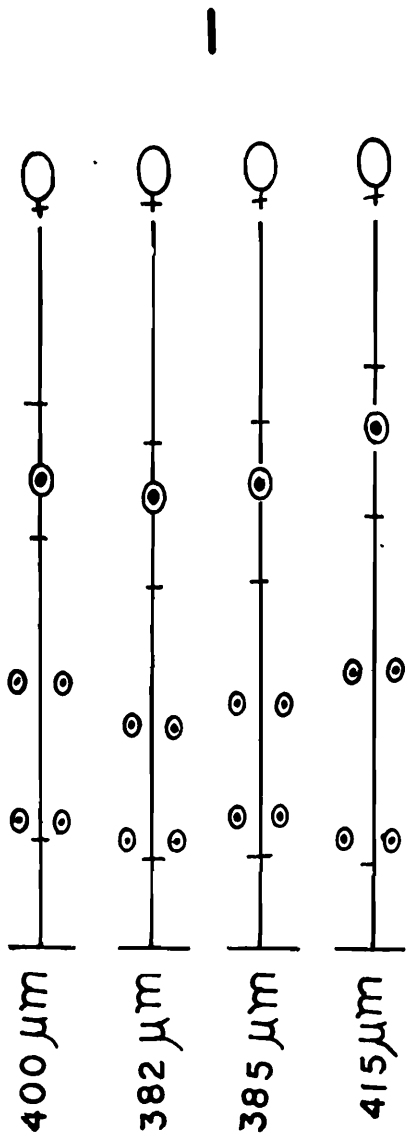
Specimens observed : Five females. Total oesophageal length 285-310 μm. Locations as follows :

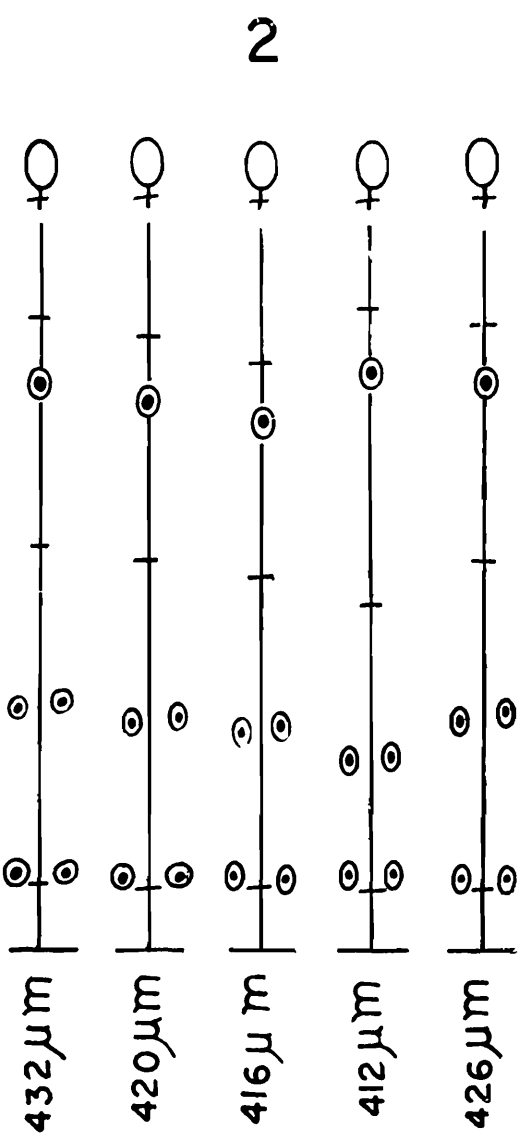
DO=46.4-53.3	S_1O=62-64	S_2N=91-93
DN=74.6-77.8	S_1N=76-77	S_2O=91-92
DO-DN=22.5-29.2	S_1N-S_1O=12.1-13.4	

The DN is far behind from DO, even slightly posterior to S_1N. The S_2N are either situated at level of S_2O or slightly below.

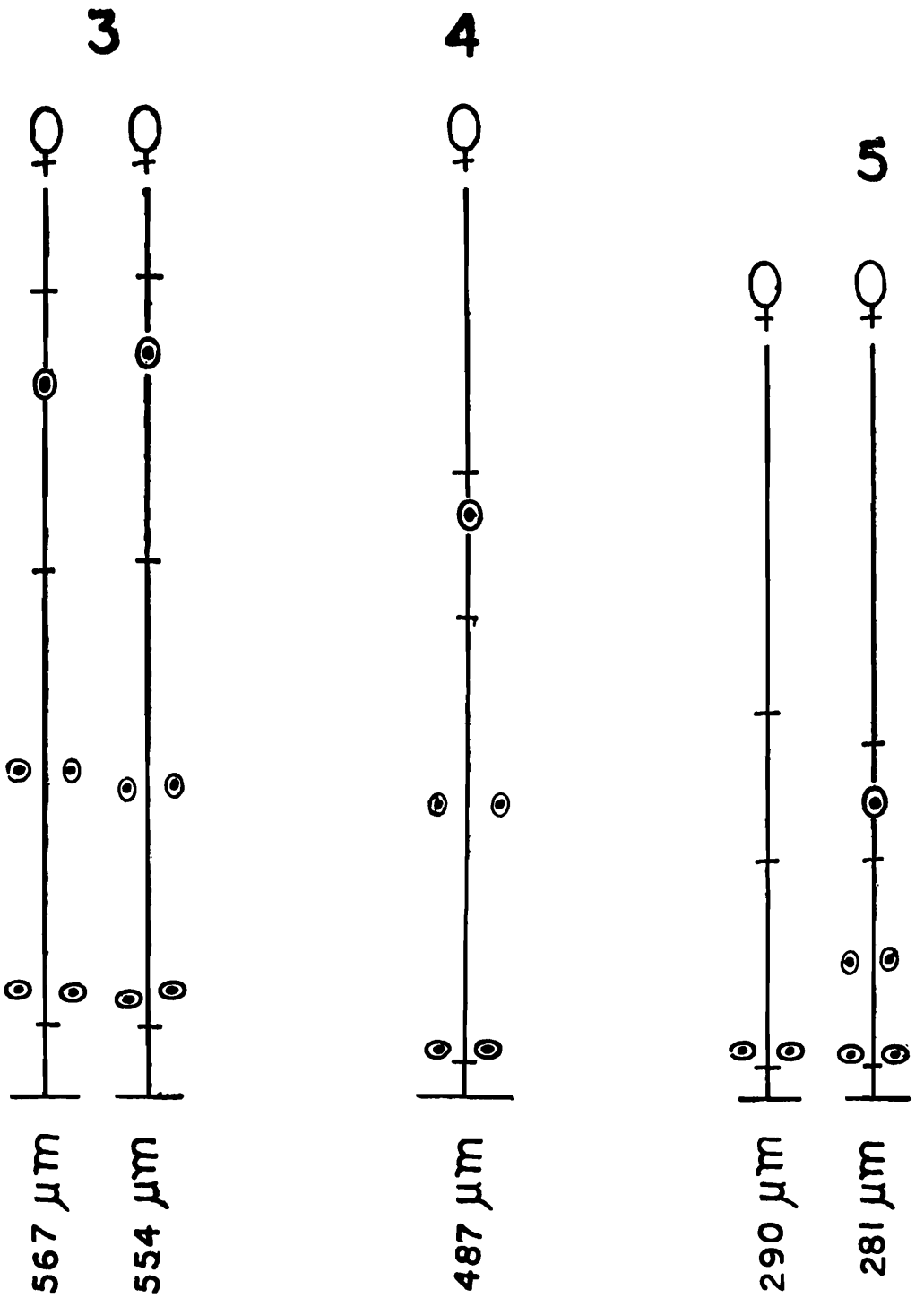
SUMMARY

The locations of oesophageal gland nuclei and their orifices have been studied in 20 species belonging to 11 genera, 6 families of the order Mononchida. The distance between S_1O and S_1N is about 10% or more of the total oesophageal length. The dorsal gland (DN) lies between DO and S_1O in the suborder Mononchina whereas in the suborder Bathyodontina, family Mononchulidae, the DN is always situated posterior to S_1O at about the level of S_1N. In the species of the genera *Iotonchus* and *Parahadronchus*, family Iotonchidae, DN is comparatively located far behind from DO, i. e., near the middle of DO-S_1O.

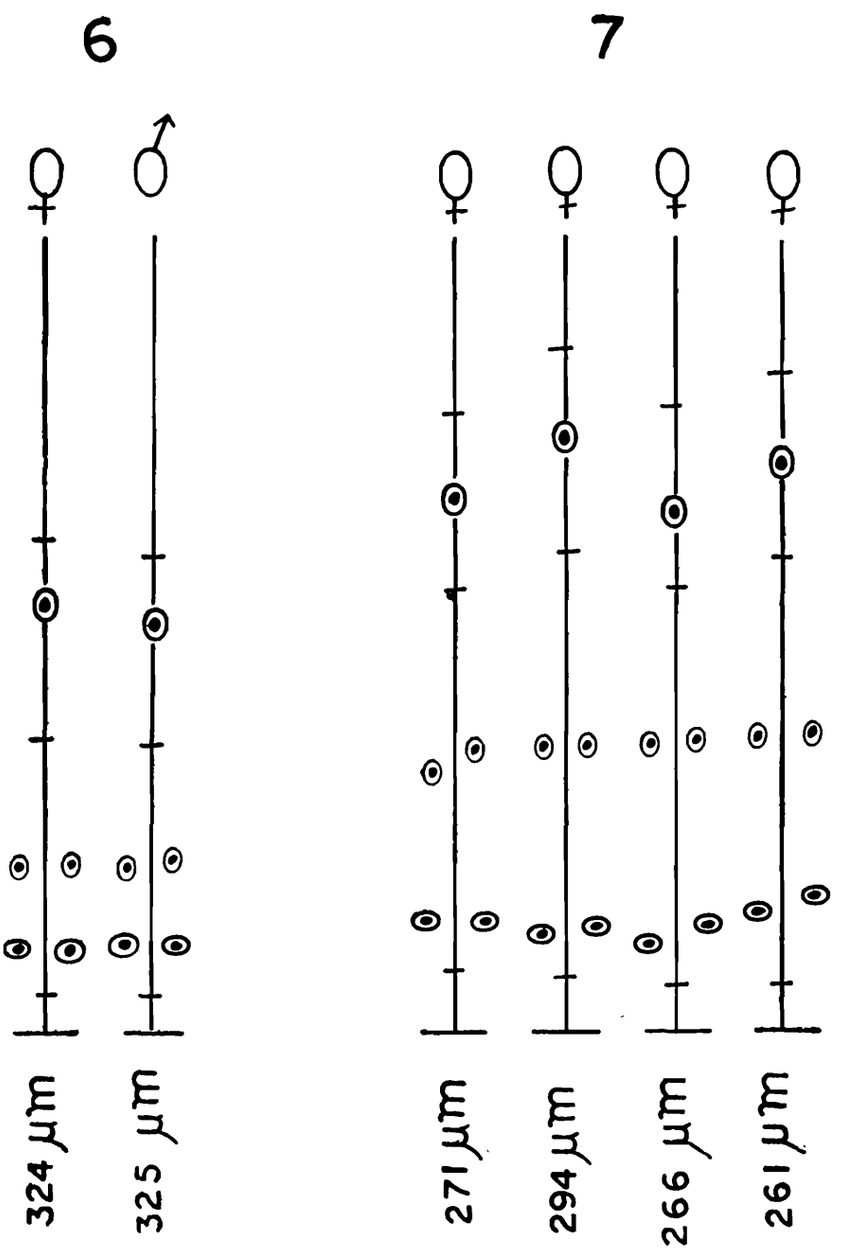




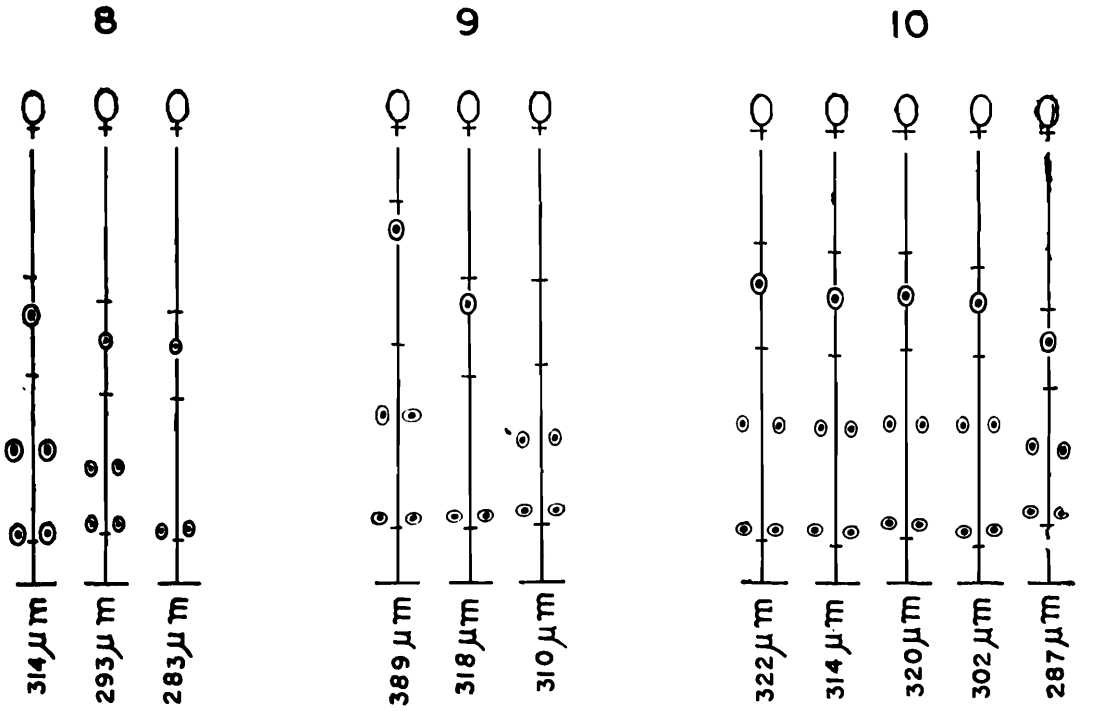
Text-fig. 1. *Monochus truncatus* ; Text-fig. 2. *Prionchulus muscorum*.



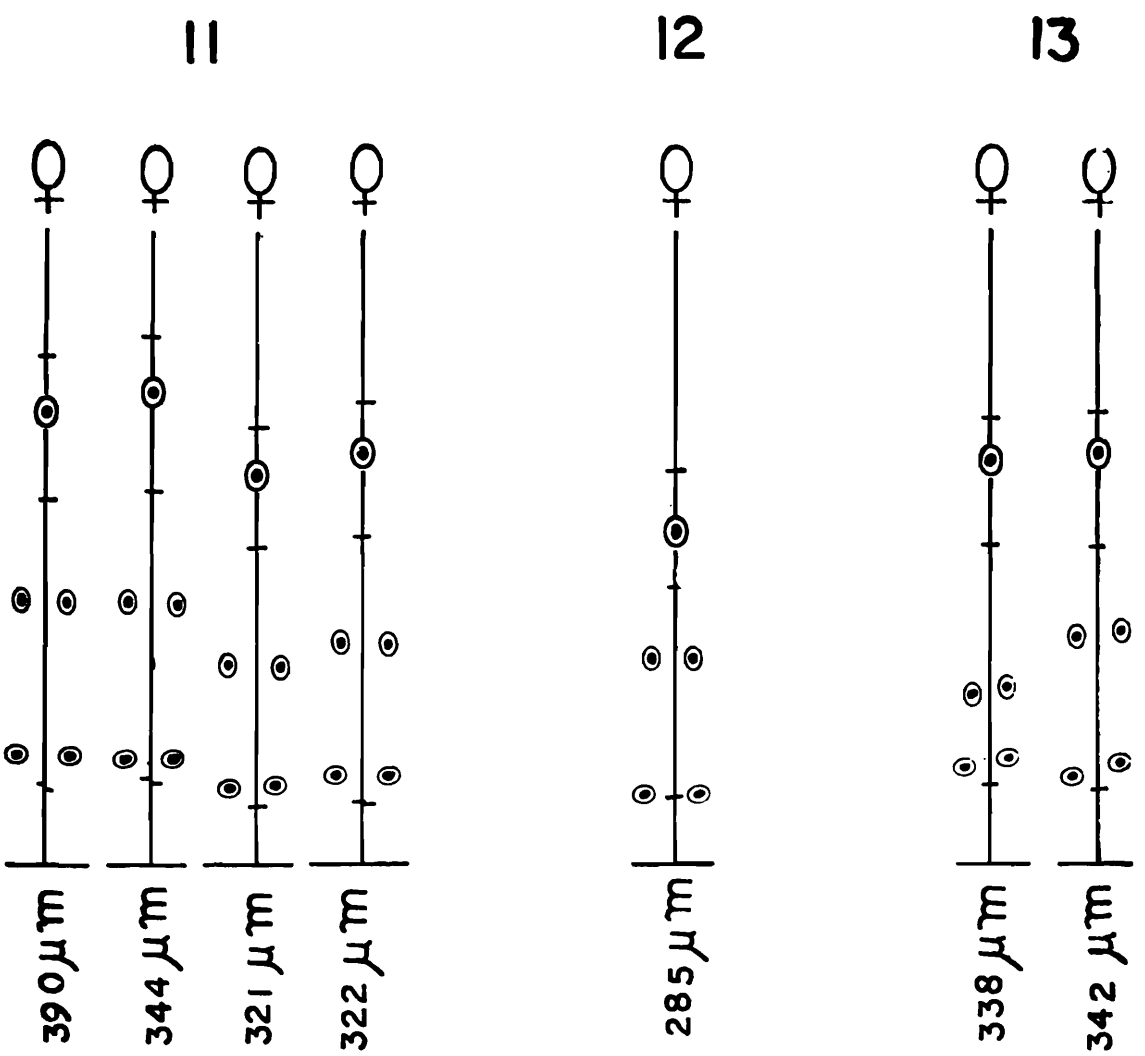
Text-fig. 3. *Prionchulus longus* ; Text-fig. 4. *Clarkus sheri* ; Text-fig. 5. *Clarkus papillatus*.



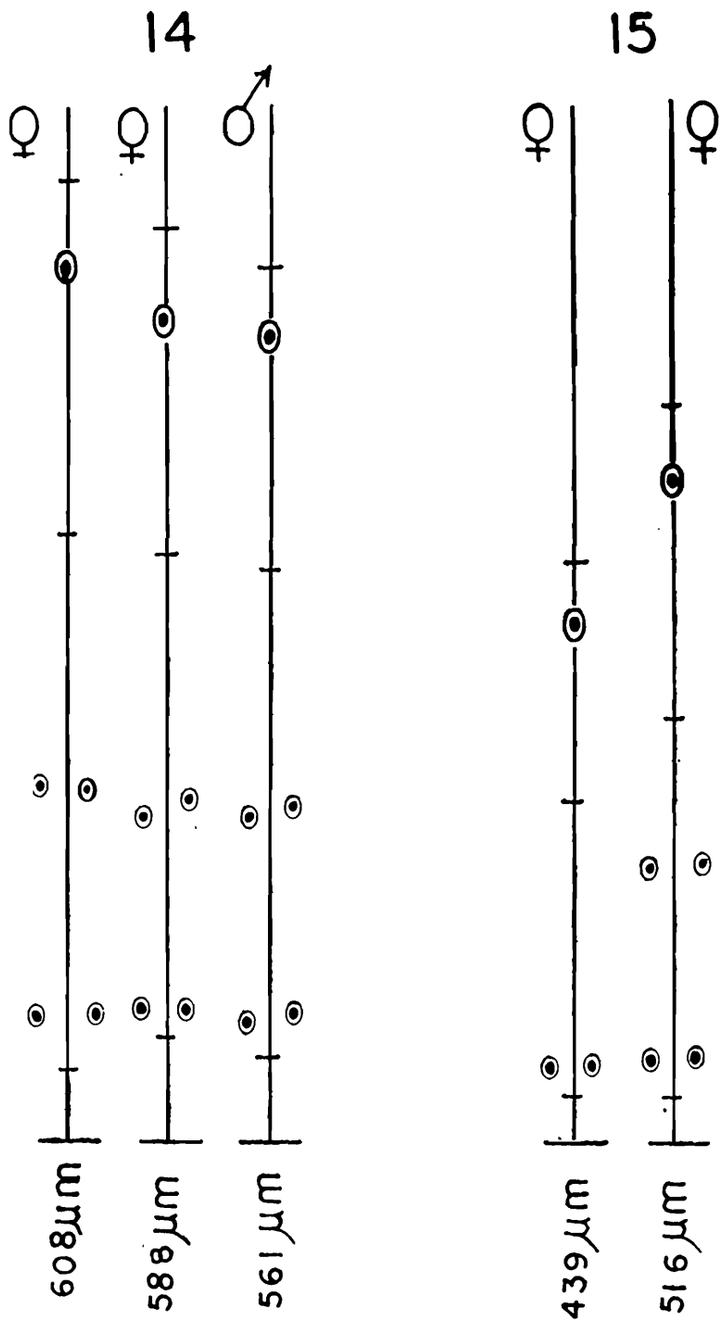
Text-fig. 6. *Cobbonchus indicus* ; Text-fig. 7. *Sporonchulus ibitensis.*



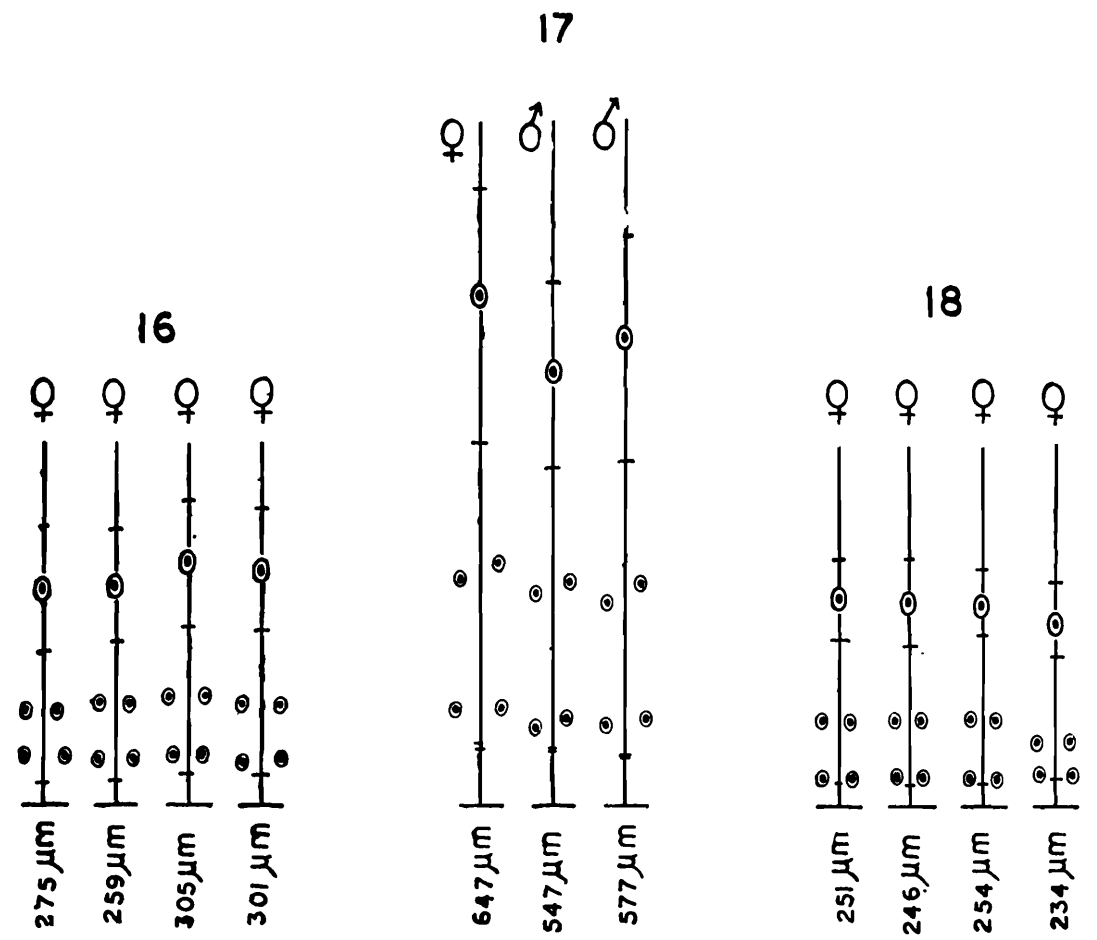
Text-fig. 8. *Mylonchulus nainitalensis* ; **Text-fig. 9.** *Mylonchulus agriculturae* ; **Text-fig. 10.** *Mylonchulus mulveyi.*



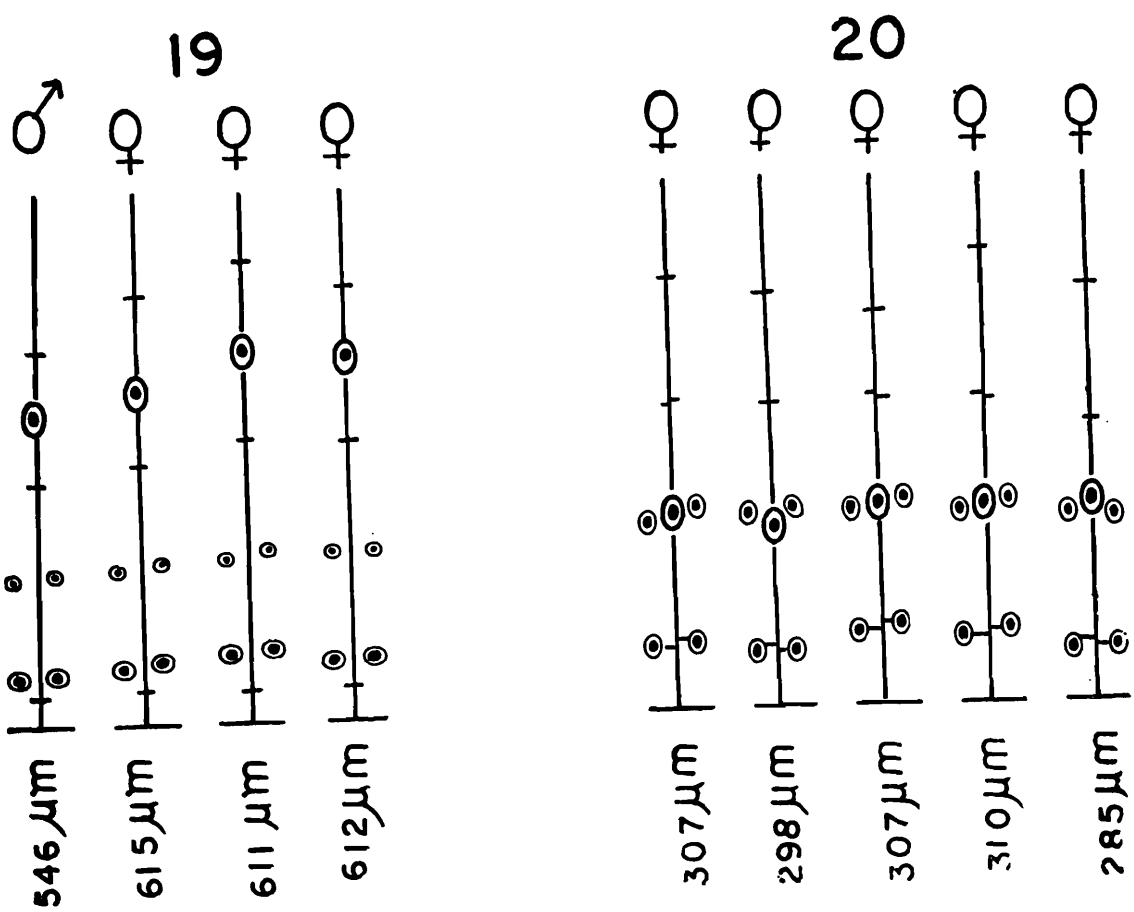
Text-fig. 11. *Mylonchulus lacustris* ; **Text-fig. 12.** *Mylonchulus striatus* ; **Text-fig. 13.** *Mylonchulus brachyurus.*



Text-fig. 14. *Anatonchus gynglymodontus* ; Text-fig. 15. *Miconchus thornei.*



Text-fig. 16. *Iotonchus longicaudatus* ; Text-fig. 17. *Iotonchus brachylaimus* ; Text-fig. 18. *Iotonchus coomansi.*



Text-fig. 19. *Parahadronchus shakili* ; Text-fig. 20. *Mononchulus nodicaudatus.*

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TAXONOMIC RESEARCH ON INDIAN MAMMALS

By

H. KHAJURIA

Zoological Survey of India, Calcutta

INTRODUCTION

The need for a review of the work on taxonomy of the important group of mammals of the Indian subcontinent has keenly been felt for sometime particularly in view of urgent necessity of preparation of second edition of several orders of Blanford's *Fauna of India* covering the whole subcontinent, the first edition having been prepared about a century ago (published 1888-1891). No such review has so far been attempted particularly during the period after Indian Independence possibly because of the vastness of this well-defined geographical zone including seven countries (India, Pakistan, Burma, Bangladesh, Nepal, Bhutan and Sri Lanka) and extensive literature scattered in numerous periodicals and monographs. Kinnear (1952) has, however, ably dealt with the history of Indian mammalogy during the pre-Independence period.

An attempt has been made here to prepare a brief review of important works on taxonomy of Indian mammals with special reference to to the present status of the subject and bibliography. The historical information given by previous authors about pre-Independence period has been condensed, recasted in the light of more literature and reclassified to suit the present needs.

Only important works of pre-Independence period have been included. Cross references to other earlier works will be found in these references. Numerous references dealing with Indian mammal survey conducted by Bombay Natural History Society (ca 1911-1929 ; but mainly from (1912-1920) are all published in the society's journal and are, thus, easily accessible. They are, thus, except Wroughton's 'summary' reports, not reproduced in the bibliography to limit space. The various sources from where the information given in this article is taken are given in the bibliography.

Thanks are due to Dr. B. Biswas, Ex-Joint Director, Zoological Survey of India, for his useful critisizm.

PRESENT STATUS OF TAXONOMIC RESEARCH

Work on taxonomy of Indian mammals during pre-independence period has mainly been done by British nationals, many of whom had

access to unrivalled British Museum collection which contained not only highly representative collection of Indian mammals but also collection from all over the world for comparison. After independence, it was very difficult for Indian workers to study British Museum collection as well as collection in other museums because of difficulty of borrowing a large series of expensive mammalian specimens. Good reference collection in Zoological Survey of India and the Bombay Natural History Society, though representative of Indian mammals, did not permit undertaking of any revisionary work without extensive borrowing of specimens from abroad. Under the circumstances, although there has been much effort in the collection of specimens, identification, cataloguing, description of new forms etc., sufficient revisionary work could not be attempted as compared with work done in other scientifically advanced countries like U. S. A., U. S. S. R. and other European countries. The said difficulty has also reduced the number of taxonomic monographs published by Indian workers. Because of confinement of reference collection, mostly to Calcutta and Bombay, the number of taxonomic workers is also very limited. The Zoological Survey of India has, however, now opened fifteen regional offices in different parts of the country. Each of these offices will develop its own collection in due course. This will help to increase the number of taxonomic workers.

Important fields which need urgent further work are :

(i) Publication of a second revised edition of Fauna of India on all groups of mammals except Primates, Carnivora and Rodentia (already revised by Pocock and Ellerman) because the first edition was published as early as 1888-1891.

(ii) World wide revision of some groups particularly of Insectivora and Chiroptera.

(iii) Further intensive collection particularly by regional offices of the Zoological Survey of India, especially in those localities and groups which could not properly be attended by the mammal survey *vide* Wroughton (1918-1919). Such a modern collection with detailed data can help in the clarification of problems on subspeciation, distribution and habits of several forms. The selected bibliography given at the end gives a clear picture of our present knowledge of the group.

About five hundred living species (Khajuria, 1963, p. 1) are likely to occur in the area under review out of about 3700 estimated by Mayr (1969) in the whole world.

A REVIEW OF TAXONOMIC RESEARCH

Work on zootaxonomy (handling of specimens including collection with field notes—labelling, identification, cataloguing, classification, etc.) of Indian mammals dates from times immemorial (see Rao, 1957). However, modern work can be considered to date from 1758, the date of publication of tenth edition of Linnaeus' *Systema Naturae* which gave modern binomial names to a number of common Indian mammals. Accessibility of Indian mammalian fauna to European scientists particularly during British regime, gave a very significant fillip to the study of taxonomy of this important group on the basis of fast advancing European science.

The era which followed can conveniently be divided into five somewhat overlapping periods with peaks lasting for about half a century[1].

(i) *Pre-Hodgson period* :

French workers such as Charles Belanger, Jean Baptiste Leschenault, Medard Diard, Alfred Duvaucel, Dussumier[2], Victor Jacquemont were active during the period mainly in collections which were studied by such well known authorities as the Cuvier, Geoffroy and Blainville. A number of new species were discovered by these workers. The well known Belanger's "*Voyage aux Indes orientales*" published in 1838 was an important contribution based on these investigations. The publication described a number of new species. Other workers such as Pallas, Erxleben and Schreber also described a number of species. The most outstanding English worker of the period was Thomas Hardwicke (1756—1835) who collected extensively in West Bengal, U. P. and Kashmir from 1778 to 1823. Under his supervision, numerous drawings particularly of large mammals were made by local artists. A number of important species were described by him but some of his descriptions were not published. Many of his illustrations were published by Gray (1830-1835).

(ii) *Hodgson-Jerdon-Blyth period* :

This period has rightly been called the Golden Age of Indian Mammalogy because of collection of large number of specimens with field data by dedicated workers but mainly by the following.

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1. Kinear (1952) has covered much wider scope while giving a history of Indian Mammalogy upto middle of this century.

2. Only surname of the worker is given where full name is not known. A few localities carry old names to avoid confusion.

Brian Houghton Hodgson (1800-1894). He was the most active worker of the period. He worked in India in various capacities from 1818 to 1843 finally retiring as Resident to the Government of Nepal. He continued to work in India upto 1858 even after retirement. He made a large collection through hunters and described several new species. He also engaged local artists to make numerous coloured drawings of mammals. He published his catalogue dealing with 115 species in 1846. Hodgson's collection, however, suffered from inadequate labelling as was the practice in those days.

Thomas Caverhill Jerdon (1811-1872). He was a medical officer and was another outstanding worker of this period. He worked from 1835-1870 in South and Central India, Kashmir and various hill stations of the Himalayas. He is well known for his work entitled "Mammals of India" published in 1874 which is the first book on taxonomy of Indian Mammals and which, though not exhaustive, considerably served the purpose for which it was prepared. The work, mainly dealt with species in Kashmir, peninsular India, and Assam and treatment of small mammals as admitted by the author was inadequate.

Edward Blyth (1810-1873). Blyth worked in India from 1841 to 1862 as Curator of Museum of the Asiatic Society of Bengal, Calcutta and published several papers and detailed catalogues of the collection. Because of his curatorial duties, his field activity was mainly confined to Bengal within the area under review. Nevertheless he was responsible for creation of considerable interest in scientific collections, because of versatile knowledge and energy.

A notable student, though not a collector, was J. E. Gray who while in London published a number of papers on Indian mammals. He is well known for his publication "Illustrations of Indian Zoology" published in 1830-35 in two volumes. Although inaccurate in many details, the work provides considerable original data.

Other notable collectors of this period are : T. Hutton (Mussoorie), Boys (Rajasthan), Tytler (Kumaon, Andamans), W. Griffith (Assam), J. McClelland (Assam), S. R. Tickell (Singhbum, Bihar, Chaibassa, Orissa), W. Elliot (Dharwar), Heath (Madras), W. H. Sykes (South India), A. L. Adams (Poona), J. Barbe (Tipperah hills, Nicobars) Stewart (Mussoorie), R. W. Frith (Cherrapunji), Baron von Hugel (Kashmir).

Other important works of this period are : (i) MS of a book on mammals and birds of India by S. R. Tickell. unpublished and kept with the Zoological Society of London ; (ii) MS of "Popular account of mammals of north western India" by T. Hutton, unpublished, locations not known ; (ii) Catalogue of species of mammals found in

Southern Mahratta country by W. Elliot ; (iv) Wanderings of a naturalist in India by A. L. Adam, (v) Papers of Baron von Hugel Reichder Sick, J. McClelland, Horsfield and J. Barbe on several species of mammals.

(iii) *Blanford-Anderson period* :

William Thomas Blanford (1822-1905) naturalist and geologist, is well known for preparation of the first edition of Fauna of British India, Mammalia, published in two parts in 1888 and 1891. He worked in India from 1855-1882 and contributed many papers. He mainly collected in South and Central India. Blanford's main work referred to above was, however, based on insufficient data, which he himself admitted. He also did not follow law of priority in naming taxa. He was also instrumental in the establishment of the Museum in Calcutta and in sanction by the Government of volumes of Fauna of British India series.

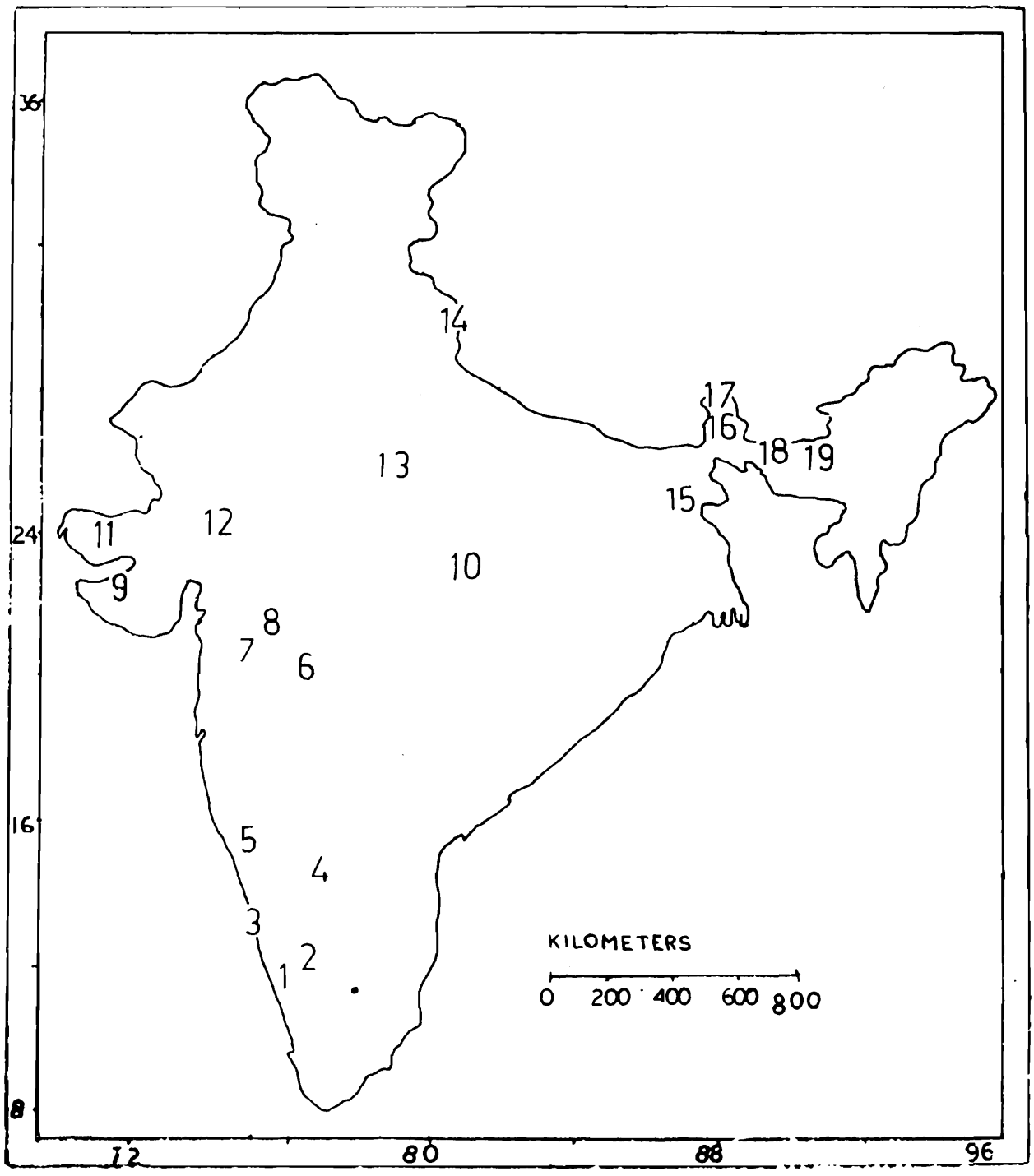
Dr. John Anderson (1833-1900) was the first Superintendent of the Indian Museum Calcutta and worked in India from 1865 to 1888. He had many publications on Indian mammals. The collection of Asiatic Society, Bengal was transferred to Indian Museum under his charge.

Other important students during the period were Horsfield, Dobson, O. Thomas, P. L. Sclater. This was mainly a study period. Among the collectors may be mentioned Mouat (Andaman Islands), C. B. Kloss (Nicobar and Andaman Islands), W. L. Abbot (Kashmir, Nicobar and Andaman), Ward (Kashmir), Theobald (Kashmir), H. Furguson (Travancore), Bitrel & Dunn (Panjab), Whitehead (Central India), C. H. Stockley (Kashmir).

(iv) *Mammal Survey period* :

The mammal survey of India along with that of the adjoining countries was started in 1911. It was interrupted by the first world war but continued till 1920. About 25,000 specimens were collected with a large amount of field data by experienced collectors in well selected localities. The study was also modernized and was carried out in British Museum by such highly experienced mammalogist as O. Thomas, R. I. Pocock, J. R. Ellerman, M. A. C. Hinton, R. C. Wroughton, T. C. S. Marrison-Scott, T. B. Fry, Ryley and Lindsay and others. This period can, thus, be called the modern age of Indian mammalogy. The study also ushered in the modern trinomial nomenclature for Indian mammals.

The reason for starting the survey was to modernize taxonomic knowledge of Indian mammals on the basis of studies carried out in



Text-fig. 1. Map of political India showing important localities where planned collections of mammals was made during Mammal survey of Bombay Natural History Society. A few localities bear old names as given in mammal survey reports.

1. Coorg ; 2. Mysore ; 3. Kanara ; 4. Bellary ; 5. Dharwar ; 6. Berar ; 7. Khandesh ; 8. Nimar ; 9. Kathiawar ; 10. Madhya Pradesh ; 11. Kutch ; 12. Palanpur ; 13. Gwalior ; 14. Kumaon, 15. 'Bengal' ; 16. Darjeeling ; 17. Sikkim ; 18. Kalimpong ; 19. Bhutan Duars.

U. S. A. towards the end of nineteenth century, particularly by Hart Marriam, by collecting a large series of specimens from well selected localities and in different seasons with detailed data on locality, altitude, date of collection, sex, age, colour of soft parts, measurements of freshly killed specimens, field notes on habits, etc. Such a study

greatly helped in the understanding of intraspecific variation and in description of new subspecies. However, the system did allow considerable difference of opinion.

The collectors primarily responsible for execution of the survey were C. A. Crump, G. C. Shortridge, A. W. Mayer, C. Primrose, Ryley O. Brain and H. W. Wells. They were helped by collectors (S. H. Prater, C. McCann, N. A. Baptista) in regular employment of the Bombay Natural History Society. Assistance was also rendered by H. H. Maharao of Kutch, Maharaja of Gwalior, Messers H. Stevens and R. H. Lister (Darjeeling), A. P. Kinloch (Malahat), A. H. A. Simcox (Kashmir), C. H. H. Stochley (Panjab and Western Himalayas), J. P. Mills (Assam), R. S. N. Pillay (Travancore, and P. Gosse (Poona). Several naturalists have donated specimens of large carnivores. Other honorary collectors also rendered help.

On the administrative side, the survey was helped by W. S. Millard, Honorary Secretary, Bombay Natural History Society, and later on in the same capacity by R. A. Spence.

This joint effort resulted in the publication of a number of excellent papers published in the Society's journal. The most important work was the second edition of Fauna of British India, Mammalia, published in two volumes, covering the orders Primates and Carnivora by R. I. Pocock (1939-1941). A revised edition of the Sterndale's popular work "Mammals of India" was also brought out in 1929 by Finn. Phillips (1935) is also an important work.

A notable event of this period was the establishment of the Zoological Survey of india in 1916 with Nelson Anandale, as the first Director and transfer of mammal collection of the Indian Museum to this department. However, there was no trained mammalogist to look after this collection till M. L. Roonwal with special interest in rodents took charge of it after about two and half decades. He, however, had also to leave to take up a research post with forces during second world war.

(v) *Post-Independence period* :

India became independent in 1947. The position of taxonomic work during this period has already been referred to briefly above. By an agreement, major part of the mammal survey collection and types were retained in the British Museum. The rest was returned to the Bombay Natural History Society. A part of the latter, selected under the supervision of the author, was given to the Zoological Survey of India. There were, thus, three centres where good taxonomic research on Indian mammals was possible. The work in the British Museum

continued with considerable zeal and resulted, in addition to a number of good papers, in such outstanding works as Checklist of Palaeartic and Indian mammals by Ellerman and Morrison Scott (1951) with second edition in 1966, and second edition of the Fauna of India, Rodentia, published in two parts in 1961 by Ellerman. S. H. Prater, Curator, Bombay Natural History Society, also published an exellent semipopular work "Book of Indian animals", in 1948, which was a great advance, over Sterndale's similar work in accuracy and scope, Second and third editions, of this book were published in 1965 and 1971 respectively. Eisenberle and Mekay (1970) published an annotated checklist for Sri Lanka and Khajuria *et al.*, (1977) an annotated catalogue of type specimens in the Zoological Survey of India. In the Zoological Survey of India also, M. L. Roonwal, Bhola Nath (trainee) and H. Khajuria, Assistant, published a number of taxonomic papers by making fresh collections or by studying the existing collections. However, both M. L. Roonwal and Bhola Nath left the department. S. H. Prater also retired and left for U. K. B. Biswas who took charge of Bird and Mammal Section and H. Khajuria, Bird and Mammal Assistant, continued the work as the time permitted as Dr. Biswas was mainly interested in birds. H. Khajuria took over as Assistant Zoologist in 1956 and M. L. Roonwal and Bhola Nath also returned to the department as Director and Assistant Zoologist, respectively. With the joining of a trainee, the taxonomic work was again restored to its former zeal. Meanwhile, some outstanding foreign workers other than those already mentioned became interested in Indian mammals and made highly praiseworthy contributions in their respective fields : J. E. Hill, A. Brosset, G. Topal (Chiroptera) ; W. C. Osman Hill, J. Fooden, P. C. Groves (Primates) ; G. H. H. Tate, J. C. Moore, H. Abe (Rodentia) ; and P. C. Groves (Ungulates). At present there are a number of active workers engaged in taxonomic research in Zoological Survey of India and its regional stations. They are M. L. Roonwal (Jodhpur), B. Biswas (Calcutta), H. Khajuria (Solan), G. U. Kurup (Madras), V. C. Agarwal, P. K. Das, R. K. Ghosh, A. K. Mandal, Y. Chaturvedi, S. Chakraborty, S. S. Saha, D. K. Ghoshal, T. P. Bhattacharyya (Calcutta) and Y. P. Sinha (Patna). The team has done highly commendable work in a short period. Other workers actively interested in the field are I. Parkash, and S. M. Monhot (Jodhpur), H. Abdulali (Bombay), H. R. Bhat and V. Dhanda (Poona). A notable feature of this period are extensive ecological observations along with taxonomic work and excellent photographs of animals in their natural habitats published in several publications on Indian wild life. Mention may also be made of revisionary monographic works

on various groups of mammals on world wide basis which also include Indian mammals. A list of these works appears in the bibliography.

A BRIEF GROUP-WISE REVIEW OF POST INDEPENDENCE LITERATURE

Order Insectivora—A taxonomic revision is overdue on both regional and world-wide basis. Roonwal and Monhot (1977) have reviewed the Indian species of family *Tupaiidae* and Agarwal (1975) has revised the subspecies of *Tupaia glis*. Biswas and Ghosh (1970) described a new species and subspecies of genus *Paraechinus*.

Order Chiroptera—The necessity of a taxonomic review is as badly needed as in the case of Insectivora. Brosset (1962) gave a good account of Central and Western Indian species with ecological notes. Khajuria (1979 and in Press) revised with ecological data all taxa found in Central India by making intensive collection in Jabalpur Dist. for about ten years. Both these works are based on recent collections made in the areas. Khajuria, in addition, studied in detailed the external morphology including bacula and forms of stomach. Brosset synonomised a number of subspecies based on colour. Hill (1963) has provided as exhaustive revision of genus *Hipposideros*. Sinha (1973) admirably revised in detail the Indian species of genus *Rhinolophus* and also described a new pipistrelle from Burma. Khajuria (1970) described a new race of *Hipposideros* from Central India.

Order Primates—Primates, because of their great importance in biomedical research, has received perhaps the maximum attention. Roonwal and Monhot (1977) is an exhaustive review of all species and provides lengthy bibliography not generally accessible to Indian students. Khajuria (1953-58) prepared catalogue of whole collection in Zoological Survey of India with detailed notes and critical examination of the whole classification and also described a new species. Thorington and Groves (1970) has ably examined the classification of the superfamily Cercopithecoidea and Hill (1974), Groves (1971, 1972) and Fooden (1975, 1976, 1979) are very good reviews of genera *Macaca Nycticebus* and gibbons.

Order Rodentia—Rodentia is another order which has been well studied during the period. The most outstanding work is Ellerman (1961) on Fauna of India. Roonwal and Biswas (1961) provided additions to this volume in form of ten new taxa not included in the volume. Agarwal (1967) published a detailed monographic study of skulls of Oriental rodents in relation to ecology. Mishra and Dhanda (1975) reviewed the genus *Millardia*. In addition to a number of collections which have been made and studied, a number of new taxa have been

added (Moore, 1950, Biswas and Khajuria 1955 ; Ghosh ; 1964 Chaturvedi, 1966, Fitgibbon, 1966, Agarwal and Ghosal, 1969 ; Agarwal and Chakraborty (1971b), Saha (1975).

Order Lagomorpha—Two new species of mouse hare have been described (Biswas and Khajuria 1958), and Agarwal and Chakraborty, 1971). The group is now under active study of one of the members of the staff of Zoological Survey of India (Shri R. K. Ghosh).

Order Carnivora—No comprehensive study has been published on this group after Pocock (1939-41). However, Ghosh (1965b) has been able to describe a new species of mongoose from West Bengal.

Order Perissodactyla—Only a few good papers by Groves (1967a, 1971a, 1972b) and Groves and Majak (1967) dealing with Rhinoceroses and wild asses have come to notice.

Order Artiodactyla—Again Grove's (1967b, 1969, 1974, 1976), excellent revisonary papers on genera *Procapra*, *Gazella*, *Muntiacus* and *Moschus* have placed the systematics of these groups on a firm footing.

Orders Cetacea, Pholidota, Sirenia, Dermaptera and Proboscidea—It is unfortunate that very little taxonomic work has been done so far on the large important group of Indian Cetacea. Our knowledge is mostly limited to stray observations and a few specimens stranded or collected by chance. Even the famous Indian mammal survey excluded it from its study possibly because of difficulty of making a systematic collection. In fact the only regional good account is still Blanford (1888-1891). However, monographs on world-wide basis have appeared by well-known authorities (*vide* bibliography), and include Indian taxa also. Because of their extensive movements and distribution, in many cases world-wide, in absence of good distributional barriers, such monographs can meet the regional needs to some extent. Except some sightings, the single species of Indian Sirenia has also not received much attention. No important work has been done on other three orders after the Mammal Survey.

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THE BURROWS OF *VARANUS BENGALENSIS* : CHARACTERISTICS AND USE

By

WALTER AUFFENBERG

Florida State Museum, University of Florida, Gainesville, Florida. 32611 U. S. A.

(With 1 Text-figure)

The only varanid species for which adequate information is available on burrow characteristics and use is *Varanus komodoensis* (Auffenberg, 1981A). That other species use burrows is well documented (Green and King, 1978, for *V. gouldii* ; Pianka, 1968, for *V. eremius* ; Corkhill, 1928, for *V. griseus* ; and others). During 1979 I was afforded an opportunity to study the burrows of *Varanus bengalensis* in several areas of northern India. I am also including a few data that I obtained during 1974 in Sri Lanka on burrows of the same species. The only statements previously made regarding burrows in this species were by Mahendra (1931), who reported on the resting posture of an individual in its burrow. D'Abreau (1933) and Smith (1932) simply stated that this species digs burrows. Deraniyagala (1957) described the construction of a nest by a female of this species.

Acknowledgement is extended to the New York Zoological Society for the support of my field work on monitors during 1974 in several Southeast Asian countries. Special thanks are given to the authorities of both the Yala and Wilpatu National Parks, Sri Lanka, for providing access and facilities for studying monitors in that country. The Indian part of the project was completed while I held an Indo-American Fellowship awarded and funded jointly by the University Grants Commission (India), the American Institute of Indian Studies (U. S. A.), and the International Communications Agency (U. S. A.). Without the cooperation of the staff of the Keoladeo Ghana Bird Sanctuary (Bharatpur) and Mr. Sadar Singh, India Biologicals (Agra), this study could not have been completed. I also wish to extend thanks to the foresters, snake charmers, and rural laborers who helped me excavate burrows and termitaria reported on here.

METHODS

Two major burrow types were investigated—those excavated in high sandy bunds surrounding agricultural plots on terraces above the Yamuna

River, approximately 6.8 km NE Agra, and those in the large termitaria of *Heterotermes* sp., 2.5 km S Sikandra and 12 km N. Agra, both in Uttar Pradesh State, India. Additional notes on similar termitaria in Yala National Park, Sri Lanka, are included, as are data on nest chambers and burrows in Keoladeo Ghana Sanctuary, Rajasthan, India. In all cases burrows were carefully excavated in the field, with measurements of all hole diameters, length, and distances from the surface made with a fiberglass retracting centimeter scale. The few temperatures given were obtained with an armoured field thermometer marked in the Celsius scale and accurate to 0.3°. Where appropriate, a few data are added from a group of captive *Varanus bengalensis* maintained by me in Florida, U. S. A. (see Auffenberg, 1981B, for description of captive facility).

Results

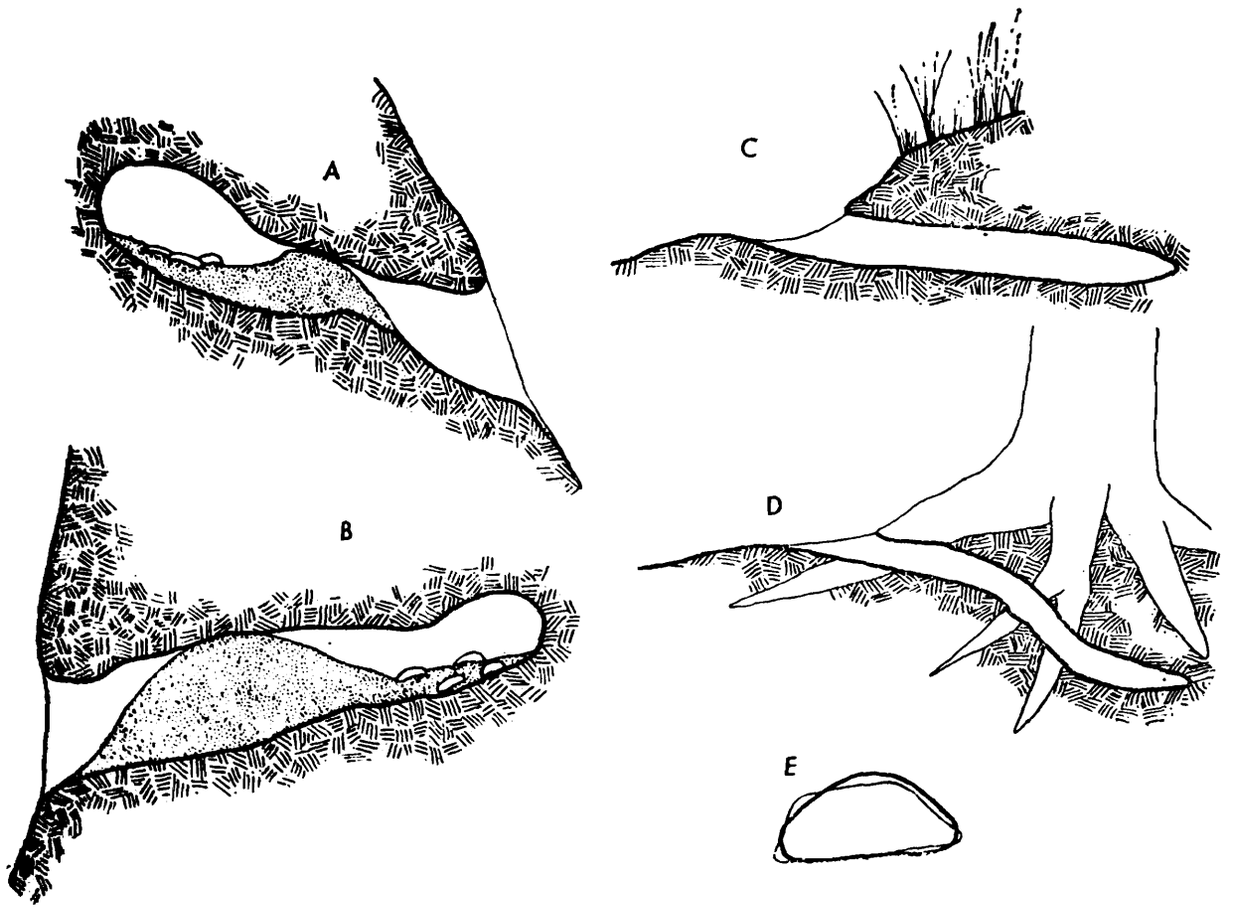
Burrows in Earth.—While individuals of *Varanus bengalensis* are capable of digging their own burrows and frequently do so, most are enlargements of pre-existing rodent burrows or natural cavities. During certain seasons hollow tree limbs and trunks are commonly utilized. When burrows are excavated entirely by the monitor lizards, they are most often dug into earthen mounds, slopes of vertical faces, and also under exposed roots and large stones (Text-fig. 1C, D) ; and the burrow cross sections are usually transversely oval, with the roof more convex than the floor (Text-fig. 1E), at least near the mouth. Farther inside the burrow lumen usually becomes more cylindrical. It is also generally widest at its mouth, usually maintaining a generally even taper to more or less accommodate the head and body of the lizard ; rarely slightly enlarged terminally.

Excavation of at least the burrow mouth area takes place at almost every entry into it, the individual using its front feet alternately to throw earth from particularly the burrow floor. At an old, frequently used hole such "cleaning excavation" is begun as much as 20 cm in front of the mouth and is continued for an almost equal distance inside as the monitor slowly enters the burrow. It is for this reason that there is rarely an earthen mound in front of the burrow, and why the mouth is frequently wider than the remainder of the hole.

The main part of the passage is relatively free of much loose earth, but not at the terminal end, where it is not uncommon to find 1-2 cm of accumulated soil. Among captive adults maintained in large semi-natural enclosures, I have noticed that individuals scratch at the terminus at almost every entry, but make relatively little effort to throw

the loose earth towards the opening. Both the narrow lumen and the loose soil at the terminus may be important in a defensive context, as explained below.

In general, the diameter of the burrows excavated are approximately the same as the vertical diameter of the body and 10-37% ($\bar{X}$=29%) wider than the greatest transverse diameter of the widest part of the belly (data from 16 captives and the holes constructed by them). However, individuals often use one another's burrows, so that hole diameter is not a reliable indicator of the size of the resident monitor, for the lizard may be much smaller than suggested.



Text-fig. 1. A and B, *Varanus bengalensis* nests in vertical banks at Keoladeo Bird Sanctuary, Bharatpur. C, typical longitudinal section of *V. bengalensis* home burrow in sandy soil without obstructions. D, typical longitudinal section of *V. bengalensis* home burrow in soil with subsurface obstructions. E, cross sections of two *V. bengalensis* home burrow mouths in sandy soils near Agra.

Except for those burrows encountering stones or roots, most are rather straight, especially in the soft earth of the Yamuna River bunds. None of the burrows is forked, though the smaller burrows of other animals frequently connect with them.

Though rural folk are often of the opinion that the burrow is very extensive (up to 15 m, I was told), excavation of 53 of them show that

in at least those habitats studied, none is very long. The mean length of all the burrows is 1.02 m, and there is no significant difference between the burrow lengths in different habitat types (Table 1). Mean depth is 0.61 m, with a significant different (t test, $P < 0.05$) between the bund burrow depth and the other types, primarily due to the fact that the bund holes are excavated into a more or less vertical face. The difference is also partly due to variation in excavation techniques in the habitats considered.

TABLE 1. *Varanus bengalensis* burrow parameters.

Locality	N	$\bar{X}$ length (in cm)	$\bar{X}$ depth (in cm)	$\bar{X}$ angle (in %)
Yamuna Bunds	28	110	121	15
Keoladeo				
Among tree roots	20	82	93	47
On open, level	5	97	51	28

Only a few burrows occur on level ground (10.6% of the present sample, though biased because they were more easily seen than those under tree roots). Table 1 shows that there is a great difference in burrow declination angle, with bund burrows least inclined, burrows on level ground more so, and those among roots most inclined. The difference between the pairs tested is significant at the 0.05% level in all cases (t tests for bund-roots $P < 0.01$, for roots-level $P = 0.05$, and bund-level $P < 0.05$).

In the Yamuna bund and Bharatpur root sites the holes showed a significantly contagious distribution on the basis that the variance of the distance between the burrows exceeded the means (Southwood, 1966). However, burrows on level land are randomly distributed. Burrows in earth are significantly more common per hundred meter transects in treeless areas than areas with trees. Thus in the Yamuna River area the mean number of burrows increased from more heavily forested sites near the Dayal Bagh Road to the virtually treeless terraces above the river ($\bar{X}$ distances between burrows Dayal Bagh=93.1 m, s^2 = 19,681.7 m, sd$\pm$104.9 m, O. R.=0.9-346.3 m, transect length=5404 m, N holes=40 ; Yamuna bund area=29.7 m, s^2=891.5 m, sd$\pm$29.3 m, 0. R.=0.6-95.4 m, transect length 970 m, N holes=44). Further discussion of hole density, etc., as it relates to monitors per ha, is provided in a manuscript (in preparation) by the author.

Burrows in Termitaria.—Sixteen burrows located in the earthen termitaria of *Heterotermes* sp. were excavated, all near Sikandra. In each

case the burrow was relatively short and diameters much more variable along the burrow length than in burrows excavated in earth (Table 2). Burrow declination angle was about 45°, with the lumen more or less contained within the area originally excavated and modified by the termites.

TABLE 2. *Varanus bengalensis* burrow dimensions (in cm) in *Heterotermes termitaria*

Burrow depth	Burrow length	Declination Angle
87-140, $\bar{X}$ =110	78-121, $\bar{X}$=92	39-47°, $\bar{X}$=45.3°

All burrows were located in abandoned termitaria, in which erosion by particularly monsoon rains had apparently weakened and in many cases even breached the carton envelope. The monitors apparently enlarge any surface break, as well as slightly widening the extensive system of large tunnel-like chambers below the surface. The excavations are apparently often made during the monsoon (July-August) for evidence of passage into or out of the openings when the soil was soft and muddy is often still present in the subsequently hardened clay (October-November). However, the crumbly dry soil at the mouths of other burrows suggests that some are made during the dry season as well.

The multiplicity of monitor burrow sizes in single termitaria suggests that several monitors use each complex, at least on a temporary basis. This is confirmed by the local snake charmers, who informed me they often saw two monitors run into the same termitarium at the same time. However, my excavations proved that these burrows were rarely interconnected by the activity of the monitors under the surface. Mammals, snakes, and other lizards also use the termitaria as refuges, but apparently the original large openings are made mainly by the monitors. During our excavations I found one *Naja naja* and one *Oligodon arnensis* in termitaria occupied by a monitor lizard, though in both instances these snakes were located in the interconnected side chambers originally made by the termites. Of the 46 termitaria examined, at least 73% had been used by one or more *Varanus bengalensis* on the basis of various signs (hole shape, scratches, tail drags, etc.).

The termitaria vary in height from 10 to 90 cm, and termite activity may extend as far as 2 m below the surface. However, most larger termite chambers rarely extend below 1 m deep. In a sample of 18 measured termitaria the circumference of the entire structure varied from 30 to 405 cm. The number of openings used by the monitors

in each of these termitaria varied from 1 to 16 ($\bar{X}$=6.6 openings) and opening size (N=46) varied from 2 to 25 cm ($\bar{X}$=67.1 cm, sd±3.1 cm). Intertermitarium distance was 3.9-36.2 cm ($\bar{X}$=16.5 m, sd±10.9 m), showing great variability (s^2=11.5 m). In spite of this, bolting monitors seem to know the location of most, if not all old termitaria nearby, for even if forced to change course through interception by our party, the monitors veered and headed straight for another, though not necessarily the closest termitarium.

Burrow Use.—Mahendra (1931) has shown that in at least one instance, a *Varanus bengalensis* was in its hole bent into a U, with its head and tail facing the opening. Observations of the Florida captives show that this is the position most frequently taken when they are resting and in an unfrightened state during either the day or night. The same position has been noted in resting *Varanus komodoensis* in the wild (Auffenberg, 1981A). However, all individuals of *V. bengalensis* uncovered during the present study had run into the burrows for refuge, and the positions they assumed must be construed to have been taken in a defensive context. All were found in the same position and at the burrow terminus. The body, tightly jammed into the narrow lumen at this point, was oriented to the rear of the burrow, with the head bent back toward the opening at a sharp angle. The tail was curled laterally so that its base was pressed against one wall of the lumen and then passed to the other side, from where it extended toward the head, sometimes parallel to the body and sometimes undulating over the body from one burrow wall to the opposite one. The loose soil at this part of the burrow tended to cover most of the hind legs and tail. When touched, the lateral part of the tail was often quickly and forcefully pushed against my fingers so that the coarse, heavily keeled scales in this area were clearly felt. The movement can only be considered a defensive act, meant to discourage a potential predator. A captive spiny-tailed monitor (*V. acanthurus*) in its burrow once even drew blood by the same action as I jammed my finger in its burrow. Cogger (1967) stated that this species "holds its tail in front of its body for protection" when in rocky crevices. The spiny-tailed agamid lizard, *Uromastix hardwickii*, uses a similar tactic to defend its burrow (Smith, 1935).

Both termitaria and ordinary burrows are ordinarily used at night and during most of the day in the cooler months (October-February). During my visit in October-December I found that the monitors usually left the burrows of either type every morning, particularly after a cold spell, though they rarely wandered far from them. Observations during the entire day made from an appropriately placed blind at the Yamuna

River terrace area showed that during this time of year they do not necessarily return to the same hole on subsequent nights. One monitor used two different holes on two consecutive nights, and the second individual used three different holes in three nights. However, local snake charmers insist that during the cold months of January and February the monitors leave their burrows for only a few hours each day and return to the same one each night, sunning themselves most of the time in nearby appropriate spots. The daily pattern of an adult male and female *V. bengalensis* observed every day for five days at Bharatpur showed this pattern, with basking normally occurring within 5 m of their burrows. The male tended to wander over a greater distance during the day ($\bar{X}$ total daily distance traveled = 27.3 m) than the female ($\bar{X}$ total = 12.7 m). Though the differences were not statistically significant, the data are consistent with earlier studies showing that male *V. bengalensis* are generally more active than the females at all times of the year (Auffenberg, 1979).

Several holes I excavated in the Yamuna River terraces contained two monitors, though there were many unoccupied holes (only 10.7% of 28 burrows excavated at the Yamuna site contained one or more monitors). While there is undoubtedly a strong tendency for dispersion, data from movement of temporary escapees in Florida show a remarkable tendency for one individual to climb and use as an overnight shelter certain trees which had been used by others previously, in spite of the fact that hundreds of other apparently identical nearby trees remain unvisited (author's unpubl. data). Hatchling *Varanus komodoensis* are thought to remain together, moving through an area in a loose group (Auffenberg, 1981A). Hatchling of *V. bengalensis* probably do the same, for I caught 12 juveniles, undoubtedly all from the same clutch, in two large adjacent trees in Pahang Malaysia. A group of 8 juveniles were seen in three adjacent trees in Yala National Park, Sri Lanka ; in spite of the fact that hatching in this area had been completed at least three months previously. Thus, at least the very young individuals of *Varanus bengalensis* seem to exhibit a tendency to cluster, and the contagious distribution of burrows at the Yumuna River site suggests that the same tendency may occur in the adults as well.

Nests.—Local snake charmers near Agra, India, told me they found eggs in the termitaria in June and July and that they have seen hatchlings in July and August. They also said that the eggs are placed in a partly filled burrow in termite-abandoned termitaria. The latter is corroborated in one nest I discovered in Sri Lanka (28 July 1974). Ten fairly recently laid eggs were found in a termitarium 1m in diameter and 0.7 m in height. Evidently several monitors had broken through the outer carton

and into the large internal chambers. One chamber, with a transverse diameter of 8 cm, was blocked with an earthen plug 13 cm long near the carton opening. The eggs were loosely piled at the unfilled end of the chamber, occupying approximately the terminal 12 cm. It was clear that the female had sealed the tunnel with earth removed from the surrounding walls. This situation is thus unlike that described by Cowles (1930) for some nests of *Varanus niloticus* in Africa, where the chamber opening was in an active termitarium and was said to have been closed by activity of the termites.

In the Sri Lanka nest the easiest route for the escaping hatchlings would have been through the plug, which was composed of loosely packed earth. I doubt that the hatchlings would have found it possible to dig through the tough carton walls of the termitarium, which were from 1 to 2 cm thick in this case. They might, however, have been able to find one of the several openings to the outside without doing any digging by following the labyrinthine chambers of the termitarium to any one of these openings.

In the absence of termitaria, *V. bengalensis* lays its eggs in a burrow in the soil excavated by the female. During November, 1979, three such nests were found in the southern end of the Keoladeo Ghana Sanctuary. Two were located on opposite sides of a nearly vertical narrow bank in an abandoned borrow pit (Text-fig. 1A, B). The eggs (4 and 8 shells in each and already hatched several months previously) were deposited in chambers 10 cm in transverse diameter, slightly less vertically, and 30 and 63 cm in length respectively. One had evidently been a rodent burrow originally, with a diameter of 5-7 cm. Though it continued toward the surface, it was blocked by a natural earth plug. Both nest burrows slanted upward at an angle of about 15°. The eggs were placed near the end of the enlarged part of the chambers, and the entrances for 20 and 31 cm respectively were filled with soil loosened from the roof and walls of the chamber. Some soil covered most of of the eggs. Escape in both cases had evidently occurred at the top of the loose earthen plug, where it touched the ceiling of the chamber.

The third nest chamber was found in one of a cluster of 14 apparently aborted chambers excavated by monitors (scratch marks from their claws were still easily apparent) in a vertical exposure of earth above and on either side of the mouth of an unoccupied striped hyaena den. All 14 chambers were very close together, most separated by about 20-30 cm and pockmarking a wall about 1.5 m high and 2.3 m wide. The depths of the excavations varied from 15 to 80 cm ($\bar{X}=51$ cm), and eight of these were slightly inclined upward toward the end, while the remaining six were more or less level. Two had apparently been

excavated by enlarging some sort of pre-existing small burrow (cliff swallows ?), but the others showed no evidence of this. Their transverse diameters fall into three size categories (10 cm=3, 7. 5-8 cm=3, 6.0-6.5 cm=8), suggesting three different females may have been responsible for the excavations. Their appearance (deterioration) suggested they had been excavated over a long period of time, and many of those in the smaller diameter class had the rim of their mouths overgrown with a species of moss that lightly covered much of the face, suggesting that these were probably the oldest. Thus I conclude that three separate females, during at least two different seasons, excavated this face with a series of nest chambers, some of which may have been aborted. However, the loose filling in the floor of one of these contained bits of egg shell of the same thickness and surface structure as those in the rests in the bank, so that at least one of these openings was at one time used as a burrow in which eggs were deposited.

In the case of both the bank and hyaena den face situations it seems significant that the nest chambers are in groups. I described similar clusters of *Varanus komodoensis* burrows from both Komodo and Flores, Indonesia (Auffenberg, 1981A). Because examination of several of them revealed no eggshell fragments, I concluded that these clusters of *V. komodoensis* burrows were not associated with reproduction. My recent discoveries regarding the apparent clustering of nests of *Varanus bengalensis* suggest that my interpretation of the *V. komodoensis* clusters may be incorrect ; that is, they may be nest clusters. Lending further credence to the latter interpretation is that most of the *V. komodoensis* burrow clusters are on steep hillsides, and, as in the case of the *V. bengalensis* clusters on nearly vertical faces, many are some distance above the base of the exposure. All of the *V. komodoensis* burrows slanted slightly downward. However, the upward slant of the chambers in *V. bengalensis* nest holes on vertical faces is probably due to the position necessarily assumed by the digging female. In any event, the location of nest burrows on steep slopes or vertical faces in either species is probably related to reducing predation. This behaviour, if I have interpreted it correctly, is to my knowledge the first instance of this particular type of antipredator tactic (nests in steep or vertical exposures) in reptiles, though Deraniyagala (1957) described still another nest chamber for *Varanus bengalensis*, in which the female laid its eggs in a flask-shaped chamber at the bottom of a large, shallow body pit. Thus at least this monitor species may lay its eggs in such diverse excavations as abandoned termite nests, flask-shaped holes on level ground, or burrows excavated into steeply sloping, or even vertical, earthen cliffs. This variation is rather surprising, since most reptiles

are apparently quite species-specific in regard to nest construction. This variation is even more significant when such variation occurs in populations of the same species separated by relatively short distances (ca 100 km), albeit in different ecological settings. Such variation shows that my earlier conclusions regarding the unusually high level of behavioural plasticitv in this family (Auffenberg, 1981A) is additionally justified. Further observations and data regarding the nesting behaviour of *Varanus bengalensis* are welcomed from biologists living within the range of the species.

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SYSTEMATICS AND DISTRIBUTION OF FISHES OF THE FAMILY LEIOGNATHIDAE (PISCES) OF THE VEMBANAD LAKE, KERALA (S. INDIA)

By

B. MADHUSOODANA KURUP[1] AND C. T. SAMUEL[2]

(With 6 Text-figures, 4 Tables and 2 Plates)

INTRODUCTION

The fishes of the family Leiognathidae distinguished by the protrusible jaws, and differentiated from the Gerridae by the presence of bony ridges, nuchal crest, cleithral projections and naked head (except in *L. elongatus*). It contributes on an average (from 1958-1967) about 2.96 percent of the total marine fish catch in India (James, 1973). Extensive studies on the Leiognathidae of India are published by Arora (1951), Jones (1966), Balan (1967) and James (1973). The present paper is a systematic account of the leiognathid fishes of the Vembanad Lake, their geographical and seasonal distribution and abundance in relation to the environmental conditions. The depth of the lake does not exceed beyond 5m except in the ship channel and so the vertical distribution of fishes in relation to environmental conditions was not attempted. The hydrology of the lake has been extensively studied by Balakrishnan (1957), Ramamritham and Jayaraman (1963), George and Kartha (1963), Cherian (1967), Qasim and Gopinath (1969), Josanto (1971) and Wallershaus (1973). No attempt has been made so far to give a detailed systematic account of Vembanad Lake fishes and to relate their occurrence and abundance to the varying hydrological conditions of the lake. The available literature on the fish and fisheries of Vembanad Lake is confined to a few papers (Shetty, 1963, 1965 ; Jhingran and Gopalakrishnan, 1971 ; Gopalakrishnaya, 1972). The systematics and distribution of the leiognathid fishes are inadequate. Systematics and fisheries of lacustrine fishes have been extensively studied both in India and abroad by a number of workers, notably Chaudhuri (1916a, 1917, 1923), Coutter (1965, 1966, 1968) ; David (1954) ; Devasundaram (1954) ; Greenwood (1973a) ; Greenwood and Gee (1969) ; Holden (1967) ; Jacob (1961) ;

[1]*U. G. C. Junior Research Fellow, Department of Marine Sciences, University of Cochin, Cochin—682 016.*

[2]*Professor and Head of the Department, Department of Industrial Fisheries, University of Cochin, Cochin—682 016.*

Jhingran *et al.*, (1963) ; Jhingran and Natarajan (1966, 1969) ; Jones and Sujunsingani (1954) ; Menon (1961) ; Pillai (1967) and Visweswara Rao (1977). The specific identity of the available species in the lake is a pre-requisite for any study on the fish and fisheries of the Vembanad Lake.

Of the fishes of the family Leiognathidae, Day (1876) reported 14 species from Indian seas ; Weber and de Beaufort (1931) listed 16 species from Indo-Australian Archipelago ; Smith (1949) listed 4 species from S. Africa ; Munro (1955) reported the occurrence of 12 species from Sri Lanka waters and recently he has described a new species from New Guinea region (Munro, 1964, 1967). Tiews *et al.*, (1965) recorded the occurrence of 17 species from Philippines ; Kuhlmorgen—Hille (1968) reported 14 species from Gulf of Thailand which include one undescribed new species and listed 31 species of leiognathid fishes in F. A. O. fish identification sheets (Kuhlmorgen-Hille, 1974). Monkolprasit (1973) reported the fishes of the genus *Secutor* from Thailand waters which include one more new species. James (1975) revised the family Leiognathidae which include the description of 18 species, out of which 17 species were collected from Indian seas which also includes two new distributional records and one new species already reported by him (James 1968, 1969). Jayabalan and Ramamoorthi (1977) reported the occurrence of 11 species from Porto Novo waters on the east coast of India.

Abbreviations used

D=Dorsal fin ; A=Anal fin ; SD=Standard deviation ; M=Mean ; SL=Standard length ; TL=Total length.

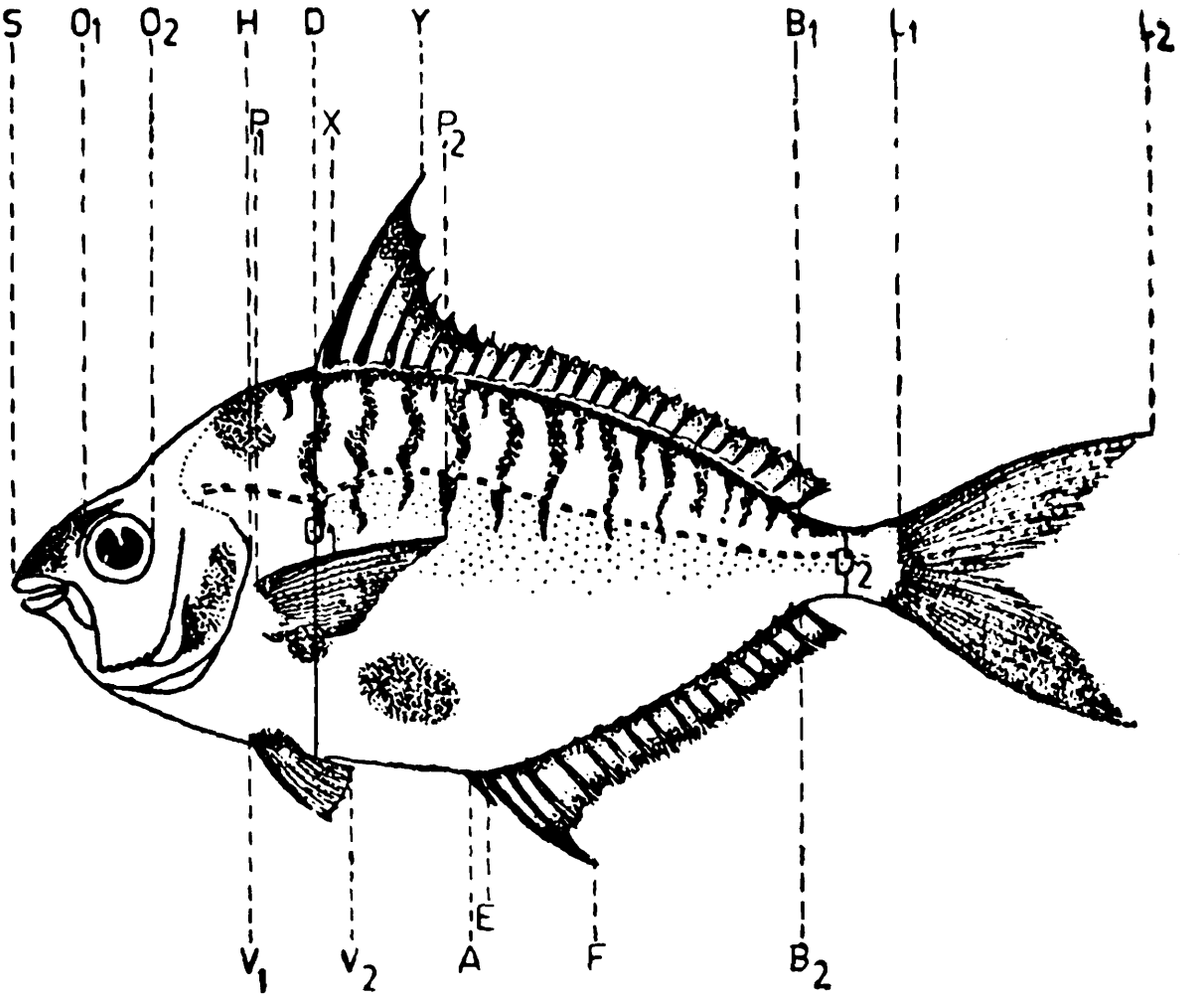
The Vembanad Lake System

The Vembanad backwater system is the largest on the south west coast of India, and extends between latitude 9°28' and 10°10' N and longitude 76°13' and 76°30'E. It has a length of about 90 km. and extends from Alleppey in the south to Thuruthippuram (east of Azheekode) in the north. The total area is about 300 sq. km. The depth varies from 1.5 to 12 m and the width varies from a few 100 m to about 14.5 km. On the northern part, there are two permanent openings to the Arabian Sea, one at Cochin, a 450 m wide channel which forms the main entrance to Cochin harbour and the other at Azheekode. These regions are subjected to regular tidal influences and have all the characteristics of a typical tropical estuary. Tides in the Cochin backwaters are of mixed semidiurnal type and two successive high and low waters occur each day with substantial difference in range and time.

The main source of fresh water for the backwater is two large rivers—Periyar in the north and Pamba in the south. Four other small rivers viz. Achankoil, Manimala, Meenachil and Moovattupuzha also empty into the backwater.

MATERIALS AND METHODS

Fortnightly cruises were made in the estuarine region and monthly cruises were made from Alleppey to Thuruthippuram in the research vessel "Sagitta" during the year 1978-'79. Fish sampling surveys were conducted from various fishing operations like stake nets, chinese



Text-fig. 1. Sketch of *Leiognathus brevirostris* showing how measurements are made.

shrimp nets and drag nets with the emphasis laid on species diversity and catch composition. Water samples for analysis were collected from 20 fixed stations.

The present study is based on the material collected exclusively from Vembanad Lake and the locations are plotted in the maps (Text-fig. 2, 3 & 4). The number of specimens examined differed for each species because of their varied occurrence. Measurements and

counts were made on preserved fishes. Considerable shrinking of specimens occurred during preservation. Details of live colouration are noted for most of the species. Except for total length, all measurements were taken from point to point (straight line) on the left side of the fish (with mouth closed). A pair of dividers and vernier calipers were used for measurements and they were rounded off to the nearest millimeter. All proportions are in per cent of standard length except the snout length, orbit diameter and inter orbital distance which are in per cent of head length (Table 1, 2 & 3). Measurements and counts are made according to William and Venkataramani (1978) and Lowe-Mc Connell (1978).

The following abbreviations are used (all measurements in m.m.) for the characters used in this study (Text-fig. 1).

SL_2 Total length, from tip of snout to tip of longest caudal fin.

SL_1 Standard length, from tip of snout to caudal base (hypural bone junction).

D_1 Body depth, from origin of first dorsal spine to dorsal point of insertion of pelvic fin.

SH Head length, from tip of snout to posterior edge of opercular bone.

SO_1 Snout length, tip of snout to the first margin of eye.

O_1O_2 Orbit diameter, horizontal distance between the free orbit rims.

XY Dorsal spine length, from origin of second dorsal spine to its tip.

EF Anal spine length, from origin of second anal spine to its tip.

B_1L_1 Length of caudal peduncle, from the point of origin of last dorsal fin ray to posterior margin of hypural bone.

D_2 Width of caudal peduncle, at the point of least depth.

DB_1 Length of dorsal fin base from origin of fin to last ray.

AB_2 Length of anal fin base.

P_1P_2 Pectoral fin length, distance from base of upper-most pectoral ray to tip of longest ray.

V_1V_2 Ventral fin length, distance from anterior point of origin of the spine to the tip of longest ray.

SD Pre-dorsal length, from tip of snout to origin of first dorsal fin spine.

SA Pre-anal length, from tip of snout to origin of first anal spine.

SP_1 Pre-pectoral length, from tip of snout to dorsal point of origin of pectoral fin.

SV_1 Pre-ventral length, from tip of snout to anterior point of origin of ventral fin.

Characters of Taxonomic Value

Fishes of the family Leiognathidae can be easily diagnosed due to the presence of the following specific characters : compressed body with deciduous cycloid scales ; head scaleless (except in *L. elongatus*) with

bony ridges ending in a nuchal crest. The jaws may be oblique or horizontal and extremely protrusible, thus forming a tube. Cleithral projections are present on opercle (Jayabalan & Ramamoorthi, 1977). Gill membranes united with isthumus ; five branchiostegal rays. A long single dorsal with 8 spines and 16 rays with conspicuous basal sheath ; anal fin with 3 spines and 14 rays. Ventrals short with one spine and 5 rays with an axillary scale-like structure. Caudal fin forked.

The family Leiognathidae consists of three genera, *Leiognathus* Lecépède, *Gazza* Rupell and *Secutor* Gistel (Smith 1949, Munro 1955, Kuhlmorgen-Hille 1968, 1974, James 1975, Nelson 1976). The direction of the protrusible jaws and the nature of jaw teeth are used for differentiating the genera. The body depth in relation to standard length, length of the second dorsal spine, presence or absence of breast scales, shape of snout and mandible, position of nostril and body colourations are also useful in differentiating the species within a genus.

A KEY TO THE SPECIES OF LEIOGNATHID FISHES OF VEMBANAD LAKE

	Jaws extremely protractile, canine teeth absent. ...	... 1
	Jaws protractile, canine teeth present. ...	**Gazza** Ruppell 10
1.	Protrusible jaws point forwards or downward, mouth horizontal, 'Y' shaped bony ridges on head, 2 cleithral projections. ...	**Leiognathus** Lacépède 2
	Protrusible jaws point upwards, mouth oblique, 'V' or 'Y' shaped bony ridge on head, cleithral projections 1 or 2, ventral profile much more convex than dorsal. ...	**Secutor** Gistel 9
2.	Dorsal profile more convex than ventral, sharp ascent from truncate snout to dorsal fin. ...	... 3
	Dorsal profile equal to or nearly the same as the ventral profile, gradual ascent from snout to dorsal fin. ...	... 4
3.	Snout shorter than eye diameter, conspicuous scales on breast, mandible slightly concave, jet black blotch on spinous dorsal. ...	*L. splendens* (Cuvier)
	Snout more or less equal to eye diameter, breast with very thin scales, apparently naked, mandible strongly concave. ...	*L. equulus* (Forskål)
4.	Lateral line ending below middle or end of soft dorsal. ...	... 5
	Lateral line continued to base of caudal fin. ...	... 8

5.	Jaws point forwards when protruded, small scales on breast.	... ...	6
	Jaws point downwards when protruded, no scales on breast.	... ...	7
6.	Ventral profile more deep and strongly compressed ; ventrals very short ; upper third of the spinous dorsal orange, edged with black on the lower border.	...	*L. bindus* (Valenciennes)
7.	Rhomboid body, back without irregular patterns ; yellow band along lateral line ; deep black blotch on spinous dorsal.	...	*L. daura* (Cuvier)
8.	A concavity on the anterior dorsal part of the body, back with irregular zig-zag marks.	...	*L. berbis* (Valenciennes)
	Scales absent on breast, black patch across nape, ochre-yellow blotch on abdomen, yellow spot near pectoral axil.	...	*L. brevirostris* (Valenciennes)
9.	Body oblong, depth 42.3-52.8% in S. L., Lateral line ends below a little before end of soft dorsal.		*S. insidiator* (Bloch)
	Body oval, depth 56.8-63.0% in S. L., Lateral line ends below middle of soft dorsal.	...	*S. ruconius* (Hamilton-Buchanan)
10.	Body depth less than 46.5% in S. L.	...	*G. minuta* (Bloch)

1. **Leiognathus splendens** (Cuvier) 1829

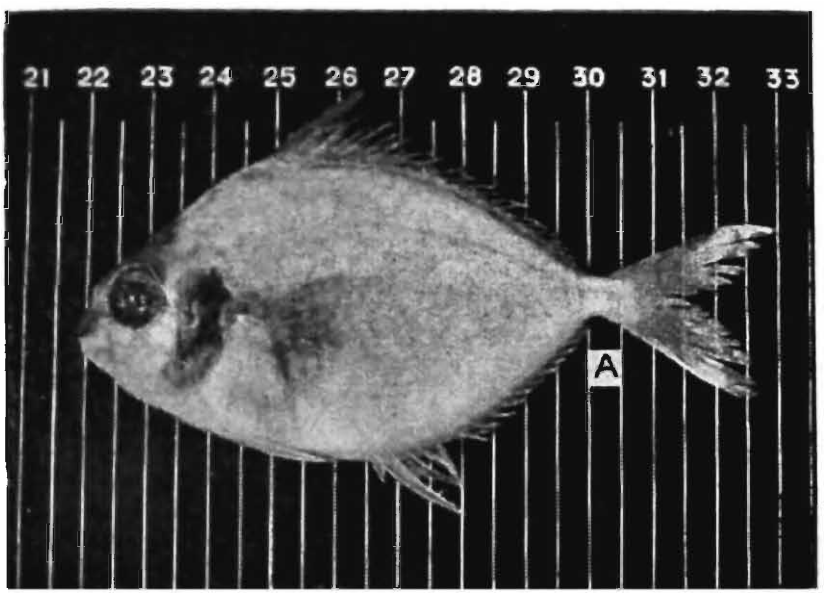
(Plate II A)

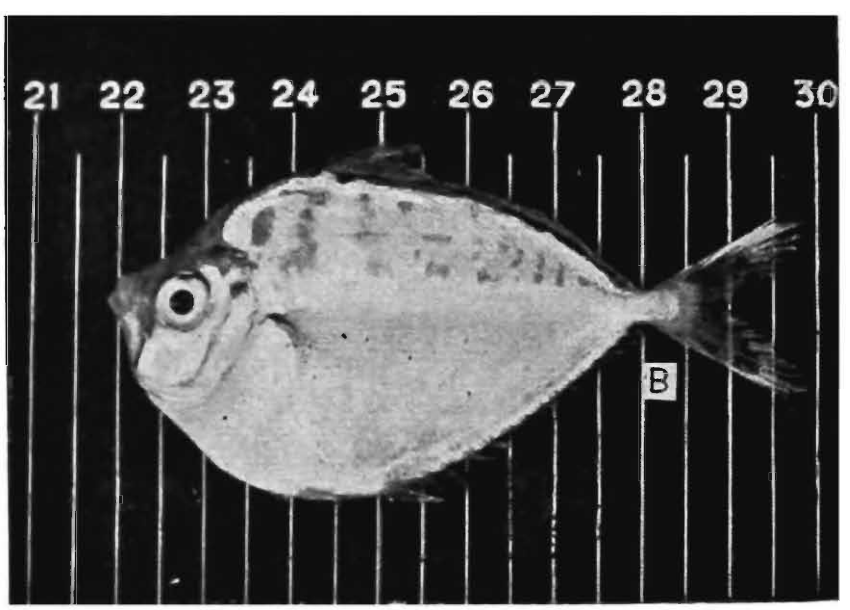
Brief description : Based on 31 specimens ranging in size 38.0-93.0 mm S. L (46.0-116.0 mm T. L). Morphometric data are summarized in Table 1. D. VIII, 16 ; A. III, 14 ; P. 18-20 : V. I, 5 ; C. 24.

Height of the body at D origin more than half of S. L. Snout length less than orbit diameter. Gill rakers on first arch 5+19-21=24-26. Lateral line with 50-57 sensory tubes.

Occurrence and Abundance in the Lake : *L. splendens* occurs from October to May in the catches from those parts of the lake (Text-fig. 2) where the salinity ranges from 19.2-33.3‰ and temperature 25.0-34.2°C. From October to January its occurrence was very sporadic and the distribution was more or less confined to the mouth and lower reaches of the estuary. The penetration of this species into the interior parts of the lake was coincided with gradual increase in salinity gradient. It's regular occurrence in small numbers was noticed from February to May in the estuary when the salinity (23.0—33.3‰) and temperature (30.4 – 34.2°C) were high.

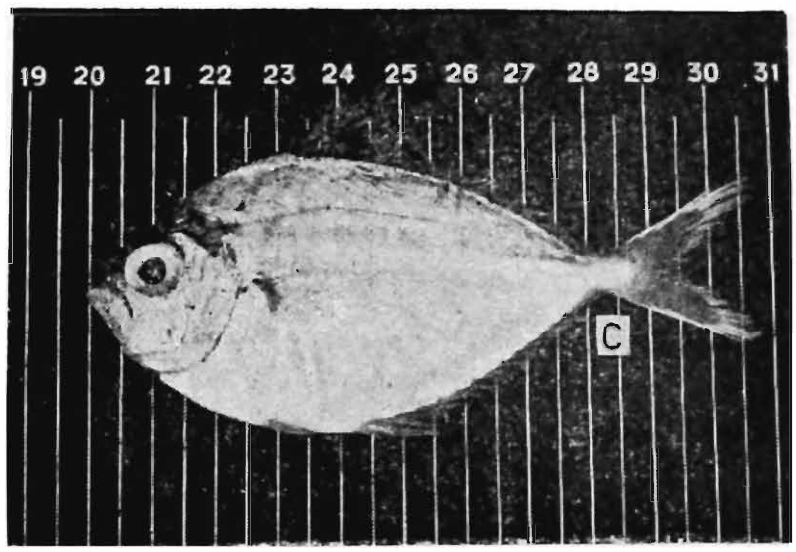
Distribution : Indo-Australian Archipelago, New Guinea, Red Sea, Madagascar, Gulf of Thailand, Sri Lanka, Andaman Islands, Siam,

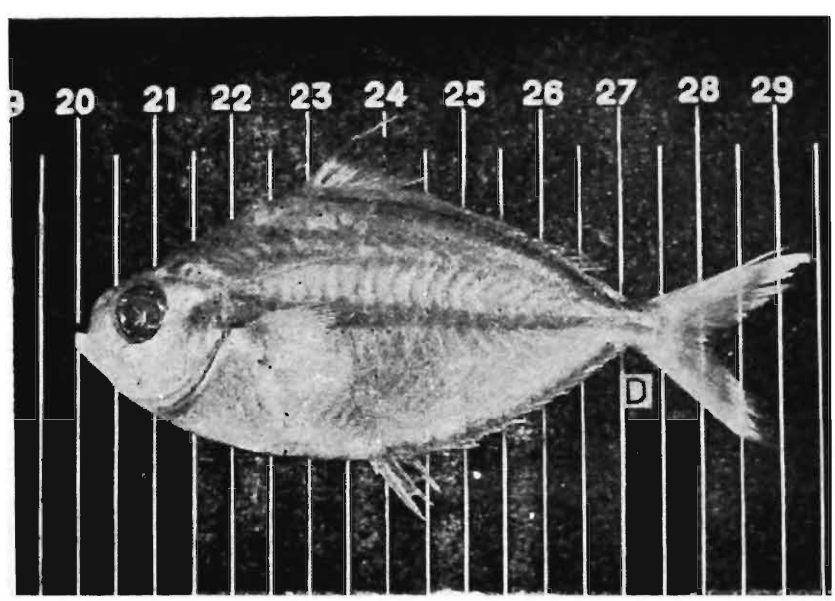




Figs. A. *Leiognathus splendens* (Cuvier)

B. *Leiognathus equulus* (Forskål)





Figs. C. *Leiognathus bindus* (Valenciennes)

D. *Leiognathus daura* (Cuvier)

China, Formosa, Philippines, Queensland, Fiji Islands, India—East Coast: Gulf of Mannar, Gopalpur, Visakhapatnam, Kakinada, Madras, Tuticorin, Coromandal coast, Palk Bay, Godavari estuary and Porto Novo ; West Coast : Goa, Karwar, Mangalore, Calicut, Malabar, Cochin, Vizhinjam and Cape Comarin.

2. **Leiognathus equulus** (Forskål) 1775

(Plate II B)

Brief description: Based on 48 specimens ranging in size 33.0—97.0 mm S.L. (41.0—125.0 mmT.L) Morphometric data are summarized in Table 1. D. VIII, 16; A.III, 14; P. 20 ; V. I,5; C. 24—25.

Height of the body at D origin more than half of S.L. Snout length nearly equal to orbit diameter. Gill rakers on first arch 4+(14-16)=18-20. Lateral line with 57-62 sensory tubes.

Occurrence and Abundance in the Lake : *L. equulus* occurs throughout the year in the catches from the lake. It is one of the most abundant species and contributes about 40% of the total silver-belly fishery of the lake. These are euryhaline fishes which are able to occupy all regions of the lake (Text-fig. 2) where the salinity (0.2 – 33.3%) and temperature (23.0 – 34.2°C) were highly fluctuating. It was relatively abundant in the mouth, middle and lower reaches of the estuary where salinity was invariably high (18.0 – 33.3‰) during the pre-monsoon period. The catch composition of this species was relatively more in the northern half (Cochin-Thuruthippuram) of Vembanad Lake than southern half. The occurrence of this species in the region east of the Thannirmukham barrage was scarce where salinity does not exceed 3.7‰. During monsoon season almost freshwater condition prevailed in the lake, so that its availability was reduced but during intermonsoon months fairly good catches were noticed especially from February to May when the salinity (9.2 – 33.3‰) and temperature (29.3 – 34.2C°) were comparatively high.

Distribution : Indo-Australian Archipelago, Red Sea, Beira, Zanzibar, Natal coast, Delagoa Bay, Chinde, Medagascar, Bourbon, Mauritius, Muscat, Sri Lanka, Siam, Bankok, Formosa, Riykiu islands, Philippines, Marianas, Australia, Solmon islands, New Calendonia, Somoa, Fiji islands, Gulf of Thailand, India-East Coast : Coromandel coast, Mandapam, Rameswaram, Kilakarai, Pamban, Madras, Porto Novo, Godavari estuary and Chilka Lake ; West Coast : Bombay, Malabar, Cochin and Cape Comarin.

3. **Leiognathus bindus** (Valenciennes) 1835

(Plate II C)

Brief description : Based on 22 specimens ranging in size 48.0-84.0 mm S.L. (61.0-117.0 mm T.L.). Morphometric data are summarized in Table 1.

D. VIII, 16 ; A. III, 14 ; P. 18-20 ; V. I, 5 ; C. 24.

Height of the body at D origin more than half of S. L. Snout length less than orbit diameter. Gill rakers on first arch 4-6+18-19=22-25. Lateral line with 37-47 sensory tubes, ending below the middle of soft dorsal.

Occurrence and Abundance in the Lake : *L. bindus* occurs in the months from January to May in the catches from the lake. It's occurrence was strictly confined to the mouth of the estuary (Text-fig. 2) when the salinty (26.2-33.3‰) and temperature (25.0-34.2°C) were uniformly high. During January and February its occurrence was very sporadic. From March to May its regular occurrence in traces was noticed in the catches when the condition prevailed in the estuary was closely related to those of the nearby inshore areas. The salinity (28.5-33.3‰) and temperature (32.5-34.2°C) were remarkably high during the above months in the estuarine mouth. By examining the catch composition it was clear that this species maintains a very low level of population in the head of Cochin barmouth and at Azheekode during the months from March to May.

Distribution : Indo-Australian Archipelago, East-Africa, Gulf of Thailand, Sea of Penang, Sri Lanka, China, Formosa, Philippines, India—East Coast : Coromandel Coast, Mandapam, Gulf of Mannar, Madras and Porto Novo ; West Coast : Cochin.

4. **Leiognathus daura** (Cuvier) 1829

(Plate II D)

Brief description : Based on 18 specimens ranging in size 67.0-73.0 mm S.L. (86.0-96.0 mm T.L). Morphometric data are summarized in Table 2.

D. VIII, 16 ; A. III, 14 ; P. 18, V. I, 5 ; C. 24.

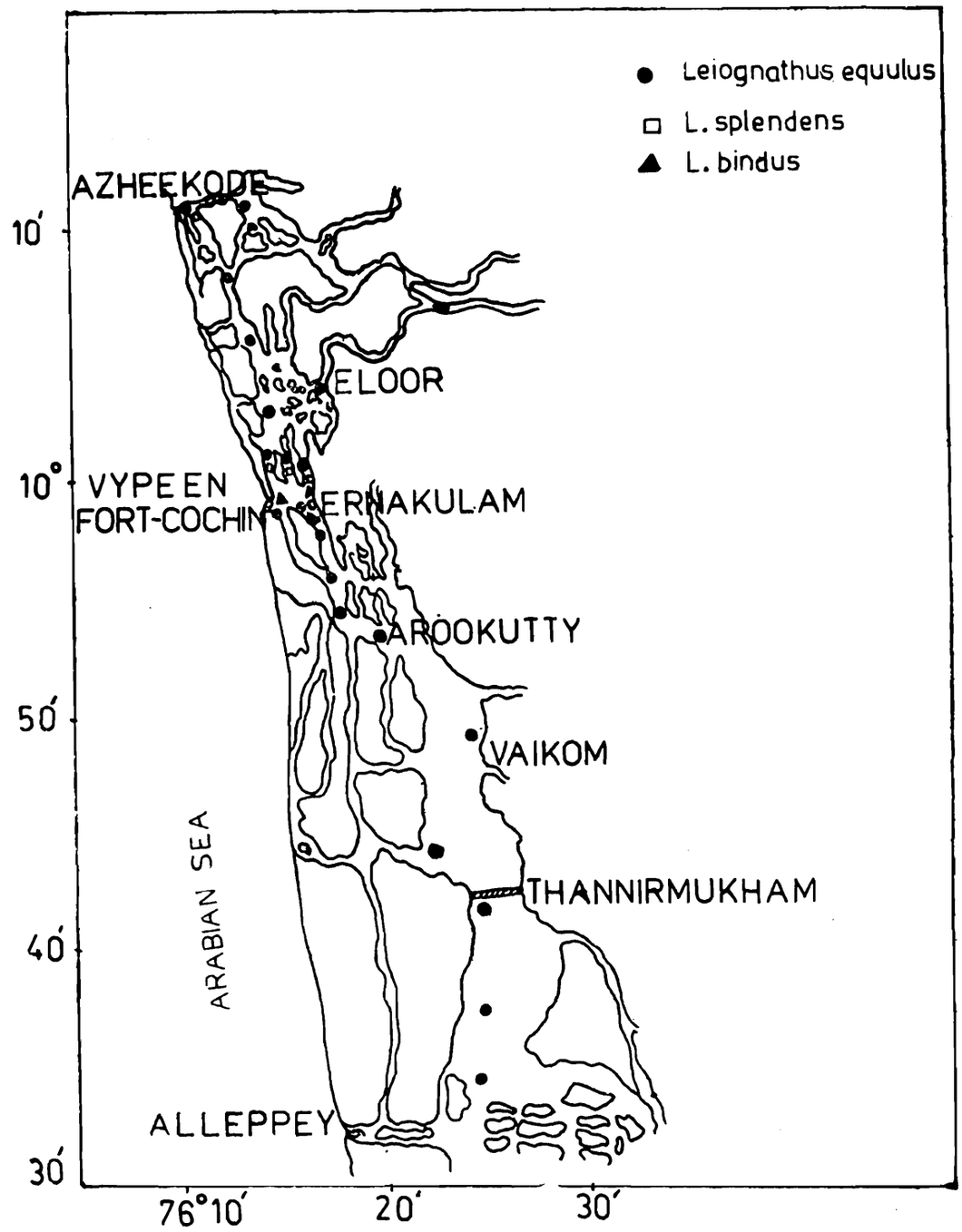
Height of the body at D origin less than half of S.L. Snout length more or less equal to orbit diameter. Gill rakers on first arch (4-6)+(15-16)=19-22. Lateral line with 49-57 sensory tubes.

Occurrence and Abundance in the Lake : *L. daura* occurs from the middle of March to May in the catches from the mouth of the estuary.

TABLE 1. Body proportions of *L. splendens*, *L. equulus* and *L. bindus* as percent of standard length and head length.

Sl. No.	Characters	*L. Splendens* Range	*L. Splendens* Mean	*L. Splendens* S. D.	*L. equulus* Range	*L. equulus* Mean	*L. equulus* S. D.	*L. bindus* Range	*L. bindus* Mean	*L. bindus* S. D.
	IN STANDARD LENGTH									
1.	Depth of body (at the origin of dorsal)	48.6-57.3	54.0	2.2	54.3-66.6	59.6	3.2	51.4-55.9	53.6	1.4
2.	Head length	31.0-34.0	32.3	0.8	33.3-37.0	34.7	1.2	29.5-31.9	30.4	0.7
3.	Dorsal origin	46.2-51.1	48.2	1.6	49.1-55.5	53.2	2.1	39.5-45.2	42.9	1.6
4.	Anal origin	49.2-56.7	53.9	1.9	52.7-60.6	57.2	1.8	52.0-59.9	55.7	1.9
5.	Pectoral origin	31.1-35.4	33.0	1.1	32.9-38.8	36.3	2.0	28.0-35.4	31.1	1.9
6.	Ventral origin	34.4-39.5	37.1	1.2	38.5-44.6	41.4	1.5	38.0-41.9	39.6	1.2
7.	D base length	49.9-59.1	56.4	2.3	52.9-62.9	56.9	3.0	54.1-59.9	57.1	1.6
8.	A base length	39.4-47.6	45.8	2.0	43.8-51.0	46.8	1.8	43.0-51.9	47.9	2.3
9.	Pectoral length	22.7-26.3	24.9	0.9	19.5-25.7	23.2	2.1	19.3-23.8	21.1	1.2
10.	Ventral length	15.0-18.0	16.3	0.7	13.6-15.7	14.7	0.8	8.8-12.4	10.1	1.0
11.	Length—Second dorsal spine	21.8-23.8	22.6	0.9	18.1-23.5	21.4	1.5	17.1-20.7	18.8	1.1
12.	Length—Second anal spine	16.4-21.0	18.3	1.4	15.4-20.6	18.3	1.5	12.5-15.2	14.5	0.9
13.	Length—Caudal peduncle	9.0-12.4	10.6	0.8	7.8-12.3	9.8	1.2	8.0-11.1	9.5	1.4
14.	Depth—Caudal peduncle	7.8-10.8	9.5	0.8	5.5- 9.2	7.4	1.0	6.6- 7.7	7.1	0.3
	IN HEAD LENGTH									
1.	Eye diameter (Horizontal)	35.0-42.3	38.4	2.1	29.1-35.4	31.6	2.0	34.6-42.8	39.4	3.7
2.	Snout	26.0-32.5	29.4	1.8	28.0-37.5	32.9	2.6	24.0-31.8	27.9	2.4
3.	Inter orbital space	33.3-40.0	35.9	1.8	33.3-43.7	38.2	3.2	30.0-43.4	36.1	3.5

During these months the entire estuary has a marine habitat. High salinity (29.6-33.3‰) and temperature (32.8-34.2°C) were noticed from its known region of occurrence (Text-fig. 2). By examining the catch composition it is clear that this species have a meagre population in the estuary during these months and constitute only a minor local fishery.



Text-fig. 2. Geographic distribution of *Leiognathus equulus*, *L. splendens* and *L. bindus* in Vembanad Lake (based on specimens personally examined).

Distribution : Indo-Australian Archipelago, Gulf of Thailand, Sea of Penang, South Arabia, Andaman Islands, Sri Lanka, Siam, Queensland, India—East Coast : Palk Bay, Gulf of Mannar, Coromandel Coast, Chilka lake and Porto Novo ; West Coast : Goa and Cochin.

5. **Leiognathus berbis** (Valenciennes) 1835

(Plate II E)

Brief description : Based on 8 specimens ranging in size 86.0-96.0 mm S.L. (106-118.0 mm T.L). Morphometric date are summarized in Table 2.

D. VIII, 16 ; A. III, 14 ; P. 16-18 ; V. I, 5 ; C. 24.

Height of the body at D origin less than half of S.L. Snout length greater than orbit diameter. Gill rakers on first arch (3-4)+(13-14)= 16-18. Lateral line with 35-52 sensory tubes, ceasing before end of soft dorsal.

Occurrence and Abundance in the Lake: *L. berbis* was found only in very small numbers during the first week of May from the ship channel and the mouth of the estuary (Text-fig.3) where high salinity (33.3‰) and temperature (32.8°C) were noticed.

Distribution : Indo-Australian Archipelago, Red Sea, Zanzibar Philippines, India—East Coast : Palk Bay, Gulf of Mannar and Porto Novo, West Coast : Goa and Cochin.

6. **Leiognathus brevirostris** (Valenciennes) 1835

(Plate II F)

Brief description : Based on 52 specimens ranging in size 59.0–85.0 mm S.L. (79.0–105.0 mm T.L). Morphometric data are summarized in Table 2.

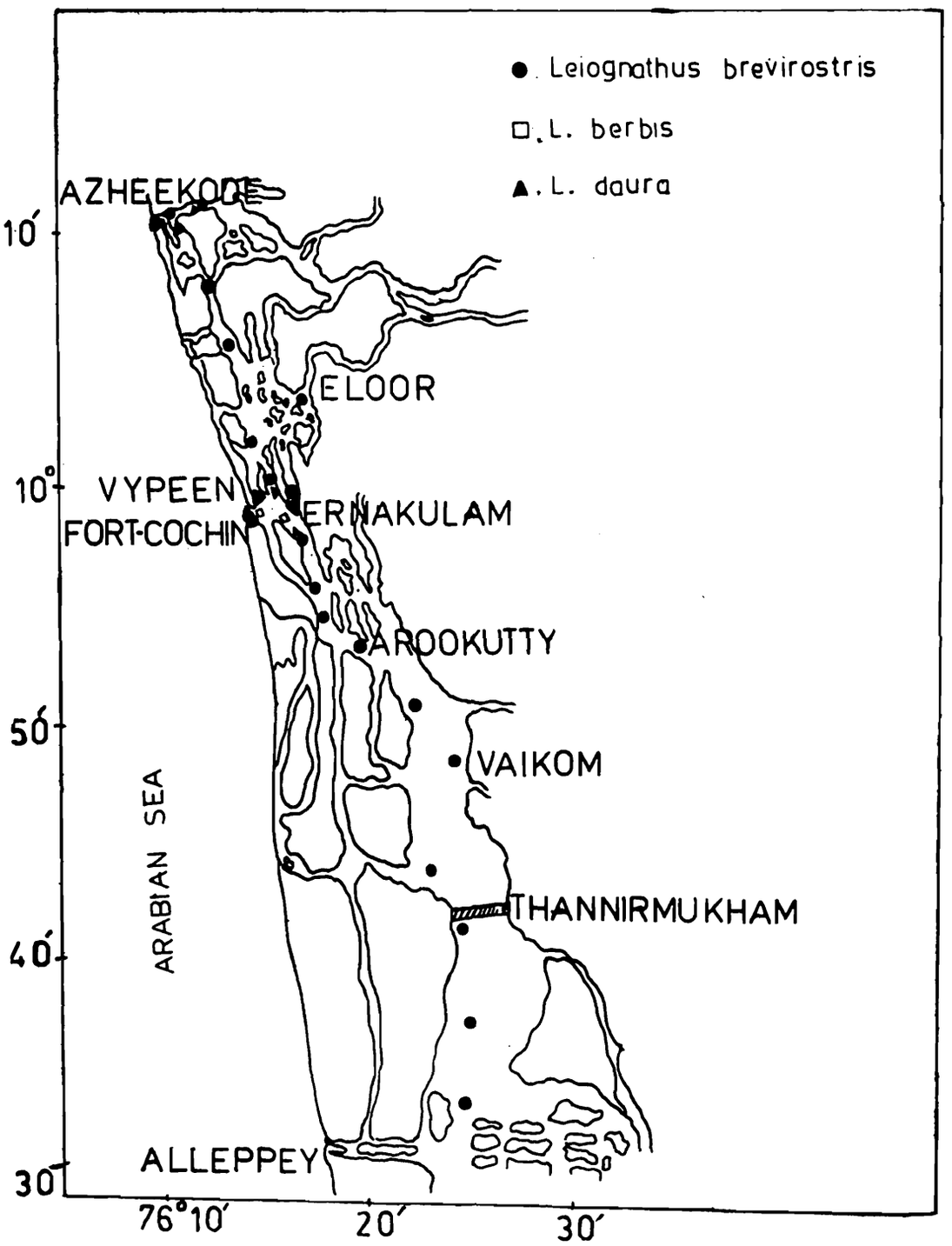
Height of the body at D origin less than half or nearly half of S.L. Snout length more than orbit diameter. Gill rakers on first arch (4-6) + (18-19)=22-25. Lateral line with 55-60 sensory tubes.

Intensity of colour varies with localities. Diffuse 12-14 irregular bands on dorsal profile. Narrow bluish green strand from isthmus to caudal peduncle in fresh condition. Opercle yellow. Golden yellow on lateral line, bordered by dusky margins. The membrane between anal spines and rays fringed with orange red colour.

Occurrence and Abundance in the Lake : *L. brevirostris* was equally abundant as *L. equulus* and its occurrence was noticed throughout the year in the catches from the lake. These are also euryhaline fishes which were able to occupy all regions of the lake (Text-fig. 3) and forms local fisheries of considerable importance. The distribution pattern of this species was more or less similar to that of *L. equulus*. During monsoon its availability was reduced but during intermonsoon months fairly good catches were noticed, especially from December to May

when the salinity ranges from 5.2-33.3‰ and temperature 24.1-34.2°C in the lake.

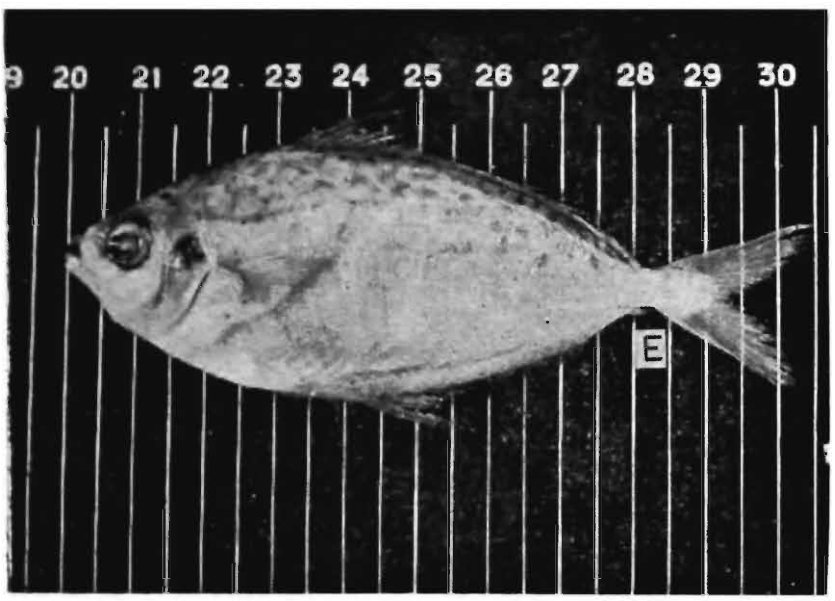
Distribution : Indo-Astralian Archipelago, China, India—East Coast : Palk Bay, Gulf of Mannar and Godavari estuary ; West Coast : Cochin.

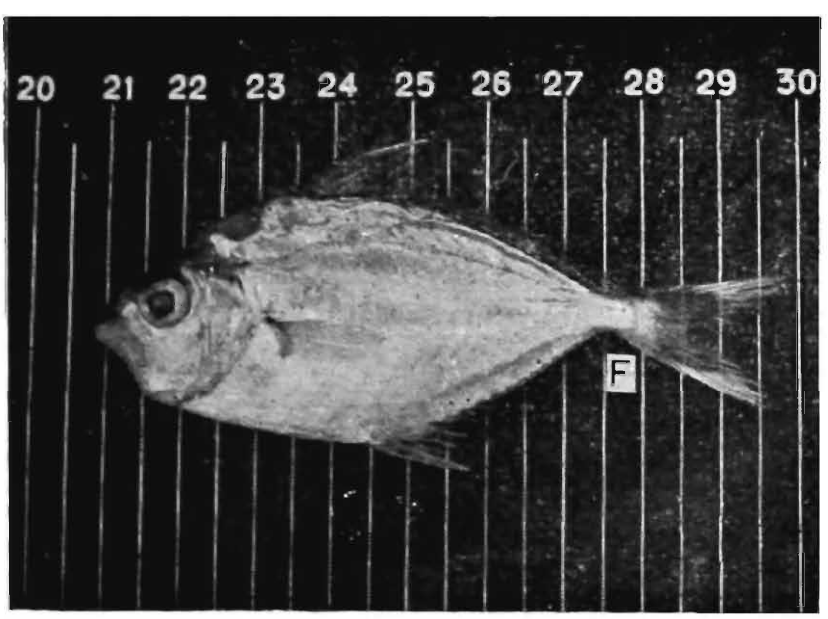


Text-fig. 3. Geographic distribution of *Leiognathus brevirostris*, *L. berbis* and *L. daura* in Vembanad Lake (based on specimens personally examined).

7. **Secutor insidiator** (Bloch) 1787
(Plate III A)

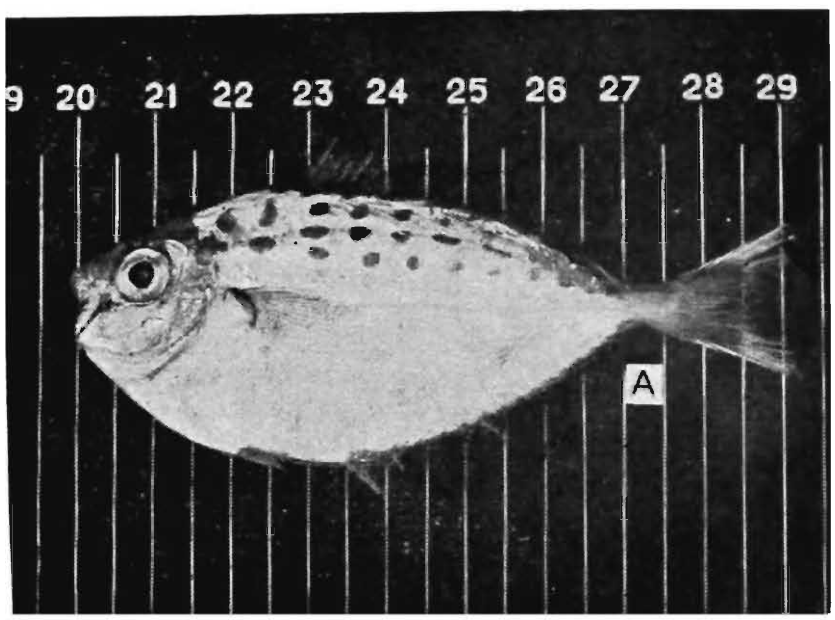
Brief description : Based on 35 specimens ranging in size 41.0-73.0 mm S.L. (49.0-91.0 mm T.L). Morphometric data are summarized in Table 3.

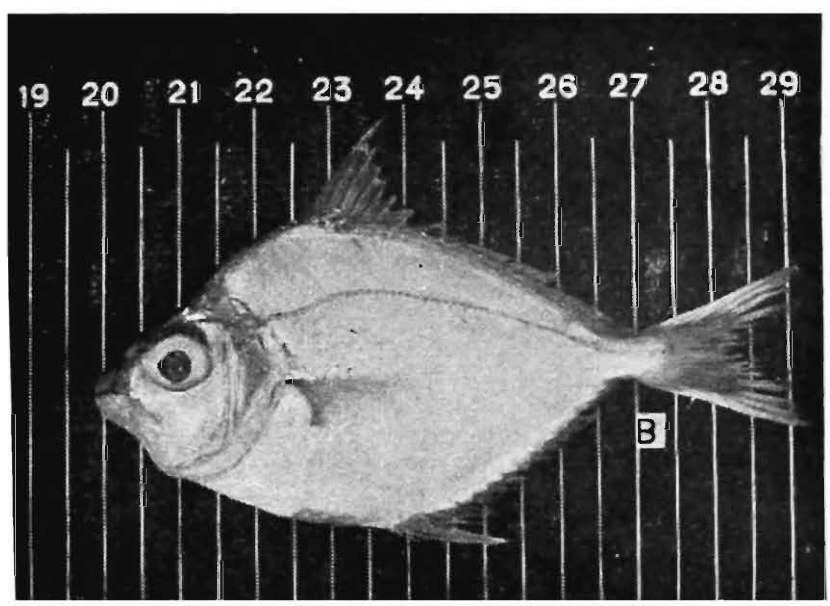




Figs. E. *Leiognathus berbis* (Valenciennes)

F. *Leiognathus brevirostris* (Valenciennes)





Figs. A. *Secutor insidiator* (Bloch)

B. *Secutor ruconius* (Hamilton—Buchanan)

TABLE 2. Body proportions of *L. daura*, *L. berbis* and *L. brevirostris* as percent of standard length and head length.

Sl. No.	Characters	*L. daura* Range	*L. daura* Mean	*L. daura* S. D.	*L. berbis* Range	*L. berbis* Mean	*L. berbis* S. D.	*L. brevirostris* Range	*L. brevirostris* Mean	*L. brevirostris* S. D.
	IN STANDARD LENGTH									
1.	Depth of body (at the origin of dorsal)	45.5-49.9	47.5	1.4	40.6-42.6	41.9	0.6	44.0-50.6	47.9	2.7
2.	Head length	28.1-30.1	29.0	0.6	27.0-29.4	28.0	0.9	29.1-32.8	30.5	1.3
3.	Dorsal origin	44.2-48.6	45.5	1.2	40.6-43.0	42.4	1.7	41.0-45.4	44.4	1.3
4.	Anal origin	53.5-56.3	55.2	0.8	54.7-57.3	55.7	1.1	49.9-55.6	53.3	2.1
5.	Pectoral origin	28.5-32.3	30.5	1.2	29.1-31.3	30.0	0.9	29.1-34.4	31.6	1.5
6.	Ventral origin	36.2-40.2	38.3	1.3	38.2-39.9	38.7	0.8	35.2-41.6	37.8	1.7
7.	D Base length	50.7-56.1	53.9	1.3	53.6-56.9	55.4	1.4	52.5-56.9	54.3	1.8
8.	A base length	42.0-45.2	44.0	1.1	41.8-46.3	43.8	2.0	43.0-48.4	45.2	1.6
9.	Pectoral length	18.8-22.5	20.5	1.4	16.8-17.1	16.9	0.1	17.1-20.6	19.2	1.2
10.	Ventral length	10.1-16.4	13.3	1.7	11.5-12.9	12.2	0.6	10.1-14.8	12.7	1.5
11.	Length—Second dorsal spine	19.4-23.8	21.5	1.2	20.9-23.5	22.6	1.1	20.3-24.6	21.5	3.1
12.	Length—Second anal spine	14.2-16.4	15.2	0.8	16.2-20.2	18.8	1.6	14.4-18.7	17.0	1.6
13.	Length—Caudal peduncle	8.5- 9.8	9.1	0.5	8.4-10.4	9.5	0.8	8.1-11.8	10.0	1.2
14.	Depth—Caudal peduncle	5.7- 8.3	7.1	0.6	6.7- 7.8	7.0	0.5	6.3- 8.2	7.0	0.7
	IN HEAD LENGTH									
1.	Eye diameter (Horizontal)	32.3-40.0	35.6	2.4	28.5-33.3	30.8	1.9	26.3-35.0	30.2	3.2
2.	Snout	27.2-35.0	31.5	2.8	32.1-34.6	33.6	1.2	29.4-37.5	34.5	3.5
3.	Inter orbital spcae	38.0-45.0	41.6	2.8	32.8-34.2	33.2	1.2	33.3-42.8	37.5	2.7

D. VIII, 16 ; A. III, 14 ; P. 16-17 ; V. I, 5 ; C.24-26.

Height of the body at D origin less than half or nearly equal to half of S.L. Snout length less than orbit diameter. Gill rakers on first arch (5-5)+(20-24)=25-30. Lateral line with 44-58 sensory tubes, extends almost upto two thirds of soft dorsal.

Occurrence and Abundance in the Lake : *S. insidiator* occurs from September to middle of June in the lake (Text-fig. 4) where salinity ranges from 14.6-33.3‰ and temperature 24.0-34.2°C. During the monsoon periods the lake is influxed by freshwater as a result of heavy rainfall, so that this species completely disappears in the catches. By examining the catch composition it is clear that from September to December it was very scarce and its occurrence was more or less confined to the mouth and lower reaches of the estuary. From January to May fairly good catches were noticed from northern half where salinity (13.8-33.3‰) and temperature (24.5-34.2°C) were comparatively high. Only very stray catches were noticed from the southern half of Vembanad Lake.

Distribution : Indo-Australian Archipelago, Gulf of Thailand, East Coast of Africa, Medagascar, Seychelles, Delagoa Bay, Natal Coast, Sri Lanka, Hongkong, Philippines, Tahiti, India—East Coast : Palk Bay, Gulf of Mannar, Coromandel Coast, Mouth of Ganges, Madura, Godavari estuary, Chilka Lake and Porto Novo ; West Coast ; Goa, Malabar and Cochin.

8. **Secutor ruconius** (Hamilton—Buchanan) 1822

(Plate III B)

Brief description : Based on 26 specimens ranging in size 33.0-78.0 mm S.L. (40.0-98.0 mm T.L.) Morphometric data are summarized in Table 3.

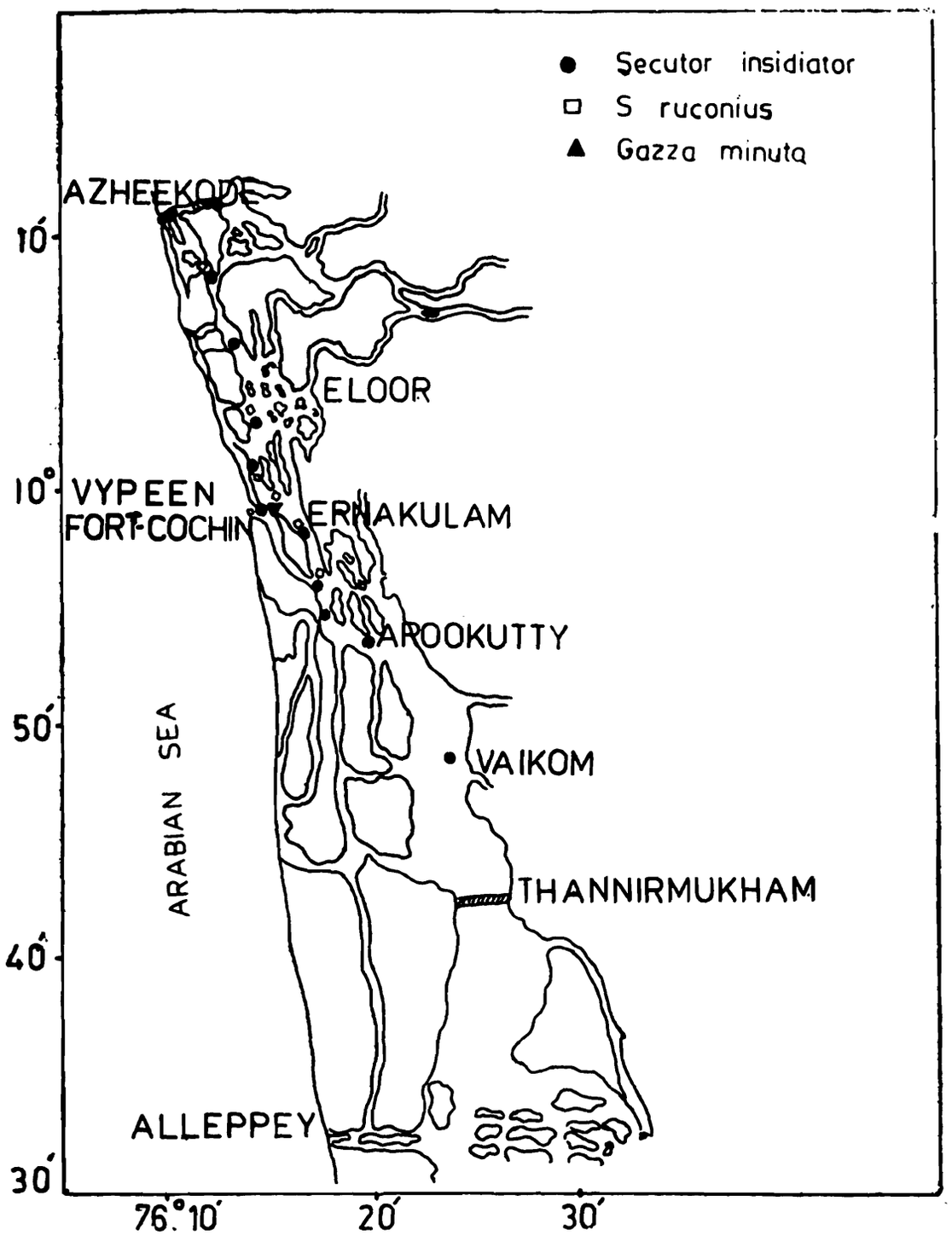
D. VIII, 16 ; A. III, 14 ; P. 16 ; V. I, 15 ; C. 24.

Height of the body at D origin more than half of S. L. Snout length less than orbit diameter. Gill rakers on first arch (5-6) (17-19)=22-25. Lateral line with 20-29 sensory tubes, extends upto middle of soft dorsal.

Occurrence and Abdundance in the Lake : *S. ruconius* occurs from February to May in the catches from the lake. During February and March only juveniles (39.0-65.0 mm S. L) were present in the estuary. It's distribution (Text-fig. 4) was mainly confined to the northern half of Vembanad Lake and only very stray occurrences were noticed upto

Thevara (South of Cochin). The occurrence of this species was noticed in those parts of the lake where the salinity (25.8-33.3‰) and temperature (30.4-34.2°C) were invariably high in the above months and nearly marine conditions were prevailing.

Distribution : Indo-Australian Archipelago, Gulf of Thailand, Westward to South Africa, South Arabia, Sri Lanka, Malayasia, China, Formosa, Philippines, India—East Coast : Palk Bay, Gulf of Mannar, Madras, Chilka lake, Porto Novo and Godavari estuary ; West coast : Goa and Cochin.



Text-fig. 4. Geographic distribution of *Secutor insidiator* *S. ruconius* and *Gazza minuta* in Vembanad Lake (based on specimens personally examined).

9. **Gazza minuta** (Bloch) 1797

(Plate III C)

Brief description : Based on 4 specimens ranging in size 107.0-116.0 mm S.L (131.0-145.0 mm T.L). Morphometric data are summarized in Table 3.

D. VIII, 16 ; A. III, 14 ; P. 20 ; V. I, 5 ; C. 24.

Height of the body at D origin less than half of S.L. Snout length less than orbit diameter. Gill rakers on first arch (3-5)+(15-16)=18-21. Lateral line with 60-62 sensory tubes.

Occurrence and Abundance in the Lake : *G. minuta* occurs very sporadically in the catches from the lake. It's occurrence was noticed only in the later half of April from the mouth of the estuary and the ship channel and was in small numbers. During the above months the estuary had a marine habitat and high salinity (32.9‰) and temperature (32.8°C) were noticed from the reported region of occurrence (Text-fig. 4).

Distribution : Indo-Australian Archipelago, Red Sea, Gulf of Thailand, Mossambique, Northern coast of Australia, Delagoa Bay, Natal coast, Medagascar, Bourbon, Mauritius, Seychelles, Andaman Islands, Minicoy Islands, Sri Lanka, Siam, Formosa, Philippines, New Guinea, Solomon Islands, New Britain, Tahiti, Tanna, Rarotonga, India—East Coast : Palk Bay, Gulf of mannar, Chilka Lake, Madras and Porto Novo ; West Coast : Cochin and Cape Comarin.

Discussion

The Vembanad Lake is the largest estuarine system of Kerala and it has a rich and diversified fish fauna. The silver-belly fishes constitute an important fishery in the lake. Shetty (1963) listed only six species of leiognathid fishes from Vembanad Lake. Among those six species, *Leiognathus lineolatus* (Valenciennes) and *L. fasciatus* (Lacépède) were not collected so far by the present authors. The authors collected 9 species of silver-belly fishes from the lake which are described in this paper. Menon (1961) listed 6 species of silver-belly fishes from Chilka Lake, Visweswara Rao (1976) listed 7 species from Godavari estuary. On comparison it is clear that Vembanad Lake which is smaller than the Chilka Lake has more species of leiognathid fishes.

The distribution of fishes within any water body shows a zonal pattern, both longitudinal and transverse, due to behavioral adjustments (physiological adaptation) for optimal water currents, temperatures and

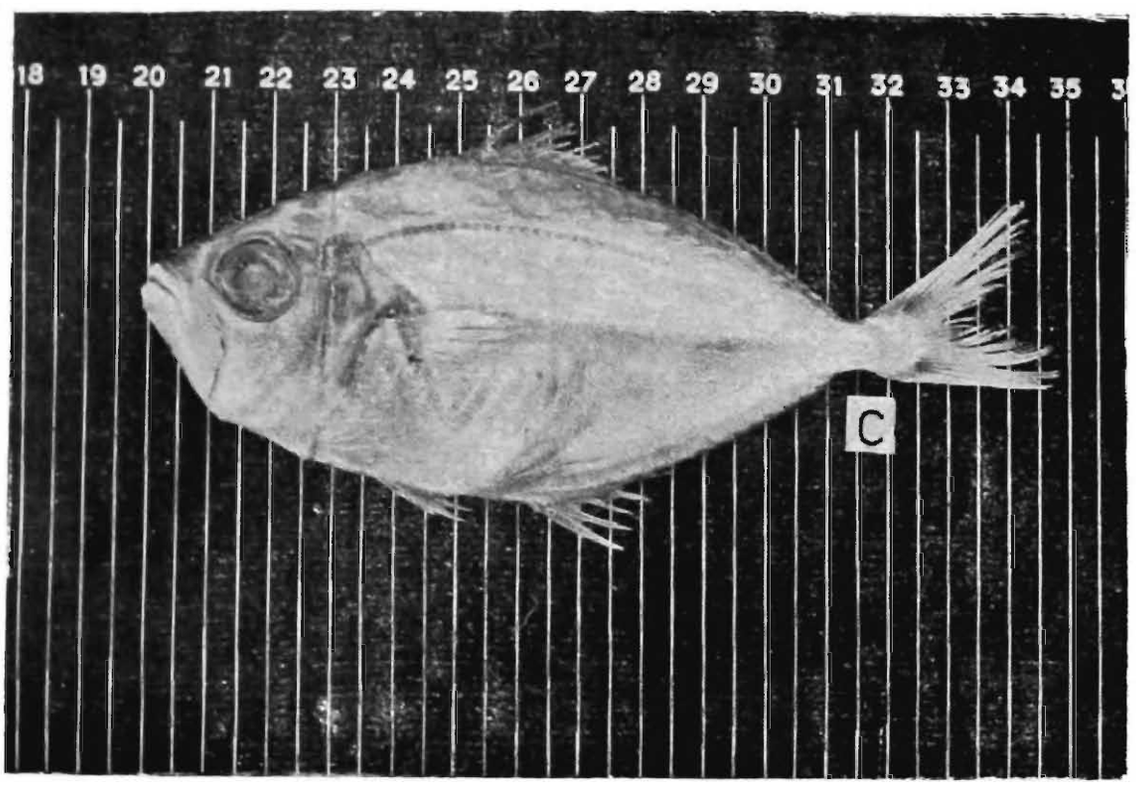
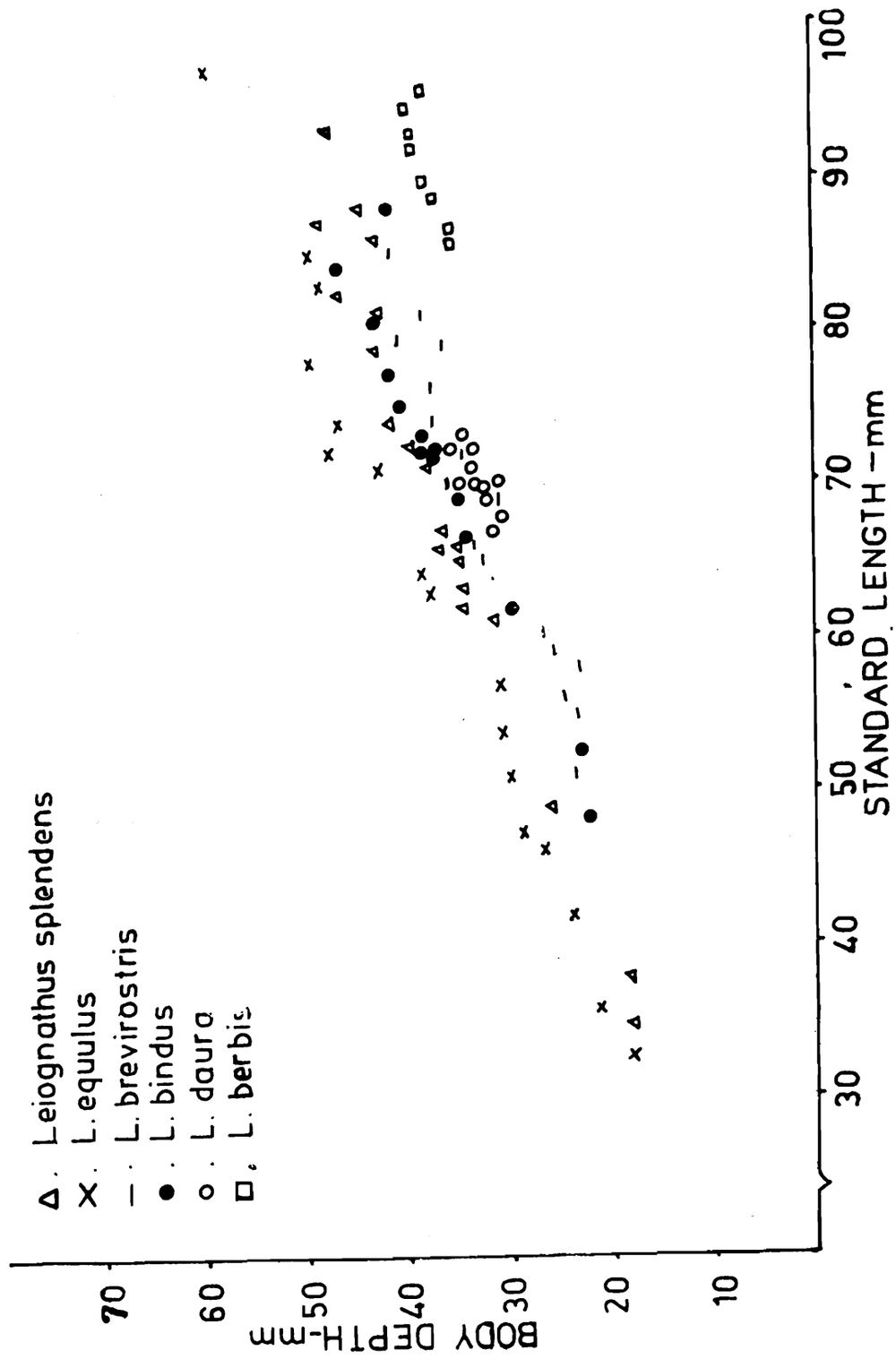


Fig. C. *Gazza minuta* (Bloch)

TABLE 3. Body proportions of *S. insidiator*, *S. ruconius* and *G. minuta* as percent of standard length and head length.

Sl. No.	Characters	*S. insidiator* Range	Mean	S. D.	*S. ruconius* Range	Mean	S. D.	*G. minuta* Range	Mean	S. D.
	IN STANDARD LENGTH									
1.	Depth of body (at the origin of dorsal)	42.3-52.8	47.3	2.6	56.8-63.0	59.2	2.1	42.0-46.1	44.0	2.8
2.	Head length	26.9-30.9	28.6	1.1	25.0-31.8	30.4	2.9	32.3-32.7	32.5	0.2
3.	Dorsal origin	34.6-41.4	38.1	2.0	35.4-42.8	39.8	2.1	43.9-44.8	44.3	0.6
4.	Anal origin	53.4-59.9	56.6	2.0	54.5-63.8	61.3	2.9	57.9-62.0	59.9	2.5
5.	Pectoral origin	27.8-30.9	29.5	0.9	29.5-34.3	31.6	1.5	33.6-34.4	34.0	0.5
6.	Ventral origin	41.1-47.2	44.1	2.3	45.4-54.5	51.2	2.5	39.2-43.1	41.1	2.7
7.	D base length	51.1-59.6	55.8	2.2	54.1-59.3	56.8	1.5	55.1-62.6	58.8	2.3
8.	A base length	46.3-51.9	49.7	1.8	48.5-55.5	51.7	1.9	42.9-44.8	43.8	1.3
9.	Pectoral length	19.9-24.9	22.4	1.2	21.2-26.8	24.3	1.6	18.2-19.8	19.0	1.1
10.	Ventral length	8.8-11.5	10.2	0.7	6.0- 8.6	8.2	1.0	13.7-14.0	13.8	0.2
11.	Length—Second dorsal spine	15.1-19.5	17.0	1.7	15.1-22.2	17.7	2.2	16.3-18.6	17.4	1.6
12.	Length—Second anal spine	9.2-12.7	10.7	1.0	8.9-13.0	11.3	1.2	14.6-15.8	15.2	0.8
13.	Length—Caudal peduncle	9.0-10.9	9.5	1.0	9.3-13.9	11.4	1.1	9.3- 9.4	9.3	0.7
14.	Depth—Caudal peduncle	5.8- 8.6	7.1	0.6	7.2- 9.7	8.5	0.6	7.0- 7.7	7.3	0.4
	IN HEAD LENGTH									
1.	Eye diameter (Horizontal)	33.3-42.8	37.9	4.1	33.2-40.0	37.9	3.5	30.6-34.3	32.4	2.6
2.	Snout	31.2-38.0	34.1	1.9	28.0-35.0	31.1	2.8	29.3-31.4	30.3	1.4
3.	Inter orbital space	30.0-42.8	36.1	4.3	30.7-40.0	36.2	4.0	34.3-34.6	34.4	0.2

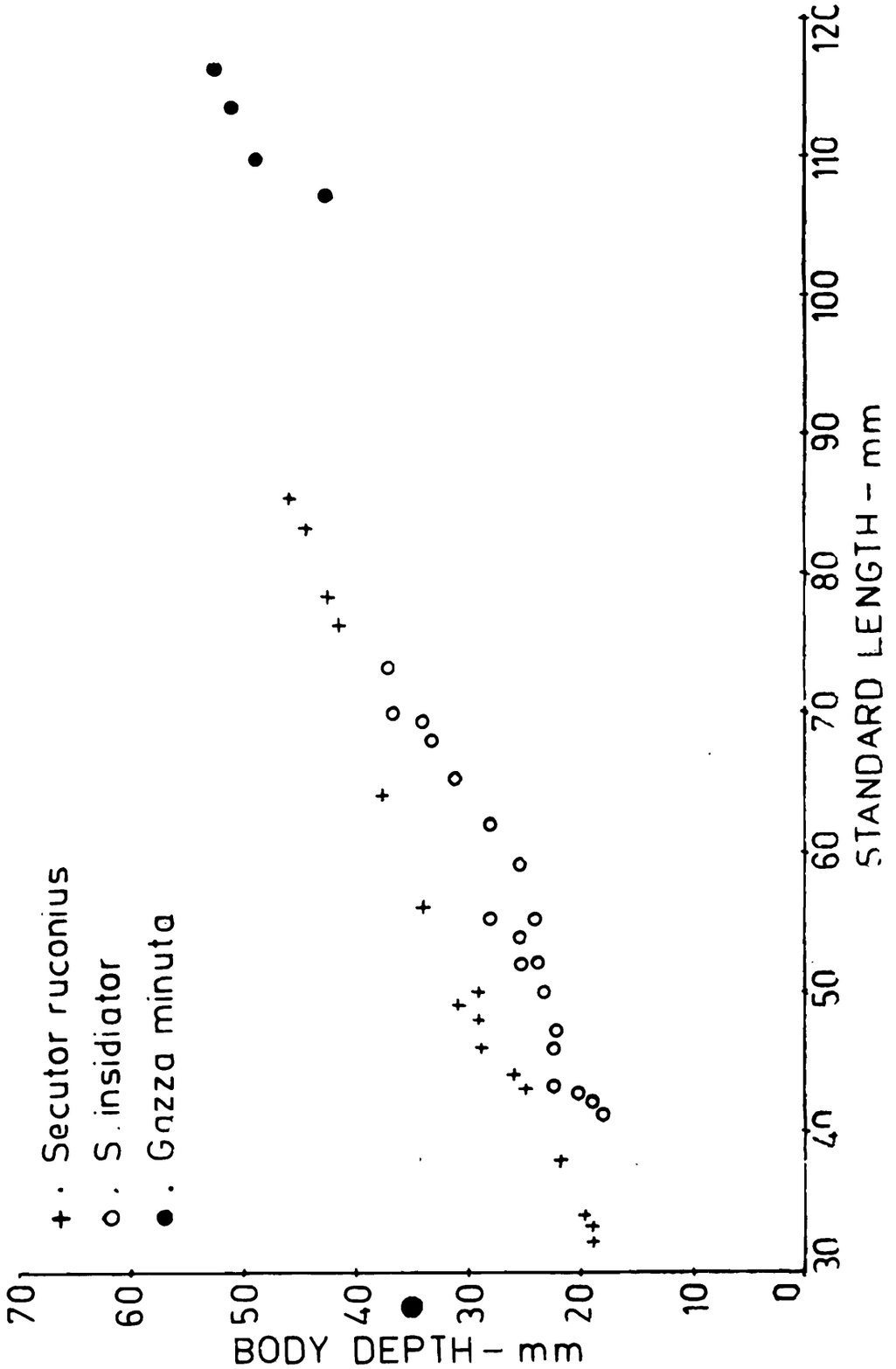
chemical concentrations (John D. Hopkrik, 1973). The study on the distribution and availability of silver-belly fishes present in the Vembanad Lake shows that they evince different patterns of distribu-



Text-fig. 5. Comparison of body depth with standard length for *Leiognathus splendens, L. equulus, L. bindus, L. daura, L. berbis* and *L. brevirostris.*

tion. The lake is permanently connected with the Arabian Sea. So there is a regular ingress and egress of marine fishes into and from

the Lake, caused in part, atleast, by tidal flow. The seasonal influence on the occurrence and abundance of leiognathid fishes in the lake



Text-fig. 6. Comparison of body depth with standard length for *Secutor insidiator*, *S. ruconius* and *Gazza minuta*.

appears to be mainly dependent on prevailing hydrographical conditions. Mergalef (1964) has argued that species diversity increases with

increasing oligotrophy. Since most of the fishes are known to perform either short or long term migrations, it becomes necessary for fishery biologists to consider the distribution of population in the estuaries and adjoining seas simultaneously (Jhingran and Gopalakrishnan, 1973). During pre-monsoon periods, the rainfall is negligible and so the conditions of salinity, temperature, water currents and food items prevalent in the lake are fovourable with the result that of catadromous fishes get into the lake. The entire estuary becomes saline and rich in animal life during the premonsoon period. About 90% of the common species occuring in the estuary registered their peak of abundance during this period (Rao and Madhu Pratap, 1975). During late June as a reault of heavy rainfall there is a heavy influx of freshwater ; so most of the marine fishes migrate towards the sea. By the end of September, brackish water conditions are established and gradual increase in salinity was noticed in the Lake. It has been reported that the maximum fishery occurs during the intermonsoon months of October-April (Silas and Parameswaran Pillai, 1975).

TABLE 4. Occurrence, Season and Frequency of the 9 species of "Leiognathid Fishes" of Vembanad Lake.

Species	Occurrence	Season	Frequency
Leiognathus splendens	Migrant	January-May	Not very common
L. equulus	Resident	All year	Fairly common
L. bindus	Migrant	March-May	Rare
L. daura	Migrant	March-May	Common
L. berbis	Vagrant	May	Very rare
L. brevirostris	Resident	All year	Fairly common
Secutor insidiator	Migrant	All year except June—August.	Common
S. ruconius	Migrant	February—May	Not very common
Gazza minuta	Vagrant	April	Very rare

Lake fish faunas characteristically falls into distinct inshore and offshore species association (Keast and Harker, 1977). Of the 9 species of silver-belly collected from the lake, *Leiognathus brevirostris* (Valenciennes) and *L. equulus* (Forskål) are euryhaline, and are undoubtedly able to utilize all regions in the lake. The occurrence of *S. insidiator* (Bloch) and *L. splendens* (Cuvier) were noticed during pre-monsoon and post-monsoon periods in the lake. The presence of *S. ruconius* (Hamilton—Buchanan), *L. bindus* (Valenciennes) and *L. daura* (Cuvier) were noticed during premonsoon periods and they maintain very small population in the lake. But only very sporadic occurrences are noticed

of *L. berbis* (Valenciennes) and *Gazza minuta* (Bloch) and they are unable to maintain large population in the lake.

In the several areas of the Indo-Pacific region, fishes of the marine origin move into estuaries and constitute local fisheries of considerable importance (Gopalakrishnan, 1973). Of the nine species of leiognathid fishes, 5 species or about 56% of the total number can be characterized as migrants i. e., they are undergoing migration from the nearby inshore areas into the lake during pre and post-monsoon periods of the year (Table 4) ; 2 species (about 23%) are vagrants i. e., they come to lake only accidently and 2 species (about 23%) are residents i. e., they constitute the stock of permanent lacustrine fishes. The data on the species composition and the pattern of distribution of leiognathid fishes in the Vembanad Lake clearly indicates that most of them have a marine origin.

SUMMARY

Nine species of silver-belly fishes (Family : Leiognathidae) are reported from Vembanad Lake (Kerala, S. India) ; *Leiognathus splendens*, *L. equulus*, *L. bindus*, *L. daura*, *L. berbis*, *L. brevirostris*, *Secutor insidiator*, *S. ruconius* and *Gazza minuta*. Notes on the occurrence of different species in the Lake, their seasonal abundance and distribution in relation to varying environmental characteristics and geographical distribution are included. Tables of morphometric characters, black-and-white photographs, distribution maps and a key are also provided.

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Rec. zool. Surv. India, 80 : 413-419, 1983

RECENT RECORDS OF SOME LIZARDS FROM WESTERN GHATS, INDIA

By

T. S. N. MURTHY

Zoological Survey of India, Madras

INTRODUCTION

The present study is the result of systematic collecting carried out by the author and his colleagues over a decade and half from 1967 through 1980 covering not only the main hill ranges—Anaimalais, Nilgiris, Cardamom Hills, and Palnis—but also the hitherto unexplored rain forests of Silent Valley and New Amarambalam with herpetology as the primary objective.

MATERIAL AND METHODS

Terrestrial species were obtained by searching on foot. Diurnal forms were taken between dawn and mid-day or shortly before sunset. Lizards found at high altitudes were generally seen and caught at mid-day. Tree living lizards were trapped by a noose or by light blows delivered at their necks.

Whenever possible, small series rather than a single specimen were picked up from an area. Species common throughout India were observed and left after examination. Specimens found "dead on road" were preserved if they were in tolerably good state for transportation and study.

Treated in detail are 21 species out of the 58 species known to occur in Western Ghats. The taxonomic arrangement follows broadly that of Smith (1935) as revised by Constable (1949), Mittleman (1952), and Underwood (1954). Measurements, scale counts, and other descriptive data are from specimens examined. The snout-vent and tail lengths of all the specimens examined excepting those with tails damaged or lost are given in parentheses after the departmental register number. Most of the colour descriptions are from live or freshly preserved specimens. Total range of the species in the Western Ghats and elsewhere as well has been given.

The entire collection is incorporated in the named reptile collections of the Southern Regional Station, Zoological Survey of India, Madras.

Key to the abbreviations :—SRSL.—Lizards of the Southern Regional Station, WRSV.—Vertebrates of the Western Regional Station, Coll.—Collector or Collected by, Juv./Juvs.—Juvenile/Juveniles, ex.—example/examples, NARF.—New Amarambalam Reserve Forest.

Accounts of Species

Family Gekkonidae

1. **Cnemaspis gracilis** (Beddome)

Material : 1 ♂, SRSL., 99, 51 (22+29) mm., Meenmutty, NARF., 23. ii. 1979, *T. S. N. Murthy*, Coll.

Distribution : Hills of South-Western India.

2. **Cnemaspis kandiana** (Kelaart)

Material : 1 ♂, SRSL. 101, Snout-vent : 32 mm., Panpuzham NARF., 27. ii. 1979, *T. S. N. Murthy*, Coll.

Distribution : (i) Western Ghats—Hills as far north as lat. 12°. (ii) *Elsewhere*—(A) India : Jog Falls and Yellapur, North Canara, Karnataka and Andaman Islands. (B) *Outside India* : Sri Lanka and Islands west of Sumatra.

3. **Cnemaspis indica** (Gray)

Material : (i) 3 ♀♀♀, SRSL., 155, Snout-vent : 31-33 mm., Doddabetta, Nilgiris, 13. iii. 1978, *T.S. N. Murthy*, Coll. (ii) 1 ♂, SRSL. 100, 79 (40+39) mm., Meenmutty, NARF., 23. ii. 1979, *T. S. N. Murthy*, Coll. (iii) 1 ♂, SRSL., 107, 78 (38+40) mm., Sayivala, NARF., 16. iii. 1979, *K. R. Rao*, Coll. (iii) 2 ♂♂, SRSL., 105-106, 68-78 mm., Sayivala, NARF., 16. iii. 1979, *K. R. Rao*, Coll. (iv) 2 ♂♂, SRSL., 105-106, 68-78 mm., Sayivala, NARF., 15. iii. 1979, *K. R. Rao*, Coll.

Distribution : Nilgiris in the Western Ghats. Smith (1935) adds Jerdon found it in Coorg (Karnataka).

4. **Cnemaspis sisparensis** (Theobald)

Material : (i) 1♂, SRSL., 198, 58 (33+25) mm., Silent Valley, 27. i. 1979, *R. S. Pillai*, Coll. (ii) 1 ♂, 32 mm., (tail lost), Sayivala, NARF., 15. iii. 1979, *K. R. Rao*, Coll.

Distribution : The three types known were reported from the Sispara Ghat, Nilgiris and Kavalai, Kerala. This forest gecko is being recorded for the first time from Silent Valley and New Amarambalam area of Kerala.

5. **Cnemaspis wynadensis** (Beddome)

(Plate 1, fig. 1)

Material : (i) 1 ♂, SRSL., 102, 62 (34+28) mm., Meenmutty, NARF., 1. iii. 1979, *T. S. N. Murthy*, Coll. (ii) 1 ♂, SRSL. 103, 73 (34+39) mm., Silent Valley, 22. i. 1979, *R. S. Pillai*, Coll.

Distribution : "Wynaad and hill ranges farther South" according to Smith (1935). The present records are from the Silent Valley and New Amarambalam area of Kerala.

Remarks : This species is being recorded from the Silent Valley for the first time.

6. **Cyrtodactylus collegalensis collegalensis** (Beddome)

Material : 1 juv., SRSL., 157, 69 (39+30) mm., Meenmutty, NARF., 15. ü. 1979, *T. S. N. Murthy*, Coll.

Distribution : Hills of Southern India and Sri Lanka.

Remarks : The specimen under study is the first record from New Amarambalam area. A rare gecko.

7. **Dravidogecko anamallensis** (Günther)

(Plate 1, fig. 3)

Material : 2♂♂, SRSL., 158, 81-88 mm., Kodaikanal, Palnis, 5. ii. 1972, *T. S. N. Murthy*, Coll.

Distribution : Anaimalais, Palnis and Hills of Tirunelveli in the Western Ghats.

Remarks : These rare geckos are additional interesting records for the area under study.

8. **Hemidactylus frenatus** Schlegel

Material : (i) ♂, SRSL., 148, 139 (67+72) mm., Meenmutty, NARF., 14. iii. 1979, *T. S. N. Murthy*, Coll. (ii) 1 ♀, SRSL., 153, 52 mm., (tail damaged), Sayivala, NARF., 15. iii. 1979, *K. R. Rao*, Coll.

Distribution : (i) *India* : Southern India. (ii) *Elsewhere* : Sri Lanka, Bangladesh, Indo-china, Hainan, Yunnan, Hongkong, Southern China.

9. **Hemidactylus reticulatus** Beddome

Material : 1♀, SRSL., 145, 62 (28+34) mm., Kodaikanal, Palnis, 7. iv. 1980, *T. S. N. Murthy*, Coll.

Distribution : (i) Western Ghats—Palnis. (ii) *Elsewhere* : Shevaroy Hills and Palkonda Hills (Eastern Ghats) and Karnataka.

Remarks : This specimen under study is the first record of this species from Palnis. A rare gecko.

Family AGAMIDAE

10. **Calotes calotes** (Linnaeus)

Material : (i) ♂, SRSL. 18, 612 (125+487) mm., Topslip, Anaimalais, 5. vi. 1973, *G. U. Kurup*, Coll. (ii) 1 juv., SRSL. 19, 413 (93+320) mm., Kulathupuzha, Tenmalais, 10. xii. 1973, *Koshy Mathew*, Coll. (iii) 1 juv., SRSL. 20, 412 (93+319) mm., Silent Valley, 17. x. 1974, *G. U. Kurup*, Coll.

Distribution : (i) Western Ghats—Anaimalais, Hills of South Kerala and Silent Valley. (ii) *Elsewhere* : (a) *India*—Shevaroy Hills (Eastern Ghats) and Nicobar Islands. (b) *Outside India*—Throughout the hills of Sri Lanka.

11. **Calotes elliotti** Günther

(Plate 1, fig. 4)

Material : (i) Juv., SRSL., 21, 215 (58+157) mm., Kodaikanal, Palnis, 18. x. 1972, *T. S. N. Murthy*, Coll. (ii) 3 juvs., SRSL., 22-24, 215-218 mm., Karianshola, Topslip, Anaimalais, 20. x. 1974, *T. S. N. Murthy*, Coll. (iii) 1♂, SRSL., 68, 249 (73+176) mm., Meenmutty, NARF, *T. S. N. Murthy*, Coll. (iv) 2♀♀, SRSL., 25-26, 227-234 mm., Attakatti, Anaimalais, 4. iii. 1976, *T. S. N. Murthy*, Coll. (v) 1♀, SRSL., 136, 270 (83+187) mm., Mukkali, Silent Valley, 16. i. 1980, *K. R. Rao*, Coll.

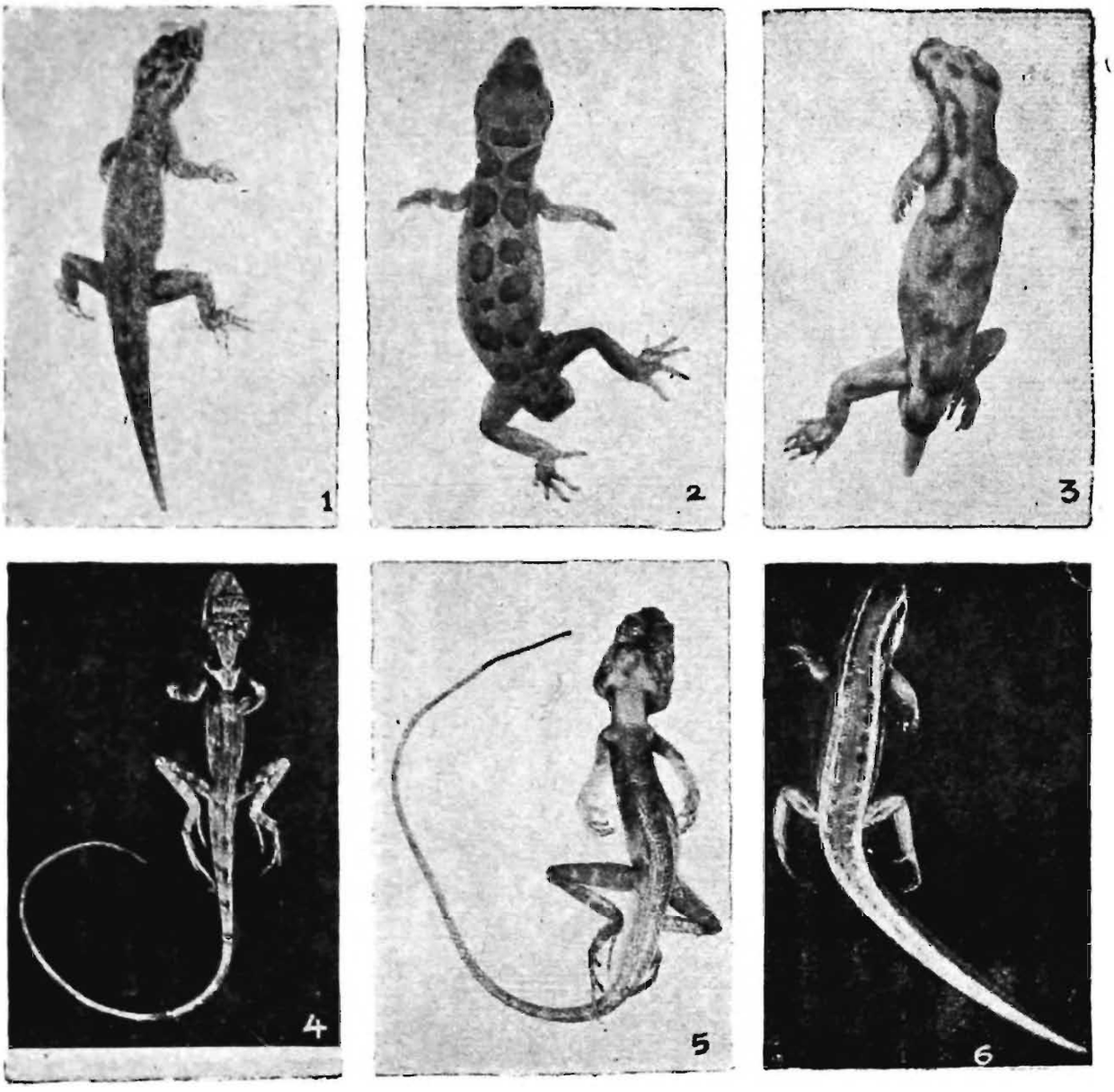
Distribution : Restricted to the Western Ghats. Reported hitherto from Anaimalais, Tirunelveli and Sivagiri Hills. The present studies extends the range of this species to Palnis.

12. **Calotes rouxi** Dumeril and Bibron

(Plate 1, fig. 5)

Material : (i) 1 juv., SRSL., 31, 159 (27+132) mm., Thekkady, Cardamom Hills, 28. x. 1974, *T. S. N. Murthy*, Coll. (ii) 1♂, SRSL., 57, 239 (67+172) mm., Punchakolli, New Amarambalam, 24. iii. 1979, *K. R. Rao*, Coll. (iii) 1♂, SRSL., 58, 221 (58+163) mm., Ottakkal, Tenmalais, 26. xi. 1973, *Koshy Mathew*, Coll.

Distribution : It is now reported from the Cardamom Hills and Tenmalais of Western Ghats.



Figs. 1. *Cnemaspis wynadensis*, 2. *Cyrtodactylus collegalensis collegalensis*,
3. *Dravidogecko anamallensis*, 4. *Calotes elliotti*,
5. *Calotes rouxi*, 6. *Sphenomorphus dussumieri*.

13. **Calotes versicolor** (Daudin)

Material : (i) 1 juv., SRSL., 32, 218 (66+152) mm., Attapadi, Silent Valley, 15. x. 1974, *G. U. Kurup.* Coll. (ii) 2 ♂ ♂, SRSL., 33-34, 318 (118+200) mm., Courtallam, Tirunelveli Hills, 30. x. 1975, *R. S. Pillai,* Coll. (iii) 1 juv., SRSL., 35, 210 (65+145) mm., Muthanga, 10. x. 1976, *R. S. Pillai,* Coll.

Distribution : Common throughout India, Sri Lanka, Pakistan and Indo-China.

14. **Draco dussumieri** Dumeril and Bibron

Material : 2 ♀ ♀, SRSL., 55, 177-183 mm., Punchakolli, NARF., 25. iii. 1979, *K. R. Rao,* Coll.

Distribution : Southern India (Madras, Travancore, Cochin, Malabar, Coorg, Karwar, Goa). Annandale records it 'common about ten miles north of Trivandrum' *vide* Smith (1935).

15. **Otocryptis beddomii** Boulenger

Material : 1 juv., SRSL., 151, 108 (35+73) mm., Kodaikanal, Palnis, 7. iv. 1980, *T. S. N. Murthy,* Coll.

Distribution : Cardamom Hills. First record from Palnis.

Remarks : Collected nearly after a century since its description. A rare agamid.

Family SCINCIDAE

16. **Ristella beddomii** Boulenger

Material : (i) 2 juvs., SRSL., 76-77, Poochipara, NARF., 12. iii. 1979, *K. R. Rao,* Coll. (ii) 3 juvs., SRSL., 93-97, 30-35 mm., (tail damaged), Meenmutty, NARF., 1. iii. 1979, *T. S. N. Murthy,* Coll.

Distribution : Restricted to Western Ghats. Recorded hitherto from Tenmalais, Sharvathy River (Karnataka) and Parambikulam (Anaimalais).

Remarks : The specimens under study are additional interesting records of this species from New Amarambalam Area, Kerala.

17. **Sphenomorphus dussumieri** (Dumeril and Bibron)

(Plate 1, fig. 6)

Material : (i) 1 ♂, SRSL., 90, 107 (48+59) mm., Nedungayam, NARF., 28. iii. 1979, *K. R. Rao,* Coll. (ii) 2 ♂ ♂, SRSL., 91-92, 116 (52+64) mm., Nedungayam, NARF., 15. iii. 1979, *T. S. N. Murthy,* Coll.

Distribution : (i) Western Ghats—From South Canara District (Karnataka) to Trivandrum (Kerala). (ii) *Elsewhere* : A single specimen from Sri Lanka.

18. **Scincella bilineatum bilineatum** (Gray)

Material : (i) 1 ex., SRSL., 138, Snout-vent 59 mm., Doddabetta, Nilgiris, 13. iii. 1978, *T. S. N. Murthy* Coll. (ii) 1 ex., SRSL., 139, Snout-vent 62 mm., Coonoor, Nilgiris, 10. iii. 1978, *T. S. N. Murthy*, Coll.

Distribution : Nilgiris in Western Ghats only.

19. **Scincella bilineatum laterimaculatum** Boulenger

Material : 2 ex., SRSL., 142, 118 (41+77) mm., and 116 (46+70) mm., Coonoor, Nilgiris, 10. iii. 1978, *T. S. N. Murthy*, Coll.

Distribution : Recorded from Nilgiris and Hills of South Kerala and Tirunelveli only.

20. **Scincella palnicum** (Boettger)

Material : 1 ex., SRSL., 140, 118 (55+63) mm., Kodaikanal, Palnis, 7. iv. 1980, *T. S. N. Murthy*, Coll.

Distribution : Restricted to Palnis in Western Ghats.

21. **Scincella travancoricum** (Beddome)

Material : 1 ex., SRSL., 141, 136 (53+83) mm., Poomparai, Palnis, 5. i. 1972, *T. S. N. Murthy*, Coll.

Distribution : Anaimalais, Palnis and Hills of South Kerala in Western Ghats.

Summary

This study is based on 21 species of lizards of the Western Ghats. Systematic accounts in brief and distributional data for all the species discussed are given. Several rare species hitherto known by one or two specimens are recollected.

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FOOD PREFERENCE AND FEEDING BEHAVIOUR OF TWO PESTIFEROUS SNAILS, *ACHATINA FULICA* BOWDICH AND *MACROCHLAMYS INDICA* GODWIN-AUSTEN

By

S. K. Raut and K. C. Ghose

Department of Zoology, University of Calcutta, Calcutta.

Introduction

The giant African land snail *Achatina fulica* is a serious agrihorticultural pest in Indo-Pacific islands for more than a century. Since its introduction in Calcutta in 1847 it has spread to a number of Indian States viz. Assam, Nagaland, Manipur, Tripura, Bihar, Orissa, Uttar Pradesh, Tamil Nadu, Karnatak, Kerala and Andaman group of islands, as well as to some neighbouring countries viz. Nepal, Bhutan and Bangladesh.

Information from the Indian subcontinent on the economic status of *Macrochlamys indica*, an endemic species, is totally lacking, while some preliminary reports on *A. fulica* (Annandale, 1907; Behura, 1955; Ghose, 1962; Srivastava, 1966; Subba Rao, 1975; Raut, 1978) are on record. Contrast to this some what exhaustive studies have been made on the extent and nature of damage to different plants caused by *A. fulica* in Ceylon (Green, 1910a, b, c, d ; Mead, 1961), Malaya (Jarrett, 1923, 1931), Micronesia (Townes, 1946 ; Mead, 1961), Java (Riel, 1933 ; van Alphen, 1954), Sumatra (Esaki and Takahashi, cited in Mead, 1961 ; Lange, 1950), Philippines (Pangga, 1949), Palau Islands (Hatai and Kato, 1943), Hawaiian islands (Weel, 1948-49 ; Mead, 1961), Chichi Jima (Mead, 1961), Tinian (Chamberlin, 1952) and Koror (Kondo, 1950a, b). To fill the lacuna in our knowledge on the economic status of *A. fulica* the infested areas of West Bengal were surveyed during the period 1974 to 1978.

Materials and Methods

Breeding of *Achatina* and *Macrochlamys* is monsoon dependent. It starts in both the species from the end of July in West Bengal, and the highest number of broods are obtained by the middle of July. By early November, the usual period of commencement of aestivation the young snails are found 100 to 120 days old. Aestivation, though interrupted by occasional showers continues till the advent

of next rainy season. On the average, in West Bengal, the life span of *A. fulica* and *M. indica* is 5 anb 3 years respectively. Young snails constitute a high per cent in a population, and as the damage is directly proportional to the number and size of the pest, snails of five different age groups viz. newly hatched, 60, 120, 365 and 730 days old of both the species were considered for the study.

Field observations :

The feeding habits and food preference of *A. fulica* and *M. indica* of different age groups were recorded from their natural habitat in the infested areas of West Bengal for a period of 5 years, 1974 to 1978. Feeding mechanism was studied in the evening—the peak period of feeding. The food preference was assayed from the extent of damage to food-plants.

Open-air cage observations :

With the initiation of consumption of plants food since hatching 200 young healthy snails of each species obtained from broods of cage reared specimens were transferred to a cage. The number was reduced to 100 for 30 days old snails. For older snails the number was 100 for each age group.

Snails of one age group were housed in a cage measuring 200 × 200 × 240 cm. the roof and the walls being made of fine polythene netting. The floor was covered with 8 cm deep loose, moist soil. The dead snails were replaced by individuals of the same age from reserve stock.

To ascertain food preference, plants were selected from a wide range including vegetables, fruit plants, fibre plants, oil producing plants, flower plants, ornamental plants and wild plants. Flowers and fruits were not removed from the twigs. Fresh plants were weighed, and supplied in excess immediately after the sun set.

In the next morning the left over plants were weighed and subtracting it from the initial weight the amount consumed was expressed in terms of per cent. The food consumption was maximum in June to October period, the period of highest activity, and this was considered as 100%.

The investigation started on July 16, 1974 and continued till July 15, 1975. The snails were kept active by occasional spraying of water.

The following plants were supplied :

Vegetable plants

1. Amaranth (*Amarantus* spp.)
2. Black bean (*Dolichos lablab*)

3. Cabbage (*Brassica oleracea*)
4. Drum stick (*Moringa indica*)
5. Garden spinach (*Spinacea oleracea*)
6. Gourd (*Cucurbita maxima*)
7. Lady's finger (*Hibiscus esculentus*)
8. Lettuce (*Lettuca sativa*)
9. Redish (*Raphanus sativus*)
10. Soybean (*Glycine max*)
11. Tomato (*Lycopersicum esculentum*)

Fruit plant

12. Papaya (*Carica papaya*)

Fibre plants

13. Cotton (*Gossypium herbaceum*)
14. Jute (*Corchorus* spp.)

Oil producing plant

15. Castor (*Ricinus communis*)

Flower plants

16. Marigold (*Tagetes patula*)
17. Zinnia (*Zinnia linearis*)

Ornamental plant

18. Vernonia (*Vernonia scandens*)

Wild plants

19. American life plant (*Bryophyllum pinnetum*)
20. Berakalmi (*Ipomea* sp.)
21. Kalkasunda (*Cassia sophera*)
22. Synedrella (*Synedrella nordiflora*)

OBSERVATIONS

Field

Achatina fulica :

The favourite haunts of *A. fulica* are in and around human habitation. Occasionally, they are found in areas far from human habitations. In wild areas, lacking cultivated plants they thrive equally well on wild plant species. In spite of differences in the amount of rainfall, temperature and humidity in different zones of West Bengal, preference is always for the same plant species, cultivated or wild, if it is available.

TABLE 1. List of food-plants and the portion of plants consumed by *A. fulica* and *M. indica* ('+' most preferred ; '±' preferred ; '—' not consumed)

PLANT SPECIES	PORTION OF PLANTS						
	Twig	Stem	Bark	Leaf	Floral bud	Flower	Fruit
VEGETABLE PLANTS :							
Amaranth (*Amarantus gangeticus, A. viridis*)*	+	+	+	+	+	—	—
Bean (*Dolichos* spp. ; *Glycine max*)*	+	+	—	+	+	+	+
Bitter gourd (*Momordica charantia*)	+	—	—	+	—	—	—
Cabbage (*Brassica oleracea*)*	+	+	+	+	—	—	—
Carum carui (*Momordica cochinchinensis*)	+	+	+	+	—	—	—
Chilly (*Capsium* spp.)	+	—	+	+	—	—	—
Drum stick (*Moringa olefera*)*	—	—	—	+	—	—	—
Fig (*Ficus hispida*)	—	—	+	+	—	—	—
Garden spinach (*Spinacea oleracea*)	+	—	—	+	—	—	—
Gourd (*Cucurbita maxima*)*	+	+	+	+	+	+	±
Khamalu (*Dioscorea alata*)*	+	+	—	+	—	—	—
Lady's finger (*Hibiscus esculentus*)	+	+	+	+	+	+	+
Lettuce (*Lettuca sativa, L. indica*)*	+	+	+	+	—	—	—
Mankachu (*Amorphophallus campanulatus*)	—	—	—	±	—	—	—
Puni (*Basella rubra*)	+	+	+	+	—	+	—
Radish (*Raphanus sativus*)*	—	+	+	+	—	—	—
Tomato (*Lycopersicum esculentum*)	+	—	—	+	—	—	±
Sponge gourd (*Luffa* spp)*	+	+	+	+	+	+	±
FLOWER PLANTS :							
Balsam (*Impatiens balsamina*)*	±	—	—	+	—	+	—
Bauhinia (*Bauhinia accuminata*)	—	—	—	±	—	+	—
Bougainvillea (*Bougainvillea spectabilis*)	—	—	—	+	—	—	—
Canna (*Canna indica*)	—	—	—	±	—	+	—
China rose (*Hibiscus rosasinensis*)	+	±	±	+	+	+	—
Chrysanthemum (*Chrysanthemum* spp.)*	+	+	+	+	+	+	—
Clitoria (*Clitoria ternatea*)*	+	—	—	+	—	+	—
Cosmos (*Cosmos* sp.)*	+	+	+	+	+	+	—
Dhalia (*Dhalia* sp.)	—	—	—	+	—	±	—
Gardenia (*Gardenia florida*)	—	—	—	+	—	—	—
Jasmin (*Jasmin sambac*)	—	—	—	±	+	±	—
Kathchampa (*Plumeria acutifolia*)	—	—	—	±	—	—	—
Land lily (*Hibiscus mutabilis*)	—	—	—	±	—	±	—
Madhabilata (*Hiptage* sp.)*	—	—	—	±	—	—	—
Marigold (*Tagetes patula*)*	+	+	+	+	+	+	—
Nine O'clock (*Portulaca* sp.)	+	+	+	+	+	+	—
Oleander (*Nerium odorum*)	—	—	—	+	—	±	—

PLANT SPECIES	PORTION OF PLANTS						
	Twig	Stem	Bark	Leaf	Floral bud	Flower	Fruit
Rose (*Rosa* spp.)	—	—	—	+	—	+	—
Sunflower (*Helianthus annus*)	+	+	±	+	+	+	—
Vernonia (*Vernonia scandens*)	—	—	—	+	—	—	—
Vinca (*Vinca rosea*)	—	—	—	±	—	—	—
Zinnia (*Zinnia linearis*)	—	—	—	+	—	—	—
FRUIT PLANTS :							
Banana (*Musa sapientum*)	—	—	—	±	—	—	—
Cucumber (*Cucummis sativus*)	+	+	+	+	+	+	+
Guava (*Psidium guava*)	+	—	—	±	—	—	—
Papaya (*Carica papaya*)	+	+	+	+	+	+	+
Star-apple (*Eugenia* sp,)	—	—	—	+	—	—	—
FIBRE PLANTS :							
Cotton (*Gossypium herbaceum*)	+	—	+	+	+	+	—
Jute (*Corchorus* spp.)	—	—	±	+	—	—	—
BEVERAGES :							
Tea (*Thea sinensis*)	—	—	—	+	—	—	—
Coffee (*Coffea* spp.)	—	—	—	—	—	—	—
CEREALS :							
Maize (*Zea mays*)	—	—	—	+	—	—	—
Rice (*Oriza sativa*)	—	—	—	—	—	—	—
WILD PLANTS :							
Fig (*Ficus hispida*)	—	—	—	+	—	—	—
Pluchea (*Pluchea indica*)*	—	—	—	+	—	—	—
Synedrella nordiflora	+	+	+	+	—	—	—
Allangana lamarcana	+	—	—	+	—	—	—
ORNAMENTAL PLANTS :							
Rheo discolor	—	—	—	+	—	—	—
Trichosanthus anguina	—	—	—	+	—	—	—
Bryophyllum pinnetum	+	+	+	+	—	—	—
Bryophyllum calynecium	+	+	+	+	—	—	—
Aloe indica	—	—	—	∓	—	—	—
Setcraesea sp.	—	—	—	+	—	—	—
Codaeum varaigata	—	—	—	+	—	—	—
Thuja orientalis	—	—	—	+	—	—	—
*Poths scandens**	—	—	—	+	—	—	—
*Dieffenbachia picta**	—	—	—	+	—	—	—

* The leaf or leaflets of the plant preferred by *M. indica*.

Such a selection is not pronounced in snails depending entirely on wild plants. Observations on the food-plant preference have been shown in Table 1. The nature and extent of damage are very serious in some cases. The seedlings and young plants of castor (Plate V, fig. 1), leaves, twigs and bark of cosmos (Plate V, fig. 2), leaflets of drum stick (Plate V, fig. 3), the whole of lettuce (Plate VI, fig. 1) and gourd (Plate VI, fig. 2), leaves and twigs of *Dioscorea* (Plate VI, fig. 3), the whole of *Rheo* (Plate VII, fig. 1), leaves of *Pothos* (Plate VII, fig. 2) and lamina without ribs of fig (Plate VII, fig. 3) are preferred. Leaves of bottle gourd Lagenaria spp.) are also among the food item. Occasionally young *A. fulica* were observed to feed on the moss, *Semibarbula orientalis*.

Macrochlamys indica :

A good number of plants constitute the food of *M. indica* though the number is much less than that for *A. fulica*. Leaves of soft texture are liked most. The range of choice food-plants and the preferred zones are recorded in Table 1. However, a special preference to fallen and decomposed leaves and flowers of papaya, balsam, marigold, rose, china rose, castor, citrus and many other plants has been repeatedly observed.

In some localities the snails have been observed to feed exclusively on the moss, *S. orientalis*. This moss species grow on old and damp brick walls and the snails live in the spaces between the bricks.

Open-air cage

Selection of food varied with age groups, seasons viz. monsoon, winter and summer in both the species *A. fulica* and *M. indica*. Selection of food in the snails kept active by artificial means was similar to that in monsoon.

The snails up to the age of 5 days ate only the broken and abandoned egg shells of the same brood. Feeding on plants started from the 6th day with the tender leaves of lettuce, beans (Plate VIII, fig. 1) and marigold. The veinules, and the petiole were not attacked till they were 14 days old. At this age they consumed whole of the leaf (Plate VIII, fig. 2) and by the 25th day started feeding on coarser leaves like those of gourd (Plate VIII, fig. 3), synedrella and amaranth. At this age they consumed whole of the leaves of lettuce, marigold, beans, synedrella and kalkasunda but the petiole was only slightly rasped. Coarser leaves like those of amaranth, papaya (Plate IX, fig. 1), jute, cotton (Plate IX, fig. 2) and cabbage were not attacked seriously. Selection and preference for food-plant and the nature of damage were almost similar in the snails 60 to 730 days old, while the younger ones restricted themselves mostly to soft plants.

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Photographs showing the nature and extent of damage of different food-plants caused by *A. fulica*. Fig. 1, Castor, Fig. 2, Cosmos, Fig. 3. Drumstick.

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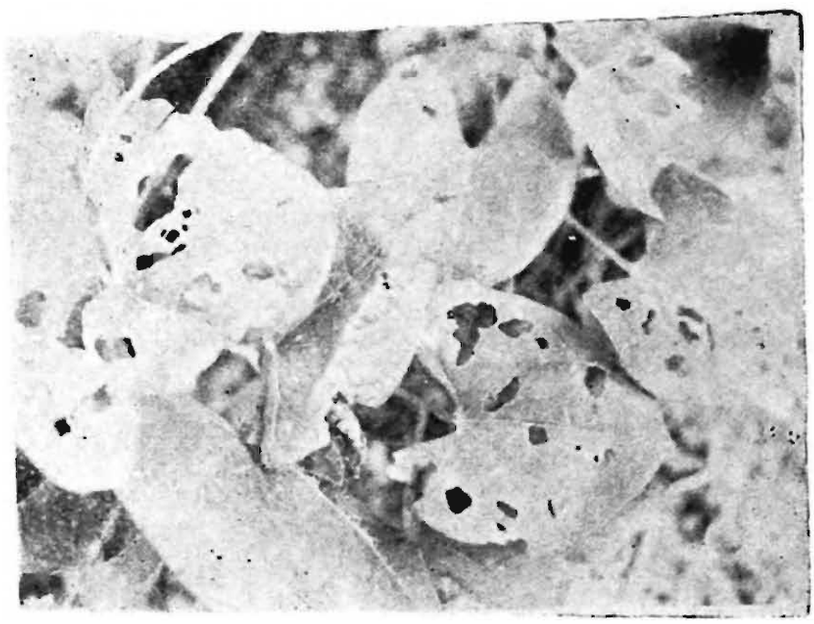

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Photographs showing the nature and extent of damage of different food-plants caused by *A. fulica*. Fig. 1. Lettuce (damaged one in the right hand). Fig. 2. Gourd, Fig. 3. *Dioscorea*.

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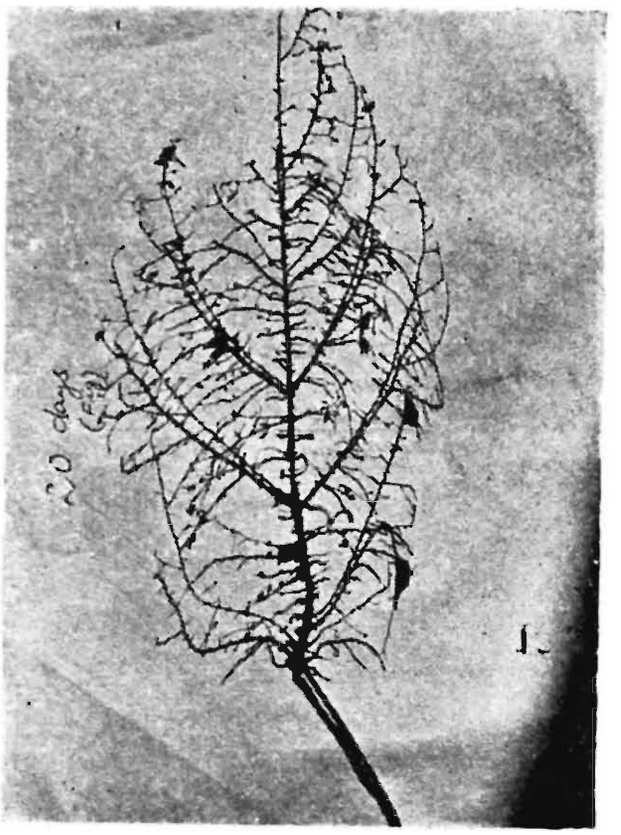

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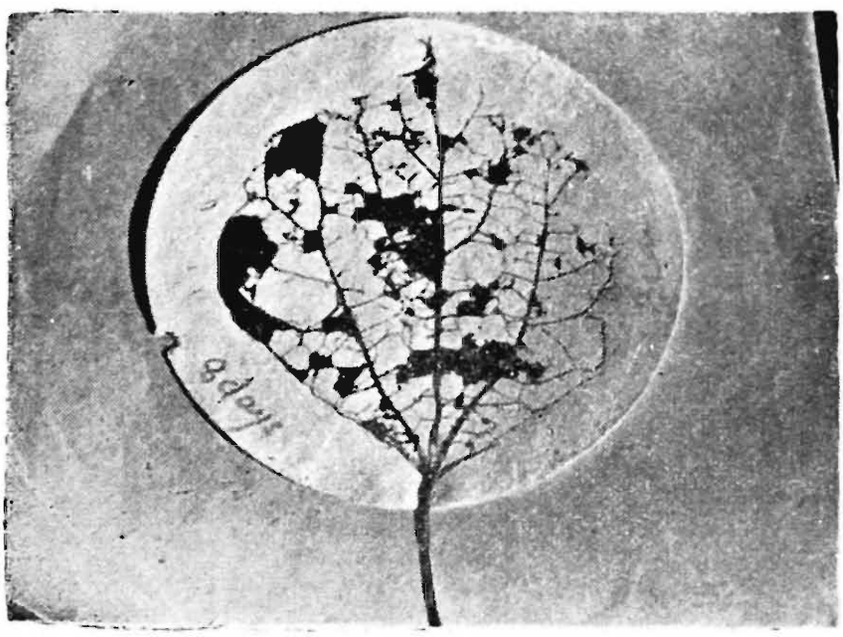
Photographs showing the nature and extent of damage of different food-plants caused by *A. fulica*. Fig. 1. *Rheo*. Fig. 2 *Pothos*. Fig. 3. Leaf of fig.



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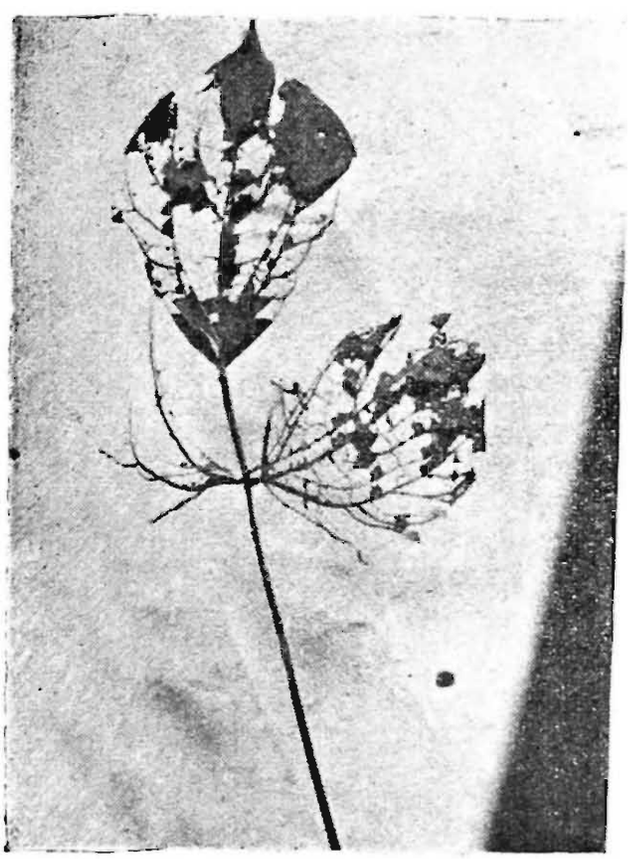

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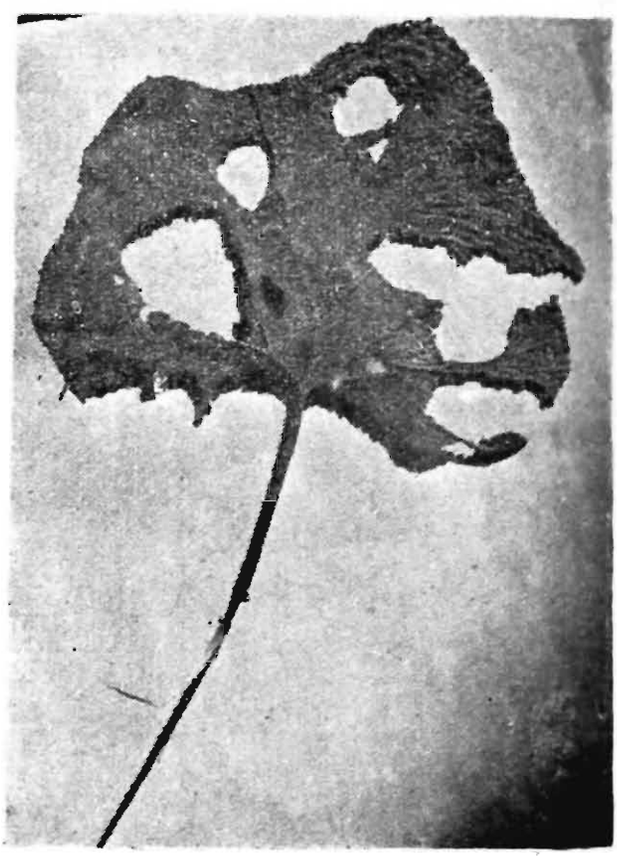

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Photographs showing the nature and extent of damage of different food-plants caused by *A. fulica*. Fig. 1. Leaflet of bean damaged by *A. fulica* of 6 to 8 days old. Fig. 2. Leaf of bean damaged by *A. fulica* of 14 days old. Fig. 3. Gourd leaf.

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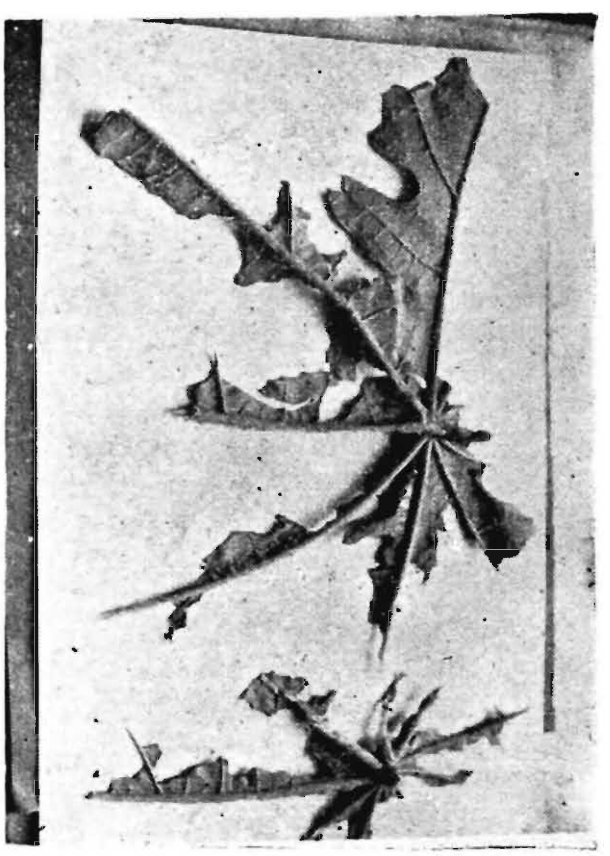

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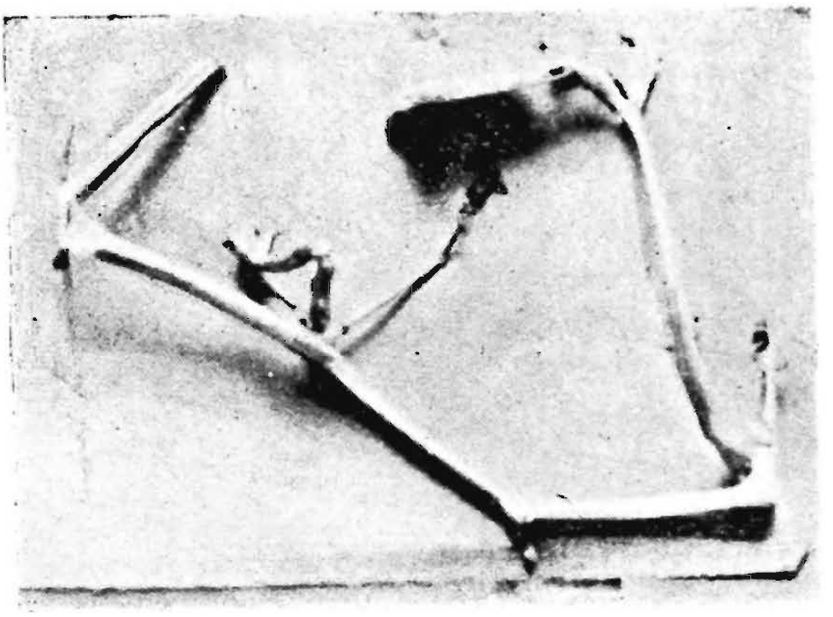
Photographs showing the nature and extent of damage of different food-plants caused by *A. fulica*. Fig. 1. Papaya leaf damaged by *A. fulica* of 25 days old. Fig. 2. Cotton leaf damaged by *A. fulica* of 27 days old. Fig. 3. Papaya leaf damaged by *A. fulica* of 28 days old.



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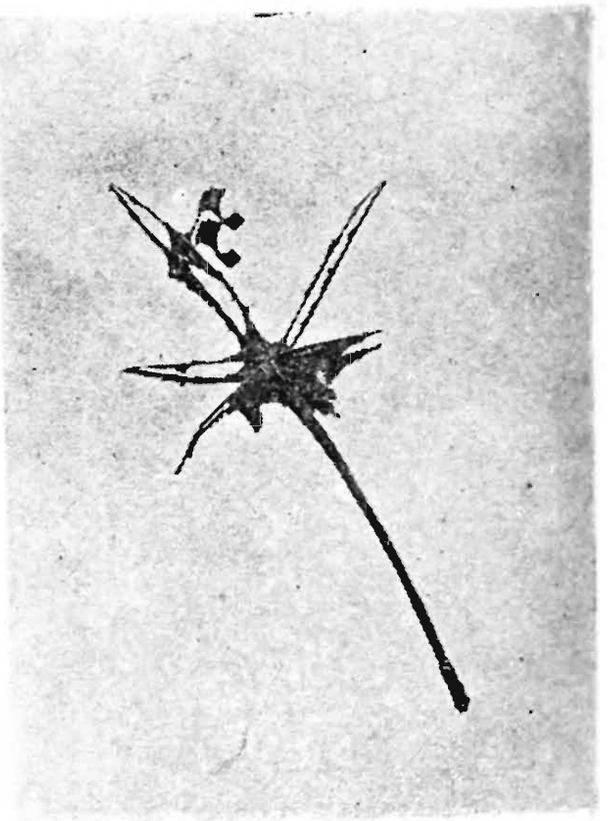

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Photographs showing the nature and extent of the leaves of different food-plants caused by *A. fulica*. Fig. 1. Gourd, Fig. 2. Castor, Fig. 3. Papaya.

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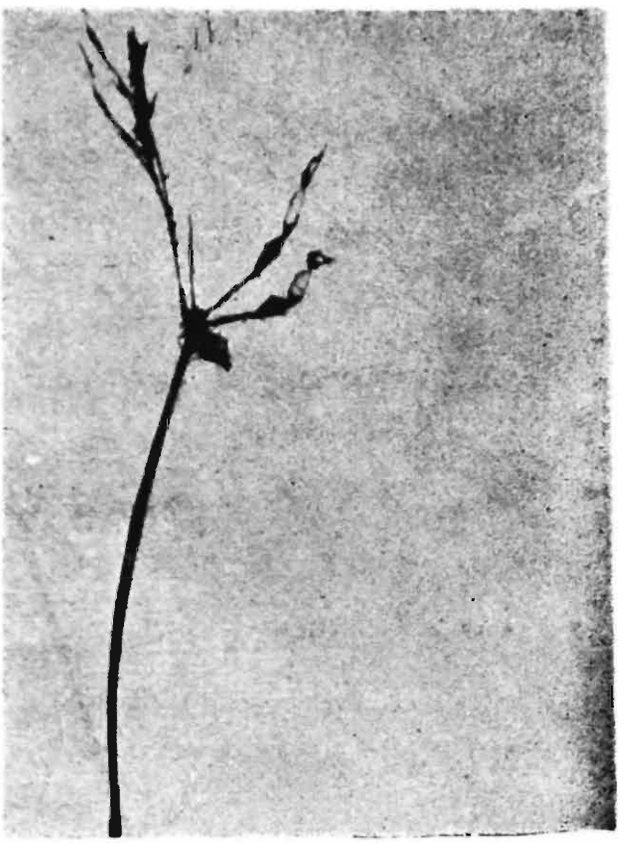

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Photographs showing the nature and extent of damage of plants or portion of the plants caused by *A. fulica*. Fig. 1. Radish, Fig. 2. Cotton leaf, Fig. 3. Leaf of papaya.

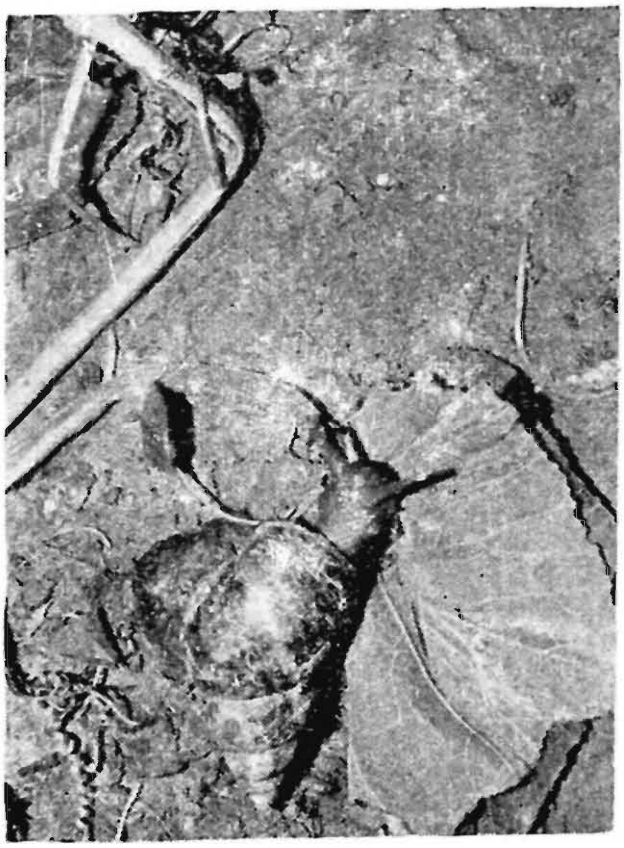

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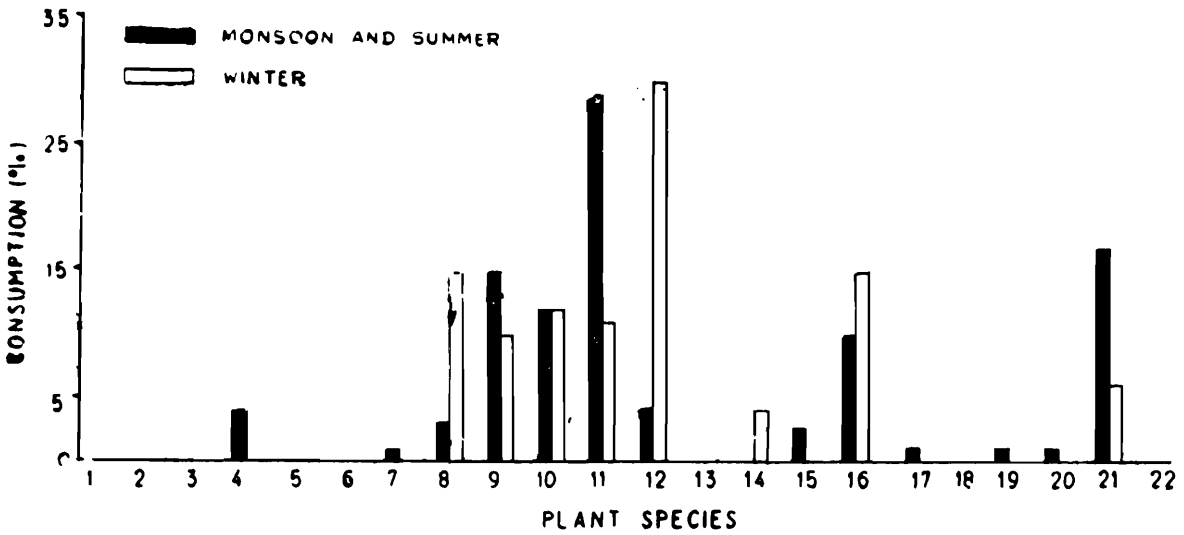
Fig. 1. *A. fulica* eating the petiole of gourd leaf. **Fig. 2.** Bean leaf damaged by *M. indica*. **Fig. 3.** A group of *A. fulica* struggling for food.

Of the 22 species the most favoured plants were gourd, beans and marigold. However, in spite of adequate supply of the favoured plants, less favouted plants like synedrella, lettuce, papaya (Plate IX, fig. 3), tomato and zinnia were also consumed. In monsoon, the preferred food-plants in order of priority were gourd, marigold, lettuce beans, synedrella and American life plant (Text-fig. 1). The portions favoured



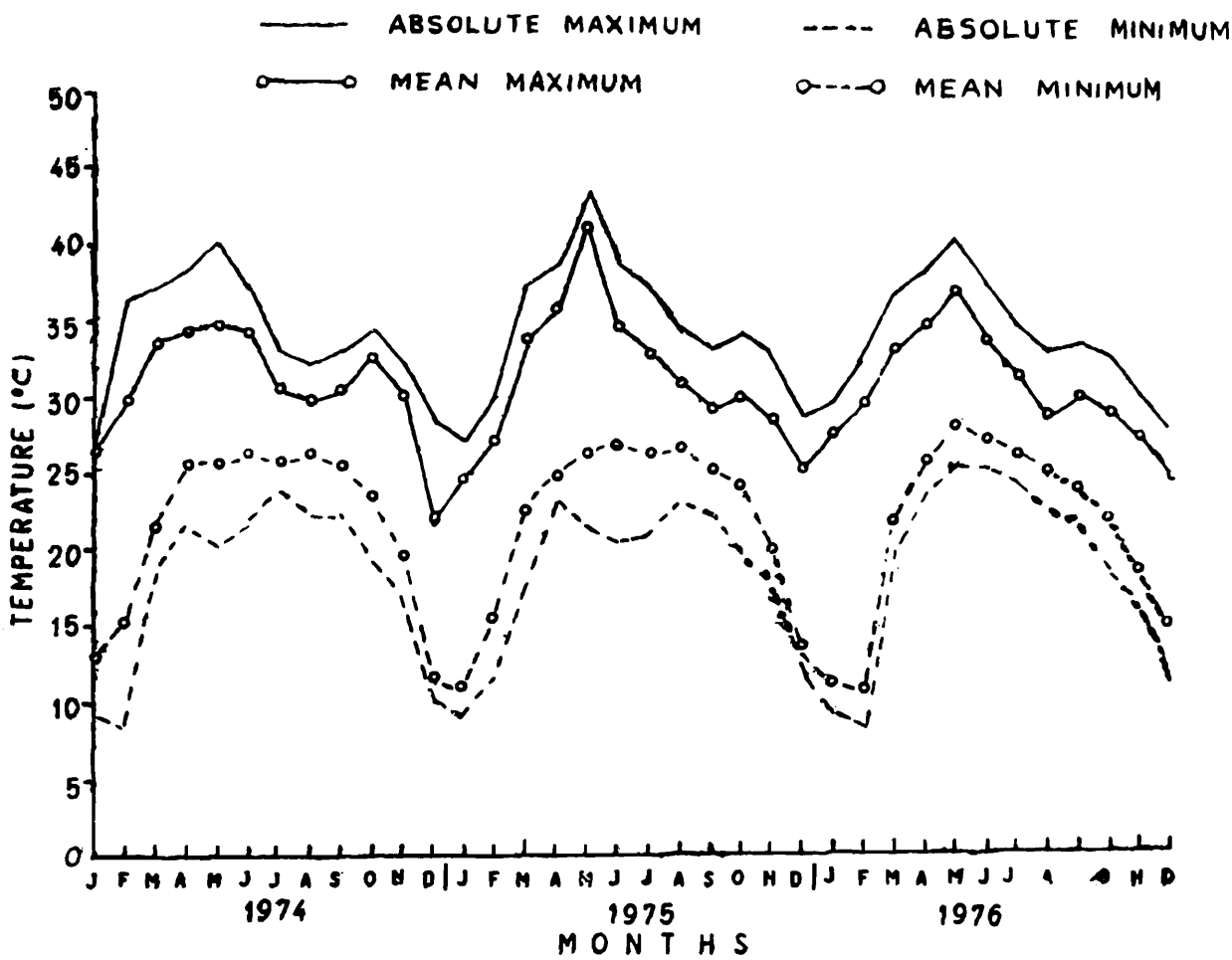
Text-fig. 1. Seasonal variation in food preference in *A. fulica*. 1 American life plant, 2 Kalkasunda, 3 Berakalmi, 4 Synedrella, 5 Vernonia, 6 Lady's finger, 7 Amaranth, 8 Cabbage, 9 Black bean, 10 Soybean, 11 Gourd, 12 Lettuce, 13 Drumstick, 14 Radish, 15 Garden, spinach, 16 Papaya, 17 Cotton, 18 Jute, 19, Tomato, 20 Castor, 21 Marigold, 22 Zinnia.

were the leaves, flowers, twigs and stem of gourd ; leaves, bark and growing region of marigold ; whole of the bean plant ; leaves, bark and growing regions of American life plant and tips of synedrella.

A favourable humidity range, 80 to 95 was maintained to keep the snails active. In winter this was maintained by spraying water with a low volume sprayer. In spite of all precautions the humidity often came down as low as 70 to 75 at noon in most of the days. The temperature range during the period was 8.6 to 26°C (Text-fig. 2), but in most of the days the temperature range during feeding was 8.6 to 10.4°C. The amount of food consumed in a 24-hour period was about 65% of that in monsoon (Text-fig. 3).

The cabbage was not a preferred food in monsoon but from November onwards the amount of cabbage consumed (Text-fig.1) was greater than that of gourd, though the snails severely damaged gourd (Plate X, fig. 2), castor (Plate X, fig. 2), papaya (Plate X, fig. 3), radish (Plate XI, fig. 1) and cotton (Plate XI, fig. 2) leaves. From about the beginning of the second week of December the snails started feeding on

succulent plants like cabbage, lettuce and American life plant and succulent parts of gourd and papaya. With the advent of winter and fall of humidity the snails preferred the ribs of the cabbage (Plate XI, fig. 3) and growing regions, petiole (Plate XII, fig. 1), floral



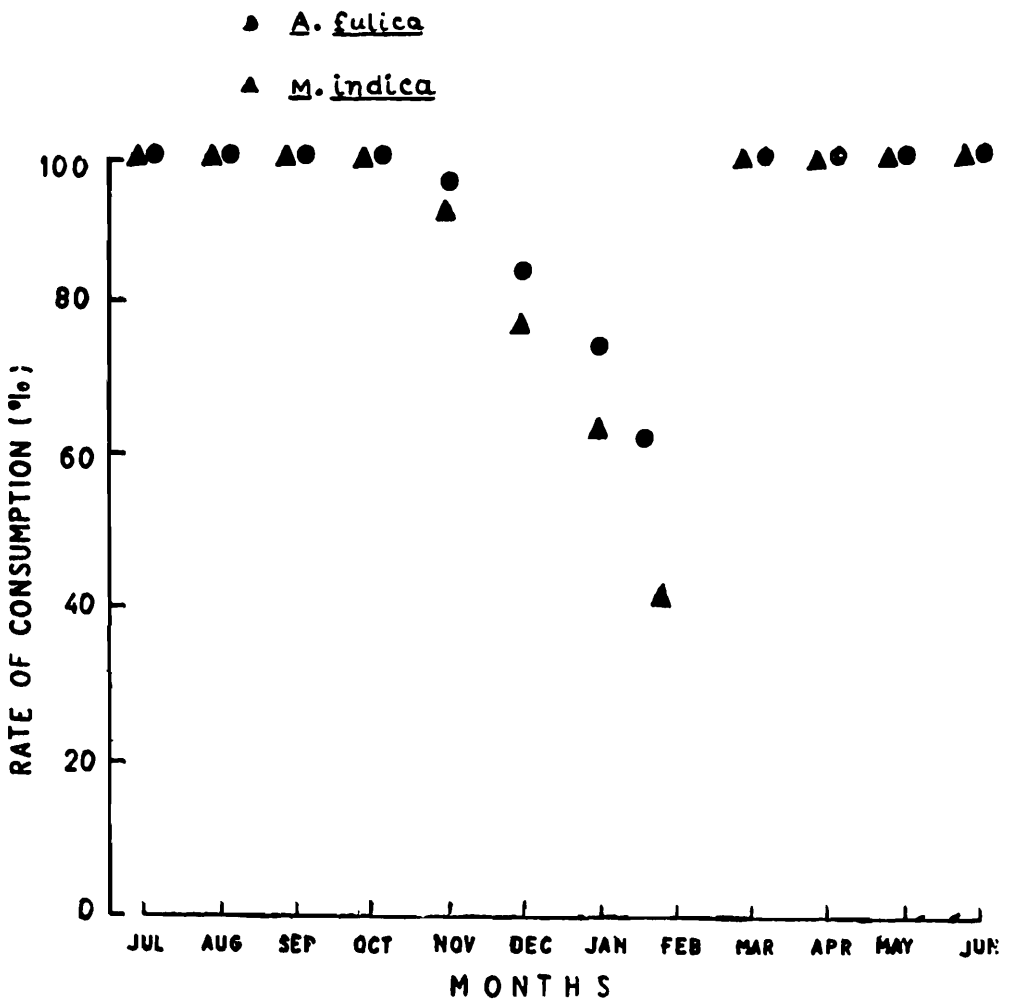
Text-fig. 2. The mean monthly temperature, the absolute maximum and absolute minimum temperature in the cage environment for the three years 1974 to 1976.

buds and chiefly the thalamus of flowers of gourd. By the third week of February, with the rise of temperature a change in food selection was recorded, and it gradually became to that similar in the monsoon. Specimens living on a very restricted number of plant species in nature and those maintained on a few selected plants since hatching showed food preference similar to those living on a wide food range when provided with other plants indicating that the feeding habit is probably genetically fixed.

Macrochlamys indica :

Contrast to *A. fulica* the newly hatched *M. indica* abstained from feeding for the first three days and swallowed only soil on the fourth day. Feeding on plants started on the fifth day and the plant food first consumed were young bean leaves (Plate XII, fig. 2.) Marigold

was eaten from the nineth day and consumption rate of bean leaves minus the ribs increased considerably. Synedrella and amaranth were eaten by the snails three weeks old. By this time they started feeding

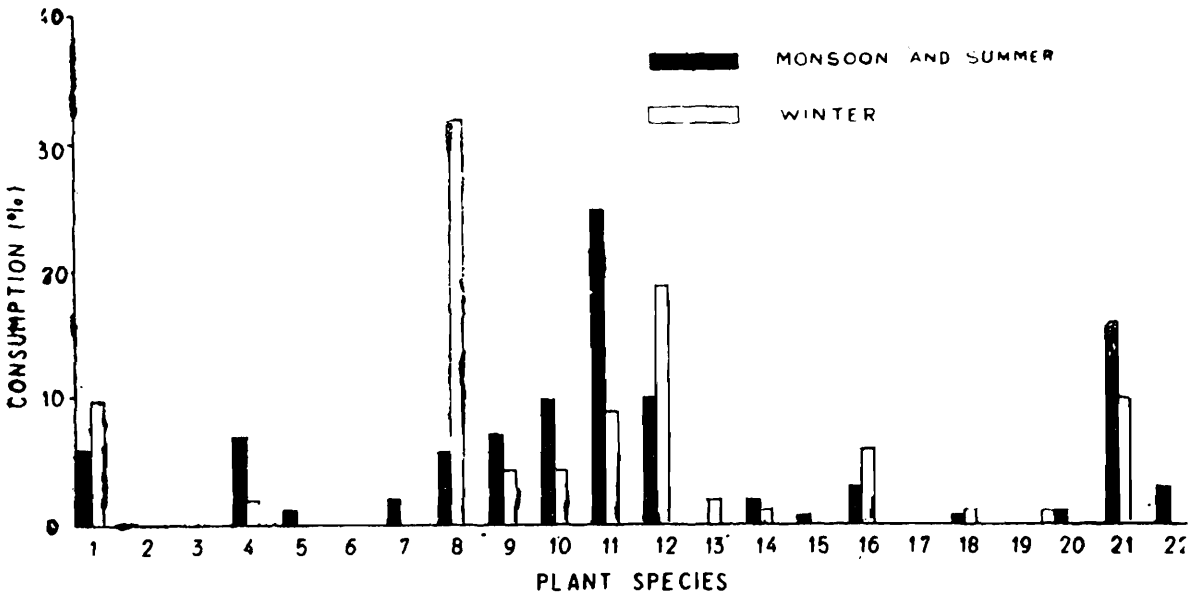


Text-fig. 3. Seasonal variation in the rate of food consumption by *A. fulica*, between 60 to 80 mm shell length and *M. indica* between 10.5 to 15.0 mm shell diameter.

upon coarser leaves like those of gourd, castor and papaya. In snails 30 days old, plant species in order of preference were beans, marigold and gourd (Text-fig. 4).

Text-fig. 4. Food preference in *M. indica*, 30 to 57 days old. (For explanations of plant species please see Text-fig. 1).

The number of plant species consumed by *M. indica* of about 60 days age group was more than that on which *A. fulica* of the same age group fed. The favoured food-plants in order of preference were gourd, beans, marigold, papaya and synedrella (Text-fig. 5). Even the fairly old snails, above 120 days age did not take principal veins of the leaves. The snails of all the higher age groups have similar food preference,



Text-fig. 5. Seasonal variation in food preference in *M. indica*. (For explanations of plants please see Text-fig. 1).

and the amount of food consumed was maximum during the period—middle of June to the middle of November (Text-fig. 3).

Food selection in winter was similar to that in *A. fulica* and preferred zones were veins of succulent plants. The stem of lettuce was avidly eaten by snails of all ages. The rate of food consumption was much less, 45% on the average in cooler months. Feeding and food preference in all age groups during summer were similar to that in monsoon.

Feeding hours and duration :

In sunny days, in monsoon, *A. fulica* in their natural habit start feeding from dusk. The period of feeding depends on the abundance of food, and may extend up to 03 hours next day. Aestivating snails activated by a heavy shower start feeding which continues for a few hours even if the day turns sunny after the rain.

M. indica emerge out of their shelter in search of food at least after one to one and half hour later than *A. fulica*. They feed for a shorter period of time, 19 to 01 hours. Similar to *A. fulica*, *M. indica* became active, after shower but feeding movement was restricted within a radius of about 100 cm from their shelter.

In cage environment feeding starts much earlier than that in the field. During day hours spraying of water induced feeding for a few hours in some of the snails.

Feeding mechanism and behaviour :

As a rule the snails of all ages start feeding from the margins of the leaves. In case the mouth can not reach the margin, a hole is first made on the lamina. The food is drawn towards the mouth with the help of extended labial palps. Occasionally the foot helps in the operation.

The labial palps, jaws and the radula, all work together in coordinated way during feeding and land snails consume food at a faster rate. The structure and functions of organs involved in feeding of land snails have been described in a number of species—*Helix pomatia* (Trappmann, 1916), *A. fulica* (Ghose, 1963), *Cryptozona semirugata* (Mantle, 1973), *Monacha cantiana* and *M. cartusiana* (Chatfield, 1976) and *Macrochlamys indica* (Das, 1977).

Feeding movement is rather fast, probably only second to breeding movement. The ocular tentacles extend to their maximum limit at a 45° angle with the substratum (ground). Momentary retroversion of the tip of the tentacles in contact with food is spontaneous. In the next moment the tentacles extend and feel the nature of food. By this time the labial palps are pressed against the food and feeding starts immediately.

A competition for food is pronounced in both the species. Fighting in the sense is absent owing to lack of offensive organs. This has been largely compensated by consuming a large amount of food in a shorter time. A new arrival often tries to dissuade others from feeding by crawling over the snails busy in feeding or by pushing the snout against it (Plate XII, Fig. 3). In the struggle stronger snails always win. A soft chuckling sound is often audible from a few feet distance when several snails eat on the same food-plant, but no such sound is audible if the same number of snails feed upon separate plants even in the same area, indicating fast eating rate in a competitive situation.

DISCUSSION

The feeding habits and food-plants of land snails have drawn the attention of workers in many countries. Members of the family Cucurbitaceae probably top the menu of *A. fulica* in Ceylon (Green 1910c), Chichi Jima (Mead, 1961), New Britain (Dun, cited in Mead, 1961), Saipan (Lange, 1950), Tinian (Chamberlin, 1953), Philippines

(Pangga, 1949) and central parts of India (Srivastava, 1966). Our observations on both *A. fulica* and *M. indica* in West Bengal are in agreement with those of others. *Lagenaria* sp. is a choice of lower order, which has not been reported by previous workers. The highly valued economic plant bean, does not occupy the same status for *Achatina* in West Bengal as in Philippine (Pangga, 1949) and Saipan (Lange, 1950) but it is true for *M. indica* here.

The plant papaya is damaged by *A. fulica* in Ceylon (Green, 1910c), Sumatra (Heubel, 1938), Saipan (Esaki and Takahashi, cited in Mead, 1961 ; Lange, 1950), Palaus (Hatai and Kato, 1943), Micronesia (Townes, 1946), Philippines (Pangga, 1949), Koror (Kondo, 1950a, b) and Tinian (Chamberlin, 1952). *A. albopicta* is a known pest of papaya in East Africa (Williams, 1951). The high latex content of the floral buds, flowers and fruits of papaya make them vulnerable to severe damage from *Achatina*. In banana the skin is rasped by *A. fulica*. The fruit inside is not damaged but the market value is greatly reduced. Loss to banana cultivation is serious in all *Achatina* infested areas of the globe except Tinian (Chamberlin, 1952). In West Bengal *Achatina* is a serious threat to banana cultivation since the plantations offer an ideal habitat for the snails. Even in most unfavourable weather the snails were abundant in banana plantations.

Reports on the damage of beverages viz. tea and coffee by land snails are scanty and scattered. *Achatina* is not a serious pest of tea. Benthem-Jutting (1934, 1938) recorded eating up of shoots and flowers in Netherlands, but Heubel (1937, 1938) holds that in Sumatra the snails feed upon young leaves of tea when nothing else is available. On the other hand, tea is a major industry in Ceylon and no damage by *Achatina* has been reported from there (Hutson, 1920 ; Mead, 1961). In West Bengal only seedlings are attacked in nursery. Coffee is attacked by *A. cravini* Tanganyika (Salaam, 1938) and by *Ariophanta solata* and *Mariaella dussumieri* in India (Bhat and Viswanathan, 1972 ; Bhat and Shamanna, 1972 ; Bhat *et. al.*, 1973). Till now *A. fulica* has not reached the coffee growing areas of India.

The most favoured flower plants of *A. fulica* and *M. indica* are marigold, portulaca, cosmos and zinnia. Of the ornamental plants *Bryophyllum, Rheo, Trichanthus, Aloe, Setcreasea and Crinum* are preferred. Pangga (1949) holds that in Philippines ornamental plants are preferred to flower plants by *A. fulica*. Barring marigold, the situation in West Bengal is similar to that of Pangga (1949) in Philippines.

The ornamental plants are consumed presumably due to their succulent nature. Preference of *Bryophyllum calynacium* by *Achatina* to

B. pinnetum supports the idea. Interestingly, in widely separated countries *viz.* Malaya (South, 1923a, b, 1926), Sumatra (Feij, 1940), Ceylon (Macmillon, 1943), Hawaii (Weel, 1948-49), Philippines (Pangga, 1949) and Seychelles (Milsum, 1950) with different biogeographical conditions *A. fulica* feed on the same kind of ornamental plants.

Attack on vegetable plants *viz.* amaranth in Saipan (Lange, 1950) and Hawaii (Weel, 1948-49), cabbage in Philippines (Pangga, 1949) and Saipan (Lange, 1950), bitter gourd in Philippines (Pangga, 1946), chilly in Sumatra (Heubel, 1937, 1938), Rota (Kondo, 1952) and Saipan (Lange, 1950) ; lettuce in Saipan (Lange, 1950) and Hawaii (Weel, 1948-49) ; radish in Sumatra (Heubel, 1937, 1938) and Saipan (Lange, 1950) ; lady's finger (okra) in Ceylon (Green, 1910c) and Saipan (Lange, 1950), and tomato in Guam (Mead, 1961) by *A. fulica* are on record. Similar observations have been made in West Bengal but sponge gourd (*Luffa* spp.) and carum carui (*Momordica cochinensis*) not reported by previous workers are readily consumed by *A. fulica.* Selection of only a few vegetables—amaranth, cabbage, lettuce and sponge gourd by *M. indica* is presumably due to abundance of these plants in the infested areas.

A number of wild plants are also consumed by *A. fulica, Arion empiricorum, A. circumscriptus* and *Rumina decollata* but nothing is known on the same point in other molluscan pests. *R. decollata* ate 73 of 90, *A. empiricorum* 158 of 197 and *A. circumscriptus* 33 of 193 wild plants offered (Frömming, 1954. 1956). In Britain, majority of the land molluscs feed on wild plants (Chatfield, 1976). In West Bengal both *A. fulica* and *M. indica* feed upon a large number of wild plants, some of them viz. fig. synedrella and *Allangana* are preferred to the cultivated ones. This minimises the damage to crop plants to some extent, but the gain is elusive, since wild plants offer shelter to the snails, render the control measures ineffective and help the snails to survive in the absence of cultivated plants, the cumulative result of which is a rapid rise in population density.

Majority of the members of the Gramineae family are immune to pestiferous snails (Green, 1910c ; Hutson, 1920 ; South, 1926 ; Heubel, 1937, 1938; Herklots, 1948 ; Weel, 1948-49; Mead, 1961) probably except *Commelina* (Owen, 1965). Damage to corn (*Zea mays*) by *A. fulica* has been reported from Indo-Pacific regions. The situation is similar in West Bengal.

Eating of algae and moss by pestiferous snail is rather important from the point of crop protection and production. Feeding on algae by *Discus rotundatus* (Chatfield, 1973), fungi by *A. fulica* (Kondo, 1964) and *Rumina decollata, Arion circumscriptus* and *A. empericorum*

Frömming, 1954, 1956) is on record. Our observations on *M. indica* and *A. fulica* are not in complete agreement with those of others. The moss. *S. orientalis* constitutes only occasionally a very small per cent of food for adult *M. indica*, and young *A. fulica*. All land snails prefer decomposed plant matter, possibly due to the growth of fungal hyphae on them. A number of fungi and bacteria secrete strong cellulolytic enzymes which degrade the cell membrane (Ghose et. al., 1968 ; Ghose and Halder, 1969 ; Ghose, 1968) and a considerable amount of nutrients locked in plant cells are readily available to animals feeding on decomposing plant matters. Chatfield (1977) suggested that feeding on microorganisms is associated to some extent with the snail's nutrition. Feeding upon decomposing materials enables consumption of more amount of food in shorter time and at the same time digestion is also somewhat easier. Presumably this had led *M. indica* and young *A. fulica* with a delicate odontophore to depend more on decomposing plant matters. It is argued that this type of feeding in land snails plays an important role in the ecosystem by transfering a considerable amount of resistant plant matters to a state in which those could be easily degraded biologically by microorganisms in the soil (Mason, 1970; Chatfield, 1976).

Information on food preference in land snails under captivity is very limited (Mohr, 1949; Kondo, 1964; Rees, 1950 ; Owen, 1965). The present observations on *A. fulica* and *M. indica* supplied with 22 plant species clearly indicate that a high degree of food selection exists in them. *Achatina* and *Macrochlamys* live chiefly on cultivated plants but preference to *Bryophyllum* and marigold may be successfully utilised in crop protection by planting those in guard rows or in between crop plants.

The solitary report of Jaski (1953) on the selection of food-plants in respect to snalis age states that young *A. fulica* feed almost exclusively upon young shoots and succulent leaves up to the age of about 4 months. Our observations on the feeding of young *A. fulica* and *M. indica* are somewhat similar to those of Jaski (1953) up to the age of 60 days in the former and 45 days in the latter. It is noteworthy that during this period both the species of snail changed their preference for plant species—beans—lettuce—gourd—marigold with age. Switching over to coarser type of food-plants in snails older than the above age indicates the development of stronger feeding apparatus.

The activity of land snails usually depends on two factors—humidity and temperature. Eating of succulent plants during dry weather has been reported by Dowdeswell (1961). Feeding upon succulent plants

with the fall in humidity per cent as recorded by us in *A. fulica* and *M. indica* may be viewed upon as an adaptation to water getting. Less food consumption during winter in both the species suggests that temperature plays an important role in digestion as has been reported by Hodasi (1979) in *Achatina* (*Achatina*) *achatina*.

We are in dark on the biological clock for feeding in land snails. Active feeding during night in their natural habit and in day time when kept in dark in the laboratory indicate that they prefer to feed under darkness. This is presumably due to their habit of avoiding strong light and sunrays, which is supported by their active feeding during day hours in heavily clouded rainy days.

SUMMARY

Studies on the food preference, feeding behaviour and duration of feeding in two species of land snail, *Achatina fulica* and *Macrochlamys indica* both in captivity and field in West Bengal, revealed that more than 80% plant species grown in this area are acceptable to them. A good number of wild species were their choice food-plants and the preference was at par with the cultivated ones. Snails living in places far away from human habitation and devoid of cultivated plants thrived equally well on wild species like those individuals occurring in and around human habitation and feeding upon crop plants. A marked preference for food-plants was recorded both in the field and in the laboratory when different species of food-plants were available or supplied at a time. The first food of *A. fulica* after 5 days of hatching were soft leaves of bean and lettuce while *M. indica* selected only the bean leaves. Older snails could rasp all the different regions of the food-plants. The number of preferred food-plants increased with the age of the snails of both the species. Seasonal influence on the selection of food-plants in both the species was well marked. In summer and monsoon months choice of food-plants was almost similar while in winter months the snails consumed only succulent varieties or succulent portions of other food-plants probably to compensate the loss of greater amount of body water due to low atmospheric humidity. The amount of food consumption was less in winter. A downward consumption rate in relation to body weight was related to the lowering of atmospheric temperature. Feeding hours extend from dusk to mid night depending on the amount of food available.

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ON SOME FRESH WATER CILIOPHORA (PROTOZOA) OF VISAKHAPATNAM

By

P. RAMA MOHANA RAO, K. HANUMANTHA RAO AND K. SHYAMASUNDARI

Department of Zoology, Andhra University, Waltair

(With 8 Text-figures)

INTRODUCTION

While studying the ciliate fauna of Visakhapatnam we have observed some relatively rare species of ciliates. This paper deals with the morphological details of *Telotrochidium crateriforme* Kent, 1880-1882; *Spirostomum ambiguum* (O. F. Müller) Ehrenberg, 1883; *Spirostomum teres* Claparède and Lachmann 1858; *Brachonella spiralis* (Smith, 1897) ; *Stentor coeruleus* Ehrenberg, 1830 and *Halteria grandinella* O. F. Müller, 1786. *T. crateriforme* is new report for the Indian sub-continent. *B. spiralis* and *S. coeruleus* are new reports from the South India.

SYSTEMATIC ACCOUNT

Phylum : CILIOPHORA Doflein

Class : OLIGOHYMENOPHORA de Puytorac *et al.*

Sub class : PERITRICHA Stein

Order : PERITRICHIDA Stein

Sub order : SESSILINA Kahl

Family : OPISTHONECTIDAE Foissner

Genus : **Telotrochidium** Kent, 1880-1882

Telotrochidium crateriforme Kent, 1880-1882

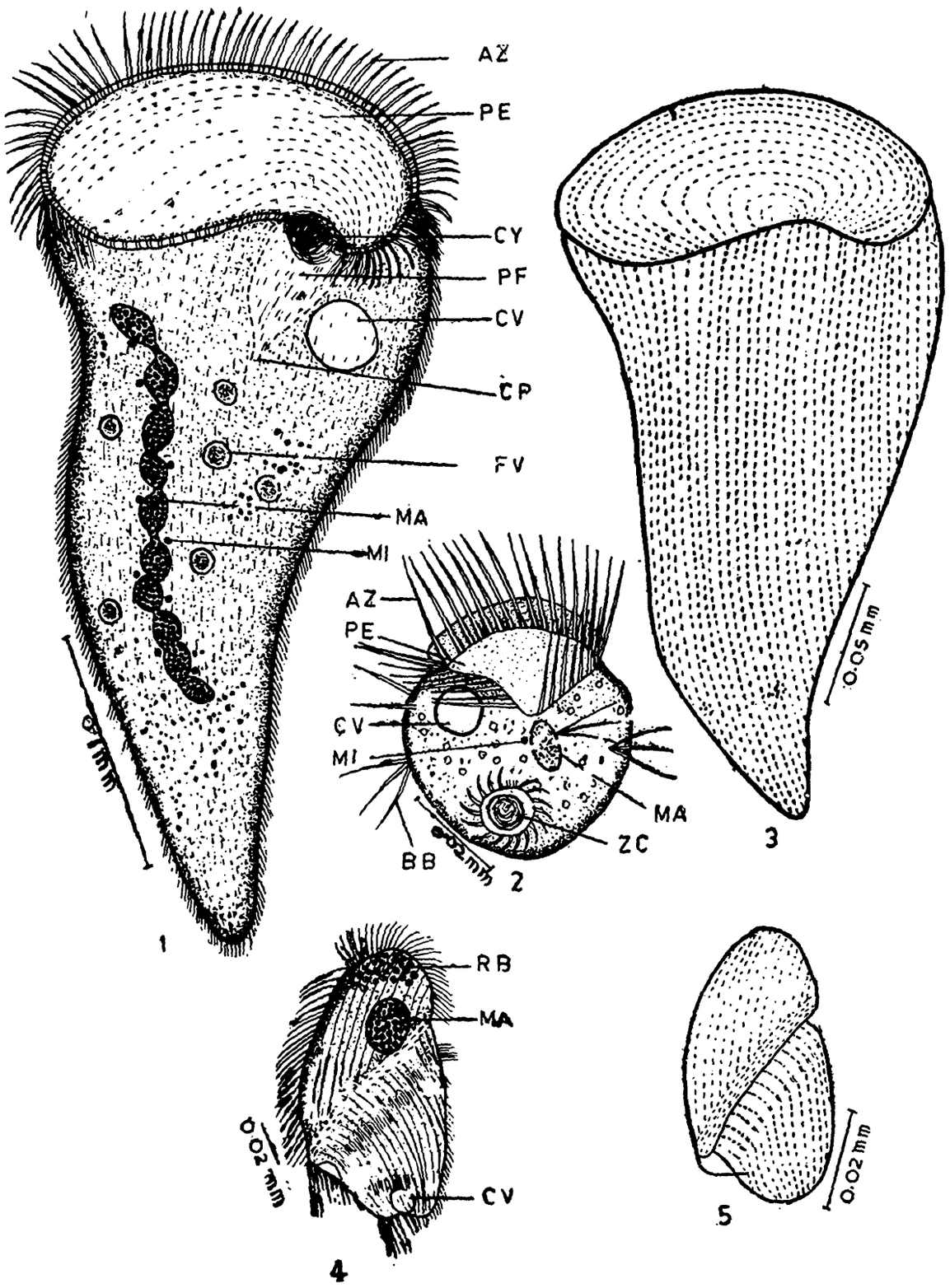
(Text-fig. 8)

Ovate or campanulate with a convex anterior margin and a non refractile rounded posterior end. Two ciliary girdles, each consisting of a single row of cilia. Cytostome ventral, situated immediately behind the anterior wreath of cilia. There is a thick annular border associated with the anterior girdle of cilia.

Contractile vacuole and macronucleus conspicuously developed. Macronucleus is long ribbon like with numerous karyosome like bodies.

The two extremities are curved to give it a horse-shoe appearance. Micronucleus lies close to the macronucleus. Multiplication is by longitudinal fission.

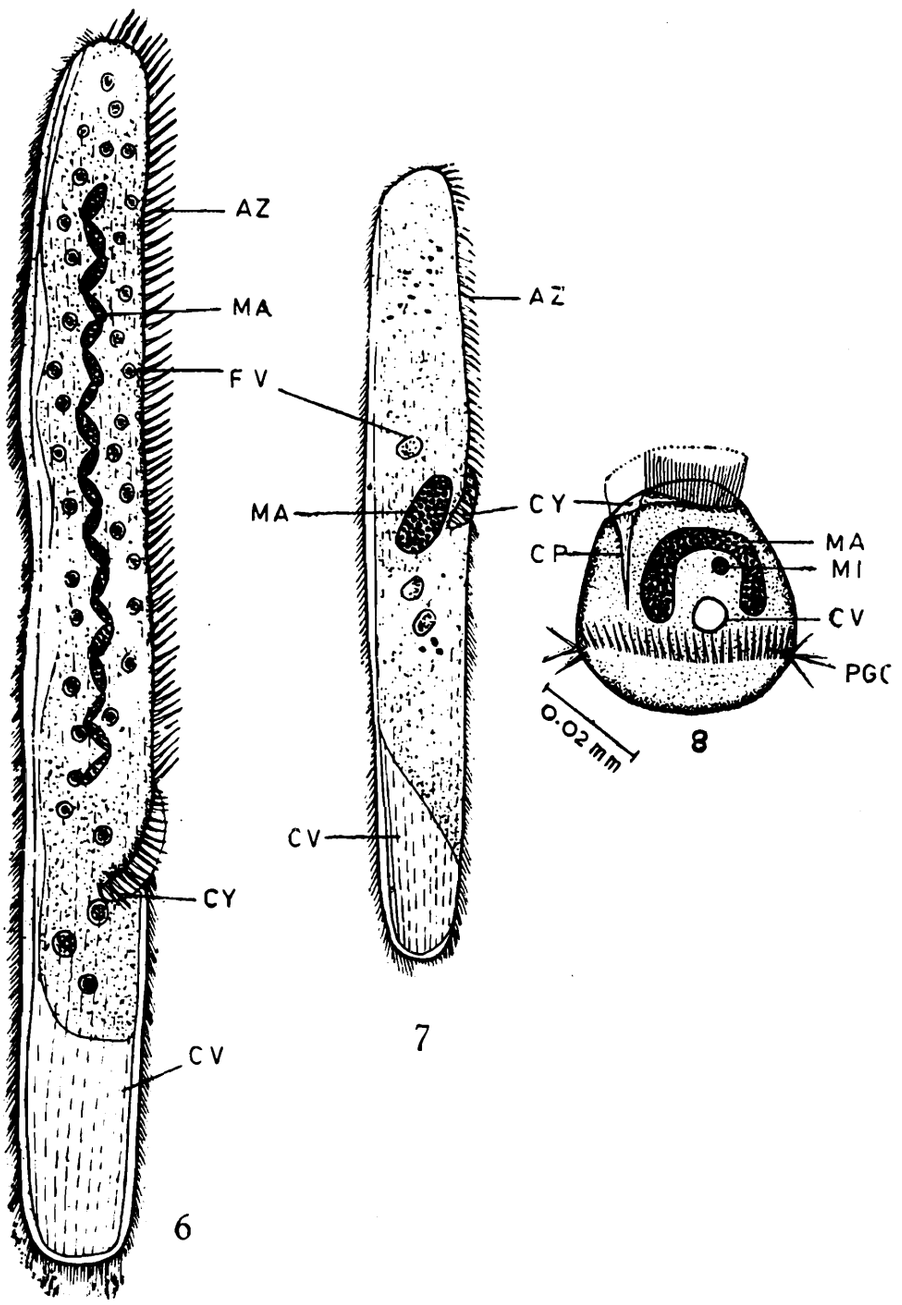
Kent (1880-1882) placed *Urocentrum* and *Telotrochidium* in the order Peritricha, but subsequent workers have shown that their correct posi-



Text-fig. 1. *Stentor coeruleus*—live animal. 2. *Halteria grandinella*—live animal. 3. *S. coeruleus*—infraciliature. 4. *Brachonella spiralis*—live animal. 5. *B. spiralis*—infraciliature.

tion is under Hymenostomata. Corliss (1961, 1977) placed this species in Peritricha. Kahl (1930-1935) is however, of the opinion that species of *Telotrochidium* are vorticellids detached from their stalks.

Gulati's (1925) and the present observations seem to show that the *Telotrochidium* is a valid genus. Bhatia (1936) is of the opinion that



Text-figs. 6. *Sporostomum ambiguum*—live animal. 7. *S. teres*—live animal. 8. *Telotrochidium crateriforme*—live animal.

ABBREVATIONS USED

AZ—Adoral zone ; BB—Bristles ; CP—Cytopharynx ; CV—Contractile vacuole; CY—Cytostome ; FV—Food vacuole ; MA—Macronucleus ; MI—Micronucleus ; PE—Peristome ; PF—Peristomial funnel ; PGC—Posterior girdle of cilia ; RB—Refractile bodies ; ZC—Zoochlorelle.

the position of the genus is close to *Urocentrum* and according to him vorticellids may be supposed to have been derived from such Holotrichian forms as *Urocentrum* and *Telotrochidium*. Corliss (1977) placed *Urocentrum* in the order Hymanostomatida of Hymenostomata and *Telotrochidium* in Peritrichida of Peritricha.

Present observations confirm the opinion of Corliss (1977) in placing *Telotrochidium* in Peritricha because in characters like shape of the body, shape of the nucleus, ciliary arrangements, single contractile vacuole it is closely related to Peritricha.

Dimensions : Body length ranges from 85 to 97 μm and width ranges from 62 to 67μm.

Class : POLYHYMENOPHORA Jankowski

Sub class : SPIROTRICHA Butschii

Order : HETEROTRICHIDA Stein

Sub order : HETEROTRICHINA Stein

Family : SPIROSTOMIDAE Stein

Genus : **Spirostomum** Ehrenberg, 1833

Spirostomum ambiguum Ehrenberg, 1833

(Text-fig. 6)

This ciliate is elongate, thread like and slim, somewhat flattened laterally. Highly elastic, contractile and flexible. Ten to twenty times or more as long as broad, cylindrical, the anterior and posterior extremities often equal rounded in some forms. Posterior truncate condition has also been observed. Peristome is long extending down the left side of the ventral surface beyond the middle of body, continues as a short cytopharynx. AZM begins at the anterior end of the animal and runs along its length. Contractile vacuole is conspicuous, it lies in the posterior part of the body and is fed by a long canal stretching dorsally from anterior end. Macronucleus is elongated and moniliform. Numerous micronuclei are seen close to the macronuclear beads.

The form and structure of the macronucleus vary in different forms. In most cases the macronucleus beads are elongated, oval, tapering at either end, they are connected by narrow commissures. In some cases the macronucleus is vermiform. There is no correspondence between the number of micronuclei and the lobes of macronucleus.

In *S. ambiguum*, the two varieties were noted by Bishop (1923), *S. ambiguum major* is 800 to 900 μm long, posterior end rounded, yellowish cytoplasm. Cytostome behind the mid-point. *S. ambiguum minor* is

400 to 500 μm long and truncated posteriorly, greyish-white cytoplasm, with its cytostome in the anterior third of the body. Bhatia and Mullick (1930) concluded that *S. teres* and the minor and major varieties of *S. ambiguum* form a series, the structural peculiarities of which are closely paralleled by the stages of growth of the individual specimens of *S. ambiguum*. The specimens found here measured 545 to 860 μm in length so that it could be concluded that they are *S. ambiguum* var. *major*. This species is cosmopolitan in distribution.

Spirostomum teres Claparède and Lachmann, 1858-1861

(Text-fig. 7)

Body is elongated, shape is similar to that of *S. ambiguum* but comparatively small. Colour yellowish or slightly brown, peristome extending up to one third of the length of the body. Posterior end may or may not be truncated. Contractile vacuole is single occupying most of the posterior end of the body and extending forward as a long canal. Oval macronucleus is situated at the middle of the body.

Bhatia (1936) reported that in the specimens found at Srinagar (India) the peristomial groove extends only up to about one third of the length of the body. But in the present study in some specimens the peristomial groove extends beyond one third of the body, in some cases up to the middle of the body.

Dimensions : Body length ranges from 175 μm to 380 μm.

Family : METOPIDAE Kahl

Genus : **Brachonella** Jankowski, 1964

Brachonella spiralis (Smith, 1897)

(Text-figs. 4 & 5)

Body roughly oval in shape. Posterior portion ends in a blunt cone. Except in the anterior left portion, the body is transparent. A few refractile granules are aggregated at the anterior left portion of the animal. The peristome is a spiral depression running diagonally from anterior half to the posterior right side thus the body presents a spiral shape. The portion near and just above the peristome is densely ciliated with long cilia, and in other parts of the body the ciliation is uniform. Body is striated in a linear form.

Macronucleus is spherical and single situated in the anterior half of the body above the peristome. Single rounded conspicuous contractile vacuole is present at the posterior end. Micronucleus is small and lies closely apposed to the macronucleus.

The description of the present species agrees with the description and illustrations given by Kahl (1930-1935), except for the few differences in dimentions. The length reported by Kahl is 80 to 150 μm. But the present specimens measure only 60 to 75 μm. Liebmann (1962) described this species as *Metopus contortus* and Jankowski (1964) described the present species as *Brachonella spiralis*. *Metopus contortus* is the synonym of *Brachonella spiralis* (Smith).

Dimensions : Body length ranges from 60 to 75 μm and width ranges from 38 to 49 μm.

Family : STENTORIDAE Carus

Genus : **Stentor** Oken, 1815

Stentor coeruleus Ehrenberg, 1830

(Text-figs. 1 & 3)

Body is cerulean blue in colour, cone or trumpet shaped in fully extended condition and capable of extension or of contraction into a sphere. The surface is covered by alternating longitudinal stripes of two kinds—bands of granules, often coloured and between these clear stripes which bear the rows of the body cilia. A thin pellicle forms the outer most surface of the cell. *S. coeruleus* anchors to the substratum by a temporary holdfast organell occurring at the posterior end. Peristomial disk slightly convex with membranellae at its margin. Frontal field is covered with alternating clear and granular stripes. Macronucleus moniliform and consists of many nodes lying within a common nuclear membrane. Micronuclei are many situated close to the macronuclear nodes. Contractile vacuole lies anteriorly and has a collecting canal.

The description given here agrees with the details and illustrations given by Tartar (1961). The specimen found here are longer than the previously reported forms. Tartar (1961) reported that the longest *Stentor* was 350 μm in length. *S. coeruleus* is the largest of all stentors. They are coloured bright in the fully distended ciliate. The number of macronuclear nodes varies from 9 to 11. Mahajan (1971) reported only 7 macronuclear beads.

Dimensions : Length of fully extended animal is 340 to 370 μm.

Genus : **Halteria** Dujardin, 1842

Halteria grandinella (O. F. Müller, 1786)

(Text-fig. 2)

Globular body. Anterior border with conspicuous frontals and AZM. Cytostome is situated at the end of the zone of the membranelles near the anterior end of the organism. A small membrane is

present on the right edge of the peristome. On the lateral body surface 7 groups of long tactile cilia or bristles are present each with three long bristles. There are over 20 par-oral membranelles. The macronucleus is oval, with a small micronucleus. Contractile vacuole lies to the left of the buccal cavity. Locomotion is of two types, slow rotatory movements and swift darts. Tamar (1974) reported that the oral membranelles are each longitudinally divided in the midline. The oral membranelles are longest anteriorly, towards the exterior opening of the buccal cavity. Our specimens show a oval macronucleus situated at the centre. But Tamar (1974) reported that the interphase macronucleus consists of two subglobose portions separated by a constriction. The present specimens are longer than those described by Dingfelder (1962), Mahajan and Nair (1971), Bick (1972) and Tamer (1974).

Dimensions : Body length ranges from 20 to 70 μm.

SUMMARY

In the present paper six fresh water ciliates belonging to five families and five genera are described in detail. Details of the infraciliature of the ciliates have been touched. *Telotrochidium carteriforme* is the first record for the Indian sub-continent.

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ON A COLLECTION OF SNAKES FROM NORTH-EAST INDIA (REPTILIA : SERPENTES)

By

MRS. R. MATHEW

Eastern Regional Station, Zoological Survey of India, Shillong

INTRODUCTION

The present paper is based on the material collected by different members of the staff of Zoological Survey of India, Eastern Regional Station, Shillong, since its inception in 1959. The collection comprises of 165 specimens and on examination revealed 33 species belonging to 22 genera. The localities include areas from Arunachal Pradesh, Assam, Meghalaya and Tripura.

SYSTEMATIC ACCOUNT

Order : SQUAMATA

Sub-order : SERPENTES

Family : TYPHLOPIDAE

1. **Typhlops braminus** (Daudin)

(Common blind snake)

Material : 11 ex ; 1 ex, INDIA : Assam, Goalpara, Dhupdhara CPWD IB compound, 21. 1. 1972, Coll. *S. Biswas* ; 3 ex, Assam, Manas sanctuary, 9. 1. 1974, Coll. *A. K. Ghosh* ; 4 ex, Kahitama forest near Manas Sanctuary, 13. 1. 1974, Coll. *A. K. Ghosh* ; 1 ex, Manas Sanctuary east bank, 14. 1. 1975, *K. R. Rao* ; 1 ex, Meghalaya, Khasi Hills, Umran, 18. 5. 1967, Coll. *R. K. Varshney* ; 1 ex, Khasi Hills, Barapani, Feb. 1975, Coll. *Asish John*.

Total length : Largest specimen measures 146 mm.

2. **Typhlops diardi** Schlegel

(Diard's blind snake)

Material : 9 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Lawsohtun, 26. 6. 1967, Coll. *S. D. Sangma* ; 1 ex, Khasi Hills, Shillong, Upland Road, 3. 7. 1968, Coll. *K. B. Khattri* ; 1 ex, Khasi Hills, Umtham, 23. 7. 1971, Coll. *S. Biswas* ; 1 ex, Khasi, Hills, Nongpoh, 23. 7. 1971, Coll. *S. Biswas* ; 1 ex, Khasi Hills, Nongpoh, 25. 8. 1972, Coll. *A. K. Ghosh* ;

1 ex, Khasi Hills, Bishnupur, 20. 5. 1970, Coll. *S. J. S. Hattar* ; 1 ex, Khasi Hills, Motinagar forest, 18. 9. 1974, Coll. *R. Zoramthanga* ; 1 ex, Khasi Hills, Golflinks, 31. 5. 1976, Coll. K. *Deb* ; 1 ex, Meghalaya, Garo Hills, Baghmara, 1. 4. 1976, Coll. *S. Biswas.*

Total length : Largest specimen measures 500 mm.

Family BOIDAE

3. **Python molurus** Linnaeus

(Indian Python)

Material : 2 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Malki forest, 18. 9. 1968, Coll. *A. S. Rao* ; 1 ex, Assam, Kaziranga, 23. 2. 1972, Coll. *G. M. Yazdani.*

Total length : Largest specimen measures approximately 14 feet.

Family COLUBRIDAE

4. **Ahaetulla ahaetulla** (Linnaeus)

(Painted Bronze-back)

Material : 1 ex, INDIA : Assam, Darrang, Dalgaon, 15. 1. 1965, Coll. *R. P. Ghosh.*

Total length : 645 mm, tail 350 mm.

5. **Amphiesma khasiensis** (Boulenger)

Material : 1 ex, INDIA : Meghalaya, Khasi Hills, Barapani, 4. 5. 1967, Coll. *S. K. Kakati.*

Total length : 400 mm, tail 190 mm.

6. **Amphiesma parallela** (Boulenger)

Material : 3 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Shillong, 9. 3. 1961, Coll. *S. N. Prasad* ; 1 ex, Shillong, 19. 4. 1972, Coll. *S. J. S. Hattar* ; 1 ex, Shillong, Risa Colony, 16. 8. 1978, Coll. *P. B. Thapa.*

Total length : Largest specimen measures 500 mm, tail 144 mm.

Remark : In one specimen there are nine supralabials on one side and eight on the other side.

7. **Amohiesm stolata** (Linnaeus)

(Striped Keel-back)

Material : 3 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Sericulture, garden, 6. 7. 1962, Coll. *S. N Prasad* ; 1 ex, Khasi Hills, Umroi, 13. 9. 1977, Coll. *S. K. Chanda* ; 1 ex, Khasi Hills, Barapani, 6. 10. 1975, Coll. *Asish John.*

Total length : Largest specimen measures 505 mm, tail 145 mm.

Remarks : One of the specimens has seven supralabials on one side and eight on the other. Another specimen has seven supralabials one either side with 3rd and 4th touching the eye. Two examples I have examined for St. Anthony's College, Shillong have eight supralabials each.

8. **Blythia reticulata** (Blyth)

Material : 1 ex, INDIA : Meghalaya, Khasi Hills, Upper Shillong, donated by the Potato Research Institute, 21. 4. 1977.

Total length : 385 mm, tail 40 mm.

9. **Boiga trigonata** (Schneider)

Material : 1 ex, INDIA : Meghalaya, Garo Hills, Anogiri, 8. 3. 1975, Coll. *S. Biswas*.

Total length : 515 mm, tail 123 mm.

Remark : The caudal count is 105, whereas Smith's (1943) highest count is 96.

10. **Chrysopelea ornata** (Shaw)

(Golden Tree Snake)

Material : 1 ex, INDIA : Meghalaya, Khasi Hills, Dawki, 11. 6. 1981, Coll. *C. Radhakrishnan*.

Total length : 1040 mm, tail 235 mm.

11. **Elaphe cantoris** (Boulenger)

Material : 2 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Weiloi, 26. 10. 1978, Coll. *S. Biswas* ; 1 ex, Arunachal Pradesh, Subansiri Expedition, Doju Bung, 15. 12. 1974, Coll. *J. M. Julka* & party.

Total length : Largest specimen measures 1250 mm, tail 230 mm.

12. **Elaphe porphyracea** (Cantor)

Material : 5 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Shillong, 2. 9. 1973, Coll. *P. Lushai* ; 2 ex, Shillong, 6. 10. 1968, Coll. *S. K. Shobhani* ; 1 ex, Shillong, 3. 6. 1977, Coll. *A. C. Sukla* ; 1 ex, Shillong, June 1975, Coll. *Asish John*.

Total length : Largest specimen measures 870 mm, tail 148 mm.

13. **Elaphe prasina** (Blyth)

(Green Tree Racer)

Material : 4 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Kenche's trace, 15. 5. 1967, Coll. *S. Biswas* ; 1 ex, Khasi Hills, Madan Laban, 17. 4. 1965, Coll. *K. Khattri* ; 1 ex, Kenche's trace, 3. 6. 1967, Coll. *S. Biswas* ; 1 ex, Arunachal Pradesh, Subansiri Expedition, 4 km North-west of Tali, 30. 1. 1975, Coll. *J. M. Julka* & party.

Total length : Largest specimen measures 960 mm, tail 350 mm.

14. **Elaphe radiata** (Schlegel)

(The Copper Head)

Material : 3 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Umroi, 17. 8. 1973, Coll. *A. K. Ghosh* ; 1 ex, Khasi Hills, Barapani, 27. 8. 1968, Coll. *E. D. Nongkhlaw* ; 1 ex, Meghalaya, Jaintia Hills, Sonapurdi, on Khliehriat Road, 27. 8. 1974, Coll. *A. R. Lahiri.*

Total length : Largest specimen measures 1870 mm, tail 400 mm.

15. **Enhydris enhydris** (Schneider)

Material : 1 ex, INDIA : Assam, Kaziranga, 25. 2. 1972, Coll. *G. M. Yazdani.*

Total length : 460 mm, tail 107 mm.

16. **Lycodon jara** (Shaw)

Material : 1 ex, INDIA : Meghalaya, Khasi Hills, Shillong, Eastern Regional Station, Zoological Survey of India, office compound, 28. 8. 1968. Coll. *S. K. Sobhani.*

Total length : 385 mm, tail 106 mm.

Remark : This apparently is the first record of this species from Meghalaya.

17. **Pareas monticola** (Cantor)

Material : 3 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Malki forest, 4. 12. 1973, Coll. *T. Deb* and *B. Endow* ; 1 ex, Khasi Hills, Nongthymai, 3. 3. 1976, Coll. *M. S. Jyrwa* ; 1 ex, without any collection data.

Total length : Largest specimen measures 770 mm, tail 160 mm.

Remarks : The vertebral row of scales not enlarged. One specimen has 3 post oculars on one side and 2 on the other. The other two specimens have 3 post oculars each on either side.

18. **Psammodynastes pulverulentus** (Boie)

Material : 5 ex; 1 ex, INDIA : Meghalaya, Khasi Hills, Old Barapani, 7. 2. 1961, Coll. *S. N. Prasad* ; 1 ex, Khasi Hills, Shillong, T. C. Road, 16. 11. 1976, Coll. *P. B. Thapa* ; 1 ex, Khasi Hills, Lawsohtun, 16. 8. 1971, Coll. *M. S. Jyrwa* ; 1 ex, Khasi Hills, Motinagar forest, 19. 1. 1977, Coll. *M. S. Jyrwa* ; 1 ex, Arunachal Pradesh, Subansiri Expedition, Siyum, 25. 11. 1974, Coll. *J. M. Julka &* party.

Total length : Largest specimen measures 435 mm., tail 170 mm.

19. **Rhabdophis himalayana** (Günther)

(Himalayan Keel-back)

Material : 17 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Shillong, Risa Colony, 28. 8. 1968, Coll. *S. K. Sobhani* ; 1 ex, Risa Colony, 30. 4. 1973, Coll. *J. K. Prasad* ; 1 ex, Risa Colony, 17. 9. 1975, Coll. *Asish John* ; 1 ex, Risa Colony, 26. 6. 1975, Coll. *K. Deb* ; 1 ex, Shillong, T. C. Road, 24. 6. 1976, Coll. *P. B. Thapa* ; 1 ex, Risa Colony, 26. 9. 1977, Coll. *B. K. Bhattacharjee* ; 1 ex, Risa Colony, 22. 9. 1975, Coll. *Chandan Singh* ; 1 ex, Risa Colony, 5. 7. 1977, Coll. *B. K. Bhattacharjee* ; 1 ex, Khasi Hills, Motinagar forest, 28. 6. 1974, Coll. *R. S. Giri* ; 1 ex, Risa Colony, 17. 8. 1977, Coll. *P. B. Thapa* ; 1 ex, Risa Colony, 2. 9. 1976, Coll. *J. K. Prasad* ; 1 ex, Shillong, T. C. Road, 3. 12. 1974, Coll. *M. S. Jyrwa* ; 1 ex, T. C. Road, 12. 7. 1976, Coll. *P. B. Thapa* ; 1 ex, Risa Colony, 8. 7. 1975, Coll. *S. J. S. Hattar* ; 1 ex, Motinagar forest, 2. 8. 1975, Coll. *R. Zoramthanga* ; 1 ex, Risa Colony, 26. 6. 1975, Coll. *K. Deb.*

Total length : Largest specimen measures 850 mm. tail 200 mm.

20. **Rhabdophis subminiata** (Schlegel)

(Red-necked Keel-back)

Material : 6 ex ; 1 ex, INDIA : Assam, Kamrup district, 9. 1. 1974, Coll. *A. K. Ghosh* ; 1 ex, Sibsagar, Upper Dehing Reserved forest, 8 km from Margharita, 15. 11. 1974, Coll. *S. K. Chanda* ; 1 ex, Kaziranga, 17. 2. 1972, Coll. *A. K. Ghosh* ; 1 ex, Meghalaya, Khasi Hills, Laitumkhrah, 16. 9. 1970, Coll. *S. K. Chanda* ; 1 ex, Khasi Hills, Shillong, Risa Colony, 20. 7. 1973, Coll. *P. Lushai* ; 1 ex, Meghalaya, Garo Hills, 25. 2. 1965, Coll. *A. S. Rajgopal* ; 1 ex, Tripura, Subalsingh, 3. 8. 1979, Coll. *K. P. Singh.*

Total length : Largest specimen measures 870 mm, tail 240 mm.

Remarks : Two of the present materials possess eight supralabials on one side and nine on the other, of which the third, fourth, and fifth

and fourth, fifth, and sixth respectively border the eye. Another material shows nine supralabials on one side and ten on the other. Post oculars are two on the left and three on the right in one specimen and three on the left and four on the right in a third specimen.

21. **Rhabdophs bicolor** (Blyth)

Material : 3 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Shillong, Fruit garden, 27. 10. 1970, Coll. *G. M. Yazdani* ; 1 ex, Shillong, Risa Colony, 6. 5. 1980, Coll. *Edilbert* ; 1 ex, Shillong, T. C. Road, 14. 8. 1976, Coll. *P. B. Thapa.*

Total length : Largest specimen measures 450 mm, tail 130 mm.

Remark : One specimen shows a ventral count as high as 226, as against Smith's (1943) highest count of 214. In another specimen the prefrontal shield shows a one-fourth division in the middle, and the rostral is slightly produced in the middle.

22. **Sibynophis collaris** (Gray)

Material : 13 ex ; 1 ex, INDIA : Meghalaya Khasi Hills, Shillong, Orchid house, 7. 6. 1973, Coll. *A. S. Rao* ; 1 ex, Forest Colony, 22. 12. 1972, Coll. *S. K. Talukdar* ; 1 ex, Shillong, 26. 6. 1967, Coll. *S. D. Sangma* ; 1 ex, Shillong, 1961, Coll. *Joseph* ; 2 ex, Shillong, Kenche's trace, 15. 5. 1967, Coll. *B. K. Tikader* ; 1 ex, Shillong, Risa Colony, 28. 5. 1974, Coll. *P. B. Thapa* ; 1 ex, Risa Colony, 20. 9. 1977, Coll. *S. J. S. Hattar* ; 1 ex, Risa Colony, 16. 7. 1977, Coll. *P. B. Thapa* ; 1 ex, Khasi Hills, Malki forest, 20. 9. 1975, Coll. *M. S. Jyrwa* ; 1 ex, Malki forest, 3. 7. 1975, Coll. *R. S. Giri* ; 1 ex, Khasi Hills, Motinagar forest, 25. 9. 1975, Coll. *P. B. Thapa* ; 1 ex, Jaintia Hills, Jowai, 4. 10. 1972, Coll. *A. R. Lahiri.*

Total length : Largest specimen measures 550 mm, tail 250 mm.

Remarks : One of the specimens possesses an entire anal shield. The median rows of black spots on the ventral shields vary greately. In some, two thirds of the ventral scales show the median rows of black spots, and in others very few of them possess it.

23. **Trachischium monticola** (Cantor)

Material : 21 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Madan Iaban, 20. 7. 1959, Coll. *H. S. P. Majumdar* ; 1 ex, Khasi Hills, Kenche's trace, 20. 4. 1967, Coll. *P. B. Thapa* ; 1 ex, Khasi Hills, Motinagar forest, 6. 9. 1961, Coll. *S. N. Prasad* ; 1 ex, Khasi Hills, Lalchand Basti, 26. 4. 1973, Coll. *V. D. Srivastava*, 1 ex, Khasi Hills, Shillong,

12. 5. 1973, Coll. *A. S. Rao* ; 1 ex, Shillong, Risa Colony, 2. 5. 1972, Coll. *R. S. Giri*, 1 ex, Risa Colony, 25. 11. 1971, Coll. *S. K. Talukdar* ; 3 ex, Shillong, Pologround, 24. 9. 1972, Coll. *K. Deb* ; 1 ex, Risa Colony, 25. 2. 1977, Coll. *B. K. Bhattacharjee* ; 1 ex, Malki forest, 22. 6. 1978, Coll. *Nongynrih* ; 1 ex, Khasi Hills, Oakland Road, P. M. G. Banglaw, 28. 7. 1977, Coll. *P. Sina* ; 1 ex, Motinagar forest, 14. 6. 1974, Coll. *R. Zoramthanga* ; 1 ex, Risa Colony, 8. 8. 1974, Coll. *K. Deb* ; 1 ex, Risa Colony, August 1975, Coll. *Asish John* ; 1 ex, Shillong, T. C. Road, 16. 4. 1977, Coll. *Chandan Singh* ; 1 ex, Risa Colony, 23. 6. 1975, Coll. *R. Mathew* ; 1 ex, Assam, Kaziranga, 22. 2. 1974, Coll. *M. Datta*.

Total length : Largest specimen measures 180 mm, tail 30 mm.

Remarks : One of the specimens shows a slightly higher ventral count of 130 scales as against Smith's (1943) highest count of 125.

24. **Xenochrophis piscator** (Schneider)

Material : 6 ex ; 1 ex, INDIA : Arunachal Pradesh, Siang district, Mathuri village, 16. 2. 1973, Coll. *R. S. Pillai* ; 1 ex, Meghalaya, Garo Hills, Rongjeng, 10. 4. 1973, Coll. *S. Biswas* ; 1 ex, Garo Hills, Rongjeng, 46 km of Baghmara, near PWD IB, 23. 2. 1971, Coll. *G. M. Yazdani* ; 1 ex, Meghalaya, Khasi Hills, Barapani, 4. 5. 1967, Coll. *S. K. Kakati* ; 1 ex, Barapani, 25. 1. 1972, Coll. *G. M. Yazdani* ; 1 ex, Manipur, Domba, 28. 1. 1977, Coll. *S. G. Patil*.

Total length : Largest specimen measures 957 mm, tail 340 mm.

25. **Zaocys nigromarginatus** (Blyth)

Material : 1 ex, INDIA : Arunachal Pradesh, Subansiri Expedition, Danin, Alt. 1000 meters, 22. 1. 1975, Coll. *J. M. Julka* & party.

Total length : 1150 mm, tail 525 mm.

Family ELAPIDAE

26. **Bungarus fasciatus** (Schneider)

(Banded Krait)

Material : 1 ex, INDIA : Assam, Goalpara, Deoripathar, 21. 9. 1973, Coll. *S. Biswas*.

Total length : 900 mm, tail 80 mm.

27. **Callophis macclellandi** (Reinhardt)

Material : 4 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Shillong, Risa Colony, 27. 6. 1977, Coll. *B. K. Bhattacharjee* ; 1 ex, Risa Colony,

22. 8. 1972, Coll. *P. B. Thapa* ; 1 ex, Shillong, Fruit garden, 21. 9. 1972, Coll. *K. Deb* ; 1 ex, Risa Colony, 18. 8. 1977, Coll. *R. S. Giri.*

Total length : Largest specimen measures 545 mm, tail 43 mm.

28. **Naja naja** (Linnaeus)

(Indian Cobra)

Material : 3 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Diengpasohu, 26. 4. 1963, Coll. *V. D. Srivastava* ; 1 ex, Diengpasohu, 27. 4. 1963, Coll. *M. R. Lyndow* ; 1 ex, Khasi Hills, Umroi, 30. 4. 1968, Coll. *R. K. Varshney.*

Total length : Largest specimen measures 1210 mm, tail 235 mm.

29. **Naja hannah** (Cantor)

(King Cobra)

Material : 3 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Umtham, 29. 10. 1964, Coll. *A. K. Mandal* ; 1 ex, Khasi Hills, Shillong, Woodland compound 15. 7. 1960, donated by Botanical Survey of India, Shillong ; 1 ex, Assam, Kamrup district, Kulsi river side, 17. 6. 1964, Donated by Botanical Survey of India, Shillong.

Total length : Largest specimen measures 2400 mm, tail 495 mm.

Family VIPERIDAE

30. **Trimeresurus monticola** Günther

Material : 13 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Risa Colony, 6. 10. 1971, Coll. *S. K. Talukdar* ; 1 ex, Khasi Hills, Lower New colony, Botanical Survey of India, office compound, date ? Coll. *B. S. I. staff* ; 1 ex, Risa Colony, 18. 8. 1977, Coll. *B. N. Marbaniang* ; 1 ex, Risa Colony, 20. 5. 1977, Coll. *E. D. Albinus* ; 1 ex, Risa Colony, 24. 8. 1976, Coll. *R. Zoramthanga* ; 2 ex, Risa Colony, 22. 7. 1976, Coll. *P. B. Thapa* ; 1 ex, Risa Colony, 14. 7. 1976, Coll. *G. B. Chettri* ; 1 ex, Khasi Hills, Pologround, 28. 4. 1976, Coll. *R. Zoramthanga* ; 2 ex, Khasi Hills, Motinagar forest, 29. 8. 1975, Coll. *Varlathanga* ; 2 ex, Khasi Hills, Upper Shillong, Central Potato Research Institute, date ? Coll. *Drs. Khanna* and *Roy* ; 1 ex, Arunachal Pradesh, Kameng division, 20. 11. 1970, Coll. *A. S. Rao.*

Total length : Largest specimen measures 580 mm, tail 116 mm.

30. **Trimeresurus jerdoni** Günther

Material : 10 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Risa Colony, 21. 9. 1973, Coll. *R. S. Pillai* ; 1 ex, Khasi Hills, Kenche's trace,

30. 8. 1971, Coll. *S. K. Chanda* ; 1 ex, Risa Colony, 10. 10. 1972, Coll. *P. B. Thapa* ; 1 ex, Khasi Hills, Bishnupur, 23. 6. 1966, Coll. *M. K. Sen* ; 1 ex, Khasi Hills, Mawroh, 14. 5. 1964, Coll. *M. R. Rynth* ; 1 ex, Risa Colony, 19. 10. 1973, Coll. *P. B. Thapa* ; 1 ex, Risa Colony, 28. 6. 1972, Coll. *P. B. Thapa* ; 2 ex, Khasi Hills, Woodland compound, 4. 10. 1966, Coll. *G. K. Dey* ; 1 ex, Risa Colony, 19. 10. 1974, Coll. *Lalualiana* ; 1 ex, Risa Colony, 21. 9. 1974, Coll. *R. Mathew* ; 1 ex, Risa Colony, 29. 8. 1975, Coll. *R. Vanlalthanga.*

Total length : Largest specimen measures 620 mm. tail 85 mm.

31. **Trimeresurus stejnegeri** Schmidt

Material : 2 ex ; 1 ex, INDIA : Arunachal Pradesh, Kameng division, 20. 1. 1970, Coll. *A. S. Rao* ; 1 ex, Meghalaya, Khasi Hills, Shillong, 2. 9. 1971, Coll. *R. S. Pillai.*

Total length : Largest specimen measures 615 mm, tail 112 mm.

32. **Trimeresurus erythrurus** (Cantor)

Material : 1 ex, juvenile, INDIA : Meghalaya, Khasi Hills, Shillong, 14. 8. 1975, Coll. *R. G. Michel.*

33. **Trimeresurus albolabris ?** Gray

Material : 3 ex ; 1 ex, INDIA : Meghalaya, Khasi Hills, Mawlai, 3. 10. 1967, Coll. *G. T. Allen* ; 1 ex, Khasi Hills, Shillong, Risa Colony, 30. 6. 1974, Coll. *R. Mathew* ; 1 ex, Shillong, T. C. Road, 31. 7. 1976, Coll. *P. B. Thapa.*

Total length : Largest specimen measures 750 mm, tail 90 mm.

All the specimens show variation. In one specimen, one of the supraoculars is partly divided transversely ; internasals not twice as large as the adjacent scales, separated by a single scale ; eight supralabials, 1st completely separated from the nasal ; caudal count 36, paired ; yellowish green above, pale yellow beneath, tail brown above with a reddish tint. In another specimen the light flank stripe extends towards the tail. *Trimeresurus erythrurus* and *Trimeresurus albolabris* possess many similar characters as is evident from the specimens of both before me. At this stage I do not have anything further to add to the observations of Smith (1943), about retaining them as distinct species or otherwise. The study of more specimens from different niches and belonging to both will only give a clear picture of their correct identity.

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SMITH, M. A. 1943. *Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese sub-region.* Reptilia and Amphibia, III, Serpentes. London, xii+583pp., figs. 1-166.

Rec. zool. Surv. India, **80** : 459-465, 1983

ON A SMALL COLLECTION OF MANTIDAE (DICTYOPTERA) FROM MAHARASHTRA, INDIA, WITH THE DESCRIPTION OF A NEW SPECIES

By

T. K. MUKHERJEE AND A. K. HAZRA

Zoological Survey of India, Calcutta-

(With 2 Text-figures)

INTRODUCTION

Mantids frequently live in grassland and forests of India. To date only 140 species of this order are known from Indian sub-region. Wood-Mason (1878, '79, '82, '85, '89 and '91) explored the Indian mantid fauna and during the last one century no significant contribution has been made from India. The present paper is a part of the "Studies on the systematics, biology and taxonomy of mantid fauna from India".

Sub-family : OXYTHESPINAE Giglio-Tos 1919

Heterochaetula tricolor (Wood-Mason) 1889

1876. *Heterochaeta tricolor*, W.-Mas. : *Ann. nat. Hist.*, **18** (4) : 441.

1889. *Heterochaetula tricolor*, W.-Mas. : *J. Asiat. Soc. Bengal*, **58** : 309.

1911. *Heterochaetula tricolor*, Rehn : *Gen. Ins., fasc.*, **119** : 20.

1927. *Heterochaetula tricolor*, Gigl.-Tos : *Das Tierreich*, **50** Lief : 287.

Material : 1 ex., ♀, Distt. Parvani, Purna River, Coll. *R. N. Chopra*, 26. xi. 70, Regd. no. 9546.

Remarks : So far only two species under this genus are recorded from India. This species differs from its allied species *H. fissispinis* W.-Mas. by the presence of simple ocular spine which is bifid in the other. The summit of the vertex in this species does not exhibit any prominent groove to hold the tip of the pronotum. Moreover the superior apical lobe of the anterior coxae not prolonged.

Sub-family : Hymenopodinae Giglio-Tos 1919

Creobroter apicalis (Saussure) 1869

1869. *Creobotra apicalis*, Sauss. *Mt. Schw. ent. Ges.*, **3** : 73.

1971. *Creobotra apicalis*, Sauss. *Mem. Soc. Geneve*, **21** : 146, 317.

1898. *Creobrotra apicalis*, Sauss. *Rev. Suisse. Zool.*, **5** : 200.

1904. *Creobroter apicalis*, Kirby, *Cat. Orth. Brit. Mus.*, **1** : 291.

1927. *Creobroter apicalis*, Giglio-Tos., *Das Tierreich.*, **50** Lief. : 558.

1931. *Creobroter apicalis*, Werner, *Proc. Zool. Soc. Lond.* Pt. II : 1334.

Material : 1 ex. ♀, Distt. Satara, Ambenali, near Pratapgad : coll. *B. K. Tikader*, 30. v. 76, Regd. no. 3/3012.

Remarks : This species was discovered from Assam and then recorded from Bangla Desh (Chittagang Hill tracts) in Indian subcontinent. It differs from the other three Indian species under this genus by the presence of big ocelli-like spot in the middle of the discoidal area of the elytra formed by two arched black bands enclosing two black spots.

Euantissa pulchra (Fabr.) 1787

1787. *Mantis pulchra.*, Fabricius, *Mant. Ins.*, **1** : 229.

1792. *Mantis flavicinta*, Oliver, *Enc. Meth.*, **7** : 631, 641.

1802. *Mantis caffrana*, Lichtenstein, *Tr. Linn Soc. Lond.*, **6** : 31.

1813. *Mantis marginalis*, Stoll, *Represent. Spec.*, **37** t. 11 fig. 43.

1815. *Mantis pulchra*, Thunb., *Mem. Ac. St.-petersb.*, **5** : 288.

1838. *Mantis* (*Ameles*) *flavicinta*, Burm., *Hand. Ent.*, **2** : 531.

1842. *Mantis* (*Oxypilus*) *marginalis*, Haan, *Verh. nat. Gesch. Nederl. Bezitt., Ins.* 87.

1871. *Antissa pulchra* Stal, *Oefv. Ak. Forh.*, **28** : 400.

1871. *Pseudomantis* (?) *pulchra* Saussure, *Mem. Soc. Geneve.* **21** : 17, 194.

1872. *Gonypeta* (*Antissa*) *marginalis*+*Gonypeta* (*Antissa*) *pulchra.*, Saussure, ibid., **23** : 32.

1877. *Antissa pulchra* Stal, *Bih. Sv. Ak.*, **4** (10) : 87.

1897. *Antissa pulchra* Boliver, *Ann. Soc. ent., France*, **66** : 313.

1927. *Euantissa pulchra* Giglio-Tos, *Das Tierreich*, **50** *Lief.* : 540.

Material : 1 ex. ♂ Poona, Mundhwa, Botanical Garden ; Coll. *A. S. Mahabal*, 28. vi. 77, Regd. no. 12439.

Remarks : This species is widely distributed in India. The specimen is comparatively small (15.0 mm). Colouration of the hind wing is little different ; the hyaline area commences from the middle of the humeral and anal margin and then proceeds upwards, gradually narrowed near the middle of the discoidal area where it ends. Tranverse veins of outer half of hind wing are white.

Sub-family : LITURGUSINAE Giglio-Tos 1919

Humbertiella ceylonica Saussure 1869

1869. *Humbertiella ceylonica*, Saussure, *Mt. Schw. ent. Ges.*, **3** : 62.

1971. *Humbertiella ceylonica* Saussure, *Mem. Soc. Geneve*, **21** : 22, t. 4 f. 5.

1889. *Humbertiella ceylonica* Westwood, *Revis. Mantid.*, : 30, t. 2 f. 1.

1891. *Theopompa septentrionum* Wood Mason, *Cat. Mant.*, : 64, t. 1 f. 3.

1892. *Humbertiella ceylonica*, Brunner, *Ann. Mus. Genova*, **33** : 60.

1904. *Humbertiella septentrionum* Kirby, *Cat. Orth. Brit. Mus.*, **1** : 214.

1927. *Humbertiella ceylonica*, Giglio Tos, *Das Tierreich*, **50** *Lief.* : 64.

Material : 1 ex., ♀ (adult). Pune, Koregaon ; coll. *R. N. Chopra*, 7. xii. 67. Regd. no. 6123.

8 exs. (nymphs). Regd. nos. 9929 (2 exs.), 9883 (3 exs.), 8965 (2 exs.) and 7900 (1 ex.).

Remarks : This specimen is rather small in size (22 mm.) in comparison to the others recorded previously. This species was previously recorded from Assam, Kerala, M. P. and U. P.

Sub-family : MANTINAE Kirby 1904

Deiphobe incisa Werner 1933

1933. *Deiphobe incisa*, Werner, *Proc. Zool. Soc. Lond.* Pt. II : 897-901.

Material : 1 ex. ♂, Distt. Nanded, Naigaon ; Coll. *K. R. Rao*, 19. viii. 71. Regd. no. 3/619.

Remarks : It differs from the type species by the presence of hyaline anal area of elytra. This character is similar with the specimen of Sagoda, U. P. described by Werner (1933).

Mantis nobilis Brunner 1892

1892. *Mantis nobilis* Brunner, *Ann. Mus Genova*, **33** : 70, t. 2 f. 23.

1904. *Mantis nobilis* Kirby, *Cat. Orth. Brit. Mus.* **1** : 251.

1927. *Mantis nobilis* Giglio-Tos, *Das Tierreich*, **50** *Lief.* : 408.

1930. *Mantis nobilis* Werner, *Proc. Zool. Soc.* Lond. Pt. II : 689.

Material : 1 ex. ♀, Pune, Ambenali ; coll. *B. K. Tikader*, 30. v. 76. Regd. no 3/3012.

Remarks : It is recorded previously from Birmanie and then from Dehra Dun. This is a first time record from Western India. Some important characters are : stigma is marked on either end by a brownish spot. A black patch is present ventral to coxal joint, as well as ventral and proximal 1/3 length of anterior coxae.

Sub-family : AMELINAE Giglio-Tos 1919

Elmantis nira sp. nov.

(Text-figs. 1-2)

Male : Greyish brown ; total length 27 mm. wing span 43 mm.

Frontal sclerite transverse ; superior margin wavy in the middle with the concavity in the middle—the sides being sinuated. The middle of upper and lower margins are blackened. Vertex with a median and

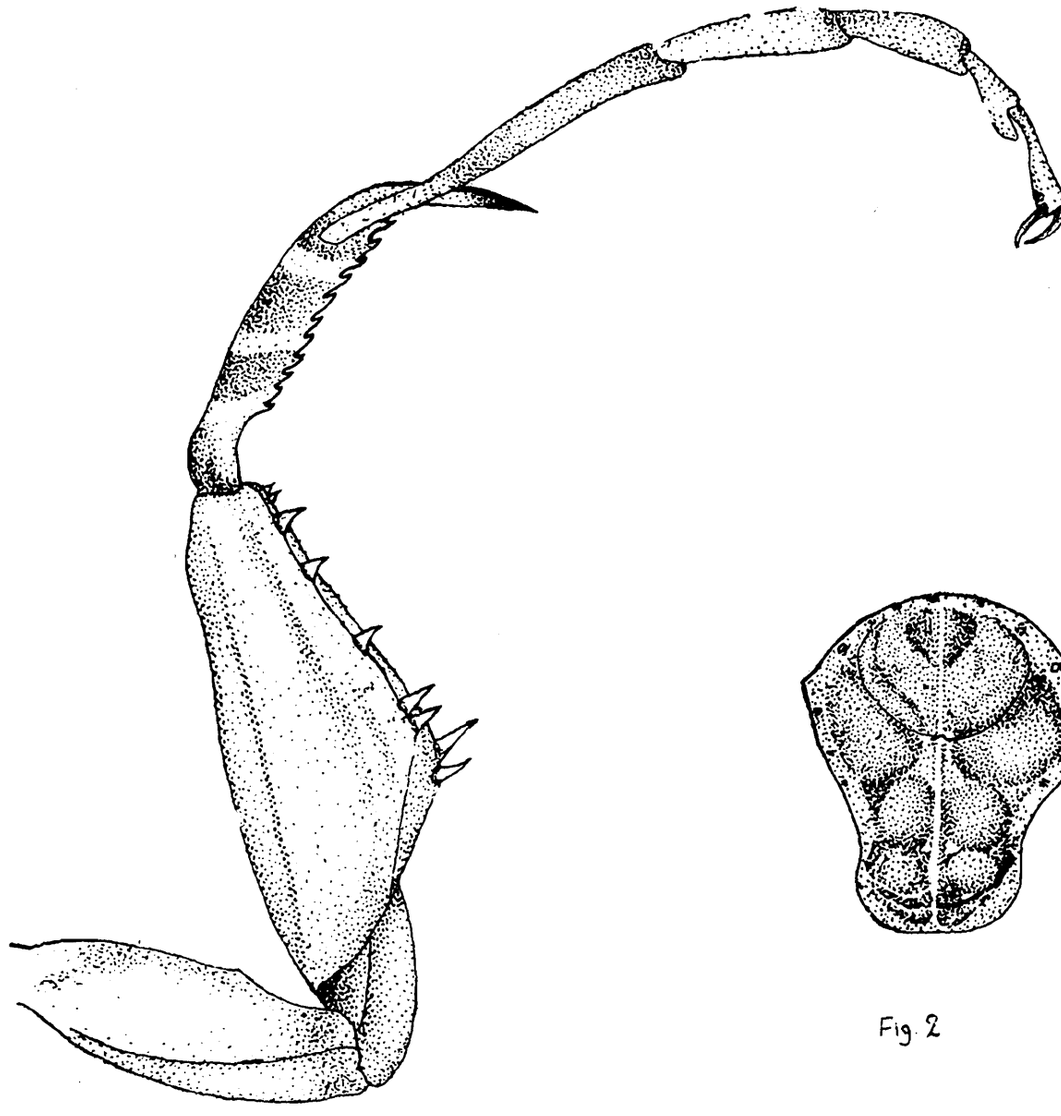

Fig 1

Fig 2

Text-figs. 1. *Elmantis nira* sp. nov. male, showing right fore leg, x 10. 8.

2. *Elmantis nira* sp, nov. male, showing pronotum from top, x 10. 8.

two lateral lobes (on each side) of which juxtacular lobes are more prominent and separated from the next inner one by a deep groove. Eyes are bulging ; antennae stout and ciliated. Ocelli very prominent.

Pronotum : Brownish with flattened margins marked by black spots ; this is highly flattened anteriorly and suddenly constricted near the

posterior quarter of metazona. Margins as well as dorsal surface is covered by stout cilia. Prozona with indistinct median groove and metazona with prominent carina. Anterior three pairs of bosseles of metazona more rounded and elevated posteriorly while the smallest basal is continued laterally along with a prominent ridge.

Elytra and wings : These are hyaline, the former being light brownish. Both are densely ciliated. Costal area of elytra very narrow with little obliquely parallel veinules. Mediastinal bifurcated distally. Anterior radial similarly bifurcated but not the posterior radial vein. Plicata vein with two branches. Each longitudinal vein of elytra and wings is alternately brown and hyaline. Apex of elytra rounded. Costal area of wing has parallel venules.

Fore legs : Anterior coxae nearly as long as pronotum and bear black spot on either sides. Upper margins of femora little arched. Basal two external spines are closely approximated and this margin bears very fine pointed spinules. Discoidal spine 4 ; internal spine 12—all are brown and only the tips are black. Tibiae with 9 internal spines gradually longer towards the apex. External spines are 11 in number. Blackish bands (3 number) are visible more clearly internally. Tarsi blackened towards apices.

Mid and hind legs : These are irregularly dotted black and also with blackish bands. Femora have apical spine. Metatarsuses are longer than other segments taken together.

Others : Supra-anal plate triangular, keeled and pointed ; short exposing most parts of genitalia. Cerci cylindrical with long cilia.

Measurements : ♂, 27 mm. Pronotum—3/4 mm. (W/L). Head width—4 mm. ; Elytra—21 mm. ; Wings—20 mm. ; Ant. coxae—4.2 mm. ; Ant. femora—5.7 mm. ; Ant. tibiae—3.1 mm. ; Ant. tarsae—4.5 mm. ; Total body length—27 mm.

Distribution : INDIA : Maharashtra.

Type locality : *Holotype*, ♂. INDIA : Maharashtra, Nira, Dt. Poona Coll. *M. B. Rao*, 11. v. 72, 2 exs.

Holotype Regd. No. 7854/H5 ; deposited to Zoological Survey of India, Calcutta.

Comparison : This is nearer to *E. lata* Gigl. Tos. by having feebly arched superior border of frontal sclerite and long elytra more or less widened at the apex. But it can be distinguished by the presence of eleven external spines in the anterior tibiae.

Sub-family : ACROMANTINAE Giglio-Tos. 1919

Ambivia popa Stal, 1877

1877. *Ambivia popa Stal, Bih. Sv. Ak.*, **4** (4) : 88.

1889. *Ambivia popa* Westwood, *Revis, Mantid.*, 22, t. 11 f. 6.

1908. *Popa undata*, Werner, *Annuaire Mus. St.-Petersb.*, **13** : 124.

1915. *Ambivia popa* Giglio-Tos, *Boll. Mus. Torino*, **30** (702) : 8.

1927. *Ambivia popa* Giglio-Tos, *Das Tierreich*, **50** *Lief.* 530.

1933. *Ambivia popa* Werner, *Proc. Zool. Soc. Lond.* Pt. II 900.

Material : (i) 1 ex. ♀, Distt. Satara, Ambenali, near Pratapgad ; Coll. *B. K. Tikader*, 3. v. 76. Regd. no. 3/3012.

(ii) 1 ex. (nymph), Pune, Khed Shivapore, Coll. *R. N. Chopra*, 17.i.69. Regd. no. 7230.

Remarks : Genus *Ambivia* is represented by only one Indian species and is widely distributed in Eastern part of India. This is first record from Western India. The diagnostic features of this species are : the four posterior femora have rounded preapical lobes. Elytra broad, pointed at the tip, spotted brownish and bears two transverse pale bands ; claw groove in the middle with a spot in vicinity to it.

SUMMARY

This paper records six species of mantids from Maharashtra, India, of which *Elmantis nira* is described as new to science.

ACKNOWLEDGEMENT

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CONTRIBUTION TO THE ODONATE (INSECTA) FAUNA OF THE ANDAMAN AND NICOBAR ISLANDS WITH DESCRIPTION OF TWO NEW SPECIES

By

G. CHHOTANI, A. R. LAHIRI AND T. R. MITRA
Zoological Survey of India, Calcutta.

(With 7 Text-figures)

INTRODUCTION

The first mention of an odonate species from the Andaman and Nicobar islands can be traced back in literature to Selys (1853) where the author described the damselfly *Libellago lineata blanda* from the Nicobar islands. Two more species, e. g. *Copera vittata serapica* Hagen and *Epophthalmia vittata* (Burmeister) were subsequently reported from these islands, by Selys in 1863 and 1875. In recent times, Fraser (1924) reported another 11 dragon- and damselflies from these islands including some new to science. These were later reported by Fraser in his Fauna of British India publication (1933-1936).

This study is based on odonate collections obtained during several surveys conducted by the Zoological Survey of India over a number of years.

Lahiri (1975) in his brief analysis of the odonate faunal composition of the South Andaman islands, referred to a detailed account of the same to the present contribution, as it was then, in the Mss. stage. Upon further critical analysis of the available material, a little change of the findings have been incorporated now.

In the present paper 21 new records of odonate species and subspecies, including two new to science have been reported which brings it to a total of 34 odonate species and subspecies known till date from this area. *Libellago andamanensis* (Fraser) has been considered here as a subspecies of *L. lineata* (Burmeister). Hitherto unknown females of two subspecies, e. g. *Libellago lineata andamanensis* (Fraser) and *Prodasineura verticalis andamanensis* (Fraser) have been described by comparing with the males. Measurements, Nodal index, necessary collection data, and a running key for all the species studied have been provided in the text along with taxonomic notes for some of them.

The types have been deposited in the National Zoological Collection.

*List of odonate species and subspecies known from the Andaman and Nicobar islands. (*indicates that the species or subspecies is present in the collections studied)*[1]

Family : CHLOROCYPHIDAE

*1. *Libellago lineata andamanensis* (Fraser)
2. *L. l. blanda* (Selys)

Family : CALOPTERYGIDAE

*3. *Vestalis gracilis gracilis* (Rambur)

Family : LESTIDAE

*4. *Lestes malabarica* Fraser
5. *L. praemorsa praemorsa* Selys

Family : PLATYSTICTIDAE

*6. *Drepanosticta annandalei* Fraser

Family : PROTONEURIDAE

*7. *Prodasineura verticalis andamanensis* (Fraser)

Family : PLATYCNEMIDIDAE

*8. *Copera marginipes* (Rambur)
9. *Copera vittata serapica* Hagen

Family : COENAGRIONIDAE

*10. *Pseudagrion andamanicum* Fraser
*11. *Ceriagrion olivaceum auranticum* Fraser
*12. *C. cerinorubellum* (Brauer)
*13. *Ischnura senegalensis* (Rambur)
*14. *Agriocnemis femina oryzae* Lieftinck
*15. *Agriocnemis pygmaea* (Rambur)

Family : GOMPHIDAE

*16. *Gomphidia ganeshi* sp. nov.

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*1. Fraser (1924) also mentioned about some specimens from the Andaman islands belonging to the genus *Libellago* Selys in British Museum collection, determined as *Micromerus lineatus* Burmeister *variety* by *R. Martin*. These are excluded from the list below on account of their uncertain subspecific status.

Family : AESHNIDAE

*17. *Oligoaeschna andamani* sp. nov.

Family : LIBELLULIDAE

18. *Epophthalmia vittata vittata* Burmeister
19. *Agrionoptera insignis insignis* (Rambur)
*20. *Lathrecista asiatica asiatica* (Fabricius)
*21. *Nesoxenia lineata* (Selys)
*22. *Potamarcha congener* (Rambur)
*23. *Orthetrum chrysis* (Selys)
24. *O. pruinosum neglectum* (Rambur)
*25. *O. s. sabina* (Drury)
*26. *Crocothemis servilia servilia* (Drury)
*27. *Diplacodes trivialis* (Rambur)
*28. *Tholymis tillarga* (Fabricius)
(Spellius should be = Trithemis)
*29. *Trithemis aurora* (Burmeister)
*30. *T. festiva* (Rambur)
31. *T. pallidinervis* (Kirby)
32. *Neurothemis fluctuans* (Fabricius)
33. *Neurothemis intermedia intermedia* (Rambur)
34. *Pantala flavescens* Fabricius

Collections studied and the collecting localities

(Table 1)

Four collections present in the Zoological Survey of India were studied, as follows :

1. A small collection by Col. R. B. S. Sewell, July—September, 1928 from South Andamans.

2. A large collection by Dr. B. S. Lamba, February — April, 1964 from the South Andamans.

3. A small collection by Dr. A Daniel and Dr. H. K. Bhowmik, March, 1966 from Great Nicobar.

4. A small collection by Dr. T. D. Soota, March — May 1969, from North and South Andamans and Car Nicobar.

Collecting localities

Collections were made from 26 different localities in the Andamans & Nicobars (Table 1) and are summarized below :

North Andamans — 4
South Andamans — 21
Car Nicobar — 1
Great Nicobar — 4

Systematic Account

KEY TO THE FAMILIES OF THE ORDER ODONATA

1.	Eyes separated by a space wider than their own diameter ; males with paired inferior anal appendages ; wings identical in shape and never dilated at base. ...	(Suborder ZYGOPTERA) 2
—	Eyes contiguous, or separated by a space not wider than their own diameter ; males with single inferior anal appendage ; fore- and hind wings differing in shape, the latter generally dilated at base. ...	(Suborder ANISOPTERA) 8
2.	5 or more antenodal cross veins present ; arc situated nearer base of wing than node. ...	(Superfamily CALOPTERYGOIDEA) 3
—	Only 2 antenodal cross veins present ; arc situated midway between base of wing and node. ...	... 4
3.	Epistome normal, not projecting ; wings non-petiolated or petiolation extending far proximal to the level of arc. ...	CALOPTERYGIDAE [*Vestalis gracilis gracilis* (Rambur)]
—	Epistome tumid and markedly projecting ; wings petiolated, petiolation extending opposite to, or slightly proximal to the level of arc. ...	CHLOROCYPHIDAE [*Libellago lineata andamanensis* (Fraser)]
4.	Male genital hamules elongated ; a variable number of intercalated sectors present at apical end of wing. ...	(Superfamily LESTIDOIDEA) Family LESTIDAE (*Lestes ? malabarica* Fraser)
—	Male genital hamules quadrate ; intercalated sectors absent at apical end of wing. ...	(Superfamily COENAGRIONOIDEA) 5
5.	IA absent ; Cu_2 markedly reduced. ...	PLATYSTICTIDAE (*Drepanosticta ? annandalei* Fraser)
—	IA present ; Cu_2 variable. ...	... 6

6.	Discoidal cell in hindwing with costal margin less than three fourths as long as the inner margin. ...	COENAGRIONIDAE
—	Discoidal cell in hindwing with costal margin more than three fourths as long as the inner margin. ...	... 7
7.	Discoidal cell with costal margin one fifth shorter than the inner margin. ...	PLATYCNEMIDIDAE [(*Copera marginipes* (Rambur)]
—	Discoidal cell with costal margin subequal to the inner margin. ...	PROTONEURIDAE [*Prodasineura verticalis andamanensis* (Fraser)]
8.	Costal and subcostal antenodal cross veins coinciding ; primary antenodals not distinguishable. ...	(Superfamily LIBELLULOIDEA) LIBELLULIDAE
—	Costal and subcostal antenodal cross veins not coinciding. ...	(Superfamily *Aeshnoidea*) 9
9.	Eyes separated on vertex ; discoidal cell of hindwing more transversely elongated than that of forewing. ...	GOMPHIDAE (*Gomphidia ganeshi* sp. nov.)
—	Eyes confluent on vertex ; discoidal cell of hindwing transversely as long as that of forewing. ...	AESHNIDAE (*Oligoaeschna andamani* sp. nov.)

Family CHLOROCYPHIDAE

Genus **Libellago** Selys

1. **Libellago lineata andamanensis** (Fraser)

1924. *Micromerus andamanensis* Fraser, (F. C.) *Rec. Indian Mus.*, **26** : 410.

1934. *Libellago andamanensis* Fraser, F. C., *Fauna British India, Odonata*, **2** : 66.

Material : 12 exs coll. *B. S. Lamba* 26 iii. '64 to 18. iv. '64 as follows : Mannar Ghat, Wright Myo (6 ♂♂, 2 ♀♀), Shoal Bay (1 ♂) ; Wrafters Creek (1 ♂), Cowriaghat (1 ♀) ; Burma nulla (1 ♀).

Description : Female : Differs from male as follows : bases of mandibles greenish yellow and a linear stripe of same colour running obliquely across cheeks and genae to frons ; labrum marked with oval greenish yellow spot on either side ; epistome on lateral edges of anterior surface bordered greenish yellow and marked with two spots of same colour on either side, *viz.* an upper large oval and a lower small triangular one ; bases of antennae, a triangular elongated spot against each eye at the level of antennae followed by two pairs of spots of which the anterior pair are small and rounded and the hinder pair transversely oval and a bit larger, are present in addition to those in male, all

greenish yellow ; spots against lateral ocelli pear shaped. Prothorax with following yellowish markings : a linear crown shaped spot on anterior lobe ; a small mid-dorsal and two large lateral pear shaped spots on posterior lobe. Legs with flexor surfaces of all femora mostly creamy white. Wings enfumed with pale brown which is more pronounced in distal half ; pterostigma medially yellowish in hindwing. Abdomen with following greenish yellow markings : segment 1 with a large triangular spot on dorsum at apex ; segments 2 to 5 with basal and apical triangular spots with a narrow stripe (sometimes absent) in between ; segment 7 with a lateral stripe which is pointed at apex ; segments 8 and 9 with subapical lateral spots ; mid-dorsal carina finely yellow throughout but variably obscured in adults.

Measurements (in mm) : ♂ (8 exs) and ♀ (4 exs) respectively ; length of abdomen 14.5-15.5, 13.0-14.0 ; length of forewing 19.0-20.5, 20.5-21.0 ; length of hindwing 18.5-20.0, 20.0-21.0 ; number of antenodal veins : forewing 5-7, 6 ; hindwing 5-7, 5-6 ; number of postnodal veins : forewing 11-13 (♀) ; hindwing 12-15, 11-13.

Remarks : The males under study vary from the description of *L. andamanensis* provided by Fraser (1934) in the following points : labium broadly marked with yellow in tenerals ; in adults, epistome black, unmarked ; prothorax with following yellow markings : a linear mid-dorsal spot on anterior lobe, two sub-dorsal oval ones on middle lobe, a mid-dorsal droplet shaped and two lateral oval ones on posterior lobe ; an upper humeral and a few scattered spots beneath synthorax present, besides those mentioned by the author ; legs with flexor surfaces of all tibiae and those of anterior femora pruinosed pulverulant white ; basal golden tinge on wings more pronounced in costal areas and extending nearly up to nodus in forewing ; apical opaque area obliquely receded posteriorly being *ca* 3.25 mm in extent medially ; abdomen greenish yellow on proximal segments ; segment 1 completely black on dorsum ; on segment 2, dorsal and lower lateral stripes confluent at base and apex.

The female, unknown so far, has been described above showing its difference from the male.

While abdominal markings leave no doubt on their identity, the specimens under study exhibit a closer similarity with *Libellago lineata* (Burmeister) than *andamanensis* in respect of markings on frons and fore femora, while a complete range between the two forms are noticed in respect of wing markings, number of antenodal cross-veins and length of abdomen. It seems most reasonable therefore that *andamanensis* Fraser is nothing but a distinct form of *lineata*

(Burmeister) charactarised by having a larger size (specially hindwing) and dark abdominal markings. So, *andamanensis* has been treated here as a subspecies of *L. lineata* (Burmeister).

Distribution : South Andamans (present and past record).

Family CALOPTERYGIDAE

Genus **Vestalis** Selys

2. **Vestalis gracilis gracilis** (Rambur)

1842. *Calopteryx gracilis* Rambur, M. P., *Hist. Nat. Ins., Ne'vropteres,* : 224.

1934. *Vestalis gracilis gracilis,* Fraser, F. C., *Fauna Brit. India, Odonata* **2** : 126.

Material : 26 exs coll. *B. S. Lamba,* 5. iii. '64 to 29. iv. '64 as follows : Mannar Ghat, Wright Myo (9 ♂♂, 7 ♀♀) ; cowriaghat (1 ♂, 3 ♀♀) ; Shoal Bay (1 ♂) ; Jaarva Gusk (1 ♂) ; Wrafters Creek (1 ♀) ; Mamyo Chhelder (1 ♀) ; Humphrygunj (2 ♀♀) ; 1 ex (♂) coll. *T. D. Soota,* S. Kalighat, 28. iii. '64.

Measurements (in mm.) : ♂ (7 exs) and ♀ (12 exs) respectively; length of abdomen 47.0-52.0, 45.0-47.0 ; length of forewing 37.0-39.5, 37.0-40.0 ; length of hindwing 35.0-37.0, 36.0-39.0 ; number of antenodal veins : forewing 23-32, 24-28 ; hindwing 25-28, 22-26; number of postnodal veins : forewing 69-78, 56-69 ; hindwing 59-67, 52-60.

Remarks : This is the first record of this species from the Andamans. The male specimens have a few more postnodal veins as compared to the number given by Fraser (1934).

Distribution : South Andamans (present record) Earlier known from various parts of INDIA, BURMA, VIETNAM and MALAYSIA.

Family LESTIDAE

Genus **Lestes** Leach

3. **Lestes ? malabarica** Fraser

1929. *Lestes malabarica* Fraser, F. C., *J. Bombay nat Hist. Soc.,* **33** : 848.

Material : 1 ex (♂), Viper Island, Coll. *R. B. S. Sewell,* 28. viii. '28.

Measurements (in mm) : ♂ (1 ex) ; length of forewing 21.0 ; length of hindwing 20.0 number of postnodal veins : forewing 11-12 ; hindwing 12.

Remarks : The single specimen available for study is damaged but from the markings of the body parts present, wing venation and measurements, it seems most likely to be *malabarica* Fraser. So, it has been doubtfully identified as such.

Distribution : South Andamans (present record). It is also known from Cochin and South Malabar, and peninsular India.

Family PLATYSTICTIDAE

Genus **Drepanosticta** Laidlaw

4. **Drepanosticta ? annandalei** Fraser

(Text-figs. 1 & 2)

1924. *Drepanosticta annandalei* Fraser, F. C., *Rec. Indian Mus.*, **26** : 412.

Material : 2 exs as follows : 1 ♀, Hope town, Poni Ghat, coll. *R. B. S. Sewell*, 27. viii. '28 ; 1 ♀, Mannar Ghat Wright Myo, coll. *B. S. Lamba*, 26. iii. '64.

Measurements (in mm) : ♀ (2 exs) ; length of abdomen 33.0-35.0 ; length of forewing 24.0 ; length of hindwing 23.0-23.5 ; number of postnodal veins ; forewing 15-17, hindwing 14-17.

Remarks : These specimens have been identified as *D. annandalei* Fraser with a little hesitation, since there were no associated males and for two other factors, namely (i) much longer abdomen than stated for *annandalei* (25 mm) by Fraser (1933) and (ii) Ab arising from posterior wing margin at the point where Ac meets it in one of the specimens under study or from a short common stalk in the other specimen, while Fraser stated that in *annandalei* Ab arises from posterior wing border a little distal to Ac. However, considering the fact that Fraser (1924) described *annandalei* from two males and a single teneral female, the difference in abdominal length could perhaps be treated as a normal variation and on that basis these may be treated as topotypes.

Distribution : South Andamans only (previous and present record).

Family PROTONEURIDAE

Genus **Prodasineura** Cowley

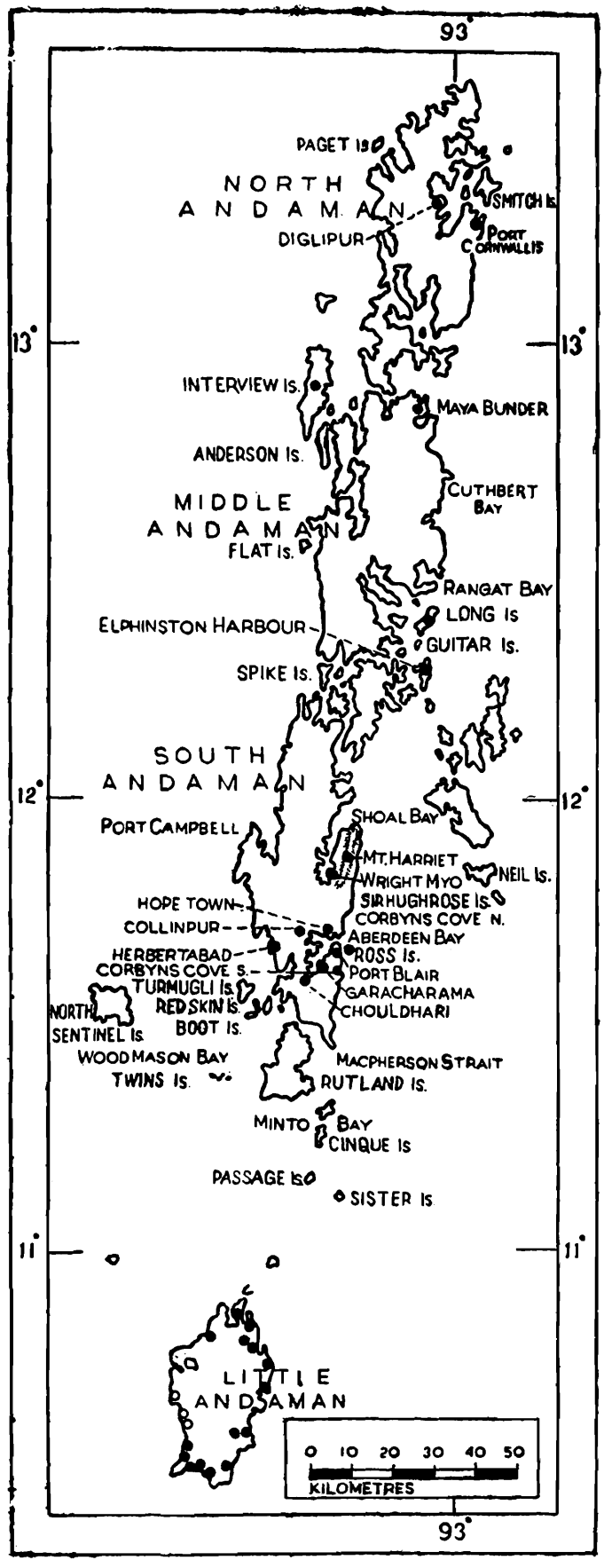
5. **Prodasineura verticalis andamanensis** (Fraser)

1924. *Caconeura verticalis* Fraser, F. C., *Rec. Indian Mus.*, **26** : 412.

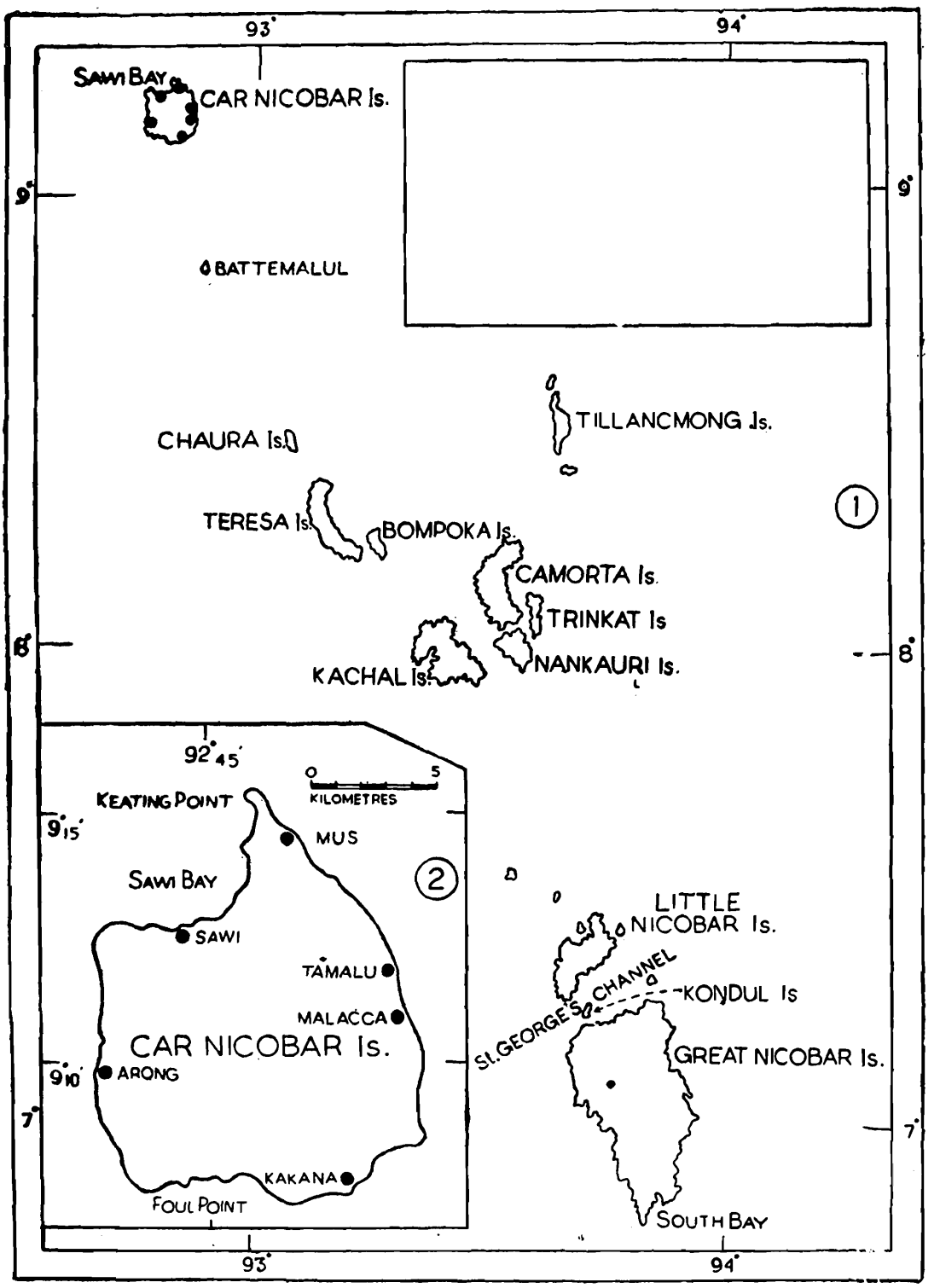
1933. *Caconeura verticalis andamanensis* Fraser, F. C., *Fauna Brit. India, Odonata*, **1** : 218.

Material : 3 exs (2 ♂♂, 1 ♀), Mannar Ghat, Wright Myo, coll. *B. S. Lamba*, 26. iii. '64.

Measurements (in mm) : ♂ (2 exs) and ♀ (1 ex) respectively ; length of abdomen 29.0, 33.0 ; length of forewing 21.0-21.5, 22.0 ; length of hindwing 19.5-20.0, 20.5 ; number of postnodal veins : forewing 15-17, 16-17 ; hindwing 13-14, 15-16.

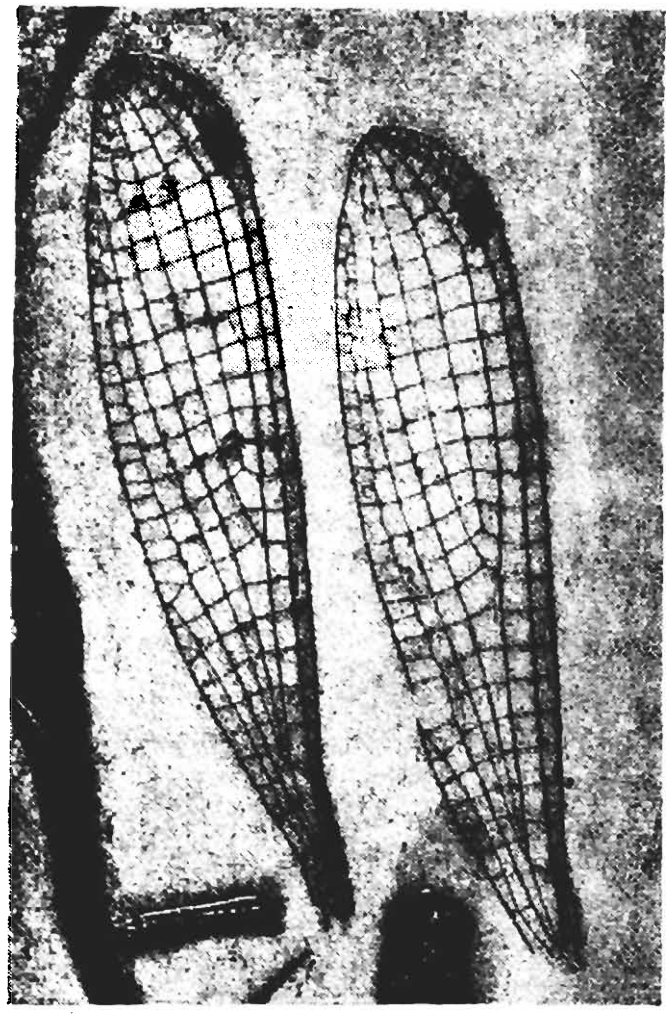


Map of Andaman Islands



Map of Nicobar Islands

Remarks : Fraser (1924) described this subspecies from South Andamans from males only, citing differences from the nominate species. The males under study exhibit the following differences from *C. v.* ***verticalis*** Selys, besides those mentioned by Fraser (1924, 1933) : the



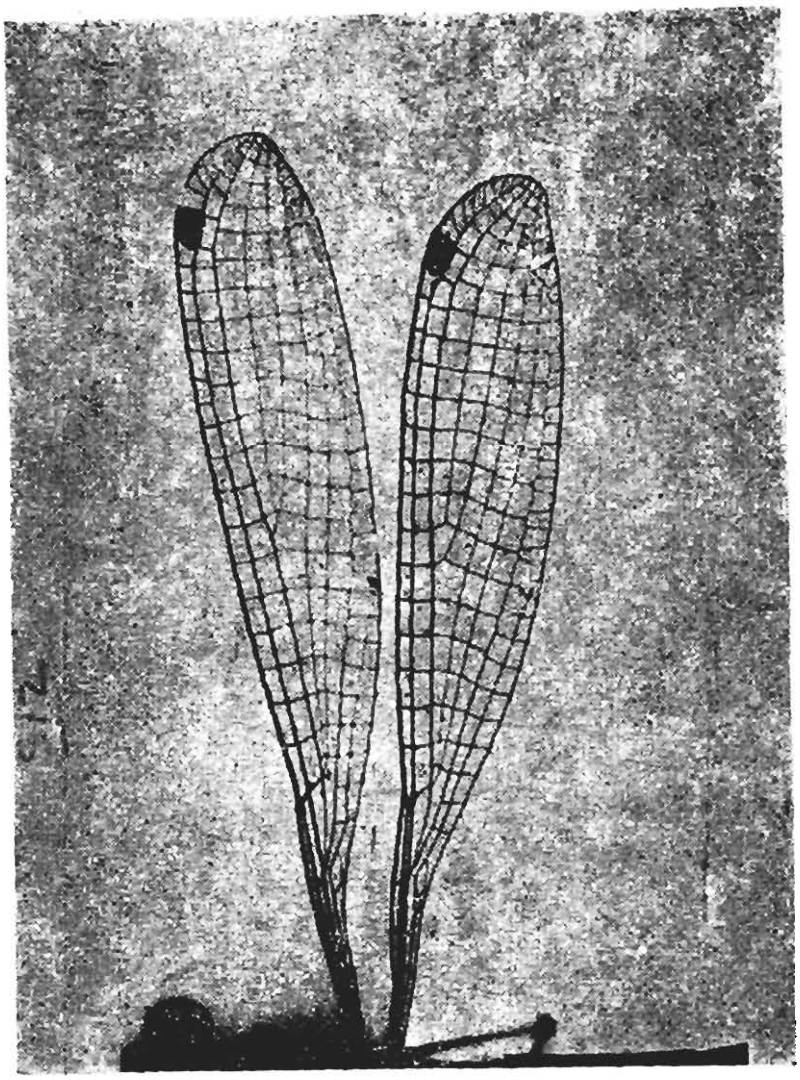
Text-fig. 1. *Drepanosticta ? annandalei* Fraser, forewings (♂).

antehumeral stripes on synthorax fall well short of antealar sinus above. Dorsum of segment 2 as well as entire abdomen beyond this segment without markings. Pterostigma margined with yellow, a little more broadened distally and covering about $1\frac{1}{2}$ cells. Cu_2 covering $3\frac{1}{2}-4$ and $5\frac{1}{2}$ cells in fore- and hindwing respectively.

The hitherto unknown female of this subspecies is reported here for the first time. The single specimen available for study differs from the female of the nominate species as described by Fraser (1933) in the markings of abdomen and that of thorax on ventral surface, as follows :

Thorax black beneath with a moderately large yellow spot at centre. Abdomen black beneath but marked with pale green as follows : segments 1-5 with broad ventrolateral stripe ; segments 2-6 finely marked

along mid-dorsal carina ; segments 3-6 with baso-lateral suboval spots. Ovipositor robust extending to end of abdomen. Cu_2 covering $3\frac{1}{2}-4$



Text-fig. 2, *Drepanosticta ? annandalei* Fraser, hindwings (♂).

and 5 cells in fore- and hindwings respectively ; pterostigma as described for male above.

Distribution : South Andamans only (present and past record).

Family PLATYCNEMIDIDAE

Genus **Copera** Kirby

6. **Copera marginipes** (Rambur)

1842. *Platycnemis marginipes* Rambur, M. P., *Hist. Nat. Ins. Ne'vropte`res,* : 240.

1933. *Copera marginipes,* Fraser, F. C., *Fauna Brit. India, Odonata,* **1** : 192.

Material : 50 exs, coll *B. S. Lamba,* March — April '64 as follows : Cowtiaghat (7♂♂, 5♀♀) ; Katan, Baratang (5♂♂) ; Mannar Ghat, Wright Myo (2♂♂, 1♀); Rajat Gar (3♂♂, 1♀) ; Shoal Bay (2♂♂) ; Wrafters Creek (20 ♂♂, 4 ♀♀).

Measurements (in mm.) ♂ (30 exs) and ♀ (7 exs) respectively; length of abdomen 30.0-32.0, 26.0-30.0 ; length of forewing 17.0-19.0, 20.0-21.5 ; length of hindwing 16.5-18.5, 19.0-20.0 ; number of postnodal veins : forewing 11-14, 12-14 ; hindwing 9-10, 9-11.

Remarks : This is the first record of this species from South Andamans. The specimens under study agree with the Indian West Coast forms described by Fraser (1933). However, the male superior anal appendages look obtusely triangular when viewed from dorsum, while the apex of the organ strongly bent inwards is visible only at a dorsolateral angle.

Distribution : South Andamans (present record). It is a well distributed species ranging from SRI LANKA and INDIA to MALAYSIA in the east.

Family COENAGRIONIDAE

KEY TO THE GENERA OF THE FAMILY COENAGRIONIDAE

1.	Arc situated distal to the level of the distal antenodal nervure. ...	**Agriocnemis** Selys
—	Arc situated at the level of the distal antenodal nervure. ...	... 2
2.	Ab arising from a point well proximal to Ac. ...	**Ischnura** Charpentier. [I. *senegalensis* (Rambur)]
—	Ab arising from a point at, or slightly proximal to Ac. ...	... 3
3.	Frons with a prominent ridge. ...	**Ceriagrion** Selys
—	Frons without a ridge as above. ...	**Pseudagrion** Selys (*P.* ? *andamanicum* Fraser)

Genus **Pseudagrion** Selys

7. **Pseudagrion ? andamanicum** Fraser

1924. *Pseudagrion andamanicum* Fraser, F. C. *Rec. Indian Mus.*, **26** : 411.

Material : 2 exs (1♂, 1♀), Viper island, coll. *R. B. S. Sewell*, 28. viii. '28.

Measurements (in mm) : ♂ (1 ex) and ♀ (1 ex) respectively ; length of forewing 18. 0, 20. 0 ; length of hindwing 17. 0, 19. 0, number of postnodal veins : forewing 11 and hindwing 9 (either sex).

Remarks : Both specimens available for study have the terminal abdominal segments missing, but from the markings on the remaining body parts, wing venation and measurements, they seem most likely to be *andamanicum* Fraser.

Distribution : South Andamans only.

Genus **Ceriagrion** Selys

KEY TO THE SPECIES OF THE GENUS **Ceriagrion** Selys

1. Abdomen bright red at base and anal ends, black on dorsum in between. ... *cerinorubellum* Brauer

— Abdomen uniformly reddish brown on dorsum. ... *olivaceum aurantieum* Fraser

8. **Ceriagrion cerinorubellum** (Brauer)

1865. *Pyrrhosoma cerinorubellum* Brauer, A, *Verh. zool.-Bot. Ges. Wien*, **15** : 511.

1933. *Ceriagrion cerinorubellum*, Fraser, F. C., *Fauna Brit. India, Odonata*, **1** : 326.

Material : 1 ♂, Viper island, coll. *R. B. S. Sewell*, 28. viii. '28.

Measurements (in mm) : ♂ (1 ex) ; length of abdomen 32. 5 ; length of forewing 20. 5 ; length of hindwing 19. 5 ; number of postnodal veins : Forewing 12, hindwing 10.

Remarks : This is the first record of this species from the Andamans. It is evidently on account of postmortem changes that the male specimen under study has its thorax mostly brownish instead of green, the colour stated in the description of the species provided by Fraser (1933).

Distribution : South Andamans (present record) this species is also known from various parts of the Indian subcontinent, Sri Lanka, Burma and Malaysia.

9. **Ceriagrion olivaceum auranticum** Fraser

1923. *Ceriagrion auranticum* Fraser, F. C., *J. Bombay nat. Hist. Soc.*, **29** : 748.

1967. *Ceriagrion olivaceum auranticum*, Asahina, S., *Jap. J. Zool.* **15** (3) : 307.

Material : 1 ex (♀), Car Nicobar, Tutop, coll. *T. D. Soota*, 12. v. '69.

Measurements (in mm) : ♀ (1ex) ; length of abdomen 32. 0 ; length of forewing 23. 0 ; length of hindwing 22. 0 ; number of postnodal veins : forewing 11-13 ; hindwing 10.

Remarks : This is the first record of this species from South Andamans.

Distribution : South Andamans (present record). This subspecies is also known from Nilgiri Wynaad and Western Ghats, Southern India.

Genus **Ischnura** Charpentier

10. **Ischnura senegalensis** (Rambur)

1850. *Agrion senegalensis* Rambur, M. P., *Hist. Nat. Ins. Nevropteres,* : 276.

1933. *Ischnura senegalensis,* Fraser, F. C., *Fauna Brit. India, Odonata,* 1 : 348.

Material : 1 ♂, Port Blair, coll. *T. D. Soota,* 28. iii. 1969.

Measurements (in mm) ♂ (1 ex) : length of abdomen 25-0 ; length of forewing 15.5 ; length of hindwing 15.0 ; number of postnodal veins ; forewing 7-8 ; hindwing 6.

Remark : This is the first record of this species from the South Andamans.

Distribution : South Andamans (present record). It is a widely distributed species throughout the tropics of the Old-World except Australia.

Genus **Agriocnemis** Selys

KEY TO THE SPECIES OF THE GENUS **Agriocnemis** Selys (Males)

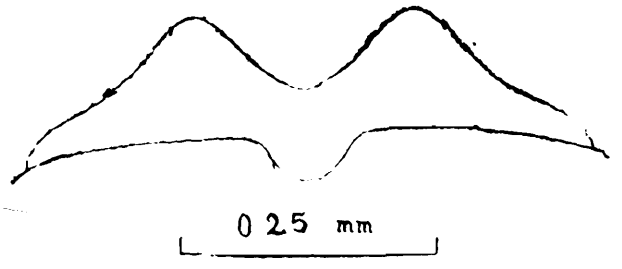
1. Inferior anal appendage longer than superior. ... *femina* group
— Inferior analappendage shorter than superior. ... *pygmaea* (Rambur)

11. **Agriocnemis femina oryzae** Lieftinck

(Text-fig. 3)

1962. *Agriocnemis femina oryzae* Lieftinck, M. A., *Insects of Micronesia,* 5 (1) : 44.

Material : 36 exs ; 2 exs, coll. *R. B. S. Sewell* as follows ; 1 ♂, Hope town, Poni Ghat, 27. viii. '28 ; 1 ♂, Denni point 3. ix. '28 ; 1 ex (♂),



Text-fig. 3. *Agriocnemis femina oryzae* Lieftinck, Posterior lobe of prothorax (♀).

Mannar Ghat, Wright Myo, coll. *B. S. Lamba,* 25. iii. '64 ; 33 exs (21 ♂♂, 12 ♀♀), Bibliaganj, Port Blair and Wright Myo, coll. *T. D. Soota,* March-April '69.

Measurements (in mm) ♂ (23 exs) and ♀ (12 exs) respectively : length of abdomen 17.0-17.5, 17.5-2 .0 ; length of forewing 9.5-11.0, 11.0-11.5 ; length of hindwing 9.0-10. 5, 10.5-11.5, number of postnodal veins : forewing 6-7, 7-8 ; hindwing 4-5, 5-7.

Remarks : This is the first record of this species from South Andamans. The specimens under study agree with *A. f. oryzae* Lieftinck in general and specially in respect of the structure of male anal appendages, but vary a little in size and rather markedly so in respect of the shape of female prothorax.

Distribution : South Andamans (present record). It is also known from Ryukyu Is., Borodino Is., CHINA and TAIWAN.

12. **Agriocnemis pygmaea** (Rambur)

1842. *Agrion pygmaeum* Rambur, M. P., *Hist. nat. Ins. Ne'vropte'res,* : 278.

1933. *Agriocnemis pygmaea,* Fraser, F. C., *Fauna British India., Odonata,* **1** : 398.

Material : 6 ♂♂, Great Nicobar, coll. *A. Daniel* and *H. K. Bhowmik* as follows : 1 ex., Campbell Bay, 13. iii. '66, 5 exs., Phulbaha, 26. iii. '66.

Measurements (in mm) : ♂ (6 exs) ; length of abdomen 17.0 ; length of forewing 11.0 ; length of hindwing 10.0 ; number of postnodal veins : forewing 6-7, hindwing 5-6.

Remark : This is the first record of this species from Great Nicobar.

Distribution : Great Nicobar (present record) ; it is a well distributed species ranging from Seychelles across entire oriental region to Australia and the Pacific islands in the east.

Family GOMPHIDAE

Genus **Gomphidia** Selys

13. **Gomphidia ganeshi** sp. nov.*

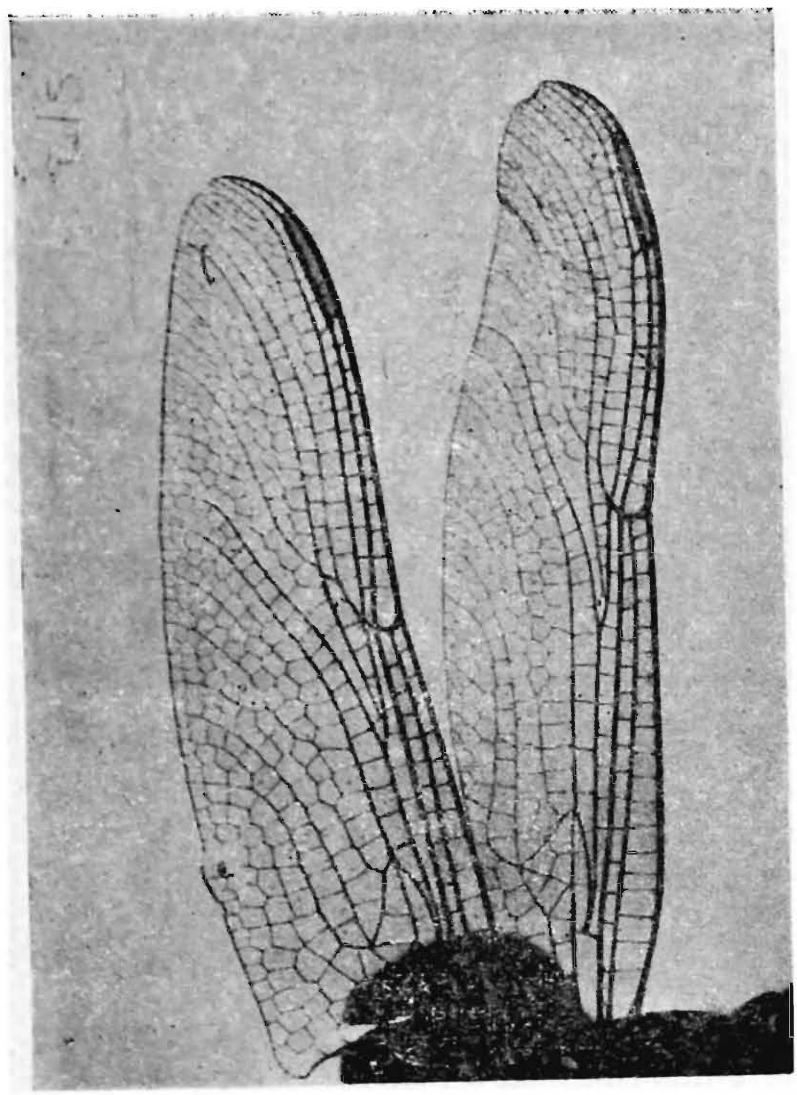
(Text-fig. 4)

Material : *Holotype* ♂, Rajatgarh, *B. S. Lamba,* 22. iii. '64. Reg. No. 5149/H8.

Description : Male (adult) Head blackish brown marked as follows : a faint yellowish rounded spot on either side of labrum ; anteclypeus and two large oval spots on frons yellow, these latter covering the crest but for its middle, reaching almost the base of sulcus and the

*The species has been named after the name of Lord Ganesh of Hindu Mythology.

lateral margins on either side of frons. The lateral ocelli guarded behind by a prominent ridge raised on either end into a pyramidal eminence and thickly beset with long fine hairs. Occiput trapezoidal, hind margin declined sharply downwards.



Text-fig. 4. *Gomphidia ganeshi* sp. nov., fore- and hindwings (holotype ♂).

Thorax blackish brown marked with yellow as follows :—a moderately broad mesothoracic collar slightly interrupted in middle ; oblong oval antehumeral stripes, reaching antealar sinus above, but falling far short of mesothoracic collar below ; two lateral stripes, of which the first running just above the spiracle but falling short of the ventral margin and the other covering most part of the metepimeron but for its ventral margin ; an obscure upper rounded spot in between the lateral stripes. Legs blackish brown, the femora yellow on inner surfaces.

Abdomen blackish brown marked with yellow as follows : Segment 1 with a broad mid-dorsal stripe falling short of the apex of the segment ;

segment 2 with a triangular mid-dorsal spot at base ; segment 7 yellow upto the jugal suture except at ventral margin ; segment 8 with an incomplete narrow ring at base ; segments 4 to 6 beset with closely set small spicules in dorsal halves ; lateral margins of segment 8 slightly dilated.

Anal appendages blackish brown ; superiors widely separated and cylindrical at base, broken shortly thereafter ; the base suggests the organs to have initially been much longer than segment 10 of abdomen and of the shape as for genus ; inferior much shorter than segment 10 and deeply bifid, the branches rapidly narrowing to pointed apex directed upwards.

Genitalia : Lamina arched ; anterior hamules narrow, posterior hamules broadly triangular and directed backwards, lobe scoop shaped.

Wings hyaline ; anal triangle 4 to 5 celled ; primary antenodals the 1st and 7th in forewing, the 1st and 5th or 6th in hindwing ; hypertrigones traversed twice in forewing, once in hindwing ; discoidal cells 3 celled in forewing, 2 celled in hindwing ; that of forewing with costal and outer margins subequal and little longer than the basal ; 5-8 cross veins between arc and the point of bifurcation of Rs in forewing, 5 in hindwing ; pterostigma long and narrow, braced, covering 5 cells and more than half the distance between node and proximal end of pterostigma in forewing, and 6 cells and a little less than half the said distance in hindwing ; anal loop 6-8 celled.

Measurements (in mm) : Holotype, ♂ : length of abdomen (without anal appendages) 44. 5 ; length of forewing 37. 0 ; length of hindwing 35.0, number of antenodal veins : forewing 17-19, hindwing 12-13, number of postnodal veins : forewing 17-19, hindwing 12-13.

Comparision : *G. ganeshi* comes closer to *G. kirschi* Laidlaw, but differs from the same in being smaller in size with lower nodal (specially postnodal) index and markings of the synthorax.

Distribution : South Andamans only.

Family AESHNIDAE

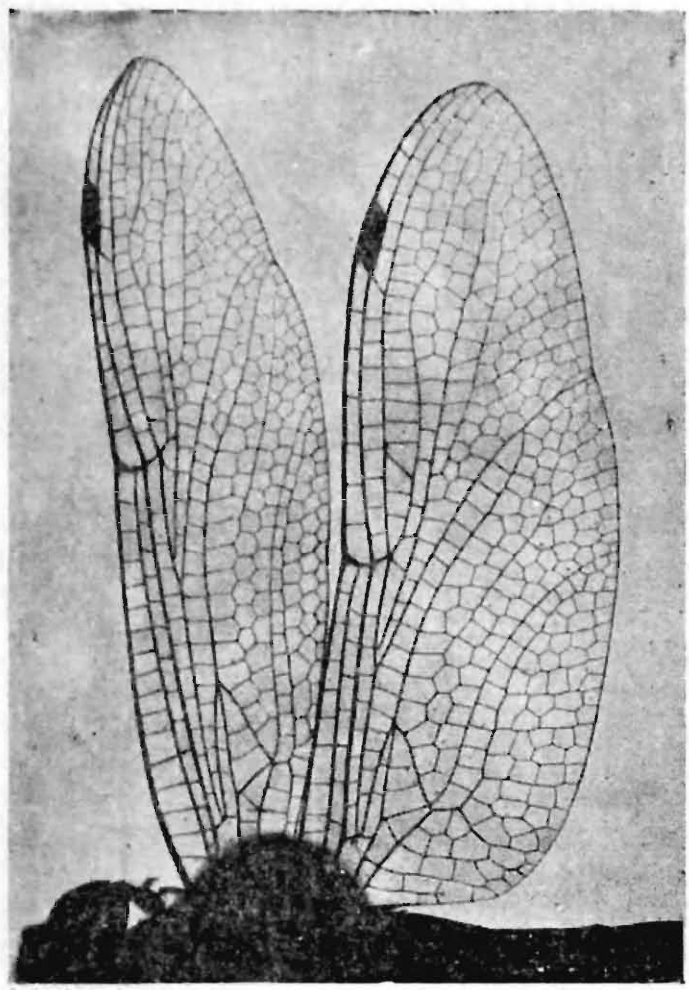
Genus **Oligoaeschna** Selys

14. **Oligoaeschna andamani** sp. nov.

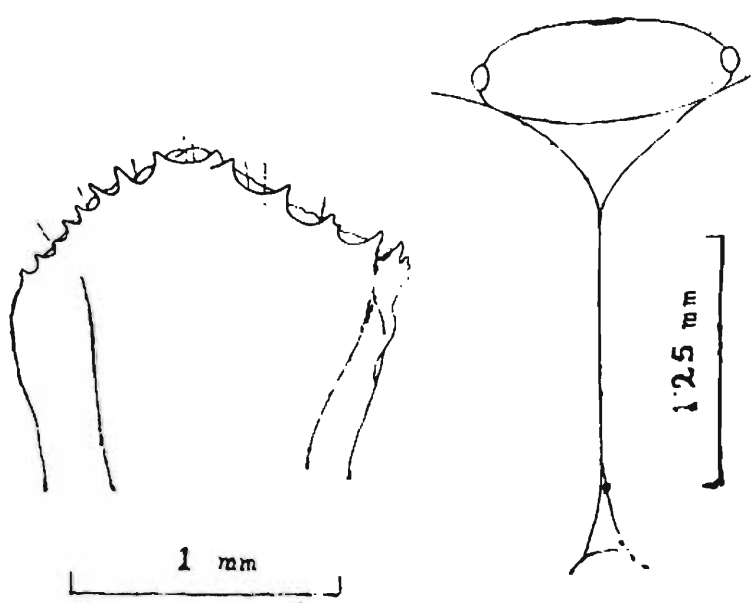
(Text-figs. 5, 6 and 7)

Material : *Holotype* ♀, Cowriaghat, coll. *B. S. Lamba*, 11. iv. '64. Reg. no. 8275/48.

Description : Female (adult) — Labium, face, eyes and head ventrally blackish brown, frons, vertex and occiput black, marked with



Text-fig. 5. *Oligoaeschna andamani* sp. nov. (holotype ♀) ; fore- and hindwings.



6 7

Text-figs. 6-7. *Oligoaeschna andamani* S P. nov.,

Fig. 6 : apical portion of the dentigerous plate,

Fig. 7 : interorbital suture and occiput.

greenish yellow as follows : a longitudinally elongated spot just across bases of mandibles, a narrow line on postclypeus at base, enlarged into a large lateral spot on either side after a short interruption ; a moderately broad stripe running across the frons between crest and base of sulcus, interrupted broadly in the middle ; frons and vertex covered with thick black hairs ; inter-orbital suture about thrice as long as occipital triangle ; diameter of head across eyes slightly less than twice width of frons.

Thorax reddish brown changing to black on dorsum marked with a pair of greenish yellow lateral stripes on either side, viz. one posthumeral and one covering most of metepimeron. Legs black but proximal half of all femora reddish brown. Wings palely tinted with brown from base, to a line running obliquely inwards from inner end of pterostigma and meeting in inner wing border at a point, where Cu_2 terminates ; deeper tint at base upto arculus continued into subcostal ray upto node and a larger subcostal postnodal spot ; primary antenodals are first and 5th ; discoidal cell traversed twice ; hypertriangle entire in left forewing but traversed thrice in right forewing and twice in hindwing ; anal loop 4-5 celled ; pterostigma rather short (2.25 mm), narrow, dark brown and braced ; two rows of cells between M_4 Mspl and 2 cells between anal loop and inner wing border. Abdomen reddish brown, darker on dorsum and gradually changing to black apically, being mostly black on segments 7-10 and marked with yellow as follows : a large subrounded spot on segment 1 on either side ; a complete ventrolateral stripe and 5 spots on segment 2 as follows : a median narrow triangular spot extending shortly from base and one pair each of postjugular and apical subtriangular spots ; ventrolateral borders of segments 8 and 9 ; segment 2 expanded at base narrowed thereafter, but again slightly expanded at apex, the narrowest part being about two-thirds as wide as broadest part ; abdomen narrowing apically but segments 8 and 9 broader and laterally compressed. Anal appendages dark brown, broken shortly after base. Apical margin of dentigerous plate suboval and armed with 15 teeth.

Measurements (in mm) : Holotype ♀ ; length of abdomen 43.0 ; length of forewing 41.0 ; length of hindwing 38.0 ; number of antenodal veins : forewing 16-17 ; hindwing 10 ; number of postnodal veins : forewing 6-7, hindwing 6-8.

Comparison : *O. andamani* comes closer to *O. modiglianii* Selys on account of long interorbital suture, general build and some details of markings and venation. However, it differs from the same in having

the thorax unmarked on dorsum, shorter hindwing, lower nodal index, larger anal loop and more cells in cubital space proximal to anal loop.

Distribution : South Andamans only.

Family LIBELLULIDAE

KEY TO THE GENERA OF THE FAMILY LIBELLULIDAE

1.	Borders of anal loop running on to meet posterior border of wing, the apex of the loop remaining open thereby. ...	**Tholymis** Hagen [*Tholymis tillarga* (Fabricius)]
—	Borders of anal loop converging to meet before posterior border of wing, the apex of the loop becoming closed thereby. ...	... 2
2.	Distal antenodal nervure in forewing complete. ...	... 3
—	Distal antenodal nervure in forewing incomplete. ...	... 4
3.	Posterior lobe of prothorax enlarged, erected as a collar and provided with long hairs. ...	**Orthetrum** Newman
—	Posterior lobe of prothorax not as above. ...	**Nesoxenia** Kirby [*Nesoxemia lineata* (Selys)]
4.	Posterior lobe of prothorax enlarged, erected as a collar and provided with long hairs. ...	**Diplacodes** Kirby [*Diplacodes trivialis* (Rambur)]
—	Posterior lobe of prothorax not as above. ...	... 5
5.	Discoidal field with borders converging strongly at wing margin. ...	**Trithemis** Brauer
—	Discoidal field with borders parallel or divergent at wing margin. ...	... 6
6.	More than 1 cubital nervure in all wings. ...	**Neurothemis** Brauer
—	Only 1 cubital nervure in all wings. ...	... 7
7.	Wings marked with amber-yellow at base. ...	**Crocothemis** Brauer [*Crocothemis servilia servilia* (Drury)]
—	Wings unmarked at base. ...	... 8
8.	Discoidal cell of hindwing traversed by a cross vein. ...	**Potamarcha** Karsch [*Potamarcha congener* (Rambur)]
—	Discoidal cell of hindwing entire. ...	**Lathrecista** Kirby [*Lathrecista asiatica asiatica* (Fabricius)]

Genus **Lathrecista** Kirby

15. **Lathrecista asiatica asiatica** (Fabricius)

1798. *Libellula asiatica* Fabricius, J. C. *Ent. Syst.* (*suppl.*), : 283.

1936. *Lathrecista asiatica asiatica*, Fraser, F. C., *Fauna Brit. India, Odonata*, **3** : 281.

Material : 14 exs as follows : 5 ♂♂, Macpherson strait, south side, coll. *R. B. S. Sewell*, 28. viii. '28 ; 9 ♂♂, Bamboo flat Road, Burma nulla, Cowriaghat, Humphrygunj and Shoal Bay, coll. *B. S. Lamba*, 6 iii.—16. iv. '64.

Measurements (in mm) : ♂ (14 exs) ; length of abdomen 32.5-33.5 ; length of forewing 34.0-36.0 ; length of hindwing 30.0-35.0 ; number of antenodal veins : forewing 15½-18½, hindwing 12-14 ; number of postnodal veins : forewing 11-14, hindwing 10-14.

Remarks : This is the first record of this species from South Andamans. The specimens under study vary from the description of the species provided by Fraser (1936) in having metallic blue black vesicle unmarked with yellow and brown thorax.

Distribution : South Andamans (present record) ; it is a well distributed species in the Oriential region.

Genus **Nesoxenia** Kirby

16. **Nesoxenia lineata** (Selys)

1879. *Agrionoptera lineata* Selys, E. L., *Ann. Mus. Civ. Genova*, **14** : 302.

1936. *Nesoxenia lineata*, Fraser, F. C., *Fauna Brit. India, Odonata*, **3** : 279.

Material : 5 exs as follows : 1 ex ♀, Wrafters Creek, coll. *B. S. Lamba*, 16. iii. '64 ; 2 ♂♂, 2 ♀♀ Great Nicobar, Casurina Bay and Campbell Bay, coll. *A. Daniel* and *H. K. Bhowmik*, 2-3. iv. '66.

Measurements (In mm.) ♂ (2 exs) and ♀, (3 exs.) respectively : length of abdomen 30.0, 26.0-31.0 ; length of forewing 32.0, 32.0-34.0 ; length of hindwing 32.0, 30.5-32.0 ; number of antenodal veins : forewing 15-16, 14-16, hindwing 13-14, 12-14 ; number of postnodal veins : forewing 13-15, 13-16, hindwing 13, 12-15.

Remarks : This is first record of this species from South Andamans. The specimens studied varies from the description of the species provided by Fraser (1936), in having metepimeron and 1st 3 abdominal segments not pruinosed.

Distribution : South Andamans (present record) ; this species is also known from Darjeeling district, eastern INDIA and MALAYSIA.

Genus **Potamarcha** Karsch

17. **Potamarcha congener** (Rambur)

1842. *Libellula congener* Rambur, M. P., *Hist. nat. Ins. Ne'vroptè'res*, : 70.

1971. *Potamarcha congener*, Lieftinck, M. A., *Ent. Scand. Suppl.* **1** : 202.

Material : 2 exs (♂ ♂), Katan, Baratang and Rajatgarh, coll. *B. S. Lamba*, 21-22, iii. '64.

Measurements (in mm) ♂ (2 exs) ; length of abdomen 31.0-31.5 ; length of forewing 34.0-36.0 ; length of hindwing 32.0-32.5 ; number of antenodal veins : forewing 13½-14½, hindwing 10, number of postnodal veins : forewing 10 ; hindwing 11.

Remark : This is the first record of this species from South Andamans.

Distribution : South Andamans (present record) ; it is a well distributed species in the Oriental region and parts of INDONESIA.

Genus **Orthetrum** Newman

KEY TO THE SPECIES OF THE GENUS **Orthetrum** NEWMAN

1. Abdomen enormously swollen at base and then abruptly slimmed and compressed to the end.... *sabina* (Drury)

2. Abdomen not as above, more or less of even width. ... *chrysis* (Selys)

18. **Orthetrum chrysis** (Selys)

1891. *Libellula testacea* race ? *chrysis* Selys, E. L., *Ann. Mus. civ. Genova*, **30** : 462.

1936. *Orthetrum chrysis*, Fraser, F. C., *Fauna Brit. India, Odonata* **3** : 310.

Material : 3 exs (♂ ♂), Cowriaghat, Katan, Baratang and Wright Myo, coll. *B. S. Lamba*, 16-21, iii. '64.

Measurements (in mm) : ♂ (3 exs) ; length of abdomen 29.0-30.0 ; length of forewing 35.0-36.0 ; length of hindwing 33.0-34. 0 ; number of antenodal veins : forewing 17, hindwing 11-14 ; number of postnodal veins : forewing 11-12, hindwing 12.

Remark : This the first record of this species from South Andamans.

Distribution : South Andamans (present record) ; it is a sparingly but widely distributed species in the Oriental region.

19. **Orthetrum sabina sabina** (Drury)

1770. *Libellula sabina* Drury, D., *Ill. Exot. Ins.*, **1** : 114.

1942. *Orthetrum sabina sabina*, Lieftinck, M. A., *Treubia*, **18** : 477.

Material : 42 exs as follows : 4 ♂♂, 6 ♀♀ Denni point, North Bay and Hope Town, Poni Ghat, coll. *R. B. S. Sewell*, 27. vii.-3. ix. '28 ; 26 ♂♂, 6 ♀♀, Burma nulla, Humphrygunj, Mannar Ghat, Wright Myo, Port Blair, Dairy Farm and Shoal Bay, coll. *B. S. Lamba*, 29. ii. -15. iv.'64.

Measurements (in mm) : ♂ (30 exs) and ♀ (14 exs) respectively ; length of abdomen 31.0-34.0, 33.0-36.0 ; length of forewing 33.0-36.0 ; 31.0-36.5 ; length of hindwing 31.0-36.0, 35.0-36.0, number of antenodal veins : forewing 12-13, 12-15 ; hindwing 9-10, 9-11 ; number of postnodal veins : forewing 9-11 (either sex) ; hindwing 10-12, 10-13.

Remark : This is the first record of the nominate species from South Andamans.

Distribution : South Andamans (present record) ; it has a wide range of distribution from Egypt, through Asia to north Australia, Oceania and Ryukyus.

Genus **Crocothemis** Brauer

20. **Crocothemis servilia servilia** (Drury)

1770. *Libellula servilia* Drury, D., *Ill. Exot. Ins.*, **1** : 112.

1936. *Crocothemis servilia servilia*, F.C., Fraser, *Fauna Brit. India, Odonata*, **3** : 345.

Material : 1 ex (♂), Port Blair, Dairy Farm, coll. *B. S. Lamba*, 29. ii. '64.

Measurements (in mm) : ♂ (1 ex) ; length of abdomen 27.0 ; length of forewing 32.0 ; length of hindwing 31.0 ; number of antenodal veins : forewing $10\frac{1}{2}$, hindwing 8 ; number of postnodal veins : forewing 9, hindwing 10-11.

Remark : This is the first record of this species from South Andamans.

Distribution : South Andamans (present record) ; it is a well distributed species all over southeast Asia and is also known from Japan and Australia.

Genus **Diplacodes** Kirby

21. **Diplacodes trivialis** (Rambur)

1842. *Libellula trivialis* Rambur, M. P., *Hist. nat. Ins. Nevropteres*, : 115.

1936. *Diplacodes trivialis*, Fraser, F. C., *Fauna Brit. India, Odonata*, **3** : 336.

Material : 19 exs as follows : 3 ♂♂, 5 ♀♀, Aberdeen, Denni point, North Bay and Viper island, coll. *R. B. S. Sewell* 28. viii-3. ix. '28 ;

4 ♂♂, 7 ♀♀, Chiriatapu, Cowriaghat, Mannar Ghat, Port Blair, Dairy Farm and Rogod Chang, Baratang, coll. *B. S. Lamba*, 1. iii.-9. iv. '64.

Measurements (in mm) : ♂ (7 exs) and ♀ (12 exs) respectively ; length of abdomen 21.0-23.0, 22.0-22.5 ; length of forewing 23.0-24.0 ; 23.0-25.0 ; length of hindwing 19.0-20.0, 21.0-21.5 ; number of antenodal viens : forewing $7\frac{1}{2}$-$8\frac{1}{2}$, 7-$7\frac{1}{2}$; number of postnodal veins : 6-7, 5-6 (either wing).

Remarks : The specimens under study are comparatively more melanotic and vary from the description of the species provided by Fraser (1936) in the following points :

Male : Prothorax without a mid-dorsal stripe.

Female : with (i) frons yellow ; (ii) synthorax blackish brown laterally ; (iii) segment 10 of abdomen black marked with lateral brown stripes.

Distribution : South Andamans (present and past record) ; it is a widely distributed species ranging from Seychelles across tropical Asia to Australia to the Western Pacific Islands.

Genus **Tholymis** Hagen

22. **Tholymis tillarga** (Fabricius)

1798. *Libellula tillarga* Fabricius, J. C., *Ent. syst.* (*suppl.*) : 285.

1936. *Tholymis tillarga*, Fraser, F. C., *Fauna Brit. India, Odonata*, 3 : 411.

Material : 2 exs as follows : 1 ♂, Maya Bunder, Burmadera, coll. *T. D. Soota*, 27. iii. '64 ; 1 ♀, Great Nicobar, Alexander river, coll. *A. Daniel* and *H. K. Bhowmik*, 13. iv. '66.

Measurements (in mm) : ♂ (1 ex) and ♀ (1 ex) respectively ; length of abdomen 29.0, 28.0 ; length of forewing 34.0, 33.0 ; length of hindwing 33.0 (both sexes) number of antenodal veins (both sexes) : forewing $9\frac{1}{2}$, hindwing 7 ; number of postnodal veins (both sexes) forewing 7-8 ; hindwing 9.

Remarks : This is the first record of this species from South Andamans and Great Nicobar.

Distribution : South Andamans and Great Nicobar (present record) ; it is a well distributed species ranging from Africa and Madagascar across south-east Asia to Australia and Oceania.

TABLE. 1. *List of Odonata collecting localities in Andamans and Car Nicobar.*

Abbreviations : A. D. : Dr. A. Daniel ; H. K. B. : Dr. H. K. Bhowmik ; B. S. L. ; Dr. B. S. Lamba ; R. B. B. S. Col. R. B. B. Sewell ; T. D. S. : T. D. Soota.

Locality	Latitude (approx)	Longitude (approx)	Collector and date of Collection
1	2	3	4
	A. *North Andamans*		
Bibliagunj (Near Diglipur)	—	—	T. D. S. 1. iv. 1969
Diglipur	13°17′N	92°59′E	T. D. S. 27. iii. 1969
Maya Bunder : Burmadera	12°52′E	92°57′E	T. D. S. 27. iii. 1969
South Kalighat (Near Diglipur)	—	—	T. D. S. 28. iii. 1969
	B *South Andamans*		
Aberdeen	11°38′— 11°42′N	92°39′— 92°46′E	R. B. B. S. 30. viii. 1928.
Bamboo Flat Road	11°34′N		B. S. L. 8. iii. 1964.
Burma Nulla	11°31′N	92°45′E	B. S. L. 8, 9 and 16. iv. 1964.
Chiriatapur	11°29′N	92°43′E	B. S. L. 9. iv. 1964
Cowriaghat	11°29′N	92°44′E	B. S. L. 8, 9, 11 and 16. iv. 1964.
Denni point	—	—	R. B. B. S. 3. ix. 1928
Hope town (Poni Ghat)	11°48′N	92°44′E	R. B. B. S. 27. vii. 1928
Humphrygunj	11°34′N	90°41′E	B. S. L. 6 and 7. iii. 1964.
Jaarva Gusk	12°11′N	92°41′E	B. S. L. 13. iii. 1964
Katan : Baratang	12°09′N	92°48′E	B. S. L. 12 and 21. iii. 1964.
Macpherson strait (South side)	11°04′— 11°08′N	92°37′— 92°04′E	R. B. B. S. 20. iii. 1928.
Mamyo : Chhelder	11°35′N	92°38′E	B. S. L. 5. iii.'64
Mannar Ghat : Wright Myo	11°44′N	92°44′E	B. S. L. 24, 25, 26, 28, and 30. iii ; 1, 2 and 3. iv. 1964.
North Bay (Near Port-Blair)	—	—	R. B. B. S. 29. iii. 1928
Port Blair ; Premnagar and Dairy Farm	11°37′N	92°43′E	B. S. L. 29. ii. and 1, iii.'64 ; T. D. S. ; 5 and 18. iii.—, 1. iv. 1969.
Rajat Gar	12°10′N	49°49′E	B. S. L. 22. iii. 64.
Rogod Chang (Baratang)	12°12′N	92°52′E	B. S. L. 20. iii. 1964.
Shoal Bay	11°48′N	92°46′E	B. S. L. 12, 16, 17 and 18. iii,' 64
Wrafters Creek	12°09′N	92°47′E	B. S. L. 12, 16, 17, and 18. iii. 64

TABLE 1. (*concluded*)

Locality	Latitude (approx)	Longitude (approx)	Collector and date of Collection
1	2	3	4
Wright Myo	11°45′N	92°44′E	B. S. L. 2 and 3 1964 ; T. D. S., 19. iii, 3 and 4. iv. 1969.
Viper Island (Near Port-Blair)	—	—	R. B. B. S. 28. iii. 1928.
		C. *Nicobars*	
Carnicobar : Tutop (Between Kakana and Mus village)	09°08′N	92°48′E	T. D. S. 14. iii. and 12. v. 1964.
		D. *Great Nicobar*	
Alexander river	—	—	A. D. & H. K. B. 13. v. 1966
Campbell bay	—	—	A. D. & H. K. B. 3 and 13. iii. 1966, 3. iv. 1966
Casuarina bay	—	—	A. D. & H. K. B. 2, 3 and 4. iv. 1966.
Phulbaha	—	—	A. D. & H. K. B. 26. iii. 1966.

Genus **Trithemis** Brauer

KEY TO THE SPECIES OF THE GENUS **Trithemis** BRAUER

1. Legs very long ; pterostigma black with its end white. ... **pallidinervis** (Kirby)
— Legs of normal length ; pterostigma unicolorous. 2
2. Wings marked with amber yellow at base. ... *aurora* (Burmeister)
— Wings marked with blackish brown at base. ... *festiva* (Rambur)

23. **Trithemis aurora** (Burmeister)

1839. *Libellula aurora* Burmeister, H., *Handb. Ent.*, **2** : 859.

1936. *Trithemis aurora*, Fraser, F. C., *Fauna Brit. India, Odonata*, **3** : 383.

Material : 2 exs (♂ ♂), Shoal Bay, coll. *B. S. Lamba*, 29. iii.' 64.

Measurements (in mm) : ♂ (2 exs), length of abdomen 21.0-22.0, length of forewing 26.0-27.0 ; length of hindwing 22.0-25.0 ; number of antenodal veins : forewing $13\frac{1}{2}$-$14\frac{1}{2}$, hindwing 10 ; number of postnodal veins : forewing 10, hindwing 11.

Remark : This is the first record of this species from South Andamans.

Distribution : South Andamans (present record) ; it is a well distributed species ranging from Ceylon and India to Philippines, Malaysia and Indonesia in the east.

24. **Trithemis festiva** (Rambur)

1842. *Libellula festiva* Rambur, M. P., *Hist. nat. Ins. Nevropteres*, : 92.

1936. *Trithemis festiva*, Fraser, F. C., *Fauna Brit. India, Odonata*, **3** : 387.

Material : 1 ex (♂), Mannar Ghat, Wright Myo, coll. *B. S. Lamba*, 1. iv.'64.

Measurements (in mm) : ♂ (1 ex) ; length of abdomen 18.0 ; length of forewing 29.0 ; length of hindwing 28.0 ; number of antenodal veins : forewing $10\frac{1}{2}$-$11\frac{1}{2}$, hindwing 7-8 ; number of postnodal veins : 7-8 (either wing).

Remarks : This is the first record of this species from South Andamans.

Distribution : South Andamans (present record) ; it is a well distributed species ranging from West Pakistan across India and Ceylon to New Guinea in the east.

25. **Trithemis pallidinervis** (Kirby)

1889. *Sympetrum pallidinervis* Kirby, W. F., *Trans. zool. Soc. Lond.*, **12** : 327.

1936. *Trithemis pallidinervis*, Fraser, F. C., *Fauna Brit India, Odonata*, **3** : 389.

Material : 1 ex (♀), Port Blair, Dairy Farm, coll. *B. S. Lamba*, 29. ii. '64.

Measurements (in mm) : ♀ (1 ex) ; length of abdomen 25.0 ; length of forewing 33.0 ; length of hindwing 32.0 ; number of antenodal veins : forewing $8\frac{1}{2}$; hindwing 6 ; number of postnodal veins : forewing 8-9; hindwing 10.

Remarks : This is the first record of this species from South Andamans.

Distribution : South Andamans (present record) ; it is a well distributed species ranging from India to Taiwan, Philippines and Malaya in the east.

Genus **Neurothemis** Brauer

KEY TO THE SPECIES OF THE GENUS **Neurothemis** BRAUER

1. Wings marked reddish brown from base nearly upto apex. ... *fluctuans* (Fabricius)

— Wings marked golden yellow only near base. ... *intermedia* group

26. **Neurothemis fluctuans** (Fabricius)

1798. *Libellula fluctuans* Fabricius, J. C., *Ent. Syst.*, **2** : 379.

1936. *Neurothemis fluctuans*, Fraser, F. C., *Fauna Brit. India, Odonata*, **3** : 355.

Material : 9 exs as follows : 4 ♂♂, 1 ♀, Katan, Baratang, Wrafters Creek and Humphrygunj, coll. *B. S. Lamba*, 7-21. iii. '64 ; 2♂♂, 2♀♀, Great Nicobar, Casuarina Bay, coll. *A. Daniel* and *H. K. Bhowmik*, 3-4. iv. '66.

Measurements (in mm) : ♂ (6 exs) and ♀ (3 exs) respectively ; length of abdomen 22.0-27.0, 20.0-23.0 ; length of forewing 27.0-32.0, 26.0-31.0 ; length of hindwing 26.0-31.0, 25.0-30.0 ; number of antenodal veins : forewing $14\frac{1}{2}$-$19\frac{1}{2}$, $14\frac{1}{2}$-$20\frac{1}{2}$; hindwing 11-15, 11-14 ; number of postnodal veins : forewing 12-17, 11-13 ; hindwing 12-13, 11-12.

Remarks : This is the first record of this species from South Andamans. The female specimen studied varies from the description of the species provided by Fraser (1936) in having discoidal cell with 6 and 2-3 cells and cubital space with 4 and 1 cross veins in fore- and hindwings respectively.

Distribution : South Andamans (present record) ; it has been reported from various parts of the mainland, Ceylon, Burma, Malacca and Malaysia.

27. **Neurothemis intermedia intermedia** (Rambur)

1842. *Libellula intermedia* Rambur, M. P., *Hist. nat. Ins. Ne'vroptères*, : 91.

1936. *Neurothemis intermedia intermedia*, Fraser, F. C., *Fauna Brit. India, Odonata*, **3** : 357.

Material : 1 ex (♀), Great Nicobar, Phalbaha, coll. *A. Daniel and H. K. Bhowmik*, 26 iii. '66.

Measurements (in mm) : ♀ (1 ex) : length of abdomen 16. 00 ; length of forewing 25. 0 ; length of hindwing 24. 0 ; number of antenodal veins : forewing $11\frac{1}{2}$, hindwing 10 ; number of postnodal veins : forewing 10, hindwing 9-10.

Remarks : This is the first record of this species from Great Nicobar.

Distribution : Great Nicobar (present record) ; this subspecies is also known from eastern and southern India, Ceylon, Nepal and Burma.

SUMMARY

Two new dragonfly species, e. g. *Gomphidia ganeshi* (family Gomphidae) and *Oligoaeschna andamani* (family Aeshnidae) and females of two damselfly species, e. g. *Libellago andamanensis* (Fraser) [consi-

dered here as a subspecies of *L. lineata* (Burmeister)] (Family Chlorocyphidae) and *Prodasineura verticalis andamanensis* (Fraser) (family Protoneuridae) have been described and 17 other dragon- and damselfly species belonging to the families Calopterygidae, Lestidae, Platycnemididae, Coenagrionidae and Libellulidae have been newly recorded from Andaman islands together with a brief review of an up-to-date knowledge of odonate Fauna of Andaman and Nicobar islands.

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STUDIES ON SOME DERMAPTERA PRESENT IN THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK

By

G. K. SRIVASTAVA

Zoological Survey of India, Calcutta

(With 3 Text-figures)

INTRODUCTION

The present report is based upon a small collection of Dermaptera from Pakistan, India, Burma, Philippine Islands and New Guinea comprising 17 species (including 3 spp up to generic level which are represented by females only) under 16 genera of which one species each belonging to genera *Anisolabis* Fieber and *Paratimomenus* Steinmann, from New Guinea are described as new to science. The material from New Guinea was collected by 4th, 5th and 6th Archibold Expeditions to the area organised by the American Museum of Natural History, New York (U. S. A.) during the years 1953, 1956 and 1957, respectively.

PYGIDICRANOIDEA

PYGIDICRANIDAE

PYGIDICRANINAE

Tagalina sp.

Material examined : NEW GUINEA : Papua, Mt. Dayaman, Maneau Range, North slope, 7000 m, 1 ♀, 15-19. vii. 1953, Camp 6, 1 ♀, 29. iv. 1953, Camp 5 (*G. M. Tate*, 4th Archibold Expedition).

Remarks : Elytra and wings are variegated.

CARCINOPHOROIDEA

CARCINOPHORIDAE

CARCINOPHORINAE

Epilandex solomonensis Brindle

Epilandex solomonensis Brindle, 1970, *Pacif. Insects*, **12** (3) : 563.

Material examined : NEW GUINEA, Papua, Mt. Riu, Sudest Isl., 250-350 m, 4 ♀ ♀, 27. viii. 1956, 2 ♂ ♂, 4 ♀ ♀, 1-5. ix. 1956, No. 10 (*L.J. Brass*, 5th Archibold Expedition).

Remarks : Previously recorded from Solomon Islands in New Guinea area.

Euborellia annulipes (Lucas)

Forficesila annulipes Lucas, 1847, *Annls. Soc. ent. Fr.*, **15** : 84.

Material examined : INDIA : Ahwa, Dangs Dist., Bombay State, 1694 ft., 1 ♀, 27. ix. 1961 (*Coll. E. M. Shull*) ; BURMA : Htawgaw, 1 ♀, —iii. 1939 (Varny Cutting Burma Expedition).

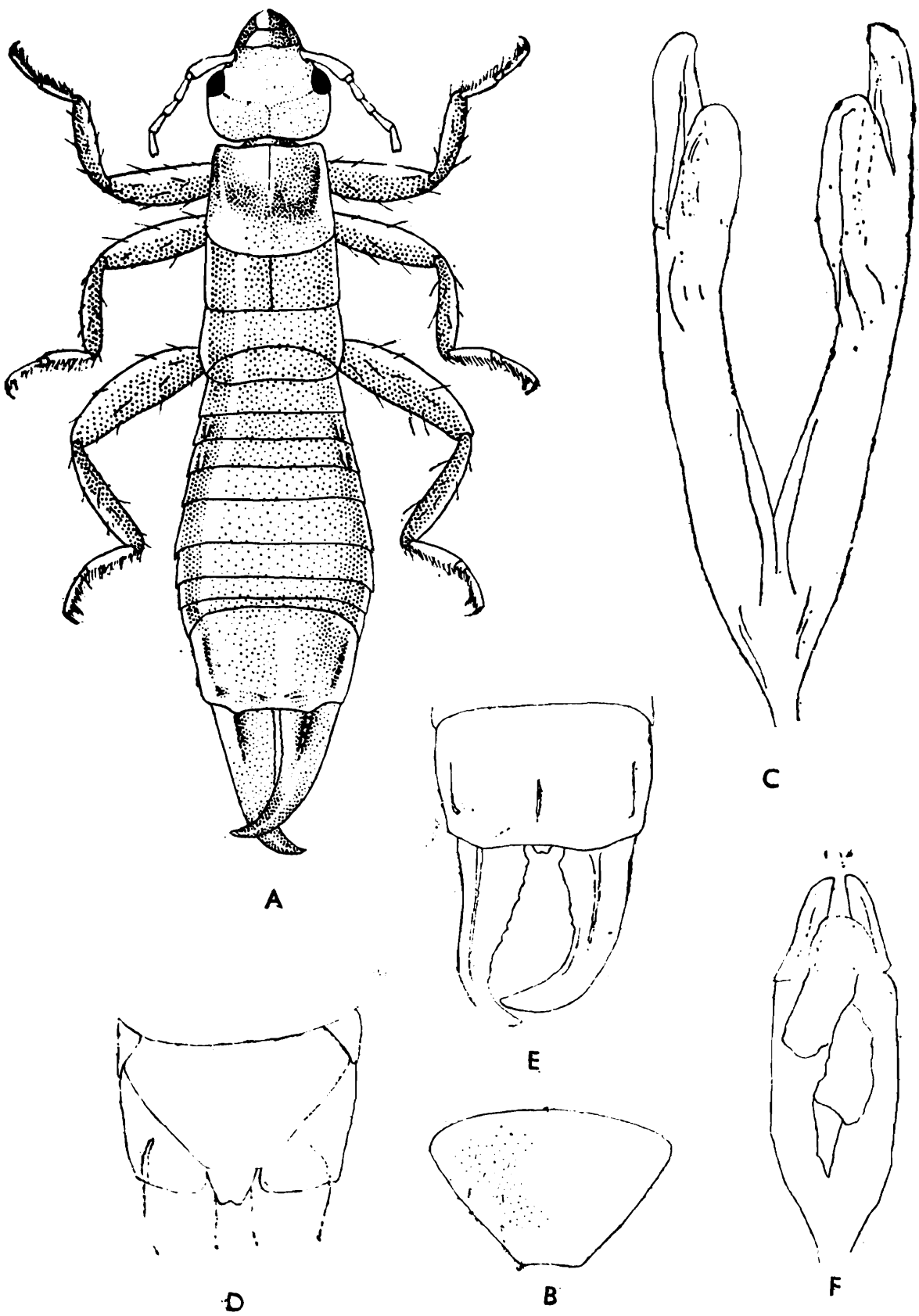
Anisolabis tatei sp. n.

(Text-fig. 1)

♂ : General colour shining brownish with varying shades on different body parts. Legs yellowish brown.

Head longer than broad, smooth, hind margin emarginate in middle, frons convex, sutures faintly marked. Eyes shorter than genae in length. Antennae partly broken (2 segments remaining on the right and 7 on the left but strongly crushed), basal segment stout, gently expanded apically ; 2nd small, almost transverse ; 3rd long and slender ; 4th slightly shorter than preceding ; 5th almost equal to 3rd ; 6th onwards gradually increasing in length and each gently expanded apically. Pronotum slightly broader than long, gently widened posteriorly, sides straight, feebly reflexed, hind margin rounded, prozona raised and well differentiated from flat metazona, median sulcus faint. Elytra and wings absent. Mesonotum posteriorly truncate and metanotum broadly concave. Legs typical of the genus. Abdomen with very fine pubescence above and obscurely punctulate, gently widened posteriorly, sides of segments 7th to 9th acute angled but median carina present on segments 7th and 8th only. Penultimate sternite triangular with hind margin subtruncate. Ultimate tergite impunctate but with faint, rough longitudinal stripes, transverse, gently narrowed posteriorly, median sulcus faint, hind margin in middle emarginate, on sides oblique. Forceps with branches contiguous and straight in basal two thirds thence strongly curved, trigonal above in basal half, afterwards depressed and attenuate, internal margin crenulate, but smooth a little before apex. Genitalia with parameres three times longer than broad, gently narrowed apically with apices broadly obtuse and faintly incurved, virga not visible, preputical sacs with fine chitinous teeth.

♀ : Agrees with male in most characters except that colour dark brownish black ; penultimate sternite obtuse posteriorly and forceps simple and straight.



Text-fig. 1A-F : *Anisolabis tatei* sp. n., Holotype ♂, A. Dorsal view ; B. Penultimate sternite, C. genitalia ; *Anisolabis perissa* Günther, Holotype ♂, D. penultimate sternite, pygidium and a portion of forceps in ventral view, E. Ultimate tergite and forceps, F. Genitalia.

Measurements : (in mm)

	Holotype ♂	♀
Length of pronotum	1.9	2.0
Width of pronotum	2.2	2.25
Length of body	13.2	16.5
Length of forceps	2.6	3.4

Material examined : New Guinea, Papua, Mt. Dayman, Maneau Range North Slope, 1550 m, Camp 5, *Holotype* ♂ ; 1 ♀ and 1 nymph, July 3-4, 1953 (Coll. *G. M. Tate*, 4th Archibold Expedition) ; deposited in American Museum of Natural History, New York (U. S. A.).

Remarks : With Steinmann's (1979) key to the species belonging to the genus *Anisolabis*, from New Guinea, the described species runs down close to *A. perissa* Günther, but differs in having the pronotum transverse (vs. as long as broad in *A. perissa*) ; penultimate sternite subtruncate posteriorly (vs. emarginate in middle posteriorly) and genitalia with both distal lobes flexed forward and parameres comparatively broader (vs. one of the distal lobe flexed backwards and parameres comparatively narrower). From *A. maritima* Bonelli, it differs by the shape of penultimate sternite and parameres and by the absence of virga.

I refer under this species 1 ♀ and 1 nymph with some hesitation from the same locality as the Holotype since these are dark brownish black and the former is slightly larger in size.

LABIDURIDAE

Nalinae

Nala lividipes (Dufour)

Nala lividipes Dufour, 1828, *Annls. Sci. nat.*, **13** : 340.

Material examined : Philippine Islands : Leyte, Abuyog 35 M. i. s. Tacloban, 1 ♂, 7. vii. 1961 (P. I. Natl. Mus. & Am. Mus. Nat. Hist. Expedition).

Nala sp.

Material examined : New Guinea : Papua, Peria Creek, Kwagira River, 50 m, 6 ♀ ♀, 18-19. viii. 1953, Camp 7 (*G. M. Tate*, 4th Archibold Expedition).

Remarks : In having rugose elytra and wings these specimens come close to *N. tenuicornis* (Bormans) but in the absence of males it is not possible to identify them up to specific level.

LABIDURINAE

Labidura riparia (Pallas)

Forficula riparia Pallas, 1773, *Reise Russ. Reichs.*, 2 : 727.

Material examined : INDIA : Ahwa, Dangs Dist., Bombay State, 1694 ft. 1 ♀, 20. x. 1963, 1 ♂, 22. x. 1963, 1 ♂, 26. x. 1963 (Coll. *E. M. Shull*) ; PAKISTAN : (Sind) Hyderabad City and environs, 1 ♂, 1 ♀, -ix, 1959-iii. 1960 (Coll. *Dr. Roy Tasker* Indus Exped. Dept. Anthrop. A. M. N. H.).

Forcipula quadrispinosa (Dohrn)

Forcipula quadrispinosa Dohrn, 1863, *Stettin. ent. Ztg*, 24 : 311.

Material examined : INDIA : Ahwa, Dangs Dist., Bombay state, 1694 ft., 1 ♂, 6. x. 1961, 1 ♂, 3. x. 1965, 1 ♂, 26. x. 1963, 1 ♀, 16. vii. 1963, 2 ♂ ♂, 17. x. 1963, 1 ♀, 22. x. 1963.

FORFICULOIDEA

LABIIDAE

SPONGIPHORINAE

Irdex papuana (Brindle)

Argusina papuana Brindle, 1970, *Entomologist* : 147.

Material examined : NEW GUINEA, Papua, Fergusson Isls., Mts. between Agamoia and Ailuluai, 900 m, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 5-17. vi. 1956, No. 4. (*L. J. Brass*, 5th Archibold Expedition).

Marava feae (Bormans)

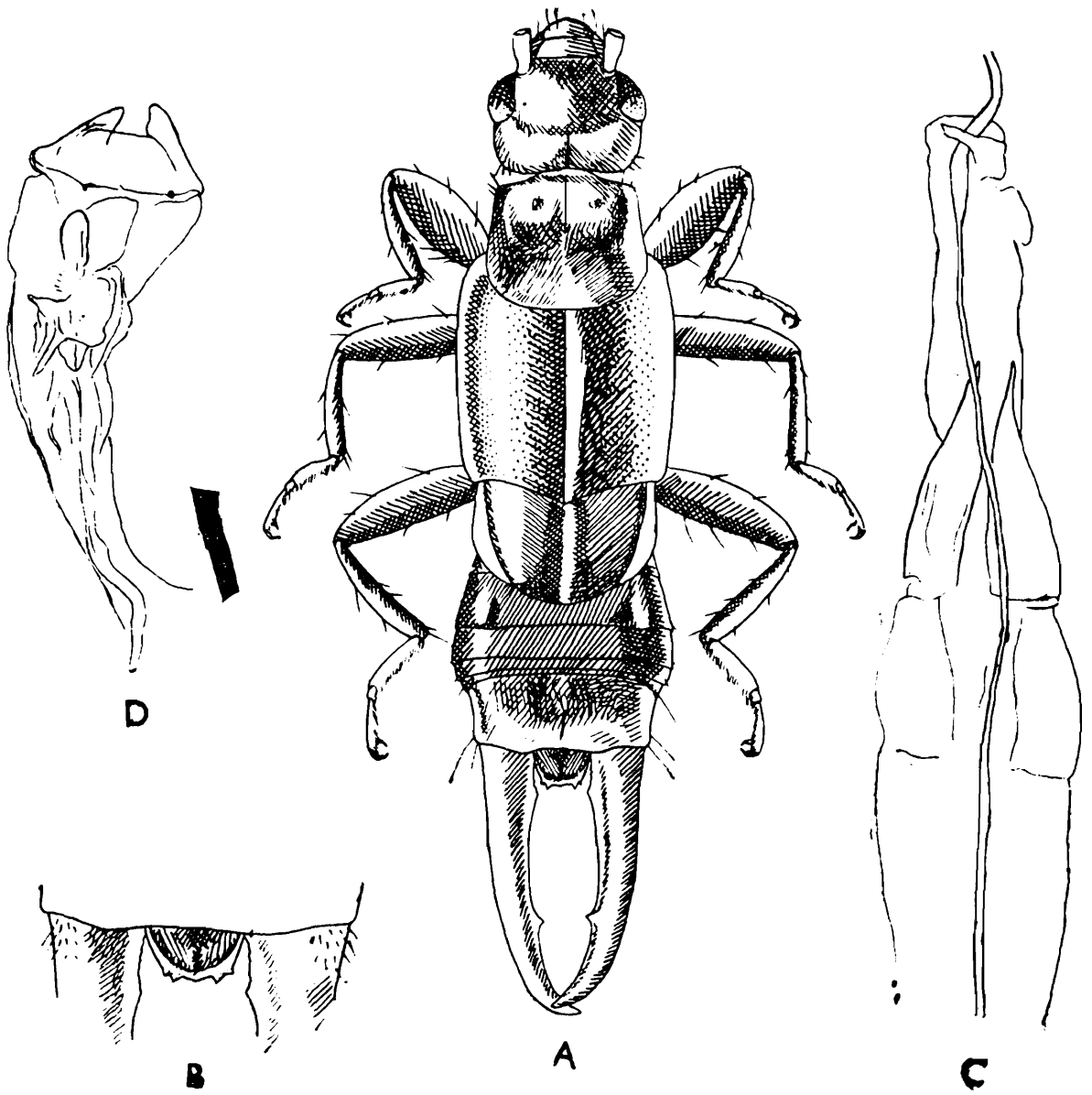
(Text-fig. 2)

Labia feae Dubrony, 1879, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 14 : 368.

Marava feae : Brindle, 1971, *Ent. Tidskr.*, 29 (1-2) : 16.

Material examined : NEW GUINEA : Papua, WaiKaiuna, Nomandy Isl., 0-50 m, 1 ♂, 3 ♀ ♀, 25. iv. 1956, No. 1 (*L.J. Brass*, 5th Archibold Expedition).

Remarks : The forceps in present ♂ are more elongated (representing forma macrolabia) and armed internally with a faint tooth near base and another more prominent one at apical third. Pygidium posteriorly is somewhat convex in middle with a pair of small tubercles postero-laterally. The ♂ genitalia is figured here for the first time.



Text-fig. 2 A-D : *Marava feae* (Bormans), ♂, A. Dorsal view, B. Hind portion of abdomen showing pygidium enlarged, C. Genitalia ; *Spongovostox gracilis* Borelli, ♂, D. Genitalia.

Spongovostox gracilis Borelli

Spongovostox gracilis Borelli, 1916, *Boll. Musei Zool. Anat. comp. R. Univ. Torino*, **31** : 2.

Material examined : PHILIPPINE ISLS. : Leyte, Abuyog 35, M. i. S. Tacloban, 1 ♂, 1 ♀, 11. vii. 1956 (P. I. Natl. Mus. and Am. Mus. Nat. Hist. Expedition).

Remarks : Body is covered with fine yellow pubescence. General colour is dark brownish black with antennae, tarsi and forceps yellowish. Elytra along with the costal margin and wings at base externally are yellow. Male genitalia is figured here for the first time.

CHELISOCHIDAE

CHELISOCHINAE

Proreus simulans (Stål)

Forficula simulans Stål, 1860, *Eug. Resa, Ins.*, : 302.

Material examined : PHILIPPINE ISLS. : Leyte, Abuyog 35, M. i. S. Tacloban, 2♂♂, 14.vii. 1961, 1♀, 11.vii. 1961 (P. I. Natl. Mus. and Am. Mus. Nat. Hist. expedition).

Chelisoches morio (Fabricius)

Forficula morio Fabricius, 1775, *Syst. Ent.*, : 270.

Material examined : NEW GUINEA : Papua, Modewa, Modewa Bay, 0-50 m, 1♀, 1956, No. 17 (*L. J. Brass*, 5th Archibold expedition).

FORFICULIDAE

FORFICULINAE

Forficula beelzebub (Burr)

Chelisoches beelzebub Burr, 1900, *Annls. Soc. ent. Belg.*, **64** : 51.

Material examined : BURMA : Htawgaw, 1♀, March, 1939 (Varny Cutting Burma expedition).

Remarks : The present specimen agrees so well with other females of the species from India that it can be referred here without hesitation.

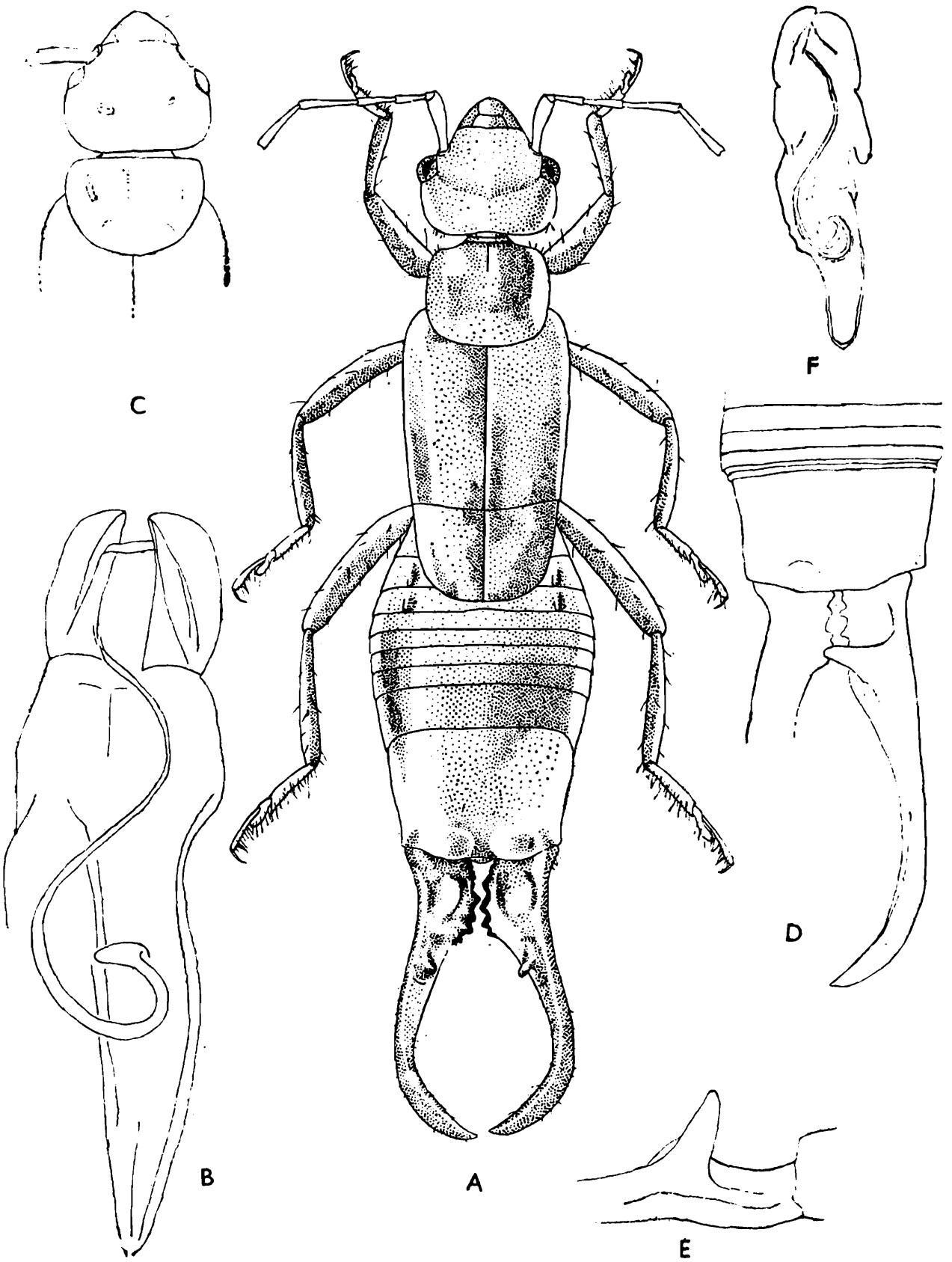
OPISTHOCOSMIINAE

Paratimomenus archiboldi sp. n.

(Text-fig. 3)

♂ : General colour chocolate brown, lighter in middle of abdominal tergites, ultimate tergite dark blackish brown in posterior half only ; forceps reddish black with apices and vertical hook black, pronotum on sides and posteriorly and legs yellowish brown. Elytra and wings light brownish black, former with longitudinal irregular yellow stripe in middle and the latter with an oblique yellow stripe medially. Fine and sparse pubescence present.

Head only slightly longer than broad, smooth, frons and occiput raised, sutures fine but distinct, hind margin freebly emarginate in middle. Eyes small, about half as long as the post-ocular length. Antennae partly broken (3 segments remaining on right side and 5 on the left), 1st stout, gently narrowed basally, longer than combined length of 2nd and 3rd ; 2nd small, about as long as broad ; 3rd onwards segments gradually increasing in length, long



Text-fig. 3 A-F : *Paratimomenus archiboldi* sp. n., Holotype ♂, A. Dorsal view, B. Genitalia ; *Forficula burgerisi* Günther, Paratype ♂, C. Anterior portion of body showing head, pronotum and a portion of elytra, D. Hind portion of body showing only right branch of forceps ; E. Basal portion of forceps in profile showing dorsal tooth.

and slender. Pronotum smooth, quadrat, slightly wider than long, anteriorly as wide as head, sides almost depressed, feebly convex, hind margin rounded, median sulcus faint, prozona raised and well demarcated from flat metazona. Prosternum longer than broad ;

meso-sternum about as long as broad with hind margin rounded ; metasternum transverse, hind margin between hind coxae narrow and truncate posteriorly. Legs normal, hind metatarsus almost equal to protarsus, 2nd segment lobed with hind margin entire, clad with fine pubescence on underside ; femora compressed, apically smooth above, not sulcate. Elytra and wings well developed, smooth. Abdomen spindle shaped, convex, tergites smooth, sides of segments smooth, convex. Penultimate sternite rounded posteriorly. Ultimate tergite transverse, smooth, convex above, sloping backwards, narrowed posteriorly with hind margin trisinuate, faintly tumid above the bases of forceps. Forceps stout, depressed in basal one third, internally strongly serrated, dorsally with an oblong depression, afterwards branches gently raised, tapering, compressed and strongly curved enclosing an oval space, armed above with a sharp vertical, posteriorly directed tooth at a little before middle. Pygidium scarcely visible from above, obtuse. Genitalia with parameres flat, narrowed apically ; virga stout.

♀ : Unknown.

Measurements : (in mm)

	Holotype ♂
Length of body	9.3
Length of forceps	3.15

Material examined : NEW GUINEA : Papua, Eastern High Land District, No. 6, Pengagi Camp East Slopes Mt. Wilhelm, 2770 m, *Holotype* ♂, 3. vii. 1959 (*L. J. Brass*, Sixth Archibold Expedition), deposited in the American Museum of Natural History, New York (U. S. A.).

Remarks : The described species can be easily separated from the other two known species of the genus viz., *P. flavocapitatus* (Shiraki) from Formosa and *P. nathani* (Srivastava) from India by following key based on males only.

1 (2). Elytra brownish black with an irregular yellow stripe in middle ; pronotum transverse ; forceps shorter in being about one third of body in length, dilated in basal one third with internal margin serrated. ... *P. archiboldi* sp. n.

2 (1). Elytra unicolourous ; pronctum not transverse ; forceps longer in being only slightly shorter than body in length, cylindrical, often armed with dorsal tooth or provided with minute teeth internally. ...

3 (4). Pronotum as long as broad ; sides of abdominal segments 7th to 9th with several tubercles; forceps long and slender, rather depressed in basal one third with an oblique ridge above ; internally provided with numerous small teeth. ... *P. nathani* (Srivastava)

4 (3). Pronotum slightly longer than broad ; sides of abdominal segment without tubercles ; forceps long, slender, armed with a strong dorsal tooth. ... *P. flavocapitatus* (Shiraki)

This species however, shows close resemblance with *Forficula biirgersi* Günther (1929), from New Guinea but differs in having the pronotum quadrat, weakly transverse (vs. strongly transverse, somewhat semicircular in *F. biirgersi*) ; forceps armed with a dorsal tooth, directed posteriorly (vs. tooth directed anteriorly) and male genitalia with parameres broad with apices obtuse and well separated from each other (vs. tip obtuse but slightly incurved and contiguous).

Type of *F. biirgersi*, has been examined. Its generic position will be discussed elsewhere since it does not belong to the genus *Forficula* L.

Eparchus simplex (Bormans)

Opisthocosmia simplex Bormans, 1894, *Annali Mus. civ. Stor. nat. Giacomo Doria*, (2) **14** : 396.

Material examined : BURMA : Htawgaw, 1 ♂, March, 1939 (Varny Cutting Burma Expedition).

Remarks : The present specimen has been compared with the syntypes of the species.

Opisthocosmia sp.

Material examined.—NEW GUINEA : Papua, Mt. Dayaman, Maneau Range, North Slope, 700 m, 2 ♀ ♀, 15-19. vii. 1953 (*G. M. Tate*, 4th Archibold Expedition) ; Fergusson Isl., Mt. between Agamoia and Ailuluai, 900 m, 2 ♀ ♀, 5-17.vi.1956, No. 10 (*L. J. Brass*, 5th Archibold Expedition).

Remarks : In the absence of males it is not possible to identity them upto specific level.

SUMMARY

The present paper deals with 17 species under 16 genera from various countries in Oriental Region and New Guinea. Of these, one new species each under the genera *Anisolabis* Fieber and *Paratimomenus* Steinmann are described from New Guinea.

ACKNOWLEDGEMENT

I am thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for providing necessary facilities during the course of present work and to Dr. Randall T. Schuh, Assistant Curator, Department of Entomology, American Museum of Natural History, New York (U.S.A.) for placing this interesting collection at my disposal. My thanks are also due to Dr. Kurt K. Günther, Zoologisches Museum für Naturkunde der Humboldt—Uni, DDR Berlin for sending types of *Anisolabis perissa* Günther and *Forficula bürgersi* Günther for my study.

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GÜNTHER, K. 1929. Die Dermapteren der deutschen Kaiserin Augusta-Fluss-Expedition 1912/13. *Mitt. zool. Mus. Berl.*, **15** (1) : 55-83.

STEINMANN, H. 1979. A revision of the Indo-Australian species of the genus *Anisolabis* Fieber, 1853. *Reichenbachia*, **17** (8) : 57-69.

Rec. zool. Surv. India, **80** : 507-524, 1983

ON SOME HOLOTHURIANS FROM THE ANDAMAN AND NICOBAR ISLANDS

By

T. D. Soota, S. K. Mukhopadhyay and T. K. Samanta
Zoological Survey of India, Calcutta

(With 5 Text-figures)

Our knowledge of the holothurian fauna of the Andaman and Nicobar Islands is mainly based on the pioneer work of Bell (1887) who reported 17 species from the area. Subsequently, Koehler and Vaney (1908) in their significant work from there described 51 species, including 17 new ones. Recently, two lists of the holothurians of the islands have appeared, viz. one by James (1969) which included 19 species present in Central Marine Fisheries Research Institute, and another by Daniel and Halder (1974) comprising 17 species. Since then, no work has appeared on these marine invertebrates.

The present paper is based on the study of the unnamed holothurians of the Andaman and Nicobar islands collected and now present in the Zoological Survey of India. These comprise 18 species belonging to 7 genera and 4 families, of which 5 species form new locality records and 11 are economically important in that they are utilised in Trepang industry.

The paper also furnishes an upto date list of holothurians of the area including the five species showing new locality records and dealt herein. As synonymies are easily available elsewhere, only original reference has been included under the different species and distribution of each species in the Indian coasts is also dealt with.

Class HOLOTHUROIDEA

Order ASPIDOCHIROTIDA

Family Holothuriidae

Genus **Actinopyga** Bronn

Actinopyga mauritiana (Quoy & Gaimard)

1833. *Holothuria mauritiana* Quoy & Gaimard, Voyages de decouvertes del' "Astralabe" : *Zoologie Zoophytes* Paris, p. 138.

Material : 4 exs., Z. S. I. Reg. No. E 799/1, Changappa Bay, 4 Km. N E of Campbell Bay, Andamans, *G. C. Rao and party*, 17. iv. 1973 ; 1 ex., Z. S. I. Reg. No. E 854/1, Kandia Ghat, 18 Km. S of Port Blair,

S. Andaman, *K. V. Surya Rao and party*, 21.i.1974 ; 1ex., Z. S. I. Reg. No. E 922/1, coral beds at kwate-in-kwage, little Andaman, *A. Daniel*, 18.ii.1961 ; 2 exs., Z. S. I. Reg. No. E 1009/1, Chiriatapu, S. Andamans, *A. K. Mukherjee*, 18. i. 1972 ; 1 ex., Z. S. I. Reg. No. E. 1046/1, in front of circuit house, Malacca village, Car Nicobar, *K. Reddiah and party*, 21. iv. 1972 ; 2 exs., Z. S. I. Reg. No. E 1112/1, South Point, Port Blair, Andamans, *K. K. Tiwari*, 7.iii.1959 ; 2 exs., Z. S. I. Reg. No. E 1113/1, Neil Island, S. Andamans, *B. K. Tikader*, 8.iv.1970.

Description : Body thick, hard, small to large but above 200 mm. generally, sometimes of quite large size, dark brown dorsally, blackish in preserved specimens ; ventrally almost whitish with some dark spots ; tentacles 25 to 28 ; anus guarded by 5 calcareous teeth (in one specimen from Port Blair their number being 6).

Spicules—rods, rosettes and tiny smooth oval grains.

Distribution : Andaman, Nicobar and Minicoy Is.

Remarks : Edible, commercialised for trepang industry.

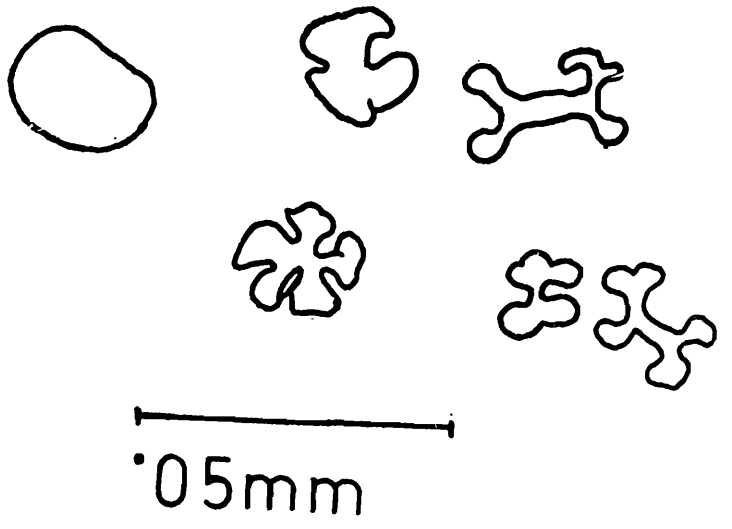
Genus **Bohadschia** Jaeger

Bohadschia marmorata Jaeger

(Text fig. 1)

1833. *Bohadschia marmorata* Jaeger, De Holothuris. *Turici*, p. 18.

Material : 2 exs., Z. S. I. Reg. No. 1104/1, Aberdeen Bay, Port Blair, Andaman, *K. K. Tiwari*, 16.iii. 1959.



Text-fig. 1. *Bohadschia marmorata* Jaeger spicules from body wall.

Description : Body cylindrical, broad, body wall thin, colour in preserved specimen light brown dorsally and lighter to almost whitish ventrally ; tentacles 18 ; pedicels and papillae scattered all over the body.

Spicules—dichotomously branched rods and simple grains.

Distribution : Bay of Bengal, Tuticorin and Minicoy Is.

Remarks : This is the first record of the species from the Andaman and Nicobar Islands. The species is utilised in trepang industry.

Genus **Holothuria** Linn.

Holothuria (Acanthotrapeza) pyxis Selenka

1867. *Holothuria pyxis* Selenka, *Z. Wiss. Zool.*, **17**, p. 337.

Material : 2 exs., Z. S. I. Reg. No. E 796/1, Chotina Bay, Nancowry, *G. C. Rao and party*, 19.iv.1973 ; 1 ex., Z. S. I. Reg. No. E 792/1, Sta. 622, Camorta Is. (coral reef on E side), Marine Survey, 10-14.i 1922.

Description : Tentacles 20 ; body cylindrical upto 30 mm., body wall soft and thick, sometimes flattend ventrally, with irregularly distributed pedicels ; dorsal papillae conical.

Spicules—tables large and clumsy ; spire of various height ; disc spinose with rim upturned ; buttons absent ; rosettes present.

Distribution : Bay of Bengal and Andamans.

Holothuria (Cystipus) rigida (Selenka)

(Text-fig. 2)

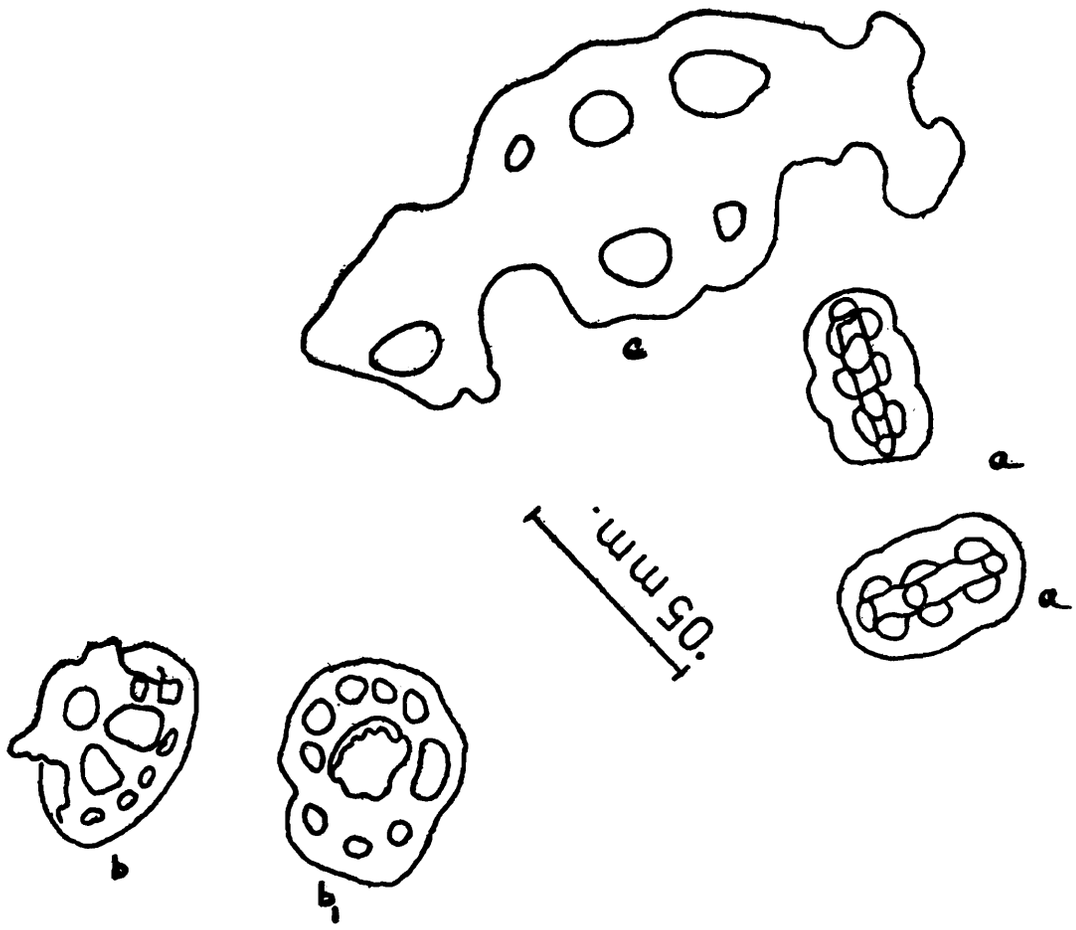
1867. *Stichopus rigida* Selenka, *Z. Wiss. Zool.*, **17**, p. 317.

Material : 8 exs., Z. S. I. Reg. No. E 809/1, from knee deep water left by tide, Port Blair, S. Andamans, *H. C. Roy*, 14. iii. 1952 ; 1 ex., Z. S. I. Reg. No. E 1041/1, below cellular jail, Port Blair, S. Andamans, *K. K. Tiwari*, 11. iii. 1959 ; 3 exs., Z. S. I. Reg. No. E 1042/1, Nachuge, Little Andaman, *A. Daniel*, 27. ii. 1961 ; 1 ex., Z. S. I. Reg. No. E 1098/1, from coral beds at the southern side of Tokaibuea, Little Andaman, *A. Daniel*, 13. ii. 1961 ; 10 exs., Z. S. I. Reg. No. E 1103/1, Aberdeen Bay, Port Blair, Andaman, *K. K. Tiwari*, 16. iii. 1959 ; 1 ex., Z. S. I. Reg. No. E 1134/1, between tide marks amongst coral rocks and in sandy parts between jones and mitchel point, Sound Is., Andamans, *H. S. Rao*, 5. iii. 1935 ; 1 ex., Z. S. I. Reg. No. E 1043/1, Sta. 615, Nancowry Is., shore collection, Marine Survey, Oct.-Nov. 1921.

Description : Body dorsoventrally flattened with ventral mouth, body wall not very thick and surface gritty to touch ; tentacles 20.

Spicules—buttons with knobs which are sometimes large and obscuring button holes ; tables with knobbed disc.

Remarks : This is the first record of the species from the Andaman and Nicobar Island and Indian coasts.



Text-fig. 2. *Holothuria* (*Cystipus*) *rigida* Selenka.
a. buttons ; b. table ; b_1. table disc : c. rod.

Holothuria (Halodeima) atra Jaeger

1833. *Holothuria atra* Jaeger, De Holothuris. Turici, p. 22.

Material : 4 exs., Z. S. I. Reg. No. E. 798/1, Sta. 7, pigmal point, Nicobar Is., *A. Daniel, H. K. Bhowmik and G. U. Kurup*, 22. iii. 1966 ; 2 exs., Z. S. I. Reg. No. E 813/1, Changappa Bay, 4 Km. NE of Campbell Bay, Sta. 6, *G. C. Rao and party*, 17. iv. 1973 ; 2 exs., Z. S. I. Reg. No. E 814/1, coral beds at Taibalowe, 16 miles E of Ingali, Sta. 4, *A. Daniel*, 22. ii. 1961 ; 1 ex., Z. S. I. Reg. No. E 815/1, Aberdeen Bay, Port Blair, Andamans, Sta. I, *A. Daniel*, 5. iii. 1961 ; 2 exs., Z. S. I. Reg. No. E 816/1, Sawai village, Car Nicobar, Andaman and Nicobar Survey, 1959 ; 1 ex., Z. S. I. Reg. No. E 863/1 ; Sta. 6, Campbell Bay, ?, 17. iv. 1973 ; 1 ex., Z. S. I. Reg. No. E 920/1, Sta. 12, long Island, *G. C. Rao and party*, 16. iii. 1974 ; 1 ex., Z. S. I. Reg. No. E 1091/1, Sta. 5, Riung chang, Port Blair, Andaman, *H. C. Ray*, 8. iii. 1952 ; 2 exs., Z. S. I. Reg. No. E 1106/1, S E of long Island, Middle Andaman, *H. S. Rao*, 18. i. 1935 ;

3 exs., Z. S. I. Reg. No. E 1107/1, coral beds at 3 fams. depth on the southern side of Tokaibuea, Little Andamans, *A. Daniel*, 9. ii. 1961 ; 2 exs., Z. S. I. Reg. No. E 1108/1, South Point Shore, 5 miles from Port Blair Camp, Andamans, *A. Daniel*, 9. iii. 1961 ; 1 ex., Z. S. I. Reg. No. E 1109/1, coral beds at Keatitu Kwage, Little Andaman, *A. Daniel*, 18. ii. 1961 ; 2 exs. Z. S. I. Reg. No. E 1168/1, 12 miles S of Tokaibuea, Little Andaman, *A. Daniel*, ? ; 1 ex., Z. S. I. Reg. No. E 1194/1, Sta. 20, Interview Is., Andaman, *A. G. K. Menon and party*, 8. ii. 1970.

Description : Body deep brown to almost black in colour, robust, cylindrical, length 150 to 200 mm ; tentacles 20 ; cuvierian tubules absent.

Spicules—tables and numerous rosettes, buttons or rods absent.

Distribution : Andaman, Nicobar, Krusadai and Minicoy Is., Mandapam and Tuticorin.

Remarks : This species is used extensively in trepang industry under the name 'Balat' or 'Balaton'.

Holothuria (Lessonothuria) pardalis Selenka

1867. *Holothuria pardalis* Selenka, *Z. Wiss. Zool.*, **17**, p. 336.

Material : 1 ex., Z. S. I. Reg. No. E 853/1, under stones in sandy places, Sound Is., Andamans, ? ; 6 exs., Z. S. I. Reg., No. E 1012/1, Nancowry Harbour, ?, 11. i. 1926.

Description : Body lightish brown in colour, whitish ventrally, cylindrical, tapering posteriorly, small to moderate in size, upto 100 mm. long with distinctly flattened sole ; pedicels and papillae arranged irregularly ventrally and dorsally ; tentacles 17-30, usually 20 in number with a collar of papillae around base.

Spicules—tables with disc spinose, rim sometimes upturned, pseudo-buttons numerous with single row of 3-4 holes, regular buttons also present.

Distribution : Andaman, Minicoy, Chetlat, and Krusadai Is., Gulf of Kutch and Port Okha.

Remarks : This species is used extensively in trepang industry.

Holothuria (Mertensiothuria) leucospilota (Brandt)

1835. *Stichopus* (*Gymnochirota*) *leucospilota* Brandt, *Petropoli*, 1, p. 51.

Material : 1 ex., Z. S. I. Reg. No. E 902/1, Sta. 710, Trinket, Nicobar Island, ? 11.ii.1926 ; 2 exs., Z. S. I. Reg. No. E 903/1, Nancowry Harbour, ? 1.i. 1926 ; 2 exs., Z. S. I. Reg. No. E 1100/1, amongst

coral rocks between jones and Mitchel points, Sound Island, N. Andaman, *H. C. Roy*, 5. iii. 1935 ; 1 ex., *Z.* S. I. Reg. No. E 1111/1, Sound Islands, N. Andaman, *H. S. Rao*, 5.iii.1935.

Description : Body light brown in colour, cylindrical, moderate to large, upto 250 mm. long, body wall soft ; tentacles 20 ; pedicels arranged ventrally in three distinct rows, papillae small and arranged dorsally irregularly ; cuvierian tubules present.

Spicules—tables with rim of disc usually spinose and with low spire ending in a ring or cluster of spines ; buttons irregular, usually with three pairs of holes, sometimes incomplete.

Distribution : Andaman, Minicoy Is., Tuticorin, Vizhingam and Karwar.

Holothuria (Metriatyla) scabra Jaeger

1833. *Holothuria scabra* Jaeger, *De Holothuris*, Turici, p. 23.

Material : 3 exs., Z. S. I. Reg. No. E 1101/1, Aberdeen Bay, Port Blair, Andamans, *K. K. Tiwari*, 11.vi.1959.

Description : Body 150-200 mm long and varied in colour, upper surface dark greenish or sometimes grayish with small white striations, ventral surface whitish with irregularly arranged pedicels, body wall soft and slightly gritty to touch ; cuvierian organs absent.

Spicules—table disc smooth, button holes 3-8 pairs with irregularly arranged knobs.

Distribution : Krusadai Is., Mandapam, Pamban and Gulf of Kutch.

Remarks : This species is extensively used for beche-de-mer and eaten fresh.

Holothuria (Platyperona) difficilis Semper

1868. *Holothuria difficilis* Semper, *Reisen im Archipel der philippinen*, **2** (1), p. 92.

Material : 19 exs., Z. S. I. Reg. No. E 881/1, Near Naval Garrison, Kamorta Is., *K. Reddiah and party*, 3. x. 1972.

Description : Body deep brown or chocolate in colour in preserved state, upto 60 mm. long, body wall soft ; tentacles 20, with prominent tentacular collar ; pedicels in three bands ventrally ; papillae irregularly distributed, cuvierian organs absent.

Spicules—tables with smooth disc, with a variable number of smooth holes, buttons with a faint median longitudinal ridge ; button holes three to five pairs.

Distribution : Andaman and Minicoy Is.

Holothuria (Selenkothuria) erinaceus Semper

(Text-fig. 3)

1868. *Holothuria erinaceus* Semper Holothurien *Reisen im Archipel der philippinen.* **2** (1), p. 91.

Material : 1 ex., Z. S. I. Reg. No. E 830/1, Interview Island, N. Andaman, K. K. Tiwari, 9. ii. 1959 ; 3 exs., Z. S. I. Reg. No. E 851/1, Harbour-jetty, Port Blair, S. Andaman, *G. C. Rao and party*, 9. iv. 1973 ; 1 ex., Z. S. I. Reg. No. E 1044/1, Sta. 615, Nancowry Island, Shore collection, Marine Survey, Nov.-Dec. 1921.

Description : Body small, 150 mm. long, body wall soft, thin ; tentacles 20 ; pedicels in three distinct rows.

Spicules—spiny rods only ; tables or buttons absent.

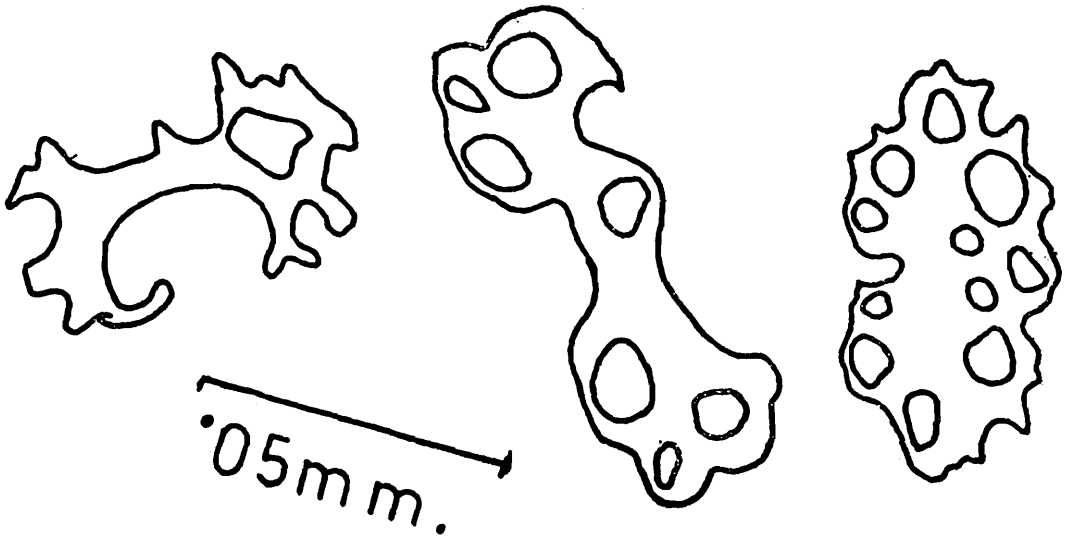
Distribution : Bay of Bengal.

Remarks : This is the first record of the species from the Andaman and Nicobar Islands.

Holothuria (Semperothuria) cinerascens (Brandt)

1835. *Stichopus* (*Gymnochirota*) *cinerascens* Brandt, Petropoli, 1, p. 51.

Material : 1 ex., Z. S. I. Reg. No. E 817/1, Rutland Island, Andamans, ?, 14. xii. 1932 ; 1 ex., Z. S. I. Reg. No, E 909/1, Andamans, ?.



Text-fig. 3. *Holothuria* (*Selenkothuria*) *erinaceus* Semper. rods from body wall.

Description : Body cylindrical, light or almost whitish yellow in colour in preserved state ; pedicels compactly arranged ventrally, divided into two groups by a narrow bare area ; papillae few ; tentacles 19, large, yellow ; cuvierian tubules absent.

Spicules—spiny rods with somewhat bent bodies and spines mostly concentrated at both ends ; tables small.

Distribution : Andaman, Mandapam and Vizhingam.

Holothuria (Thymiosycia) arenicola Semper

1868. *Holothuria arenicola* Semper, Holothurien *Reisen im Archipel der philippinen*, 2 (1), p. 81.

Material : 3 exs., Z. S. I. Reg. No. E 825/1, Sta. 669, Marine Survey, 20. ii. 1924 ; 4 exs., Z. S. I. Reg. No. E 892/1, 2 Km. W of Jetty, Neil Island, S. Andaman, *K. K. Tiwari*, 9. iv. 1970.

Description : Body light yellow to deep orange in preserved state ; cylindrical, spindle shaped ; 80-150 mm. long ; tentacles 20 ; papillae and pedicels irregularly arranged all over body ; cuvierian organs present.

Spicules—tables small, with 4 to 8 marginal holes, buttons smooth with three pairs of often minute holes.

Distribution : Andaman and Bay of Bengal.

Holothuria (Thymiosycia) impatiens Forskal

1775. *Fistularia impatiens* Forskal, *Descriptiones animalium quae in itinere orientali observait P. Forskal, Hauniae*, p. 121.

Material : 1 ex., Z. S. I. Reg. No. E 794/1, Corbyn's Cove, Andaman, ?, 28. ii. 1932 ; 1 ex., Z. S. I. Reg. No. E 811/1, Camp 6, Havelock Island, Andaman, *G. C. Rao and party*, 4. iv. 1974 ; 5 exs., Z. S. I. Reg. No. E 821/1, South Point, Port Blair, Andamans, ?, 11. ii. 1933 ; 1 ex., Z. S. I. Reg. No. E 827/1, Sta. 669, Marine Survey, 20. ii. 1920 ; 4 exs., Z. S. I. Reg. No. E 882/1, Sta. 3, Marine Survey, ? ; 1 ex., Z. S. I. Reg. No. E 893/1, Sta. 673, East Bay, Kachal Island, Nicobar Island, Marine Survey, 9. iii. 1925 ; 1 ex., Z. S. I. Reg. No. E 894/1, Aberdeen Jetty, *B. K. Tikader*, 25. i. 1970 ; 2 exs., Z. S. I. Reg. No. E 910/1, intertidal zone, Aberdeen, Andamans, ?, 5. iii. 1969 ; 1 ex., Z. S. I. Reg. No. E 1010/1, Sta. 655, Marine Survey, 10. xii. 1923 ; 1 ex., Z. S. I. Reg. No. E 1016/1, Sta. 28, Curlew Island, coral reef, Nicobar Islands, *A. G. K. Menon and party*, 13. ii. 1970 ; 1 ex., Z. S. I. Reg. No. E 1048/1, Sta. 710, Trinket, Nicobar Islands, ?, 11. ii. 1926 ; 4 exs., Z. S. I. Reg. No. E 1136/1, Between tide marks amongst coral rocks and in sandy parts, between Jones and Mitchel point, *H. S. Rao*, 5. iii. 1935 ; 1 ex., Z. S. I. Reg. No. E 1169/1, Andaman Island, *A. G. K. Menon and party*, ?.

Description : Body whitish to brownish in colour, slender, upto 150 mm. long, dorsally all over with papillae on conical eminences, ventrally with irregularly scattered pedicels ; body surface sometimes gritty to touch ; tentacles 20 ; cuvierian organs absent.

Spicules—tables squarish in outline with typically 8 prominent holes ; buttons regular and smooth with mostly 3 pairs of large holes ; supporting rods with swollen central perforated part and having small openings at both ends.

Distribution : Andaman and Minicoy Is.

Remarks : This species is much used in Trepang industry and sometimes even eaten fresh.

Family STICHOPODIDAE

Genus **Stichopus** Brandt

Stichopus chloronotus Brandt

1835. *Stichopus* (*Perideris*) *chloronotus* Brandt, Petropoli, 1, p. 50.

Material : 2 exs., Z. S. I. Reg. No. E 791/1, Ritche Archipelago, Havelock Island, Andamans, ?, 30. i. 1930 ; 4 exs., Z. S. I. Reg. No. E 818/1, Changappa Bay, 4 Km. N E of Campbell Bay, Sta. 6, *G. C. Rao and party*, 17. iv. 1973 ; 1 ex., Z. S. I. Reg. No. E 824/1, Ross Island, Andamans, ?, 27. x. 1932 ; 1 ex., Z. S. I. Reg. No. E 846/1, Sta. 6, Campbell Bay, Andamans, *G. C. Rao and party*, 17. iv. 1973 ; 2 exs., Z. S. I. Reg. No. E 852/1,/littoral region between Teetop and Sanri village, Car Nicobar, *A. G. K. Menon and party*, 3. x. 1972 ; 1 ex., Z. S. I. Reg. No. E 861/1, under Stones in sandy places, Andamans, ?, 9. iii. 1933 ; 1 ex., Z. S. I. Reg. No. E 833/1, Teetop Beach, Car Nicobar, *K. V. Surya Rao and party*, 27. i. 1974 ; 1 ex., Z. S. I. Reg. No. E 895/1, Neil Island Jetty, S. Andaman, *G. C. Rao and party*, 29. iii. 1974 ; 2 exs., Z. S. I. Reg. No. E 1131/1, between tide marks amongst coral rocks in sandy parts, between Jones and Mitchel point, Sound Island, Andamans, *H. S. Rao*, 5. iii. 1935 ; 2 exs., Z. S. I. Reg. No. E 1196/1, Havelock Jetty, Andamans, *G. C. Rao and party*, 4. v. 1975.

Description : Body of moderate size, elongate, quadrangular, with tapering ends, upto 200 mm. long ; dorso- and ventrolateral ambulacral angles with double rows of conical papillae arranged alternately giving a characteristic appearance ; locomotory podia arranged in three rows to form distinct creeping sole ventrally.

Spicules—tables and 'c' shaped rods and rosettes.

Distribution ; Andaman, Nicobar, Krusadai and Chetlat Is.

Remarks : This species is used in trepang industry.

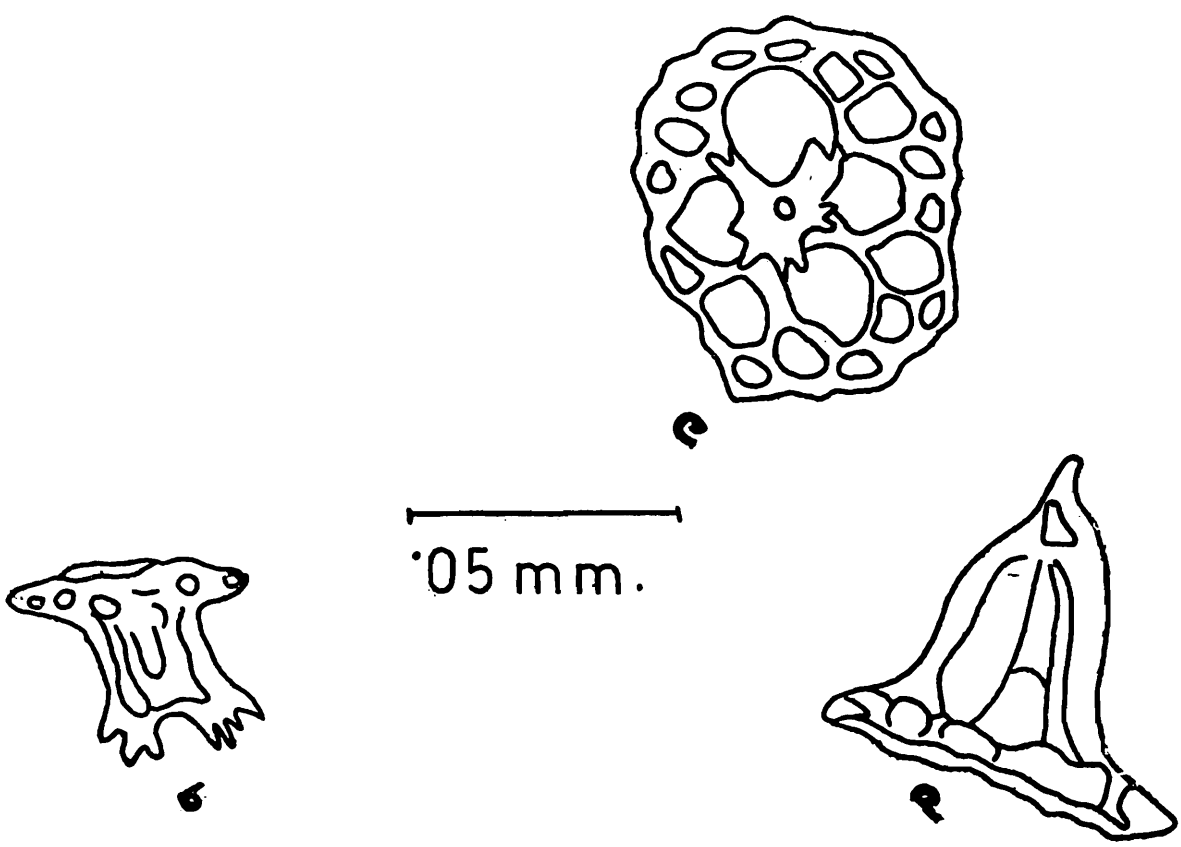
Stichopus horrens Selenka

(Text-fig. 4)

1867. *Stichopus horrens* Selenka, *Z. Wiss. Zool.*, **17**, p. 316.

Material : 1 ex., Z. S. I. Reg. No. E 844/1, Round about Ross Island, N. Andamans, ?, 30.xii. 1933 ; 1 ex., Z. S. I. Reg. No. E 1014/1, Nancowry Harbour, Andamans, Marine Survey, 1921-1922.

Description : Body 200 mm. long in preserved specimen ; tentacles 19, in specimens of Ross Island 14.



Text-fig. 4. *Stichopus horrens* Selenka.
a. table ; b. same in side view ; c. table disc.

Spicules—with two types of tables, small and large, the latter with conical spines, numerous rosettes and 'c' shaped rods ; supporting rods from tube feet with perforated plate at middle.

Remarks : This is the first record of the species from Andaman and Nicobar Islands and Indian coasts.

Order APODIDA

Family SYNAPTIDAE

Genus *Synapta* Eschscholtz

Synapta maculata (Chamisso and Eysenhardt)

1821. *Holothuria maculata* Chamisso and Eysenhardt, II *Nova Acta Acad. Caesar Lcop. Carol.*, **10**, p. 352.

Material : 6 exs., Z. S. I. Reg. No. E 800/1, Sta. 17, Aberdeen Bay, Port Blair, Andamans, *K. K. Tiwari*, ? ; 1 ex., Z. S. I. Reg. No. E 801/1, Malacca village, Car Nicobar, Sta. 25, *K. K. Tiwari*, 24. iii. 1959 ; 1 ex., Z. S. I. Reg. No. E 806/1, in front of circuit house, Malacca village, Car Nicobar, *K. Reddiah and party*, 27. ix. 1972 ; 1 ex., Z. S. I. Reg. No. E 823/1, Tamalu beach, 3 Km. N of Malacca village, Car Nicobar, *K. V. Surya Rao and party*, 26. i. 1974 ; 1 ex., Z. S. I. Reg. No. E 834/1, Andamans, *A. K. Mukherjee*, 1972 ; 1 ex., Z. S. I. Reg. No. E 845/1, East of Sound Island, N. Andaman, ?, 30.xii. 1933 ; 2 exs., Z. S. I. Reg. No. E 900/1, Aberdeen Bay, Port Blair, Andamans, *K. K. Tiwari*, 11. i. 1959.

Description : Body snake like, longest among the members of the family, measuring upto 600 mm. in fully extended state with 5 distinct longitudinal bands of two or three different colours, crossed by incomplete dark bands, body surface rough and sticks to the finger with thin fragile body wall ; tentacles 15, pinnate.

Spicules—robust anchors with almost quadrangular anchor plates with numerous smooth holes, anchor base smooth.

Distribution : Andaman and Minicoy Is.

Genus **Synaptula** Orsted

Synaptula recta (Semper)

(Text-fig. 5)

1868. *Synapta recta* Semper, Holothurien. *Reisen im Archipel der Philippinen*, **2** (1), p. 14.

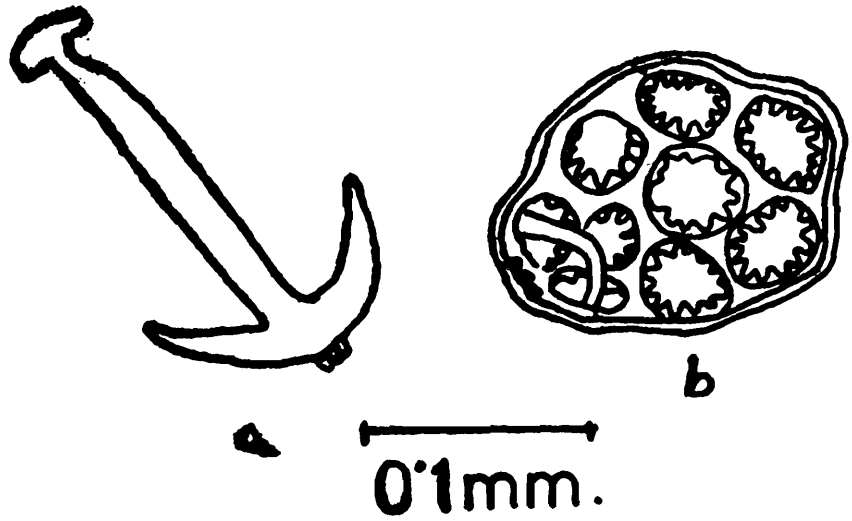
Material : 1 ex., Z. S. I. Reg. No. E 1015/1, in sandy pools at tide marks between blair reef and chattam, causeway, Port Blair, Andamans, *H. S. Rao*, 7. i. 1935.

Description : Body small, light brown rather yellowish in colour, about 50 mm. long ; tentacles 13, equal.

Spicules—small ; anchor plates with toothed holes tapering posteriorly, miliary granules numerous appearing like minute oval grains.

Distribution : Bay of Bengal.

Remarks : This is the first record of the species from the Andaman and Nicobar Islands.



Text-fig. 5. *Synaptula recta* Semper.
a. anchor ; b. anchor plate.

Family Chiridotidae

Genus **Polycheira** H. L. Clark

Polycheira rufescens (Brandt)

1935. *Chiridota rufescens* Bandt, Petropoli, 1, p. 59.

Material : 16 exs., Z. S. I. Reg. No. E 790/1, Sta. 615, Andamans, Marine Survey, Nov-Dec, 1921 ; 1 ex., Z. S. I. Reg. No. E 859/1, in sandy pool at low tide, blair reef, Port Blair, Andamans, *H. S. Rao*, 12. xi. 1934 ; 2 exs., Z. S. I. Reg. No. E 860/1, East of Sound Is., N. Andaman, ?, 30. xii. 1933 ; 13 exs., Z. S. I. Reg. No. E 897/1, Chiriatapu, Andamans, *G. C. Rao and party*, 15. iv. 1974 ; 5 exs., Z. S. I. Reg. No. E 898/1, Shore collection, round about Ross Island, Port Blair, S. Andamans, ?, 1. iv. 1930 ; 8 exs. Z. S. I. Reg. No. E 899/1, from below stones in rocky beach, Port Cornowallis, N. Andaman, *K. K. Tiwari*, 31. i. 1959 ; 4 exs., Z. S. I. Reg. No. E 905/1, Nancowry Harbour, Marine Survey of India, 1. iii. 1925 ; 3 exs., Z. S. I. Reg. No. E 1047/1, Beach near Chattam Jetty, Port Blair, S. Andaman, *K. V. Surya Rao*, 26. ii. 1974 ; 4 exs., Z. S. I. Reg. No. E 1097/1, Ross Island, S. Andaman, *S. W. Kemp*, ? ; 10 exs., Z. S. I. Reg. N. E 1105/1, Chiriatapu, Port Blair, S. Andaman, *A. K. Mandal*, 16. vii. 1972.

Description : Body light brown, creamy, 35-100 mm long, body wall thin, soft with annular markings, tentacles 18, peltato-digitate ; cuvierian tubules present.

Spicules—six spoked wheels and prominent sigmoid bodies.

Distribution : Andaman and Bay of Bengal.

List of Holothurians hitherto known from the Andaman & Nicobar Islands.

Class—HOLOTHUROIDEA

Order—ASPIDOCHIROTIDA

Family—HOLOTHURIIDAE

Genus **Actinopyga** Bronn

Actinopyga echinites (Jaeger)
A. lecanora (Jaeger)
A. mauritiana (Quoy & Gaimard)
A. miliaris (Quoy & Gaimard)

Genus **Bohadschia** Jaeger

Bohadschia marmorata Jaeger

Genus **Holothuria** Linn.

Holothuria (*Acanthotrapeza*) *pyxis* Selenka
H. (*Cystipus*) *inhabilis* Selenka
H. (*Cystipus*) *rigida* Selenka
H. (*Halodeima*) *atra* Jaeger
H. (*Halodeima*) *edulis* Lesson
H. (*Lessonothuria*) *pardalis* Selenka
H. (*Mertensiothuria*) *exilis* Koehler & Vaney
H. (*Mertensiothuria*) *leucospilota* (Brandt)
H. (*Metriatyla*) *scabra* Jaeger
H. (*Platyperona*) *difficilis* Semper
H. (*Selenkothuria*) *erinaceus* Semper
H. (*Selenkothuria*) *glaberrima* Selenka
H. (*Semperothuria*) *cinerascens* Brandt
H. (*Stauropora*) *prompta* Koehler & Vaney
H. (*Thymiosycia*) *arenicola* Semper
H. (*Thymiosycia*) *hilla* Lesson
H. (*Thymiosycia*) *impatiens* Forskal
H. (*Thymiosycia*) *impatiens* var. *bicolor* Clark
H. (*Thymiosycia*) *remollescens* Lampert

Genus **Labidodemas** Selenka

Labidodemas rugosa (Ludwig)
L. semperianum Selenka

Family—STICHOPODIDAE

Genus **Stichopus** Brandt

Stichopus chloronotus Brandt
S. horrens Selenka
S. variegatus Semper

Family—SYNALLACTIDAE

Genus **Synallactes** Ludwig

Synallactes rigidus Koehler & Vaney
S. woodmasoni (Walsh)

Genus **Bathyplotes** Ostergren

Bathyplotes cinctus Koehler & Vaney
B. crenulatus Koehler & Vaney
B. profundus Koehler & Vaney

Genus **Pelopatides** Theel

Pelopatides dissidens Koehler & Vaney
Pelopatides gelatinosus (Walsh)
P. modestus Koehler & Vaney
P. mollis Koehler & Vaney
P. ovalis (Walsh)
P. verrucosus Koehler & Vaney

Genus **Allopatides** Koehler & Vaney

Allopatides dendroides Koehler & Vaney

Genus **Benthothuria** Remy Perrier

Benthothuria cristatus Koehler & Vaney

Order DENDROCHIROTIDA

Family CUCUMARIIDAE

Genus **Trachythyone** Studer

Trachythyone alcocki (Koehler & Vaney)

Genus **Leptopentacta** H. L. Clark

Leptopentacta bacilliformis (Koehler & Vaney)

Genus **Cladolabes** Brandt

Cladolabes acicula (Semper)

Genus **Ypsilothuria** Perrier

Ypsilothuria bitentaculata (Ludwig)

Order APODIDA

Family SYNAPTIDAE

Genus **Synapta** Eschscholtz

Synapta maculata (Chamisso & Eysenhardt)

Genus **Synaptula** Orsted

Synaptula recta Semper

S. striata (Sluiter)

Genus **Protankyra** Ostergren

Protankyra errata Koehler & Vaney

P. innominata Ludwig

Genus **Opheodesoma** Fisher

Opheodesoma grisea (Semper)

Family CHIRIDOTIDAE

Genus **Polycheira** H. L. Clark

Polycheira rufescens (Brandt)

Order MOLPADIDA

Family MOLPADIDAE

Genus **Molpadia** Cuvier

Molpadia andamanense Walsh

M. brevicaudatum Koehler & Vaney

M. elongatum Koehler & Vaney

M. musculus Risso

M. musculus var. *acutum* Koehler & Vaney

M. musculus var. *undulatum* Koehler & Vaney

Genus **Acaudina** H. L. Clark

Acaudina molpadioides (Semper)

Genus **Paracaudina** Heding

Paracaudina australis (Semper)

Order ELASIPODIDA

Family DEIMATIDAE

Genus **Apodogaster** Walsh

Apodogaster alcocki Walsh

Genus **Deima** Theel

Deima validum Theel

Genus **Orphnurgus** Theel

Orphnurgus glober Walsh

Family PELAGOTHURIIDAE

Genus **Euriplastes** Koehler & Vaney

Euriplastes obscura Koehler & Vaney

Family PSYCHROPOTIDAE

Genus **Benthodytes** Theel

Benthodytes typia Theel

B. sanguinolenta Theel

Genus **Filithuria** Koehler & Vaney

Filithuria elegans Koehler & Vaney

List of species utilised in the Trepang or Beche-de-mer industry

The following is a list of holothurian species found in Andaman & Nicobar Islands utilised for Beche-de-mer industry, but utility of other species for the same purpose needs investigation.

Actinopyga mauritiana (Quoy & Gaimard)
A. echinites (Jaeger)
Bohadschia marmorata Jaeger
Holothuria (*Halodeima*) *atra* Jaeger
H. (*H.*) *edulis* Lesson
H. (*Thymiosycia*) *impatiens* Forskal
H. (*T.*) *hilla* Lesson
H. (*Lessonothuria*) *pardalis* Selenka
H. (*Metriatyla*) *scabra* Jaeger
Stichopus chloronotus Brandt
S. variegatus Semper

SUMMARY

The paper deals with 19 species of holothurians from the Andaman and Nicobar Islands. Five form new locality records and 11 are economically important. An upto date list of species of the area has also been furnished.

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OSTEOLOGY OF THE INDIAN MOUNTAIN LIZARD *JAPALURA VARIEGATA* GRAY (REPTILIA : AGAMIDAE)

By

R. C. SHARMA*

Zoological Survey of India, Calcutta

(With 9 Text-figures)

INTRODUCTION

Japalura variegata Gray is a terrestrial lizard found in Eastern Himalayas up to an altitude of 3000 metres. The range of distribution of this species includes Sikkim, Darjeeling and Jalpaiguri district of North Bengal. The specimens used in the present work were from Darjeeling.

Beddard (1905) worked out the cranial osteology of *Uromastix* and *Chalmydosaurus kingi*. Boulengar (1890) described the skull of *Calotes jubatus*. Broom (1922) studied the osteology of *Agama hispida*. De Beer (1937) described the osteology of the skull of *Draco*, *Ascalobates* and *Tiliqua*. El-Toubi (1945, 1947) has given the accounts of the osteology of *Uromastix aegyptia* and *Agama stellio*. Iyer (1943) described the ostiology of *Calotes versicolor*. Prasad (1955) has given the account of the osteology of *Draco dussumieri*. Siebenrock (1895) presented an elaborate work on the osteology of *Agamids*. Tilak (1964) described the osteology of *Uromastix hardwicki*.

KEY TO LETTERINGS OF TEXT-FIGURES

AFBOC—articular facet for basioccipital ; AFEXO—articular facet for exoccipital ; AFO—articular facet for quadrate ; AN—angular ; API—acetabular part of ilium ; APIS—acetabular part of ischium ; APP—acetabular part of pubis ; ARI—articular facet of ilium ; AROP—articular process for odontoid process ; ART—articular ; AT—atlas ; AX—axis ; BF—basipital fossa ; BP—basisphenoid ; CART—Cartilage between quadrate and paraoccipital process ; CB—chevron bone ; CBOC—part of occipital condyle formed by basioccipital ; CC—concavity ; CD—Coracoid ; CDF—coracoid foramen ; CEXO—part of occipital condyle formed by exoccipital ; CFI—condyle for fibula ; CJ—cartilaginous joint ; CL—clavicle ; CO—Coronoid ; CP—clawed distal phalanges ; CR1—1st cervical rib ; CR2—2nd cervical rib ; CT—Cent-

*Present Address : *Desert Regional Station, Zoological Survey of India, Patodi House, Paota Lines, 'B' Road, 3rd street, Jodhpur (Rajasthan).*

rale ; CTI—condyl for tibia ; D—Dentary ; DCI—1st distal carpal ; DC5—5th distal carpal ; DR—deltoid ridge ; DT—distal tarsal ; EAP—extra acetabular portion of ilium ; ECD—epicoracoid ; ECTPT—ectopterygoid ; EPB—epipubis ; EPS—episternum ; EPT—epipterygoid ; ESTS—extra stapes ; EXO—exoccipital and opisthotic, EXOPR—paroccipital process ; F—foramen ; FC—fibrous covering between supraoccipital and parietal ; FCS—foramen between Coracoid and scapula ; FE—femur ; FI—fibula ; FIB—Fibulare ; FM—foramen magnum ; FMCK—fossa meckelii ; FOR—foramen rotundus ; FOV—Part of foramen ovalis ; FR—frontal ; FV—foramen for vagus ; GF—Glenoid fossa ; H—head ; HP—hypocentrum ; HU—humerus ; HYP1—1st hypophysis ; HYP2—2nd hypophysis ; HYP3—3rd hypophysis ; HYPS 1-HYPS 2, HYPS 3—the anterior, the medial and the posterior parts of hypoischium ; IM—intermedium ; IOS—cartilagenous interorbital septum ; IP—interparietal ; IPT—interpterygoid space ; ISS—ischeal symphysis ; ITF—infratemporal fossa ; ITR—internal trochanter ; J—jugal ; LAC—lachrymal ; LG—ligament ; MC—metacarpal ; MC 1—1st metacarpal ; MC 5—5th metacarpal ; MCK—meckel's cartilage ; MIP—metaischial process ; MPIS—medial arm of ischium ; MPP—medial arm of pubis ; MPR—medial process ; MT 1—1st metatarsal ; MT 5—5th metatarsal ; MX—maxilla ; N—Nasal ; NC—Neural canal ; NCA—nasal capsule ; NP—neurapophysis ; NS—neural spine ; OF—obturatar foramen ; OP—odontoid process ; OPR—olecranon process ; ORSPH—orbitosphenoid ; P—parietal ; PAL—palatine, PAP—preacetabular process of ilium ; PBSPH—pterygoid process of basisphenoid ; PEC. AR—pectoral arch ; PEP—pterygoectopterygoid projection ; PAF—palatine foramen ; PF—parietal foramen ; PFR—prefrontal ; PL—phalanges ; PL 1—1st phalanx ; PL2—2nd phalanx ; PM—process messetericus ; PMX—premexille ; POR—post orbital ; PPR—prepublic process ; PPT—palatine process of pterygoid ; PRO—prootic ; PS—pisiform ; PSPM—parasphenoid ; PT—pterygoid ; PTF—posttemporal fossa ; PTL—ptellae at the knee joint ; PUS—pubic symphysis ; PVO—prevomer ; PZS—prezygapophysis ; PZT—postzygopophysis ; QD—quadrate ; QPT—quadrate process of pterygoid, R—radius ; RC—radial condyle ; RD—radiale ; S—sternum ; SC—sterno-costal element ; SCDF—supracoracoid foramen; SMX—septomaxillary ; SN—surangular ; SOC—supraoccipital ; SP—scapula ; SQ—Squa mosal ; SR—sternal portion of rib ; SS—suprascapula ; ST—supratemporal ; STF—supratemporal fossa ; STP—supratemporal process of parietal ; STS—stapes ; T—teeth ; TI—tibia ; TIB—tibiale ; TP—transverse process ; TYP—tympanic process ; U—ulna ; UC—ulnar condyl ; UN—ulnare ; VP—ventral process ; VR—vertebral rib.

MATERIAL AND METHOD

The skeletal material used for this study was obtained by maceration of alcohol preserved specimens from Darjeeling.

THE OSTEOLOGY

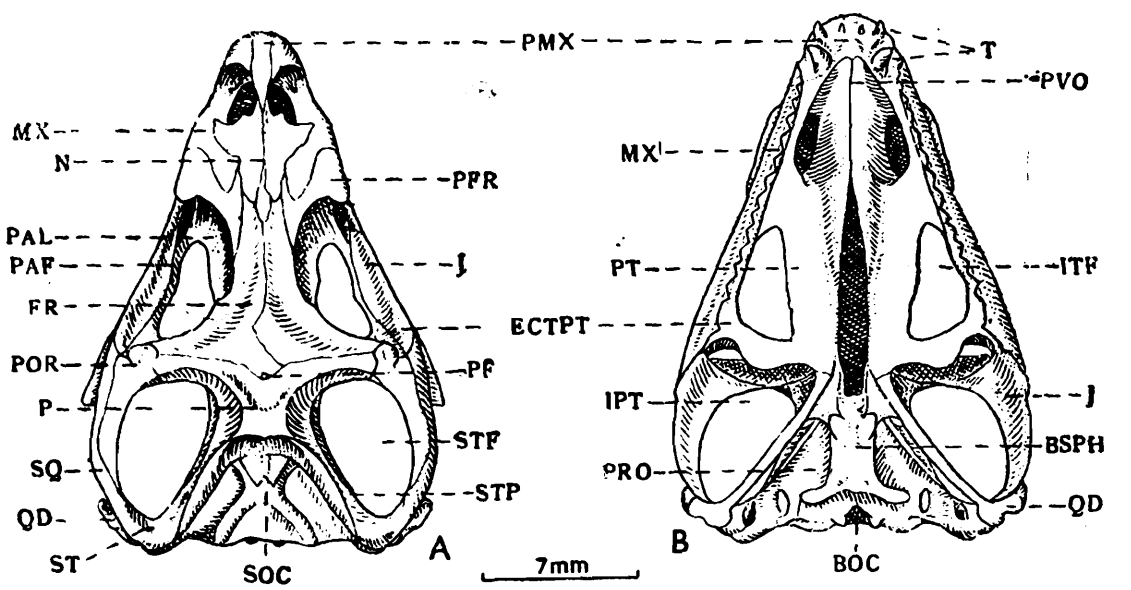
(A) The Skull

(Text-figs. 1 & 2)

(1) *General*

On measuring the 15 skulls the observed ranges are as follows : Length (occipital condyl to tip of snout) 2.3-2.4 cm., width (behind the orbits) 1.55-1.65 cm., and height (between the lower jaw and parietals) 1.6 cm.

The skull is well ossified, and the fore skull is with a concavity ; its anterior extremity is pointed, thus forming an acute snout. Orbits are surrounded by strongly ossified bones ; distal surface



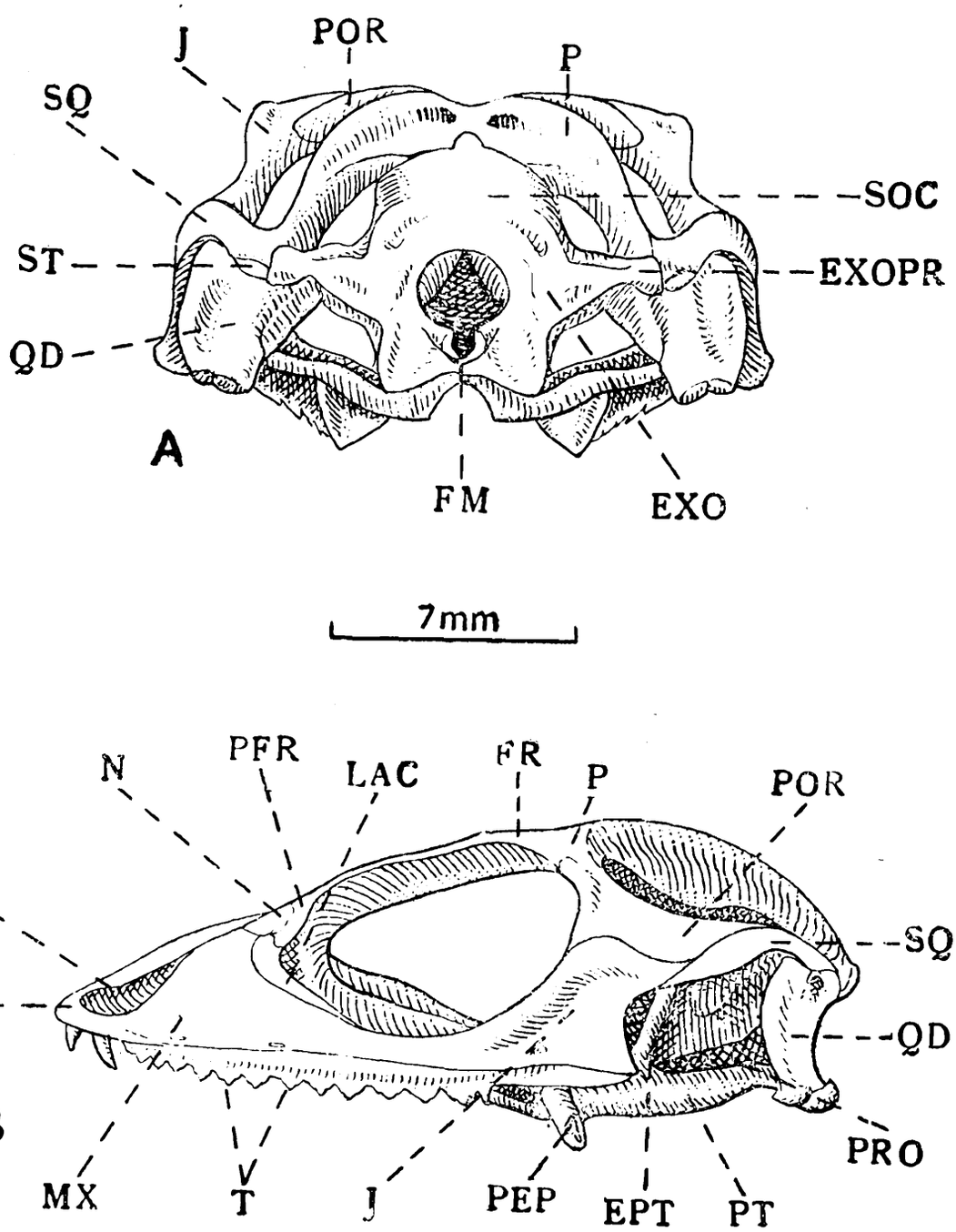
Text-fig. 1. A. Dorsal view of skull.
B. Ventral view of skull.

is flattened ; all sutures are obliterated due to ossification and overlaping of bones ; dorsal and lateral planes of the skull meet at a right angle and along that edge there is a prominent antero-posterior ridge ; mid-dorsal aspect, through parietals is a flat plane having steep slope towards occipital region and a gradual slope ending at the extreme tip of premaxilla.

(2) *Occipital complex* (Text-fig. 2 A)

Four elements, namely, a *supraoccipital* (Text-fig. 3 A), *basioccipital* (Text-fig. 3 E) and two exoccipitals (Text-fig. 3 G) form this region of

the skull. The foramenmagnum has a ridged border and *exoccipitals* form its superior, lateral and inferior margins. The base and the roof of the occipital condyl is formed by *basioccipital* and supra-occipital. *Supraoccipital* is a cross-shaped bone with three prominent dorsal ridges. The *occipital* crest forms the mid-longitudinal ridge as well as two prominent lateral ridges which from the continuity with the ridges on the anterior margin of exoccipitals. A minute



Text-fig. 2. A. The occipital region of skull
B. Lateral view of skull.

bony structure extends from the anterior cephalic margin of supra-occipital, providing a loose connection between the supraoccipital and parietal. Such a loose attachment provides a flexible and lever-like mechanism between *supraoccipital* and the parietal and also renders

slight movement in the fronto-parietal portion over the occipito-sphenoidal region of the cranium.

The much extended lateral part of *exoccipital* has been formed by its fusion with the opisthotic. The fan-shaped posterior part of exoccipital forms the lateral boundary of foramen-magnum and bears three minute formina, which aids in orientating the positions of the fused elements. The much extended outermost process (*parotic processus*) articulates independently with *squamosal* and *quadrate*. The small ridged basioccipital takes a major part in the formation of *occipital condyl*. A prominent tubercle on each of its lateral aspect demarcates it from the *exoccipital*. The posterior aspect of these tubercles is slightly convex and provides a flexible attachment to the articular process of the *atlas*. Anteriorly, the *basioccipital* articulates with the much serrated posterior margin of *basisphenoid*, while posteriorly it bears a curved ridge forming the basal margin of *occipital-condyle* and articulating with the *odontoid-process* of the *axis*.

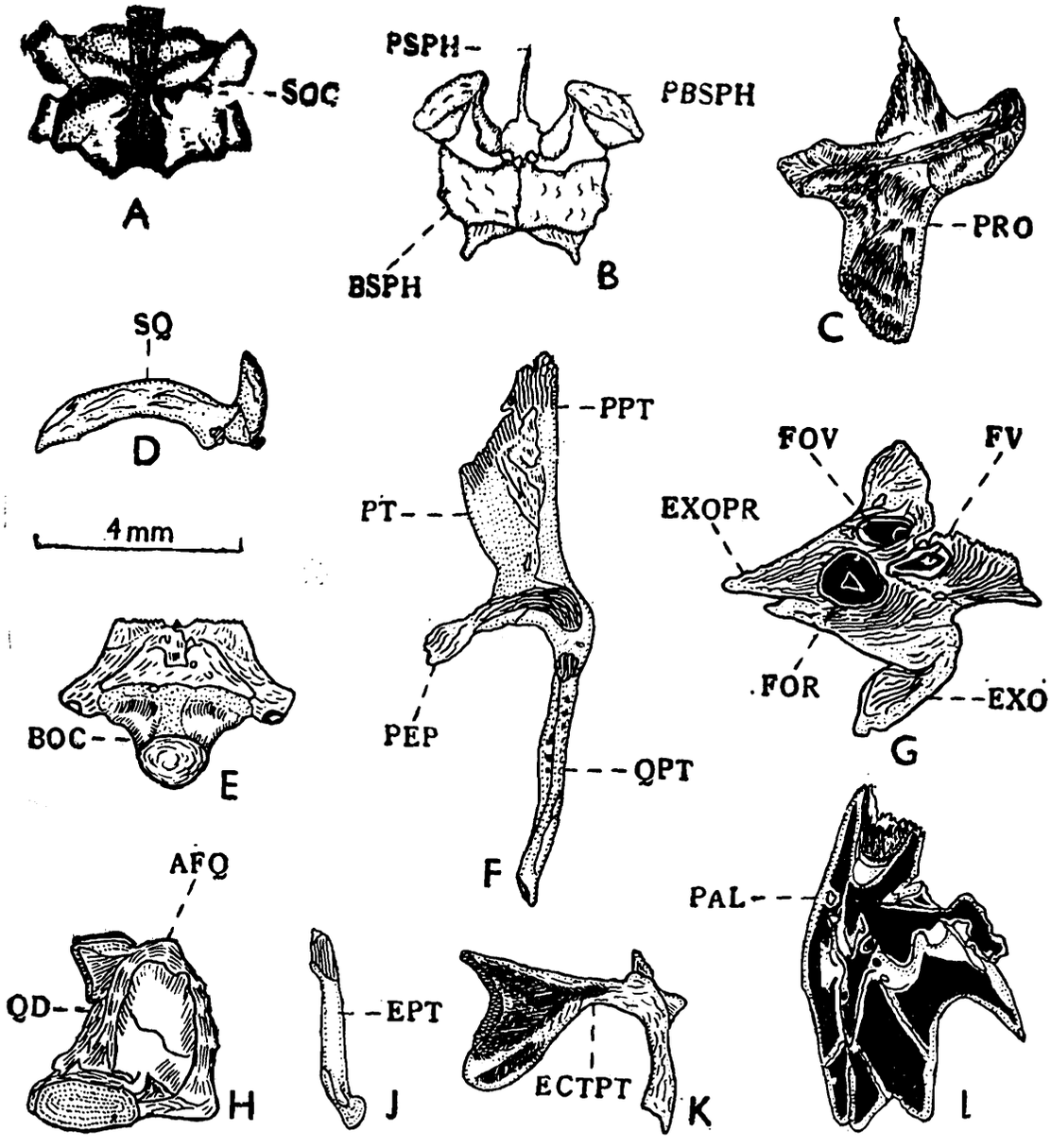
(3) *The frontoparietal complex* (Text-fig. 1A)

This includes the anterior and middorsal regions forming the muzzle and the roof of the skull. It consists of four unpaired (*frontal*, *parietal*, *basisphenoid* and *parasphenoid*) and two paired (*prefrontal* and *postorbitofrontal*) elements. The *parasphenoid* is practically fused with *basisphenoid*.

Frontal (Text-fig. 4A) : It is an elongated, crested, roughly pyramidal or inverted, T-shaped median bone, whose combined lateral borders, along with prefrontal, form the upper dorsal margin of the orbits. Its posterior aspect which bears a notch is a bow-shaped, elevated structure at the middle and fits into a semicircular depression on the anterior border of parietal. The articulation of *frontal* with *parietal* is sutural and the notch, in collaboration with a small pit on the anterior margin of *parietal* forms a foramen, the frontoparietal *foramen*. Its lateral process on each side articulates with *postorbitofrontal* (*postfrontal*) by a distinct suture. On the anterior margin it articulates with *nasals*, *premaxilla* and *prefrontals* by a much serrated, acute margin formed by the sharp pointed invaginations of bony elements. Overlapping of bones is extreme on the anterior margin, and dorsally it bears two strong lateral L-shaped ridges originating from the anterior margin and continuing upto the end of the posterolateral aspects.

Prefrontals (Text-fig. 4 J) : These are small roughly triangular bones situated on the anterolateral aspects of skull, bordering the inner anterior portion of the orbits. The antero-lateral apex and more than half

of the antero-median border of *prefrontals* closely touch the dorsal aspect of the *maxillae*. In the anteromedian region of the skull their dorsal fan-shaped aspects overlap the posterolateral margin of *nasal* and anterolateral margin of frontal. The posterolateral part of each *prefrontal* articulate with *lachrymal* and jugal, while its median posterior border overlaps the *palatine*.



Text-fig. 3. A. Supraoccipital ; B. Basisphenoid and Parasphenoid ; C. Prootic ; D. Squamosal ; E. Basioccipital ; F. Pterygoid ; G. Exoccipital ; H. Quadrate ; J. Epipterygoid ; K. Ectopterygoid ; L. Palatine.

Postorbitofrontals (Postfrontal or Postorbital, Text-fig. 4 K) : They are paired and each has been formed by the fusion of two elements, i. e. *postfrontal* and *postorbital*, and has sutural unions with *frontal*, *parietal*, *jugal* and *squamosal*. Its anterolateral aspect forms the posterolateral border of the orbit and its posterior aspect makes the anterolateral border of the *supratemporal fossa*. The posterolateral dagger-shaped

edge articulates suturally with the dorsolateral margin of *jugal* and, in coordination with *squamosal*, completes the posterolateral boundary of the *supratemporal cavity*. Its vertically directed, clubshaped process makes almost a right angle in forming a common sutural articulation with the narrow lateral aspects of *frontal* and *parietal*.

Parietal (Text-fig. 4B) : It is a single, median, butterfly-shaped investing bone. It possesses a much elongated, sharp, posterolateral process on each side, which articulate with the *supratemporal*, *squamosal* and the *paraoccipital* process of *exoccipital*, forming the posterior boundary of the *supratemporal fossa* and the anterior boundary of the *posttemporal fossa*. From either side of it a process runs downwards to meet the *epipterygoid*. In the front it articulates with the *frontal* and on the side with the *postorbitofrontals*, forming the anteromedian boundary of the *supratemporal vacuity*. A minute foramen is present in the middle of the transverse frontoparietal suture or coronal suture. On the middle of the posterior margin, it bears a small subtriangular notch, to which fits a small bone from the anterior cephalic margin of the *supraoccipital*. Such an attachment with the *supraoccipital* provides a flexible articulation to the parietal and occipital complexes.

Basisphenoid (Text-fig. 3B) : It is a W-shaped replacing bone resting just in the mid-ventral aspect of the cranium, thus forming the lower surface of the frontoparietal complex. Anteriorly, it bears a median prolonged spinose bony structure, the *parasphenoid process of basisphenoid* or *basisphenoidal rostrum*, which posteriorly forms a sutural articulation with *basioccipital*. Its two lateral processes, known as *basipterygoids* form a loose and cartilaginous articulation with the anterior margin of the pterygoid process.

Parasphenoid : It is perfectly ossified, anteriorly pointed, rod-shaped bone, emerging from the anterior margin of *basisphenoid*, close to the *parasphenoid* process.

(4) *The olfactory complex* (Text-fig. 1 A, B)

This complex forms the facial portion of skull and consists of *nasals*, *septomaxillaries*, *prevomer* and the *vomeronasal organ* (Jacobson's organ).

Prevomer (Text-fig. 4 D) : It is a single toothless, dermal, thin, leaf-like bone with a smooth surface articulating anteriorly with *premaxilla* and at the latero-posterior margin with *palatines*. Its posterior margin is much serrated and the articulation with palatines is sutural.

Vomeronasal organ (Jacobson's organ) : It is a distinct clubshaped and pocket like structure, situated between *prevomer* and *premaxilla*. It is a sense organ and has developed as an outgrowth of the nasal cavity.

Nasals (Text-fig. 4 E) : They are paired and triangular and are dorsally completely separated by the long *processus nasalis* of the premaxilla. Posteriorly they about on the wide frontal. Ventrally they touch each other in the mid-posterior region.

Septomaxillary : These are minute, projecting bones lying on each side, slightly above the prevomer. They bound the hinder upper corners of nostrils and articulate with the anterolateral aspect of nasals.

(5) *The palatal complex* (Text-fig. 1B)

The bones of this region exhibit great structural modifications and they comprise the paired pterygoids, palatines and transpalatines (ectopterygoids or transversum). The pterygoids and prevomer are separated by palatines.

Pterygoids (Text-fig. 3 F) : On either side each teethless pterygoid is an elongated, triradiate, dermal bone which forms an oblique sutural articulation with palatine anteriorly while its lateral aspect forms a sutural contact with ectopterygoid. Posterolaterally, its long quadrate process articulates with the inner aspect of the upper end of quadrate. Medially it touches the pterygoid process of basisphenoid by means of a ligament. Its anterior arm is like a thin blade with sharp, oblique, anterolateral margins while the mediodorsal aspect bears an elevated ridge. An osseous thickening on its midlongitudinal portion sends two processes of which the smaller one articulate with ectopterygoid, while the other which is quite long, diverges posterolaterally so as to reach the quadrate. Its lateral process is a flat, roughly triangular structure, known as pterygotranspalatine process, and articulates with the notch-like inner aspect of the ectopterygoid. On the dorsal aspect of the pterygo-quadrate process, slightly posterior to its junction with pterygo-ectopterygoidal process (just lateral to the articular facet of basisphenoid) lies a cavity for the articulation of epipterygoid.

Ectopterygoids (Transpalatine or Transversun Text-fig, 3 K) : They are paired, dumble-shaped, lateroventral in position and articulating firmly with maxilla and jugal on the outer and pterygoid (through pterygo-ectopterygoidal process) on the inner aspects.

Palatines (Text-fig. 3 L) : They are somewhat flat and roughly triradiate, ridged structures forming the anteriormost part of the palatal complex along with prevomers. The anteromedial border of each palatine articulates with dorsolateral margin of prevomer. Their posterior blade-like arm is connected by a broad oblique suture with the

pterygoid. Their serrated anterolateral border makes a sutural articulation with maxilla through the maxillo palatine process, while dorsally they are in contact with the prefrontals.

(6) *The orbital camplex* (Text-fig. 2 B)

The bones of the circumorbital series exhibit great modifications and form a capsule-like structure to provide a suitable socket for the eye ball. The supraorbital arch is formed by frontal and prefrontal. The anterior margin is shared by pre-frontal and lachrymal. Postorbitofrontal forms the posterior boundary of the orbit and the architecture of its flooring is shared by the posterior projections of lachrymal, jugal, transpalatine, pterygoid and palatine.

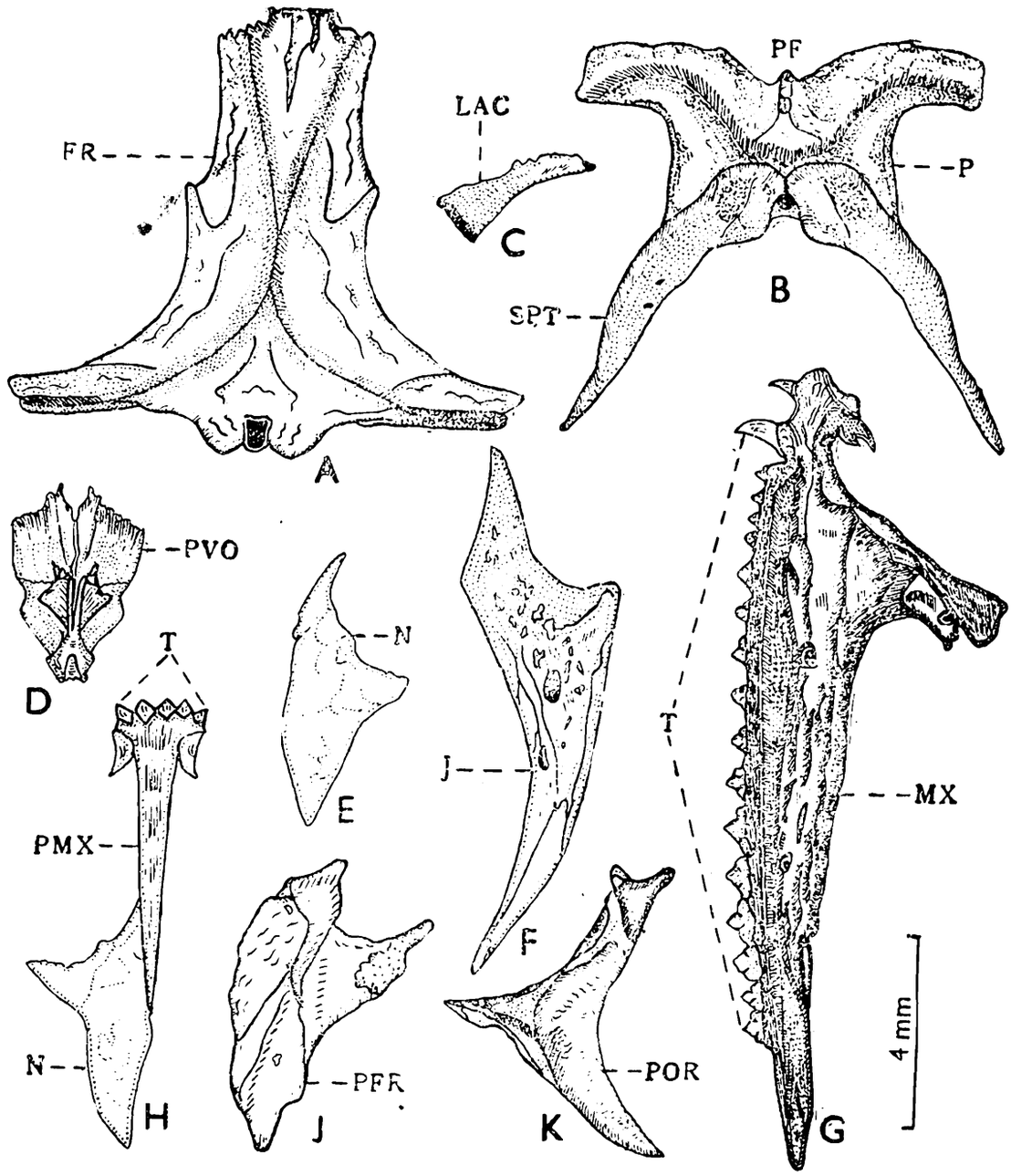
Lachrymals (Text-figs. 2 B, 4 C) : Consists of a pair of bones. Each one is a small, roughly triangular bone, which antero-ventrally articulates with maxilla, dorsally with prefrontal by means of sutures, posteriorly, through a narrow projection, with the elongated anterior projection of jugal, thus completing the interorbital arch. Each labra bears an orifice at the anterolateral corner of the orbit for the passage of the lachrymal canal.

Jugal (Text-figs. 2 B, 4 F) : They are paired roughly dagger-shaped bones suturally articulating with squamasal, postorbitofrontal, ectopterygoid, prefrontal, lachrymal, maxilla and palatine. The posterodorsal portion of jugal is a flat serrated structure bearing a ridge on its dorsal expanded margin which articulate posteriorly with squamosal and dorsally with postorbitofrontal. The posterodorsal suture formed by the union of postorbitofrontal and jugal, is bow-shaped. The anterolateral arm of postorbitofrontal sends a lateral arm over jugal in the midposterior part of the orbit. The projected extreme posterior end of jugal articulates obliquely with the anterior facet of squamosal, thus forming the dorsal boundary of the infratemporal fossa. The anterior portion of jugal is a narrow projection which with its entire ventral margin articulates firmly with the maxilla. The extreme anterior tip of this projection just touches lachrymal, prefrontal and palatine. At its inner median aspect, almost at the middle of infraorbital arch, it articulates with ectopterygoid.

(7) *The auditory complex*

The auditory complex is composed of tympanum, protic and opisthotic, forming an auditory capsule on either side of the occipital region.

Prootic : It is a somewhat cross-shaped bone forming the anterior part of the auditory capsule. On its posterior margin lies the exoccipital, while on the latero-ventral aspect the basis-phenoid. Postero-dorsally, it articulates with the exoccipital, supraoccipital, parietal and epipterygoid.



Text-fig. 4. A. Frontal ; B. Parietal ; C. Lachrymal ; D. Prevomer ; E. Nasal ; F. Jugal ; G. Maxilla ; H. Premaxilla and Nasal ; J. Prefrontal ; K. Postorbitofrontal.

Opisthotic : The opisthotic does not carry a separate identity and is represented only by a postero-lateral thickening on the preoccipital process of exoccipital. It forms a well marked exterior prolongation (parotic process) along with prootic and exoccipital. The columella auris is composed of two things a slender rod-like stapes and a cartila-

ginons tubercle, the extrastapes. The flac and dis-like proximal invagination of the stapes remains in close contact with the membranous lid of fenestra ovalis. The distal end of stapes extends up to the capitula of quadrate. The extrastapes is also an important replacing bone of the auditory capsule, attached on one side with stapes and on the other with tympanic membrane. The tympanum is not exposed.

(8) *The maxillary complex* (Text-fig. 2 B)

A single premaxilla and a paired maxilla share in the formation of this complex.

Premaxilla (Text-fig. 4 H) : It is a median peg-like bone with a broad dentate anterior part which forms the tip of snout, and a posterior thin and much elongated nasal process. The nasal process articulates with the anteromedian margins of nasals. The anterolateral border of premaxilla articulates with maxilla by a suture and with prevomer on the posteroventral aspect. The anterior broad margin possesses four sharp pointed acrodont teeth.

Maxilla (Text-figs. 2 B, 4 G) : It is a paired bone articulating with premaxilla, jugal, nasal, prefrontal, prevomer, lachrymal, palatine, septomaxilla and epipterygoid. It provides a definite symmetry to the sides of skull and keeps a close association with palatal and olfactory complexes. *Epiterygoid* serves as a bridge between maxilla and these complexes. It is an elongated ridged bone marked with coossified osteoderms and the labial foramina. Its anteriormost portion which articulates with premaxilla bears two distinct teeth (an insisor and canine). Most of its posterior portion is provided with 15 or 16 molars. Dorsally it articulates suturally with nasal.

(9) *The suspensorial complex* (Text-fig. 2 B)

The elements of this complex form a flexible attachment of the cranium with the lower jaw through quadrate. The bones which participate in the architecture of suspensorium are epipterygoid, squamosal, quadrate and supratemporal.

Quadrate (Text-fig. 3 H) : It serves as a hanger in providing a suspended articulation to mandibles and a streptostylic movement to the bones of head. It is a small bone with an outer concave and an inner convex margin. It articulates with squamosal, supratemporal and collumella auris by means of its somewhat flat and broad dorsal aspect. The ventral aspect, which is comparatively narrow and less flat, forms a ligamentous articulation with the articular portion of

the lower jaw. The articulation of quadrate with pterygoid has already been discussed under the palatal complex.

Squamosal (Text-fig. 3 D) : It is a small, smooth and paired bone, forming an arch-like postero-lateral boundary of skull, thus enclosing the supratemporal fossa on the dorsal aspect. The anteriormost facet of the anteriorly elongated and somewhat bow-shaped portion of squamosal articulates with jugal below while postorbitofrontal above. The end of its much smaller posterior part articulates with quadrate below and supratemporal and parietal above.

Supratemporal (Text-fig. 1A) : It is a small and splint-like paired bone almost fused to the extreme postero-lateral tip of the elongated lateral process of parietal, wedged between squamosal externally and ophisthotic medially. It articulates with quadrate by its posteroventral aspect.

Epipterygoid (Text-fig. 3 J) : It is a rod-shaped paired bony structure. Each epipterygoid is situated adjacent to the auditory capsule, like dorsoventral pillars. It emerges from a notch on the dorsal surface of pterygoid, and ascends dorsally to form a ligamentous connection with a small process formed by supraoccipital.

(10) *The mandibular complex* (Text-fig. 5A & B)

Each ramus is an elongated and slightly curved structure formed basically by the combination of seven elements viz. prearticular, angular, articular surangular, opercular or spleniod, coronoid and dentary. The intermandibular articulation is ligamentous.

Prearticular and Articular (Figs. 5 A & B)

These two elements have fused into a single roughly triangular bone, which has been formed as a result of endochondral ossification. Its posteriorly tapering post-articular process articulates with quadrate and the dorsal aspect carries a rough flat area known as "fovea articularis". On the outer side of mandible, its anterodorsal aspect forms an oblique sutural union with surangular. In the same plane its anterior and anteroventral aspects articulate suturally with the angular. On the inner aspects its slightly curved and rod-shaped portion extends anteriorly to form the basal margin of the "Meckclian fossa" and ultimately forms sutural articulations, antero-dorsally with coronoid and anteroventrally with angular and splenial.

Angular (Text-fig. 5 A & B) : It is an elongated, curved and distinct bone whose butt-shaped broad posterior part forms sutural articulations with the surangular dorsally and with the articular posteriorly and

ventrally. Its narrow and blade-like anterior portion recurves on the inner aspect of the mandibular ramus where it suturally articulates with the splenial dorsally and the dentary ventrally. Its anteriormost pointed end rests on dentary and extends little bit into the cavity for "Meckel's cartilage".

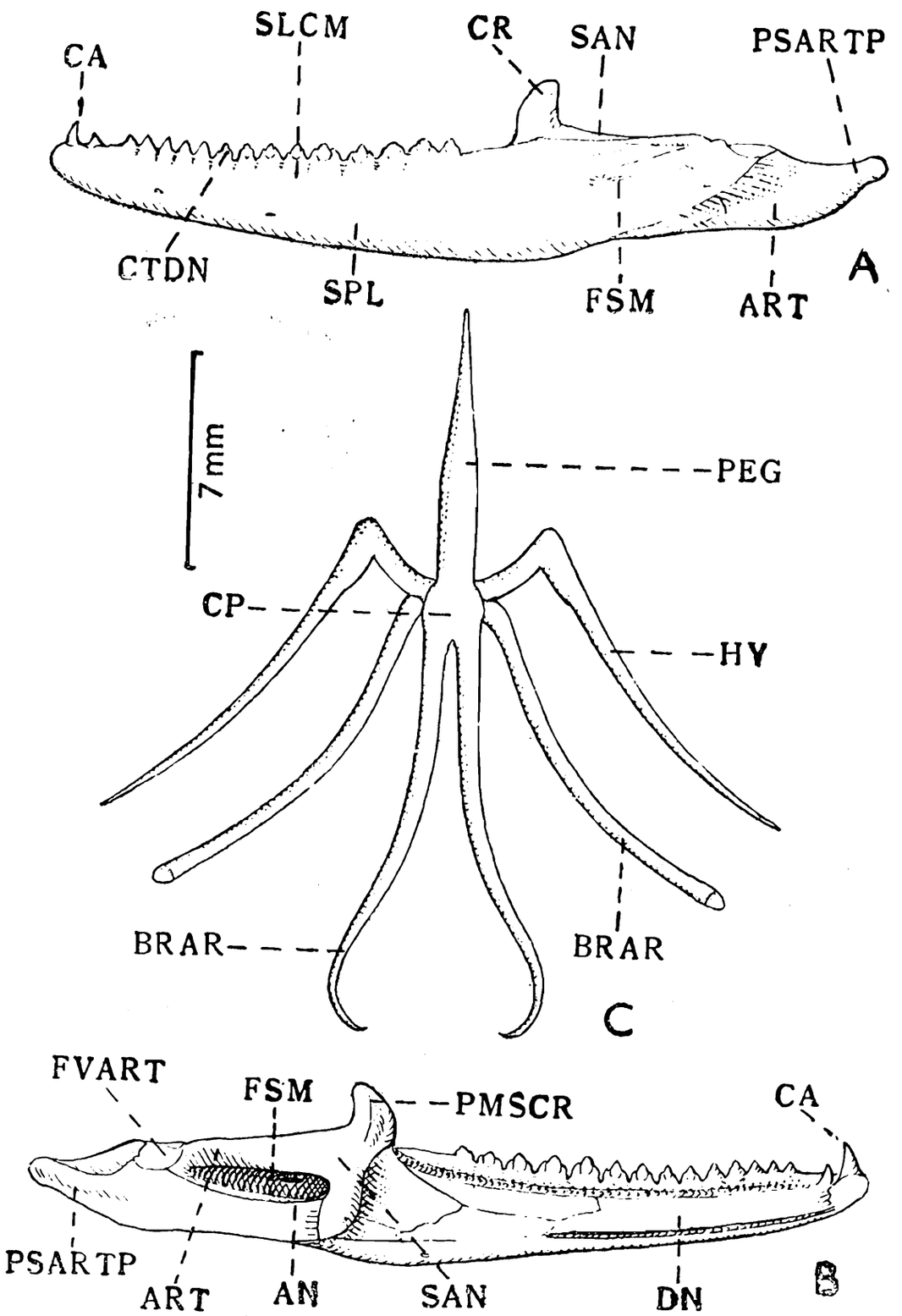
Surangular (Text-figs. 5 A & B) : It is a distinct bone whose median, oblique antero-dorsal and much serrated anterior margins articulate suturally with dentary. Most of its ventral bladelike margin, on one side articulates suturally with angular and on the other with the antero-dorsal portion of articular. The posterior ridged margin forms a tight articulation with the "fovea articularis" portion of articular. On the outer side of ramus, its uppermost anterodorsal margin articulates with coronoid by means of a curved suture originating at its anterodorsal outer aspect and passing on the inner aspect of the mandibular ramus. The inner surface is provided with an elongated and roughly oval depression (fossa Meckellii).

Splenial (Opercular, Text-figs. 5 A & B) : It is an elongated, median and triangular bone, articulating suturally antero-dorsally and anteriorly with dentary, postero-dorsally with coronoid, posteriorly with articular and ventrally with angular. Its anterior end possesses a slight concavity, bifurcating the tip into two parts. The lower part of its anterior end forms the extreme posterior boundary of the cavity for Meckel's cartilage. The suture between it and the coronoid is much serrated.

Coronoid (Complementary, Text-figs. 5 & B) : It is a roughly X-shaped bone having a straight median crest and two arms, visible on the inner aspect of ramus. Its anterior, quite broad bladelike arm articulates with splenial by a much serrated oblique suture. The posterior, slightly curved and narrow arm articulates postero-ventrally with surangular. The extreme dorsal apex of coronoid is known as "processus massetericus" and makes the extreme upper end of the median ridge of coronoid, which descents gradually and ultimately forms a sutural connection with underlying articular.

Dentary (Text-fig. 5 B) : The dentary is a major and most important tooth-bearing element of the lower jaw and constitutes more than half of the mandibular ramus. On the outer side, its posterior margin articulates with surangular and with the median upper aspect of angular. The articulation with angular is continuous on the inner side of the ramus. The postero-dorsal outer margin articulates with coronoid. On the inner aspect of ramus, it articulates with coronoid and splenial. A distinct cleft, the crista-dentalis, is present on its dorsal aspect.

The crest possesses a row of regularly arranged 19 teeth, of which the posterior 16 are molars and the rest are pointed and slightly recurved canines. All the teeth are sheathed firmly above minute concave depressions. Just below the Crista-dentalis lies a narrow canal for the Meckel's cartilage.



Text-fig. 5. A. Outer view of the ramus of the mandible.
B. Inner view of the ramus of the mandible ;
C. Hyoid apparatus.

In lizards, the articulation of mandibles with skull and the intermandibular articulation has considerable taxonomic significance. The comparison of these structures with that of fossil forms might serve as an important tool in tracing the exact ancestry of modern lizards. The intramandibular region is a structure of importance in reptilian taxonomy and the further studies on it might also help in establishing, the proper place of lizards among reptiles.

(11) *The Hyoid apparatus* (Text-fig. 5 C)

All the three visceral cornua or arches of the hyoid apparatus are well developed and emerge on each side from corpus hyoideum extending backward and upward in the region of neck. The corpus hyoideum, which represents the main body of the hyoid apparatus, is cartilaginous medially and bony on the margins. The anterior portion of corpus hyoideum becomes narrow and gradually extends anteriorly into a slender tapering medial process, known as processus lingualis or processus entoglossus. The anteriormost cornua or the hyoid cornua, which emerges on either side of corpus hyoideum is formed by the union of two parts. The proximal part of the hyoid cornua is a short bony element having a cartilaginous connection with the long slender distal portion. The first branchial cornua is also composed of two parts, a much elongated proximal bony ceratobranchial and a minute distal cartilaginous epibranchial. From the posterior aspect of corpus hyoideum on either side emerges two parallel long whip-like bony extensions representing the second branchial cornua of the hyoid apparatus.

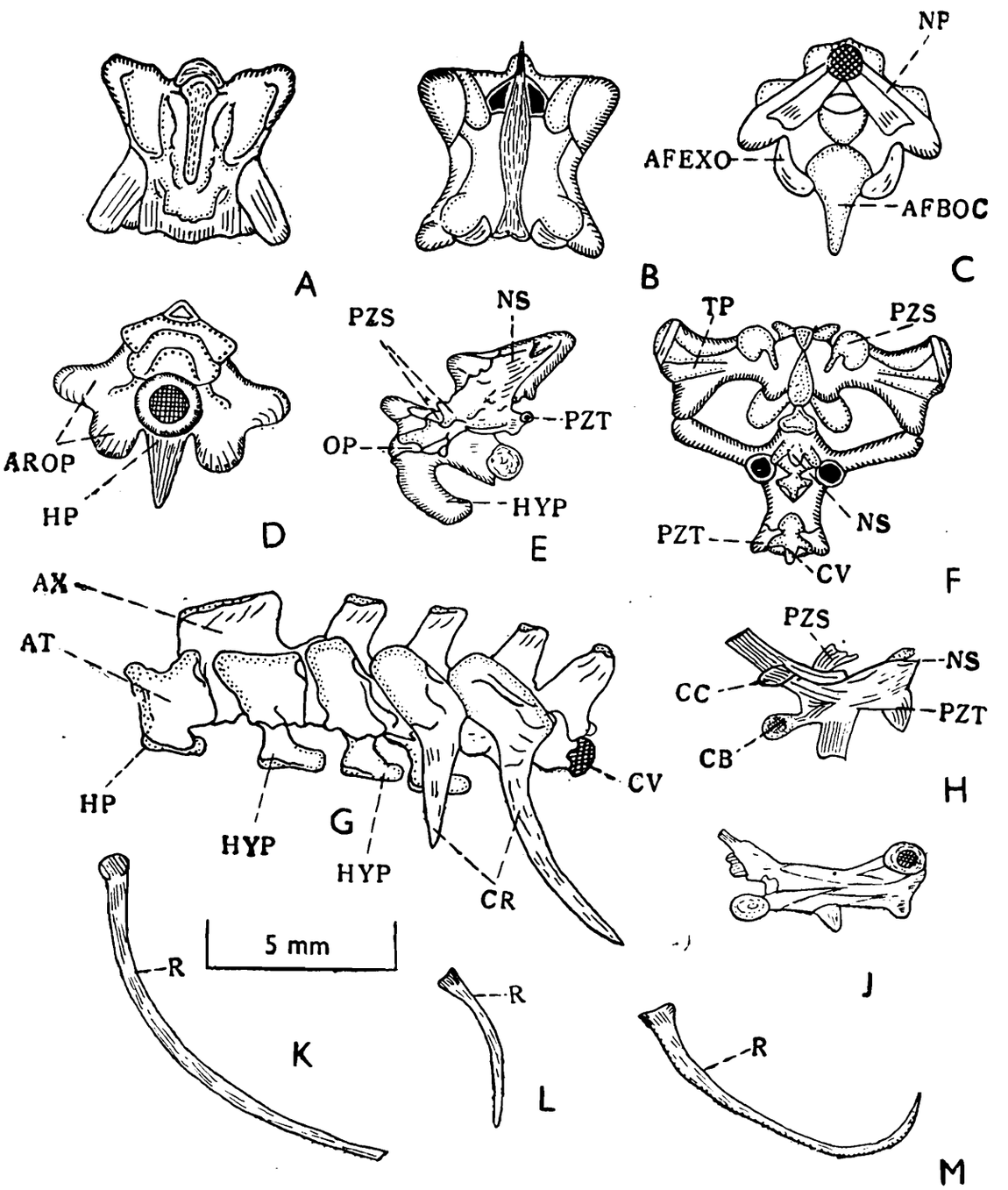
(B) **The Vertebral complex**

(Text-fig. 6)

The vertebral column is made up of 57 procoelous vertebrae (7 cervical, 18 thoracic, 1 lumber, 2 sacral and 29 caudal). The posterior 4 cervicals and the anterior 17 thoracics bear ribs. The 6 posterior thoracic, the lumber and both the sacral vertebrae possess enlarged transverse processes. In the posterior thoracic vertebrae the transverse processes are much enlarged and look like fused ribs. Out of the 29 caudal vertebrae, the 8 anterior ones possess transverse processes and neural spines, while the remaining 16 are devoid of such structures.

The Cervical vertebrae (Text-fig. 6 G) : The first 3 cervival vertebrae, viz. the atlas, the axis and the third one are devoid of ribs ; the remaining 4 possess free ribs.

The atlas (Text-figs. 6A, B, C & D) : It is devoid of neural spine and transverse processes. Its dorsal surface bears a flat neural arch formed by the union of the lateral neurapophysis. Basally both the neurapophyses have a bony connection with the hypapophysis. The dorso-



Text-fig. 6. A. Dorsal view of atlas vertebra;
B. Ventral view of atlas vertebra ;
C. Anterior view of atlas vertebra ;
D. Posterior view of atlas vertebra ;
E. Lateral view of axis vertebra ;
F. Dorsal view of scral vertebrae ;
G. Mode of articulation in cervical vertebrae ;
H, and J. Lateral aspect of caudal vertebra ;
K, L, and M. Ribs.

posterior portion of the neurapophysis (postzygapophysis) forms a firm articulation with the prezygapophysis (post-zygapophysis) forms a firm articulation with prezygapophysis of the axis vertebra. Certain bony thickenings on the anterior aspect forms the articular facets for the exoccipital and the basioccipital. On the same aspect a median, ventrally projected spine-like hypocentrum is visible. The posterior aspect bears articular facets for the odontoid process of the axis. Each dorsolateral portion of the atlas is formed by the union of antero-dorsal and postero-dorsal parts of the neurapophysis.

The axis : (Text-fig. 6 E) : It is devoid of transverse process and possesses a pointed, posteriorly directed, laminar neural crest on the dorsal aspect. A prominent, posteriorly curved hypapophysis and an antero-median somewhat conicervical vertebrae possess a pre- and postzygapophysis, a well developed neural spine and a hypapophysis on the ventral aspect except that the third one is devoid of ribs.

The thoracic vertebrae : These are 18 in number, and possess well developed pre- and postzygapophysis, neural spines, and cup-shaped sockets at the base of antero-lateral aspect of the cranium for providing movable articulation to ribs.

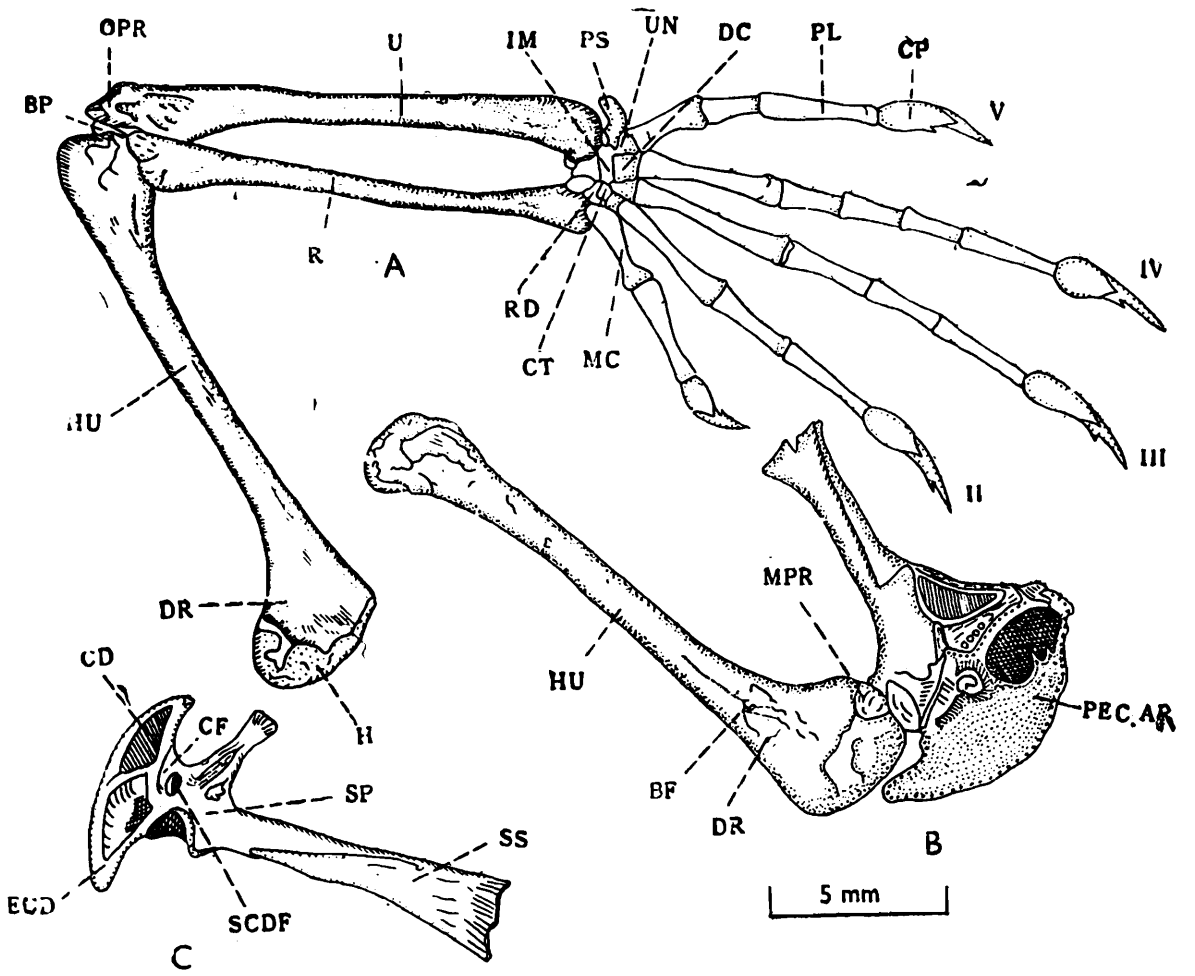
Lumbar : A single lumbar vertebra with a strong antero-dorsally pointed pre-zygapophysis and a well developed transverse process, lies between the thoracic and the sacral vertebrae. It does not bear ribs and its postzygapophysis is fused medially with a postero-dorsally directed neural spine.

Sacral (Text-fig. 6 F) : Sacrals are two in number and bear laterally well developed and expanded transverse process. Neural spines are less prominent. Haemal arches are lacking and pre- and postzygapophysis are well developed. The transverse process of anterior sacral is stronger than that of the posterior one.

Caudal vertebrae (Text-fig. 6 J) : The 29 caudal vertebrae are differentiated into three types, thus : (i) The Intermediate posteacrals with a well developed transverse process, neural spines and devoid of haemal arches. (ii) The remaining anterior caudal vertebrae with transverse process, neural spines and haemal arches. The haemal arches or chevran bones are the ventral extensions which emerge from the centrum (intercentrum) and form a demarcation between the caudal muscles. (iii) The elongated tubular posterior tail vertebrae without transverse processes and neural spines but with well developed pre- and postzygapophysis.

suprascapula, coracoid, epicoracoid, clavicle and interclavicle participate in the formation of this girdle. The Supra-scapula and epicoracoid are cartilaginous structures while the other four are bony.

The Clavicles (Text-fig. 7) are curved bones on the ventral side, articulating medially with the anterolateral aspect of interclavicle. Dorso-medially clavicles rest just above the epicoracoids and extend laterally to touch at the middle of anterior margins of scapula. *The Interclavicle* (Text-fig. 7) is a roughly T-shaped median ventral bone lying beneath the sternum. *The Suprascapula* (Text-fig. 8 C) It is a thin cartilaginous



Text-fig. 8. A. Humerus, radius, ulna and bones of manus ;
B. Humerus and pectoral arch ;
C. the Ventral view of the pectoral arch.

bone attached to the dorso-lateral edge of scapula. *The Scapula* (Text-fig. 8 C) forms a dorso-lateral bony extension of pectoral girdle, and forms a sutural articulation with coronoid. *The Coronoid* (Text-fig. 7) is a large flat slightly convex structure bearing the glenoid fossa. Its thin sharp and curved median part articulates posteromedially with cartilaginous epicoracoid. A minute circular aperture, the coronoid fossa, lies above the glenoid fossa.

The Forelimbs (Text-fig. 8) : Each forelimb consists of the humerus, ulna, radius, carpals, metacarpals and phalanges. *The Humerus* (Text-figs.

8 A & B) is moderately elongated bone with a shaft and broad ends. The proximal end articulates with pectoral girdle. The deltoid ridge is quite prominent and bicipital fossa (depression between deltoid ridge and head) possesses many foramina. The bicondylar distal end articulates with radius and ulna.

Radius and Ulna (Text-fig. 8 A) are thin elongated bones lying parallel to each other. The radius is thinner than ulna and both articulate with each other proximally. The Ulna bears well developed postaxially projected olecranon process. On the distal aspect, ulna articulates with pissiform and the ulnare, and radius fits into a socket-like proximal aspect of radiale.

The Metacarpals (Text-fig. 8 A) are five in number. The first and the fifth ones are the smallest in size. Third metacarpal is the longest, while the second and the fourth are of equal size. The phalangial formula is 2, 3, 4, 5, 3. Each distal phalanx of all the five digits is strongly clawed and bears a notch on the inner aspect of its terminal portion. *The Carpus* (Text-fig. 8 A) is formed of 9 elements viz., the pisiform, well developed ulnare and radiale in proximal series ; a small centrale in the middle row and 5 carpals in the distal row. Out of 5 distal carpals, first is very small ; second and third are of moderate size and compressed on sides ; fourth is biggest, compressed on sides and fifth is slightly rounded, smaller than fourth.

The Pelvic girdle (Text-fig. 9)

The Pelvic girdle is composed of two triradiate elements to form a bilaterally symmetrical composite structure. Each triradiate half consists of three bones viz., pubis, ischium and ilium. All these bones of each innominate fuse with one another on the lateral aspect and the sutures between them are not distinct.

Pubis (Text-figs. 9 B, C & D) : It is an anteroventral, dorsoventrally compressed and somewhat triangular bone. Its anteriormost tip bears a minute cartilaginous structure, the epipubis. The laterally directed angular process (prepubic process) is well developed and tipped with cartilage. The posterior arm of pubis ends into a ridge forming the anterior boundary of acetabulum and merges with the depressed anterior end of ilium. Posteriorly pubis bears a foramen for the obturator nerve.

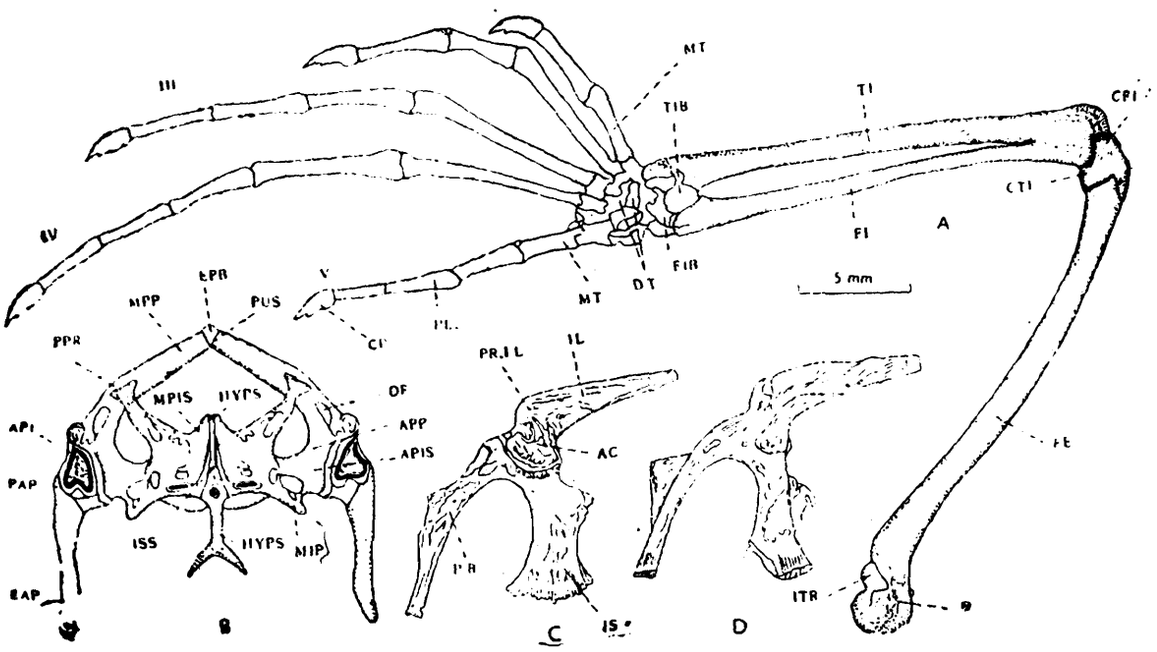
Ischium (Text-figs. 9 C & D) : Ischium is a broad and roughly fan-shaped bone, separated from its counterpart of opposite side by hypoischial cartilage. The bone is ridged at the acetabular end forming the anteromedial portion of the acetabulum.

The Hind limbs (Text-fig. 9)

Each hind limb is made up of femur, tibia, fibula, tarsus and pes.

Femur (Text-fig. 9 A) : It is a strong elongated and rod-shaped bone with a shaft and articular extremities. The proximal end possesses a head which fits into the deep acetabulum. On the preaxial aspect near the head is present a process, known as trochanter. The distal end is bicondylar articulating with the proximal ends of tibia and fibula.

Tibia and Fibula (Text-fig. 9 A) : The Tibia is a strong bone lying preaxially while the fibula is a thin postaxial bone. Both of them rest side by side articulating with each other at proximal and distal aspects.



Text-fig. 9. A. Femur, tibia, fibula and bones of tarsus ;
B. Upper view of the pelvic girdle ;
C. Dorsal view of the innominate of pelvic girdle ;
D. Ventral view of innominate of the pelvic girdle.

Tarsus (Text-fig. 9 A) : It is made up of 6 parts namely, febulare, tibiale, and four nodular structures, situated on the proximal ends of metatarsals. Fibulare and tibiale are united by a median compact suture. The proximal aspects of fibulare and tibiale are provided with slight concavites which receive the distal ends of fibula and tibia. Tibiale is almost three times as large as fibulare and provides articulation to the distal end of tibia and almost half of the distal aspect of fibula. The remaining four pieces of tarsus form its distal row and articulate with the proximal ends of metatarsals. The first piece is very small and articulate with first metatarsal ; second is slightly bigger and articulates with second and third metatarsals ; third one is roughly triangular

central piece articulating with fourth metatarsal and fourth is small rounded, cartilaginous structure partly fused with fifth metatarsal.

Metatarsals (Text-fig. 9 A) : They are 5 in number, out of which third and fourth are of equal size ; second is smaller than third ; first is almost half of the second and fifth is the smallest, much ossified and hooked. The phalangeal formula is 2, 3, 4, 5, 4 (number of phalanges in first to fifth toe). All the digits are strongly clawed.

Summary

1. The skull bones are well ossified.
2. A minute bony structure extending from the anterior cephalic margin of supraoccipital provides a loose connection between the supraoccipital and parietal.
3. The frontal articulates with nasals, premaxilla and prefrontals by a much serrated acute margin formed by the sharp pointed bony invaginations.
4. The median posterior border of prefrontal overlaps the palatine.
5. The postfrontal and postorbital bones fuse together and form a single bony structure, i. e., Postorbitofrontal.
6. A minute foramen is present in the middle of the transverse frontoparietal suture.
7. The Basisphenoid at its anterior aspect bears a median prolonged spinose bony structure, the basisphenoidal rostrum.
8. The Parasphenoid is perfectly ossified.
9. The Prevomer is toothless, dermal, leaf like bone.
10. The Vomeronasal organ is a club-shaped outgrowth in the nasal cavity.
11. The Nasals are completely separated by the processus nasalis of premaxilla.
12. The Pterygoids are toothless, triradiate dermal bones.
13. The Palatines articulate with prevomer.
14. Lachrymal bears an orifice at the anterolateral corner of the orbit for the passage of the lachrymal canal.
15. The opisthotic is represented by a posterolateral thickening on the paraoccipital process of exoccipital.
16. The Tympanum is not exposed.
17. The Maxilla is provided with one inscisor, one canine and 15 or 16 molars.

18. The Quadrate has a ligamentous articulation with lower jaw.
19. The intermandibular articulation is ligamentous.
20. The Prearticular and articular are fused and have been formed as a result of endochordral ossification.
21. The Dentary possesses 3 pointed canines and 16 molars.
22. The Hyoid and the first branchial cornua are composed of two parts.
23. The vertebral column is made up of 57 procoelous vertebrae (7 cervical, 18 thoracic, 1 lumbar, 2 sacral and 29 caudal).
24. There are 22 pairs of ribs out of which five are attached to the sternum.
25. A separate Xiphisternum is present and sternum bears a pair of fontanelles.
26. The suprascapula and epicoracoid are cartilaginous.
27. The bicipital fossa of deltoidridge of humerous possesses many formina.
28. The metacarpals are five in number ; the phalangial formula is 2, 3, 4, 5, 3, and the Carpus is formed of 9 elements.
29. The pubis, ischium and ilium fuse with one another on the lateral aspect.
30. The tarsus is made up of 6 parts.
31. The metatarsals are 5 in number, the third and fourth are of equal size ; the phalangeal formula is 2, 3, 4, 5, 4.

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REVIEWS

Review on The Fauna of India : Spiders, Vol. 2

The Fauna of India. Spiders : Araneae. Vol. 2, Part 1. Family Araneidae (=Argiopidae), Typical Orb-weavers. Part 2. Family Gnaphosidae.—By B. K. Tikader. xiv+536 pp., 504 figs., 3 col. pls. 1982. Calcutta (Zoological Survey of India). Price : In India : Rs. 200·00, Foreign : £ 20·00 or U. S. : $ 75·00

This is the second volume of the *Fauna of India* on spiders, (for the first volume by the same author, published in 1980, see the *Journal, Bombay nat. Hist. Soc.*, **77**, p. 310, 1980), and is like the first equally well written and well produced, for which both the author and the printers deserve congratulations.

Part 1 (pp. 1-293) deals with the orb-weavers of family Araneidae and includes 21 genera and 101 species. The introductory part contains an account of the orb-weaving mechanism, the general taxonomic characters of spiders, a list of all the spider families of the world of which 43 are stated to occur in India, keys to families and genera of Indian spiders and, finally, keys to the subfamilies and genera of the Indian Araneidae. This is followed by an illustrated account of the various genera and species. Then follows a bibliography and a short index.

Part 2 (pp. 295-536) deals with the family Gnaphosidae and follows the same pattern as Part 1, except that it includes a useful glossary of anatomical terms for spiders. The account includes 21 genera and 89 species. Altogether, therefore, the volume covers 42 genera and 190 species.

The generic and species descriptions are brief but clear and succinct, and synonymies with references are provided in each case.

The book forms a very welcome addition to the understanding of our large spider fauna and we shall look forward to many more volumes by the same author which will be required to cover the entire group. For the families covered, the present volume will remain a standard work of reference for many years to come, and we hope that all zoological libraries will acquire it.

A small suggestion may be offered for the index. It should include the synonymies as well in a distinguishable type besides the valid species. At present the italicised type includes only those for which detailed descriptions are given.

M. L. Roonwal