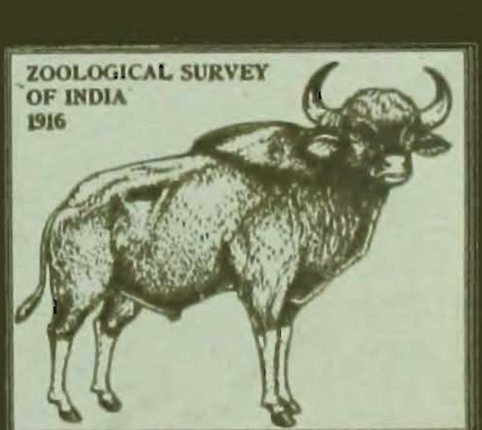
BULLETIN

OF THE

ZOOLOGICAL SURVEY OF INDIA



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BULLETIN OF THE ZOOLOGICAL SURVEY OF INDIA

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CHROMOSOMES OF *DEIPHOBE OCELLATA* SAUSSURE (DICTYOPTERA : MANTIDAE)

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ABSTRACT

Deiphobe ocellata has karyotype of 8AA+XO. All the chromosomes are metacentric. The sex-chromosome is largest in the complement. This species of genus *Deiphobe* is considered to be more primitive than those described by Gupta (1964). Variation in their chromosome number and sex-chromosome mechanism have been discussed.

INTRODUCTION

The contribution of Indian workers in the field of mantid cytology is very limited. Asana (1934), Dutt (1954), Dasgupta (1960), Gupta (1964, 66) have studied the chromosomes of Indian mantids. Among the other workers, Oguma (1921), King (1931), White (1940, 41, 73), Hughes-Schrader (1943*a*, *b*, 50, 51) and Wahrman (1954) have helped us in understanding the cytology and cytotaxonomy of this group. Considerable range of variation in the chromosome number and in sex-determining mechanism at inter as well as intra-specific level is reported. Therefore, it is worthwhile to study related species to understand the mechanism of chromosomal polymorphism and evolutionary phenomenon. Gupta (1966) reported chromosome number and sex-chromosome mechanism in *Deiphobe brunneri* (Sauss.) and *Deiphobe indica* Giglio Tos to be 18+XO and $24+X_1X_2Y$ respectively. This is the third species of the same genus which further shows variation in the chromosome number.

MATERIAL AND TECHNIQUE

Only male specimens (adult) were collected from Solan (Himachal Pradesh) during the months of June-July, 1975. They were injected with 0.2 cc of 0.05% colchicine and sacrifised after four hours. Testes and hepatic caeca were treated in hypotonic solution of 0.56% KCL for 5-6 minutes and fixed in 1 : 3 Aceto-methanol. Air-dried preparations were stained in Giemsa and finally mounted in DPX. The measurements such as relative percentage lengths (L^R) and centromeric indices (I^C) were calculated according to the method of Levan *et al.* (1964) which are given in the table.

OBSERVATIONS

The meiotic divisions in the mantids are completed mostly in the last nymphal instar. Unfortunately, our specimens were adult therefore no suitable plates could be scored from the testicular material.

Observations were based on the somatic

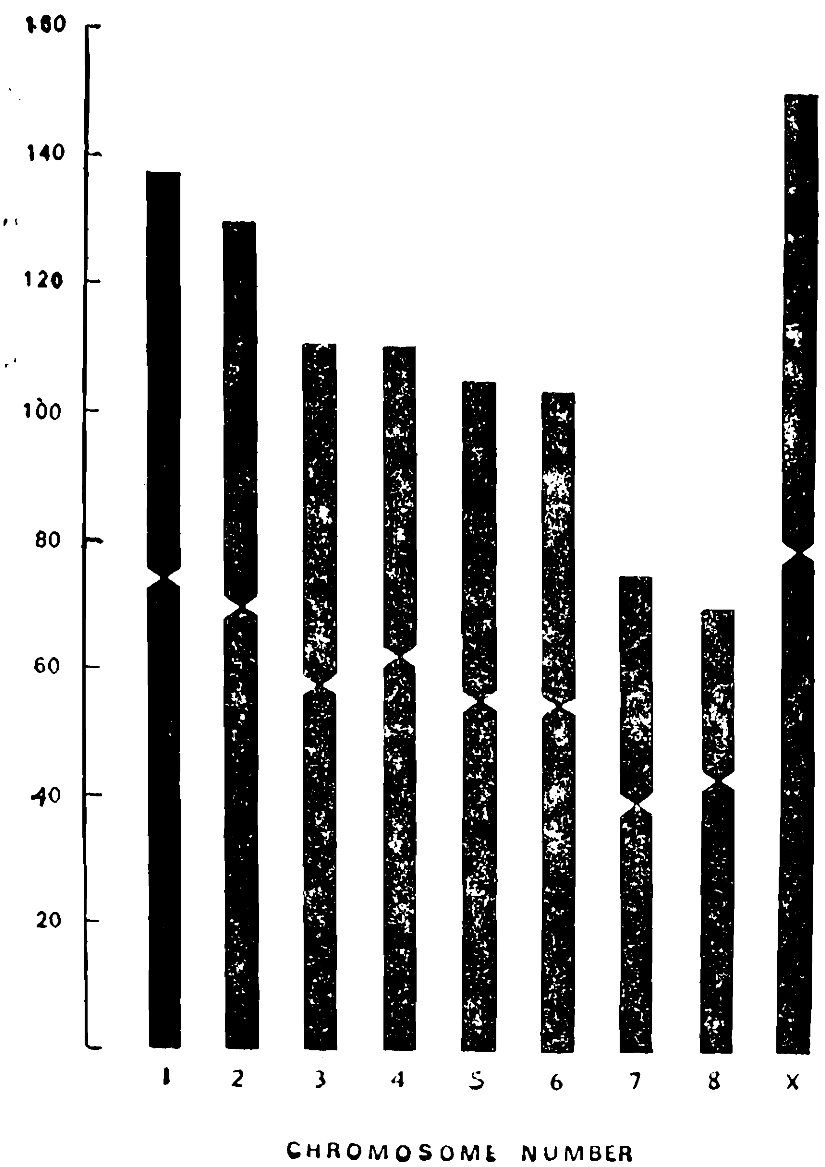

Fig. 1. Idiogram of *Deiphobe ocellata*

chromosomes from the hepatic caeca. The diploid chromosome number was observed to be 17. In all the chromosomes the centromeres are located on the median region (m). An unpaired chromosome, the largest in the complement, is the X chromosome (Fig. 1 & Pl. 1).

Discussion

Wahıman (1954) suggested that in mantids, species with low chromosome number and the sex-chromosomes as large as the autosomes, are considered to be more primitive than those which have a huge sex-chromosome compared to much smaller autosomes. Our species with 17 chromosomes apparently falls under former category and cytotaxonomically could be more primitive than *Deiphobe brunneri* having 2n♂ =18+XO (Gupta, 1966). The XO sex-chromosome mechanism also is presumed to be primitive than X_1X_2Y system reported in *Deiphobe indica* having 2n♂ =24+X_1X_2Y (Gupta, 1966).

TABLE 1. Measurements of the chromosome complement of *Deiphobe ocellata*

Chromosome number	1	2	3	4	5	6	7	8	X
L^R	138.24	130.66	111.46	111.46	106.24	104.73	75.93	70.71	150.53
I^C	ț5.71	46.14	47.58	42.55	46.26	48.55	48.11	37.53	46.75

Such an interspecific difference in chromosome numbers are presumably on the Robertsonian principle. The evolutionary equivalence of one metacentric is to two acrocentric chromosomes. The 19 and 27 numbered chromosomal species would have evolved from this 17 number metacentric chromosomal species. The X_1X_2Y system evolved in *D. indica* may be due to the reciprocal translocation between a metacentric X and an autosome, which could give rise to X_1X_2 and unaltered homologue of the autosome forms the Y chromosome. (White 1940, 41).

The presence of XO and X_1X_2Y system and such a wide variation in the chromosome number in the genus *Deiphobe* is of utmost evolutionary impotrance, and needs further exhaustive cytological probe at the population level.

ACKNOWLEDGEMENTS

We are grateful to the Director, Zoological Survey of India for providing necessary laboratory facilities and encouragement for the work. Our sincere thanks goes to Sri Suresh Kumar Mishra of Zoological Survey of India for kindly identifying the specimens.

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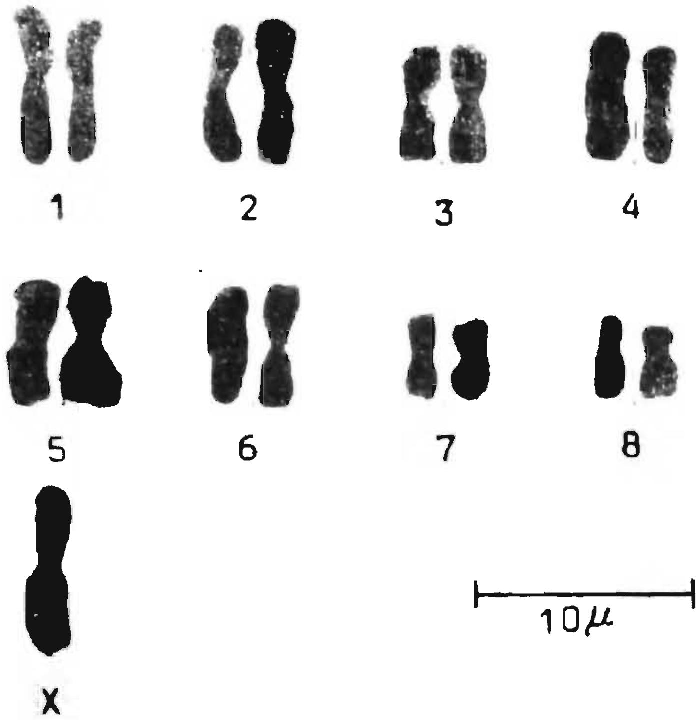

Karyotype of *Diephobe ocellata*

*Bull. zool. Surv. India, 1 (3) : 211-220, 1978

REVISION OF THE GENUS *SPONDYLUS* LINNAEUS (PELECYPODA : MOLLUSCA) FROM CRETACEOUS BEDS OF TRICHINOPOLY (S. INDIA) WITH NOTES ON RELATED SPECIES

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ABSTRACT

This paper deals with the revision of the species of the genus *Spondylus* from Cretaceous beds of Trichinopoly, which includes a new subspecies. *S. subsquamosus* Forbes was given priority over *S. calcaratus* Forbes. Specimens inadvertantly placed earlier are now shifted to their proper places. Observations on related species from the adjacent countries is also appended. Keys to the subgenera and species from Cretaceous beds of Trichinopoly are provided.

INTRODUCTION

The genus *Spondylus* Linnaeus is well represented in the Cretaceous beds of Southern India (Forbes, 1846 ; Stoliczka, 1871 ; Kossmat, 1897). The senior author, during 1970 survey of the Trichinopoly fossil bearing beds encountered some members of this genus. This material along with Stoliczka (*op. cit.*) and Kossmat (*op. cit.*) collections from Cretaceous beds of Trichinopoly available in the Geological Survey of India (here after referred to as G. S. I.) and specimens in the Indian Museum Invertebrate fossil gallery, Calcutta, were examined. This paper deals with a revision of the species involved together with notes on related species in view of the utility of the genus at times in the stratigraphic zonation as for example, *Spondylus* shales in Tibet (Hayden, 1907).

SYSTEMATIC ACCOUNT

Subclass *PTEROIDA* Newell, 1965

Superfamily PECTINACEA Rafinsque, 1815

Family SPONDYLIDAE Gray, 1826

Genus **Spondylus** Linnaeus, 1758, *nec* *Spondylus* Thomson, 1866 *pro* *Spondylis* C. Fabricius, 1775. Type species (by subsequent designation, Schmidt, 1818 : 61) *S. gaederopus* Linnaeus.

The characters of the genus *Spondylus* were discussed by Hertlein & Cox (1969). The species are medium sized, orbicular, or oval ; gibbous ; with unequal valves ; right valve larger and more convex, pectinate, byssal notch lacking ; auriculate. Adductor impressions large, subcentral ; ligament internal and located in a triangular pit. Teeth strong, one in the left and two in the right valves on either side of the ligament pit. Radial costae usually spinose. Ranges from Jurassic to Recent. Hertlein & Cox (1969) recognized three subgenera viz., *Spondylus s.s.*, *Corallospondylus* Monterosato, and *Eltopera* Iredale.

In the following descriptions, rib has been used for prominent stout costa, and costae or costellae for longitudinal striations in between two ribs or otherwise, basing on their width ; wings are preferred to ears.

Key to the subgenera

1. Shell small, terebratuloid ; radial costellae delicately or weakly spinose . .. . *Corallospondylus* Monterosato
— Shell large, inflated ....2.

2. Shell strongly inflated ; radial sculpture spinose, or foliaceous ; right valve large, triangular : crural teeth short, heavy, smooth, or crenulated .... *Spondylus* L. *s.s.*

— Shell less inflated : radial sculpture weakly spinose ; cardinal area of the right valve much elongated ; crural teeth small, widely separated .... *Eltopera* Iredale

Species Reported

Five species are known from Cretaceous beds of Trichinopoly. On the basis of our examination, it is possible to group them under the following subgenera :

1. *S.* (*Spondylus*) *subsquamosus* Forbes (=*S.* (*S*) *calcaratus*). Podicherry (Forbes, 1846) *Trigonarca* beds of Pondicherry (Forbes. 1846 ; Kossmat, 1897) ; Trichinopoly (Stoliczka, 1871).
2. *S.* (*S.*) *lamellosus* Kossmat. *Trigonarca* beds of Pondicherry (Kossmat, 1897).
3. *S.* (*Corallospondylus*) *arrialoorensis* Stoliczka. Ariyalur (Stoliczka, 1871 ; *Trigonarca* beds of Pondicherry (Kossmat, 1897).
4. *S* (*Eltopera*) *sulcatellus* Stoliczka. Ariyalur (Stoliczka, 1871).
5. *S.* (*E.*) *subcostulats* Stoliczka. Utatur (Stoliczka, 1871).

The new subspecies described here under, viz., *kallarensis* belongs to *S.* (*S.*) *lamellosus* Kossmat.

Remarks on the Species

1. **Spondylus (Spondylus) subsquamosus** Forbes, 1846

(pl. II, fig. 1 A-C.)

Spondylus (*Spondylus*) *subsquamosus* Forbes, 1846. *Trans. geol. Soc. Lond.*, (2) 7 : 154, pl. xviii, fig. 1.

S. calcaratus Forbes 1846. *Trans. geol. Soc. Lond.*, (2) 7 : 155, pl. xviii, fig. 2

S. calcaratus Forbes : Stoliczka, 1871. *Palaeont. indica*, (6) 3 : 448, pl. 33, figs. 10. (*partim*).

S. calcaratus Forbes : Kossmat, 1897. *Rec. geol. Surv. India*, 30 (2) : 6, 10.

? *S. calcaratus* Forbes : Bion, 1926. *Rec. geol. Surv. India*, 56 (3) : 268.

Stoliczka (1871) stated that he agrees with d'Orbigny, in concluding that *S. subsquamosus* Forbes and *S. calcaratus* Forbes are conspecific. Strangely, however, he used the name *S. calcaratus* (Forbes, 1846, p. 155, pl. 18 fig. 2 in preference to *S. subsquamosus* (Forbes, 1846, p. 154, pl. 18 fig. 1) which is untenable under the *Rules of Priority*. Therefore, we restore *S. subsquamosus* Forbes as the name of the species.

Stoliczka collections in G. S. I. include four specimens labelled as *S. calcaratus* Forbes, bearing the Type Nos. 1335 (pl. 33 fig. 6), 1336 (pl. 33 figs. 7, 7a), 1338 (pl. 33 figs. 9, 9a), and 1339 (pl. 33 fig. 10). Of these, only Type No. 1339 (pl. 33 fig. 10) belongs to *S. calcaratus* Forbes *sensu* Stoliczka (1871) and the other specimens bearing Type Nos. 1335, 1336, 1339, belong to *S. sulcatellus* Stoliczka (Stoliczka, 1871 : 448, pl. 34, fig. 1 Therefore, we included *S. calcaratus* Forbes *sensu* Stoliczka (*partim*) and referrable to his specimen with Type No. 1339, pl. 33 fig. 10 only in the species under discussion, Forbes (1846) described and figured excellently the species. The Z. S. I. has several examples, some of which are nearly complete and others are broken. Wings are however present in G. S. I. specimen. Shape of the valves suborbicular with radiating longitudinal ribs alternating with finer striations or costae numbering from 2-5. Transverse striations are present, but indistinct towards the umbonal region. The characteristic feature of the species lies in the presence of scaly tubercles placed at irregular intervals, which at times fuse when they are crowded ; the tubercles are confined to the longitudinal ribs, but often overlap the striae also.

Material Examined : One example, Andoor ; Ariyalur group (sp. No. L 57 in the box No. L 5/58 in show case No. 79 of the Invertebrate fossil gallery, Indian Museum, Calcutta, labelled as *S. calcaratus* Forbes ; (G. S. I. Type No. 1339), Serdamungalam, Trichinopoly Group, labelled as *S. calcaratus* Forbes, pl. 33 fig. (10), Coll. *F. Stoliczka* colls. ; 9 examples (Z. S. I. Regd. Nos. IVP 42-50), Kallar River beds, 1.5 km S. E. of Kallankuruchi village, *c* 5 km E. of Ariyalur (Ariyalur Stage), 17. i. 1970, coll. *K. V. Lakshminarayana.*

Measurements (cm)

		Height	Length	
G.S.I. Type No, 1339		7.7	7.6	
Z.S.I. IVP	42	10,2	8.3	(Incomplete)
	43	Incomplete specimen		
	44	7.2	7 2	
	45	10.4	10.2	(Incomplete specimen)
	46	8.5	6.3	-do-
	47	6.7	6.8	(Incomplete specimen)
	48	Incomplete specimen		
	49	-do-		
	50	-do-		

Remarks : We preferred to treat this species as *S.* (*S.*) *subsquamosus* Forbes for the reasons already cited. The material referred to by Forbes (1846), Kossmat (1897), and Bion (1925) are not however, available in the G. S. I. collections. Forbes (1846) reported it from Pondicherry and Kossmat (1897) also recorded it from the *Trigonarca* beds of Pondicherry Cretaceous which corresponds to the Lower Ariyalur stage in the Trichinopoly Cretaceous. Bion (1925) doubtfully identified his specimens from the Upper Cretaceous beds of Afghanistan *i. e.* K. 11314, end of gorge of the Karnard River, left bank, just above Andao (lat. 35° 20′ ; long. 67° 53′) (H. H. H.), and H. 42/556, south-eastern slope of Koh-i-ab-i-shora, South of Shadian, near Balkh, Afghanistan. Stoliczka (1871) though reported four specimens labelled as *S. calcaratus*, (G. S. I. Type Nos. 1335-1339) only 1339 in fact, pertains to this species. Our material collected from Kallar River beds near Kallankuruchi village, definitely belongs to the Ariyalur stage, and it is interesting to note that Kossmat (1897) also reported it from *Trigonarca* beds equivalent to Lower Ariyalur Stage in Pondicherry. Since Stoliczka (1871) reported it from Trichinopoly Stage, it can be safely inferred hat the species extends probably from the uppermost beds of Trichinopoly Stage and extends into Ariyalur Stage both in Tamil Nadu and Pondicherry.

2. Spondylus (Spondylus) lamellosus Kossmat, 1897

Apart from Kossmat (1897), no one else have so far reported this species either from Pondicherry or elsewhere and Z. S. I. collections include this species, which we consider to be a subspecies of *S.* (*S.*) *lamellosus* Kossmat.

2. (a) Spondylus (Spondylus lamellosus Kossmat, *sens. str.* 1897. *Rec. geol. Surv. India*, 30 (2) : 94, (also 61, 106) pl. IX, fig. 10 a. b.

TABLE I

OTHER KNOWN SPECIES FROM INDIA

(All measurements are given in

	Name of the species	*Epoch/Locality*	*Source of information*
	1	2	3
1.	*S. santoniensis* D'Orb.	U. Cretaceous ; Baluchistan (Pakistan).	Noetling, 1897.
2.	*Spondylus* sp.	—do—	—do —
3.	? *S. calcaratus* Forbes	Cretaceous ; Afghanistan	Bion, 1925
4.	*S. rouaulti* d'Archiac & Haime	—do—	—do—
5.	*S. subserratus* Douv.	—do—	—do—
6.	*S roxanae* Vredenburg in Cossmann & Pissarro	Palaeocene ; Upper Ranikot, Sind (Pakistan)	Vredenburg in Cossmann & Pissarro, 1927.
7.	*S. alexandrae* V. in C. & P.	—do—	—do—
8.	*S. rouaulti* d'Archiac & Haime	Palaeocene-Eocene. Palaeocene ; Upper Ranikot, Sind (Pakistan) Eocene ;	d'Archiac & Haime, 1854
		4.8 km above Dzong Tibet.	Douville, 1916
		Palaeocene ; Upper Ranikot ; (Sind, Pakistan) ; Eocene ; Laki beds of Salt Range (Pakistan) & Laki beds ? of Tibet.	Cox, 1931.
		Lower Miocene ; Kathiawar.	Pascoe, 1963
9.	*S. perhorridus* Oppenheim	Eocene ; Kohat Shales (Basal Kirthar) of Kohat, N. W. F. P (Pakistan)	Cox, 1931.
10.	*S. geniculatus* d' Archiac & Haime	Eocene ; Sind (Pakistan)	d'Archiac & Haime, 1854
11.	*S. radula* Lamarck	Eocene ; Laki limestone of Kohat, N. W. F. P. (Pakistan) ; Lower Kirthar of Baluchistan (Bugti Hills).	———
		(Pakistan). Hisai Jebel, Bahra'n Is., Persian Gulf.	Cox, 1936

AND ADJACENT COUNTRIES

cm Height × Length)

Type/Regd. No.	*Remarks*
4	5
G. S. I. No. 3019 (12.4×10.0)	
G. S. I. No. 3021 (4.0×3.8)	Does not appear as *Spondylus*.
——	Specimens not available.
——	—do—
——	—do—
G. S. I. No. 10983 (5.2×4.0)	Finer striae and prominent ribs present. Appears similar to *S. subcostulatus* Stol, but the long axis is more and tubercles prominent.
G. S. I. No. 10982 (2.6×2.7) G. S. I. No. 10984 3.0—3.6×3.2—3.9	Though this specimen is labelled as *S. alexan-a drae*, it is identical with *S. roxanae*. Cox (1931) however, considers these two species conspecific with *S. rouaulti*.
——	Specimens not available.
G. S. I. No. 12800 (=k9/495) (4.8×4.6) ; G. S. I. No. 12801 (4.7×4.5)	Prominent ribs with costae in between. Inter-costal furrows equal to costae, which are also tuberculated. Transverse striations are also more. 12801 incomplete. Exact specific diagnosis not possible.
——	Specimens not available.
——	Specimens not available.
——	Specimens not available. Strongly tuberculated with prominent ribs in Cox's figures.
——	Specimens not available.
——	Specimens not available. From the figures it appears closer to *S. sulcatellus* Stol., but well tuberculated.
G. S. I. No. 17361 (=k9/763) (1.5×1.5)	Cox (1936) figured this specimen (pl. 3 fig. 10). Very small. Impression only. Tubercules and wings not clear. Costae very fine.

TABLE 1 (Contd.)

(All measurements are given in

12. *S. crassicosta* Lamarck	Eocene ; Close to Latidun, w. of Bandar Abbas, (Persia)	Cox, 1936
13. *Spondylus* sp.	Eocene : Musefeni Pass, e. of Kasedan, Baluchistan, (Pakistan)	——
14. *Spondylus* sp.	Bet. Muniari Fort & Karry Kachh, Nummulitic beds.	——
15. *S. tallavignesi* d'Archiac & Haime	Miocene ; Sind (Pakistan)	d'Archiac & Haime, 1854.
16. *Spondylus* sp.	Miocene ; Burma, in zone of *Aricia humerosa*, Thayetmyo.	Noetling, 1897
17. *Spondylus* sp. off. *entiacus*.	Miocene ; Fars Series, Kharak Is., Persian Gulf.	——
18. *Spondylus* sp.	Miocene ; Gaj Stage, Nearing the Gorge Panigumbrok, Sind, (Pakistan)	——
19. *Spondylus* sp.	Miocene, Gaj Stage, Bet. Pindara & Virpur, W. Kathiawar.	——

(Pl. II, fig. D)

Although, Kossmat (1897) considers this species a very common one in the Ariyalur stage of Pondicherry (*Trigonarca* beds), yet his collections include a single specimen which is available in G. S. I. collections. The species is similar to the above, but with concentric lamellae instead of scaly tubercles at irregular distances from one another which are very characteristic.

Material examined : One example (G. S. I. Type No. 6553), Saidarampet, 0.4 km. west of Rautankupam ; two examples ; Andoor, Ariyalur group. (Sp. No. L5 / 58 in show case No. 79 of the Invertebrate fossil gallery, Indian museum, Calcutta) labelled as *S. calcaratus* Forbes.

Measurements (cm)

	Height	*Length*	
G.S.I. Type No 6553	6.9—7.8	7.4—8.7	(Both valves)

Remarks ; This species comes no doubt very close to *S. subsquamosus* Forbes, but can easily be distinguished by the concentric irregular lamellae radiating across instead of scaly tubercles. Two examples in show case No. 79, Sp. No. L5 / 58 in the Invertebrate fossil gallery, Indian Museum, Calcutta and labelled as *S. calcaratus*, belongs to this species. Also an example in vertical show case No. 33. sp. No. 1816, in the Invertebrate fossil gallery, Indian Museum, Calcutta, from the Tertiary deposits of Beanuis, Dep. del. oise and labelled as *lamellosus* does not belong to this species.

cm Height × Length)

G. S. I. No 17398 (5.9× 5.5) G. S. I. No. 17399 (=k21/219) (8.2× 8.9) G. S. I. No. 17400 (8.7× —).	Ribs and tubercles prominent. Intercostal furrows equal or subequal to costae.
Sp. No. K10/450 in show case No. 93 of the Invertebrate fossil gallery, Indian Museum.	Approaches near *S. arrialoorensis* Stol.
Sp. No. C. 050 E. in show case No. 93 of the Invertebrate fossil gallery, Indian Museum.	Not possible to determine its status.
——	Specimens not available.
——	Specimens not available.
Sp. No. C. 362/1 in Show case No. 93 in the Invertebrate fossil gallery, Indian Museum.	Approaches near *S. lamellosus* Kossmat.
Sp. No. 280/406 in Show case No. 98 in the Invertebrate fossil gallery, Indian Museum.	Appears near *S. subsquamosus* Forbes.
Sp. No. H1/24 in show case No. 99 in the Invertebrate fossil gallery, Indian Museum.	Not possible to determine.

2. (b) Spondylus (Spondylus) lamellosus kallarensis subsp. nov.

(pl. II fig. E)

The material referred to under this subspecies was collected along with several examples of *S. subsquamosus.* Although, in general facies, tt agrees with *S.* (*S.*) *lamellosus sens. str.*, this subspecies can be easily distinguished from *S. lamellosus* Kossmat, by the lamellae not placed at irregular distances but are continuous from end to end, and the prominent radiating ribs are absent and the costal striations are continuous. Therefore, we are inclined to place this under a separate subspecies.

Material examined : One example (Z. S. I. Reg. No. IVP. 51) from Kallar River beds, 1.5 km S.E. of Kallankuruchi Village, *c* 5 km E. of Ariyalur (Ariyalur Stage), 17. i. 1970, coll. *K. V. Lakshminarayana.*

Measurements (cm)

	Height	*Length*
Z.S.I. Reg. No. IVP 51	8.3	7.1 (incomplete)

Remarks : The specimen although incomplete, shows the diagnostic characters very well. The species *sens. str.*, was hitherto, known only in the *Trigonarca* beds (Lower Ariyalur Stage) of Pondicherry, and therefore, the present records of the subspecies from Ariyalur Stage of Trichinopoly Cretaceous is interesting. It confirms Kossmat's view that *Trigonarca* beds belong to Ariyalur Stage only

3. Spondylus (Corallospondylus) arrialoorensis Stoliczka, 1871.

(Pl. II, fig. F)

S. arrialoorensis Stoliczka, 1871. *Palaeont. Indica,* (6) 3 : 447, pl. XXXIII fig. 5.

S. ariyalurensis : Kossmat, 1897. *Rec. geol. Surv. India,* 30 (2) : 60, 106, pl. X, figs. 2a, b.

This species (Stoliczka, 1871) belongs to the subgenus *Corallospondylus,* because of its small size, and the radial costellae delicately or weakly spinose. Stoliczka (*op cit.*) reported that its lower valve was attached to a fragment of *Inoceramus.* Valves are small, asymmetrical, umbonal region irregular, prominent, radially striated, with concentric rings of growth. Some of the radiating costae bear strong tubercles or spines. The wings are large.

Material examined : One example (G.S.I. Type No. 1334), S. W. of Mulloor, Ariyalur Stage, Coll. *F. Stoliczka.*

Measurements (cm)

	Height	Length
G.S.I. Type No. 1334	2.7	2.6

Remarks : Only example referred to and figured by Stoliczka (1871) is available in G.S.I. collections. Material referred by Kossmat (1897) from 0.8 km W.S.W. of Tutipet from the *Trigonarca* beds (Ariyalur Stage) and numbered as G.S.I. Type No. 6559 is missing in the G.S.I. The figures however, agree with those of Stoliczka.

4. Spondylus (Eltopera) sulcatellus Stoliczka, 1871.

(Pl. II, figs. G-H)

S. sulcatellus, Stoliczka, 1871. *Palaeont. indica.* (6) 3 ; 448, pl. XXXIV fig. 1.

S. calcaratus, Forbes : Stoliczka, 1871.. *Palaeont. indica* (6) 3 : 448, pl. XXXIII, figs. 6, 7, 7a, 9, 9a, (*Partim*). N. Synonymy.

S. sulcatellus : Spengler, 1923. *Palaeont. indica,* N. S. 8 (1) : 18, pl. II, figs, 13 a, q.

Stoliczka (1871) described this species to include specimens with valves, having radiating sharp and laterally compressed ribs, with furrows equal to the thickness of the ribs. Few tubercles are present on the ribs. The valves are asymmetrical and the ribs present a rough or rugose exterior. Stoliczka (1871) described this species basing on a single example. But on examination of Stoliczka collections available in the G.S.I., we found that specimens with Type Nos. 1335, 1336, 1338, labelled as *S. calcaratus* Forbes also in fact, belong to this species, therefore, we include here partly the material of *S. calcaratus* Forbes *sensu* Stoliczka The Z.S.I. collections also include a single example of this species.

Material examined : One example (kl/228) N. of Poodoopolliam, Ariyalur group, Show case No. 79, Invertebrate fossil gallery, Indian Museum, Calcutta , one example (G.S.I. Type No. 1340), N. of Poodoopolliam (Pudupalayam), (Ariyalur Stage) ; three examples (G.S.I. Type Nos. 1335, 1336, 1338) from Serdamungalum (Trichinopoly Stage), Coll. *F. Stoliczka* colls. ; One example Z. S. I. Reg. No. IVP 52, Kallar River beds, 1.5 km of Kallankuruchi Village, *c* 5 km E. of Ariyalur, 17. i. 1970, Coll. *K. V. Lakshminarayana.*

Measurements (cm)

		Height	Length
G. S. I. Type No,	1340	5.3	5.9
,,	1335	6.4	5.9
,,	1336	7.6	6.6
,,	1338	6.4	6.0
Indian Museum No.	Kl/228	6.8	5.0
Z. S. I. IVP 52		4.1	4.9 (incomplete)

Remarks : Stoliczka (1871) collections include material from both Trichinopoly and Ariyalur Stages. The present Z.S.I., collections include one example from Ariyalur stage and therefore, we may safely conclude that the species extend from Trichinopoly to middle Ariyalur. Spengler (1923) reported this species from Tharia ghat, Maomlah (Assam). His figures indicate that this species definitely existed in Assam region.

5. Spondylus (Eltopera) subcostulatus Stoliczka, 1871.

(Pl. II, fig. 1)

S. subcostulatus Stoliczka, 1871. *Palaeont. indica.* (6) 3 : 449. pls XXXIII fig 8 & XXXIV fig. 2,

S. subcostulatus Stol. : Hayden, 1913-14. *Faune Cretaciche del Caracarum spedizione Italiana de Filippi nell' Himalaia, Caracaorum E Turchestan Cinese,* (2) 6 : 124.

Stoliczka (1871) based his species on two examples. The Z.S.I. collections include one example. The valves are variable, wings when preserved are unequal. The striae or ribs are very fine, intercostal space equal to subequal to the striae. The valves tend to be very smooth, with prominent umbonal arch.

Material examined : One example (G. S. I. Type No. 1337), 'E. of Parally', Moraviatoor (Maruvattoor), Ootatoor Stage (Utatur Stage) ; One example (G. S. I. Type No. 1341) Locality labelled as Ootatoor group can be inferred as Odium from his description), Utatur Stage, coll. *F. Stoliczka* colls. One example (Z. S. I. Reg. No. IVP 41), Kallar River beds, 1.5 km. S. E. of Kallankuruchi village, c 5 km. E. of Ariyalur, 17. 1. 1970, coll. *K. V. Lakshminarayana.*

Measurement (cm)

	Height	*Length*
G. S.. I. Type No. 1337	4.4	4.4
G. S I. Type No. 1341	6.0	5.3
Z. S. I. IVP 41	3.6	3.5

Remarks : Stoliczka (1871) recorded it from the Utatur Stage, and the present record from Ariyalur Stage, therefore, extends its range from Utatur to Ariyalur (Middle) and is yet to be reported from Trichinopoly Stage. Hayden (1913-14) material is not however, available for study, but the specimens from parts of Tibet are often referred to as *S. rouaulti* d' Arch.. & Haime.

Key to the species from Cretaceous beds of Trichinopoly

1. Tubercles scaly or lamellose ; numerous. ... . 2.
 —Tubercles spiny ; sparse...
2. Tubercles scaly ; stout ribs alternating with 2- 5 fine costae ... .. *S.* (*S.*) *subsquamosus* Forbes
 —Tubercles lamellose.......... 3.
3. Transverse lamellose tubercles not continuous from end to end, irregularly placed ...... *S.* (*S.*) *lamellosus lamellosus* Kossmat
 —Transverse lamellose tubercles continuous from end to end, regularly placed........ .. *S.* (*S.*) *lamellosus kallarensis* n. ssp.
4. Valves large .... 5.
 —Valves small ; smooth, shining ; sulcations and ribs equal ; weakly spinose...... *S.* (*C.*) *arrialoorensis* Stol.
5. Valves mostly asymmetrical ; ribs appear as rugose ; sulcations deep and equal to ribs .... *S.* (*E.*) *sulcatus* Stol.
 —Valves regular ; ribs fine, not rugose ; intercostal spaces subequal to equal to ribs .... *S.* (*E*) *subcostulatus* Stol.

NOTES ON OTHER SPECIES

Other known species of India and adjacent countries along with our observations are noted in Table No. 1.

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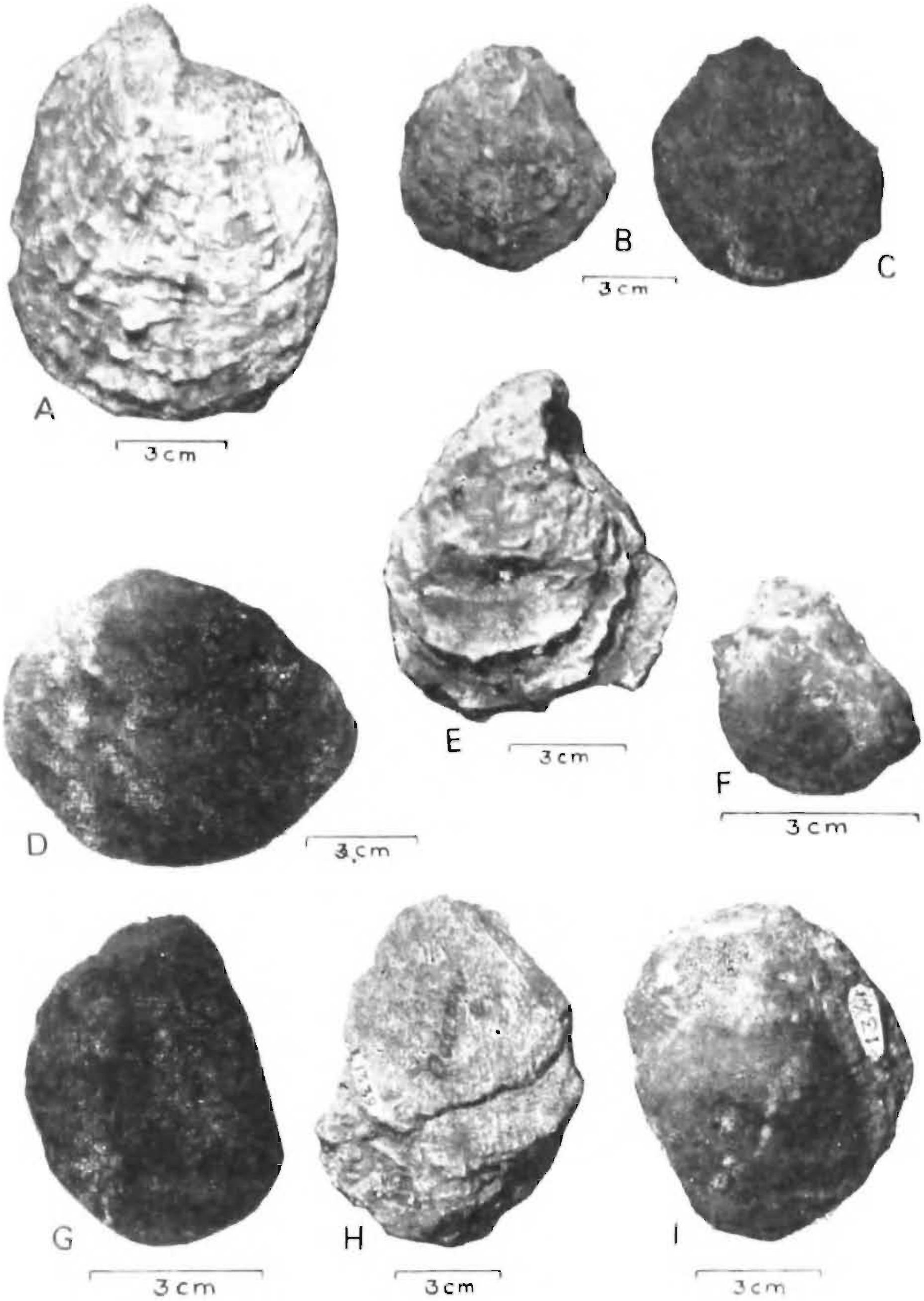
* Original not seen.



A—C. *Spondylus* (*Spondylus*) *subsquamoses* Forbes
D. *Spondylus* (*Spondylus*) *lamelloses* Kossmat, *sens. str.*
E. *Spondylus* (*Spondylus*) *lamellosus* Kallerensis su. sp. nov.
F. *Spondylus* (*Corallospondylus*) *arrialoorensis* Stoliczka
G&H. *Spondylus* (*Eltopera*) *sulcatellus* Stoliczka
I. *Spondylus* (*Eltopera*) *subcostulatus* Stoliczka

Bull. zool. Surv. India, 1 (3) : 221-226, 1978

HUMIDITY REACTIONS OF WORKERS AND SOLDIERS OF *ODONTOTERMES MICRODENTATUS* ROONWAL & SEN SARMA AND *ODONTOTERMES OBESUS* (RAMBUR) IN A HUMIDITY GRADIENT APPARATUS AT A CONSTANT TEMPERATURE*†

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ABSTRACT

The humidity reactions were studied in a humidty gradient apparatus. All the experimental workers and soldiers of *Odontoterms microdentatus* Roonwal & Sen Sarma and *O. Obesus* (Rambur) were kept in an atmosphere of high humidity prior to their release in the apparatus. The time required by these termites to register a positive response to the humid zone was rather long in both the species of *Odontotermes* as compared to other species of termites. The response of workers was much faster than the soldiers. The humidity preferendum seems to be about 93-95% which coincides with the relative humidity as measured inside the mound.

INTRODUCTION

The animal behaviour and their relationship existing with the environment have been earlier investigated by the several workers in terms of physical factors such as temperature, relative humidity and light (Gunn 1934, Franenkel & Gun 1940, Deal 1941, Ewer & Ewer 1942, Dakshinamutry 1948, Aziz 1957, Hafez & Makky 1960). Of these three factors, humidty is known to be of more ecological importance in the lives of insects and other terrestrial animals. Except for the work of Williams (1946), Emerson (1956) Ernst (1957) and Sen-Sharma and Chatterjee (1966), there is very little on record regarding the work on these lines in termites. Further, humidity reactions of not even single mound building termite species, has yet been reported this is an attempt to fill up the exiting gap in case of mound building termites.

MATERIAL AND METHODS

Humidity behaviour was studied in a humidity gradient apparatus similar to one used by Sen-Sarma and Chatterjee (1966). It consisted of a rectangular tray (33.5×14.5× 3.5 cm.) made out of a galvanized iron sheet. Its inner space was divided into seven equal compartments on either side

* The study was carried out in forest Entomology Branch of Forest Research Institute and Colleges. Dehra Dun.

† Part of Ph.D. thesis approved by Meerut University, Meerut.

of a central open passage which was 5 cm. wide. The wall separating the side compartments from the central passage was kept low so as to facilitate diffusion of water vapour from the compartments to the central passage (Fig. 1). Smooth polythene foil was glued on the side wall of the apparatus with a view to preventing termites to climb up the side wall and escape. The saturated aqueous solution of the appropriate inorganic salts was kept in plastic dishes in the side compartments as follows : (i) Calcium chloride (fused) in one pair of end chamber (No. 1), (ii) saturated aqueous solution of NaCl in the middle pair of chambers (No. 4) and (iii) distilled water in the remaining pair of end chambers (no. 7). A humidity gradient of 43%, 55%, 65%. 80%, 85%, 93% and 95% was obtained (Fig. 2). Relative humidity obtained in different compartment were checked by means of a hair hygrometer. Fluctuations did not exceed ± 2%. All the experiments were performed in an underground cellar where a temperature of 28°C ±1°C was maintained.

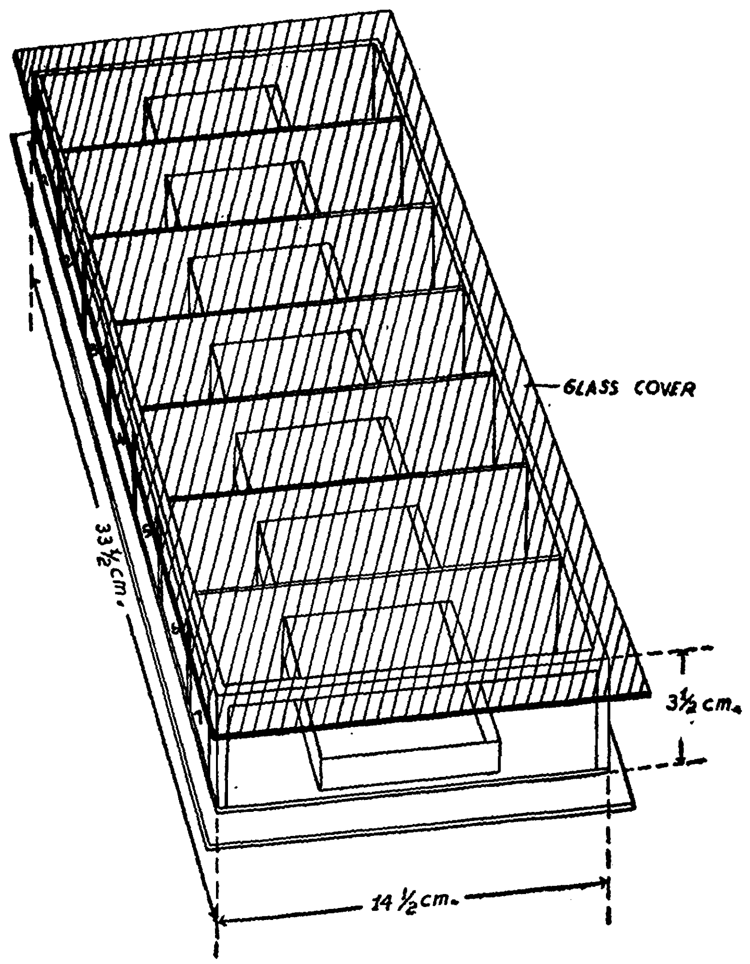

Fig. 1, The schematic Diagram of the humidity gradient apparatus made out of galvanized iron sheet.

Healthy workers and soldiers of each species were only used. The termites were extracted from the fresh fungus combs and were kept in high humidity before their release in the apparatus. A total of ten experiments containing 10 termites in one batch for each caste of each species was performed. The temites in five experiments were released from humid side, and in other five experiments, they were released from dry side. After completion of one experiment, the central eliminate passage way was swabbed with alcohol to eliminate possible odour trails as suggested by Emerson (1956). Observations for the position records were made hourly upto three hours. The intensity of humidity reactions has been expressed as the excess percentage ratio of termites on the humid and Chatterjee 1966), where W represented the number of position records in the humid zone (93-95% r.h.) and D the number found in the dry zone (43-85% R.H.).

The control experiments were conducted in an isohygrous condition without the gradient of air humidity. It was observed that experimental termites did not show any preference for any chamber except for a very weak thigmotactic reaction to end chambers and sides.

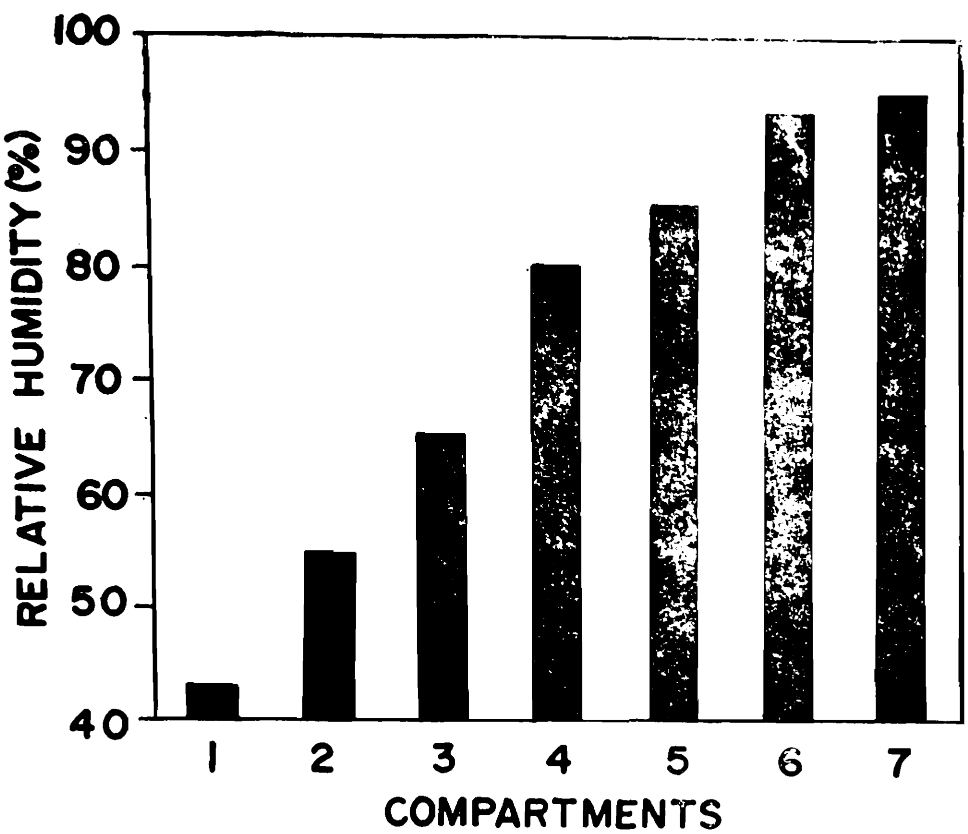

Fig. 2. Relative humidity (in percent obtained in different compartments of the humidity gradient apparatus.

zone (93-95 % R.H.) and was calculated by using the formula $1C0 \times \frac{W-D}{W+B}$ (Gunn & Gosway 1938) and the percentage of termites present in the humid zone was calculated using the formula $100 \times \frac{W}{W+D}$ (Sen-Sarma

RESULTS AND DISCUSSION

The intensity of humidity reaction of workers and soldiers and the percentage of workers and soldiers recorded in the humid zone at different intervals of time in *O. microdentatus* (Figs. 3A & 4A) and *O.*

obesus (Figs. 3B & 4B) have been depicted.

The time required to register a positive response of these termites to the humid zone was rather long in both the species of *Odontotermes* as compared to the duration reported by Emerson ' (1956), Ernst (1957) and Sen-Sarma & Chatterjee (1966) for other species of termites. The slower response to high humidity may be due to the fact that the experimental termites were stored in an atmosphere of humidity before their release in the humidity gradient apparatus and the response of insects to varying humidity are governed by the humidity conditions to which have earlier been exposed (Gunn and Cosway 1938, Perttunen 1951, Parker 1952, Hafez and Ibraheim 1964). Sen-Sarma & Chatterjee (1966) also observed slower response to high humidity in case of wet preconditioned workers than the dry preconditioned workert in *Microcerotermes beesoni*. It is significans to note that the response of workers was

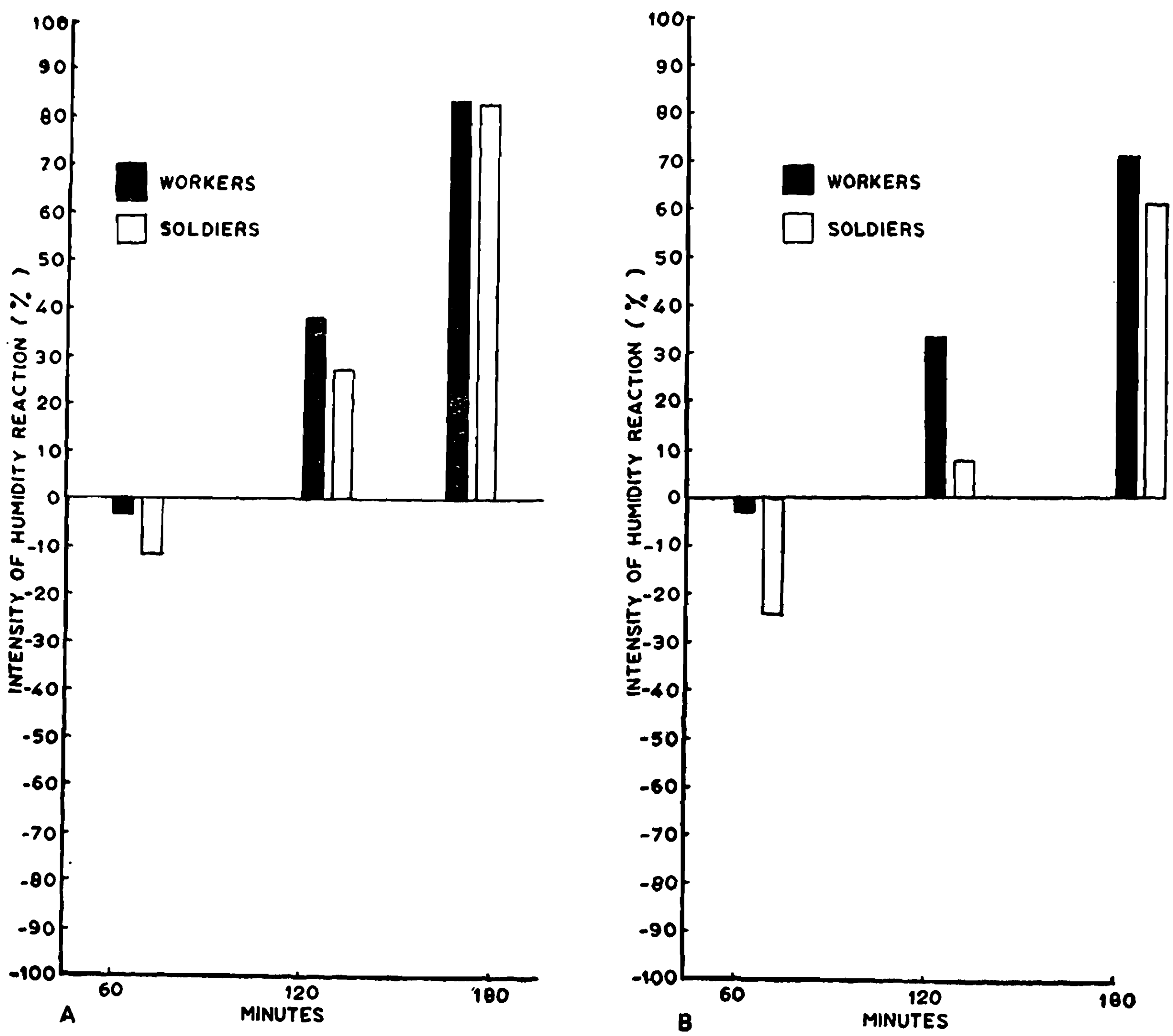

Fig. 3. (A & B) Intensity of humidity reactions expressed as the excess percentag ratio of termites in the humid zone (93-95%) of workers and soldiers of A. *Odontotermes microdentatus* to humidity gradient. B. *Odontotermes obesus* to humidity gradient.

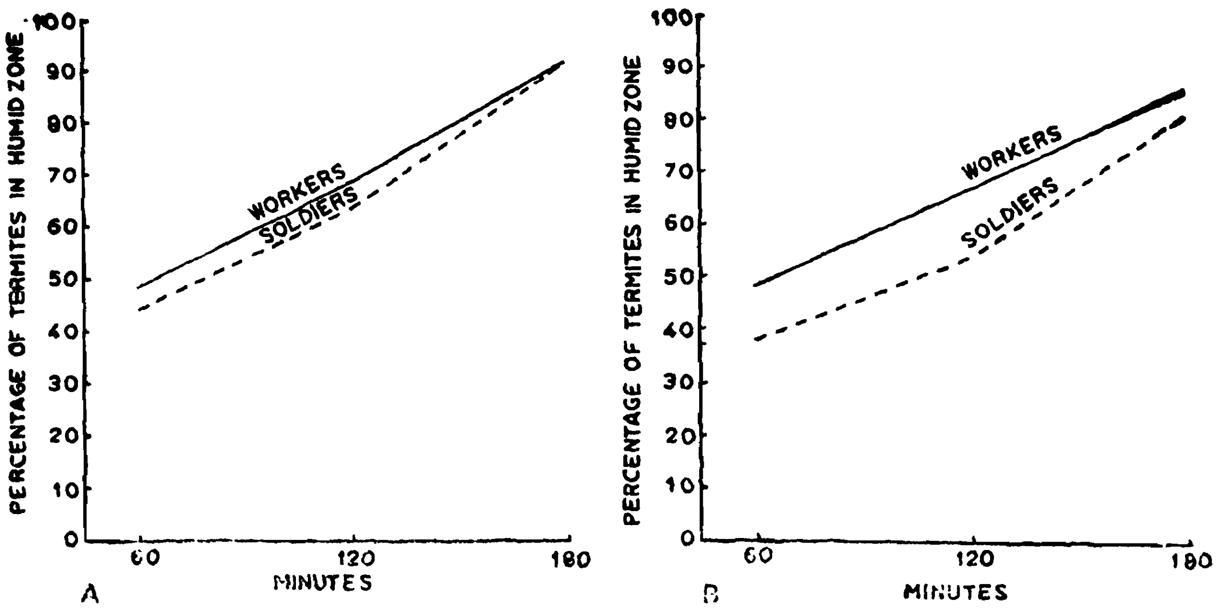

Fig. 4. (A & B) The percentage of workers and soldiers in the humid zone at different intervals of time in A. *Odontotermes microdentatus*. B. *Odontotermes obesus*.

much faster than in the soldiers in both the species. Emerson (1956), however, did not find any difference in humidity response of soldiers and workers in *Termes panamaensis, Nasutitermes nigriceps, N. columbicus* and *Amitermes foreli.* The slower orientation of soldiers to high humidity than in workers is apparently due to slower rate of water loss from the body of soldiers. The higher survival period of soldiers than that of the workers under different combinations of temperature and relative humidity (Agarwal, unpublihed, a, c), also tends to support to this contention. The humidity prefrendum, therefore is about 93.95% R.H. which also follows with the rela ive humidity (92-96% R.H.) measured inside the mound (Agarwal & Sensarma, unpublished ; Agarwal, unpublished, b).

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Bull. zool. Surv. India, 1 (3) ; 227-241, 1978

LARVAL DEVELOPMENT OF *MACROBRACHIUM LAMARREI* (H. MILNE-EDWARDS, 1837) [CRUSTACEA : DECAPODA : PALAEMONIDAE] UNDER LABORATORY CONDITIONS

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ABSTRACT

The paper reports the development of individuals of *Macrobrachium lamarrei* (H. Milne-Edwards) hatched in the laboratory from berried females collected from the Indian Museum Tank and the Dhakuria Lake (Ravindra Sarovar), Calcutta. The observations were made in November, 1975 and April, 1976. The species, common in many parts of India, goes through abbreviated larval history consisting of three larval stages preceding the postlarva. All the larval stages and their parts are described in detail and illustrated. It appears that the November brood takes slightly longer time in development (from extrusion of eggs to hatching and metamorphosis into first post larva) than the April brood. Some morphological differences between the present observations and those made by Rajyalakshmi on material drawn from riverine-estuarine population were noticed.

INTRODUCTION

Over two and a half dozen species of the palaemonid prawns of the genus *Macrobrachium* Bate, 1868, have been reported from the inland and estuarine waters of India. Of these, larval development in Indian populations has been studied in detail only in four species viz., *M. lamarrei* (H. Milne Edwards, 1837) by Rajyalakshmi (1961), *M. malcolmsonii* (H. Milne Edwards, 1837) by Kewalramani *et al.*, (1973), *M. idella* (Hilgendorf, 1898) by Pillai and Mohamed (1973) and *M. hendersodayanum* (Tiwari, 1952) by Jalihal and Sankolli (1975). In addition to these, there are some records on larval stages of *M. rosenbergii* (de Man, 1879) and *M. rude* (Heller, 1862) by Menon (1938), and of embryonic development in *M. idae* by Nataraj (1947) and Aiyer (1949). Das (1935) also gave an abstract of larval stages of *M. lamarrei*, but he never published the full account.

In the present work, the development of *M. lamarrei* from hatching to post-larval stage has been followed under laboratory conditions. This species occurs very commonly in various freshwater bodies in a major portion of Indian subcontinent. It is also, to some extent, used as food but does not have any established fishery. As mentioned above, Rajyalakshmi (1961) has already published an account of larval development in this species. However, her study material was drawn from riverine populations in the Hooghly river, presumably, from waters under tidal influence. On the other hand, the present material was obtained from confined freshwaters in Calcutta. This study was undertaken with a view to find out the impact of differences in habitats on the developmental process. The present investigation, though broadly conforming to Rajyalakshmi's findings, also indicated certain notable differences in the developmental pattern.

MATERIAL AND METHODS

Berried females of *M. lamarrei* were collected from the Indian Museum Tank and Dhakuria Lake, Calcutta, and kept in laboratory aquaria containing water from the same habitat from where the specimens were obtained. The investigations were carried out in two seasons. The first set of observations was made in November 1975, and the second was conducted in April, 1976.

The berried females were fed with cooked rice, and unconsumed food matter was removed about half an hour after feeding was over, to avoid fouling of water. Females in advanced stages of berry were kept singly in glass jars of one litre capacity and containing water from the original habitat. After hatching was over, the larvae were removed from the jars and spent females transferred to another aquarium.

Rearing of larvae was carried out in glass beakers of 250 ml. capacity. Two to three larvae were kept in one beaker with about 150 ml. of pond water and covered on top with fine muslin cloth to prevent dust particles from settling in the beakers. A few examples of each larval stage were preserved in neutral formalin mixed with glycerine (9 : 1). Exuviae were also collected and preserved likewise. Attempt to keep some larvae in tap water did not succeed ; calcium precipitate adhered to setae of their appendages, obstructing the larval movements and leading to mortality.

The larvae were kept at room temperature and water was not artificially aerated, nor were the individuals fed.

Measurements were made wtih ocular micrometer on preserved larvae. Appendages were dissected and mounted in polyvinyl alcohol-lectophenol mixture. Appendages dissected from larval exuviae gave excellent results. All the drawings were made with camera lucida and measurements recorded in millimeters.

OBSERVATIONS

General : In berried females, the pleopods showed constant movements. Though no records were maintained of the frequency of movements, it appeared that there was an increase in the rate of pleopod movements as the time for hatching drew nearer. Feeding of the berried females was necessary. In some cases, where the females were not supplied with food, there was no hatching.

Eggs : The eggs in this species are rather large and oblong varying from 1.5 mm to 1.7 mm in longer diameter and 0.97 mm to 0.90 mm along the shorter axis (Fig. 1 A & B). In the early stages they were yellowish green in colour. With the advancement of embryonic growth, they turned yellowish brown.

Hatching : Hatching apparently occurred later in the night after 21 hrs., usually in two, occasionally in three, batches. Though in the present observations no egg was seen to hatch during day time, on an earlier occasion, one of us (K. K. T.) had watched the hatching of eggs during day time, around 11 a.m. On this occasion eggs hatched one after another with a time interval varying from about three to

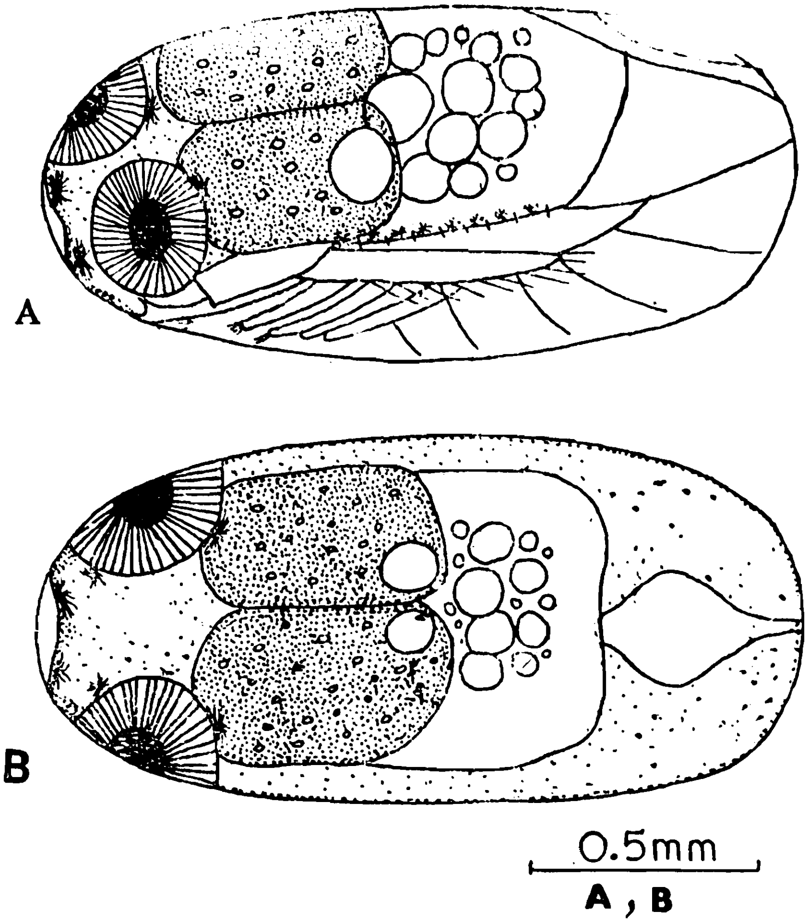

Fig. 1. Egg of *Macrobrachium lamarrei* (H. M. Edw.), before hatching. A—lateral view ; B—dorsal view.

fifteen minutes. Before the larvae emerged from the eggs, wriggling movements could be observed inside the eggs. On emergence through a tear in the egg membrane, the larvae passively sank to the bottom of the vessel, but within a few minutes they started swimming, settling along the sides of the container or on the undersurface of blades of aquatic weeds kept therein.

There was some seasonal variation in hatching period. In females that came in berry in November, 1975, eggs took 18 to 20 days to hatch after extrusion. In females that berried in April, 1976, hatching was completed in 12 days time. This indicated that perhaps the duration of hatching period is influenced by temperature.

DESCRIPTIONS OF LARVAL STAGES

First larval stage (Fig. 2 A-S)

Average length : 4.350 mm.

Description : Carapace smooth, its antero-ventral edge on each side produced into small pterygostomian spine (Fig. 2 D), large amount of yolk granules present under the carapace ; rostrum unarmed ; eyes sessile ; antennule, antenna and mouth parts developed ; five pairs of pereiopods present, only the last two pairs uniramous, first two pairs of pereiopods chelate and nonfunctional ; abdomen with six segments and with five pairs of pleopods ; telson not separated from 6th abdominal segment (Fig. 2 A-C).

Antennule (Fig. 2E) : Antennular peduncle long, slender, and unsegmented ; carrying two flagella, inner one long, slender and plumose, outer stumpy, bearing four aesthetes and one short spine-like pulmose inner seta.

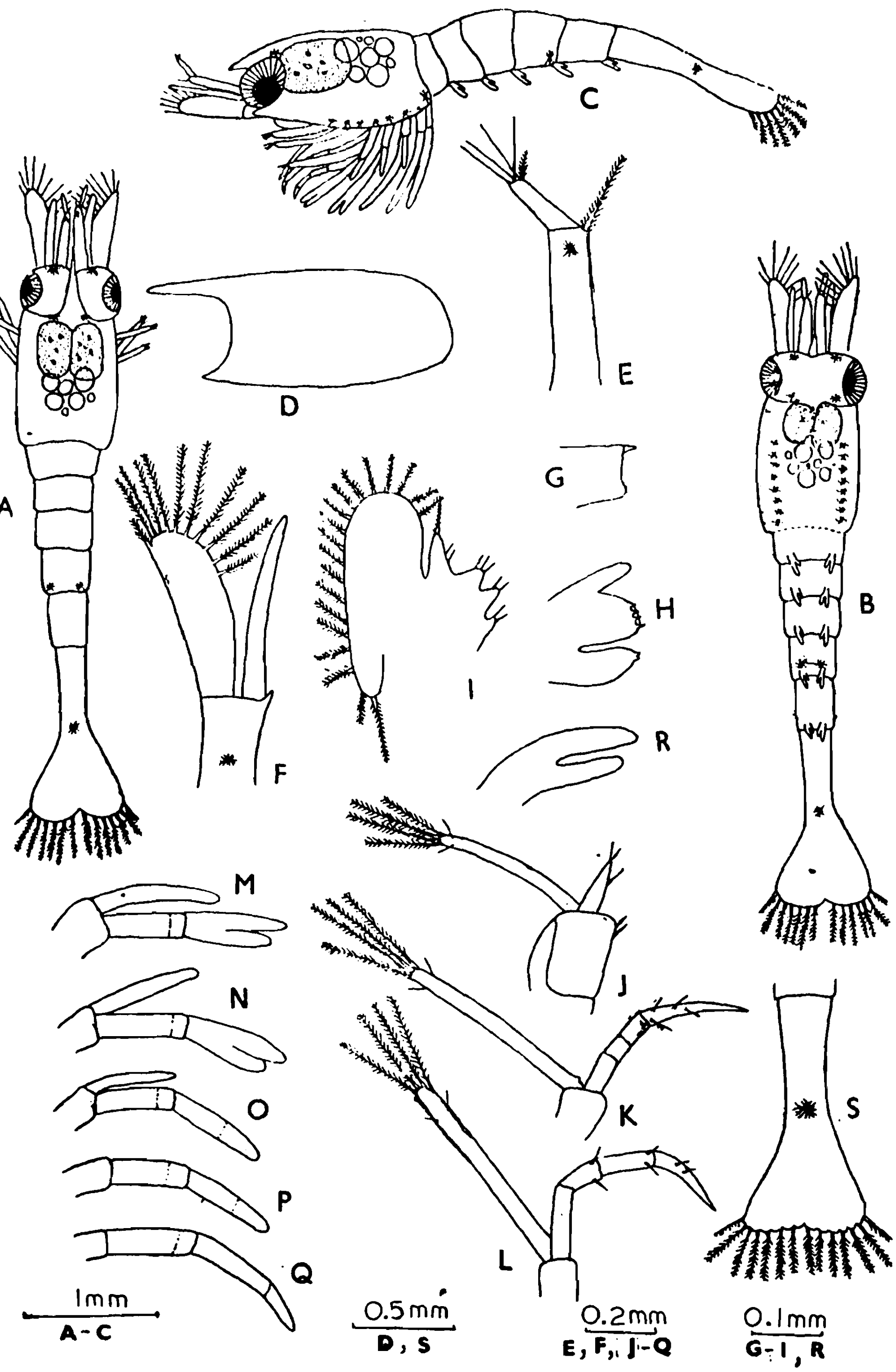

Fig. 2. First Larval Stage of *Macrobrachium lamarrei* A—C larva (dorsal, ventral and lateral views). D. carapace ; E. antennule ; F. antenna ; G. mandible ; H. maxilla I ; I. maxilla II ; J—L. maxillipeds I—III ; M—Q. pereiopods I—V ; R. pleopod ; S. telson.

Antenna (Fig. 2F) : Antennal peduncle (endopod) stout, unsegmented process reaching beyond the exopod margin ; exopod distinct, plate like, its inner margin carrying 10 or 11 plumose and a single short plumose setae present at the distal extremity of its external border.

Mandibles (Fig. 2G) : Two large prominent structures, no demarcation between the incisor and molar parts ; one sharp tooth in the upper incisor region, molar region almost smooth.

Maxilla I (Fig. 2 H) : Three distinct lobes ; endopod smooth, not bifid ; the proximal lacinia carrying two small spines and larger distal lacinia with two large spines on the outer border and two on the inner border.

Maxilla II (Fig. 2 I) : Exopod with 19 plumose setae along its margin, the hindmost seta long and directed backwards, endopod with a single seta at its extremity and two small setae at its base ; exopod carrying three masticatory processes, 1st with three setae, 2nd with two and 3rd with one seta and also carries an additional seta, a little lower.

Maxillipeds (Fig. 2J-L) : Three pairs of well developed biramous maxillipeds with setose exopodites ; basal segment of 1st maxilliped expanding and carrying short and thick endopodite, a bud like epipodite also present ; maxillipeds II and III almost identical, each with a 4-segmented endopodite, ending in a stout dactylus ; maxilliped II also carries a small epipodial bud.

Pereiopods (Fig. 2 M-Q) : Five pairs of pereiopods present ; 4th and 5th pairs without exopodites ; chelae present on 1st and 2nd pairs of pereiopods ; setose exopodites present on only first three pairs of pereiopods ; no spine or setae present on each chela.

Pleopods (Fig. 2R) : Small, biramous pleopods present on I-V abdominal segments ; each pleopod having a clear basal segment.

Telson (Fig 2S) : Not distinct from 6th abdominal segment ; broad, concave posteriorly, carrying 7 setose spines on either side.

Chromatophores : Larva transparent, distal margin of antennular peduncle with reticulate orange red chromatophores ; anterior and posterior dorsal margins of eye with stellate orange red chromatophores and junction of eye and carapace with diffused violet chromatophore located on a bluish background, stellate red chromatophores on the base of each of maxillipeds as well as five pairs of pereiopods ; abdominal chromatophores situated on 3rd abdominal segment (on lateral side) and ventrally on 4th abdominal segment ; an additional dendritic orange red chromatophore situated at the base of telson.

This larva differs from typical zoea larva in having :

(i) unsegmented apex of antennal peduncle (endopod) ;

(ii) buccal structures less differentiated ;

(iii) epipodite present in Maxilliped I ; and

(iv) pereiopods being more advanced.

Second Larval Stage (Fig. 3.A-S)

Time for 1st moult : 2-3 days in observation I (in November, 1975). One day in observation II (in April, 1976).

Length of larva : 4.4 mm.

Description : No significant increase in size, larva having undergone considerable morphological changes (fig. 3A-C) ; carapace with prominent supraorbital and branchiostegal

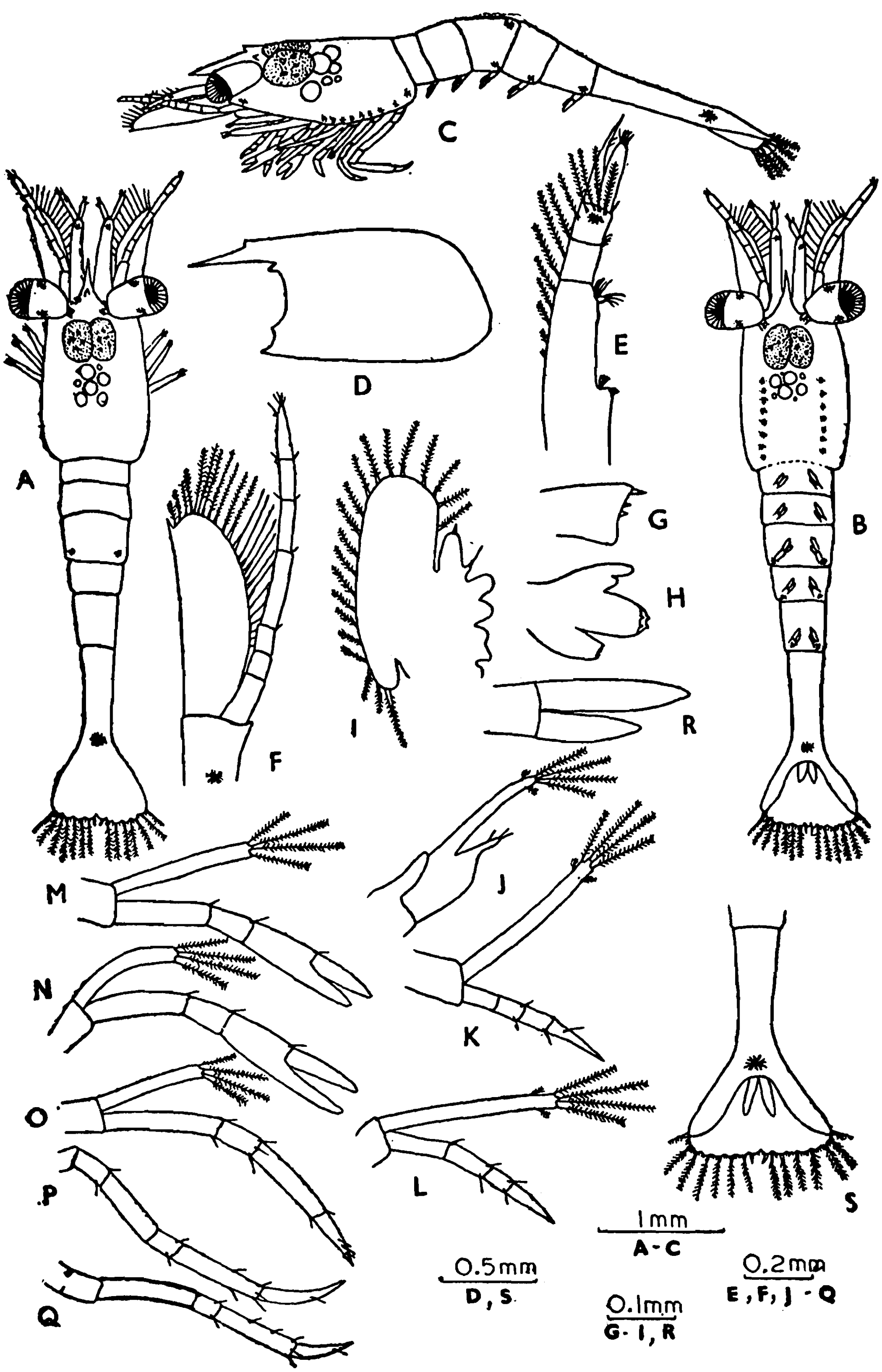

Fig. 3. Second Larval Stage of *Macrobrachium lamarrei* A—C, larva (dorsal, ventral and lateral views) ; D. carapace ; E. antennule ; F. antenna ; G. mandible ; H. maxilla I ; I. maxillaII ; J—L. maxillipeds I-III ; M—Q. pereiopods I-V ; R. pleopod, S. telson.

spines in addition to pterygostomian spine (fig. 3D) ; rostral formula 1/0 ; eyes stalked ; chromatophores at the base of 4th pair of pleopods more prominent ; additional chromatophores developed at the basis of 3rd and 5th pairs of pleopods.

Antennule (Fig. 3E) ; Antennular peduncle 3-segmented ; outer and inner flagella unsegmented, outer flagellum with four aesthetes and inner long spine-like setae and two aesthetes ; inner margin of the antennular peduncle withe 13 plumose setae, five of them encircling the terminal segment of peduncle , large number of setae present on all joints on outer margin of peduncle.

Antenna (Fig. 3F) ; Antenna showing all characteristic features of the adult appendage ; endopod long and multijointed ; exopodite provided with 24 plumose setae along its inner margin and a distinct spine at the distal extremity on the outer border.

Mandibles (Fig. 3G) : Incisor and molar parts still not distinct ; former carrying 2-3 teeth and the latter with only one tooth.

Maxilla I (Fig. 3H) : Endopod bifid ; proximal and distal lacinae with four small spines.

Maxilla II (Fig. 3 I) : Almost retains the same structure ; 1st and 2nd masticatory processes lacking setae.

Maxillipeds (Fig. 3 J-L) : Epipodial bud of maxilliped-I more elongated, endopodites of maxillipeds II and III still 4-segmented ; more spines present on the segments.

Pereiopods (Fig. 3 M-Q) : Pereiopods showing some movement but still not functional ; segmentation between coxa and basis ischium and merus not distinct ; chelae of pereiopods 1st and 2nd faintly marked ; more setae appearing on the segments of 3rd to 5th pereiopods.

Pleopods (Fig. 3 R) : Five pairs of biramous pleopods ; each pleopod 2-segmented.

Telson (Fig. 3 S) : Still not distinct from 6th abdominal segment ; carrying 8+8 spines ; one additional small, non-setose spine developed on inner aspect of each side of telson ; outermost spine on each side having setae only on the inner side ; in experiment conducted in November, 1975, the development of inner seta on left side was suppressed in all specimens, resulting in only 7+8 setae ; outlines of developing uropods distinguishable in larvae which were about to moult to next larval stage.

Third Larval Stage (Fig. 4, A-S)

Time for 2nd moult : 2-3 days in observation I (November, 1975) 2 days in observation II (April, 1976).

Length of larva : 4.51 mm.

Description : Carapace with epigastral hump, well developed supraorbital, branchiostegal and pterygostomian spines. (Fig 4D) ; rostral formula 2/0 or 3/0 ; a pair of lateral spines on 5th abdominal segment ; telson separated from 6th abdominal segment; additional reticulate orange chromatophore appearing at the basal segment of antennular peduncle, additional pair of chromatophores developed at the base of 2nd pair of pleopods, that at the base of telson becoming less distinct (fig. 4A-C).

Antennule (Fig. 4E) : Antennular peduncle expanded and 3-segmented ; inner flagellum elongated, 3-segmented, carrying 2 aesthetes ; outer flagellum divided into 2 distally ; number of setae encircling terminal segment and that on the inner margin of peduncle almost same.

Antenna (Fig. 4F) : No considerable morphological change in antennae ; endopodite

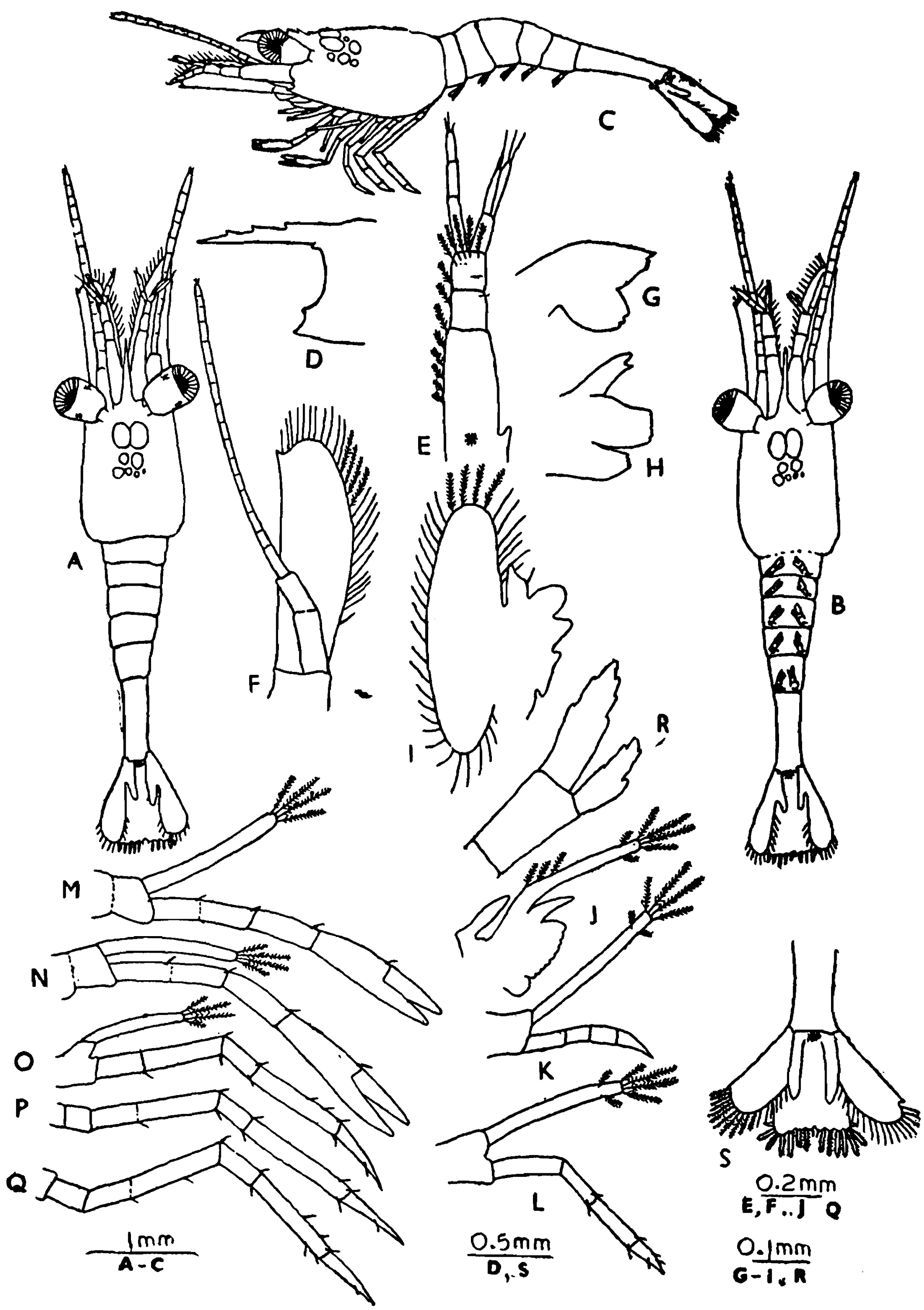

Fig. 4. Third Larval Stage of *Macrobrachium lamarrei* A—C. larva (dorsal, ventral and lateral views) ; D. carapace (anterior end) ; E. antennule ; F. antenna ; G. mandible ; H. maxilla I ; I. Maxilla II ; J—L. maxillipeds I-III M—Q. pereiopods I-V, R. pleopod ; S. telson and uropod.

very long, multi-jointed with large number of setae along its length, 4 setae at the apex of flagellum.

Mandible (Fig. 4G) : Considerable morphological changes in the shape of mandibles ; incisor and molar processes marked from each other ; incisor process with one tooth and three denticles and molar process with two denticles.

Maxilla I (Fig. 4H) : Endopod deeply notched ; proximal lacinia with 4 spines and distal with 5 spines.

Maxilla II (Fig. 4I) : More plumose setae developed all along the margin of exopod ; endopod without any setae, one seta only at its base ; masticatory processes with setae.

Maxillpeds (Figs. 4J-L) : Coxa and basis of 1st pair of maxillipeds flattened, leaf-like and projecting inwards, basis bearing a row of projections all along its border ; epipodite still more elongated ; basal part of exopodite slightly flattened and carrying 3 plumose setae along its outer margin ; endopodites of maxillipeds II and III still 4-segmented.

Pereiopods (Figs. 4M-Q) : Pereiopods still not functional ; segmentation between ischium and merus not distinct ; in 1st and 2nd pairs of chelate legs, propodus and dactylus clearly demarcated ; claws not bearing spines.

Pleopods (Fig. 4R) : An appendix interna making appearance on 2nd to 5th pairs of pleopods ; the outer edges of exopodites and endopodites of each pleopod not smooth.

Telson and Uropods (Fig. 4S) : Both demarcated from each other in this stage ; uropod biramous, exopodite larger, with 20 plumose setae at its distal border ; small endopodite not setose ; telson separated from last abdominal segment, less broad and concave at its posterior margin, with 8 + 8 spines at the posterior border.

The larva which emerges out after 3rd moult, has almost all adult characters and represents the post-larval stage.

Fourth Larval Stage :

(Post-larva) (Fig. 5, A-S)

Time for 3rd moult : 3 days in observation I (November, 1975). 2 days in observation II (April, 1976).

Total length : 4.78 mm.

Description : Carapace with an epigasteral hump, well developed supraorbital, branchiostegal and pterygostomian spines (Fig. 5D), small amount of yolk granules still left under the carapace ; rostrum elongated, rostral formula 4/0 or 5/0 and 1, 2 small plumose setae under 5th rostral tooth and one under 3rd tooth ; articulation of telson with 6th abdominal segment well defined, uropods developed ; orange red chromatophores on eye peduncle, and also in the epigastric region of carapace ; chromatophores also developed at the bases of all pairs of pleopods while that situated at the base of telson becomes less distinct (Fig. 5A-C).

Antennule (Fig. 5E) : Statocyst seen at the expanded base of antennular peduncle, sensorial setae arranged themselves along a circular arc on statocyst ; inner flagellum multi-jointed, carrying 2 terminal setae ; outer flagellum divided into 2 branches, outer branch 4-segmented and carrying 3 setae, inner branch terminating in an aestheta and carrying one lateral aestheta and 2 terminal setae ; 13 long plumose setae on the inner surface of antennule.

Antenna (Fig. 5F) : No significant morphological change in antenna ; antennal peduncle(endopod) carrying more plumose setae ; exopod (flagellum) becomes more elongated and multi-segmented.

Mandible (Fig. 5G) : Incisor and molar parts distinct ; 3 teeth on the molar process and 5 on the incisor process,

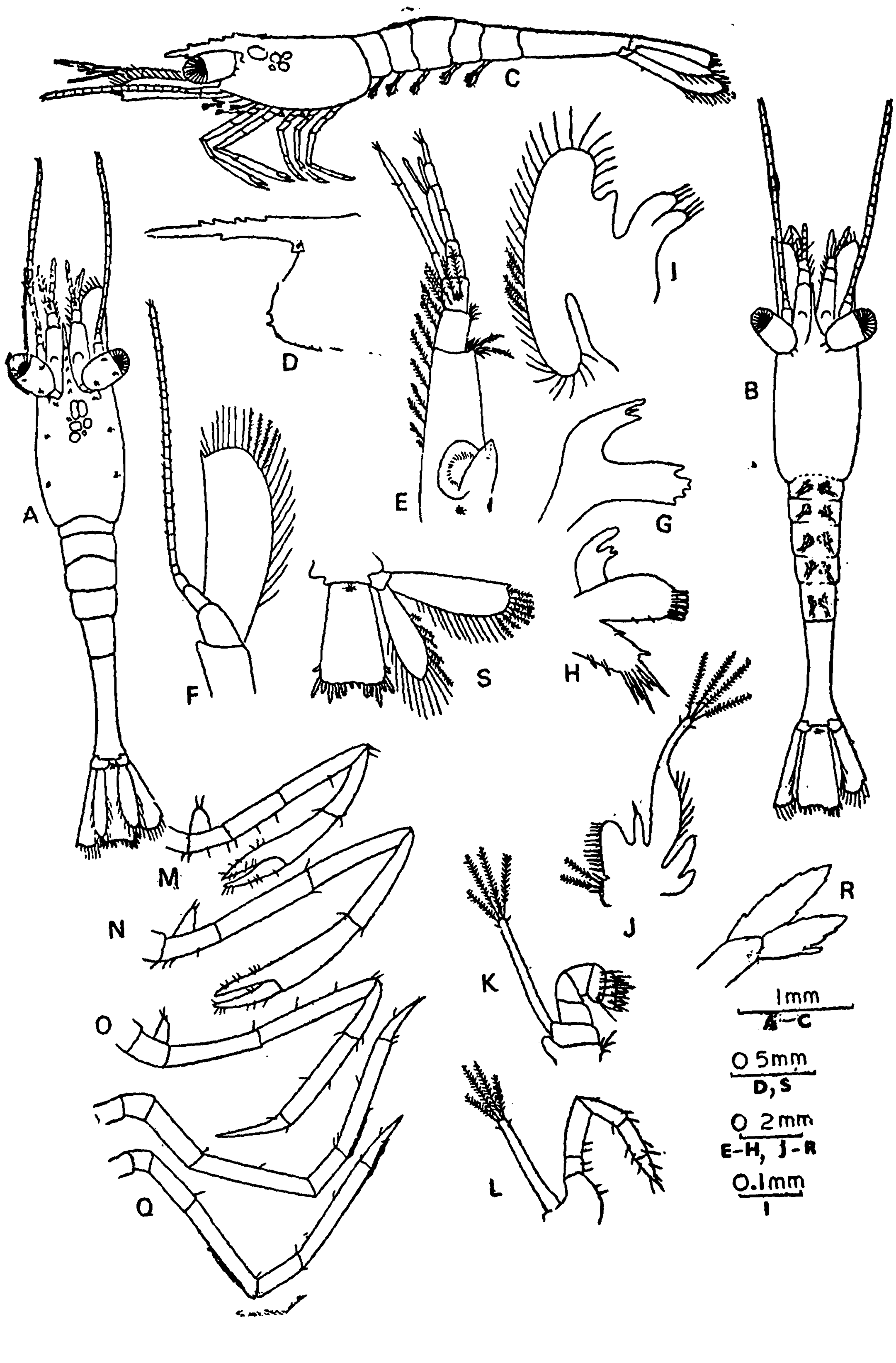

Fig. 5. Fourth Stage (Post-larval Stage) of *Macrobrachium lamarrei* A—C, post-larva (dorsal, ventral and lateral views) ; D. carapace (anterior part) ; E. antennule ; F. antenna ; G. mandible ; H. maxillla I. I. maxilla II ; J—L. maxillipeds I-III, M—Q. pereiopods I-V ; R. pleopod ; S telson and uropod.

Maxilla I (Fig. 5H) : Distal lacinia with 8 stout teeth and 2 marginal spines ; proximal lacinia with 6 teeth and 3 marginal spines.

Maxilla II (Fig, 5I) : Exopod of maxilla II with more plumose setae ; endopod simple and bare, basis with endites each terminating into 3 bristle-like setae.

Maxillipeds (Fig. 5J-L) : Basis of maxilliped I with 18 short setae and 2 plumose setae, endopodite small and bearing a single seta apically, base of exopodite expanded and bearing 7 plumose setae, epipodite bilobed ; endopodite of maxilliped II 5-segmented, propodus and dactylus broad and bearing several setae ; endopodite of 3rd pair of maxillipeds also 5-segmented and profusely setose.

Pereiopods (Figs. 5M-Q) : Segmentation in pereiopods distinct ; exopodites on 1st, 2nd and 3rd pairs of pereiopods very much reduced ; chelipeds I and II showing setae on their segments ; chelae with well developed sharp terminal claws, no teeth visible on their inner margins (edges).

Pleopods (Fig. 5R) : All pairs of pleopods biramous ; exopodites and endopodites carrying long plumose setae all along their distal borders ; appendix interna still bud like.

Telson and Uropods (Fig. 5S) : Each uropod biramous, exopod with 13 and endopod with 6 plumose setae, telson longer, broader at posterior end and bearing five spines and one lateral spine on either side.

DISCUSSION

As regards the larval development, the genus *Macrobrachium* exhibits three different patterns :

(i) Prolonged larval history : With large number of small-sized eggs and larval history having a large number of free swimming larval stages (8-16 zoeal stages) e.g., *M. rosenbergii*, (Ling and Merican, 1961 ; Ling 1969 ; Uno and Kwon,1969), *M. carcinus*,(Lewis, 1961 ; Lewis and Ward, 1965 ; Chaudhury, 1971), *M. nipponense*, (Kwon and Uno, 1969), *M. acanthurus*, (Chaudhury. 1970), *M. malcolmsonii* (Kewalramani *et. al.*, 1970), *M. formosense* (Shokita, 1970), *M. niloticum* and *M. intermedium*, (Williamson, 1972), *M. idella*, (Pillai and Mohamed, 1973).

(ii) Abbreviated larval history : With comparatively larger sized and lesser number of eggs than in the first type and also with lesser number (three) of free swimming larval stages e.g., *M. lamarrei*, (Rajyalakshmi, 1961), *M. australiense*, (Fielder, 1970).

(iii) Nearly suppressed larval history : With eggs generally larger than in the second type and lesser in number, larval stages minimum, the larvae on hatching without functional legs and resemble postlarva or adult e.g., *M. potuina*, (Sollaud, 1923) *M. shokitai*, (Shokita, 1973) and *M. hendersodayanum* (Jalihal and Sankolli, 1975).

The larval development of *M. lamarrei*, as mentioned earlier, fits in the second category. The larvae hatch out with a few characters of normal zoea and many of those of advanced larva and they need only three moults to enter the postlarval stage. This type of abbreviated development has also been pointed by Fielder (1970) in *M. australiense*, which also showed three larval stages.

The larvae of Palaemoninae were described by Sollaud (1923) under two groups. To the first group belonged the normal zoea and the second group larvae were termed as hypomysis, with again two phases *i.e*, 'subparva' and 'preparva'. The larvae which hatch out in *M. lamarrei* are similar to Sollaud's 'subparva'. In this species the newly hatched larvae have five pairs of immobile feet which lie folded on the ventral side of carapace. However, exopodites of all the maxillipeds and endopodites of maxillipeds II and III serve in locomotion. The latter function as feet only after the first larval moult and mark the beginning of the 'Mysis phase', but the chelipeds become functional only after the third and final moult. Moreover, the suppressed development of all buccal organs in these larvae can be correlated with the presence of sufficient amount of reserve food material due to which the larvae do not have to depend upon the external food supply. On the other hand, the differentiated scaphognathite of Maxilla II helps to produce a respiratory current in the branchial chamber right from the time of hatching.

The present observations are in general conformity with findings of Rajyalakshmi (1961) though there are some differences in details. For example, the size and shape of eggs in the populations presently studied are somewhat different from those described by Rajyalakshmi. In our specimens, eggs were rather oblong, and not oval and their longer diameter was more (1.5 mm to 1.7 mm ; average 1.6 mm) than in other population (1.33 mm to 1.45 mm ; average 1.36 mm). However, Koshy and Tiwari (1975) gave the average length of eggs as 1.32 mm.

It has already been remarked that the embryonic development (the time between extrusion of eggs and their hatching) took longer time i.e., 18 to 20 days, in November, 1975 brood, than in April, 1976 when this period was reduced to 12 days only. In the material studied by Rajyalakshmi this interval varied from 12 to 14 days, corresponding roughly with the April brood. In the larval development also the same differences are noticed. In the population studied in November, 1975, the larval development (from hatching to third moult) took 7 to 9 days but in April brood, it took only five days. Rajyalakshmi's specimens went through three moults in about four days time, again agreeing with the present summer observations.

Though the number of observations are not sufficient to make any generalisations, apparently temperature seemed to play some role in development. In November, 1975, when the temperatures were somewhat lower, the entire developmental process from the extrusion of eggs till the emergence of post-larva took about 3-4 weeks, while in April, 1976, it was completed in less than three weeks.

In addition, certain morphological differences are noticed in the larval development in the present observations and those of Rajyalakshmi. These are tabulated below :

Present observation	Rajyalakshmi (1961)
1. *1st Larval Stage*	1. *1st Larval Stage*
(i) Antennary flagellum unsegmented.	(i) Antennary flagellum 3-segmented at basal region ;
(ii) endopod of maxilla I, smooth ;	(ii) endopod of maxilla I bi-fid ;
(iii) endopodites of maxillipeds II and III, 4-segmented ;	(iii) endopodites of maxillipeds II and III, 5-segmented ;
(iv) 4th and 5th pairs of pereiopods uniramous.	(iv) only 5th pair of pereiopods uniramous.
2. *2nd Larval Stage*	2. *2nd Larval Stage*
(i) Carapace with supraorbital, branchiostegal and pterygostomian spines.	(i) only first two types of spines present ;

(ii) inner and outer flagella of antennule unsegmented ;	(ii) inner flagellum 2-segmented and outer flagellum 3-segmented ;
(iii) rostral formula : 1/0 ;	(iii) rostral formula : 2/0
(iv) 4th and 5th pereiopods uniramous ;	(iv) only 5th pair of pereiopods uniramous ;
(v) endopodites of maxillipeds II and III still 4-segmented ;	(v) endopodites of these maxillipeds 5 segmented ;
(vi) telson carrying 8+8 setae but 7+8 setae observed in all specimens in observation I (November, 1975).	(v.) telson carrying 8+8 setae ;
(vii) additional chromatophores developed.	(vii) chromatophores same as in larva I.
3. *3rd Larval Stage*	3. *3rd Larval Stage*
(i) carapace with supraorbital, branchiostegal and pterygostomian spines ;	(i) ?
(ii) epigastral hump on carapace noticed ;	(ii) no epigastral hump ;
(iii) rostral formula : 2/0 or 3/0	(iii) rostral formula : 2/0 ;
(iv) endopodites of maxillipedes II and III 4-segmented ;	(iv) endopodites of maxillipeds 5-segmented ;
(v) segmentation of endopodites on all pereiopods not distinct ;	(v) segmentation quite distinct ;
(vi) telson spines : 8+8 ;	(vi) telson spines : 7+7.
4. *4th Stage* (*Post-Larva*)	4. *4th Stage* (*Post-Larva*) :
(i) in carapace, branchiostegal and pterygostomian spines more distinct ;	(i) ?
(ii) epigastral hump on carapace ;	(ii) no epigastral hump ;
(iii) rostral formula : 4-5/0—1 ;	(iii) rostral formula : 4/0—1 ;
(iv) upper rostral teeth having plumose setae below them ;	(iv) no plumose setae recorded or figured ;
(v) small amount of yolk granules still present ;	(v) yolk granules exhausted ;
(vi) in maxilliped II, joint between ischium and merus of endopodite distinct.	(vi) joint not distinct.

Some of the differences seem to be more than individual variations and probably reflect the genetic diversity resulting from diversity in habitats. It has been suggested by Gurney (1942) that land-locked populations tend to favour abbreviated development and the amount of yolk in the eggs have great influence on the course of development. This abbreviation in larval life leads to suppression of exopods on all legs. In Rajyalakshmi's material only the exopods on last pairs of pereiopods were suppressed. In the populations studied by us, on the other hand, the suppression of exopod in larvae extended to the fourth pair of pereiopods also. As has already been mentioned, our material is drawn from populations inhabiting confined freshwaters in Calcutta with ecological characteristic different from those in the estuarine-riverine habitat from where Rajyalakshmi's study material was collected. It apparently seems to lend weight to Gurney's hypothesis.

Macrobrachium lamarrei is wide spread in

India occupying large variety of ecological niches i.e., fluvial, lacustrine and estuarine. Yet very little work, particularly at infra-specific level, has been done on populations of this species to ascertain the population dynamics, genetics and related biological problems connected with temporal and spatial attributes. The differences observed here by us in the development of two populations from the same geographical area, but from different habitats, suggest that such investigations could be scientifically very rewarding.

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STUDIES ON THE AESTIVATING POPULATION OF *ACHATINA FULICA* BOWDICH (MOLLUSCA : ACHATINIDAE) IN WEST BENGAL

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ABSTRACT

Population estimation of aestivating *Achatina fulica* in their natural habitat has been made from five districts of West Bengal. Aestivating snails were found to aggregate in protective pocket according to its capacity. The aestivating sites are categorised herein as (i) large pocket with 17—61 snails, (ii) small pocket with 5—14 snails and (iii) sparsely distributed sites with 5—19 snails per square metre area. A some sort of age dependant aggregation was noted.

INTRODUCTION

Land snails which are generally moisture loving are active in monsoon and pass the dry seasons in dormant state. In West Bengal, dormancy extends from November to June (Raut and Ghose, 1977). This is primarily due to low moisture content in the air, and the term applied for such behaviour is known as 'aestivation'. The present study was made to investigate the aestivation, aestivating behaviour and the population of the giant African snail *Achatina fulica*, a notorious agrihorticultural pest of the Indo-Pacific Islands with a view to launch suitable controlling measures.

MATERIAL AND METHODS

Aestivating snail populations were studied from 20 gardens in five districts—Calcutta, Hooghly, Howrah, Midnapore and 24-Parganas. For convenience the sites were categorised as (i) large pocket, having 15 or more aestivating snails ; (ii) small pocket, having 14 or less number of aestivating snails, and (iii) sparsely distributed *i.e.* aestivated snails scattered along the boundary of the gardens. Population was estimated as follows :

(a) Counting of all the snails aggregated in the large and small pocket as mentioned above.

(b) In case of sparsely distributed aestivating snails counting was made on the number of snails present in a square metre area, and from one garden 3 such readings were considered as the actual number of aestivating snails per square metre area of the garden. It is to be noted here that only the areas where the snails aestivated were selected for studies.

Behaviour and mode of aggregation were

* Research Scholar

noted from other districts of the State West Bengal.

Observations

Aestivating sites and behaviour : Aestivating *A. Fulica* were found in a number of protective pockets but most of them were in close contact with the soil directing the shell aperture downward. Sometimes the outer lip of the shell is buried in small area, often one above the other. From all the gardens a few snails were recorded from burrows 3—6 cm deep into the soil. A some sort of age dependant aggregation during aestivation was observed.

Furthermore, whatever be the aestivating sites and the age of the snails, aestivating specimens sealed their shell apertures with the secretion of mucus, called epiphragm, leaving only a slit corresponding to the pneumostome.

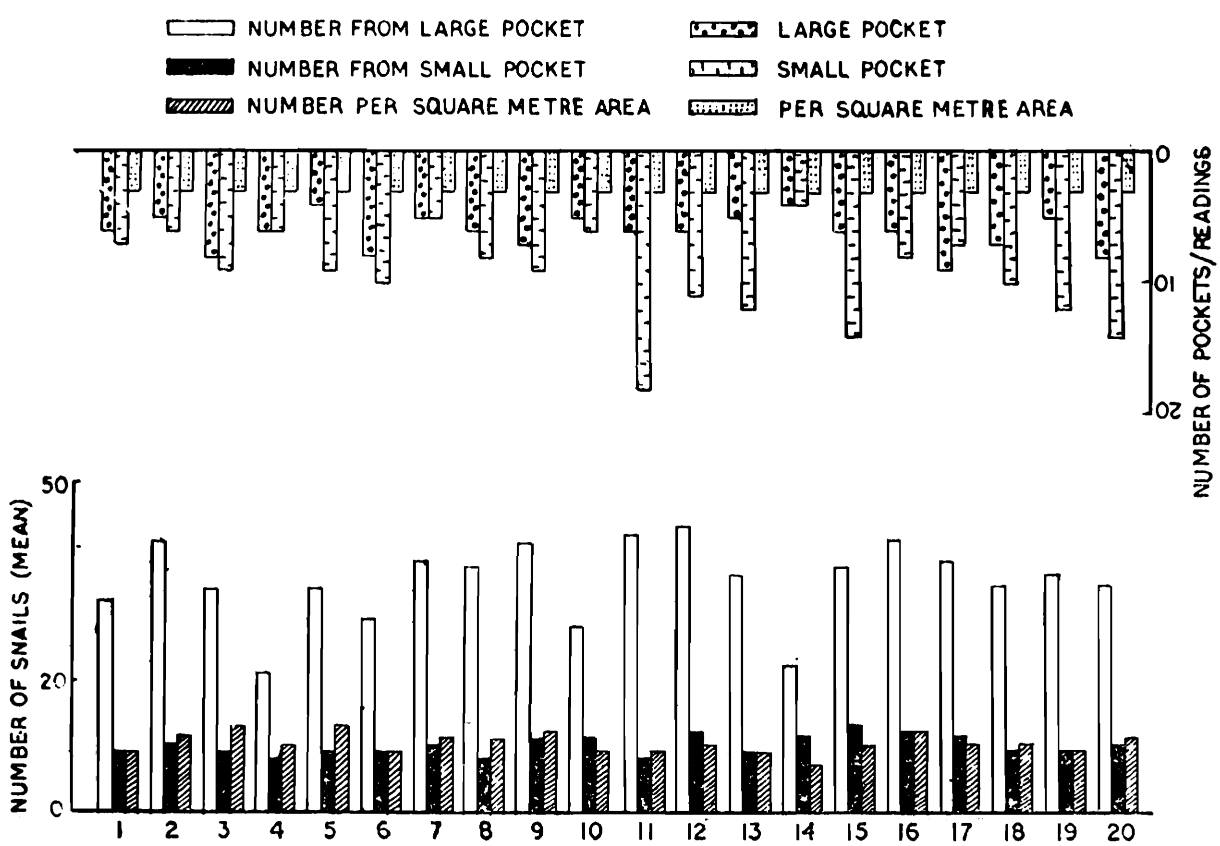

Fig. 1. Histogram showing aestivating population of *Achatina fulica* from different localities of West Bengal. 1—Ballygunge, 2—Bhawanipur, 3—Sreerampur, 4—Amta, 5—Bali, 6—Uttarpara, 7—Belda, 8—Contai, 9—Dantan, 10—Egra, 11—Gobra, 12—Kalindi, 13—Mangalpur, 14—Patashpur, 15—Baruipur, 16—Birati, 17—Jadav pur, 18—Joynagar, 19—Naihati, 20—Taratala.

the soil. The aestivating sites are the bushes, crevices, crotches of trees, empty pots, under decaying twigs and leaves, and inside the leaf bases of young coconut trees. Aestivating specimens huddled together in a

Population : In each garden a good number (4—9) of large aestivating pockets were recorded where 17—61 individuals took their shelter. From each 9 pockets 342 snails were counted in one garden. Small aestivating pockets were much more in numbers (4—18) in each garden where 5—14 snails were counted with a total of 182 snails from 18 pockets. 5—19 snails have been observed sparsely aestivated per square metre area. It is interesting that in these large and small pockets there was no room for further accommodation of snails. Data collected from different stations are shown in Fig. 1.

DISCUSSION

Numerous reports on the dormant state (aestivation and hibernation) of land snails are available both from the temperate and cold countries (Bequaert 1919 ; Lang 1919 ; Hora 1928 ; Williams 1951 ; Mead 1961 ; Blinn 1963 , Pomeroy 1969 , Raut and Ghose 1977). But no account of aestivating population concerning land snails is available. It is generally believed that humidity, temperature and loss of body weight due to lack of proper nutrition are responsible for the comatose state (Duval, 1930 ; Kamada 1933 ; Howes and Wells 1934 *a*, *b* ; Wells 1944 ; Ress 1950 ; Kondo 1964).

From the present study and a perusal of literature, the major factors guiding the selection of sites for aestivation in land snails appear to be related with moisture, security and also to escape the sight of the predators.

The behaviour of congregation of aestivating *A. fulica* preferably in a protective site, the 'aestivating home', is of common occurrence. They are quite at ease aestivated even one above the other inside their aestivating home. At the onset of aestivation the snails move about in search of a suitable site and accommodate themselves neatly closed in accordance to the capacity of the pocket available. Such suitable sites being limited, a large number of snails, finding no alternative, undergo aestivation individually along the boundary line of the garden.

The phenomenon of congregation of *A. fulica* during aestivation indicates that it is easier to locate more snails during aestivating period than in their breeding season. Chemical control with the help of about 50 molluscicides has failed (Mead, 1961) and their control through biological agents such as predators and parasite is not encouraging. For these reasons, the local Governments of the infested areas, are still engaging persons for the physical destruction of the snails as a part of their eradication programme. As the snails aggregate in large number in protective pockets during aestivation (November to June), it is recommended to launch such a programme during aestivation rather than in their active period. This would necessarily involve less man-power and minimum financial outlay.

ACKNOWLEDGEMENTS

The author is thankful to the Director, Zoological Survey of India, to Sri A. S. Rajagopal and Dr. N. V. Subba Rao, of the Malacology Division, Z. S. I. facilities provided and encouragement.

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ECONOMIC SPECIES OF *CRYPTOLESTES* (CUCUJIDAE : COLEOPTERA) OCCURRING IN INDIA AND THEIR CONTROL

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AND

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ABSTRACT

Taxonomy, biology and control of *Cryptolestes pusillus* (Schonherr) and *Cryptolestes ferrugineus* (Stephens) have been dealt. A key to pest species of *Cryptolestes* is given.

INTRODUCTION

Cryptolestes is a cosmopolitan genus, closely related to the genus *Laemophloeus* Dejean and *Microlaemus* Lefkovitch, differing from the former in having front coxal cavities close behind, intercoxal process of ventrite 1 broad and its apical margin slightly rounded, fronto-clypeal suture absent and apical margin of clypeus never with five apical emarginations. Unlike *Microlaemus*, the head of *Cryptolestes* is devoid of frontoclypeal suture, front coxae globular and its cavities close behind. Grouvelle's species of Indian *Cryptolestes* were so far placed under the genus *Laemophloeus*, moreover, until recently the pest species *Cryptolestes ferrugineus* and *Cryptolestes pusillus* were considered as *Laemophloeus* and this name has been used in several text books.

There are six species of the genus *Cryptolestes* Ganglbauer, namely *ferrugineus* (Stephens), *pusillus* (Schonherr), *turcicus* (Grouvelle), *pusilloides* (Steel & Howe), *ugandae* Steel & Howe and *capensis* (Waltl) recorded as pest of stored products from the world. They generally infest husked rice, wheat and wheat products, sorghum, maize, barley and occasionally on oil seeds. Though the close external similarity of the members of this genus often lead to confusion, considerable differences do exist in the range of geographical distribution, habitat and in sclerites associated with male and female genitalia. Of the six known pest species of *Cryptolestes*, the species *turcicus* (Grouvelle), *pusilloides* (Steel & Howe), *ugandae* Steel & Howe and *capensis* (Waltl) do not occur in India. The most important pest species of this genus are *pusillus* (Schonherr) and

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ferrugineus (Stephens) which are quite common in India and serious pest of stored grain and their products. *Cryptolestes turcicus* (Grouvelle) is more or less confined to the temperate regions of the world and infest wheat, grain residues, maize, dried fruits etc. ; *C. pusilloides* (Steel & Howe) is distributed mainly in Southern hemisphere and recorded from wheat and wheat products, sorghum, rice, barley and occasionally from oil seeds ; *C. ugandae* Steel & Howe is known from Central Africa and associated with stored food ; whereas *C. capensis* (Waltl) has been recorded from Europe, North and South Africa from flour mills. Till to date only two species, *C. pusillus* (Schonherr) and *C. ferrugineus* (Stephens) were known from India. Authors have discovered seven more species of *Cryptolestes* from India including three new to science, which will be dealt elsewhere. Of the two pest species of *Cryptolestes* in India, *pusillus* is more common and causes seriousdamage to unboiled rice, suji and flour. Prior to 1939 *C. pusillus* was

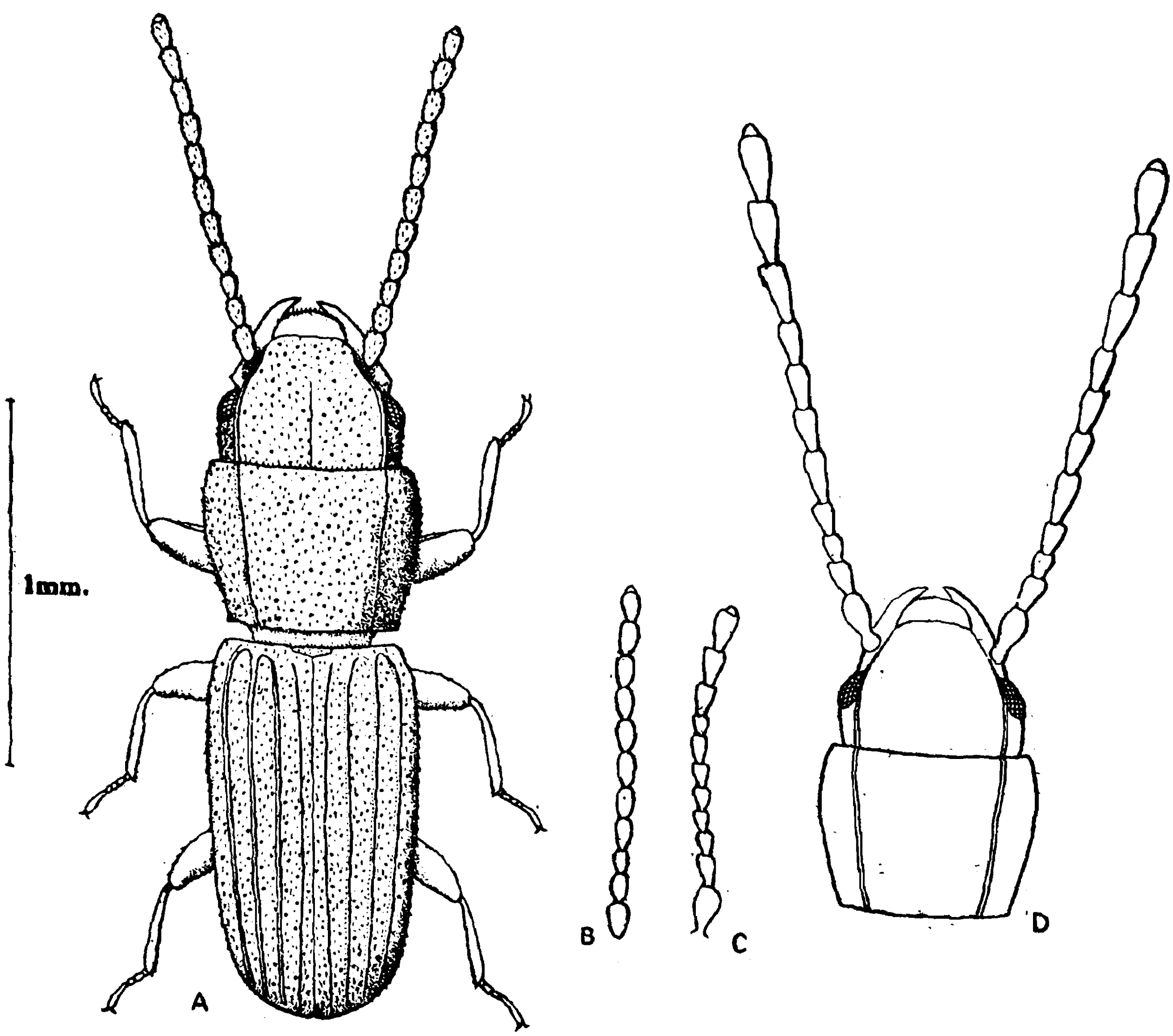

Fig. 1-(A-B) *Cryptolestes ferrugineus* (Stephens) A. Dorsal view. B. antenna of female ; (C-D) *Cryptolestes pusillus* (Schonherr) C. antenna of female, D. head and prothorax of male.

considered to be a secondary pest, but during the second world war it was recorded as a serious, widespread pest of rice.

Key to the stored grain species of **Cryptolestes** Ganglbauer

1. Length of antennae in male either as long as or longer than body, outer margin of mandible simple and rounded	3
—Length of antennae never exceed two thirds of the body in both sexes, outer margin of mandible with a distinct tooth like structure near base.	2
2. Hind angles of pronotum prominent & acute, pronotum slightly narrowed posteriorly, segment 3 of antenna about as long as pedicel........	*ferrugineus* (Stephens)
—Hind angles of pronotum obtuse, pronotum markedly narrowed posteriorly, segment 3 of antenna distinctly longer than pedicel..	*capensis* (Waltl)
3. Pronotum quadrate	4
—Pronotum not quadrate and narrowed posteriorly..	5
4. Apical margin of clypeus straight	*turcicus* (Grouvelle)
—Apical margin of clypeus distinctly emarginate........	*ugandae* Steel & Howe
5. Each cell of elytra with two rows of punctures ; dorsal surface of the body densely pubescent, pronotum 1.4 times as broad as long....	*pusillus* (Schonherr)
—Each cell of elytra with one row of punctures ; dorsal surface of the body less pubescent, pronotum 1.1—1.2 times as broad as long....	*pusilloides* (Steel & Howe)

Cryptolestes puillsus (Schonherr)

This elongated, flattened, parallel-sided, reddish brown, densely and finely pubescent beetle is popularly known as 'flat grain beetle' and mostly common in humid tropical areas, less so in cooler drier climates and unable to survive in temperate regions. They are scavenging by nature, infesting grains which are out of condition and generally follows up the attack of *Silophilus oryzae* (L.) and *Tribolium castaneum* (Herbst). The larvae of the species are particularly fond of germ in wheat. In India, authors have recorded the species infesting biscuits (Calcutta, March), flour (Calcutta, March), unboiled rice (Chaibasa : Bihar, June). Suji (Calcutta, August). Besides this, it is also recorded from under bark of *Iagerstroemia perviflora* (Lythraceae) : Hasimara : West Bengal, *Stereospermum chelonoides* (Bignoniaceae) Dainadubi : Meghalaya, *Bombax malabaricum* (Bombacaceae) : Kaziranga : Assam, *Quercus dilatata* (Fagaceae) : Dehra-Dun : Uttar Pradesh.

Head transverse, frontoclypeal suture and median line on vertex indistinct, lateral line at the inner margin of eyes ridged, vertex densely, finely and closely punctured and pubescent ; eyes small, black and moderately coarsely faceted ; antennae 11—segmented and longer in male than female. External surface of mandible (Fig. 2A) simple and rounded. Prothorax (Fig. 1D) transverse, narrowed at base, front angle obtuse, hind angle not-projected and less acute, lateral line on either side ridged, pubescence and punctures similar to that of on head. Scutellum transverse and finely punctured. Elytra less than two times longer than its width, humeral and apical angles rounded, each elytron with three cells. Sclerites associated with male and female genitalia are as figured (Fig. 2, B,C). Males can be easily distinguishable from females, especially in antennal character. The antenna of male is a long as the body, with segments 9-11 forming an indistinguishable club. In the females the antennae never exceeds two-thiıds of its body length and segments 9-11 form rather distinct club (Fig. 1C).

Biological notes : Adults are apparently unable to attack healthy grains but the larvae particularly attack the grain embryos.

The adult female lays 100-140 eggs, the larvae being very active, flat, moderately elongated, slightly narrowed in front and hehind with heavily chitinized urogomphi. The larval stage lasts for 2-4 weeks. Pupation takes place within the cocoon formed by fine silky materials. Under favourable condition species complete its development from egg to adult stage in about 6-9 weeks. Aitken (1975) noted that the lowest temperature limit for development is somewhere between 15°C and 17°C and lowest relative humidity is 50% and shortest life cycle recorded, is 21 days at 37°C and 80% humidity.

Cryptolestes ferrugineus (Stephens)

It is commonly known as 'rusty grain beetle' feeds on whole and processed grains and oilseeds and causes serious infestation in stored grains in absence of any other pest species and is usually found in flour mills. They have been also recorded infesting copra, oilcake. cocoa, beans and dried fruits. In India, we have re-

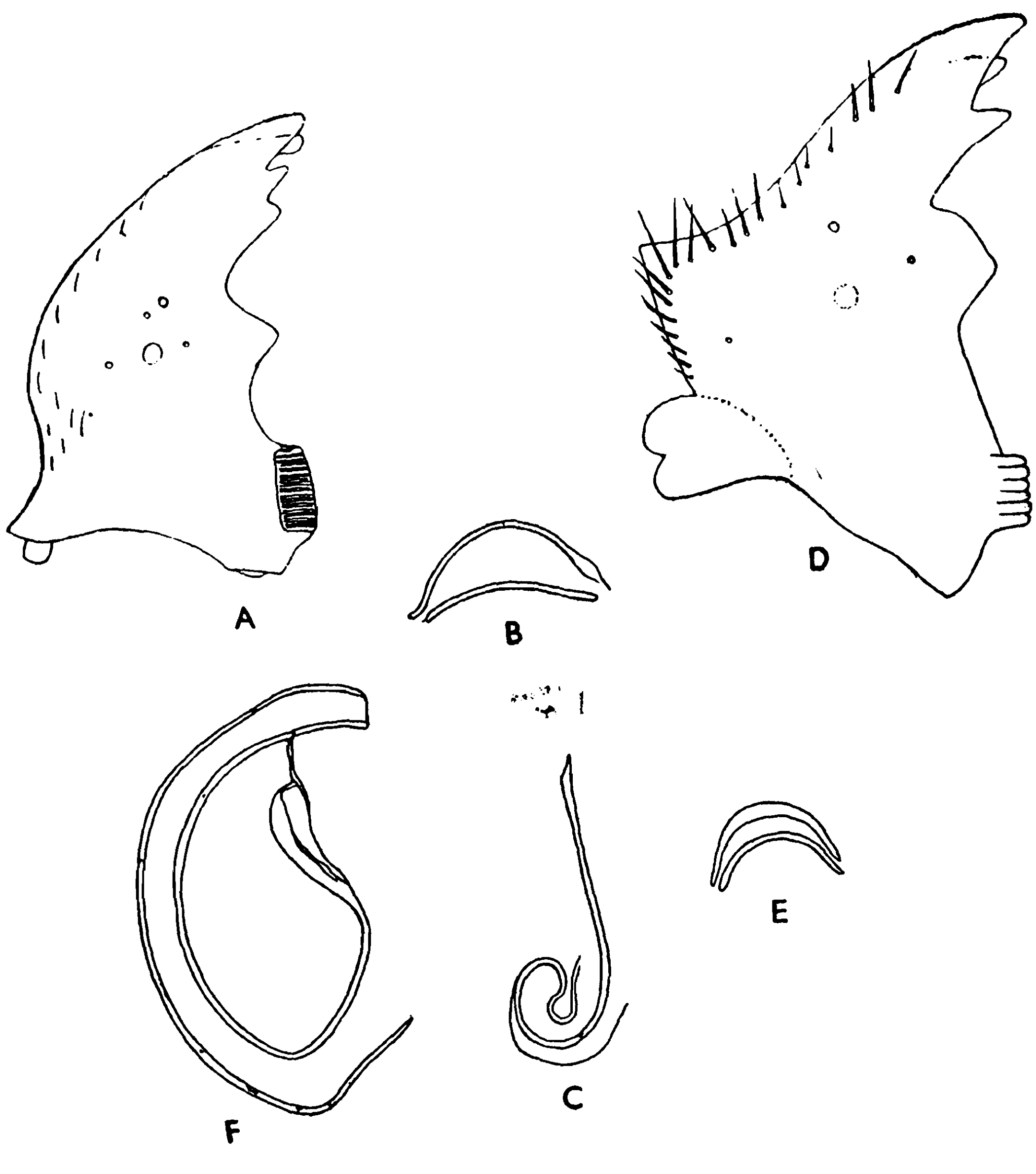

Fig. 2. (A-C) *C. pusillus* (Schonherr) A. mandible. B. sclerite associated with male genitalia, C. sclerite associated with female genitalia ; (D-F) *C. ferrugineus* (Stephens) D. mandible of male, E. sclerite associated with male genitalia, F. sclerite associated with female genitalia.

corded this species from : Calcutta, West Bengal infesting rice and wheat during the month of September and November respectively. This species generally favours dry conditions, coarse food and has low larval density.

Characteristic feature : General appearance (Fig. 1A) elongated, flattened, dorsal surface ferrugineus. Head transverse, frontoclypeal suture indistinct, median line on vertex distinct, lateral line at the inner margin of eyes ridged, vertex with moderately large, closely arranged punctures and pubescent ; eyes small, black and moderately coarsely faceted. Antennae 11-segmented, somewhat moniliform and its length not extending more than half of its body length in both sexes. Outer margin of mandible (Fig. 2D) of male with a distinct tooth like structure near base. Prothorax transverse, distinctly narrowed at base, front angle obtuse, hind angle projected and distinctly acute, lateral line on either side ridged, puncturation and pubescence similar to that of on head. Scutellum transverse and finely punctured. Elytra less than two times longer than its width, humeral and apical angle rounded, each elytron with three cells, sclerites associated with male and female genitalia as figured (Fig. 2E,F). Unlike as in *C. pusillus,* in this species the sexual dimorphism is confined to the nature of mandible, the outer margin of which in males with a distinct tooth like structure near base (Fig. 2D), while in the female the outer margin is simply rounded.

Biological notes : The life cycle of this species has been studied by Rilett (1949). Young larvae enter into the seed coat through hole made by them. Unlike *C. turcicus* (Grouv.). This species is generally unable to produce a tough silken cocoon, but whenever one is produced it is very fragile and contains very little silk. At 75% relative humidity, the life cycle varies from 69-103 days at 21°C to 17-26 days at 38°C. Above 75%, relative humidity has no effect on the length of life cycle, but below this level, development is retarded.

CONTROL OF STORED GRAIN BEETLES

Effective control measures mean the working together of good husbandry and chemical control. This includes adequate preparation and maintenance of clean building structures coupled with well planned chemical treatment of uninfested and infested grains.

1. *Building structures* : Prior to bringing in of fresh, uninfested grains in storage, the building, silos, bins etc. should be thoroughly cleaned. Any remains on which insects might feed and breed or prevent them from a contact with insecticides should be removed. After the cleaning operations are completed the building structures should be treated with insecticides. In western countries the two recommended compounds are fenitrothion and primiphos methyl, both of which are organophosphates. On porous surfaces wettable powder formulations are suitable as they give a good deposit. For metal surfaces e. g. grain bins, emulsifiable concentrates are recommended. In places where sprays do not gain access insecticide smokes are suggested e. g. γ - HCH or lindane (Old abbreviation γ - BHC). Chemical treatment should be coupled with careful inspection of all material when brought in for storage. Some additional helpful steps include constructing the building such as to keep stored products dry, constructions should also be sufficiently tight to aid efficient fumigation.

2. *Infested grains* : In general the insecticides (fumigants) that are used to control stored grain pests have a non-specific mode of action. Thus most of them do not combine with specific targets at the molecular level yet achieve high activity with a relatively low concentration. As such compounds used against the grain weevil can also be used to control these beetles.

In Western countries the most commonly used fumigant mixture is ethylene dichloride +carbon tetrachloride either in 3 : 1 combination or 1 : 1 combination. Ethylene chloride is mixed with carbon tetrachloride to reduce fire hazard, however, ethylene chloride is toxic to warm blooded animals and should be handled with care. Operators should not inhale the vapour, should keep the liquid off skin and clothes, and should not use naked lights or smoke, as on exposure to heat the gas produce the highly toxic phosgine. In our country the fumigants widely used are phospine, ethylene dibromide and methyl bromide. Phosphine is easily available and easy to handle. It is normally generated from tablets of aluminium phosphate and ammonium carbamate which in presence of moisture produces phosphine. Recommended dose under atmospheric pressure is 45 tablets or 165 pellets per 30 m^3 (=1000 ft^3 approx.). Fumigation should be carried out for 5 days at 12 to 15°C, 4 days at 16 to 20°C and 3 days at 21°C or above. It is very toxic to higher animals and thus a controlled release is recommended. Ethylene dibromide is an important fumigant and has a comparatively longer effect than methyl bromide or phosphine. It is however very toxic to higher animals and must be handled with care. Methyl bromide has proved of great value in fumigation of stored products, but is an insidious poison, rendering it quite unsafe for use by untrained persons. For preventing reinfestation or cross-infestation grain bag stacks are treated with dust or wettable powder formulations of DDT and HCH. Other insecticides used include aldrin, dieldrin and endrin.

3. *Uninfested grains* : A very useful protective measure particularly in buildings with previous history of infestation, is to treat the grains with a mixture of malathion plus lindane. The insecticide mixture can be either mixed into the grains as a dust, or sprayed as an emulsion. The recommended dose is a mixture not exceeding 500 gm/tonne (20% malathion + 0.5% lindane). When spray is used malathion should not exceed 1 litre/tonne (1.2% emulsion). The choice of correct applicatons also has profound influence on the efficiency of the chemical control measures.

In recent years resistance to insecticides in stored product pests has created an additional problem in the way of effective control measures. Cross resistance and multiple resistance together with the limited choice of alternative chemicals creates further complications. It is therefore valuable to know the mechanism of resistance. This information can be used to try either alternative insecticides or synergists. The practical importance of resistance detected in the laboratory differs with the residual life of a chemical. Thus in case of compounds like malathion or fenitrothion resistance will mean that only the effective life of treatment will be reduced. With fumigants no residual life is involved and thus the practical consequences of resistance will be felt immediately.

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SIMULIIDAE (DIPTERA) FROM SIKKIM, INDIA

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ABSTRACT

Six species of Simuliidae (Diptera) are recorded from Sikkim, India, bringing the number of species in the State to seven, *viz. Simulium* (*Himalayum*) *indicum* Becher, *Simulium* (*Simulium*) *rufibasis* Brunetti, *S.* (*S.*) *himalayense* Puri, *S.* (*S.*) *dentatum* Puri, *Simulium* (*Gomphostilbia*) *metatarsale* Brunetti, *S.* (*G.*) *tenuistylum* Datta and *Simulium* (*Eusimulium*) species D of Datta, Dey and Paul, 1975.

INTRODUCTION

The simuliid fauna of Sikkim is one of the least known in India, despite the potential economic importance of this family as the blood-sucking pest of man and animals. Prior to the present report, only *Simulium* (*Himalayum*) *indicum* Becher (locally called pipsa) has long been known to represent the fauna (Cotes, 1894 ; Lewis, 1974). Recently, while examining a small collection of immature stages taken on bamboo leaves from a stream of Gangtok (altitude 1704 m.) on the 26th April, 1976, by Mr. T. K. Pal under the leadership of Mr. A. R. Bhowmik, Zoological Survey of India, Calcutta, the author encountered six species which are recorded here for the first time from the State. It appears fairly certain that the simuliid fauna of Sikkim is very similar to that of the Himalayan Darjeeling District of West Bengal (*cf.* Brunetti, 1911 ; Puri, 1932a & b ; Datta, 1973 ; 1974 ; Datta, Dey and Paul, 1975 ; Datta, Dey, Paul and Pal, 1975).

Subfamily SIMULIINAE Newman

Tribe SIMULIINI Newman

1. Simulium (Simulium) rufibasis Brunetti

Simulium rufibasis Brunetti, 1911, *Rec. Indian Mus.*, **4** : 285 ; Smart, 1945, *Trans. R. ent. Soc. Lond.* **95** : 513.

Simulium (*Simulium*) *rufibasis* Brunetti : Puri, 1932, *Indian J. med. Res.*, **19** : 899 ; Crosskey, 1969, *Bull. Brit. Mus. nat. Hist.* (*Ent.*) *Suppl.* **14** : 115 ; Lewis, 1973, *Bull. ent. Res.*, **62** : 455 ; Crosskey, 1973. *A Catalog of the Diptera of the Oriental Region*, **1** : 428 ; Datta, 1974, *Oriental Ins.* **8** : 19.

Material examined : 12 pupae (in alcohol).

Distribution : INDIA : West Bengal, Himachal Pradesh, Meghalaya, Manipur and Arunachal Pradesh ; PAKISTAN and ? JAPAN.

Remarks : Brunetti (1911) described the species from a single female collected from Kurseong in West Bengal and the type (Regd. no. 2307/20) in partly damaged condition is in the collection of the Zoological Survey of India, Calcutta. A single specimen (Regd. no. 936/H6) of the species collected by Revd. Pettigrew from Manipur is also in the same collection. The distribution of this species in Arunachal Pradesh and Meghalaya is supplied from the author's unpublished records. The species was also recorded from Japan (Ogata and Sasa, 1954), but recently Dr. H. Takahasi (*in litt.*, 1974), after a careful comparison of the Japanese form with the Indian one, has come to the conclusion that these two forms are quite different and obviously the Japanese form requires a new name.

2. Simulium (Simulium) himalayense Puri

Simulium (Simulium) himalayense Puri, 1932. *Indian J. med. Res.*, **19** : 885 ; Crosskey, 1969, *Bull. Br. Mus. nat. Hist.* (*Ent.*) *Suppl.* **14** : 115 ; Lewis, 1973, *Bull. ent. Res.*, **62** : 455 ; Crosskey, 1973, *A Catalog of the Diptera of the Oriental Region.* **1** : 427 ; Datta, 1974, *Oriental Ins.*, **8** : 20.

Simulium himalayense Puri : Smart, 1945, *Trans. R. ent. Soc. Lond.* **95** : 506.

Material examined : 7 pupae (in alcohol).

Distribution : INDIA : Himachal Pradesh, West Bengal, Bihar, Arunachal Pradesh, Manipur ; and PAKISTAN.

Remarks : Puri (1932a) described the species from material collected from different localities around Simla in Himachal Pradesh and from Kurseong and Darjeeling in West Bengal and the type is in the collection of the National Institute of Communicable Diseases, Delhi (Lewis, 1974). The distribution of this species in Arunachal Pradesh and Manipur is supplied from the author's unpublished records.

3. Siumlium (Simulium) dentatum Puri

Simulium (Simulium) dentatum Puri, 1932, *Indian J. med. Res.*, **19** : 1135 ; Crosskey, 1968, *Bull. Br. Mus. nat. Hist.* (*Ent.*) *Suppl.* **14** : 115 ; Crosskey, 1973, *A Catalog of the Diptera of the Oriental Region*, **1** : 426 ; Datta, 1974, *Oriental Ins.* **8** : 21.

Simulium dentatum Puri : Smart, 1945, *Trans. R. ent. Soc. Lond.*, **95** : 508.

Material examined : 2 pupae (in alcohol).

Distribution : INDIA : West Bengal and Meghalaya.

Remarks : Puri (1932b) described the species from the material collected from Bengal Terai and Kurseong in West Bengal and from Tura in Meghalaya, and the type is in the collection of the National Institute of Communicable Diseases, Delhi (Lewis, 1974). The author, while collecting simuliid specimens from Arunachal Pradesh, came across this species or its ally.

4. Simulium (Gomphostilbia) metatarsale Brunetti

Simulium metatarsalis Brunetti, 1911, *Rec. Indian Mus.*, **4** : 284 ; Smart, 1945, *Trans. R. ent. Soc. Lond.*, **95** : 509.

Simulium metatarsale Brunetti : Edwards, 1934, *Archiv. Hydrobiol. Suppl.*, **13** : 119.

Simulium (Gomphostilbia) metatarsale Brunetti : Crosskey, 1967, *J. nat. Hist.*, **1** : 38 ; Crosskey, 1973, *A Catalog of the Diptera of the Oriental Region*, **1** ; 425.

Material examined : 1 pupa (in alcohol).

Distribution : INDIA : West Bengal ; MALAYSIA and INDONESIA.

Remarks : Brunetti (1911) described the species from a single male specimen collected from Kurseong in West Bengal and deposited the type in the Indian Museum (the entire collection of which is now in the Zoological Survey of India, Calcutta). While dealing with the simuliids of the Darjeeling area, Datta (1973) left a mention that the type is in the collection of the Zoological Survey of India, on the basis of the literature. Despite careful searches in the depository, the author could not trace out the type material but the label of the type is still in the cabinet. It is, therefore, almost certain that the type has become lost.

5. Simulium (Gomphostilbia) tenuistylum Datta

Simulium (Gomphostilbia) tenuistylum Datta, 1973, *Oriental Ins.*, **7** : 377.

Material examined : 1 pupa and 1 larva (in alcohol).

Distribution : INDIA : West Bengal.

Remarks : This species was described by Datta (1973) from Darjeeling (West Bengal) and the type is now in the collection of the Zoological Survey of India. This species has not so far been recorded from far North-East India or other parts of India.

6. Simullum (Eusimulium) species D

Simulium (Eusimulium) species D, Datta, Dey and Paul, 1975, *Proc. Indian Acad. Sci.* (*B*), **82** : 97.

Material examined : 1 pupa and 2 larvae (in alcohol).

Distribution : INDIA : West Bengal.

Remarks : This species was reported by Datta *et al.* (1975) from Darjeeling (West Bengal). The description of the species will be possible only when reared adults, larvae and pupae are available for study and comparison with *Simulium (Eusimulium) praelargum* Datta with which it apparently resembles very closely.

Key to species of *Simulium* known from Sikkim

Since the Sikkimese simuliids are mainly known from the pupal stages, the following key is based only on pupae. The identity of other stages of these species can be confirmed by published descriptions of the authors cited in the text.

1.	Gill filaments 6	2
	—Gill filaments 8	5
2.	Abdominal segments 7 and 8 invariably with spine-combs dorsally ; cocoon without neck......	3
	—No spine-combs on segments 5-9 ; cocoon with neck.	*indicum*
3.	Gill as long as or longer than pupal body ; filaments gradually divergent	Species D
	—Gill shorter than pupal body ; filaments with convergent ends..	4
4.	Filaments of middle pair distinctly arising from common stalk of upper pair of filaments	*rufibasis*
	—Filaments of middle pair distinctly arising beside base of common stalk of upper pair of filaments	*himalayense*
5.	Gill filaments arranged in 2+2+2+2 ; cocoon closely woven and with large lateral aperture anteriorly	*dentatum*
	—Gill filaments arranged in 3+3+2 ; cocoon loosely woven but without large lateral aperture	6
6.	Petiole of dorsal triplet comparatively long	*metatarsale*
	—Petiole of dorsal triplet comparatively short	*tenuistylum*

ACKNOWLEDGEMENTS

The author is thankful to the Director, Zoological Survey of India, Calcutta, for allowing him to undertake the project and to Messrs. A. R. Bhowmik, Assistant Zoologist, and T. K. Pal, Research Fellow of the same Organisation for kindly collecting the material for studies.

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Bull. zool. Surv. India, 1 (3) : 257-261, 1978

TWO NEW SPECIES OF TUBULIFERA (THYSANOPTERA : PHLAEOTHRIPIDAE) FROM N. E. INDIA WITH THE DESCRIPTION OF A NEW SUBGENUS

N. MURALEEDHARAN AND S. SEN

Zoological Survey of India, Calcutta

ABSTRACT

A new subgenus *Inermothrips* under the genus *Crotonothrips* Ananthakrishnan and two new species *Crotonothrips* (*Inermothrips*) *cacharensis* and *Liothrips aberrans* are described from N. E. India.

Genus Crotonothrips Ananthakrishnan.

Crotonothrips Anantakrihshnan, 1967, *Oriental Ins.* 1 (1-2) : 189.

Phaeothrips Ananthakrishnan, 1969, *Senckenber. iena biol.*, 50 (3-4) : 189,

Crotonothrips Ananthakrishnan, 1976, *Oriental Ins.*, 10 (3) : 411,

Inermothrips Subgen. nov.

General taxonomic characters as in *Crotonothrips*. Foretarsi unarmed in both sexes. B_1-B_3 of abdominal segment IX of females almost subequal.

Type species : *Crotonothrips* (*Inermothrips*) *cacharensis* sp. n.

Ananthakrishnan (1976) revised the genus *Crotonothrips* and provided a key to the known species of the genus. The species described below was collected from Assam and forms the first record of this genus from North Eastern India, all the hitherto known species being reported from South India.

Crotonothrips (Inermothrips) cacharensis sp. n. (Fig. 1).

Female (*Macropterous*) : Body brown ; head, prothorax and abdominal segments V-IX and tube dark ; forefemora yellow, brown at base ; mid-and hind femora brown, yellow at apex, foretibiae yellow ; mid-and hind tibiae brown ; all tarsi light brown ; antennal segments I brown, yellow at extreme base ; II yellow, brown at base and margin ; III-IV yellow ; VII-VIII brown. All setae dark brown, blunt Wings, infumate.

Head broad, 180*—192 long, 188—200 wide across eyes, 220—232 across cheeks, 224—248 at base ; cheeks crenulate, slightly constricted at base, surface strongly reticulate. Eyes 72—80 long 60 wide all ocelli 24—28 wide, median ocellus over hanging

* All measurements in microns unless otherwise mentioned

at the base of antennae. Postoculars short, about half the length of eyes 48—52 long, blunt, placed 12—20 below posterior margin of eyes. Antennal segment III-VII pedicellate, VII-VIII forming a close unit ; length (width)—I : 40—44 (36—40) ; II : 52—60 (32—36) ; III : 60 - 64 (28—32) ; IV : 56—60 (36) ; V : 56—60 (32) ; VI : 52 (28—32) ; VII : 44—48 (24—28) ; VIII : (12—16) ; sense cones 28—36 long. Mouthcone broad 96—100 long, 140—144 wide at base, 92—96 at apex. Maxillary stylets oculad, very close at middle, maxillary guides distinct.

Prothorax about as long as head, 160—184 long, 260—280 wide at anterior margin, 360—400 at posterior margin. Pronotal chaetotaxy-anteroangulars 28—36 long, anteromarginals 20—28 long, midlaterals 36—48 long, postangulars 72 long, epimerals 100—112 long. Epimeral suture complete. Forefemora 84—100 wide, foretarsi with a hump. Pterothorax 380—400 long, 420—460 wide

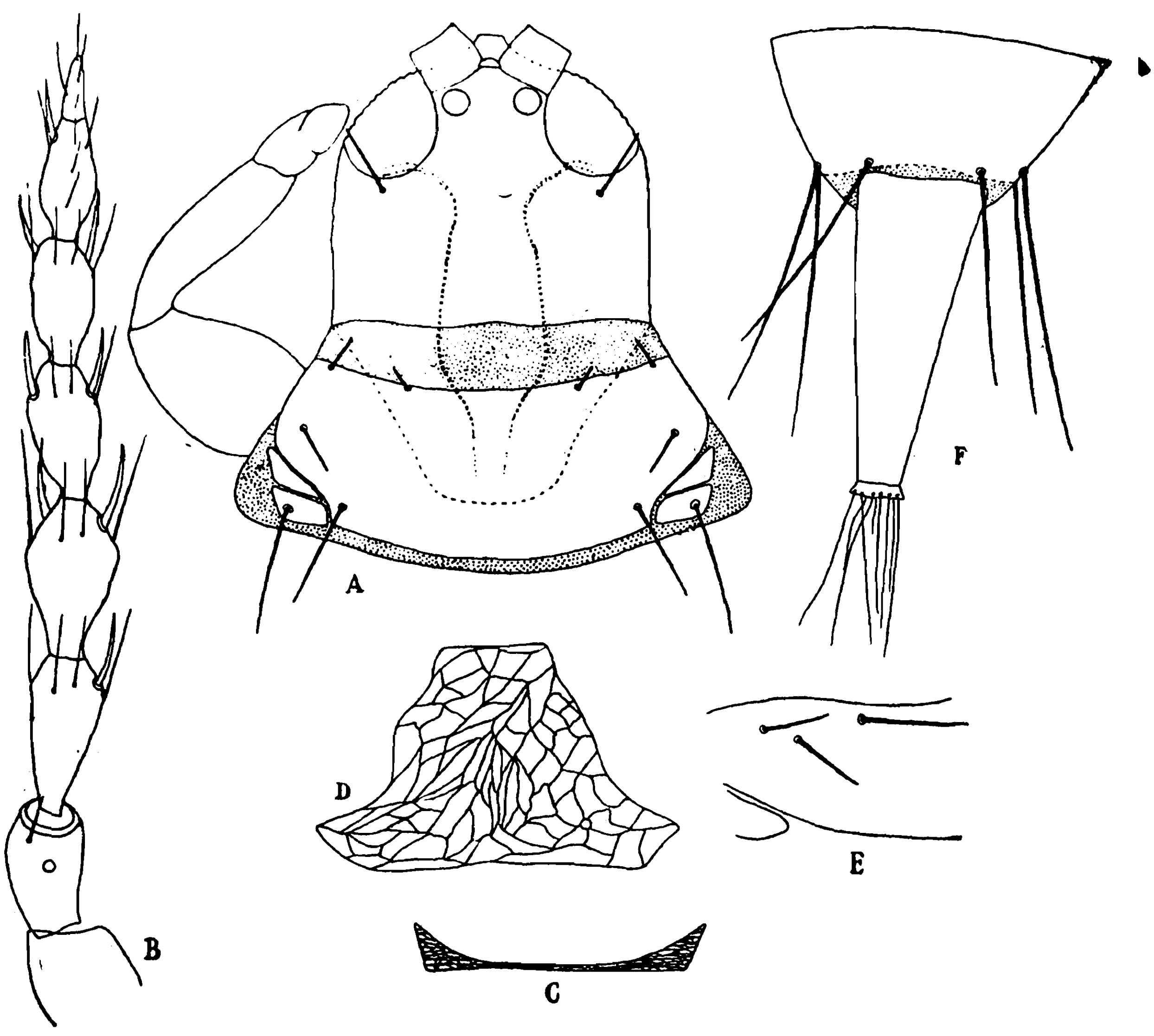

Fig. 1. *Crotonothrips* (*Inermothrips*) *cacharensis* ♀, A—Head and prothorax, B—Antenna, C—Pelta, D—Mesopraesternum, E—Basalwing bristles, F—Terminal abdominal segments.

across meso-and 412—448 across metathorax. Forewings broad, almost uniform wide 697—731 long, 76—96, wide with 6—7 double fringes, basal wing bristles 56 ; 60 ; 72 long respectively. Mesopraesternum complete, extremely thin at middle.

Abdomen 400—460 wide at base, 396—480 at middle, 300—340 across segment VIII, 160—232 across segment IX Petta roughly triangular. B_1—B_3 of segment IX : 120—144 ; 140—180 ; 184—200 long respectively. Tube 180—204 long, anal setae 108—120 long. Total body length 1.79-2.13 mm.

Male (Macropterous) : Colouration as in female. Head 176 long, 180 wide across eyes, 208 across cheeks, 216 across base. Eyes 72—76 long, 60 wide, postoculars 60 long. Antennal segments 1—8, length (width) —32 (36) ; 52 (32—36) ; 60 (28) ; 60 (32) ; 56 (28) ; 52 (24) ; 44 (24) ; 28 (16) ; sense cones 32—36 long. Mouthcone 140 long, 180 wide at base, 104 at apex.

Prothorax 160 long ; 272 wide at anterior margin ; 380 at posterior margin. Anteroangulars 28 long ; anteromarginals 16 long ; midlaterals 40 long ; postangulars 60 long ; epimerals 96 long. Forefemora 92 wide. Pterothorax 380 long, 428 wide across meso- and 400 across metathorax. Forewings 697—714 long ; 72—88 wide ; basal wing bristles 56 ; 64 and 72 long with 6—7 double fringes.

Abdomen 412 wide at base, 400 at middle, 252 across segment VIII, 160 across segment IX ; B_1—B_3 of segment IX—144, 84 and 208 long respectively. Tube 180 long, anal setae 100 long. Total body length—1·9 mm.

Holotype : ♀ (Z. S. I. Reg. No. 95/H17) ; allotype : ♂ (Z. S. I Reg. No. 96/H17) ; paratypes : 3 ♀♀ (Z. S. I. Reg. Nos. 97—99/H17) INDIA : Assam, Cachar Dist. Lohaiband 13. x. 1975, (*Dr. N. Muraleedharan*) Coll.) paratypes : 3 ♀♀ (Z. S. I. Reg. Nos. 100—102/H17) INDIA : Assam, Silchar, Cachar Dist. 1. x. 1975 (*Dr. N. Muraleedharan* Coll) deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

Liothrips aberrans sp. n. (Fig. 2)

Female Macropterous : Body brown ; head, prothorax, abdominal segments, tube and all femora brown ; foretibiae and all tarsi yellow ; hind and mid tibiae brown. Antennal segments I and II brown, III yellow, IV—VI yellow with apical half brownish, VII and VIII pale brown. All setae dark brown, roughly pointed. Wings transparent with a median brown streak. All major setae long and well developed.

Head long, 380—392 long, 268—280 wide across eyes, 272—292 wide across cheeks, 240—264 wide at base. Cheeks finely crenulate with one or two setae. Eyes 120 long, 80—96 wide, ocelli 28 wide. Postoculars, 104—112 long. Antennal segments elongate ; length (width) I 40—48 (56—60), II 72—84 (40), III 160 (36—40), IV 156—160 (44—48), V 128 (44), VI 100 (44), VII 80—84 (32—36), VIII 44—52 (16—20) ; Sense cones 32—40 long. Mouthcone pointed, 200—220 long, 232—256 wide at base and 80—120 wide at apex, Maxillary stylets oculad, close at middle.

Prothorax shorter than head, 200—252 long, 256—276 wide at anterior margin, 408—420 wide at posterior margin. Anteroangulars 92—96 long, anteromarginals 84—100 long, mid laterals 116—180 long, posrangulars 200—208 long, epimerals 180—212 long. Epimeral suture complete. Forefemora 344—380 long, 132—140 wide. Pterothorax 612—697 long, 629—680 wide across mesothorax and 595—646 wide across metathorax. Forewings 1.19—1.39 mm long, 140 wide with 13—18 double fringes ; basal wing bristles 148—160, 160—188, 156—180 long. Mesopraesternum, incomplete, and repre-

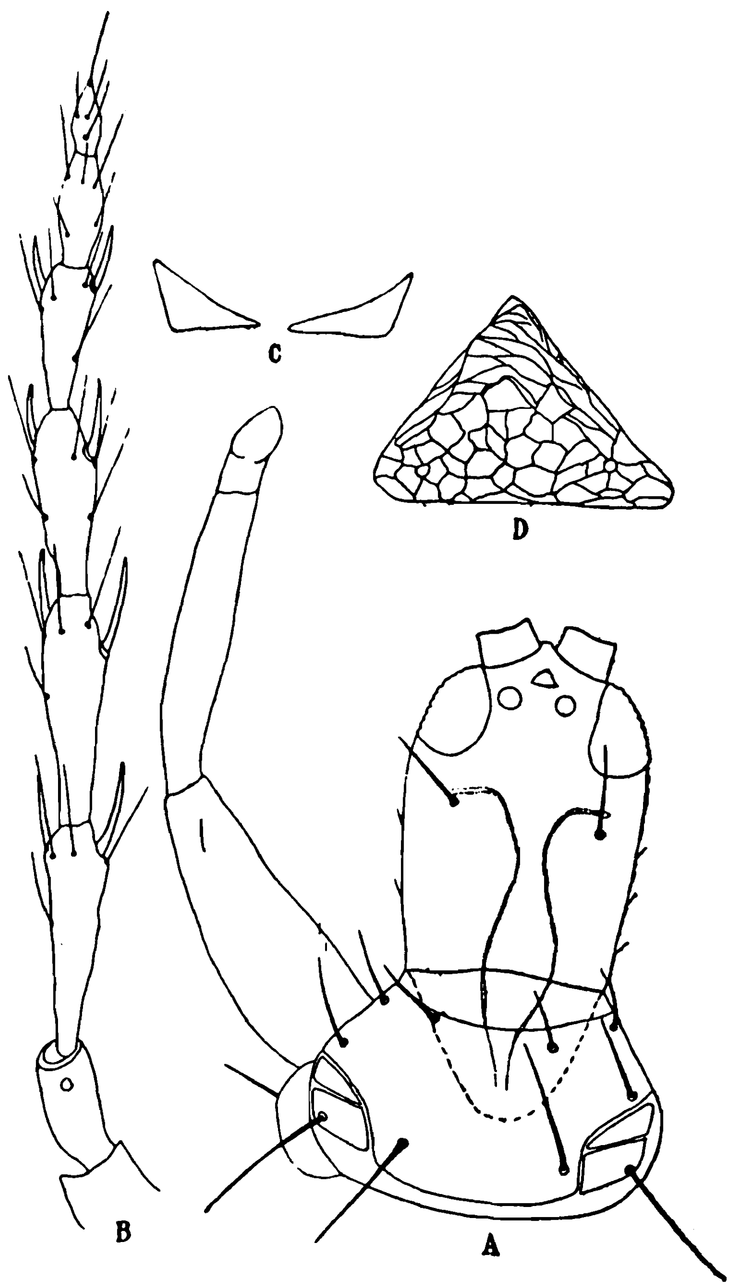

Fig. 2. *Liothrips aberrans*, ♀, A—Head and prothorax, B—Antenna, C—Pelta, D—Mesopraesternum.

sented as two triangular sclerites. Abdomen 595—680 wide at base, 578—629 at middle, 317—425 across VIII, 248—260 across segment IX. B_1—B_3 of segment IX, 190—200, 180—200, 180—200 long. Tube \ 340 long, Anal setae 220—240 long. Total body length 3.52—3·57 mm.

Male Macropterous : Colour as in female. Head 348—360 long, 252 wide across eyes, 252 across cheeks, 212—216 wide at base. Eyes 104 long and 80 wide ; Ocelli 24—28, wide. Postoculars 80—88 long. Antennal segments length (width) I 40 (48—56), II 60—80 (36), III 136—148 (32), IV 136—140 (40—44), V 100—112 (40), VI 88—100 (36), VII 72—76 (28—32) VIII 40 (16—20). Sense cones 32—40 long. Mouthcone 180—200 long, 212—228 wide at base and 92—100 wide at apex.

Prothorax 212—220 long, 228—260 wide at anterior margin, 340—400 wide at posterior margin. Anteroangulars 80—88, anteromarginals 80—88. midlaterals 120—140, postangulars 168—172, epimerals 164—176. Forefemora 320 long and 112—128 wide.

Pterothorax 544—595 long, 527—595 wide at meso and 510—561 at metathorax. Forewings long, 112—120 wide at middle and with 14 double fringes, Basal wing bristles 120 ; 160 ; 132 long respectively.

Abdomen 476—561 wide at base, 425—527 across middle, 289—?40 across VIII and 160—196 across segment IX B_1—B_3 of IX 148—200 ; 80—172 ; 260 long respectively Tube 320—360 long and anal setae 190—200 long.

Total body length 3.11—3.33 mm.

Holotype : ♀ (Z. S. I. Reg. No. 1/H17) ; allotype ♂ (Z. S. I. Reg. No. 2/H/17) ; paratypes : 2 ♀♀ (Z. S. I. Reg. Nos. 3—4/H17) INDIA : W. Bengal, Ghoombanjan, Darjeeling District 29. iv. 1976 (*A. R. Bhaumik and party* Coll.) paratypes : 1 ♂, 1 ♀ (Z. S. I. Reg. Nos. 5—6/H17) INDIA ;

W. Bengal, Dow Hills, Darjeeling District, 30. iv. 1976 (*A. R Bhanmik and party* Coll.) ; paratype : 1 ♀ (Z. S. I. Reg. No. 7/H17) INDIA : Sikkim, Phensong, near Gangtok. (*A. R. Bhaumik and party* Coll.), deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

This species is closely related to *Liothrips himalayanus* Ananthakrishnan and Jagadish but can be easily distinguished by the dark setae, shorter postoculars, well developed anteroangulars and anteromarginals and clear wings.

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We express our sincere gratitude to the Director, Zoological Survey of India, Calcutta for providing facilities to work, confirming the identity of the new taxa, going through the manuscript and offering valuable suggestions.

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THE COMPARATIVE ECOLOGY OF TWO SYMPATRIC SPECIES OF *OXYURICHTHYS* BLEEKER (PISCES : GOBIIDAE) FROM THE ENNORE ESTUARY, MADRAS

1. Length-weight relationsnip of *O. microlepis* (Bleeker) and *O. tentacularis* (Cuv. & Val.)

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ABSTRACT

Oxyurichthys microlepis (Bleeker) and *O. tentacularis* (Cuv. & Val.) co-exist in the shallow waters of the Ennore estuary. The length-weight relationship of *O. microlepis* and *O. tentacularis* during the period, 1975-76 were studied to find out whether the regressions differed between the two species and between the [sexes. The analysis indicated significant difference between the two species. The [regression coefficients of the two species were, however, found to conform to the cube law. The analysis showed no difference in the relationship betweeu the sexes and the prediction equation for both sexes combined are (Log W= —5.3133+3.024 Log L) and (Log W= —5.1910+ 2.9541 Log L) for *O. mircolepis* and *O. tentacularis* respectively.

INTRODUCTION

The length-weight relationships for *O. microlepis* and *O. tentacularis* of Ennore estuary has been worked out. It is generally accepted that the weight of fishes varies as cube of their lengths. Many species follow this condition. This view has a biological basis in that it represents an isometric growth. Nevertheless, deviations from the hypothetical value are not uncommon. In the case of the two species studied the regression coefficients were found to conform to the cube law but the rate of growth was different and the adult size varies between the species, which is considered as an important factor in the ecology of these species.

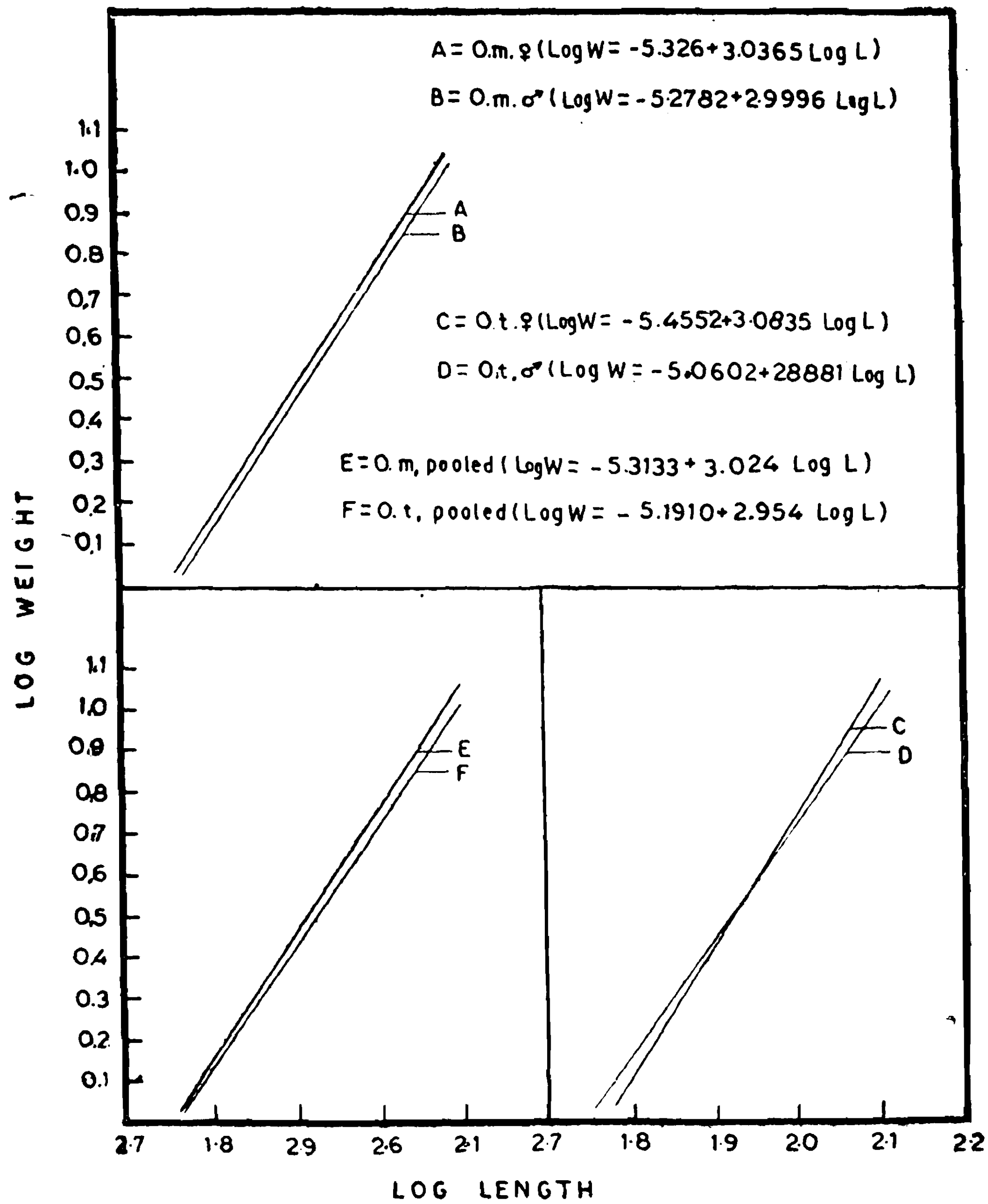
MATERIAL AND METHODS

Material for the present study was collected from the Ennore estuary during the years 1975 and 1976. 586 specimens of *O. microlepis* consisting of 413 females, 56·0 mm. to 125·0 mm. in T. L. and 173 males, 56.0 mm to 125.0 mm in T. L. and 153 specimens of *O. tentacularis* consisting of 111 females, 81·0 mm. to 145·0 mm. in T. L., and 42 males, 56·0 mm. to 145·0 mm. in T. L. were analysed with class interval of 5 mm. Total length was measured to the nearest mm. and weight to the nearest 0·01 gm. The length-weight data was analysed according to Le Cren (1951). The length-weight relationship can be expressed by the formula $W = aL^b$ of Log W =log a + b log L, where W = weight, L = length and a and b are constants which were calculated by the method of least squares. The length-weight regressions for the different sexes and species were tested by the method of analysis of co-variance and the t-test (Snedecor, 1961) was used to test whether the regression coefficient was significantly different from the cube law.

RESULTS

The length-weight relationships obtained are given in Table 1. The data of the length-weight relationship for male and female *O. microlepis* and *O. tentacularis* analysed to test the significance of variations between the regression coefficients (b) showed that between the sexes the regression coefficients are not significant at 5% level of significance. Hence a length-weight equation common to both sexes is justified as follows.

$$\text{Log } W = -5{\cdot}3133 + 3{\cdot}024 \text{ Log } L$$



and Log W = − 5·1910 + 2·9541 Log L for *O. microlepis* and *O. tentacularis* respectively. Between the two species the regression coefficients were significant at 5% level of significance showing a difference in growth rate between the two species *O. microlepis* being more robust than *O. tentacularis* of the same length (Fig. 1 E & F). The statistical analyses are given in Table 2. Within *O. tentacularis* the female is lighter than the male when small and as it matures it becomes heavier than male, the point of intersection being the length at which the female matures. (Fig. 1 C & D)

The extent of association of length and weight was again gauged from the coefficient of correlation (r) (Table 1). In *O. microlepis* female r = 0·9098 (d. f. 12, r 5% = 0·532 and r 1% = 0·661) in *O. microlepis* male r = 0·9067 (d. f. 12, r 5% = 0·532 and r 1% = 0·661), in *O. tentacularis* female r = 0·9749 (d. f. 11. r 5% = 0·553 and r 1% = 0·684) and in *O. tentacularis* male r = 0·9340 (d. f. 15, r 5% = 0·482 and r 1% = 0·606). This shows that in both the sexes of the two species, r is significant and hence a perfect relationship exists between the length and weight.

With a view to see whether the regression coefficient (b) differs from 3, the 't' test was employed. In *O. microlepis* t is found to be 0·6046 (d. f. 12, t 1% = 3·055, t 5% =

TABLE 1. Regression equations for Length-weight relationship

SOURCE		EQUATION	r
A. *O. microlepis*	♀	Log W= −5.326+3.0365 Log L	0.91
B. *O. microlepis*	♂	Log W= −5.2782+2.9996 Log L	0.91
C. Pooled		Log W= −5.3133+3.024 Log L	0.91
D. *O. tentacularis*	♀	Log W= −5.4552+3.0835 Log L	0.97
E. *O. tentacularis*	♂	Log W= −5.0602+2.8881 Log L	0.93
F. Pooled		Log W= −5.1910+2.9541 Log L	0.93

TABLE 2. Comparison of the regression lines

SOURCE	d. f.	S x^2	S xy	S y^2	Deviation from Regression Sum of Squares	Mean Sum of Squares	d. f.
A	13	0.1397	0.4245	1.2871	0.0024	0.000199	12
B	13	0.1355	0.4077	1.2248	0.0018	0.000146	12
C	13	0.1375	0.4158	1.2547	0.0029	0.00021	12
D	12	0.0706	0.2177	0.6854	0.0142	0.00129	11
E	16	0.2057	0.5941	1.7226	0.0068	0.00045	15
F	16	0.2071	0.6118	1.8093	0.0021	0.000138	15

2·179) and in *O. tentacularis* t is 1·6326 (d. f. 15, t 1% = 2.947, t 5% = 2·131). Thus in both the species the length-weight relationship does not differ from 3, indicating thereby that they strictly follow the cube law. However, there is difference in growth rate between the species as shown by the increased regression coefficient in *O. microlepis*. The adult size varies between the species 125·0 mm. and 145·0 mm. being the maximum sizes observed in *O. microlepis* and *O. tentacularis* respectively. The b values in the females of both the species are slightly higher than the males and may be attributed to the unisometric growth of their ovaries during maturation.

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Bull. zool. Surv. India, 1 (3) : 267-269, 1978

A NEW SPECIES OF *LASIOCHILUS* REUTER (HETEROPTERA : ANTHOCORIDAE) FROM INDIA

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ABSTRACT

The genus *Lasiochilus* Reuter is recorded for the first time from the Indian mainland and a new species, *Lasiochilus indicus*, is described.

The subfamily Lasiochilinae Carayon (1972), recognised to be the most premitive of anthocorids, is characterised by the metathoracic scent gland canal curved backwards, second and third antennal segments with long setae, surface of pronotum and margins of hemelytra closely packed with setae, hamus arising from m-cu and split of the abdominal segment not extending beyond second tergite. This subfamily is not well represented in India with the exception of *Lasiochilus corticus* Reuter, reported from Nicobar Island (Distant, 1910). During the present investigation on Indian anthocorids the author has come across an interesting new species of *Lasiochilus* and this forms the first record of this genus from the Indian mainland.

Genus **Lasiochilus** Reuter

Lasiochilus Reuter, 1871, *Ofvers. K. Vetensk Akad. Forh.*, 5 ; 562. Type species : *Lasiochilus pallidulus* Reuter

Body longly pilose. Head with apex produced and rostrum reaching intermediate coxae. Antennae long and pilose ; first segment reaching apex of head, second incrassate at apex, remaining segments slender and filiform. Anterior margin of pronotum with collar well developed, basal margin slightly concave, lateral margins straight and densely setose. Ostiolar canal backwardly directed. Hemelytra covering abdomen ; longly pilose. Ovipositor well developed.

Lasiochilus indicus sp. nov.

(Fig. 1)

Colour : General body colour dark. Head, pronotum and scutellum brown ; rostrum yellowish brown, antennal segments I and II brown, III brown at base and yellow at apex, IV pale yellow. Embolium, cuneus, inner margin of clavus and corium brown, rest pale brown , membrane clouded. Legs yellowish brown. *Structure :* Body hirsute ; head almost as long as wide ; ocelli situated near posterior margin of eyes. Rostrum reaching base of midcoxae. Eyes with setae. Antero-lateral margins of pronotum broadly rounded and posterior margin a little concave. Ostiolar canal backwardly directed. Fore and hindfemora, a little incrassate, midfemora not thickened ;

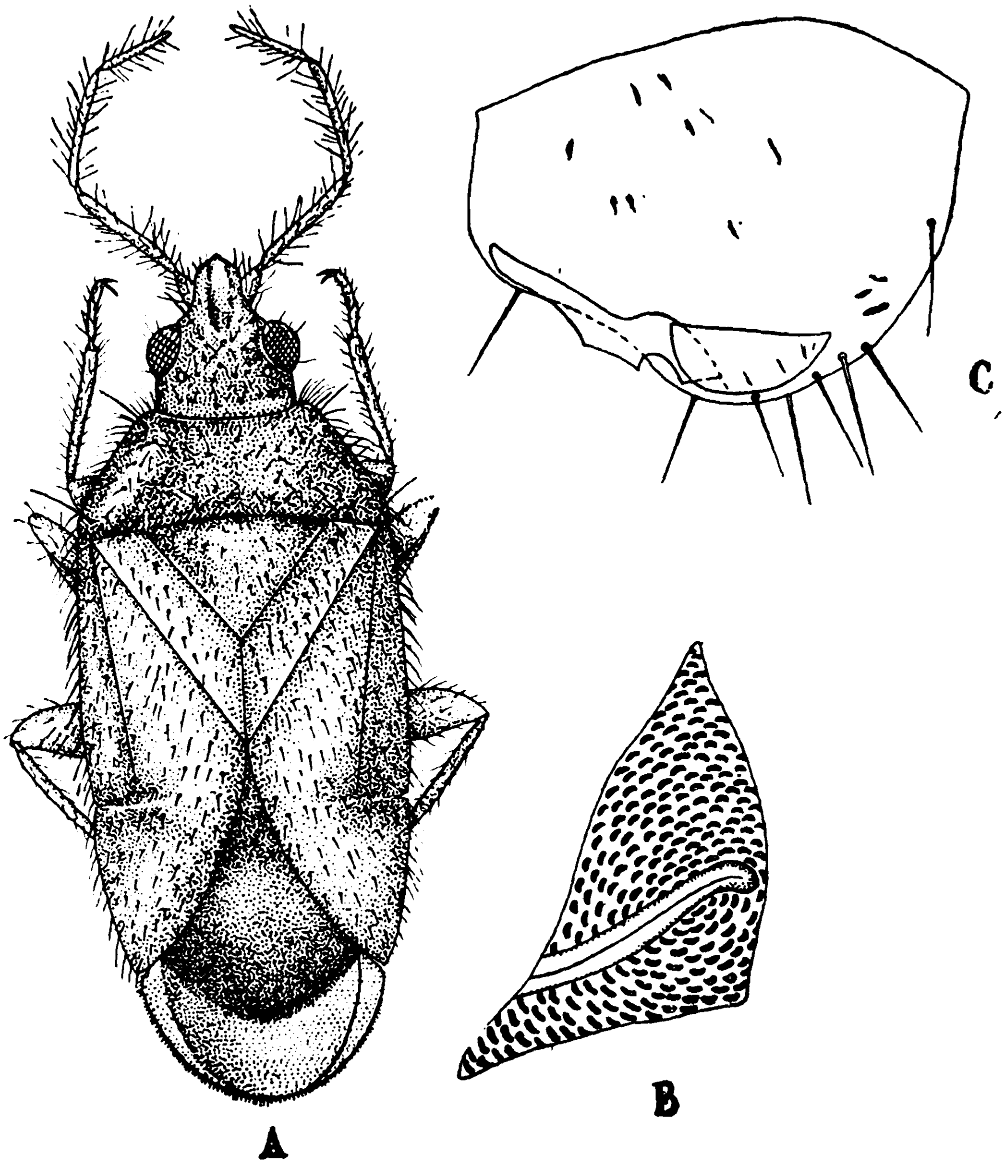

Fig. 1. *Lasiochilus indicus* sp. nov. A—Adult female, B—Metathoracic scent gland, C—Abdominal apex of male showing paramere.

6

tibiae with strong spines and fore-tibiae with a setal cushion. Abdominal apex with long bristles. Genital clasper of male simple. Phallus very long and thorny.

Measurements in mm.	♂	♀
Total length of body	1.52	1.53—1.58
Length of head	0.31	0 33—0.35
Width across eyes	0.28	0.31—0.38
Length of rostrum	0.72	0.75—0.77
Length of antennal segment I	0.10	0.10—0.12
do II	0.26	0.26—0.28
do III	0.22	0.25
do IV	0.22	0.25
Length of pronotum	0.20	0.25
Width of pronotum along posterior margin	0.55	0.57

Holotype : ♂ (Reg. No. 378/H 15) on slide, INDIA : Tamil Nadu, Madras 10.1.1972, Coll. *Muraleedharan*, Paratypes : 5 ♀ ♀ (Reg. No. 379/H 15) in spirit, data same for holotype.

The species, resembles *Lasiochilus perminutus* Poppius (1909) in general appearance but the presence of setae on eyes and nature of male genitalia make this species distinct.

ACKNOWLEDGEMENTS

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Bull. zool. Surv. India, 1 (3) : 271-274, 1978

ON A NEW SPECIES OF *HESIONIDES* (POLYCHAETA : HESIONIDAE) FROM ORISSA COAST, INDIA

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ABSTRACT

A new species of the mesopsammic polychaete genus *Hesionides* collected in the intertidal sands on Orissa coast (Bay of Bengal), is described under the name *H. similis*. The new species is closely related to *H. peculiaris* Westheide and Rao, but clearly differs from it in morphological details.

INTRODUCTION

Species of the interesting mesopsammic genus *Hesionides* Friedrich form characteristic inhabitants of intertidal zone and recent investigations on different coasts revealed their worldwide distribution in tropical and subtropical beaches. Until now, four species of the genus, *viz.*, *H. arenaria* Friedrich, *H. gohari* Hartmann-Schroder, *H. maxima* Westheide, and *H. unilamellata* Westheide, are known to occur on the coasts of Europe and Galapagos Islands. Two of these species, *viz.*, *H. arenaria* and *H. gohari* are known to have a wide geographical distribution (Westheide, 1971) and were also recorded on the Indian coast (Rao and Ganapati, 1967). Recent faunistic investigations undertaken by the Zoological Survey of India on the Indian east coast revealed the presence of three new species, *viz.*, *H. minima* Westheide and Rao, *H. peculiaris* Westheide and Rao, *H. indooceanica* Westheide and Rao, in addition to the two known species already recorded on Indian coast. These studies indicated the Indian sandy beaches to support more species of this genus than in the mesopsammon of any other faunistic region hitherto explored. An examination of the living collections of interstitial meiofauna made by the author during January 1977 from the intertidal sands on Orissa coast showed the presence of yet another new species of the genus *Hesionides*, which is described here under the name *H. similis*.

SYSTEMATIC ACCOUNT

Order : ERRANTIA
Family : HESIONIDAE
Genus : **Hesionides** Friedrich, 1937
Hesionides similis sp. n. (Fig. 1. A-J)

Material: Three specimens collected by the author on 31 January 1977 in coarse and medium sands 10 cm below surface between low and half-tide levels of the intertidal zone, Gopalpur Beach (19° 15′ 12″ N and 84° 53′ 20″ E), Orissa coast, India. Holotype, one specimen with a length of 1.2 mm and 23 body segments, deposited in the National Zoological Collections at the Zoolc-gical Survey of India, Calcutta, Regd. No. An 921/1.

Description

Small, active and contractile worms, with an elongate and compact body. Whitish-green in colour and without pigmentation. Total body length ranges between 1.0 mm (with 18 setigers) and 1.2 mm (with 23 setigers). Maximum width without parapodia varies between from 60 μm to 90 μm. Body tapers posteriorly. Anterior end with 11 appendages characteristic of the genus (Fig. 1. A). Dorsal and ventral tentacles directed forward, nearly equal in length and measure about 40 μm. Median tentacle occurs at the level of second tentacular cirri and about 65-70 μm long, projecting well beyond anterior extremity of head. Three pairs of tentacular cirri nearly laterally directed and their length progressively increases from the first (65 μm) to the third (100 μm). Tentacles with distinct knot-shaped swellings. Tentacular cirri with indistinct swellings. Tentacles and tentacular cirri distinctly broad at their bases and taper towards their tips.

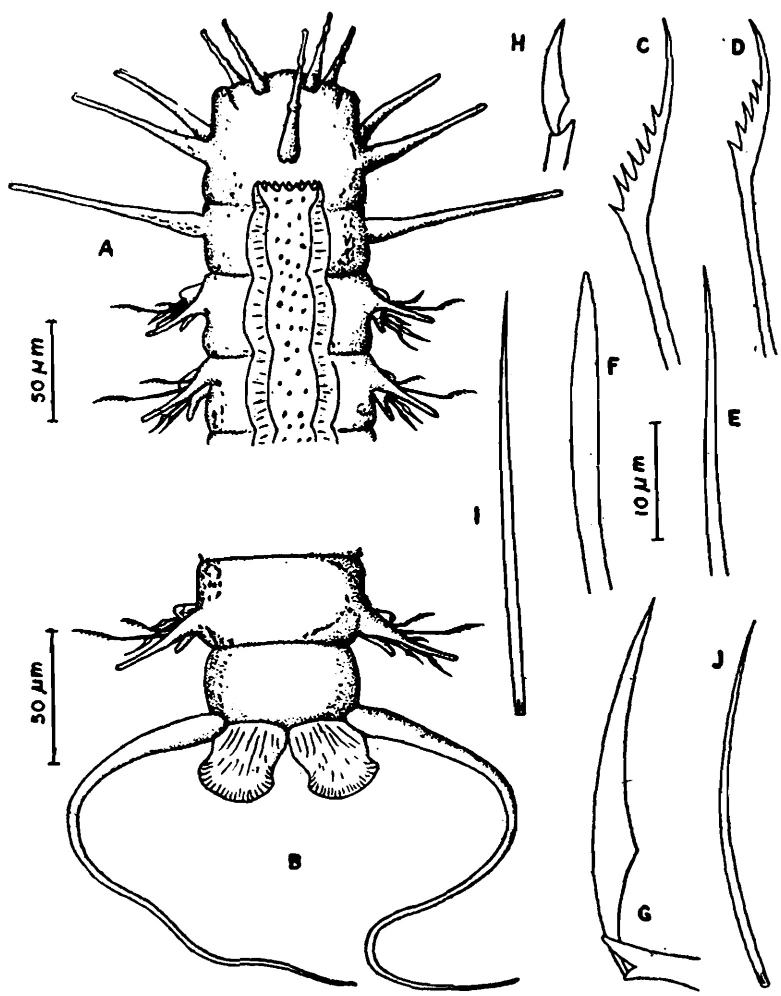

Fig. 1, A-J. *Hesionides similis* sp. n. A. Anterior end, dorsal view ; B. Posterior end, dorsal view ; C. Distal part of long notoseta ; D. Distal part of short notoseta ; E. Aciculum of notopodium on 3rd setiger ; F. Aciculum of notopodium on 13th setiger ; G. Distal part of large neuroseta ; H. Distal part of small neuroseta ; I—J. Acicula of neuropodium.

Setigerous segments distinctly separated, wider than long and narrowed towards caudal region. Few setigers of middle body region longer than wide. Biramous parapodia stand erect slightly above body stem. Notopodia with dorsal cirri 25-35 µm long, with indistinct knot-shaped swellings. Two simple notosetae of different length are widely streched out, the longer one extending well beyond dorsal cirrus. Notosetae sharply bent in subdistal part ; the longer one with 7 distinct, closely separated saw-shaped teeth and the shorter one with 5 similar teeth. Both the setae distally pointed (Fig. 1, C-D). Notopodium with one fine tapering aciculum in first four segments (Fig. 1, E) ; the acicula strikingly larger from fifth setiger onwards (Fig. 1, F). Neuropodia nearly rectangular, with short and slightly bent cirri. Mostly 5 compound neurosetae present, with slightly curved, unidentate terminal blades of variable length ; two of the setae with large blades (Fig. 1, G) and three with small blades (Fig. 1, H). Neuropodium with two slender tapering acicula, one of them being fine and slightly bent (Fig. 1, I-J).

Pygidium with two distinctly separated, nearly square-shaped anal lamellae, about 30 × 25 µm in size and distally broadened into semicircular lappets with openings of adhesive glands (Fig. 1, B). Two divergent thread-like anal cirri about 260 µm. long, swollen at their bases and taper towards their tips.

In internal organization, pharynx has three folds extending from behind median tentacle up to third setigerous segment. Anteriorly, pharynx terminates with 12 tapering papillae. Sexes separate. Female with oocytes extending from seventh setiger nearly up to last segments. Each oocyte attains about 35-40 µm in diameter. Male with thread-like sperm ; paired vesiculae occur in fourth setigerous segment. Openings of male genital ducts occur just in front of median tentacle at anterior end.

REMARKS

Of the seven species of the genus *Hesionides* hitherto known, the new species *H. similis* Rao shows close resemblance to *H. peculiaris* Westheide and Rao in general organization, particularly in the structure of sharply bent notosetae characteristic of the latter. But *H. similis* clearly differs from *H. peculiaris* in the following characters : body size and number of segments, colouration, disposition of ventral pair of tentacles, relative size of cephalic appendages, dentation of parapodial setae, structure of acicula and shape of anal lammellae.

The specific name of the new species refers to the similar characters it shares with *H. peculiaris.*

ECOLOGICAL NOTES

The polychaetes were collected in coarse and medium sands with little detritus and fine shell gravel 10 cm below surface between low and half-tide levels of the intertidal zone. The sands are silicious, subangular and their texture ranged between 300 and 600 µm in mean diameter. At the time of collection, temperature in the habitat was read 27°C, while the salinity of interstitial water varied between 31 and 32%. The interstitial animal community collected in association with these worms included all the typical inhabitants of this biotope, as Ciliata, Turbellaria, Nematoda, Gastrotricha, Archiannelida, Polychaeta, Oligochaeta, Copepoda and Isopoda.

ACKNOWLEDGEMENTS

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Bull. zool. Surv. India, **1** (3) : 275-277, 1978

ON A NEW SPECIES OF SILVER-BELLY, *LEIOGNATHUS INDICUS* PISCES : LEIOGNATHIDAE [FROM THE BAY OF BENGAL]

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ABSTRACT

A new species of silver-belly, *Leiognathus indicus*, is described from the Bay of Bengal and its affinities with related forms in the Indo-Pacific region discussed.

INTRODUCTION

The fishes of the family Leiognathidae, popularly called silver-bellies, have gained importance in recent years in India due to their steady rise in the commercial catches. It is now known that thirteen species of *Leiognathus* Lacépède inhabit the seas around India (Day, 1889 ; Weber and de Beaufort, 1931 ; James, 1969, 1971, 1978 ; Fischer and Whitehead, 1974). During the course of studies on the fishes of the family Leiognathidae from Indian waters, an undescribed species of *Leiognathus* was discovered in the recent collection from Puri (Orissa). In the present communication the new species of *Leiognathus* is described and its relationship with allied species discussed.

SYSTEMATIC ACCOUNT

Leiognathus indicus sp. nov.
[Fig. 1]

Material : Holotype (Fig. 1) : 89 mm in standard length, Puri (Orissa), 21 January 1977 ; coll. *Rani Singh ;* ZSI Regd. No. F. 7363/2.

Paratypes : (i) 7 ex., 64—89 mm standard length, collected with the holotype ; ZSI Regd. No. F. 7364/2. (ii) 1 ex., 71 mm standard length, Rangat (North Andaman Is.), 3 February 1970, coll. *A. G. K. Menon ;* ZSI Regd. No. F. 7365/2.

Description : Based on the holotype and eight paratypes. Meristic counts and morphometric measurements are presented in the table.

Body compressed and rather deep ; dorsal profile slightly more convex than ventral profile. Mouth small, horizontal, when protracted forms a tube directed downward ; gape of mouth below lower edge of eye. Snout obtuse, shorter than eye diameter. Maxilla extending to vertical from anterior margin of the pupil. Mandibular profile slightly concave. Preopercle with an obtuse angle, its lower edge and ridge denticulated. Interorbital space flat, its width equal to eye

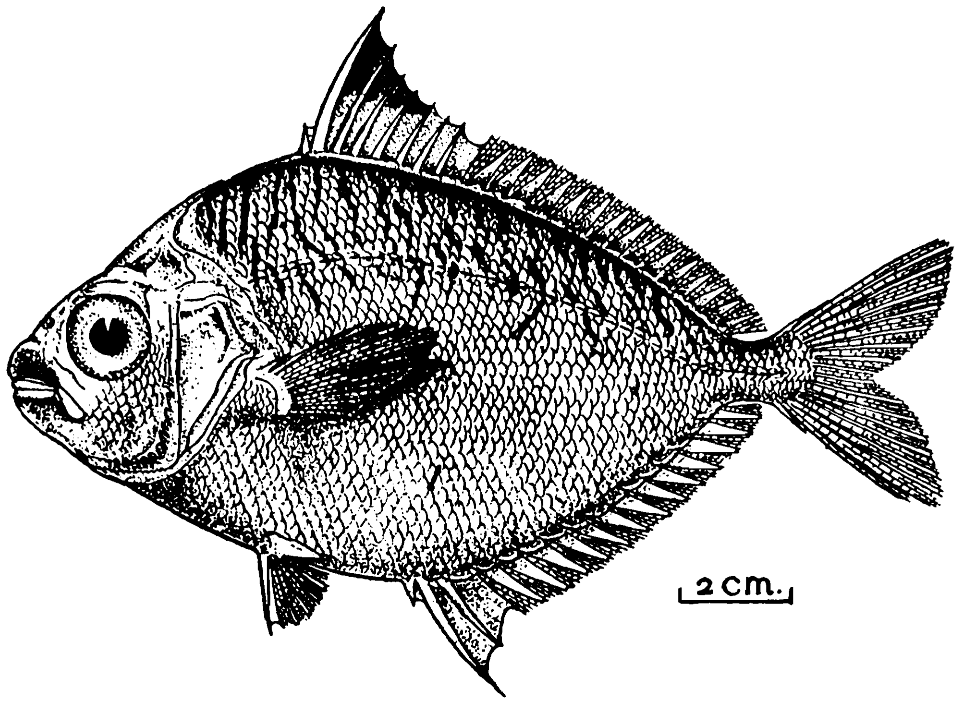

Fig. 1. Holotype of *Leiognathus indicus* Rani Singh & Talwar.

diameter, bounded by two ridges which continue posteriorly as outer edges of the nuchal spine ; a small ridge encircles the anterior end of the nuchal spine and joins posteriorly with the outer ridge on either side. A pair of spines present opposite front border of eye, the outer more prominent than the inner ; supraorbital edge serrated. Cleithrum, supracleithrum and extrascapular denticulated. Gill-rakers lanceolate, each with double row of serrae. Teeth villiform, in a single row in both jaws ; no teeth on vomer, palatines and tongue.

Dorsal and anal fin spines weak ; second dorsal fin spine 2.0—2.2 in height of body ; third and fourth dorsal fin spines, and third anal fin spine denticulated anteriorly in their lower half. Pectoral fin shorter than length of head ; pelvic fins not reaching to anal fin origin. Caudal fin forked, lobes rounded.

Head naked but cheeks with 5 rows of minute, thin scales (not clearly discernible with naked eye). Scales on body small, cycloid ; scales on breast very thin and deciduous. Scales in the lateral series 41 to 48 ; transverse rows 8-9 / 18-20. Lateral line extends to base of caudal fin.

Colour : in alcohol, light brown with close-set grey zig-zag marks over upper half of body ; snout dusky. A black blotch on upper third of spinous dorsal fin between second and sixth spines.

Affinities

The present new species is characterised by the presence of scales on the cheeks. Only two species of *Leiognathus* from the Indo-Pacific region are reported in the literature with scales on the cheeks : *L. elongatus* (Gunther 1874) and *L. rapsoni* Munro, 1964. The new species may be easily distinguished from the former species in having a much deeper body, its depth about two (*vs.* five) times in standard length and in the presence (*vs.* absence) of a conspicuous black blotch on spinous dorsal fin. From *Leiogna-*

TABLE 1.—Selected meristic counts and measurements (in mm) of holotype and paratypes of *Leiognathus indicus*.

	Holotype Regd. No. F 7363/2				Paratypes Regd. No. F 7364/2				Regd. No. F7365/2
Dorsal f. r.	VIII 16	VIII 16	VIII 16	VIII 16	VIII 16	VIII 16	VIII 16	VIII 16	VIII 16
Anal f. r.	III 14	III 14	III 14	III 14	III 14	III 14	III 14	III 14	III 14
Gill-rakers on first arch	4+18	5+19	5+18	5+19	4+18	5+19	5+19	4+19	4+18
Standard length	89.0	64.0	77.0	83.0	67.0	73.0	72.0	72.5	71.0
Body depth	46.0	34.0	39.0	41.0	34.0	36.0	37.0	37.0	36.0
Head length	29.0	20.0	23.5	26.0	20.0	22.0	22.0	22.0	20.5
Eyediameter	10.0	8.5	9.5	10.0	8.0	9.0	8.0	8.5	8.5
Snout length	9.0	7.0	7.0	8.0	6.0	6.0	7.0	6.5	6.0
Pectoral fin length	22.0	16.5	20.0	21.0	17.0	18.0	—	18.0	17.0
Length of 2nd dorsal fin spine	21.0	15.0	18.0	20.0	17.0	17.0	17.0	17.0	17.0
Length of 2nd anal fin spine	18.0	13.5	16.0	17.0	15.0	15.0	15.0	14.0	14.0

thus rapsoni Munro it may be separated in having lesser number of gill-rakers (18 to 19 *vs.* 21 to 23) on lower arm of first arch and the second anal fin spine 2.1—2.5 (*vs.* 2.7—2.9) in body depth.

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ADAPTIVE RADIATION IN THE MASTACEMBELOID FISHES

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ABSTRACT

The modifications of various characters such as body, head, scales, spines snout, jaws, pectoral girdle, caudal fin skeleton, vertebrae and alimentary canal have been traced in the three families of mastacembeloid fishes namely, Mastacembelidae, Pillaiidae and Chaudhuriidae. It is concluded that all these families constitute a homogeneous group and have evolved from some perciform fish, sharing most of the characters of Mastacembelidae (spring eels) in adaptation to different modes of living. Pillaiidae forms a link between Mastacembelidae and Chaudhuriidae, the latter, the extremely specialised fish, probably evolved through stages resembling Pillaiidae.

INTRODUCTION

Though appreciating the basic common characters between Mastacembelidae (Spiny eels) and Chaudhuriidae, Berg (1940) recognised two separate orders Mastacembeliformes and Chaudhuriiformes, respectively. Greenwood, Rosen, Weitzman and Myers (1966), however, grouped these families under the suborder Mastacembeloidei of the order perciformes. Yazdani (1976) created the family Pillaiidae for the genus *Pillaia* Yazdani and placed it under the suborder Mastacembeloidei.

The mastacembeloid fishes offer an exceptional opportunity for studying the adaptive radiation. They form a homogeneous group which is characterised by their eel-like body, non-protractile upper jaw, absence of pelvic girdle and fin, pectoral girdle attached to the vertebral column, short pectoral fin, elongated skull which gradually narrows anteriorly, large nasals, frontal and infraorbitals, small lateral ethmoid, and swim-bladder without an open duct. Among them, Mastacembelidae contains two genera, *Mastacembelus* and *Macrognathus* and Chaudhuriidae and Pillaiidae each contains single genus, *Chaudhuria* and *Pillaia*, respectively. Mastacembelidae occurs both in the Oriental and Ethiopian regions whereas Chaudhuriidae is restricted in distribution to the Inlé Lake, Upper Burma at an altitude of 3,000 ft. (See Annandale, 1918), and Pillaiidae to the Khasi Hills at an altitude of 3,500 ft. (See Yazdani, 1972, 1976) and plains of Assam in India (See Talwar, Yazdani and Kundu, 1977).

Both Pillaiidae and Chaudhuriidae can be distinguished from Mastacembelidae by the absence of spines before dorsal and anal fins, absence of scales and fleshy rostral appendage, and caudal fin lacking branched rays. Pillaiidae can be further distinguished from Chaudhuriidae by the caudal having 8-12 rays, which is united with the dorsal and anal and presence of a very indistinct fleshy rostral process.

MATERIAL and METHOD

The morphology of the following species has been studied. The classification of species followed is that of Greenwood, Rosen Weitzman & Myers (1966).

MASTACEMBELIDAE	*Mastacembelus armatus* Lacépède
PILLAIIDAE	*Pillaia indica* Yazdani *Pillaia khajuriai* Talwar, Yazdani and Kundu.
CHAUDHURIIDAE	*Chaudhuria caudata* Annandale

The various characters of *M. armatus* and *P. indica* have been studied by dissecting specimens as well as by examining alizarin preparations. The type-specimens of *C. caudata* and *P. khajuriai* which is the only material of these species available at the Zoological Survey of India, Calcutta, have been examined. For comparison with the members of other families, informations about various characters of *Chaudhuria caudata*, the only known species of the Chaudhuriidae, have been taken from published work.

The main outlines of most of the figures have been drawn free hand.

NATURAL HISTORY

A brief account of the natural history of mastacembeloid fishes is given below :

The spiny eels (*Mastacembelidae*) : The spiny eels occur in plains as well as at high altitudes, in running and still waters, clear or muddy, usually hiding in crevices of rocks or among vegetation near the bank.

Sundar Raj (1916, p. 289) and Job (1941, p. 130) have observed that in an aquarium *Macrognathus aculeatus* and *Mastacembelus pancalus* both lie buried in the mud or sand during the day, while at night they swim about freely. Job (*op. cit*) says the following about the burrowing habits of *M. pancalus* : "The fish glides about the bottom nosing the substratum with its mobile, trilobed sensitive snout and selecting a suitable spot, wriggles itself into the substratum by a brisk side to side and forward movement until most of the body and tail are concealed. sometimes the tail sticks out as also the tip of the head". Deraniyagala (1932, p. 269) has made the following observations regarding the use of spines by *Mastacembelus armatus* for defensive purpose : "When held in the hand the fish wriggles backward and its short dorsal spines act like the teeth of saw inflicting a nasty slash in the palm of the inexperienced fishermen".

The food and feeding behaviour of these fishes is not properly known. However, the gut contents of some of these fishes have been found to contain eggs and fry of other fishes (Hamid Khan, 1934, p. 268), crustaceans, larvae of insects, coleopterans (Job, 1941, p. 131). These food items clearly suggest that the spiny eels are carnivorous.

These fishes grow to a large size. *Mastacembelus armatus* is said to grow to 3 ft. (Job, 1941).

The Indian eel-like fish (*Pillaiidae*) : I have observed the habits of *Pillaia indica* both in an aquarium and in its natural habitat. This little fish is very inactive and mostly spends its time lying at the bottom either buried in mud or clinging to some submerge vegetation along the edges of streams which have over-hanging vegetation (Fig. 1). It appears to have a very narrow range of habitat preference, and even in the same stream it occurs only in certain areas near the edge where the bottom contains a very fine mud. It is only found in those areas of the stream where the water is moving very slowly. Its ecological niche is so restricted that no other fish has generally been collected with it. It avoids light and tries to hide into the mud. It has been reported by *Khasi* people that this fish is also found in the paddy field (adjoining the streams) during the rainy season. Its swimming and crawling movements resemble those of the anguilliform fishes. It appears to be a hardy fish as I was able to bring by train a live specimen to Poona from the Khasi Hill, keeping it in a big jar containing water, a little mud at the bottom and a few aquatic plants.

P. indica does not seem to search for its food. It catches the moving food and gulps it while entangling itself to some submerged vegetation in the stream. The gut contents of this fish have been found to contain parts of mayfly (Ephemeroptera) naiads, parts of other insects and spores. This suggests that *P. indica* is also a carnivorous fish.

Pillaia khajuriai, the only other species in the family Pillaiidae, has been found to occur in the paddy fields of Garo Hills (Meghalaya) and in the Kaziranga Wild Life Sanctuary (Assam) which is situated on the southern bank of R. Brahmaputra, very close to Mikir Hills. The close resemblance

Fig. 1. A sketch of the habitat of *Pillaia indica* showing its way of life.

of *P. khajuriai* with *P. indica* suggests that it perhaps shares the habits of the latter.

Both *P. indica* and *P. khajuriai* do not grow to a large size : the mature specimens of *P. indica* range between 37—77 mm. in length, whereas the specimens of *P khajuriai*, so far available. vary in length from 57.0 86 mm.

The Burmese eel-like fish (*Chaudhuriidae*) : *Chaudhuria caudata* appears to be a high altitude species, for, it is so far restricted in distribution to Inlé Lake and a stream in Upper Burma. Its habits are unknown. However, Annandale (1918) stated that these fish were obtained in fishing baskets filled with peat and weeds and sunk in the Inlé Lake and also from dense vegetation at the edge of floating islands. This clearly suggests that *C. caudata* is a bottom dweller and perhaps hides under vegetation etc. Annandale (*op. cit*) also found that the stomach of a specimen of *C. caudata* was full of young crustaceans. This suggests that it is a carnivorous fish and perhaps moves around in search for food. The occurrence of *C. caudata* in the floating islands as well as at the bottom of the lake (see Annandale *op. cit*) clearly indicates that it is an active fish which swims around in search for food etc.

C. caudata does not grow to a large size : the largest mature specimen known so far is 52.0 mm. in total length (Annandale, *op. cit.*).

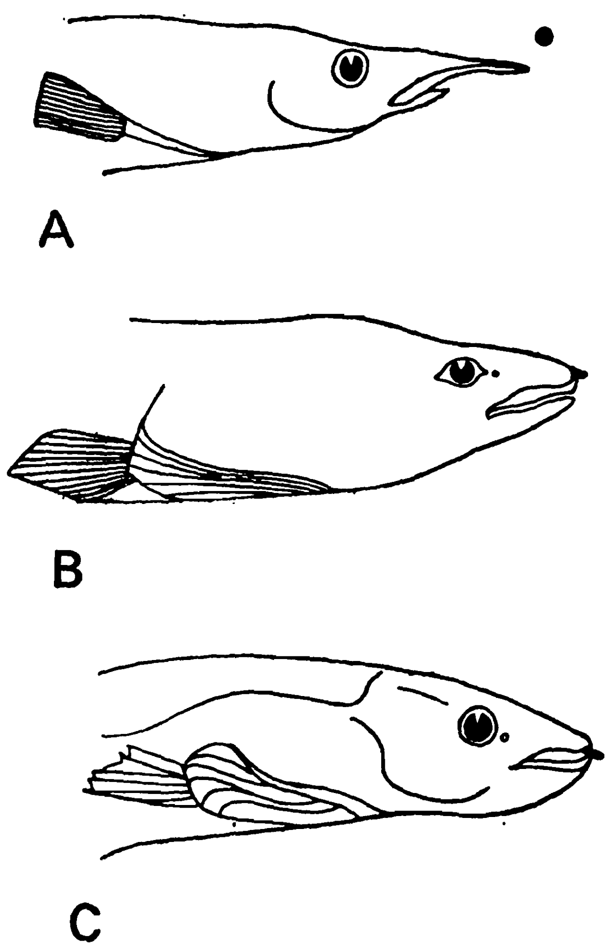

Fig. 2. Outline drawings (semidiagrammatic) of heads in A—Mastacembelidae, B—Pillaiidae, C—Chaudhuriidae.

Morphological Characters

The morphological characters showing various modifications in different groups of mastacembeloid fishes will now be described.

Body : In all the mastacembeloid fishes the body is eel-like, elongated (Fig. 6). In Mastacembelidae and Chaudhuriidae, the body is compressed whereas in Pillaiidae it is subcylindrical. The dorsal and anal fins are united with the caudal in Pillaiidae and some members of Mastacembelidae whereas in Chaudhuriidae the caudal fin is united to the dorsal and anal by a low membrane and gives it a characteristic appearance of a broom.

The body is covered with minute scales in Mastacembelidae but in Pillaiidae & Chaudhuriidae it is completely naked. Similarly, there are free spines before long dorsal and anal fins in Mastacembelidae but no such spines occur in other families.

Head : In *Pillaia indica* the head shows a characteristic depression, especially in the preorbital region ; in *P. Khajuriai*, however, the head is rather conical and less depressed. In other families the head is somewhat conical, more so in Mastacembelidae owing to the rostral appendage (Fig. 2).

The eyes are almost dorsally placed in *P. indica* but in *P. Khajuriai* and other families (Mastacembelidae and Chaudhuriidae) they are situated laterally.

The mouth is subterminal in Mastacembelidae but terminal in Pillaiidae and Chaudhuriidae. (Fig. 2)

Snout : In Mastacembelidae, the snout is elongated and provided with a well-developed fleshy rostral appendage. It is supported by a cartilaginous rod, ending in a sensitive tip flanked by the tubular anterior nostrils. In Pillaiidae and Choudhuriidae the snout is short but in the former a very indistinct fleshy rostral process bearing the tubular anterior nostrils exists whereas in Chaudhuriidae, there is no trace of such a process.

Jaws : The upper jaw is non-protractile in all the mastacembeloid fishes. In Mastacembelidae, the upper jaw consists of two bones *viz.* a premaxilla bearing teeth and a toothless maxilla, as is found in all the perciform fishes (see Greenwood *et. al.*, 1966). In Pillaiidae (*P. indica*), however, the upper jaw consists of a single hockey-stick shaped bone bearing

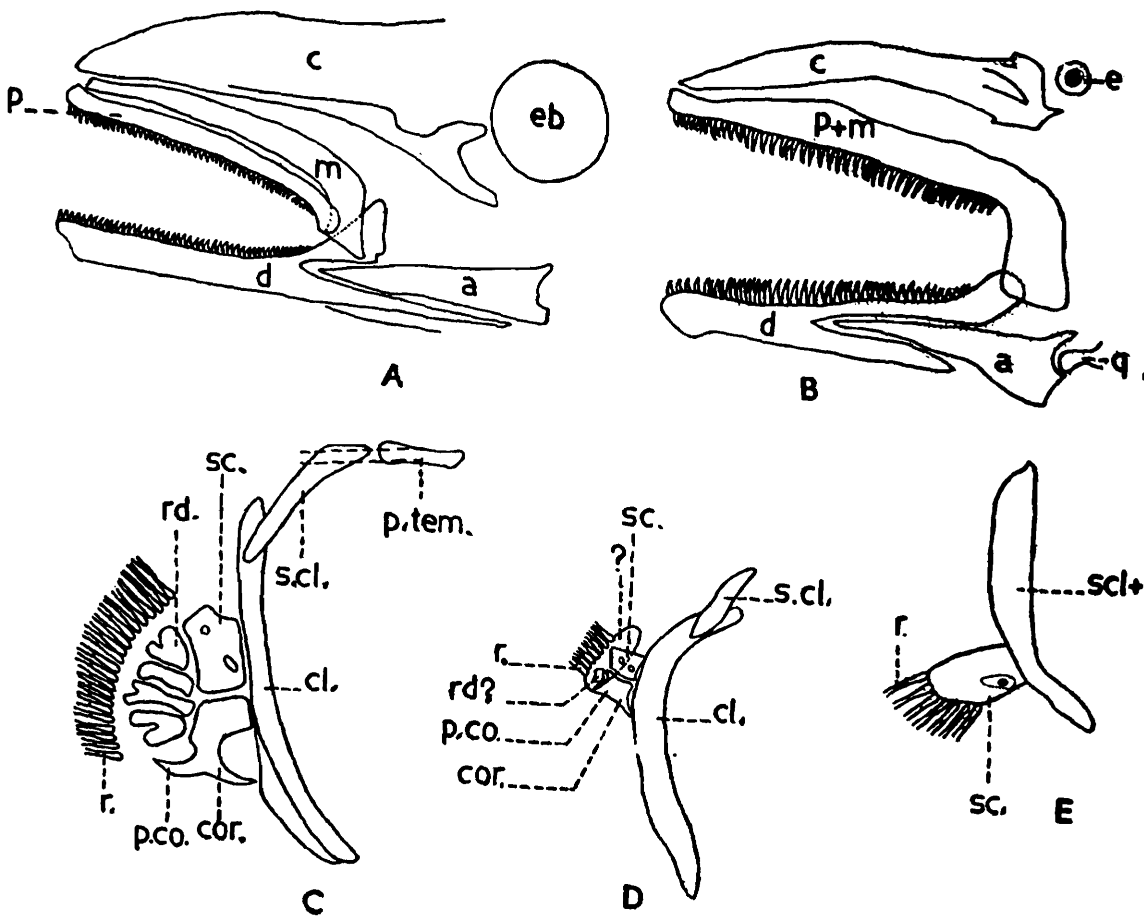

Fig. 2. Outline drawings (semidiagrammatic) (A—B) The jaw bones of, A—*Mastacembelus armatus*, B—*Pillaia indica*. (C—E) Pectoral girdles of C—*Mastacembelus armatus*, D—*Pillaia indica*, E—*Chaudhuria caudata* (Adopted from Annandale & Hora, 1923.)

teeth (Fig. 3 B), corresponding to the premaxilla of perciform fishes. But the jaw muscles, adductor mandibulae (A_1) inserts directly on the posterior ventral face of this bone. As in the percifom fishes this muscle inserts on the posterior ventral face of the maxilla, it appears quite probable that in *P. indica* the posterior half of the single upper jaw bone reprcsents the maxilla. This view also finds support by the fact that premaxilla and maxilla of *Mastacembelus armatus* (Fig. 3 A) together give a hockey-stick shape rather comparable to the upper jaw bone of *P. indica*.

No proper account of the upper jaw of *Chaudhuria caudata* (Chaudhuriidae) is available. However, the tooth-bearing upper jaw bone in *C. caudata* which Annandale (1918) called "maxillary" appears to correspond to the upper jaw bone of *P. indica*. It seems probable that in *C. caudata* also the upper jaw consists of a single bone bearing teeth which represents both premaxilla and maxilla.

In all the three families, both the upper and lower jaws bear sharp conical, inwardly curved teeth.

Pectoral girdle : In Mastacembelidae, the pectoral girdle consists of a supracleithrum, attached by ligaments to the vertebra column, hypercoracoid with perforation, hypocoraccid with a strong post coracoid process ; four radials, two on the hyper and two on the hypocoracoid (Fig. 3 C), no mesocoracoid ; and no post-temporal but the lateral line canal is ossified in this region and posses through the supracleithrum. The pectoral fin contains 17—27 rays.

In Pillaiidae, the supracleithrum is attached

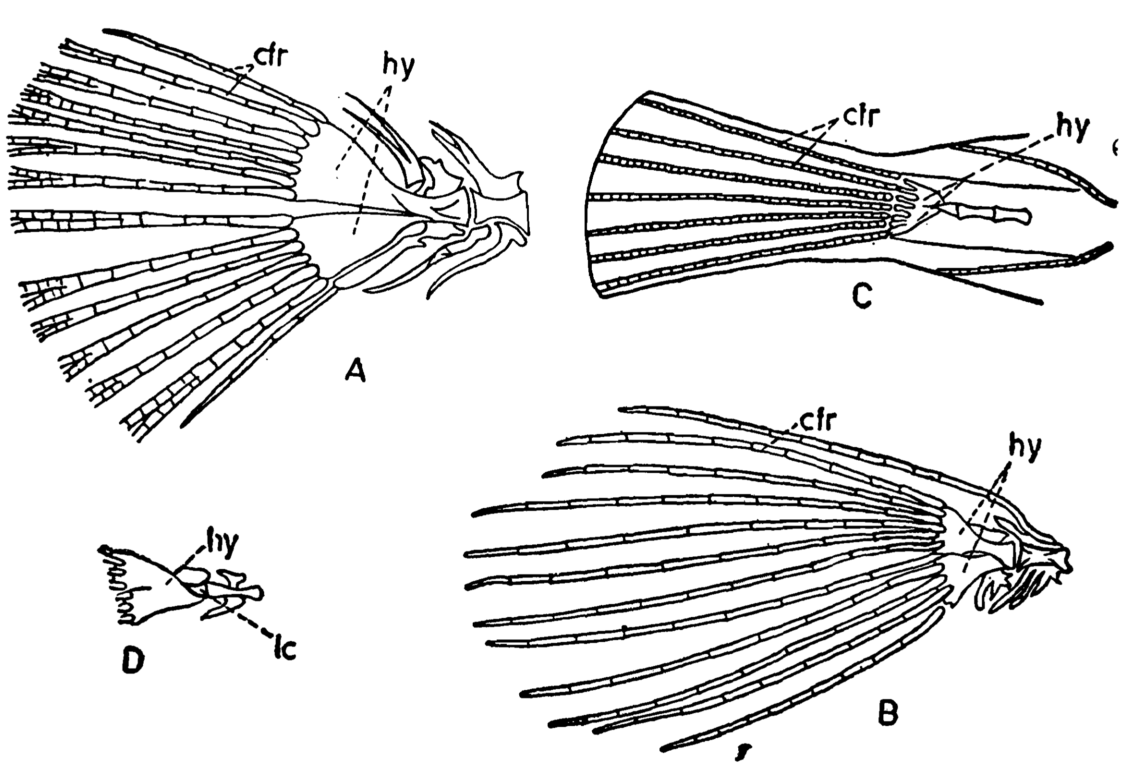

Fig. 4. Outline drawings of caudal fin skeleton of A—*Mastacembelus armatus*, B—*Pillaia indica*, C—Tail of *Chaudhuria caudata* (Adopted from Fig. 1 of Annandale, 1918 ; the hypural bones are represented diagrammatically and the dorsal and ventral elements of the vertebrae are omitted), D—Caud fin skeleton of *Chaudhuria* (*After* White, house, 918.)

to the vertebral column, cleithrum is present but post-temporal bone, including its lateral line component, is absent ; hypercoraiod with p:rforation, hypocoracoid with a post-coracoid proeess and a small differentiated bone, which might represent one of the radials, is present. In addition, a roughly oval, flat bone lying median to hyper & hypocoracoids is undetermined (Fig. 3 D).

is attached to the vertebral column. Hypo- and hypercoracoids are not distinguishable but a large, conspicuous perforation in this region indicates the presence of hyper coracoid. The radials are not differentiated. The pectoral fin contains only 6 rays.

Caudal fin skeleton : In Mastacembelidae the caudal fin is homocercal, short, either

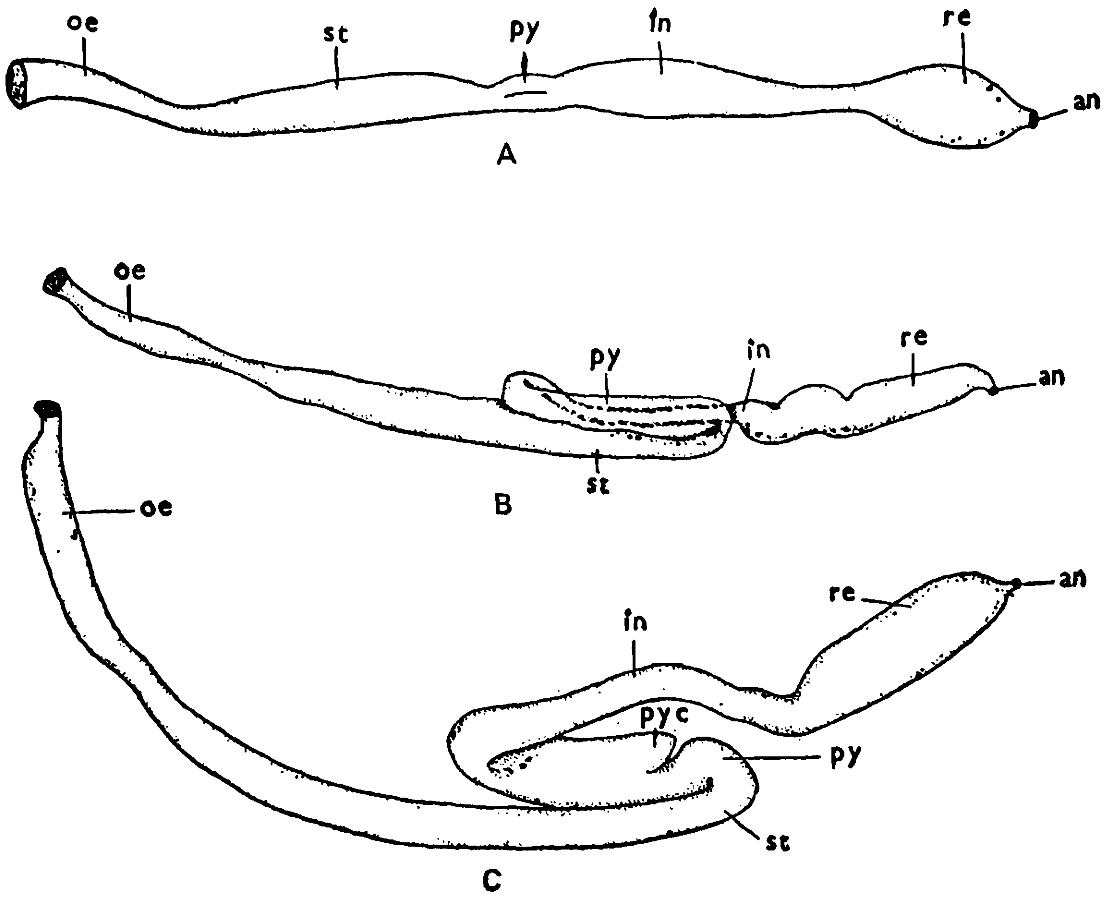

Fig. 5. Outline drawings of alimentary canals of A—*Chaudhuria caudata* (*After* Annandale, and Hora 1923, enlarged), B—*Pillaia indica*, C—*Mastacembelus armatus*.

The pectoral fin contains 7—9 rays in *Pillaia indica* and 19-20 rays in *P. khajuriai.*

Annandale & Hora (1923) have given a brief account of the pectoral girdle of *Chaudhuria caudata* ; their illustration of this bone is reproduced in Fig. 3 E. The pectoral girdle lacks post-temporal, and the supracleithrum which is completely fused with the cleithrum,

confluent with the dorsal and anal or narrowly separated. Five to seven hypurals bearing 15 or more branched rays are present (Fig. 4 A).

In Pillaiidae the caudal fin is homocercal, short, confluent with the dorsal and anal. Two large hypurals which are united at their bases and fused with the last centrum, bear 8—10 unbranched rays (Fig. 4 B).

In Chaudhuriidae (See Annandale 1918, White-house, 1918) the caudal fin is homocercal, fairly long and separated by the dorsal and anal. Two large hypurals which are united at their bases and firmly attached to or fused with the last centrum bear 7 unbranched rays (Fig. 4 C. D)

Vertebrae. In Mastacembelidae, the number of vertebrae varies from 85-96 (37-39 precaudal, and 47-48 caudal) (Sufi 1956) and in Pillaiidae and Chaudhuriidae it is 62 (26 pre-caudal and 36 caudal) and 70, respectively. Thr first few vertebrae in all these fishes possess flattened neural spine : in Mastacembelidae the first 4 to 8 vertebrae, in Pillaiidae first 3 or 4 vertebrae and in Chaudhuriidae at least first two vertebrae bear flattened neural spine.

Alimentary canal : In Mastacembelidae, the oesophagus is narrow and tubular. The stomach is bent a little in front of the pyloric end in a V- or U-shaped fashion ; the tubular cardiac portion of the stomach widens out behind and particularly at the bend it consists of the long anterior limb, the bend and the short posterior limb, ending in the pylorus. There are two lateral pyloric caeca. The intestine is long, narrow and bent like a 'U'. It consists of a short limb, the bend and a long second limb. The second limb is directed forwards and ends in the rectum. The rectum is elongated, fusiform and is much wider than the intestine (Fig. 5C).

In Pillaiidae, the oesophagus is narrow and tubular ; it narrows behind and passess gradually into the stomach. The stomach is long and tubular and is bent on itself in front of the pyloric end in a narrow U-shaped fashion (Fig. 5B). It, therefore, consists of a long anterior limb, the bend and the short posterior limb, ending in the pylorus. There are no pyloric caeca. The intestine is narrow, tubular and bent like a 'U' running posteriorly almost under the bend of the stomach. It, therefore, consists of a short limb, the bend a long second limb. The second limb is

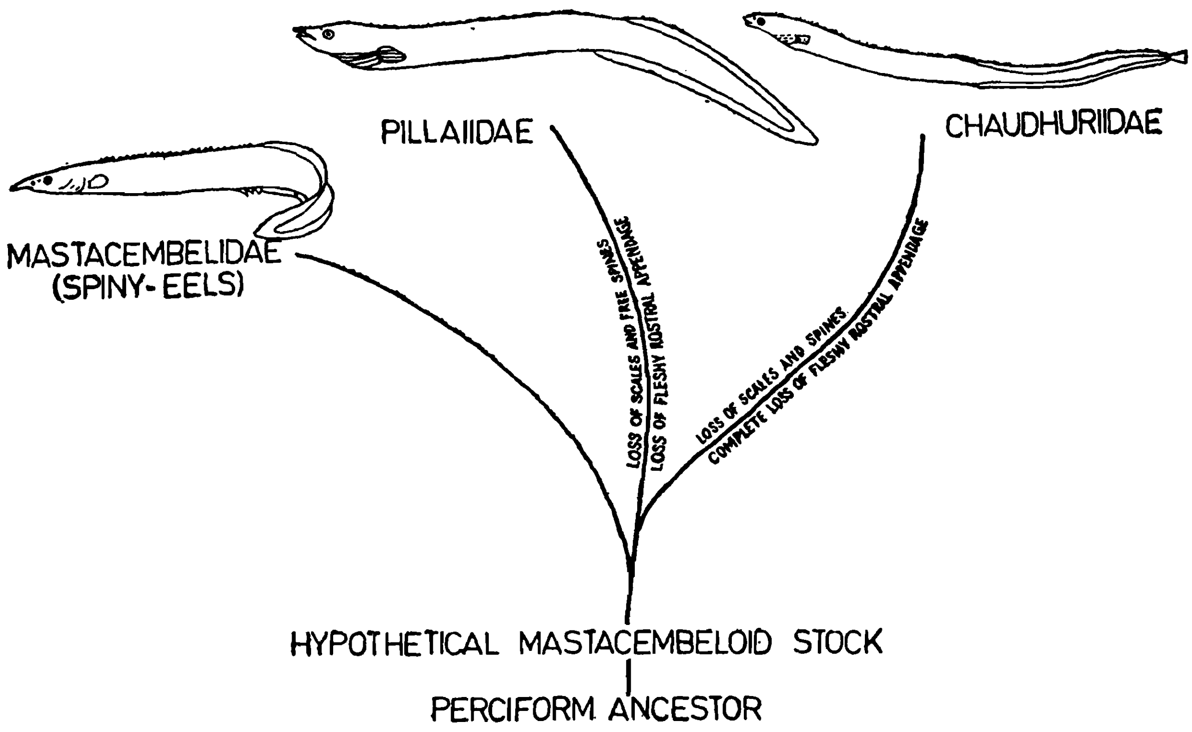

Fig. 6. Diagram showing my conception of the evolutionaryrelationships of Mastacembeloid fishes.

a narrow tube which ends in the rectum. The rectum is wide in front and narrow, tapering behind. It has two annular constriction in its front half.

The account of alimentary canal of *Chaudhuria caudata* have been given by Annandale & Hora (1923) and Mitra & Ghosh (1931). In Chaudhuriidae, the alimentary canal is almost straight, the oesophagus is more or less funnel-shaped and is imperceptibly continuous with the stomach. The stomach is long, straight, tubular and somewhat tapering. The pyloric portion of the stomach is externally demarcated from the cardiac portion by a faint oblique groove. There are no pyloric caeca. The intestine is wide, tubular and runs straight to the rectum which is somewhat club-shaped, wide in front, narrow and tapering behind. It is separated frcm the intestine by a distinct annular constriction (Fig. 5A).

DISCUSSION

The various morphological charactcrs of mastacembeloid fishes will now be discussed in relation to their habits and habitats.

The eel-like, elongated body in mastacembeloid fishes is well suited for hiding in crevices, and for concealing in mud or sand or under some vegetation. Both Chaudhuriidae and Pillaiidae appear to rely on concealment alone for escaping enemies, whereas in Mastacembelidae the protection from enemies appears to be achieved both by way of concealment and by use of spines as an organ of defence. The compressed body with scales and spines in Mastacembelidae is equipped well for exploiting various types of habitat and this has perhaps resulted in their wider distribution. The members of Pillaiidae which have subcyclindrical, naked body, have only succeeded in exploiting narrow range of ecological niches where they can easily borrow in mud or hide under vegetation to capture the live prey. These fishes have specialised to burrow in fine mud, coming out and hiding under vegetation for food etc. The streams and paddy fields wherefrom *Pillaia* spp. have been recorded do not have many predators. This factor seems to havc prevented these fishes from exploiting new niches where they might face greater danger of predation. Probably, this is one of the important reasons why members of Pillaiidae are restricted in distribution to a small area in the north-eastern part of India, although they are capable of living in plains as well as at high altitudes. In Chaudhuriidae, the body is rather compressed and lacks scales and spines. The naked body is better suited for hiding under dense vegetation *etc.* rather than in crevices in rock, or in mud or sand. These fishes appear to have specialized for living at high altitudes where predators are generally few. Probably, this very specialisation is largely responsible for their occurrence in a very restricted area of upper Burma.

In mastacembeloid fishes, a gradual broadening of the forehead is seen from Mastacembelidae. through Pillaiidae to Chaudhuriidae (Fig. 2). In Mastacembelidae, the forehead is extreamely conical due to the prolongation of the snout into an appendage, but in Pillaiidae it is rather conical (more conical in *P. khajuriai* than in *P. indica*) and in Chaudhuriidae it is less conical. The forehead in Mastacembelidae is well and Pillaiidae is well suited for their burrowing-type way of life but that of *Chaudhuria* appears better adapted for living under dense vegetation etc. rather than for burrowing.

The position of eyes in mastacembeloid fishes also show a gradual change in the field of vision. Both Mastacembelidae and Chaudhuriidae which move around in search for food have lateral eyes, suited to see almost all sides. But in Pillaiidae, especially in *P. indica* where the eyes are placed dorsally due to remarkable depression of the forehead, the field of vision is mainly restricted to the dorsal side. The position of eyes in these fish is, therefore, well-suited for a dorsal vision while they are lying on the bottom either buried in mud or clinging to some vegetation.

The gradual loss of the fleshy rostral appendage from Mastacembelidae through Pillaiidae to Chaudhuriidae clearly suggests that it has occurred owing to change in habits of the latter two families. The members of Mastacembelidae have subterminal mouth and search their food at the bottom by the aid of tactile organ-the fleshy rostral appendage. But the fishes of other two families have terminal mouth and take in the moving food which they catch both at bottom and in midwater. This gives them a wider choice for food in streams or lake. The faint trace of fleshy rostral appendage in Pillaiidae appears to be a vestigial organ, showing a stage transitional between fully develoved rostral appendage, as in Mastacembelidae, and without any trace of it, as in Chaudhuriidae.

The upper jaw is non-protrusible in all the mastacembeloid fishes. However, it shows a greater range of adaptive radiation than what is known so far in any group of bony fishes. The loss of protrusion in the upper jaw appears correlated with their habit of catching food either from the bottom or by way of getting it into the mouth with respiratory current. In Mastacembelidae, the toothed premaxilla and a toothless maxilla, like that of a percoid fish, are present. But in the other families these:bones have fused (presumably in Chaudhuriidae) to provide a stronger upper jaw bone for the purpose of catching live prey more efficiently. Since the function of maxilla in acathopterygian fish is to help protrude the upper jaw (See Alexander, 1967), the loss of free maxilla in Pillaiidae (and Chaudhuriidae) is a case of specialization, unparallel in the evolutionary history of acanthopterygian fishes.

The pectoral girdles and fins of mastacembeloid fishes also show loss or fusion of bony components from Mastacembelidae through Pillaiidae to Chaudhuriidae (Fig. 3C-E). The gradual reduction in the number of pectoral fin rays among the mastacembeloid fish is found in this order : *Mastacembelus* spp. 17-27 ; *Pillaia khajuriai* 19-20 *Pillaia indica* 7-9 and *Chaudhuria caudata* 6. A well-developed pectoral fin is generally found in fishes which are active swimmers because the pectorals are used as brakes. Since none of the mastacembeloid fishes are active swimmers, the pectoral fins and girdles appear to have undergone degeneration, more in Pillaiidae and Chaudhuriidae than in Mastacembelidae. This is in correlation with the fact that members of Mastacembelidae are more active than those of the other families.

The caudal fin is the main propulsive organ in fishes. It shows a great deal of variation among the mastacembeloid fishes. The members of Mastacembelidae possess a well-developed caudal skeleton to support the caudal fin, possessing a higher number of branched rays (15 or more). But the fishes of other families have caudal skeletons with reduced numbers of elements which appears correlated with the fact that both in Pillaiidae and Chaudhuriidae the caudal fins possess a rather small number of unbranched rays. The spiny eels are more active and possess a better developed caudal fin and caudal skeleton, whereas members of Pillaiidae and Chaudhuriidae are less active and possess a rather poorly developed caudal fin and caudal skeleton.

Among generalised perciform fishes the

number of vertebrae is 24. (See Greenwood *et. al.* 1966). In the mastacembeloid fishes, however, the number of vertebrae has increased owing to the elongation of body for an eel-like way of life. The members of Mastacembelidae grow to a large size and possess a high number (85-96) of vertebrae. The members of other families are small sized fishes and contain 62-70 vertebrae.

In all the mastacembeloid fishes, a few of the anterior vertebrae possess flattened neural spine which probably provides an additional support to the cranium. The number of anterior vertebrae, possessing flattened neural spine, in Mastacembelidae is higher than that of Pillaiidae and Chaudhuriidae. This seems to be correlated with the fact that spiny eels grow to a large size whereas the fishes of other two families do not.

The alimentary canal is basically similar in all the mastacembeloid fishes, but a gradual reduction in length has occurred from Mastacembelidae through Pillaiidae to Chaudhuriidae. As Suyehiro (1942) pointed out that the digestive organs of fishes depend upon their phylogeny as well as feeding habits it would seem reasonable to believe that the basic similarities in the alimentary canals between these three families is owing to their common descent, and the various modifications have occurred in relation to differences in their feeding habits.

Among mastacembeloid fishes, the pyloric caeca are present only in members of Mastacembelidae. Sinee the pyloric caeca are unrelated to the nature of diet (See Khanna, 1962) and their occurrence is believed to be meant for increasing the general surface of the intestine (Al-Hussaini, 1947) it seems probable that the pyloric caeca in spiny eels are also meant for increasing the surface area of the alimentary canal.

CONCLUSION

All the three families, Mastacembelidae, Pillaiidae and Chaudhuriidae share basic common characters. The gradual modification of various characters in each of these families has led to clear adaptive radiation.

These fishes appear to have evolved from a perciform stock through stages resembling spiny-eels. Pillaiidae is considered less specialised than Chaudhuriidae and it seems probable that the latter evolved from a stock resembling Mastacembelidae through stages comparable to Pillaiidae (see Fig. 7). Among Pillaiidae which shows affinities with both Mastacembelidae and Chaudhuriidae, *Pillaia khajuriai* exhibits a closer resemblance with the members of spiny-eels.

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The following abbreviations are used in figs. 3, 4 & 5.

a articular ; an anus ; c cranium : cfr caudal fin ray ; cl cleithrum ; cor hypocoracoid ; d dentary ; e eye ; eb eye-ball ; hy hypural ; in intestine ; lc last centrum ; m maxila ; oe oesophagus ; p premaxilla ; pco post coracoid process ; p. tem. post-temporal canal bone ; py pylorus ; pyc pyloric caeca ; q quadrate ; r rays ; rd radials ; re rectum ; sc hypercoracoid ; scl supracleithrum ; st stomach.

Bull. zool. Surv. India, 1 (3) : 291-294, 1978

A NEW SPECIES OF *PHRYNOCEPHALUS* KAUP (REPTILIA : AGAMIDAE) FROM THE RAJASTHAN DESERT, INDIA WITH NOTES ON ITS ECOLOGY

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ABSTRACT

Phrynocephalus laungwalaensis, a new species of lizard belonging to the family Agamidae, inhabiting the barren sand-dunes in Laungwala, Sam village and Lunar village, Jaisalmer District, Rajasthan, India, is described. It is diurnal in habit and has the capacity to bury itself upto a depth of *Ca.* 30 cm. in the loose sand by vigorous wriggling movements of the body, limb and the tail.

INTRODUCTION

While surveying Jaisalmer district of Rajasthan during 1975-1977, numerous examples of a new saltatorial agamid lizard of genus *Phrynocephalus* Kaup (1825), were found to inhabit the various sand-dune localities near Laungwala, Sam and Lunar. According to Smith (1935) and Minton (1966) the genus already includes 40 species, out of which five, namely, *P. scutellatus* (Olivier), *P. leuteoguttatus* Boulenger, *P. ornatus* Boulenger, *P. maculatus* Anderson and *P. euptilopus* Alcock and Finn occur in Pakistan, while the remaining 35 are restricted to Western and Central Asia.

Phrynocephalus laungwalansis, n. sp.
(Pls. III & IV)

Material examined (*R. C. Sharma* coll.) : 1 adult ♂, Laungwala, Alt. 149·96 m. ; lat. 26°46'N ; long. 70°13'E, 10. x. 1975. (ii) 2♂♂, 1 ♀, Sam village, Alt. 176·78 m. ; lat. 26°50'N ; long. 70°30'E, 5. v. 1976. (iii) 5♂♂, 1 ♀, Lunar village (near Dhanana), Alt. 139.29 m. ; lat. 26°35' ; long. 70°10'E, 17. iv. 1976.

DESCRIPTION

Dorsum dark greyish and thickly speckeled with black ; black spots on the back arranged in more or less longitudinal rows ; chin, neck, shoulders, dorsal aspect of tail, upper surface of limbs, gular region, and dorsal and lateral aspects of head liberally spotted with black ; the complete ventrum whitish. All examples from the sand-dunes of Sam village possessed two blue spots on ventral aspect, slightly below the neck.

Body long, stout, flattened dorso-ventrally and with a prominent lateral fold. Head roughly oval and quite distinct from neck ; snout vertical, comparatively more acute than in other allied species of the genus ; nasal shields not in contact with one another, separated by a vertical row of 1-3 scales ; nostrils directed vertically upward and forward, nasal region much bulged ; supraorbital ridge prominent and composed of strongly keeled scales ; eyes small, pupil round, eyelids with acute, fringed scales ; gular fold most distinct ; head region with mixed smaller and larger scales which are largest and grouped together on the parietal region (roughly on the middle of head) ; right supralabials 16, left 17 ; right infralabials 16, left 16 ; sides of back of head and of neck with long spinous tubercles ; dorsal scales subequal, imbricate and bearing spinous tubercles or keels ; scales on flanks just like the dorsal scales ; gular scales strongly keeled and bear a spine-shaped posterior tip ; two rows of enlarged scales parallel to the infralabials not separated from one another by smaller ones ; mental shield large, almost two times larger than the adjacent labials ; limbs long and stout, the hind-limbs reaching the eyes ; digits long, with keeled spinous lamellae beneath and with lateral spinous denticulations whose length is not more than the breadth of the digit ; a strong postanal fold in all examples. Tail shorter than head and-body, swollen and compressed dorsoventrally at its base, becoming slender and round posteriorly and ultimately tapering into a bluntly pointed tip ; covered above with large, strongly keeled, spinose scales intermixed with a few smaller ones.

Measurements : Snout to vent, length ♂♂ 29-69 mm., ♀♀ 31-54 mm. ; tail length ♂♂ 15-42 mm., ♀♀ 18-32 mm. ; axilla to groin distance ♂♂ 12-37 mm. ; ♀♀ 13-15 mm. ; head-width ♂♂ 8-18 mm. ; ♀♀ 9-14 mm. ; head-length ♂♂ 10-23 mm., ♀♀ 10-16 mm. ; girth at the mid-body ♂♂ 25-54 mm., ♀♀ 27-47 mm.

Type-specimens ; *Holotype* : ♂ adult, *vide* "material" (i) above, Z. S. I. Reg. No. 23452, deposited in National Zoological Collections, Zoological Survey of India, Calcutta. *Paratypes* : 7 ♂♂ and 2 ♀♀ *vide* "materials" (ii) and (iii) above, Z. S. I. Reg. No. 23453-23461, also in Z. S. I., Calcutta.

Type-locality and distribution : INDIA : Type-locality : Sand-dunes near Laungwala. Distribution—the type-locality : Sam (*c.* 40 km. W. of Jaisalmer) and Lunar village, Jaisalmer District, Rajasthan.

Comparison : *Phrynocephalus laungwalaensis* sp. n. comes close to *P. euptilopus* Alcock and Finn, but differs from it as follows : 1. Body longer. 2. Snout acute (*vs.* blunt). 3. Nasal shields not in contact with one another, separated by a row of scales (*vs.* in contact with one another). 4. Nostrils directed vertically upwards and forward, the region much bulged (*vs.* directed more or less straight forward). 5. Supraorbital ridge most prominent and projected (*vs.* less projected and prominent). 6. Gular fold most distinct (*vs.* feebly developed). 7. Gular scales strongly keeled (*vs.* smooth). 8. Ventral scales feebly keeled (*vs.* smooth, mucronate). 9. Two rows of enlarged scales, parallel with infralabials, not separated from one another by smaller ones (*vs.* separated from one another by smaller scales). 10. Mental scales large, almost two times larger than the adjacent labials (*vs.* very small, not larger than the adjacent labials). 11. Digits with keeled, spinous lamellae beneath (*vs.* with smooth or feebly keeled lamellae beneath). 12. Digits with smaller lateral spinous denticulations beneath, whose length not greater than the breadth of the digit (*vs.* digits with well-developed lateral denticulations, whose length being greater than the breadth of the digit). 13. A strong post-anal fold present (*vs.* feebly developed). 14. Tail shorter than head-and-body, covered with large, keeled, spinous scales which are intermixed with few smaller ones (*vs.* tail always longer than the head-and-body, covered with subequal moderately keeled scales).

ECOLOGICAL NOTES

P. laungwalaensis sp. n. inhabits the most western sandy desert parts of Jaisalmer district where the dry almost barren, vegetation-less, 5-20 metres high, shifting type of sand-dunes prevail. Scarcity of water, intense heat and wind erosion hazards add severe constraints on plant animal life and on human beings. The dunes are composed of loose sand of a light brown to whitish-yellow colour. In between the dunes, patches of gravel make a marked feature. The inter-dunal spaces, which run for miles, are covered with dense, xerophytic vegetation, comprising mainly the small to medium herbs, shrubs and trees, like *Acacia senegal*, *A. jaquemontia*, *Prosopis spicigera*, *Acacia juliflora*, *Erianthus munja*, *Tacoma undulata*, *Euphorbia neriifolia*, *Commiphora mukul*, *Salvadora cleoides*, *Aerua tomentosa*, *Calligonum polygonoides*, *Capparis aphylla*, *Crotolaria burhis*, *Leptodesmia sparticum* and *Lycium barbatum*, etc. Such inter-dunal spaces provide a favourable zone for various animals for shelter and food. Innumerable burrows of rodents, lizards and insects represent a characteristic feature of these spaces. Among the various species which were noticed in the runnels of such inter-dunal spaces are : two species of rodents, two species of lizards (*Agama agilis* and *Acanthodactylus cantoris*), and various orthopterans and beetles. *Phrynocephalus laungwalaensis* does not dwell in this inter-dunal zone of vegetation but lives considerably above, on barren sand-dunes. It does not make burrows and is diurnal in habit.

During March to June these lizards were found to be most active during morning upto 11 A. M. Activities were also noticed during the afternoon after 4 P. M., but movements were slower. During noon, either they remained under the cover of sand or the activities were quite slow. They were capable of running extremely fast over loose sand, and even while climbing the steep elevations of the sand-dunes the speed was kept up. The lizards are capable of burying themselves in loose sand by vigorous, wriggling movements of the body, limbs and the tail, and on many occasions they were found concealed up to a depth of *c*. 30 cm. The spinous lamellae beneath and the lateral spinous denticulations on the toes help them a great deal in going under the cover of loose sand, barely in 3 to 4 seconds. Their capability of closing the nostrils and a built in sand trap in their nose help them to breathe under the sand without suffocation. Their strongly projecting and fringed scaly eyelids are most suited for their fossorial—saltatorial habits, and when closed do not permit sand to enter their eyes. It was interesting to observe that when the lizards are disturbed they immediately sink into loose sand up to 3 or 4 cm., leaving a clear trail on the sand. Many lizards were caught easily with the help of a long forcep by inserting it quickly on both the sides of this trail. If the lizard is not caught in the first attempt, it sinks deeper into the sand and escapes. A few lizards were noticed in the open when the wind velocity was too high, but otherwise they were seen in considerable numbers on the edges of the sand-dunes in the morning up to 10.30 A. M. and after 4 P. M. in the afternoon during May.

Food and feeding : The food, as evidenced by the stomach contents, comprises mainly of small red ants (*Monomorium aberrans*, family Formicidae), which are found in abundance on sand-dunes the year round. The food also includes large black ants ; various hymenopterous insects (families Apidae and Braconidae) ; many species of small beetles (family Scarabaeidae) ; various orthopterous insects like *Chrotogonus* sp. and *Schizodactylus* sp., and grubs of beetles. The optimum feeding of these lizards was noticed at about 10.30 A. M.

TABLE 1. Related climatic factors effecting the life of *Phrynocephalus laungwalaensis* (Range is given for the complete month of May, 1976)

TEMPERATURE									RELATIVE HUMIDITY (%)		WIND VELOCITY [For 24 hrs, averaged for the whole month] KMPH
AIR		SOIL									
		Morning			Evening						
Maximum	Minimum	5 cm depth	15 cm depth	30 cm depth	5cm depth	15 cm depth	30cm depth		Morning	Evening	
39.2°—45.8°c	22.8°—30.5°c	23.0°-34.0°c	31.0°-37.4°c	29.5°-38.7°	49.6°-57.2°c	36.0°-40.5°c	29.5°-38.8°c		53% to 92%	10% t 48%	12 6-28.1

On many occasions it was observed at Sam village that the lizards are capable of capturing grass-hoppers (*Chrotogonus* sp.) and other insects with a marked accuracy even at the time of high wind velocity. They thrust their snout into the burrows of the hoppers and catch the victims without giving them a chance to escape. On seeing an insects within their reach, they lie motionless and then suddenly grab insect with surprising agility.

Related climatic factors : The main factors which influence the life of these diurnal lizards in such a difficult habitat are temperature, humidity and velocity (Table 1.).

ACKNOWLEDGEMENTS

I am grateful to the Director, Zoological Survey of India for providing necessary facilities. I am deeply indebted to Dr. M. L. Roonwal for valuable suggestions and guidance.

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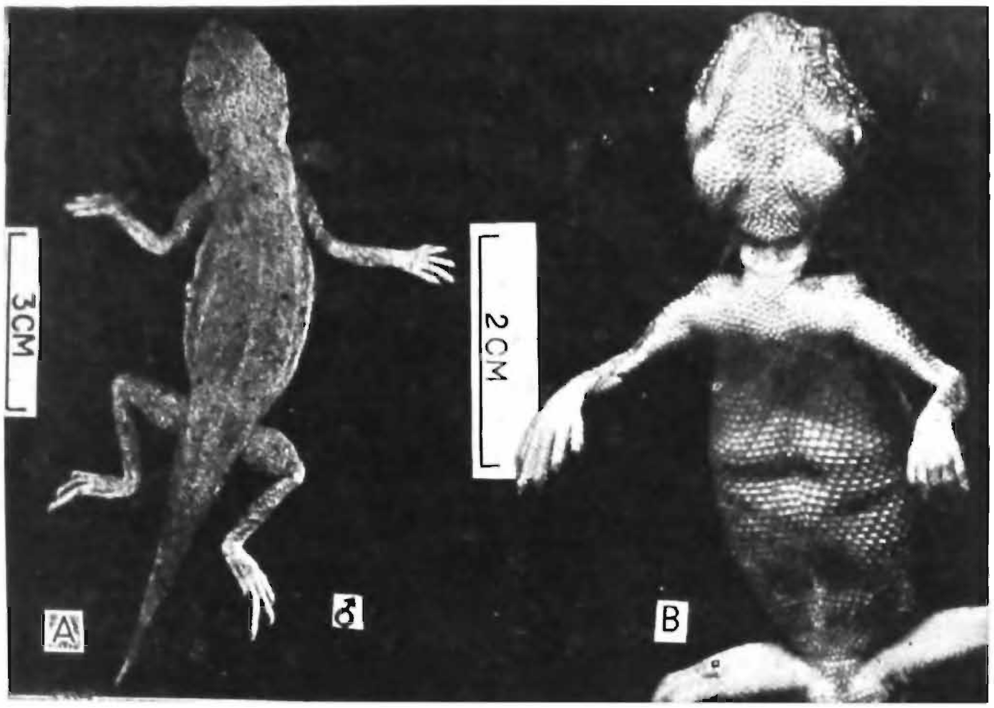
SHARMA PLATE III

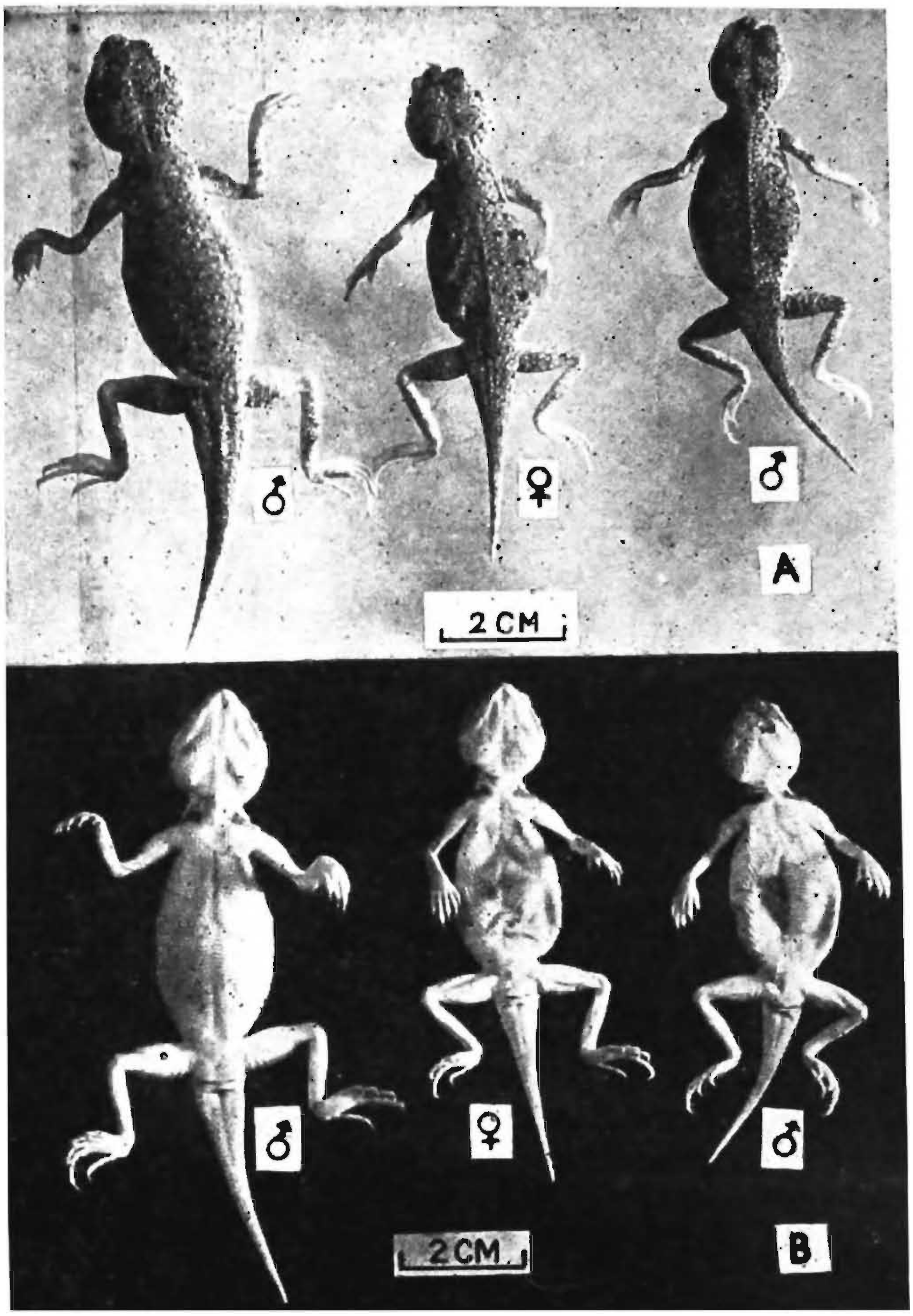


Phrynocephalus laungwalaensis sp. n.

A. Dorsal view

B. Ventral view, showing the breeding colouration at the shoulder.

SHARMA PLATE IV



Phrynocephalus laungwalaensis sp. n.

A. Dorsal view
B. Ventral view

Bull. zool. Surv. India, 1 (3) : 295-301, 1978

REDESCRIPTION OF *HARA HARA* (HAMILTON) AND *HARA HORAI* MISRA WITH A KEY TO THE SPECIES OF *HARA* BLYTH (PISCES : SISORIDAE)

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ABSTRACT

Fresh descriptions and figures of *Hara hara* (Hamilton) and the Neotype of *Hara horai* Misra are provided to record the additional points of difference between the two species. Taxonomic characters of *Hara jerdoni* Day and a revised key to the species of the genus *Hara* Blyth are also included.

INTRODUCTION

Tilak and Talwar (1976) have clarified the situation under which the holotype for *Hara horai* was not designated by Misra (1976) and they have now designated the second specimen from the type-locality as Neotype. From the details furnished by Tilak and Talwar (1976) it is clear that Misra (1976) drew up the description of *Hara horai* based on the figures published by Hora (1950) and presumably also his own manuscript notes prepared many years ago. As he did not designate any type material for the new species, it is clear that he did not have the actual material (ZSI regd. No. F. 11390/1, from Rerai & Duars, N. Bengal) before him at the time of drawing up of the description of the species. The specimen of *Hara hara,* figured by Hora (1950) and bearing the regd. No. F. 11390/1, is not traceable in the collections of Zoological Survey of India ; the figures of this specimen (Hora, 1950) formed the basis of *Hara horai* Misra (Misra, 1976), The figures of *Hara hara* (Hamilton) and the Neotype of *Hara horai* Misra are, therefore, not available and need to be provided. The present author has studied the material of *Hara hara* (Hamilton) and also the Neotype of *Hara Horai* Misra (the second specimen with regd. No. F. 11390/1, reregistered at FF. 955) and observe that the descriptions of the two species given by Misra (1976) are confusing and need amendment. The present study has also brought out some additional and trenchant points of difference between *Hara hara* and *Hara horai,* not mentioned by Misra (1976). Under the circumstances, therefore, it has been considered appropriate to give here fresh descriptions and figures of *Hara hara* (Hamilton) and Neotype of *Hara horai* Misra. The description of *Hara jerdoni* Day, given by Misra (1976), is also somewhat faulty. A redescription of *Hara jerdoni* Day, has been already provided by Tilak and Husain (in press). For sake of reference, the important impoints of *Hara jerdoni* are also given here. A revised key to the species of the genus *Hara* has been provided here.

DESCRIPTIONS

Hara hara (Hamilton)

(Fig. 1 A—C)

1822. *Pimelodus hara* Hamilton, *Fishes of Ganges* : 190, 378 (Type-locality : Kosi river)
1860. *Hara filamentosa* Blyth, *J. Asiat. Soc. Beng.*, **29** : 161 (Type-locality : Tenasserim)
1976. *Hara filamentosa* : Misra, *Fauna of India*, Pisces (2nd ed), **3** : 242.
1976. *Hara hara* : Misra, *Fauna of India*, Pisces (2nd ed.), **3** : 243.

B. VII, D. 1/6-7, P. 1/7, V. 1/5, A. 4/7-8, C. 16

The body is moderately long with the ventral side flattened. The profile of the body rises from the tip of snout up to the base of the dorsal after which it slopes down to the base of the caudal fin. The head is somewhat flattened and its length is contained 4.5 times in the total length and 3.6—4.0 times in the standard length. The snout is depressed and is contained 2.0 times in the length of head. The eyes are small, subcutaneous, superior and lie in the posterior half of the head. The diameter of the eye is contained 9.0 times in head length, 4.4 times in snout and 3.0 times in the interorbital width. The nostrils are equidistant between the eye and the tip of the snout. The mouth is inferior and the upper jaw is longer with the lips papillated. The maxillary barbels reach the base of the pectoral fin. The outer mandibular barbels reach the gill opening while the inner mandibular barbels are somewhat smaller. The nasal barbels reach the tip of the snout as well as the anterior margin of the orbit. The median longitudinal groove does not reach the base of the occipital process which is twice as long as broad at the base. The occipital process is separated from the basal bone of the dorsal fin by an interspacc. Both the jaws are beset with villiform teeth. The palate is edentulous. The isthmus is wide and its width is contained from 2.5-2.6 times in the length of head. The depth of body is contained from 5.4-5.9 times in the total length and 4.3-4.7 times in standard length of body.

The scapular and cubito-humeral processes are well developed. The cleithral process is prominent but does not reach the pelvic fin. *The length of the cleithral process is contained from 1.6—1.8 times in the distance between the origin of the cleithral process and the base of the pelvic fin.* There is no adhesive thoracic apparatus.

The origin of the dorsal fin is nearer the adipose fin than the tip of the snout. The height of the dorsal fin is contained 1.1 times in the head length. The dorsal spine is strong with 6-7 serrations on the posterior border and an equal number of somewhat smaller and upwardly directed serrations on the upper side of the anterior border. The length of the base of the adipose fin is contained 1.28-1.35 times in the length of the base of the rayed dorsal fin. The adipose fin extends nearly an eye diameter behind the posterior end of the anal fin. The interdorsal space is contained 1.4 times in the base of the adipose and 1.8-1.9 times in the length of the base of the rayed dorsal fin, although in an example from Sadiya (Assam), the interdorsal space is somewhat longer than the adipose fi

The pectoral fins are low. *The pectoral spine is small, longer than the head and does not reach the base of the pelvic fin.* The pectoral spine is flattened and strong. There are 15-17 spines (all pointing away from the base) on the outer border of the pectoral spine and 10-12 stronger spines (all pointing towards the base of the spine) on the inner border of the pectoral spine. The length of the pelvic fin is contained 1.7 times in the length of head. The origin of the pelvic fin lies below the middle of the dorsal fin. The

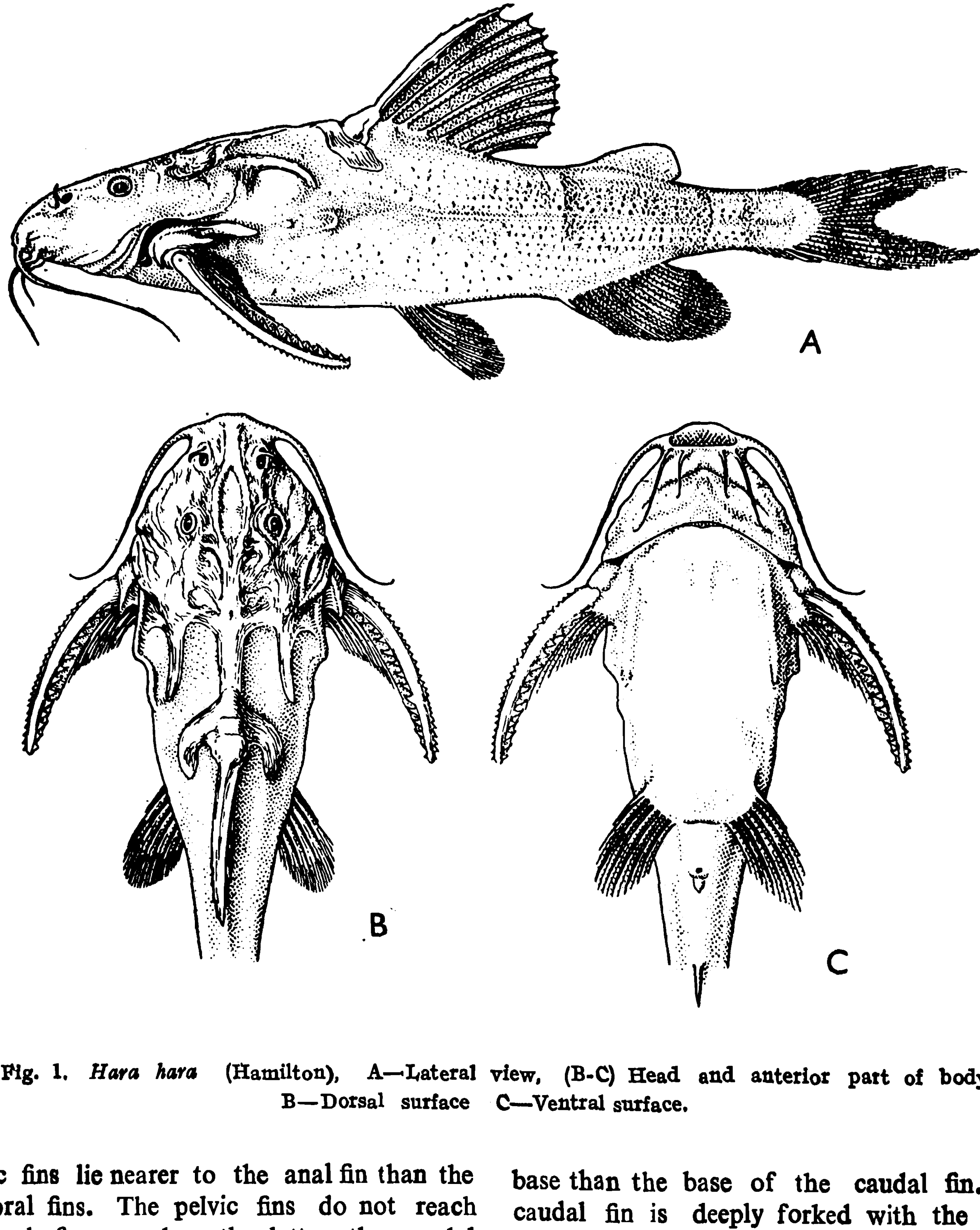

Fig. 1. *Hara hara* (Hamilton), A—Lateral view, (B-C) Head and anterior part of body B—Dorsal surface C—Ventral surface.

pelvic fins lie nearer to the anal fin than the pectoral fins. The pelvic fins do not reach the anal fin nor does the latter the cuadal base. The length of the anal fin is contained 1.3 times in the length of head. The origin of the anal fin lies opposite to that of the adipose dorsal and is far behind the rayed dorsal fin. The anal fin lies nearer the pelvic base than the base of the caudal fin. The caudal fin is deeply forked with the lower lobe somewhat longer than the upper. The caudal peduncle is narrow and its least height is contained from 2.5-2.7 times in its length. The lateral line is complete.

The skin is tuberculated ; the tubercles are arranged in a series of 3-4 rows above the lateral line and the same number below it. The dorsal side of the head is rugose.

The ground colour of the body is yellowish brown with four broad cross bands behind the dorsal fin ; one below the rayed dorsal fin, the second below the adipose, the third on the caudal peduncle and the fourth on the base of the caudal fin. There are two cross bands each on the paired and media fins. There is a dark blotch at the end of the adipose fin.

Remarks : In the description of this species, the points related to the length of the cleithral process (Humeral process). serrations on the dorsal spine, the length of the base of the adipose dorsal in relation to that of the rayed dorsal fin, the interdorsal space in relation to the base of the adipose fin, the length of the pectoral fin in relation to the head length and relationship of the origin of the pelvic and anal fins to that of the rayed dorsal have been emended.

The relationship of the length of the cleithral process with the distance between the origin of this process and the base of the pelvic fin, and the relationship of the length of the pectoral spine with the length of the head and the distance between it and the base of the pelvic fin have been added as additional points of taxonomic importance for *Hara hara* (Ham.) and *Hara horai* Misra.

The material of *Hara filamentosa* Blyth from Burma (from Bassein, regd. No. 1453 ; Meetan, regd. No. F. 11049/1) in Zoological Survey of India, Calcutta has been examined and found that this material resembles *Hara hara* (Ham.) in all important details ; the morphometric characters of this material fall within the range of variation of *Hara hara*. In the preserved material, the prolongation of the tip of the tails is not traceable ; this has, probably, been the only point of distinction between *Hara hara* and *Hara filamentosa*, as it wa pointed out by Blyth (1860) himself. Fortitous prolongation of fins have been observed in some species of fishes and this character, therefore, may not be attached any taxonomic importance. Hora (1950 : 201) also made observations on the relationship of these species, in the light of which as well as the present study, it is only appropriate to keep *Hara filamentosa* as a synonym of *Hara hara* (Ham.).

Distribution : *India* (slow-moving freshwater rivers and streams in Uttar Pradesh, Assam and Orissa) and *Nepal* (Kosi river).

Hara horai Misra

(Fig. 2 A-C)

B. VII, D. II/6, P. I/6, V. 1/5, A. III/7, C. 16

The body is elongated although the anterior part is the widest. The ventral surface of the body is flattened. The head is depressed and ventrally flattened. The width of the head is shorter then its length by a diameter of an eye. The length of head is contained 3.3 times in standard length (caudal fin is broken). The snout is pointed and contained 1.85 times in the length of head. The eyes are subcutaneous and lie in the posterior half of the head. The diameter of eye is contained 9.55 times in the length of head, 5.0 times in snout and 3.00 times in the interorbital width. The mouth is inferior and the lips are papillated. The jaws bear patches of villiform teeth. The palate is edentulous.

The maxillary barbels have broad bases and reach the gill opening. The outer and inner mandibular barbels are shorter. The nasal barbels are small and do not reach the eye or tip of the snout. The median longitudinal groove on head does not reach the occipital process. The occipital process is separated from the basal bone of the dorsal fin by an interspace and is twice longer than its width at the base, The scapular and cubito-humeral processes are well developed. *The cleithral processes are long but do not reach the pelvic fins. The length of the cleithral process is contained* 1.38 *times in the distance between its base and the origin of the pelvic fin.* A thoracic adhesive apparatus is absent.

The origin of the dorsal fin is nearer the adipose than the tip of snout. The height of the dorsal fin is contained 1.32 times in the length of head. The spine of the dorsal fin is strong and bears 8 serrations on the posterior side. The length of the adipose dorsal fin is contained 2.1 times in the length of the base of the rayed dorsal fin. The origin of adipose fin lies behind that of anal fin but it extends to the end of the latter fin. The interdorsal space is almost equal to the length of the base of the adipose dorsal fin. The pectorals are low and horizontal. *The length of the pectoral spine is equal to the distance between the origin of the cleithral process and the origin of the pelvic fin. The pectoral spine reaches the base of the pelvic fin.* The pectoral spine is nearly equal to the length of the head. The pectoral spine is strong, flattened and bears 13 serrations on the inner border (all directed towards the base) and 22 on the outer border (all directed away from the base), The pelvic fins

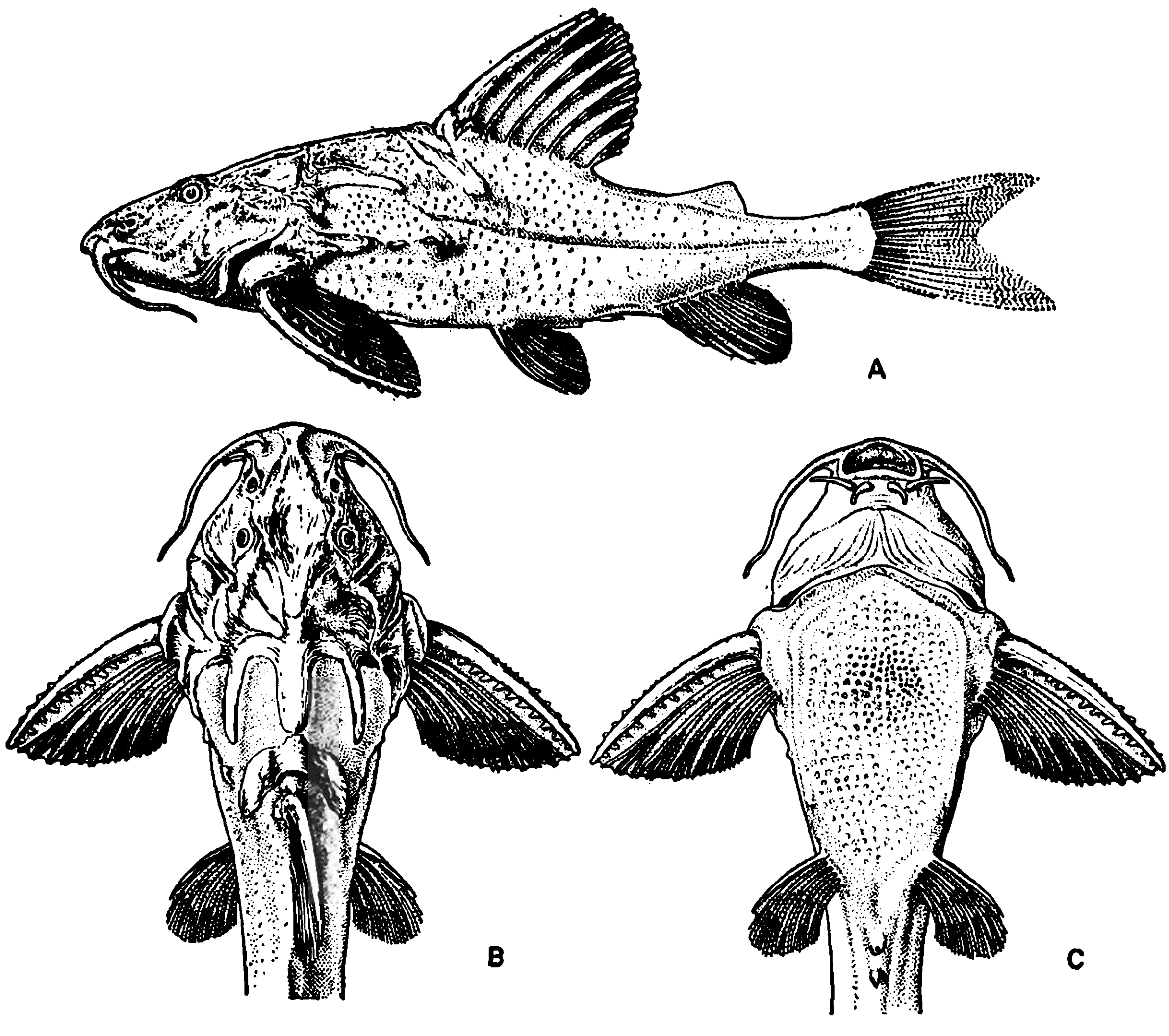

Fig. 2. *Hara horai* Misra, A—Lateral view, (B-C) Head and anterior part of body, B—Dorsal surface, C—Ventral surface.

do not reach the base of the anal fin nor does the latter the base of the caudal fin. The length of the pelvic fin is contained nearly 2.00 times in the length of head. The origin of the pelvic fin lies below the 2nd branched ray of the dorsal fin and lies nearer the anal base than that of the pectoral fin. The length of the anal fin is equal to the length of the pelvic fin and is contained nearly 2.00 times in the length of head. The caudal fin is forked; its lower lobe is longer than the upper. The least of the caudal peduncle is contained 2.25 times in its length. The lateral line is complete.

The body is profusely tuberculated on the dorsal and ventral sides. The dorsal side of the head is rugose.

The ground colour is yellowish brown. The pelvic and anal fins bear two cross bands each. There are faint cross bands on the body behind the level of the dorsal fin.

Remarks : The points connection with the relationship of the length of base of adipose dorsal fin with that of the rayed dorsal, number of serrations on the pectoral spine and the relationship of the pelvic fin have been corrected.

Distribution : *India* (Terai & Duars, N. Bengal).

Hara jerdoni Day

Tilak and Husain (in press) have provided a redescription and distribution of *Hara jerdoni* Day. The description of this species given by Misra (1976) differs from the description given by Day (1870) and Tilak and Husain (in press). The material of this species has been re-examined and pending publication of the paper by Tilak and Husain (in press), the following important taxonomic points of this species are given for sake of reference.

(1) The eyes lie in the middle of head.

(2) The length of the dorsal spine is contained 1.4 times in the length of head.

(3) The adipose fin is smaller than the interdorsal space.

(4) The origin of the pelvic fin lies below the last dorsal ray.

(5) The origin of the anal fin lies opposite the adipose dorsal fin.

(6) The least height of the caudal peduncle is contained 2 times in its length.

(7) The length of the pectoral spine is much more than the distance between the origin of the cleithral process and the base of the pelvic fin. The pectoral spine crosses the middle of the length of the pelvic fin.

(8) The length of the cleithral process is contained 1.23 times in the distance between the origin of the cleithral process and the base of the pelvic fin.

Key to the species of **Hara** Blyth

1. The pectoral spine may or may not reach the base of pelvic fin ; length of the cleithral process 1.38-1.8 times in the distance between the origin of the cleithral process and base of pelvic fin ...... (2)

   The pectoral spine is very long and crosses the middle of pelvic fin length ; length of cleithral process 1.23 times the distance between origins of the cleithral process and the pelvic fin .... *Hara jerdoni* Day

2. The pectoral spine reaches the origin of pelvic fin ; length of cleithral process 1.38 times in the distance between origins of cleithral process and pelvic fin ; adipose fin extends upto end of anal fin .... *Hara horai* Misra

The pectoral spine does not reach the origin of pelvic fin ; length of cleithral process 1.6-1.8 times in the distance between origin of cleithral process and base of pelvic fin ; adipose fin extends nearly an eye diameter behind the posterior end of the anal fin .... *Hara hara* (Ham.)

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Bull. zool. Surv. India, 1 (3) : 303-304, 1978

A NEW SPECIES OF THE GENUS *CROCIDURA* WAGLER (INSECTIVORA : SORICIDAE) FROM WRIGHT MYO, SOUTH ANDAMAN ISLAND, INDIA

S. CHAKRABORTY

Zoological Survey of India, Calcutta

ABSTRACT

A new species of shrew, *Crocidura jenkinsi* sp. nov., is described from Wright Myo, south Andaman Island, India. Moderately large size, bistre coloured dorsum, semispinous pelage and tail shorter than head and body length are its important features.

During the faunistic survey of the Andaman group of Islands by the Zoological Survey of India party in 1972, a specimen of the shrew belonging to the genus *Crocidura* Wagler was collected from Wright Myo, South Andaman Island, which does not agree with any known species of the genus. The specimen was sent to the British Museum, London, for comparison with the holotype of two nearest species, namely, *C. hispida* Thomas and *C. andamanensis* Miller. According to Dr. P. D. Jenkins of the Mammal Section, it does not fit with either of the two. A new species is therefore proposed to accommodate the present specimen.

The measurements of *C. nicobarica* and *C. andamanensis* were taken from original description (Miller, 1902) and those of *C. hispida* were taken by Dr. Jenkins. The colour names given in the text with initial capital letters are according to Ridgway's (1886) nomenclature.

Crocidura jenkinsi, sp. nov.

Material : Holotype : Z. S. I. Reg. No. 19860, adult female ; Wright Myo, South Andaman Island, India ; 26 July 1972 ; Coll. *Dr. A. K. Mandal* ; study skin and skull ; deposited in the Zoological Survey of India, Calcutta.

DESCRIPTION

A moderately large *Crocidura* with semispinous pelage ; under the microscope many of the hairs appear flat and broad. Dorsum bistre coloured ; hairs moderate in length measuring upto 7 mm. on the back. Venter brown coloured ; hairs thick but smaller than those of dorsum. Hands and feet Wood brown in colour ; sparsely haired ; hairs over claws pure white. Tail shorter than head and body length (Table I) ; Seal brown in colour ; spersely clothed with short white hairs, interspersed with a few longer ones. Vibrissae bistre coloured ; fairly well developed, measuring upto 33 mm. and directed backwards. Ear small, almost round in out line. Eye very small. Tip of rostrum bifurcated. Lateral glands well developed, situated nearly half way between the fore and hind limb.

Around the gland, fur rather sparse and of Isabelline colour.

Skull without any marked peculiarities and very similar to that of *C. hispida*. However, the condylobasal length as percentage of head and body length is much smaller in *jenkinsi* (Table I).

Diagnosis : Moderately large size ; Bistre coloured dorsum ; semispinous pelage ; tail shorter than head and body length.

TABLE 1. Summary of external and cranial characters of the type of four species of the genus *Crocidura* Wagler. (Colour characters of *hispida*, *andamanensis* and *nicobarica* were taken from the original descriptions while some characters were studied by Dr. Jenkins.)

Characters	*C. hispida*	*C. andamanensis*	*C. nicobarica*	*C. jenkinsi*
Dorsal colouration	Gray with a brownish wash	Gray with a wasp of Broccoli brown	Prouts brown	Bistre
Length of dorsal hairs	8 mm.	8 mm.	4 mm.	7 mm.
Texture of pelage	Semispinous, many of the hairs flat and broad	Smooth and velvety, some of the hairs flat but not broad	Crisp and velvety, some of the hairs flat, broad and thickened at the edges	Semispinous, many of the hair flat and broad
Length of head and body	85 mm.	114 mm.	120 mm.	107 mm.
Length of tail	103 mm.	86 mm.	90 mm.	95 mm.
Length of hind foot	25.5 mm.	25 mm.	24 mm.	26 mm.
Condylobasal length	27.4 mm.	25.6 mm.	26 mm.	26.4 mm.
Condylobasal length as percentage of head and body length	32%	23%	22%	25%
Length of maxillary tooth row	12.3 mm.	12 mm.	12.8 mm.	12.4 mm.
Length of mandible	14.9 mm.	15 mm.	15 mm.	14.6 mm.

Relationship : *Crocidura jenkinsi* is allied to *C. nicobarica*, *C. andamanensis* and *C. hispida* but differs from all of them as shown in table 1.

Etymology : The species is named after Dr. P. D. Jenkins, Mammal Section, British Museum, London, who kindly studied and compared the present specimen with other species of the genus *Crocidura*.

ACKNOWLEDGEMENT

My thanks are due to the Director, Zoological Survey of India, for facilities given for this work, and to Dr. B. Biswas, Deputy Director, Dr. A. K. Mukherjee, Superintending Zoologist, Shri P. K. Das, Zoologist of this department for valuable suggestions and reviewing the manuscript. Further, I am thankful to the authorities of the British Museum, London for their co-operation.

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Bull. zool. Surv. India, 1 (3) : 305-307, 1978

THE TAIL AND ITS DISPLAY BEHAVIOUR IN THE GOLDEN LANGUR, *PRESBYTIS GEEI* KHAJURIA

R. P. MUKHERJEE AND S. S. SAHA

Zoological Survey of India, Calcutta

ABSTRACT

The paper describes the difference in the structure of the tail between the adult male and adult female in the Golden langur. The subterminal part is more bushy in adult male than adult female.

In vertebrates, the tail movement is functionally a part of the activity of the trunk muscles. Tail elevation represents a local exaggeration of increased tonus in the anti-gravity muscles of the back, and the lateral movement represents contraction of the longissimus muscles. In the terrestrial mammals, however, trunk undulations are no longer part of normal locomotion, and tail elevation is more widespread than tail waving (Andrew, 1964).

Different species of monkeys of the genus *Cercopithecus* are readily distinguishable during locomotion by their tail position (Haddow, 1952). In the Common Langur, *Presbytis entellus* (Dufresne) (Fig. 1E) also, tail display provides clue for differentiation between the northern and southern populations in India (Jay, 1965). Again, in the Rhesus Monkey, *Macaca mulatta* (Zimmermann), tail carriage is correlated with dominance (Ojha, 1974). Social hierarchy in order of dominance of individuals in a group exists in the Rhesus Monkey, the apex of the social pyramid being invariably occupied by a male commonly known as the dominant male. Unlike in the langurs, in which a normal bisexual group has generally one adult male, the question of retention of the dominant position arises only when some of the subadult male members of the group become adult, or an outsider challenges the position of the leader in the established group. Despite this, the display of various organs that establish communication among the individuals is also exhibited in the langurs. From the structural modifications such as larger canines and bigger size, and other secondary sex characters, namely, modification of colour pattern in the anogenital region including the scrotal sac, the adult male in the group can readily be recognised in langurs. But in the Golden Langur, *Presbytis geei* Khajuria, the display of the anogenital region, particularly the scrotal sac, is apparently obscured due to luxuriant growth of its hair. Again, unlike in other langurs, the colour differentiation of that region is altogether absent.

Variations in the tails of primates (Fig. 1) may be correlated with the habits of the animals. In the restricted ecozone in the canopy of the dense tropical forests and for arboreal habits, the tail in certain species of primates serves as an important organ for visual communication. The suspended tail serves best as a display organ amidst the thick foliage when the animal is on the branch of tree. Modification of the tail structure, as an efficient display organ of the following species of primates, is apparently correlated with their arboreal habits.

Formation of tassel and tuft at the tail tip has been a feature of certain species. A big tassel along the free end of the tail is present in the species of *Colobus* (Fig. 1B) in the African region. In the Indian sub-region, a beautiful tuft is present in the Liontail Macaque, *Macaca silenus* (Linnaeus) (Fig. 1A), and we have observed the tassel formation at the tail tip to a certain degree in the Golden Langur as well as in the Capped Langur, *Presbytis pileatus* (Blyth) (Fig. 1D). In the Golden Langur (Fig. 1C), the thick and bushy tail arises at tne coccyx and tapers for a few centimetres ; it is then uniformly cylindrical throughout until the subterminal part, where it again thickens to form a small swollen tassel. In adult males, the tassel is larger and thicker than in adult females. This feature is

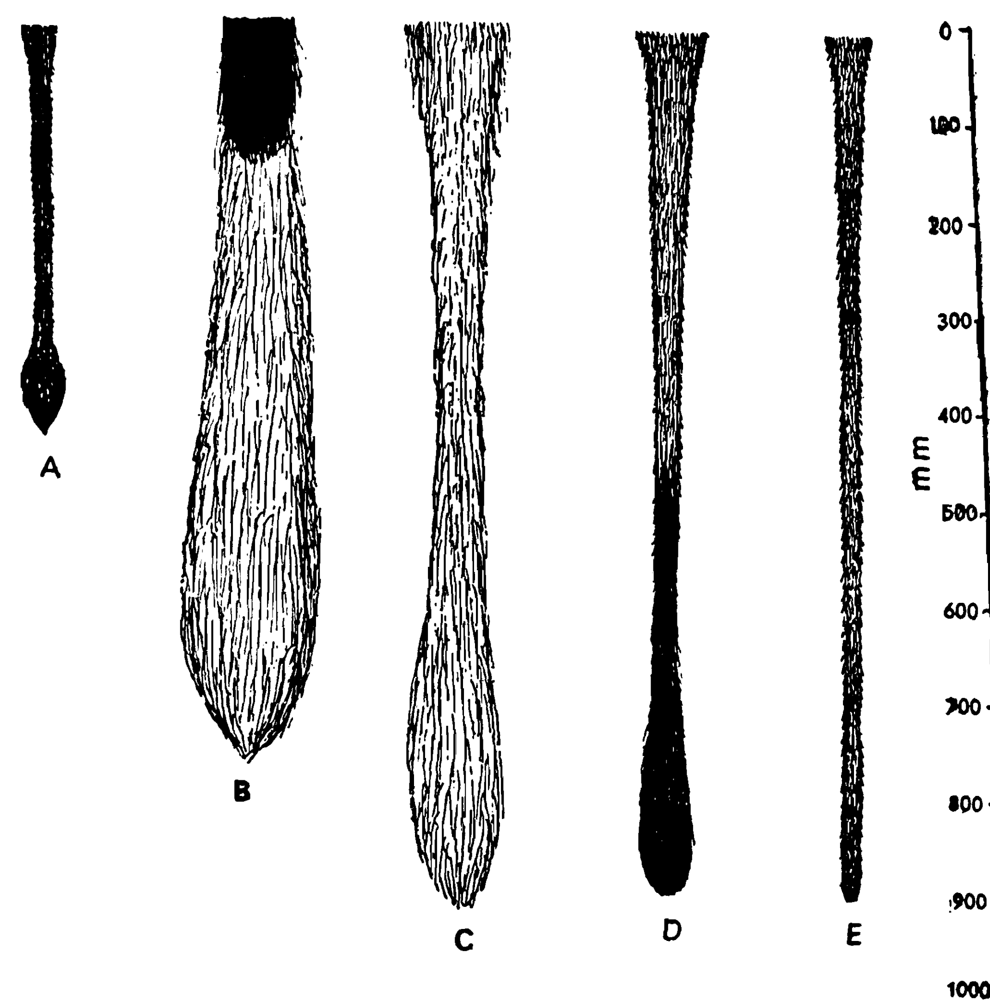

Fig. 1 (A-E) Diagrametic representation of the tails of some primates. A—*Macaca silenus*, B—*Colobus polycomos*, C—*Presbytis geei*, D—*Presbytis pileatus*, E—*Presbytis entellus*.

more pronounced in the adult males of Golden Langur than the Capped Langur. It may be interesting to note that under the genus *Presbytis* this characteristic feature is pronounced only in these two parapetric species, namely, the Golden Langur and the Capped Langur in India. These two species can be differentiated, to a certain extent, from the mode of display of their tail, that is, from the tail carriage itself besides other morphological characters. In Capped Langur the tail is elevated more than Golden Langur in locomotion and the tail is not so bushy and the tassel is not so developed as in Golden Langur. Moreover, this langur has a thorough control over its tail, suggesting a highly increased tonus in the antigravity muscles of the back. This, thus reflects its locomotory habits as an admixture of terrestrial and arboreal movements. In the Golden Langur, on the other hand, the tail display is tail waving, an unfamiliar mammalian display on land, suggesting the longissimus contraction. It thus, reflects its habits being restricted to arboreal movements. This langur has apparently no control over its tail in so far as no loop formation has ever been observed, and the tail is passively tossed sidewise during locomotion. One of us (R. P. M.) had an opportunity to observe a Golden Langur troop on the ground in the Sakosh river bed at Jamduar in Assam. Unlike in *P. entellus*, where the tail is carried above the ground, in Golden Langur the tail hangs down (Pl. V) while the monkeys are moving on the ground. Adherence to arboreal habits has been observed in the free ranging groups of the Golden Langur (Mukherjee and Saha, 1974). The tail carriage during locomotion in the horizontal plane in this species has been observed as a clumsy affair, and while jumping through a wide gap from one branch to another, the tail has been found as if to follow the animal as a flying appendage.

ACKNOWLEDGEMENTS

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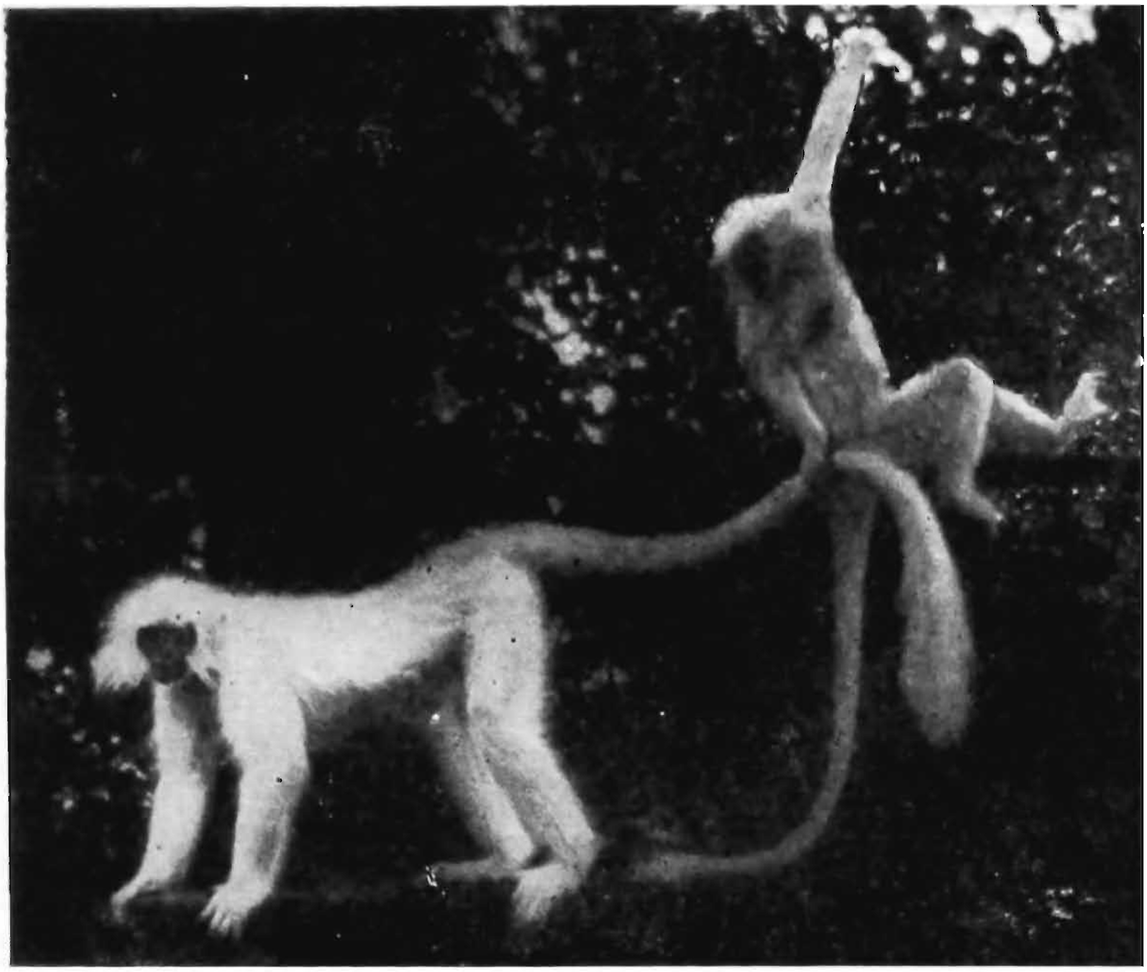
MUKHERJEE & SAHA PLATE V



Presbytis geei Khajuria

Note the thick tassel in the tail of the adult mele (standing) held playfully by the adult female. Thh tassel tail of the female (lying horizontally on the platform) is not as thick.

SHORT COMMUNICATION

Bull. zool. Surv. India, 1 (3) : 309-310, 1978

ON THE LARVAL CASTS AND FORMATION OF PUPAE FROM INCOMPLETELY MOULTED LAST INSTAR LARVAE OF *SITOTROGA CEREALELLA* (OLIVIER) (LEPIDOPTERA : GELECHIIDAE)

The Angoumois grain moth, *Sitotroga cerealella* (Olivier), is a pest of stored cereals in India. Cotes (1891-93). recorded it for the first time. Infestation was noted to rise with the return of favourable conditions more so during the summer spell followed by rains, chiefly at places where adequate control measures were not undertaken.

For the purpose of studies the moths were reared in the laboratory for a number of generations on fresh and dry maize grains *Zea mays*.

Observations were made on the casts of the larvae which have been shed by them during moulting. For this purpose, 397 maize grains were picked up from the laboratory culture of the moth. To be sure that the moultings are over, only those grains which comprised exit windows with their covers intact or sometimes open were collected (Pl. VI A & B). The grains were then cut into two halves one by one by means of a fine razor blade into different planes as needed (longitudinal or transverse or oblique) depending on the positions of the exit-windows ; precisely under which were found the heads of the pupae. Care was taken that the immature stages resting inside are not damaged or displaced. Out of 397 grains 365 contained pupae, 7 of which were dead and the rest of the grains had live prepupae.

The casts found within, almost always entangled themselves with the frass and the silk material which was dumped compactly inside minute cavities of the infested grains, the cavities being excavated by the larvae while feeding The number of the casts varied from 3 to 6 per grain signifying the number of times the larva had moulted. This obviously did not all the time concur to the description given by Crombie (1943) "Four larval instars were found, followed by a pupa, from which the adult eventually emerged".

It was noticed that the moults of all the larval instars were shed as two separate pieces (the head cast and the body cast, the latter being fragile, mostly indistinct and embarassing to find) except that the last instar where whole of the moult parted as one-piece structure (Pl. VI C). In certain cases though rare (9 instances out of 358) the last instar larvae did not shed the complete moult as one-piece, but only the body cast was given up and the head cast remained firm and its place (Pl. VI D & E). The caterpillars, nevertheless, changed themselves to pupae which were then isolated for observations.

It was found, however, from those pupae in due course that incomplete moulting did not have any ill effect on these stages except that it prolonged the normal emergence of moths and they maintained their standard contour (Pl. VI F).

Thanks are due to the Director, Zoological Survey of India, Calcutta for providing the necessary facilities.

Zoological Survey of India, Calcutta

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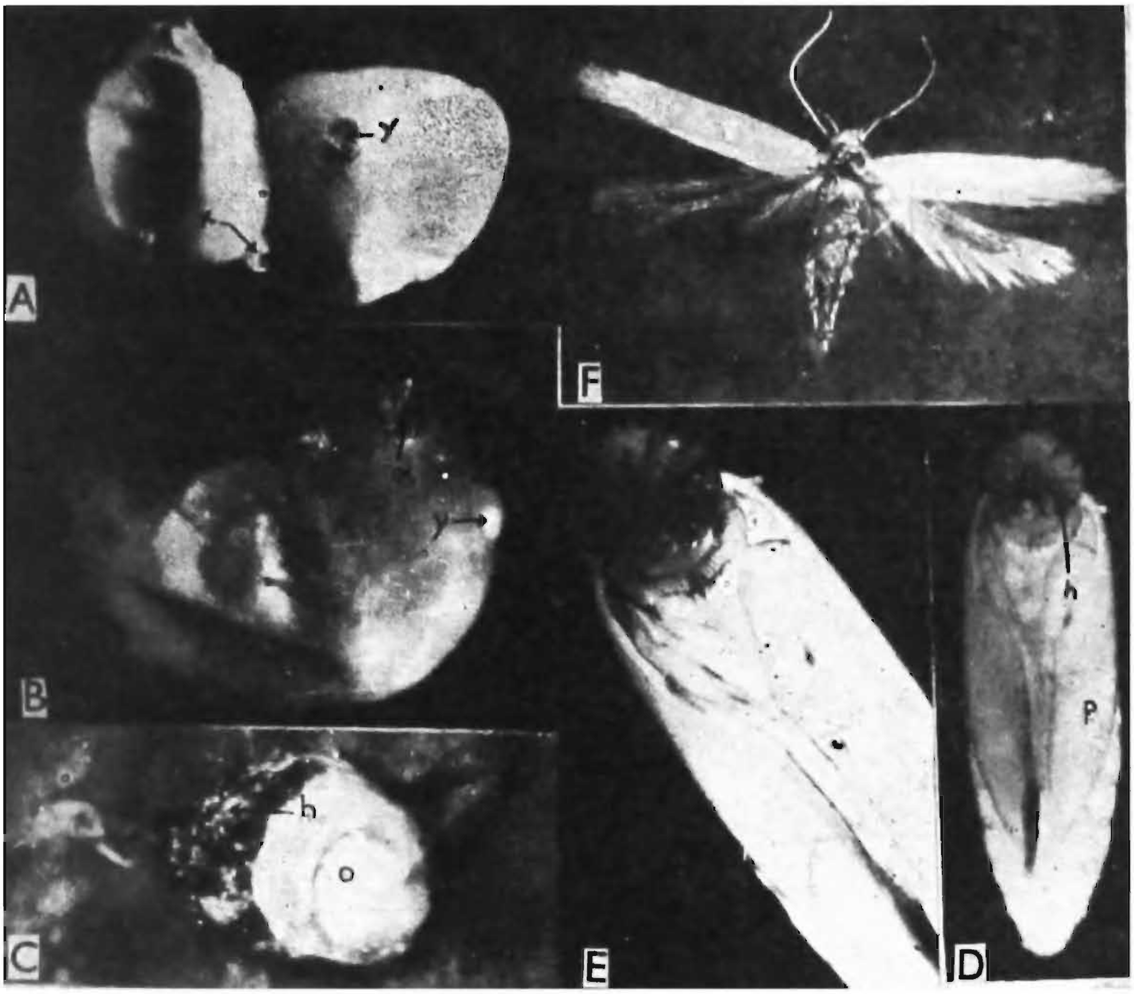
G. JOSHI

JOSHI PLATE VI



Sitotroga cerealella (Oliver)

A. Two maize grains in association depicting :
X—Exit cover (=E. C.) used, showing central tearing of the window during motl emergence. Y—E. C. unused.

B. Double infestation on one mazie grain.
X—E. C. used, showing precise one-half tearing of the window during moth emergence. Y—E. C. unused.

C. One-piece cast of the last instar larva. h—Head cast ; o—Body cast.

D. Incompletely moulted last instar larva.
h—Head cast intact ; p—Exposed pupal body.

E. Same enlarged. Note the deep wrinkles on the head cast which are otherwise relaxed.

F. Adult moth from a pupa from incompletely moulted last instar larva.

Bull. zool. Surv. India, 1 (3) : 311-314, 1978

SOME NEW RECORDS OF HYPERMASTIGIDS (PROTOZOA) FROM SAGAR ISLAND, WEST BENGAL

Chakravarty and Banerjee (1956) described three species of hypermastigid flagellates viz., *Holomastigotoides* Grassi and Foa, *Pseudotrichonympha* Grassi and Foa and *Spirotrichonympha* Grassi and Foa from the termites of Calcutta. Later Das (1976) described three more species and ten new records of the species belonging to the aforesaid genera from West Bengal. Subsequently Tiwari (1977) added one more species of *Spirotrichonympha bhadreshwarensis* Tiwari to the flagellates of termites of West Bengal. During the course of further studies on termite flagellates, the author came across four new host records and a new record from West Bengal, of species belonging to two genera viz., *Holomastigotoides* and *Pseudotrichonympha* from Sagar Island, 24-Parganas district, West Bengal.

The Sagar Island is an unexplored area so far as the termite symbionts are concerned. It is approximately 358.4 square kilometers in area. Wood-eating termites were collected from mango (*Mangifera indica*), banyan (*Ficus bengalensis*), pipal (*Ficus religiosa*) and drumstick (*Moringa* sp.). The heavy infestation of the termites were noticed on *Moringa* sp. (Tiwari, 1977a). The guts of the termites were dissected and the smears of the gut contents prepared. The live flagellates were studied in fresh smears of the gut contents diluted with 67% locke's solution, in which symbionts remained more active for a prolonged period. The micropreparations were fixed in Schaudinn's fluid and stained in iron-haematoxylin. All the measurements were taken with the aid of ocular micrometer.

Order HYPERMASTIGIDA
Family HOLOMASTIGOTIDAE

Holomastigotoides bengalensis Chakravarty and Banerjee, 1956

Pl. VII, Fig. A

Description : The body is more or less oval with the anterior part of the body gradually tapering and terminating in a blunt cone while the posterior end is round. The body length measures 67.50 - 72.72 µ (average 69.86 µ) and breadth 41.25 - 45 µ (average 43.12 µ). The spiral bands are dexiotropic. Twenty five spiral bands could be counted from the side of the body. A little portion of the posterior part of the body is devoid of flagellar bands. The axostyle is well developed extending up to the posterior extremity of the body. The nucleus lies anterior, oval in shape and 12.18 × 9.37 µ in size. The prenuclear zone conical, is densely granulated around the anterior end of the nucleus.

Hosts : *Heterotermes* sp., Calcutta (Type host) ; *Heterotermes indicola* (Wasm.), Indian Museum Campus, Calcutta ; *Coptotermes heimi* (Wasm.), Bamankhali, Sagar Island, 24-Parganas district, West Bengal.

Remarks : Chakravarty and Banerjee (1956) described *H. bengalensis* from undetermined species of *Heterotermes*. Das (1976) recorded this species from the host *Heterotermes indicola* (Wasm.) West Bengal. *Copto-*

termes heimi (Wasm.) is therefore a new host record for *H. bengalensis* from Sagar Island, 24-Parganas district. Specimens of *H. bengalensis* in the present study are identical with the types in all respect except that they are slightly smaller and the axostyle is extending up to the posterior extremity of the body wall.

Holomastigotoides hartmanni Koidzumi, 1921

Pl. VII, Fig. B

Description : This species is oval or elliptical in outline and slightly narrowed at the anterior end. It measures 93 - 75 - 175.5 µ (average 110.62 µ) in length and 63.75 - 86.25 µ (average 75 µ) in breadth. The shape of the body seems to be constant. The spiral bands are dexiotropic and are 26 in number. Two types of flagella cover the body. The first variety of flagella covers the major portion of the body except the posterior one fourth. The second variety of flagella at the posterior end are fairly large. The nucleus is oval, situated near the anterior end of the body, measuring 15.93×11.99 µ. The prenuclear zone is well developed. The endoplasm contains a large quantity of fragments of wood of different sizes. The food contents are clearly visible in posterior part of the body. As a result of heavy ingestion of food, mainly wood, the axostyle could not be detected.

Hosts : *Coptotermes formosanus* Shiraki, Formosa (Type host) ; *Coptotermes heimi* (Wasm.), Gangasagar, Sagar Island, 24-Parganas district, West Bengal.

Remarks : Koidzumi (1921) described this species from the host *Coptotermes formosanus* collected from Formosa. Specimens of *H. hartmanni*, collected now from the new host *Coptotermes heimi* from Sagar Island, West Bengal are identical with those described by Koidzumi, except that the prenuclear zone in the present record is very well developed.

Holomastigotoides ogivalis de Mello, 1935

Pl. VII, Fig. C

Description : The body resembles the form of an inverted cup with a blunt finger like elevation, measures 67.5 - 94 µ (average 80.75 µ) in length and 40.5 - 56.25 µ (average 48.37 µ) in breadth. The body is covered by two types of flagella. The shorter flagella occupy the whole of the body in dexiotropic rows while longer ones are situated densely on the posterior surface. The ovoid nucleus is anterior, measures 11.62×9 µ and carries a distinct prenuclear zone. The axostyle is indistinct.

Hosts : *Coptotermes* sp., Daman, India (Type host) ; *C. heimi* (Wasm.), Dharwar, India ; *C. heimi* (Wasm.) Haldia (Midnapur district) and Falta (24-Parganas district) ; *Heterotermes indicola* (Wasm.), Sapkhali, Sagar Island, 24-Parganas district, West Bengal.

Remarks : de Mello (1935) described this species from *Coptotermes* sp. Karandikar and Vittal (1954) and Das (1976) recorded it from *C. heimi*. The species recorded frcm the new host *H. indicola* from Sagar Island, 24-Parganas district, in the present study is identical with type except in this the finger like elevation is well developed.

Family : TRICHONYMPHIDAE

Pseudotrichonympha cardiformes Karaudikar and Vittal, 1954

Pl. VII, Fig. D

Description : The body is heart-shaped and measures 105.00 - 131.25 µ (average 118.12 µ) in length and 82.2 - 101.25 µ (average 91.87 µ) in breadth. The anterior part consists of a bell like campanula. The middle portion of the campanula is called rostral tube which measures 15 μ. The tube bears a hemispherical apical cap. The campanular surface is covered by three types of flagella which are distinguishable from one another in regards to their length and location. The flagella of first type are relatively short and confined to the rostral tube region of the campanula. The flagella of second type are the longest and extremely mobile. They arise in a thick circular band just below the first type of flagella. The flagella of the third type which are situated posterior to the circular band of the second type are a little longer those of the first type and arranged in longitudinal rows in a leiotropic manner. They cover the campanula and the rest of the body except the short glabrous end of the posterior extremity. The nucleus is spherical and situated in the middle region of the body. It measures 15 μ in diameter. The endoplasm contains fragments of wood of different size.

Hosts : *Heterotermes malabarica* Snyder and *C. heimi* (Wasm.), Dharwar, Karnatak (Type host) ; *Heterotermes indicola* (Wasm.), Sapkhali, Sagar Island, 24-Parganas district, West Bengal.

Remarks : Karandikar and Vittal (1954) described this species from the host *Heterotermes malabaricus* and *Coptotermes heimi* from Dharwar, India. *Heterotermes indicola* is a new host for *P. cardiformes* from Sagar Island, 24-Parganas, West Bengal. The specimens recorded from *H. indicola* are exactly identical with the type in all characters except that it is smaller.

Pseudotrichonympha subapicalis Karandikar and Vittal, 1954

Pl. VII, Fig. E

Description : The body is generally rounded and swollen anteriorly, slightly narrow posteriorly to a blunt end, measures 172.5 - 195 μ (average 181.66 μ) in length and 82.5 - 90 μ (average 87.5 μ) in breadth. The campanula is situated in the middle in the anterior portion of the body. The campanular region can be seen in the form of two circular areas situated one within the other. The outer circle in the species represents the peripheral margin of the campanula. The middle circle represented the rim along which are arranged the second series of the flagella like the eyelashes. The inner circle has the tiny aperture in the centre. The disc represents flexed upper margin of the rostral tube, while the tiny aperture corresponds to its lumen. The body covered all over with the third series of flagella. The endoplasm is distinguishable in two zones. The zone adjoining the campanular region is finally granular while the rest is full of coarse granules is spherical and is usually found in anterior region, measures 18.12 μ in diameter.

Hosts : *Coptotermes heimi* (Wasm.) and *Heterotermes malabaricus* Snyder, Dharwar, India (Type host) ; *C. heimi* (Wasm.), Bamankhali, Sagar Island, 24-Parganas district, West Bengal.

Remarks : *Pseudotrichonympha subapicalis* collected from the termites of West Bengal. Comparatively smaller in dimension and the anterior end of the body is disc like.

Sincere thanks are due to the Director, Zoological Survey of India for facilities provided for the work. I am also grateful to Dr. A. K. Mandal, Zoological Survey of India, for going through the manuscript and Dr. P. K. Maity of the same department for identifying the hosts used for this study.

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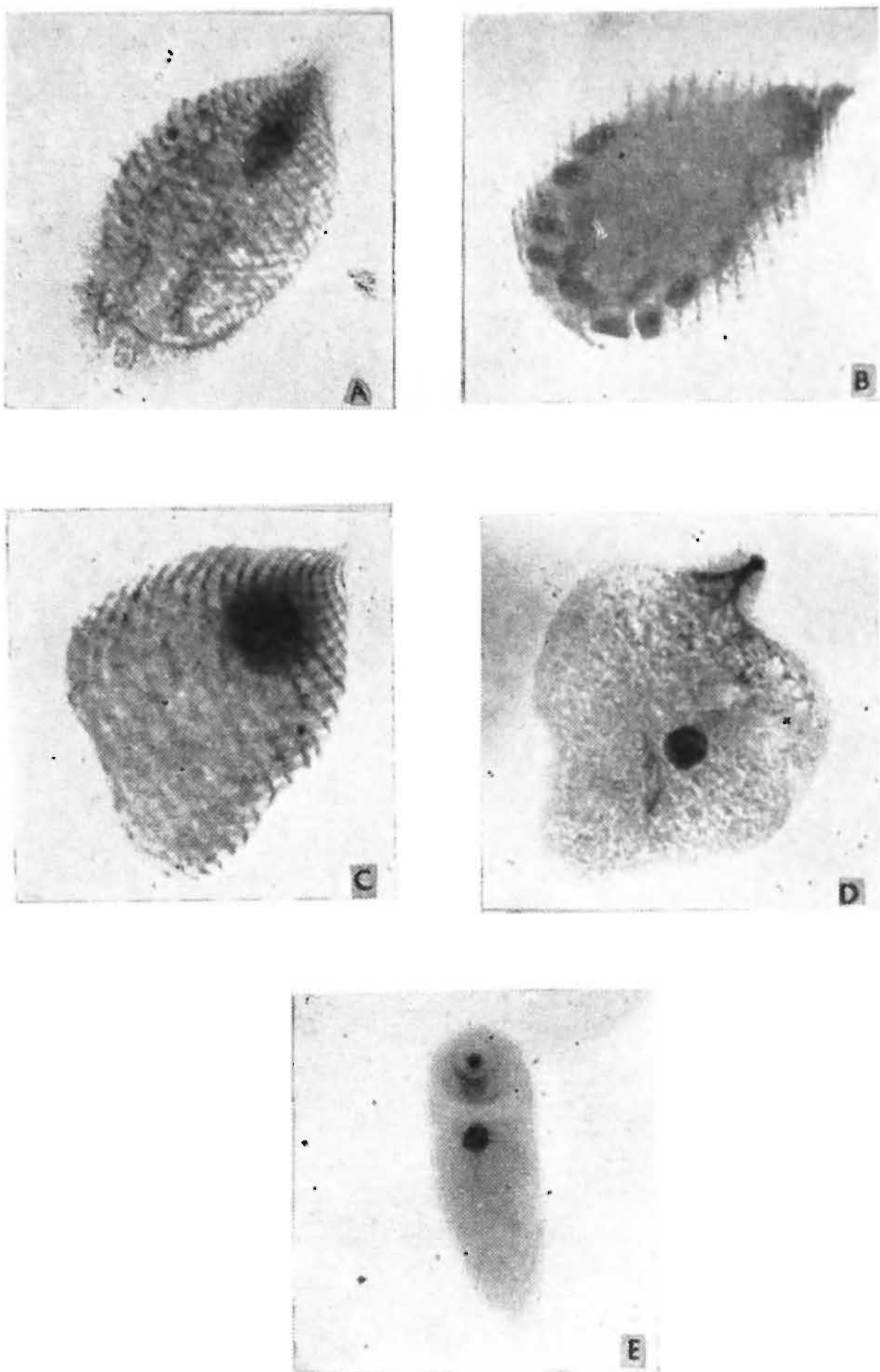
Zoological Survey of India, Calcutta

D. N. TIWARI

TIWARI PLATE VII



A. *Holomastigotoides bengalensis* Chakravarty and Banerjee ;
B. *Holomastigotoides hartmanni* Koidzumi ;
C. *Holomastigotoides ogivalis* de Mello ;
D. *Pseudotrichonympha cardiformes* Karandikar and Vittal ;
E. *Pseudotrichonympha Subapicalis* Karandikar and Vittal.

SHORT COMMUNICATION

Bull. zool. Surv. India, **1** (3) : 315-316, 1978

NOTES ON SOME ECHIURA FROM THE EAST COAST OF INDIA

From the east coast of India, so far, eight species of Echiura were described. The present note reports the occurence of four species of Echiura : *Thalassema diaphanes* Sluiter, 1889, *Anelassorhynchus branchiorhynchus* (Annandale and Kemp, 1915), *A. dendrorhynchus* (Annandale and Kemp, 1915) and *A. sabinus* (Lanchester, 1905). Out of them, *T. diaphanes* and *A. sabinus* are hitherto not known from the east coast. *A. dendrorhynchus* is recorded for the first time outside the type locality, while *A. branchiorhynchus* originally based on a single specimen was collected in abundance at present locality.

Order ECHIUROINEA BOCK
Family ECHIURIDAE de Blainville
Subfamily THALASSEMATINAE Monro

Thalassema diaphanes Sluiter

Material : 1 ex. off Porto Novo, Tamilnadu, 12. iii. 1975, Coll. *B. Srikrishnadhas* (C. A. S. in Marine Biology).

Remarks : The length of the proboscis is about a half than that of the trunk ; its distal extremity is broader than the middle part and truncated and its proximal extremeties join to form a very short tube.

The trunk measured 10 mm in length. The skin papillae are more or less of same size and uniformly distributed over the body without any localised concentrations. Longitudinal muscle layer of the body wall is continuous, One pair of short nephridia occur, the nephrostomal lips of which are not spirally coiled as in *Anelassorhynchus*. Anal vesicles are short and transparent.

Besides the proboscis—trunk relation, other characters justify the specific status.

Distribution : West coast of Africa, South Africa, Cape Province, Maldive and Laccadive Islands, Andaman Islands, Bay of Batavia (Type Locality) and New Britain.

Anelassorhynchus branchiorhynchus
(Annandale and Kemp)

Material: 12 ex. Champatala, Sagar Island, 28. x. 1966, Coll. *S. S. Saha* ; 17 ex. Vanga Tushkhali, Sundarban, 15. iii. 1975, Coll. *A. Mishra*.

Habitat : Specimens were collected from hard black humus soil and fine muddy sand behind sandy bed. On lifting from the substratum waves of contraction were observed passing from anterior to posterior end of the body. Their burrows are U shaped but both the arms of U are very narrow as opposed to *Urechis caupo* Fisher and MacGinitie. Here, the burrow is shared with a gobiid fish, a polychaete of the family Polynoidae and an isopod.

Remarks : The largest specimen measured about 130 mm in length including 45 mm proboscis and 43 mm in maximum width of the trunk, while smallest one attained 55 mm in length including 17 mm proboscis. The proboscis is more or less truncate and the dendritic outgrowths are more developed than reported by earlier workers. Dorsal surface of the proboscis is practically smooth as opposed to the reported tuberculate appearance (Annandale and Kemp, 1915) but the conspicuous longitudinal ridge is present on the ventral surface of the proximal part of the proboscis. The hooks are dark brown, tipped with golden yellow and vice versa.

Distribution : India : Chingrihata, out skirts of Calcutta (Type locality), Chandipore and Port Okha.

Anelassorhynchus dendrorhynchus (Annandale and Kemp)

Material : 1 ex. Pamban near Rameswaram, Tamilnadu, 4. iii. 1975, Coll. *B. P. Haldar* ; 4 ex. (not available in the Z. S. I. collection), Sagar Island, 28. v. 1975, Coll. *A. Das* (University of Calcutta).

Habitat : Occurence of this species was not as abundant as *A. branchiorhynchus*, but collected from the same type of bed. Commensals of its burrow were not observed.

Remarks : The largest specimen measured 70 mm in length excluding 9 mm proboscis, while the smallest one attained 28 mm excluding 5 mm proboscis. The proboscis-trunk relation ranges from 1/6 to 1/8. The proboscis has dendritic outgrowths but the longitudinal ridge on the ventral surface as seen in *A. branchiorhynchus* is absent. Two circles of large conical papillae occur at the posterior region of the body-one around the anus and the other in the preanal region. The circum-anal region is devoid of concentric folds as stated by Annandale and Kemp, 1915. Anal trees reach about half the length of the trunk.

Distribution : The present record shows that this species has a wide range of distribution on the east coast on either side of the type locality, Chilka Lake, Orissa.

Anelassorhynchus sabinus (Lanchester)

Material : 1 ex. Pamban near Rameswaram, Tamilnadu. 1. iii. 1975, Coll. *B. P. Haldar* ; 1 ex. off Porto Novo, Tamilnadu, 12. iii. 1975, Coll. *B. Srikrishnadhas* (C. A. S. in Marine Biology).

Remarks : Out of the two specimens, one proved to be an immature form as the gonoducts are devoid of sex cells. The length of the trunk ranges from 7.5 mm to 19 mm, while proboscis forms 1/4 to 1/6 of the trunk length, respectively. The proboscis shows the beginning of the formation of gill like outgrowths. The trunk is covered uniformly with large and small papillae. Muscle layer is continuous. Spirally coiled filaments of nephridia extend out of the nephrostomal lips. Short anal vesicles, a small caecum and a pair of ventral hooks close to the proboscis are present.

Distribution : Japan, Korea, Indonesia (Type Locality), Thailand and Pirotan Island (India).

REFERENCE

ANNANDALE, N. AND KEMP, S. 1915. Fauna of the Chilka Lake. The Echiuroidea of the lake and the Gangetic Delta. *Mem. Indian Mus.*, 5 : 55 - 63.

Zoological Survey of India, Calcutta

BADRI PRASAD HALDAR

SHORT COMMUNICATION

Bull. zool. Surv. India, 1 (3) : 317, 1978

RECORD OF A STRANGE ASSEMBLEGE OF SEA TURTLE SHELLS (*LEPIDOCHELYS* Sp.) NEAR THE SOUTHERN PART OF DIGHA SHORE, WEST BENGAL.

In the course of attempts to search the breeding grounds of the horse-shoe crabs,* *Tachypleus gigas* (Müller) and *Carcinoscorpius rotundicauda* (Latreille) along the southern part of the Digha shore with two Japanese Scientists* during last April, 1977, nine full-sized dry skeleton shells of the sea turtle *Lepidochelys* sp. were noticed at one place lying side by side in a half buried and scattered condition on a plain sandy ground surrounded by sand dunes at a distance of approximately 150 metres from the sea. The shells on examination of and it appeared that they were buried for many years, as the original carapace, colour (olive green) of most of these shells had been lost and the white bony surfaces being exposed. The original colour patches were found here and there over the surfaces of a few carapaces only. Out of the nine shells, five shells were found in moderately good condition.

In one case, the dry half-broken head was found still lying joined with one shell. All these five shells (Plate VIII) were properly arranged, measured and photographed. Length of the carapaces of all the nine shells varies between 65.4 cm.—70.2 cm. In five cases, both the carapace and plastron were found to be still in joined condition but in other four cases only the carapace were found.

According to the discussions the author had with the specialists of this department this sort of peculiar assemblege is extremely unusual and unknown and attributed to the facts that this might be due to some sort of natural calamity.

It may be explained that due to the natural egg-laying instinct, the concerned sea turtles might have come together at this spot for egg-laying but were suddenly trapped due to some unnatural calamity.

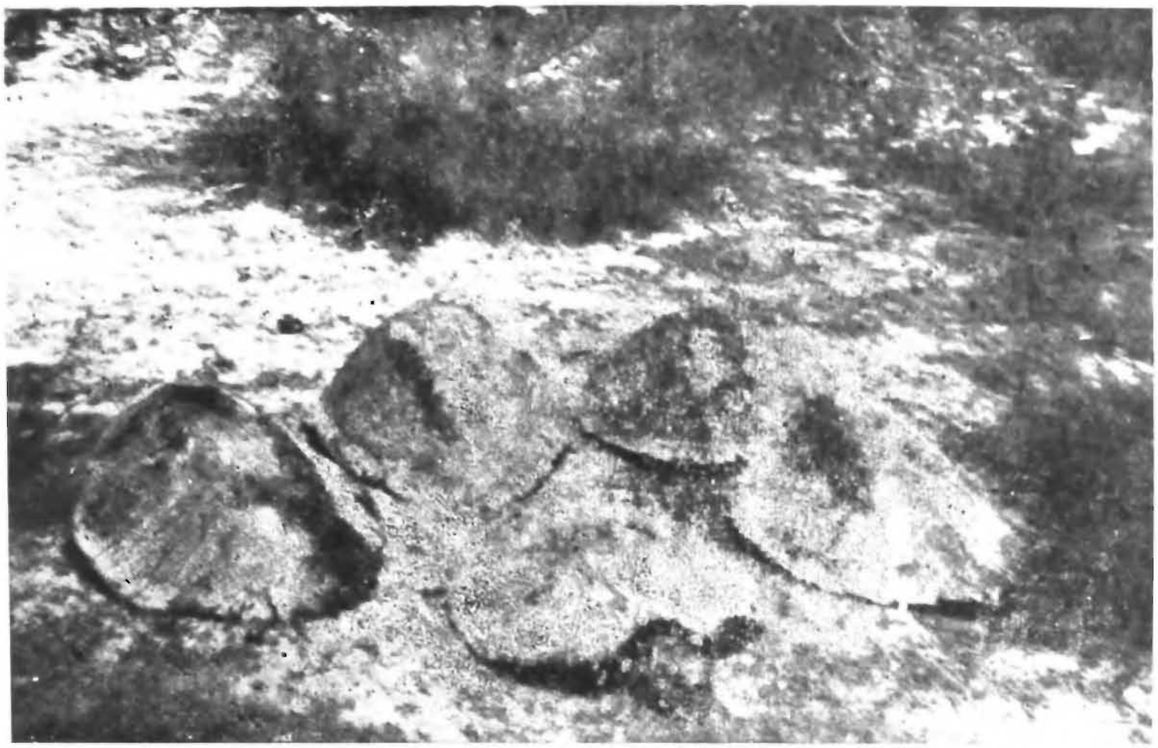
Zoological Survey of India,
Calcutta

T. K. SEN

* The author accompanied a team of Japanese Scientists during April-May, 1977 as Liaison Officer in connection with their research works on Indian horse-shoe crabs along the West Bengal coastal regions.

SEN

PLATE VIII



Dry skeleton shell of the sea turtle
Lepidochelys sp.

Bull. zool. Surv. India, 1 (3) : 319-320, 1978

FOUR NEW RECORDS OF REPTILES FROM MIZORAM, INDIA

While studying a small lot of reptiles collected from Mizoram, the following four well-preserved species constitute the new records from this locality.

Order SQUAMATA
Suborder SAURIA
Family SCINCIDAE

1. Lygosoma indicum indicum (Gray)

Material : 1 ex. ; Bhumtilong, c. 16 km. from Aijal, Mizo district, Mizoram ; coll. *T. G. Vazirani* ; 19. x. 1960, (Z. S. I. Reg. No. 21709). Standard length (snout to vent) 65.5 mm., tail 85 mm.

Remarks : According to Smith (1935) this species is confined to the Eastern Himalayas (Darjeeling, Sikkim and Arunachal Pradesh) within the Indian limits. The present finding extends the known range of the species up to northeasternmost part of India.

Suborder SERPENTES
Family COLUBRIDAE

2. Dinodon septentrionalis (Günther)

Material : 1 ex., Bhumtilong, Mizo district, Mizoram ; coll. *T. G. Vazirani* ; 23. x. 1960, (Z. S. I. Reg. No. 21904). Standard length (snout to vent) 305 mm., tail 85 mm.

Remarks : This species has earlier (Smith, 1943) been reported from the Eastern Himalayas (Darjeeling district) and Assam within the Indian limits. The present finding extends its known range further to the northeasternmost part of India.

3. Lycodon aulicus aulicus (Linnaeus)
(Common Wolf-Snake)

Material : 1 ex., Selingkwan, Mizo district, Mizoram ; coll. *T G. Vazirani* ; 20. x. 1960, (Z. S. I. Reg. No. 21'06'). Standard length (snout to vent) 44 mm., tail 129 mm.

Remarks : According to smith (*op. cit.*) this Wolf-Snake has been recorded from the various parts of India and Indo-China, mainly from the Northern Himalayas (Kangra district, Himachal Pradesh) and the Andaman and Nicobar Islands. The present record of the species, therefore, constitutes the first authentic record from Mizoram.

Family VIPERIDAE

4. Trimeresurus erythrurus (Cantor)
(Pit Viper)

Material : 1 ex., Bhumtilong, Mizo district, Mizoram ; coll. *T. G. Vazirani ;* 23. x. 19'0, (Z. S. I. Reg. No. 21911). Standard length (snout to vent) 440.5 mm., tail '00.5 mm.

Remarks : This species of Pit Viper has earlier (Smith, 1943) been reported from

Bengal and the Himalayas (east of longitude 88°); Assam, Naga Hills (Nagaland) and Garo Hills (Meghalaya) within the Indian limits. The aforesaid finding of the species, therefore, constitutes the first authentic record from Mizoram and thereby extending the known range of its distribution further to northeasternmost part of India.

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SMITH, M. A. 1935. *Fauna of British India including Ceylon and Burma.* Amphibia and Reptilia. Vol. II- (Sauria) Taylor and Francis (London).

SMITH, M. A. 1943. *Fauna of British India including Ceylon and Burma.* Amphibia and Reptilia. Vol III - (Serpentes) Taylor and Francis (London).

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S. K. TALUKDAR
D. P. SANYAL

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WIGGLESWORTH, V. B. 1950. *The Principle of Insect Physiology* (4th ed.) : viii+1-544, London (Methuen & Co.).

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