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BIO-ECOLOGICAL OBSERVATIONS OF *SIMULIUM (EUSIMULIUM)*
AUREOHIRTUM BRUNETTI (DIPTERA : SIMULIIDAE)

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ABSTRACT

The present paper deals with the oviposition, hibernation, voltinism, habitat preference, larval feeding and cannibalism, and depredation of *Simulium (Eusimulium) aureohirtum* Brunetti studied in Shillong, and at and around Jowai and Garompani of Meghalaya ; Gulzang, Lamzang, Pengzang and Kangvai of Manipur ; Kolasib and Chhiatlang of Mizoram ; and Sapargiri and Mara of Arunachal Pradesh in the North-East India. Oviposition occurred in water with currents of about 0.2-0.5 m/sec. but never in water with high velocity (i) by tapping the abdomen through the water while hovering, and (ii) by crawling under the water, from the forenoon to the late afternoon with a pause at mid-day. This was a univoltine species overwintering in the larval stage. The population of larvae and pupae of this species showed an evolutionary sequence from almost quiet water to rapid water. The larvae were found to feed on algae and hardly to show cannibalistic nature on one hand, and to fall as prey to ants on the other.

INTRODUCTION

Simulium (Eusimulium) aureohirtum Brunetti is widely distributed in India (Datta, Dey, Paul and Pal, 1976) and this is one of the very few species in India to occur as an exotic species in Pakistan (Puri, 1933 ; Lewis, 1973), Japan (Ogata and Sasa, 1955) and Ryukyu Islands (Ogata, 1956). Despite its wide distribution and abundance, information on the bio-ecology of this species appears lacking, mostly because of its apparent non-bloodsucking habit. Datta *et al.* (1975, 1976) have briefly indicated some aspects of the ecology of this species. Further details of the bio-ecology of this species from the North-East India are presented here.

NATURE OF HABITATS

Observations on the bio-ecology of *S. (E.) aureohirtum* were mainly made in Shillong (1380-1450 m) of Meghalaya, and data from places at and around Jowai (200-250 m) and Garompani (150 m) of Meghalaya ; Gulzang (800 m), Lamzang (800 m), Pengzang (875 m) and Kangvai (875 m) of Manipur ; Kolasib (715 m) and Chhiatlang (925 m) of Mizoram ; and Sapargiri (175 m) and Mara (360 m) of Arunachal Pradesh were also associated. The main site of investigation was the Botanical Garden near the Ward Lake in Shillong. The outlet for the excess water from the lake was found to form a semi-permanent stream of moderate current and of nearly two metres'

width. The stream-bed generally had soil cover over rocks and mainly decaying twigs and leaves were the substrata for oviposition. The site almost always remained dark due to the presence of hardwood forest canopy. The small tributaries resulting from a water fall at a place near Jowai (Pl. I, fig. 1) were not even each a foot wide had moderate current. These trickles of water were rock-bottomed and margined by floating grasses. The cultivatable paddy fields at Garompani (Pl. I, fig. 2) were surprisingly found to have tremendous growth of larval population of this species on stubbles submerged in water. The water was almost stagnant and remained exposed to direct sunlight throughout the day because of absence of tall trees nearby. A semi-permanent stream at Gulzang (Pl. I, fig. 3) was another breeding site of this species. The stream-bed was muddy in nature but the scattered stones and decaying twigs or leaves were used as substrata. In many places like Kangvai (Pl. I, fig. 4) this species was found to breed in man-made irrigating channels with moderate or rapid current. In other places of Manipur, Mizoram and Arunachal Pradesh there were many trickles of water with feeble water current or with almost stagnant water inhabited by the immature stages of this species on trailing vegetation or decaying leaves.

OVIPOSITION

Females of this species mainly oviposited in water with currents of about 0.2-0.5 m/sec. but never in water with high velocity. Two methods of oviposition were observed in this species. Firstly, females at the time of oviposition, singly or in groups crawled under the water and reached the undersurface of the substratum to lay their eggs. After oviposition they simply floated themselves on the water surface and being held up by any kind of

obstruction they got off. Lastly, females were observed to hover over the substratum constantly splashed with water or over-lain by a thin film of flowing water with very slow current and to deposit eggs on the surface by tapping the abdomen gently through the layer of water. An egg was roughly triangular in shape approximately being $0.25 \text{ mm} \times 0.15 \text{ mm}$ in size. A female laid nearly 225 eggs. Oviposition was observed to begin in the forenoon at the shady places and to end with the fall of darkness by a pause at mid-day only if the place was full of sunlight throughout the day.

HIBERNATION AND VOLTINISM

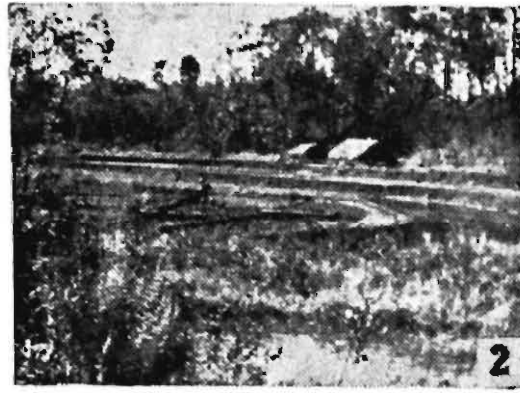
Eggs of this species were observed to hatch with the advent of autumn and to continue till early winter. Larvae developed probably during winter and hibernated in this stage. Pupae began to appear in the late winter with the rise of temperature. The occurrence of pupal exuviae in the field from the early spring led to believe that adults began to emerge from that time, although no adults could be collected in the field before the month of May when considerable emergence was evidenced, implying its univoltine nature particularly in high altitude areas. In lowland areas, a comparatively steady synchronization of the larval and pupal developments with the emergence of adults appeared difficult to conceive.

HABITAT PREFERENCE

This species seemed to prefer smooth surfaces of dead or decaying leaves for oviposition. It also laid eggs on trailing vegetation or floating grasses but avoided the hairy or rough surfaces. Occasionally, however, when the abovementioned substrata were lacking, it deposited eggs on stubbles of paddy fields. Larvae of this species were found to

DATTA

PLATE I



1. Collection of immature stages of *S. (E.) aureohirtum* Brunetti from tributaries at a place near Jowai, Meghalaya.
2. The cultivatable paddy fields at Garompani, Meghalaya, harbouring innumerable larvae of *S. (E.) aureohirtum* Brunetti.
3. A semi-permanent stream at Gulzang, Manipur, harbouring immature stages of *S. (E.) aureohirtum* Brunetti.
4. A man-made irrigating channel at Kangvai, Manipur, harbouring immature stages of *S. (E.) aureohirtum* Brunetti.

occur in higher numbers and more often on decaying leaves or grasses in small streams or trickles of water with very slow current. They, however, preferred clear water but could tolerate suspensoids to a certain degree. They were generally crowded together in extraordinary dense masses on a substratum but pupae were found to spread out. Pupae almost always occurred in situations free from full force of the current but the pupal respiratory filaments must have a constant change of water.

LARVAL FEEDING AND CANNIBALISM

The contents of the alimentary tract of some larvae from different localities were examined. Various algae especially diatoms, sand grains and vegetable debris could be identified from the tract. A specimen from Shillong was also found to contain a deformed and indigested simuliid larva in the tract.

DEPREDAATION

While collecting the immature forms of this species from a paddy field at Garompani, aphids were found associated with ants to infest grass-blades above the water surface but the portions under the water were found to frequent with the larvae of this species. Surprisingly, an ant was observed to attack a larva remained just at the water level, and to seize the opportunity to catch the larva.

DISCUSSION

The species under investigation bred in almost all sorts of watercourses having very slow to medium flow of water. The methods of oviposition of this species (i) by tapping the abdomen through the water while hovering; and (ii) by crawling under the water, were basically in conformity with those

followed by *S. (E.) praelargum* Datta and *S. (E.) gracilis* Datta, as reported by Datta, Dey, Paul and Pal (1975), but these latter species oviposited while alighting. The practice of alighting or of crawling might have come up only in the water with slower current without much disturbance (Grenier, 1949). The period of oviposition was also earlier when the place of oviposition was naturally dark. Other meteorological factors also might have impact on oviposition (Davies and Peterson, 1956).

In a high altitude place like Shillong, this species was univoltine. The larvae began to appear with the advent of autumn and overwintered in the same stage. Whether or not was there a single generation per year in low altitude places was yet to be established, for a steady synchronization of developments consequent upon the complex physico-chemical changes of the ecological niches was not clear. However, according to Davies (1961) this synchronization might have been achieved by the higher temperature threshold for pupation than that for larval development.

The choice of substrata by females of this species during oviposition indicated partial selectivity towards the nature and texture of the same. Larvae mostly frequented on the decaying leaves or grasses in small streams or trickles of water as a result of migration. Their distribution appeared to depend mainly on the availability of food and oxygen made by the speed of current of water and presence of a substratum suitable for attachment.

In an earlier report (Datta, 1975) the colonization by this species in relation to the velocity of water current had already been indicated. This investigation also revealed that the species successfully colonized the area where the immature stages were mainly the

inhabitants of watercourses with very slow current. Notwithstanding a small fraction of the population of larvae and pupae was found in rapid water, presumably with more suitable environs. Thus, this species appeared to have been passing through an evolutionary sequence from almost quiet water to rapid water wherein the immature stages might eventually be shown to have adapted well. Not only the current provided the larvae with mechanical force for attachment to suitable substrata (Hocking and Pickering, 1952) but also assured an abundant supply of food and oxygen (Wolfe and Peterson, 1959) which were uncertain in the very slow current of water. Thus, the adaptation to the habitat preferred by larvae was the most important factor in the life of the insect since the first ovarian cycle was supposedly dependant upon the level of nutrition of the larval stage (see Davies, 1961).

The food material recovered from the alimentary tract suggested that the larvae were mainly herbivorous. This nature was also pointed out by Davies and Syme (1958) in cases of *Prosimulium fuscum* Syme and Davies, and *P. mixtum* Syme and Davies. The cannibalistic nature of black fly larvae was observed in captivity by Peterson and Davies (1960), and Wu (1931), but this investigation confirmed this habit in nature. Peterson and Davies (*op. cit.*) observed ants to prey upon adult black flies and Crisp (1956) reported ants to attack exposed eggs, larvae and pupae of *Simulium damnosum* Theobald. This investigation also recorded an attack of ant to a larva of this species in the field.

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I am grateful to the Director, Zoological Survey of India, Calcutta, for kindly critically going through the manuscript; and to

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ON NEW AND LITTLE-KNOWN SPECIES OF PLANIPENNIA
(ORDER NEUROPTERA) FROM INDIA

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ABSTRACT

Two new species, viz., *Neuroleon unpunctatus*, and *Bubopsis rubrapunctata* from India have been described. Also, the distribution of three genera, *Nohoveus* Navas, *Geyria* Esben-Petersen and *Bubopsis* MacLachlan, has been reported for the first time from India. Redescription of two species, *Cueta lineosa* (Rambur) and *Geyria lepidula* (Navas), have also been incorporated.

In course of studying the neuropteran material from Peninsular India, the author has come across several interesting forms. Amongst five species distributed over an equal number of genera in two families, *Neuroleon unpunctatus* of the family Myrmeleonidae from Rajasthan on the north and *Bubopsis rubrapunctata* of the family Ascalaphidae from Karnataka on the south of the Indian peninsula have been described as new to science. Also, three genera, viz., *Geyria* Esben-Petersen, *Nohoveus* Navas and *Bubopsis* MacLachlan, have been observed to constitute new locality records for India. Moreover, two species, namely, *Geyria lepidula* Navas and *Cueta lineosa* (Rambur) have been redescribed. The present classification has been adopted after Holzeli (1972) for the first family and, after Weele (1908) for the other, in accordance with the suitable convenience of the author.

SYSTEMATIC ACCOUNT

Order NEUROPTERA

The order comprising about 300 species from India, can be best recognised by rather equal and membranous wings with netted

venation. It is known to occur in both the Old and New World. It is characterised by being predatory on the insects injurious to the crops of economic importance. Imms (1957) classified the order into two suborders, viz., Planipennia and Megaloptera, of which the former is presently dealt with.

Suborder PLANIPENNIA

This suborder can be diagnosed by the branches of veins bifurcated at margin and Rs with numerous branches on both wings. It is known to be widely distributed in both the world. It is represented by about 250 species in eleven families from India, all of which have been listed by Ghosh & Sen (1977). Presently, only two families are dealt with along with the key as hereunder.

Key to families

Antenna short, weakly clubbed or flattened at apex ; hypostigmatic cell elongate and well-differentiated	Myrmeleonidae
Antenna long, strongly clavate at apex ; hypostigmatic cell not differentiated	Ascalaphidae

1. Family MYRMELEONIDAE

The family is the largest of all its allies known from India. It is almost widely distributed and represented by three subfamilies, of which only one is incorporated hereunder.

Subfamily MYRMELEONINAE

This widely distributed subfamily is easily recognised by hind wing with Rs not arising close to the base, Cua distinctly forked and Cua 2 divergent. It is interesting to note that quite a number of tribes, being heterogeneously treated by Markel (1954), were sunk into the synonymy list of seven valid tribes by Holzel (1972). Of these, only three, as presently dealt with, were hitherto known mainly from the palaeartic region, though several other members of these tribes were also reported from the oriental region including India.

Key to tribes

- | | | |
|--|----------------|---|
| 1. Forewing 2A never angled but geniculate ; 2A and 3A distinct from each other ... | ... | 2 |
| — 2A simple ; 2A & 3A fused with each other ... | Distoleonini | |
| 2. Male with paired hairy structures at 6th & 7th or only at 7th abdominal segment ; axillary plate absent ... | Myrmecaelurini | |
| — Male without hairy structure ; axillary plate present or absent ... | Isoleonini | |

Tribe MYRMECAELURINI

This tribe was represented by a single genus from India. Presently, one more is added new for India and, dealt with hereunder.

Genus *Nohoveus* Navas

1919 *Nohoveus* NAVAS, *Insecta*, 8 : 169.

Type-species : *Myrmeleon lepidus* Klug

Diagnostic characters : Gradate cross-veins in the apical field of hindwing present ; ectoproct in males long and reaching upto ventral end of abdomen.

Distribution : Africa (North), Anatolia, Arab, Asia (Central), Europe (South-east), India, Iran and Kazastan.

Remark : Only one species from India is dealt with hereunder.

Nohoveus implexus (Walker)

1853. *Myrmeleon implexus* Walker, *Cat. Brit. Mus. Neur.*, 376.

1868. *Myrmecaelurus implexus*, MacLachlan, *J. Linn. Soc.*, 9 : 279.

Male : Maxillary and labial palpi, labrum, clypeus and frons : yellow ; a brown spot on 3rd segment of labial palpus ; antenna : brown ; epicranium (Fig. 1, A) : two brown spots on either side of epicranial suture ; pronotum (Fig. 1, A) : yellow, with long and short white hairs on lateral margin ; a longitudinal brown median stripe extending upto the anterior transverse groove besides a longitudinal brown lateral one on either side of it ; mesonotum : broad ; prescutum anteriorly and scutum laterally blackish ; scutellum with a blackish brown spot at middle ; metanotum : laterally black and posteriorly with a small black spot ; wings (Pl. III, A) : broad and rounded at apices ; forewing veins yellow ; basal half of pterostigma brown and apical field with a row of cross-veins ; inner radial field with 5 cross-veins ; hindwing : shorter and narrower than forewing ; apical field without gradate veinlet ; otherwise similar to forewing ; leg : yellow ; femur with white bristles and hairs ; tibiae with black bristles ; a row of small

white hairs on foretibia ; hind tibia as long as femur and tarsus taken together ; spur of hind tibia almost equal to 1st and 2nd tarsal segments taken together ; claws brown ; abdomen (Fig. 1, B) : dorsum with a median and two lateral longitudinal brown stripes ; each segment with long white hairs ; 6th and 7th segments with bunch of hairs (Fig. 1, C) ;

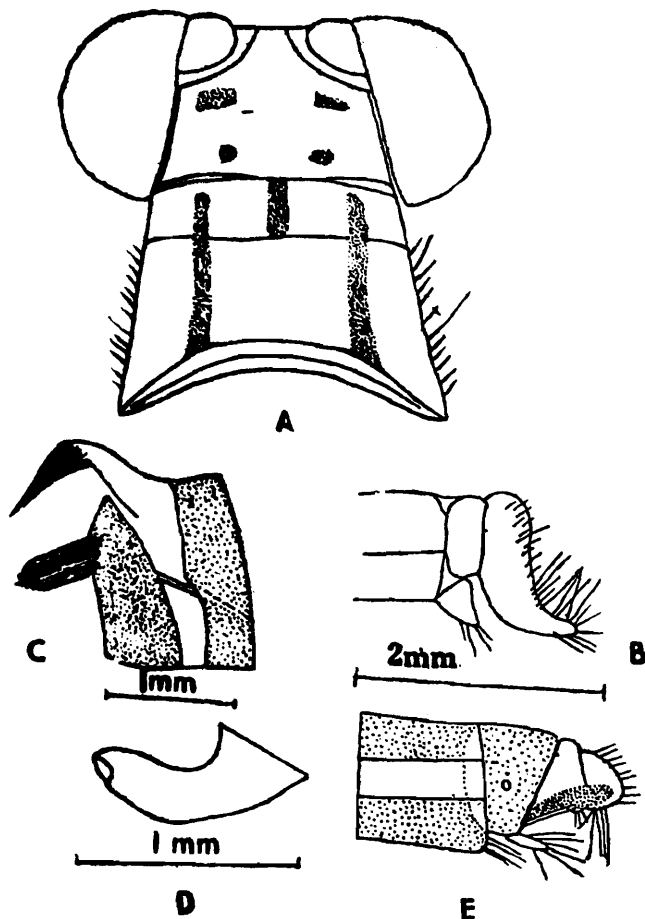


Fig. 1. (A-E) *Nohoveus implexus* (Walker), male : A. head & pronotum (dorsal) ; B. tip of abdomen (lateral) ; C. 6th and 7th segments of abdomen (lateral) ; D. coxopodite and paramere (lateral) ; female : E. tip of abdomen (lateral).

ectoproct long (Fig. 1, D). *Female* abdomen : terminal part as in Fig. 1, E.

Measurements ; ♂ : length of forewing, 20 mm ; of hindwing, 17 mm. ♀ : length of forewing, 16 mm ; of hindwing, 13 mm.

Material : 1 ♂ : India : Rajasthan, Bikaner, Kalayat, 14. ix. 1960 ; 1 ♀ : Pugal, 19. ix. 1960 ; (Coll. *M. Chandra*).

Distribution : India : Rajasthan.

Remarks : The species comes closer to *Nohoveus palpalis* (Kalapalek) in size, length of forewing and colouration of veins but can be easily differentiated by the bicoloured pterostigma. Moreover, considering the length of the ectoproct and the presence of gradate cross-veins in the apical field, the species is placed under the genus *Nohoveus* Navas.

Tribe ISOLEONINI

This tribe is represented by two genera from India, of which only one is presently dealt with.

Genus *Cueta* Navas

1911. *Cueta* Navas, *Insecta*, 1 : 242.

Type-species : *Myrmeleon lineosus* Rambur

Diagnostic characters : Inner radial field of hindwing with more than 5 cross-veins ; abdomen longer than wings ; ectoproct in male long and cylindrical.

Distribution : Afghanistan, Africa, Anatolia, Arab, Europe (South-east), India, Iran, Malagasy, Mongolia, Persia, Sri Lanka and Vietnam.

Remark : This genus is represented by six species and a subspecies from India excluding the present one, which is dealt with hereunder.

Cueta lineosa (Rambur)

1842. *Myrmeleon lineosus* Rambur, *Hist. Nat. Ins. Neur.*, 1389.

1853. *Myrmeleon morosus* Walker, *Cat. Brit. Mus. Neur.*, 389.

1968. *Cueta lineosa*, Holzel, *Beitr. Z. Naturk.*, 181 : 18.

Redescription : Labial and maxillary palpi, labrum, clypeus frons and antenna : brown ;

epicranium : with a broad, black, median interantennal mark encircling outwardly the base of antenna and extending upto the inner edge of each eye on either side ; vertex : brown with black spots as in Fig. 2, A ; pronotum (Fig. 2, A) : broader than long, with long and short white bristles on its lateral margin, with a median longitudinal black stripe and a similar stripe on either side of it ; meso- and metanotum as in Fig. 2, A ;

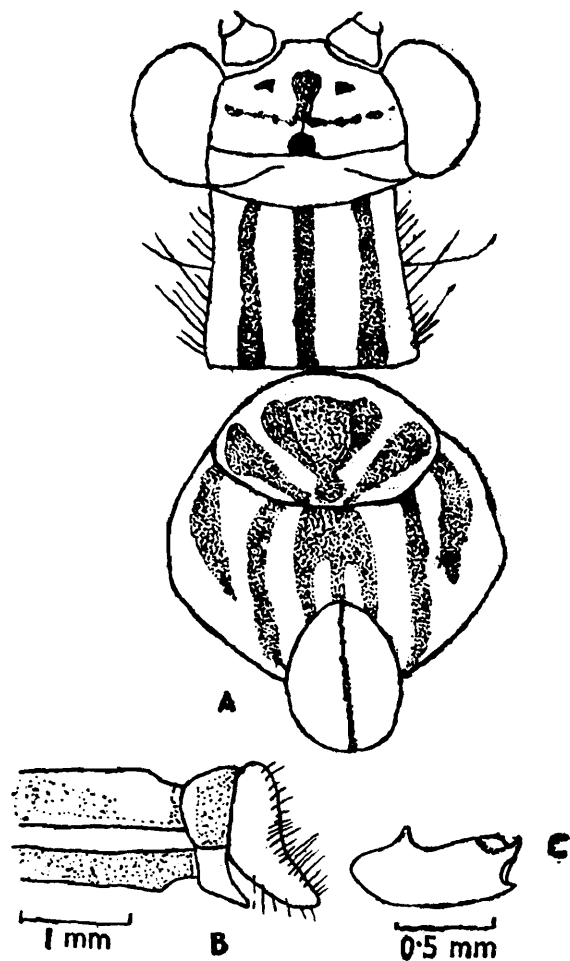


Fig. 2. (A-C) *Cueta lineosa* (Rambur), male : A. head, pro-, meso- and metanotum (dorsal) ; B. tip of abdomen (lateral) ; C. gonarcus (lateral).

wings as in Pl. III, D ; forewing : longitudinal veins yellow with dark brown stripes ; cross-veins either wholly or partially brown ; pterostigma brownish with a black marking ; a small brown spot at rhagma ; an oblique brown mark at the tip of Cua 2 extending

upto middle of intercubital area ; inner radial field with 8 cross-veins ; hindwing : same as forewing, but brown markings indistinct ; inner radial field with 6-7 cross-veins ; leg : yellow with brown markings ; femora with black dots besides a black longitudinal fascia on each mid- and hindfemur, which is with a row of long black hairs ; tibia as long as famur ; spur of hind tibia much shorter than basal tarsal segment, which is almost equal to 5th ; abdomen : dorsally yellow with three longitudinal black stripes extending from base to tip and also with short black hairs ; ventrally dark brown, tip of abdomen and genitalia in male as in Fig. 2, B-C.

Measurements : ♂ : length of forewing, 18-19 mm ; of hindwing, 14-15 mm.

Material : 1 ♂ : India : Rajasthan, Jaisalmer, Noah, 24. viii. 1960 (Coll. *M. Chandra*) ; 1 ♂ : Sambhar lake, 5. vii. 1959 (Coll. *A. K. Mukherjee*).

Distribution : Afghanistan, Africa, Anatolia, Arab, India, Iran and Kazastan.

Tribe DISTOLBONINI

This tribe is represented by only five genera from India, of which two, as keyed below, are presently dealt with.

Key to genera

Cup on forewing very short ; ectoproct in male cylindrical and longer than 8th abdominal segment

Geyria
Esben-Petersen

Cup on forewing appreciably long ; ectoproct in male oval and shorter than 8th abdominal segment ...

Neuroleon Navas

Genus *Geyria* Esben-Petersen

1920. *Geyria* Esben-Petersen, *Arch. f. natur.*, **84**(9) : 146.

Type-species : *Geyria saharica* Esben-Petersen.

Diagnostic characters : *vide* Key.

Distribution : Afghanistan, Africa, Arab, India and Iran.

Remark : This small genus, a new record for India, comprises only three species, being hitherto restricted to the palaeartic region. Of these, *Geyria lepidula* (Navas) is redescribed hereunder.

Geyria lepidula (Navas)

1912. *Macronemurus lepidulus* Navas, *Congr. Zool. Graz.*, 8 : 748.

1972. *Geyria lepidula*, Holzel, *Beitr. naturk. Forsch. SudwDtl.*, 1 : 44.

Redescription : Maxillary and labial palpi, labrum, clypeus and frons : yellow ; antenna : brownish ; epicranium : black at the base of antenna, with a median brown stripe and two rows of irregular brown spots ; pronotum : broader than long, yellow and with long white hairs on lateral margin, which is broadly black upto the anterior transverse groove ; with a v-shaped brown spot at middle besides two small brown spots on either side of it ; meso- and metanotum : yellow with two dark brown median longitudinal stripes ; meso- and metascutum : laterally black ; forewing (Pl. III, C) : long and oval, with pointed apex ; costal field with one row of cells ; pterostigma yellow with brown basal half ; apical field with a row of gradates ; banksian line absent ; Cup shorter than a cross-vein ; longitudinal veins yellowish with brown bands ; most of the cross-veins yellow with upper and lower portions brown ; forked veinlets at base on hind margin ; gradate veinlets in apical field and the cross-veins at base of hypostigmatic cell clouded with brown ; a brown oblique mark extending from tip of Cua 2+IA to intercubital field ; gradate veinlets from Cua 1+M₁ also clouded

with brown ; hindwing (Pl. III, C) : shorter than forewing ; cross-veins simple ; inner radial field with a single cross-vein ; Sc, R₁ and Cua with distinct brown bands ; membrane unmarked ; leg : fore- and midfemora yellow with distal brown spots ; with short white bristles besides long white hairs in the former ; hindfemur with a brown longitudinal stripe ; very long hairs and a few small white bristles ; fore- and midtibiae yellow ; dark brown at tip and with small brown spots throughout along with short white bristles ; hindtibia yellow but with brown tip, as long as femur and with long black bristles besides short hairs ; spur on hind tibia almost equal to the 1st segment of tarsus, which is brownish ; claw dark brown ; abdomen (Fig. 4, A) : dorsum dark brown with yellow longitudinal stripe on either side of each segment ; dark brown ventrally and with short white hairs ; ectoproct in male very long, cylindrical and with dark hairs.

Measurements : ♂ : length of forewing, 14 mm ; of hindwing, 13 mm. ♀ : length of forewing, 17 mm ; of hindwing, 15 mm.

Material : 1 ♂ : India : Rajasthan, Bikaner, Pugal, 19. x. 1960 ; 1 ♀ : Kalyat, 13. ix. 1960, (Coll. *M. Chandra*).

Distribution : India : Rajasthan ; Africa, Arab and Iran.

Genus *Neuroleon* Navas

1909. *Neuroleon* Navas, *Act. Mem. Congr. Nat. Esp.*, 1 : 148.

Type-species : *Myremleon arenarius* Navas

Diagnostic characters : *vide* Key.

Distribution : Africa, Afghanistan, Arab, Europe, India, Indonesia, Iran, Malagasy, Malay, Pakistan.

Remark: The genus is represented by two species from India excluding the present one, which is described hereunder.

***Neuroleon unpunctatus* sp. nov.**

Labial palpus: yellow but apical segment dark brown; maxillary palpus, labrum, clypeus and frons: yellow; antenna: scape yellow with small black bristles on inner side; pedicel dark brown, but flagellum brown with

scutum black laterally and scutellum yellow; metanotum: yellow with several black hairs; wings (Pl. III, B): hyaline, without spots; veins luteous; dark hairs on veins; pterostigma not very distinct; venation as in Pl. III, B; leg: yellow with brown tarsus and claw; with black bristles; forefemur with small dark brown spots on outer side; hind tibia longer than hind femur and its spur equal to basal two tarsal segments taken together; 5th tarsal segment longest of all; abdomen: black with the tip and genitalia in male as in Figs. 3, B-C and tip of abdomen in female as in Fig. 3, D.

Measurements: 1 ♂: length of forewing, 25 mm; of hindwing, 21 mm. 1 ♀: length of forewing, 24 mm; of hindwing, 20 mm.

Material: 1 ♂ (Holotype): Rajasthan, Bikaner, Pugal, 17. ix. 1960. Regd. no. 961/H₁₂; 1 ♀ (Allotype): Jaisalmer, Nokh, 29. viii. 1960. (Coll. *M. Chandra*). Regd. no. 962/H₁₂.

Distribution: India: Rajasthan.

Remark: The species may be easily distinguished from all other species of *Neuroleon* Navas by the unspotted wings.

Family ASCALAPHIDAE

This family is represented by three subfamilies, viz., Protascalaphinae, Holophthalminae and Schizophthalminae. It is reported to occur mainly in tropical belts of both the Old and New World. Presently, one subfamily is dealt with.

Subfamily SCHIZOPHTHALMINAE

This subfamily, which is recognised by the horizontally subdivided eyes, is reported from the Palaearctic, Ethiopian and Indo-Australian regions of the Old World. It includes five tribes from India, of which only one is presently dealt with.

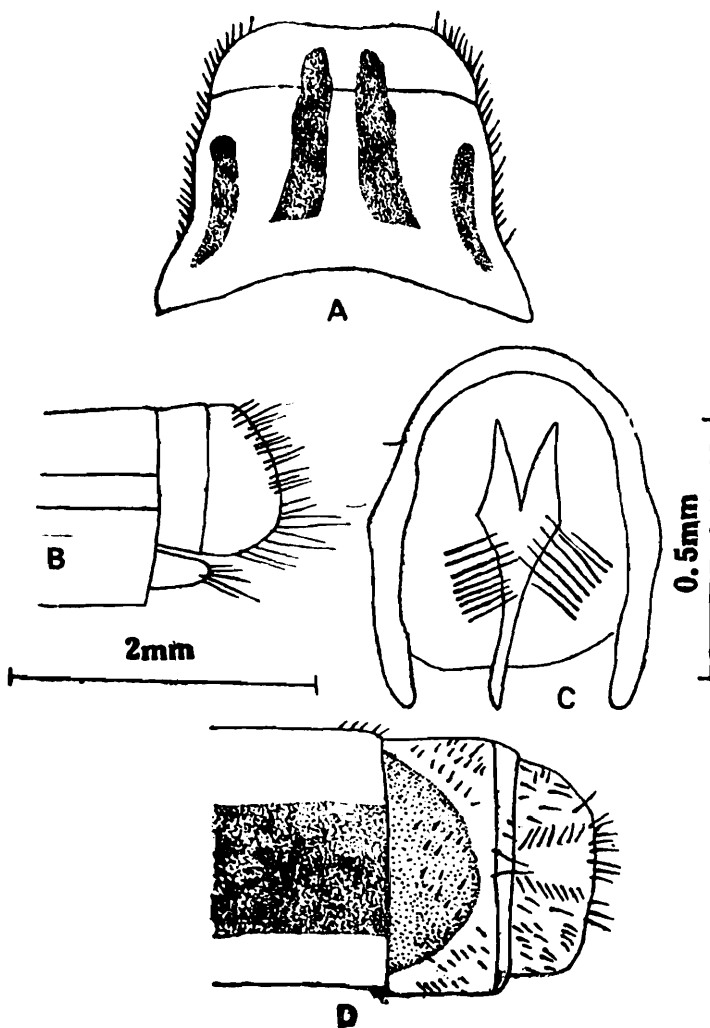


Fig. 3. (A-D) *Neuroleon unpunctatus* sp. nov., male: A. pronotum (dorsal); B. tip of abdomen (lateral); C. gonarcus and paramere (ventral); D. female: tip of abdomen (lateral).

small black hairs; pronotum (Fig. 3.A): two median longitudinal dark brown stripes present; mesonotum: prescutum with two irregular black longitudinal stripes; meso-

Tribe ENCYOPOSINI

This tribe can be best recognised by wings with narrow pterostigma and male genital valve very small as compared to the superior appendix. It is mostly reported from the different corners of Asia and Africa and rarely from Western Australia. Only two genera are so far known from India and the distributional record of one more is newly added, as hereunder.

Genus **Bubopsis** MacLachlan

1898. *Bubopsis* MacLachlan, *Trans. ent. Soc. Lond.*, 159.

Type-species : *Bubo agrioides* Rambur

Diagnostic characters : Superior appendix in male very long, geniculate and with a branch at middle.

Distribution : Palaearctic and Oriental.

Remark : This genus is a new record for India, under which the new species is described below.

Bubopsis rubrapunctata sp. nov.

Female : Clypeus and labrum : brown ; labial and maxillary palpi : yellow ; mandible : brownish, but dark-brown at tip ; face : with long brownish and yellowish vestiture ; antenna : reddish brown, without hair and club blackish brown ; vertex : with long greyish and blackish hairs ; eye : divided, lower division about half the size of upper one ; pronotum : blackish brown, with long brown hairs specially on hind margin and with white hairs laterally ; mesonotum : concolorous with pronotum, with long brown hairs on convex areas and long white hairs on antero-lateral corners of mesoscutum ; metanotum : colouration same as for pronotum but with long white hairs ; pleura : brown with long brownish and whitish hairs ; wings

(Pl. III, E) : hyaline and the space between Sc and R_1 with brown tinge ; forewing : costa yellowish ; Sc, R_1 , Cua2, 1A and 2A red ; vein M and Cua1 red upto a certain distance from base of wing ; all other veins and cross-veins brown except for a few red veinlets at base of costa, before R_s , and amongst M, Cua1 and Cua2 ; 21 costal veinlets before brown pterostigma, latter with 4 cross-veins ; apical field beyond pterostigma with two rows of cells ; axillary angle broad and red ; hindwing : smaller than forewing ; costa, Sc and R_1 conspicuously concolorous with forewing ; majority of the costal veinlets with smoky brown patches ; 20 costal veinlets before pterostigma, which is more elongated than that of forewing ; otherwise similar to forewing ; leg : femur reddish with long and dense white hairs ; tibia with long white bristles throughout and short black bristles only distally ; spur of hind tibia almost equal to 1st two tarsal segments taken together ; all tarsal segments with black bristles ; claws brown ; abdomen : rusty red ; 1st tergite covered with long brownish hairs ; 2nd segment with a cluster of moderately long white hairs at middle and with black hairs laterally ; superior appendages brown, broadened basally but narrowed distally and with short black bristles.

Measurements : length of body, 20 mm ; of antenna, 16 mm ; of forewing, 23 mm ; length of hindwing, 20 mm ; of abdomen, 14 mm.

Material : Holotype ♀ : India : Karnataka, Maruti Hills, Belgaum ; coll. nil, 27. xii. 1971, Regd. no. 963/H₁₂.

Male : Variations are noted below : labium, labrum, clypeus, maxillary and labial palpi : yellow ; wings : costal field in hindwing tinged with brown ; costal veinlets with more

strikingly smoky brown patches; 23 costal cross-veins before pterostigma in forewing and 18 in hindwing; abdomen (Figs. 4, B-C): superior appendages brownish yellow, forcipated, almost equal to half of abdominal length and with white hairs at base and black bristles on the inner margin, each provided with a small outgrowth on the inner margin at a certain distance from base and also furnished with small black bristles

Measurements: length of body, 20 mm; of antenna, 17 mm; of forewing, 21 mm; of hindwing, 17 mm; of abdomen, 15 mm.

Material: Allotype ♂: Loc. data same as for female. Regd. no. 964/H₁₂.

Distribution: India: Karanataka.

Remark: The species may be distinguished from all other species by the colouration of wings, legs and abdomen.

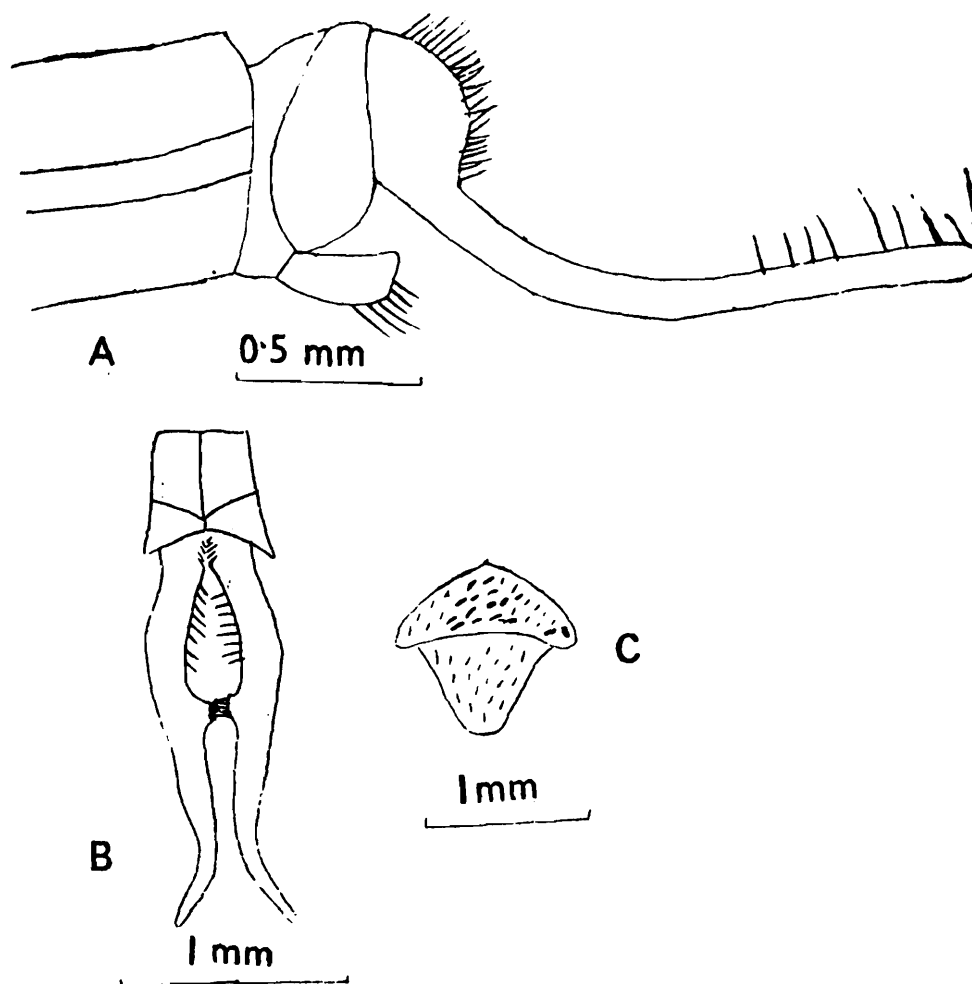


Fig. 4. (A) *Geyria lepidula* (Navas), male: A. tip of abdomen (lateral).

(B-C.) *Bubopsis rubrapunctata* sp. nov., male; B. superior appendages (dorsal); C. 9th sternite (ventral).

at tip; 9th sternite broad at middle, with a short pedunculate structure on each side, which is with white hairs and produced distally into a rounded protuberance bearing black hairs.

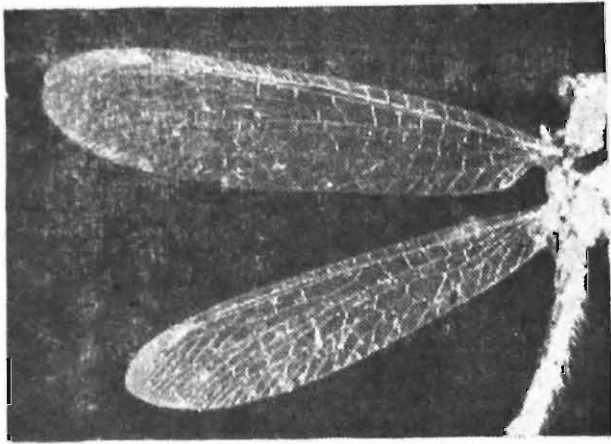
ACKNOWLEDGEMENTS

The author is grateful to the Director, Zoological Survey of India, for kindly providing laboratory facilities and to Sri D. K. Mandal, Assistant Zoologist, Lepidoptera

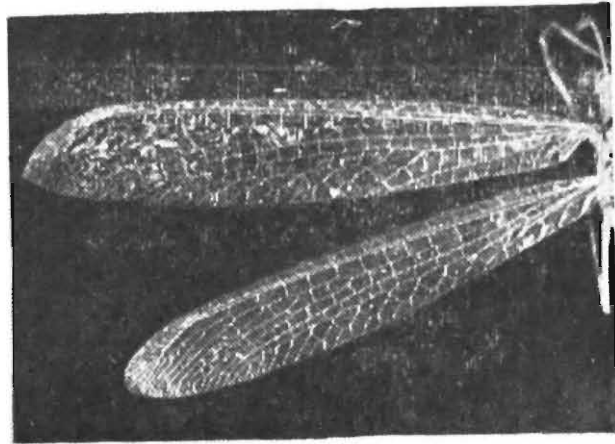
Section for numerous courtesies. My deepest appreciation and gratitude go to Dr. H. Holzel, Joanneumring 7, Graz, for critically reviewing the paper and confirming the identity of the species.

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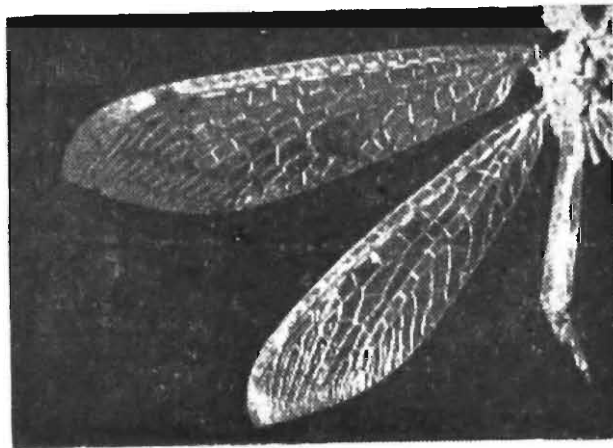
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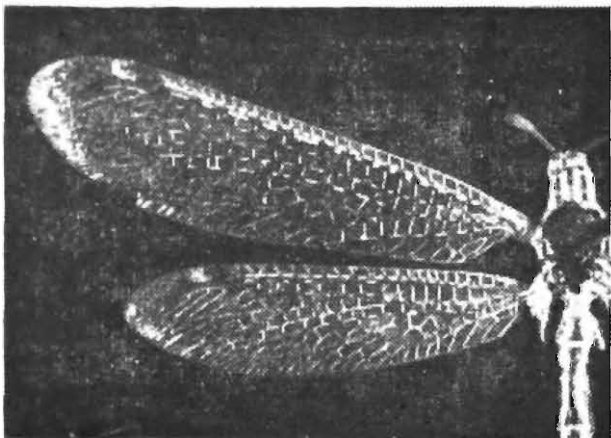
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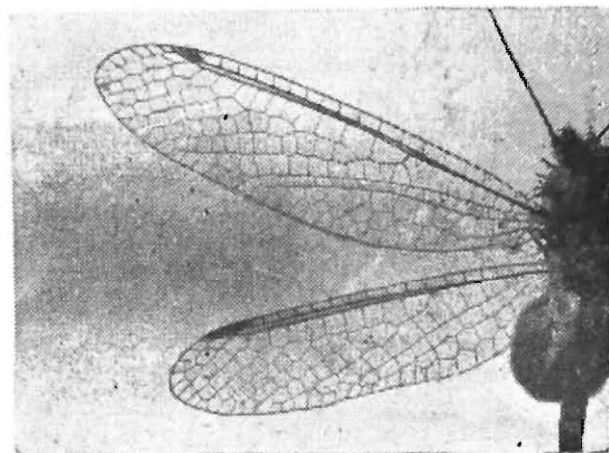
B



C



D



E

- A. *Nohoveus implexus* (Walker), male : fore- and hindwing ;
B. *Neuroleon unpunctatus* sp. nov., male ; fore- and hindwing ;
C. *Geyria lepidula* (Navas), male : fore- and hindwing ;
D. *Cueta lineosa* (Rambur), male : fore- and hindwing ;
E. *Bubopsis rubrapunctata* sp. nov., male : fore- and hindwing.

NOTES ON AN ABERRANT SPECIMEN OF COLUBRID SNAKE,
ENHYDRIS ENHYDRIS (SCHNEIDER)

S. K. TALUKDAR

Zoological Survey of India, Calcutta

ABSTRACT

An aberrant specimen of the colubrid snake, *Enhydris enhydris* (Schneider) was obtained from the Palta Water Works, Palta, 24-Parganas district, West Bengal. The snake possesses two well-differentiated heads. Details of this anomaly are presented in this communication.

INTRODUCTION

During the course of my investigation on the reptiles of Lower Bengal, an aberrant specimen of a colubrid snake, *Enhydris enhydris* (Schneider), collected from the vicinity of the Palta Water Works, Palta, 24-Parganas district, West Bengal, was noted. The specimen is characterised by two well-differentiated heads bifurcated from the neck region. Double-headed snakes occur as occasional freaks. In the present specimen both the heads appear to have originated from a common axis in the cervical region. Furthermore, it is evident that one of the heads has bifurcated a little earlier than the other (Plate II) and has a bend to the left, indicating anterior dichotomy.

Material examined : 1 ex., juv. ; from the vicinity of the Palta Water Works, Palta, 24-Parganas district, West Bengal ; Coll. S. L. Hora ; 27 July, 1930 (ZSI Regd. No. 23561).

Measurements : 164 mm standard length ; 41 mm tail length ; 11 mm head lengths and

6 mm maximum breadth of heads. The neck of the second head (which has a bend to the right) is 3 mm more than that of the first.

DISCUSSION

The occurrence of such anomaly is recorded by Wall (1905) in *Lycodon* Boie, 1826. Wall remarked "Such anomaly arises from a cleavage of one or other pole of the developing embryo and may occur either anteriorly or posteriorly". Dobson (1873) also recorded the occurrence of such abnormality in the Wolf Snake, *Lycodon aulicus* (Linnaeus), which is present in the Zoological Survey of India (Regd. No. 7965). Acharji (1945) reported an example of the Russell's Viper, *Vipera russelli* (Shaw), with two distinct heads on one body. Buckland [see Wall (*op. cit.*)] stated "There are two specimens of European Grass snakes with two heads on one body in the Royal College of Surgeons' Museum, London" Shortt (1868) mentioned a marine species of snake of the genus *Hydrophis*

Latreille, 1802, caught at Madras with two heads. Wall (*op. cit.*) referred to Nicolson's book 'Indian Snakes' (p.22) and mentioned a young two-headed snake of the genus *Xenochrophis* Günther, 1864, preserved in the Madras Museum. He, further, referred to 'Madras Times' of January 13, 1897, a specimen of a two-headed snake in the possession of Mr. Fisher of New York. The specimen was later confirmed as the American Hog-nosed snake, *Heterodon simus* (Linnaeus), which is a foot long and over four months old. Flower (1899) described a water snake, *Homolopsis buccatta* (Linnaeus), preserved in Thailand Museum, with two heads, side by side, each about equally and perfectly developed. Johnsons (1901) presented skiagrams of 13 specimen of snakes collected from the various museums in America and referred to 17 other instances of such anomaly culled from literature dating as far back as 640 AD. Very recently, Talukdar (1977) recorded such phenomenon in a Checkered Keelback, *Xenochrophis piscator* (Schneider), taken from the Chota Nagpur plateau of Bihar.

ACKNOWLEDGEMENTS

The author is grateful to the Director, Zoological Survey of India, Calcutta, for kindly providing the laboratory facilities. His heartfelt thanks of gratitude are due to Dr. B. Biswas and Dr. K. C. Jayaram, Deputy Directors for patient correction of the manuscript and valuable suggestions. He is indebted to Dr. R. C. Sharma, Zoologist

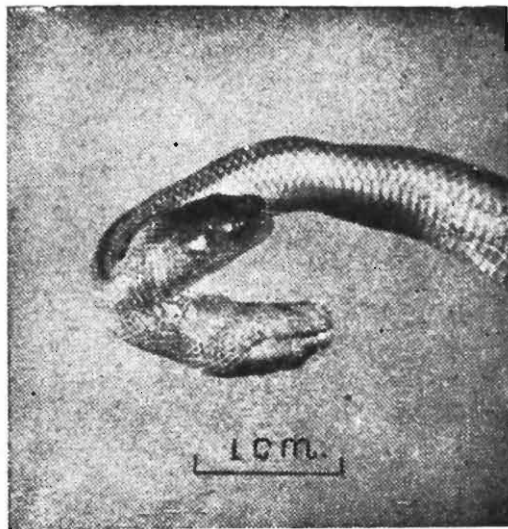
for his keen interest, co-operation and encouragement.

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TALUKDAR

PLATE II



Photograph of the head of *Enhydris enhydris* (Schneider) showing anterior dichotomy.

MICROCHIRONOMUS CLARILATUS SP. NOV. (DIPTERA : CHIRONOMIDAE)
FROM WEST BENGAL, INDIA

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ABSTRACT

A new species, *Microchironomus clarilatus* is described in this paper. The generic status of one species, *Cryptochironomus primitivus* Johannsen (1932) has been proposed as *Microchironomus primitivus* as a new combination.

INTRODUCTION

While going through the collections of chironomid midges, quite a few specimens were observed to belong to the genus *Microchironomus* Kieffer. The genus was described originally by Kieffer (1918) as a subgenus of *Chironomus* Meigen with *Chironomus lendli* as its type-species. Though no species of this genus was recorded previously from the Orient, we consider *Chironomus* (*Cryptochironomus*) *primitivus* described by Johannsen (1932) from Java to be a member of *Microchironomus*. With the present the number of species of the above genus comes to two from the Orient and one from India.

Microchironomus clarilatus sp. nov.

(Fig. 1 a-g)

Male :

Head : Brown in colour. Vertex light brown with 10 (outer verticals 5, inner verticals 5) setae, corona without seta. Clypeus with 14-16 (16) setae, clypeal ratio 0.94.

Maxillary palp (Fig. 1, a) yellow, length ratio of palpomeres I-V 3 : 2 : 4 : 6 : 8, L/W ratio 3.2. Eyes bare, reniform, extended dorsally, extension being 0.09 mm long. Frontal tubercle absent. Antenna dark brown, length ratio of flagellomeres I-X 1 : 1 : 1 : 1 : 1 : 1 : 1 : 1 : 1 : 32, AR 3.5. Pedicel ratio 1.2. CA 0.55, CP 1.2.

Thorax (Fig. 1, b) : Light yellow in colour. Anteprepronotum very thin, collar-like with a narrow emargination. Acrostichals 10 dorso-centrals 8, humeral 1 and prealars 2. Scutellum with 12 setae, postscutellum dark brown and bare.

Wing (Fig. 1, c) : Hyaline with veins light brown and the anterior veins more distinct than the posterior ones. Brachiolum with 2 setae. M with 3-4 setae ; R_{2+3} meets C very close to R_1 ; ending of R_{4+5} with C pointed ; r—m dark and proximal to f—cu ; An ends below f—cu. Squama with 5-6 setae. Haltere light brown without seta. CR 0.97, VR 1.12.

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Legs (Fig. 1, d) : Brown in colour except tarsomeres V of mid and hind legs. Fore tibial scale blunt bearing 2 long setae. Spurs of mid tibia equal, 0.017 mm long, ratio of length of spurs to the apical diameter of mid tibia 4 : 10 ; spurs of hind tibia unequal, 0.021 mm and 0.025 mm long, ratio of length of

developed with a cone shaped blunt apex bearing 10 setae at its base. Gonocoxite short with 10-12 (10) setae over it ; gonostylus long, little constricted at the middle, apical part swollen slightly with an abrupt tip, gonostylus with 5-7 long setae at its outer margin and 10 setae at its inner apical margin.

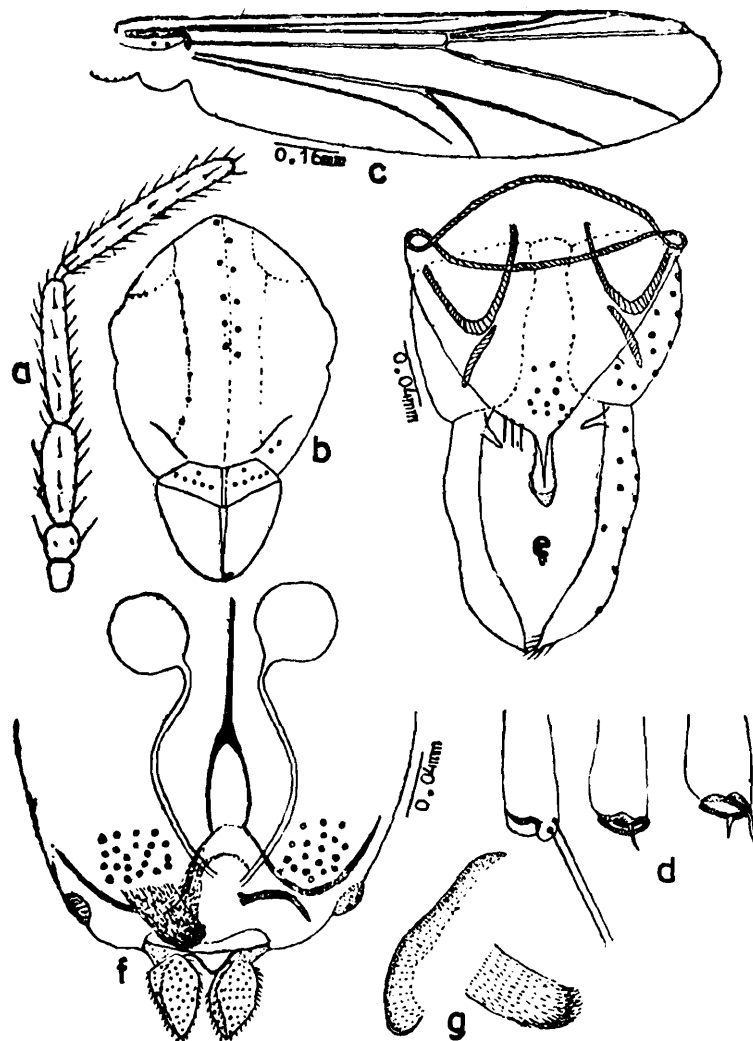


Fig. 1.a-g. *Cryptochironomus clarilatus* sp. nov.

(a) maxillary palp, (b) thorax, (c) wing, (d) tibial ends of fore, mid and hind legs, (e) hypopygium of male and (f-g) genitalia of female.

spurs to the apical diameter of hind tibia 5 : 11 and 6 : 11. Tarsomere V of mid and hind legs dorsoventrally flattened and dark. Pulvilli broad. LR 1.19 in fore, 0.58 in mid and 0.63 in hind legs.

Hypopygium (Fig. 1, e) : Anal point well

Appendage 1 very short and bare, appendage 2 absent. Laterotergite with 8 setae. Transverse sternapodeme 0.14 mm long, lateral sternapodeme 0.06 mm long and coxapodeme 0.03 mm long. HR 0.5, HV 1.8.

Female :

Similar to male with usual sex differences. Antenna brown, flagellomere V brown with an apical seta and 3 sensilla, length ratio of flagellomeres I-V 16 : 9 : 11 : 9 : 25, AR 0.56. Wing hyaline, chaetotaxy as in male. Genitalia (Figs. 1, f-g) : Notum 0.3 mm long. Coxosternapodeme broad and gently bent at the middle, gonocoxapodeme VIII broad and rounded with 6 setae. Gonocoxite IX with 3 setae. Gonapophysis VIII divided into a long dorso-mesal and a broad ventrolateral lobe. Apodeme lobe weak. Tergum IX with 6-7 setae on each side, tergum X with a small seta on each side. Postgenital plate conical. Cerci normal with 7 setae. Labia with microtrichia. Seminal capsules (Fig. 1, f) spherical, equal, with a neck ; main body of the capsules measuring 0.15 mm by 0.08 mm ; ducts of seminal capsules with or without bends and opening separately.

Measurements : Body length ♂, 3.02 (2.95-3.25, n=5) mm, ♀, 2.16 mm ; wing length ♂, 1.22 (1.1-1.28, n=5) mm, ♀, 1.24 mm ; wing breadth ♂ 0.36 (0.33-0.38, n=5) mm, ♀, 0.41 mm.

Diagnosis : In view of the hyaline wing the present species is named as *Microchironomus clarilatus*. It shows similarity with *Microchironomus deribae* (Freeman) from Sudan, France, Israel and Turkey in respect to the male hypopygium. Similarly, the body pattern and the male hypopygium of the present species seem close to *M. stilifer* (Freeman) from Afrotropical region and *M.*

forcipatus (Freeman) from Africa and Australia but the chaetotaxy of thorax, hyaline wing, antennal ratio (AR), leg ratio (LR), anal point and the gonostylus in particular separate it from all other species described from the world.

Holotype : ♂ (Z. S. I. Reg. no. 6559/H₀), West Bengal, Raniganj, 2. viii. 1975, Coll. P. K. Chaudhuri.

Allotype : ♀ (Z. S. I. Reg. no. 6560/H_a), data same as holotype.

Paratypes : 4 ♂♂ and 3 ♀♀, 14.iv. 1977, and 10.vii. 1978, rest data same as holotype and kept in the collections of insects at the Department of Zoology, University of Burdwan.

ACKNOWLEDGEMENTS

We are grateful to the Director, Zoological Survey of India, Calcutta and Prof. S. K. Das Gupta, Head of the department of Zoology, Presidency College, Calcutta for helps and criticisms.

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ON A NEW SPECIES OF THE GENUS *NANNISOLABIS* BURR (INSECTA :
DERMAPTERA) FROM BURMA WITH A KEY TO ORIENTAL SPECIES

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ABSTRACT

A new species of the genus *Nannisolabis* Burr, from Burma is described along with a key to the identification of various species of this genus.

Recently I had an opportunity to examine 1 ♂ from Burma determined by Hincks (1947) as *Metisolabis caudelli* (Burr), available in the collections of Naturhistoriska Riksmuseet, Stockholm (Sweden). A detailed examination of all morphological characters and ♂ genitalia shows, it represents an undescribed species of the genus *Nannisolabis* Burr. Hincks (1.c.) referred two males but the fate of the other ♂ is not known to me. However on basis of ♂ genitalia figured by him it appears that second ♂ will be conspecific with this specimen.

This genus is mainly characterised by the presence of eyes shorter than the post-ocular length of head and placed anteriorly; mesonotum at shoulder with a blunt incurved fold and the area inbetween depressed, representing a transverse depression.

Burr (1910) erected this genus with *Brachylabis philetas* Burr (1901) as its type and *Nannisolabis willeyi* Burr, both from Ceylon. Besides, three more species viz., *N. dammermani* Borelli (1926) and *N. javana* Boeseman (1954) from Java and *N. ceylonicus* Brindle

(1977) from Ceylon; are known from the Oriental Region. *N. javana* described from a ♀, does not seem to belong to this genus since it lacks lateral apical fold as well as transverse median depression on mesonotum. It may perhaps be referable to genus *Antisolabis* Burr. However, for its correct generic assignment the discovery of ♂ and re-examination of Holotype will be desirable.

All the known species of the genus including the described species can be separated by the following key. *N. javana* Boeseman, has not been included owing to its uncertain generic position.

Key to species of genus *Nannisolabis* Burr

(on males only)

- | | |
|---|-------------------------------------|
| 1(4). Pronotum longer than broad | |
| 2(3). Head and pronotum punctate | ... <i>N. dammermani</i>
Borelli |
| 3(2). Head near hind margin and pronotum obscurely punctulate | ... <i>N. willeyi</i> Burr |
| 4(1). Pronotum as long as broad or broader than long | |

- 5(6). Body less strongly punctate, punctures sparsely placed; pronotum as broad as long; forceps remote at base, incurved ... *N. philetas* (Burr)

- 7(8). Size smaller (6 mm), antennae unicolorous; pronotum parallel sided; genitalia with virga long and slender ... *N. ceylonicus* Brindle

- 8(7). Size larger (9.45 mm); pronotum with sides gently diverging posteriorly; genitalia with virga short and stout, distally tridentate, median tooth longer, acuminate and lateral tooth shorter and curved ... *N. hincksi* sp. n.

Family : CARCINOPHORIDAE

Subfamily : BRACHYLABINAE

Nannisolabis hincksi sp. n.

(Fig. 1, A-C)

Male : General colour shining dark brownish black; antennae with one or two preapical segments whitish, other segments with a whitish ring apically, apical portion of femora, whole of tibiae and tarsi yellowish, pronotum laterally as well as in posterior half, abdominal tergites close to hind margin lighter in colour.

Head obscurely punctate near hind margin, smooth above, slightly longer than broad, convex above, strongly sloping laterally and posteriorly, sutures obsolete, hind margin almost straight. Eyes a trifle shorter than post-ocular length, anteriorly placed. Antennae partly broken (only 15 segments remaining), 1st stout longer than the distance between antennal bases, narrowed at base; 2nd small, about as long as broad; 3rd long and slender; 4th subclavate, almost equal to preceding, remaining gradually increasing in length except a few preapical ones which are shortened and strongly narrowed basally. Pronotum impunctate, a trifle broader than

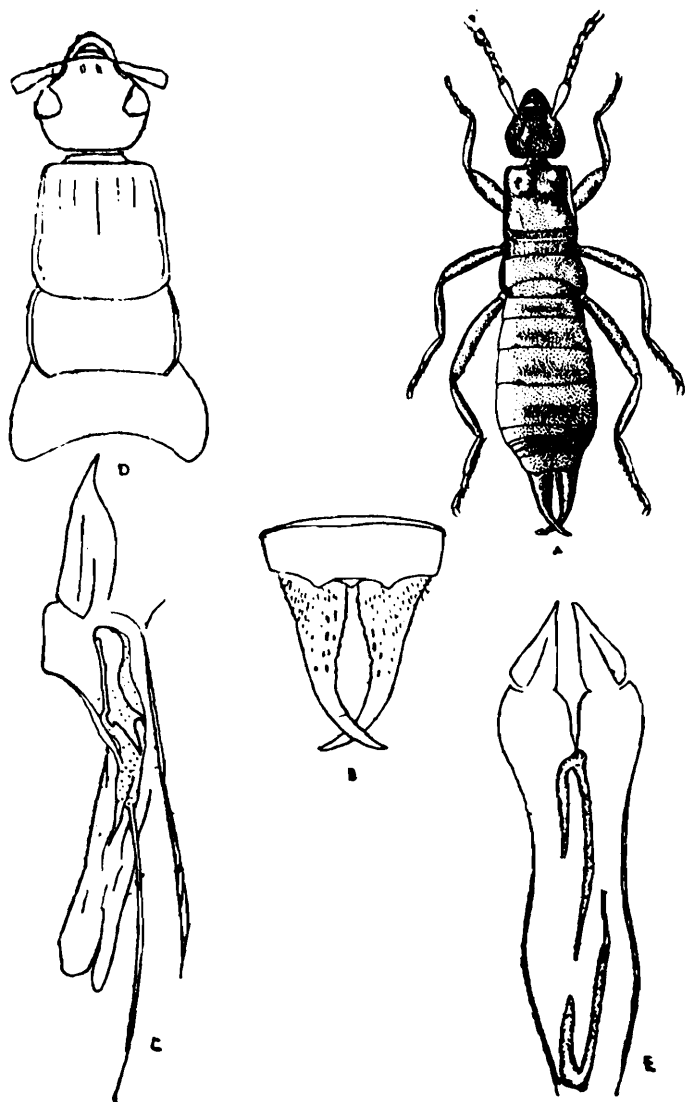


Fig. 1. *Nannisolabis hincksi* sp. n., Holotype ♂
A. Dorsal view, B. Ultimate tergite and forceps enlarged and C. A portion of genitalia; *Isolabis caudelli* Burr, Holotype ♂, D. Head and thorax and E. Genitalia

- 6(5). Body more strongly punctate, punctures closely placed; pronotum broader than long; forceps subcontiguous near base, almost straight in basal two thirds afterward strongly incurved.

long, sides straight, reflexed, faintly diverging posteriorly, hind margin subtruncate; prozona weakly raised with a faint circular depression on either side of faint median sulcus, metazona depressed. Mesonotum deeply and closely punctate, about half as long as pronotum, hind margin straight, antero-laterally an incurved fold present, in anterior half a transverse depression present. Metanotum with same texture, hind margin deeply emarginate. Elytra and wings absent. Legs long and slender. Abdomen deeply and closely punctate but on some hind tergites punctation gradually becoming weaker, spindle shaped, sides of segments convex, punctation same as above. Penultimate sternite transverse, narrow posteriorly with slight emargination in middle. Ultimate tergite with punctation weaker than on meso- and metanotum and a few anterior abdominal tergites and sparsely placed, median sulcus faint, hind margin trisinate, oblique laterally, above the roots of forceps produced in the form of a projecting triangular lobe. Pygidium scarcely visible from above, vertical, triangular, at base almost filling the space between branches of forceps, apex pointed. Forceps subcontiguous at base, cylindrical, gradually tapering from base to apex, almost straight in basal two thirds, afterwards strongly hooked with tip pointed, impunctate, with fine golden pubescence at base only, internally crenulate in basal two thirds. Genitalia with parameres acuminate apically, virga short and stout, distally tridentate, median spine prolonged and acuminate, lateral spines shorter and incurved.

Female : Unknown

		Holotype
<i>Measurements</i> —(in mm.)		♂
Length of head	—	1.4
Width of head	—	1.2

Length of pronotum	—	1.45
Width of pronotum	—	1.55
Length of body	—	8.05
Length of forceps	—	1.4

Material examined : Holotype ♂, N. E. BURMA, Kambaiti, 2000 m, 12. iv. 1934 (*R. Malaise*), Reg. No. 210/26, Det. by W. D. Hincks as *Metisolabis caudelli* Burr; genitalia mounted between two cover slips and pinned with the specimen (Naturhistoriska Riksmuseet, Stockholm, Sweden).

Remarks : This species was confused by Hincks (1947) with *Isolabis caudelli* (Burr) which is quite distinct due to the presence of a sharp raised carina all along the sides of mesonotum and distinctive parameres and virga (Fig. 1, D-E).

ACKNOWLEDGEMENTS

I am thankful to the Director, Zoological Survey of India, Calcutta for necessary facilities and Dr. Per Inge Persson, Naturhistoriska Riksmuseet, Stockholm (Sweden) for placing this interesting specimen at my disposal. My thanks are also due to Dr. D. R. Ragge and Mrs. J. Marshall, British Museum (Natural History, London for supplying the notes as well illustrations from the Holotype ♂ of *Brachylabis caudelli* Burr, prepared by Mr. A. Brindle of Manchester Museum, Manchester (U.K.), from which figures 1, D-E in the present paper have been redrawn.

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ON THE OCCURRENCE OF THE SEA ANEMONE *PHYTOCOETEOPSIS RAMUNII* PANIKKAR (ACTINIARIA : HALIACTIIDAE) IN A TIDAL CREEK OF SAGAR ISLAND, WEST BENGAL ; AND A NOTE ON ITS NEMATOCYSTS

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ABSTRACT

Phytocoeteopsis ramunii has been reported for the first time from the Gangetic delta. The distribution and the size of different types of nematocysts, are studied.

Rao (1925) reported an undetermined sea anemone from the backwater of Adyar lake, Madras, and furnished a general account of the anatomy, habits and habitat of the species. Panikkar (1936) obtaining more specimens of this species from the same locality, created the new genus *Phytocoeteopsis* with *P. ramunii* as its type species. Cheriyan (1964) reported the species from the backwaters of Cochin, Kerala, extending its distributional range westwards. As the earlier reports have failed to give detailed account of cnidom which are essential key characters of the species, the present note intends to enumerate the same, as well as reports a new locality record and further extension of range.

Material : 42 exs., Sagar Island (Sundarbans, 24-Parganas), A. Misra and M. Chatterjee, 27. 11. 1974, Z. S. I. Reg. No. P. 2722/1 ; 10 exs., Sagar Island, A. Choudhury, 10. 1. 1975, unregistered at S. D. Marine Biological Research Institute, Sagar Island.

Diagnosis : This species is characterised by a typical arrangement of its tentacles and

acontia. The tentacles are apparently arranged in four whorls, with 24 in each. The outermost whorl is biggest, the innermost smaller, and the two middle ones smallest. Acontia slender and short, and are arranged serially below the filament on all the macrocnemes.

Description : Body long, vermiform and more or less divided into three regions, a physa-like base, a scapus provided with longitudinal rows of cinclides, and a thin-walled capitulum. Mesenteries divided into macro- and microcnemes, which are more numerous at the margin than at the base. Only six pairs of macrocnemes are perfect and provided with retractors, filaments, gonads and acontia, while the microcnemes (18 pairs) lack these organs. Retractors strong and restricted, more or less reniform, the detailed account of which has already been furnished by the earlier workers. The cnidom complement of this species which has not yet been studied in the light of recently used terminology, consists of spirocyst, basitrich, and microbasic amastigophores. The distribution and size

of nematocysts are as follows :

Tentacle :	Spirocyst	...25-35 × 4-6 μm
	Basitrich	...12-14 × 6-8 μm
	Microbasic amastigophore	...26-35 × 5-6 μm
Column :	Microbasic amastigophore	...40-50 × 5-8 μm
	Basitrich	...14-20 × 3-6 μm
Filament :	Microbasic amastigophore	...20-24 × 6-8 μm
Acontia :	Basitrich	...12-16 × 2-4 μm
	Microbasic amastigophore	...35-60 × 6-8 μm

A minimum of 50 nematocysts of each type were measured to determine the size range for each class. Camera lucida drawings of each category of nematocysts from diffe-

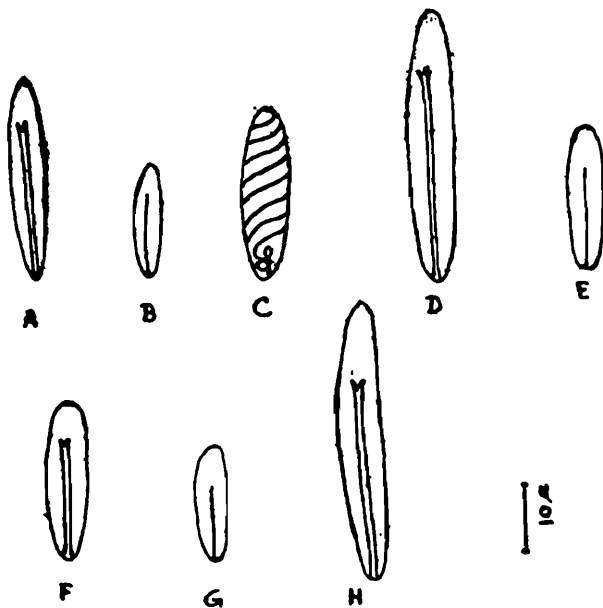


Fig. 1. Nematocysts of *Phytocoeteopsis ramunii* (all nematocysts drawn to same scale). A-C, tentacle; D-E, column; F, filament; G-H, acontia. Spirocyst (C); Basitrich (B, E, G); Microbasic amastigophore (A, D, F, H).

rent body regions are given in Fig. 1. All the figures are drawn to the same scale.

Remarks : The species has so far been reported from Adyar lake, Madras and in the backwaters of Cochin, Kerala. The present record from Chemaguri creek of Sagar Island in the Gangetic delta extends its range north-eastwards.

Habitat : The species has been reported to occur in very low levels in the shallow esturine mudflats from which the specimens have been collected. The body remains completely buried in the substratum with only the oral disc and crown of tentacles above.

DISCUSSION : Panikkar (1936) while describing the species, considered only two types of nematocysts, namely penicilli and spirulae. But these terms are not in accordance with the more generally accepted terminology of Weil (1934), augmented by Carlgren (1940, 1945). The latter author, in his monographic work (1949) reported that the acontia of this species were with basitrich and probably microbasic amastigophores, which characters are confirmed by the present authors. This acontiate athenarian species sharing characters of both thenaria and Athenaria, requires a detailed study, particularly in the light of the recent view of Hand (1966) on the evolution of actiniaria. It is generally held that actiniaria lacking skeleton, are more primitive than corals. But Hand (*op. cit.*) suggested that actiniaria may be derived from corals, while athenaria being primitive anemones, may better be considered as secondarily derived forms. The thenarian anemones closely resembling corals may be considered as primitive. Thus, the sequence of evolution within zoantharians as proposed by Hand, may be arranged as corals → thenaria → acontiate thenaria → acontiate athenaria → athenaria.

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RECORDS OF NEW HOST AND LOCALITY FOR *PLAGIORCHIS* (*METAPLAGIORCHIS*) *HIMALAYAI* (JORDAN, 1930) AND NEW LOCATION FOR *PARABASCUS MACRORCHIS* (GOGATE, 1939) (TREMATODA : DIGENEA)

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ABSTRACT

Plagiorchis (*Metaplagiorchis*) *himalayai* (Jordan, 1930) has been reported from Patna (Bihar, India) and *Parabascus macrorchis* (Gogate, 1939) from gall bladder. Both species were collected from *Calotes versicolor* Daud.

INTRODUCTION

While studying the trematode parasites of lizards of Patna, we came across one specimen of *Plagiorchis* (*metaplagiorchis*) *himalayai* (Jordan, 1930) which proved to be a new host and locality record for this species. *Parabascus macrorchis* (Gogate, 1939) was found from the gall bladder of *Calotes versicolor* which is a new location record.

***Plagiorchis* (*Metaplagiorchis*) *himalayai*
(Jordan, 1930)**

Jordan (1930) provided an abstract description of *Lepoderma himalayai*. Mehra (1937) furnished the detailed account of this species. The genus *Lepoderma* being synonym of *Plagiorchis*, *L. himalayai* became *P. himalayai*. This species was assigned to the subgenus *Plagiorchis* by Skrjabin & Antipin (1958). Timofeeva (1962) proposed the genus *Metaplagiorchis* for species having Caeca and/or vitellaria not reaching posterior extremity; genitalpore submedian, immediately preacetabular; Cirrus pouch curving round acetabulum

on its right side, containing elongate or tubular, sometimes moniliform seminal vesicle. Yamaguti (1971) did not consider above mentioned characters sufficient to justify a separate genus and relegated *Metaplagiorchis* to subgeneric rank.

Jordan (1930) recorded *Plagiorchis* (*M.*) *himalayai* from *Bufo latastii* from Srinagar (Jammu and Kashmir State). Kaw (1950) collected it from the intestine of *Bufo viridis* from a number of places in Jammu and Kashmir State.

Here *Plagiorchis* (*Metaplagiorchis*) *himalayai* is recorded from the intestine of *Calotes versicolor* at Patna (Bihar) in Gangetic Plains of India. We have examined about 51 garden lizards and have been able to collect only one trematode of this species. Our specimen closely resembles the figure and description of this species given by Mehra (1937) but differs from it in the vitelline follicles reaching anteriorly the level of anterior margin of the ventral sucker and the posterior coalescence of vitellaria not so well pronounced. Ovary

is clearly behind the ventral sucker. Skrjabin and Antipin (1958 pg. 124 and 127) have mentioned that Kaw (1950) collected his species from *Rana viridis* which appears to be an error for *Bufo viridis* (Kaw 1950, p. 70).

Parabascus macrorchis (Gogate, 1939)

Goate (1939) erected the genus *Palitrema* for *P. microrchis* from the intestine of *Calotes versicolor* and *Hemidactylus brooki* from Rangoon. Baugh (1956) accepted the validity of the genus *Palitrema*. Yamaguti (1958) considered *Palitrema* congeneric with *Postorchigenes* Tubangui, 1928. Odening (1969) considered *P. macrorchis* Gogate, 1939; *P. majeedi* Sinha & Hakim, 1967; and *P. indica* Agrawal, 1968 as synonyms of *Postorchigenes ovatus* Tubangui, 1928. Skrjabin (1970) treated *Palitrema*, *Postorchigenes*, *Parabascooides*, *Limatuloides* in part and *Czosnowia* synonym of *Parabascus*. Recently Ghosh (1977) has agreed with Skrjabin (1970) on the question of synonyms of the genus *Parabascus* but recognised *Parabascus macrorchis* (Gogate, 1939) as a distinct species. During routine collection of trematode parasites at Patna, 40 specimens belonging to *Parabascus macrorchis* were collected from the intestine but in a case, one example was collected from gall bladder of *Calotes versicolor*. So far all the specimens referable to the genus *Parabascus* are known from intestine of their hosts.

Our material shows great variation in different characters. Some specimens resemble *P. macrorchis* and others *P. ovatus*. Intraspecific variation in the present material and the question of synonymy of various species will be dealt with separately.

ACKNOWLEDGEMENT

Authors are thankful to the Director, Zoological Survey of India, Calcutta for the facilities during the work.

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SURVEY ON THE PROTOZOAN FAUNA OF NORTH BENGAL

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ABSTRACT

A total of 1233 cold-blooded vertebrates belonging to 37 species and 480 xylophagous termites belonging to 4 species were examined for haematozoa and symbiotic flagellates respectively. Eighty-nine fishes (28.5%) of 9 species, 125 anurans (14.9%) of 4 species and 89 reptiles (20.6%) of 6 species harbour one or more blood parasites. All the termites harbour symbiotic flagellates. The genera *Trypanosoma*, *Haemogregarina*, *Lankesterella* and *Pirhemocytton* from cold-blooded vertebrates were recorded. All the parasites are reported herein for the first time from this region.

INTRODUCTION

Although some reports on the protozoan parasites of different animals have been published from North Bengal since 1949 (Ray, 1949) the results have unfortunately not followed any uniform pattern. In some cases, no attempt has been made to identify the various protozoan parasites as to species. Still another factor limiting the value of all surveys, is the relatively very small number of sampling of the host species examined, thus resulting in negative findings, or giving insufficient data for significant comparisons. The present survey was undertaken with a view to study the parasitic protozoan, especially the blood protozoans of fishes, amphibians and reptiles and the symbiotic flagellates of Wood-eating white ants from North Bengal.

MATERIAL AND METHODS

A total of 312 fishes, 834 amphibians and 87 reptiles belonging to 37 species and 480 termites comprising of 4 species have been examined for protozoan parasites from diffe-

rent localities of North Bengal during 1979-80. Termites were dissected and the living flagellates were studied in fresh smears of gut contents. For permanent preparations, thin and uniform smears of the gut contents mixed with 0.5% Normal Saline, were drawn on the slide, fixed in Schaudinn's fixative and stained with Heidenhain's hematoxylin.

For the blood protozoa, permanent preparations were made after capturing the live fishes, frogs and reptiles. The blood was obtained by cutting the finger tips or toes or tail tips of snakes, and sometimes the whole animal was sacrificed. Blood smears were made from each example on greese free slides and fixed in methanol. The blood smears were stained with Leishman's or Giemsa's stains. For detecting the parasites the stained slides were observed under a high resolution microscope.

RESULT AND DISCUSSION

Of the 312 fishes of 19 species, 834 amphibians of 8 species and 87 reptiles of 10 species

TABLE—1. Prevalence of Blood Parasites in cold-blooded vertebrates from North Bengal.

Host species	Total number		Parasite	Locality
	No.	Exam. Infected		
PISCES				
1. <i>Anabas testudineus</i> (Bloch.)	50	25	<i>Trypanosoma anabasi</i> Mandal	Berhampore
2. <i>Clarias batrachus</i> (Linn.)	50	20	<i>T. batrachi</i> Qudri	Dinhatah, Cooch-behar
3. <i>Heteropneustes fossilis</i> (Bloch.)	40	13	<i>T. danilewsky saccobranchi</i> Qudri	Berhampore
4. <i>Mastocembellus armatus</i> Lacépède	30	11	<i>T. armati</i> Mandal	"
5. <i>Mastocembellus punctatus</i> (Hamilton)	20	5	<i>T. punctati</i> Mandal	Malda
6. <i>Mystus vittatus</i> (Bloch.)	75	5	<i>T. vittati</i> Tandon & Joshi	Dinhata, Cooch-behar
7. <i>Nandus nandus</i> (Ham.)	10	3	<i>Trypanosoma</i> sp.	Malda
8. <i>Ophicephalus punctatus</i> (Bloch.)	12	3	<i>T. punctati</i> Hasan & Qusim	Raiganj
9. <i>Ophicephalus striatus</i> (Bloch.)	15	4	<i>T. striati</i> Qudri	Raiganj
* Uninfected species	10			
	Total	312	89(28.5%)	
AMPHIBIA				
10. <i>Bufo melanostictus</i> Schneider	205	45	<i>Haemogregarina nucleo-bisecans</i> Shortt	Malda
			<i>Trypanosoma rotatorium</i> (Mayer)	Berhampore
			<i>Pirhemocyton</i> sp.	Raiganj
11. <i>Rana cyanophlyctis</i> Schneider	465	25	<i>Trypanosoma rotatorium</i> (Mayer)	Garumara, Jalpaiguri
			<i>Pirhemocyton</i> sp.	Sainthia, Birbhum
12. <i>Rana limnocharis</i> Wiegmann	105	30	<i>Trypanosoma rotatorium</i> (Mayer)	Rangpoo, Darjeeling
			<i>Haemogregarina berestneffi</i> Castellani & Willey	Reang, "
13. <i>Rana tigrina</i> Daudin	55	25	<i>Trypanosoma rotatorium</i> (Mayer)	Garumara, Jalpaiguri
			<i>Haemogregarina magna</i> (Grassi & Feletti)	"
			<i>Haemogregarina berestneffi</i> Castellani & Willey	Berhampore
** Uninfected species	4			
	Total	894	125(14.9%)	<i>Lankesterella minima</i> (Chaussat) "

*PISCES: *Labeo bata* (Ham.) (20), *L. calbasu* (Ham.) (5); *L. rohita* (Ham.) (15); *Wallago attu* (Bl. & Sch.) (2); *Mystus tengara* (Ham.) (50); *M. guleo* (Ham.) (40); *Amphipnous cuchia* (Ham.) (2); *Ophicephalus gachua* Ham. (10); *Lepidocephalichthys guntea* (Ham.) (25); *Berbus (Puntius) dorsalis* (Jerdon) (100).

** AMPHIBIA: *Rana hexadactyla* Lesson (10); *Kafoula pulchra taprobatica* Parker (55); *Uperodon systoma* (Schneider) (10); *Rhacophorus maculatus* (Gray) (25).

TABLE 1. Concluded.

Host species	Total number		Parasite	Locality
	No. exam.	Infected		
REPTILIA				
14. <i>Calotes versicolor</i> (Daudin)	25	3	<i>Haemogregarina</i> sp.	Reang, Darjeeling
15. <i>Enhydryis enhydryis</i> (Schneider)	15	5	<i>Trypanosoma enhydryis</i> Sinha & Mandal	Coochbehar
16. <i>Hemidactylus flaviviridis</i> Rüppell	10	2	<i>Haemogregarina</i> sp.	Garumara, Jalpai- guri
17. <i>Natrix piscator</i> (Daudin)	10	2	<i>Haemogregarina mirabilis</i> Castellani & Willey	Coochbehar
18. <i>Natrix stolata</i> (Linn.)	8	1	<i>Haemogregarina</i> sp.	"
19. <i>Mabuya carinata</i> (Schneider)	15	5	<i>Haemogregarina</i> sp.	Raiganj, West Dinajpur
* Uninfected species		4		
Total	87	18 (20.6%)		

TABLE—2. Prevalence of Termite flagellates from North Bengal.

Host species	Total No. exam.	Total No. infected	Symbionts present	Locality
1. <i>Coptotermes heimi</i> (Wasm.)	200	200	<i>Holomastigotoides emersoni</i> Das <i>H. ogivalis</i> de Mello <i>H. bengalensis</i> Chakraborty & Banerjee <i>Pseudotriconympha indica</i> Chakra- borty & Banerjee <i>P. cordiformes</i> Karandikar & Vittal <i>Spirotrichonympha froilanai</i> Karandikar & Vittal <i>Spirotrichonympha roonwali</i> Das	Murshidabad " Raiganj Rangpoo " Balurghat Malda & Raiganj
2. <i>Heterotermes indicola</i> (Wasm.)	150	150	<i>Holomastigotoides hollandi</i> Das <i>Spirotrichonympha pyriformis</i> Chakraborty & Banerjee	Murshida- bad Balurghat
3. <i>Cryptotermes havilandi</i> (Sjöstedt)	80	80	<i>Holomastigotoides hollandi</i> Das <i>Devescovina glabra</i> Grassi <i>Stephanonympha pyriformis</i> Das & Choudhury	" Raiganj Coochbehar
4. <i>Neotermes bosei</i> Snyder	50	50	<i>Oxymonas bosei</i> Das <i>O. grandis</i> Cleveland <i>Stephanonympha minuta</i> Das & Choudhury <i>S. pyriformis</i> Das & Choudhury	Jalpaiguri " Coochbehar "
Total	480	480 (100%)		

* REPTILIA : *Lissemys punctata granosa* (Schopff) (10) ; *Typhlops braminus* (Daudin) (7), *Riopa albopunctata* Gray (5), *Ptyas mucosus* (Linn.) (2).

examined, 89 fishes (28.5%) belonging to 9 species 125 amphibians (14.9%) belonging to 4 species and 83 reptiles (20.6%) belonging to 6 species showed protozoan infection in their blood. All the 480 examples of termites belonging to 4 species showed 14 species of symbiotic flagellates in their gut. The results are presented in Table 1 & 2 respectively.

Infections with species of *Trypanosoma* in 89 fishes, 55 amphibians and 5 reptiles, *Haemogregarina* in 60 amphibians, 15 reptiles and *Lankesterella* in 8 amphibians, were recorded. The genus *Pirhemocytion* whose taxonomic position is doubtful even today, has been recorded from *Bufo melanostictus* (5 exs.) and *Rana cyanophlyctis* (15 exs.). Double and multiple infections were recorded in 85 amphibians. No fish showed haemogregarine infection in their blood. However, all the blood parasites are reported herein for the first time from this region of India.

A perusal of literature indicates that there are a few stray reports of protozoan infection in cold-blooded vertebrates from North Bengal. Sinha (1979) and Sinha *et al.*, (1978, 1979) restricted themselves in reporting some species of coccidia from Darjeeling only. Previously Das (1974), Das and Choudhury (1972) reported some species of *Oxymonas* and Calonymphid flagellates from the termites of Jalpaiguri & Coochbehar forest ranges.

In this present investigation the authors have surveyed almost all the districts of North Bengal during 1979-'80. As a result 8 species of piscine *Trypanosoma* viz., *T. anabasi*, *T. batrachi*, *T. d. saccobranchi*, *T. armati*, *T. puncali*, *T. vittati*, *T. punctati* and *T. striati* in addition to one undetermined species were detected. *Trypanosoma rotatorium* has been recorded from *Bufo melanostictus*, *Rana*

tigrina, *R. limnocharis* and *R. cyanophlyctis*. Three species of *Haemogregarina* viz., *H. nucleobisecans*, *H. magna* and *H. berestneffi* have been reported from amphibians. Two unnamed *Haemogregarina* are reported in garden-lizard, *Calotes versicolor* and *Mabuya carinata* for the first time from India. The termite flagellates reported herein constitute new records. The present survey reveals a higher incidence of *Trypanosoma* infection (28.5%) in fishes rather than amphibians and reptiles. The higher rate of parasitism is presumably a result of higher vector activity and density.

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ON THE MONOTYPY OF THE GENERA *ANCHITREMA* LOOSS, 1899 AND *TREMIORCHIS* MEHRA AND NEGI, 1926 WITH A NOTE ON *PLEUROGENES-PLEUROGENOIDES-INDOPLEUROGENES-ALLOINDOPLEUROGENES* COMPLEX

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ABSTRACT

A large number of specimens collected from the coastal belt of Orissa and W. Bengal from bats and frogs belonging to the families Anchitremitidae, Brachycoeliidae and Lecithodendriidae have been studied. The genus *Mujibia* Bilgees and Kaikobad, 1972 has been presumed to be congeneric with *Anchitrema* Looss, 1899 which is most probably a monotypic genus. The validity of various species in the genus *Tremiorchis* Mehra & Negi, 1926 has been considered. It has been concluded that the status of the genus *Tremiorchis* also is monotypic. Several populations of specimens belonging to the genus *Pleurogenoides* Travassos, 1921 have also been studied. It has been indicated that most of the characters of various species show variations. *Pleurogenoides sitapurii* (Srivastava, 1934) has been found to be synonymous with *P. solus* (Johnston, 1912). Further, the genus *Pleurogenes* Looss, 1896 is, no doubt, monotypic with *P. claviger* as its type species. The rest of the species belong to the genus *Pleurogenoides*. *Indopleurogenes* Yamaguti, 1971 has been found untenable and therefore a synonym of *Pleurogenoides*. Doubt has been cast on the tenability of the genus *Alloindopleurogenes* Kalyankar and Palladwar, 1977 in favour of *Pleurogenoides gastroporus*.

The present study is based on collections of populations of digenetic trematodes of bats and frogs made from various places along the east coast of India including West Bengal. Actually this is a study of variations among the individuals of a population. Relevant literature was closely scrutinized in the light of the findings. Consequently, some interesting conclusions have been drawn. All the specimens have been deposited with the National Collection at the Zoological Survey of India, Calcutta.

Family ANCHITREMATIDAE Mehra, 1935

Genus *Anchitrema* Looss, 1899

Syn. *Exorchocoelium* Thapar, 1931

Anchitrema sanguineum (Sonsino, 1894) Looss, 1899

(Fig. 1)

Host : *Pipistrellus mimus*, Indian Pygmy Pipistrelle, (Vespertilionidae)

Location : Intestine

Locality : Bhajna, 24-Parganas (W. Bengal)

No. of specimens: 6, collected on May 2, 1977

Specimens deposited : Z. S. I. Reg. No. W7299/1

These specimens are referred to *Anchitrema sanguineum* (Sonsino, 1894).

Anchitrema Looss is the genus of trematodes infecting mainly bats and chameleons, but it has also been reported from common shrew, *Suncus murinus*, by Ghosh (1978). Thapar's (1931, 1956) genus *Exorchocoelium* as against *Anchitrema* has been synonymised by Pandey (1935) and concurred by Agrawal (1966). This synonymy is beyond doubt and has been accepted by Yamaguti (1971) also. *Platynosomum philippinorum* Tubangui, 1928 and *Platynosomum philippinorum congoense* Sandground, 1937 were transferred to the genus *Anchitrema* by Skarbilovich (1948). It should be noted that the various species of *Anchitrema* resemble each other very much and differ only in relative sizes of organs and body proportions. Rohde (1966) made a large collection of specimens of *Anchitrema* from various species of bats in Malaya. He studied them very carefully population-wise. He found that the differences among species of *Anchitrema* "are due to allometric growth of various organs and parts of the body" Consequently, he synonymised *A. philippinorum* (Tubangui, 1928) and *A. congoense* (Sandground, 1937) with *A. sanguineum*. Saoud and Ramadan (1977) made an exhaustive collection of specimens of *Anchitrema* from Egyptian bats and studied them. They reviewed the genus *Anchitrema* synonymising *A. congoense* with *A. latum* Gedoelst, 1919, and *A. lucknowensis* Agrawal, 1966 with *A. philippinorum*. They, further, redescribed *A. sanguineum*

and described a new species *A. longiformis*. While differentiating this new species of *Anchitrema*, the authors state that it resembles

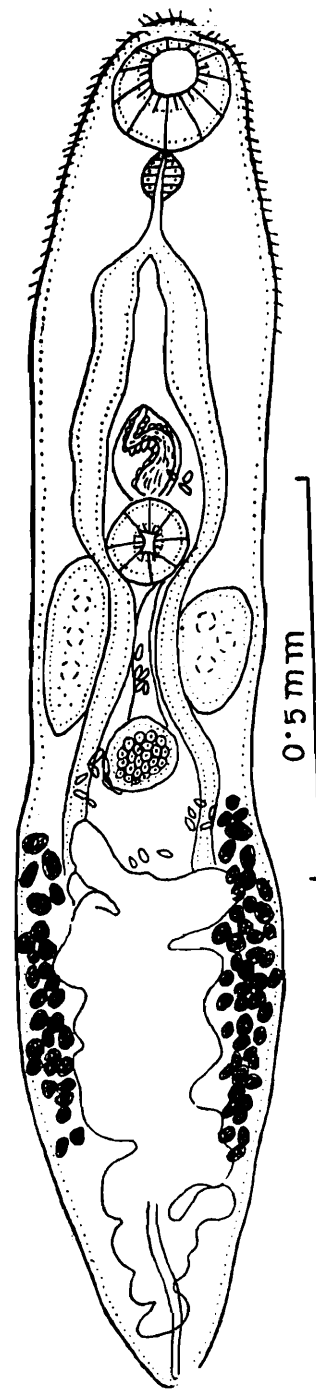


Fig. 1. *Anchitrema sanguineum* (Sonsino, 1894). Ventral View.

A. philippinorum most. Bilqees and Kaikobad (1972) proposed a new genus *Mujibia* (type species *M. elongatum*) from an unidentified snake from Sind, Pakistan. They differentiated it from *Anchitrema* on the basis of

unspined body, large oral sucker, absence of oesophagus, and wide ceca, and testes located behind the posterior region of the cecal ends. It may be pointed out that the type species *Mujibia elongatum* has been described on the basis of a single specimen, and the characters used in differential diagnosis are also found in *Anchitrema*. It has been observed that in some specimens of *Anchitrema sanguineum* the parts of the ceca behind testes get obscured by the testes themselves, coils of uterus and follicles of vitellaria specially in bad preservations. Probably this has happened in Bilqees and Kaikobad's specimen of *M. elongatum*. In *Anchitrema* a very short oesophagus has been reported which may be rendered indiscernible in some contracted specimens. The authors are inclined to believe that *Mujibia elongatum* Bilqees and Kaikobad, 1972 is nothing but *Anchitrema sanguineum* (Sonsino, 1894). But, as the type specimen is difficult to make available for re-examination, *Mujibia* is presumed to be a synonym of *Anchitrema*.

The excellent works of Rohde (*loc. cit.*) and Saoud and Ramadan (*loc. cit.*) on large collections of specimens of *Anchitrema* from the bats of Malaya and Egypt respectively, throw light on the very close resemblances of various species, and the ultimate results of their work are overlapping of synonymies among the species of *Anchitrema* to the extent that the genus is rendered monotypic.

Family BRACHYCOELIIDAE Johnston, 1912

Genus *Tremiorchis* Mehra and Negi, 1925

Syn. *Centrovitus* Bhalerao, 1926

Tremiorchis ranarum Mehra and Negi, 1926

Syn. *T. mehrai* Rai, 1962

T. vitelloconfluentum Rai, 1962

T. attenuatus Karyakarte, 1973 n. syn.

T. tigrinarum Sinha *et al.*, 1974 n. syn.

T. mathuraensis Swarup and Jain, 1976 n. syn.

Host : *Rana cyanophlyctis* (Amphibia : Ranidae)
 Location : Intestine
 Locality : Puri (Orissa)
 No. of specimens : 8, collected on June 5, 1972.
 Specimens deposited : Z. S. I. Reg. Nos. W7300/1—W7301/1

These specimens are identified as *Tremiorchis ranarum*. It is well known that *Tremiorchis ranarum* shows variations and abnormalities. Studies of Bhardwaj (1962) reveal this. Of the six species reported in the genus *Tremiorchis*, *T. mehrai* Rai, 1962 and *T. vitelloconfluentum* Rai, 1962 have been synonymised by Mukherjee and Ghosh (1970) with *T. ranarum* in the light of Bhardwaj's work, *T. varanum* Verma, 1930 has been transferred in the genus *Astiotrema* Looss, 1900 by the same authors. We concur with these synonymies and transfer. *T. attenuatus* Karyakarte, 1973 and *T. tigrinarum* Sinha *et al.*, 1974 also do not look different from the type species, *T. ranarum*. In the population of few specimens of the type species some minor and insignificant variations are always noted. All the specimens are not fixed in the same state of contraction or relaxation. Sometimes excessive pressure is used for flattening the flukes. Some populations are collected when the flukes are less mature while others are collected at an advanced state of maturity. All these factors cause variations, distortions or differences as the workers may interpret them. Some of the body spines may be shed off during processing. The anterior part of the pharynx is almost always overlapped by the oral sucker, making it difficult to detect the presence or absence of the short prepharynx. The seminal receptacle may occupy any position in the vicinity

of the ovary. Sometimes its normal position is affected by the amount of pressure applied for flattening. If the orientation of the fluke is not made proper before pressing under cover glass, the acetabulum may be deflected this way or that way. *T attenuatus* Karyakarte, 1973 and *T tigrinarum* Sinha et al, 1974 are based, it is believed, on variations in *T ranarum*. Therefore, the former two species are considered as synonyms of the latter.

Tremiorchis mathuraensis Swarup and Jain, 1976 has been described on the basis of specimens which were in an advanced state of maturity leading to massive development of uterine coils and bigger growth of vitelline follicles, and due to excessive pressure applied during pressing groups of follicles got coalesced together giving rise to their lobulated appearance. We, therefore, think that *T mathuraensis* is nothing but *T. ranarum*. *Tremiorchis* Mehra and Negi, 1926 is thus far monotypic.

Family LECITHODENDRIIDAE

Genus *Pleurogenoides* Travassos, 1921

Syn. *Sonsinotrema* Balozet et Callot, 1938

Indopleurogenes Yamaguti, 1971 n. syn.

Pleurogenoides solus (Johnston, 1912)

P. sitapurii (Srivastava, 1934) n. syn.

(Figs. 2, 3)

Host : *Rana cyanophlyctis*
(Amphibia : Ranidae)

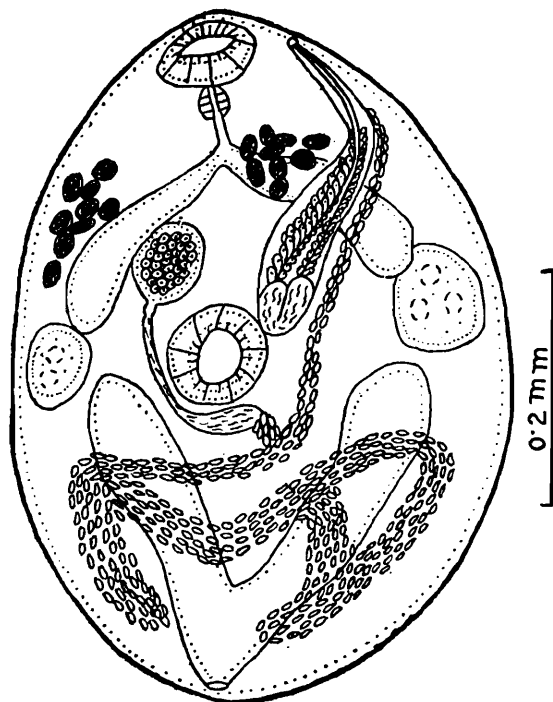
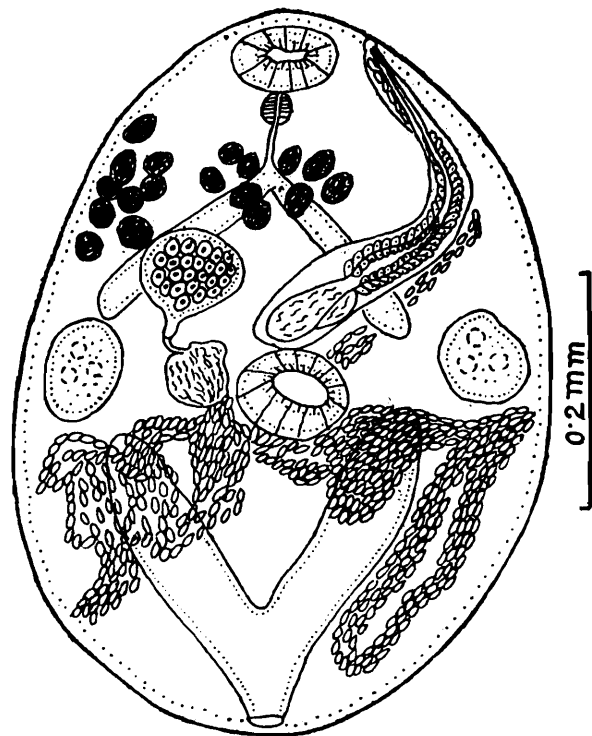
Location : Intestine

Locality : Chandbali (Orissa)

No. of specimens : 20, collected on December 24, 1973.

Specimens deposited : Z. S. I. Reg. Nos.
W7302/1—W7306/1

Johnston (1912) described his species from *Hyla aurea* from Australia. Srivastava (1934) distinguished his species from the closely resembling species, *P solus* (Johnston, 1912),



Figs. 2 & 3. *Pleurogenoides solus* (Johnston, 1912)
Ventral View. Showing some variations.

on the basis of the length of oesophagus and intestinal ceca, position and size of gonads

(probably in relation to acetabulum), size and number of the vitelline follicles, arrangement of uterine coils and position of excretory pore. Most of these characters are found to be variable in the present collection. After studying the original description of the two species and comparing them with our specimens, Srivastava's does not seem to be materially distinct from Johnston's and the variations in the present twenty specimens further reduce the gap between the two so that *Pleurogenoides sitapurii* appears to be conspecific with *P. solus*.

***Pleurogenoides gastroporus* Lühe, 1901**

(Fig. 4)

Syn. *P. equalis* Mehra and Negi, 1928
P. orientalis Srivastava, 1934
P. sawanensis Gupta, 1954

Host : *Rana cyanophlyctis*,
 (Amphibia : Ranidae)

Location : Intestine

Localities : Chandipur, Chand-
 bali, Gopalpur, Kon-
 arak and Puri (Oris-
 sa); Bakkhali and
 Ankhola in 24-Parga-
 nas (West Bengal).

No. of specimens : Several, collected in
 1972, 1973 and 1977.

Specimens deposited : Z. S. I. Reg. Nos.
 W 7307/1—W
 7324/1

Many populations of this species were collected from the same species of frog from the places noted above. They exhibit variations in the absence or presence of short oesophagus, distribution of vitellaria and level of genital opening. Mehra and Negi (1928)

have already indicated such variations. In view of the variations, we concur with Mukherjee and Ghosh (1970) that *P. equalis* Mehra and Negi, 1928, *P. orientalis* Srivastava, 1934 and *P. sawanensis* Gupta, 1954 are synonymous with *P. gastroporus* Lühe, 1901.

The validity of *Pleurogenoides* Travassos, 1921 as against *Pleurogenes* Looss, 1896 has been disputed by some workers like Gupta and Agrawal (1966) and Kakaji (1968). Mukherjee and Ghosh (1970) and Yamaguti (1971) considered the two genera as distinct one from the other. But Yamaguti (1971) added a third element in the confusion. He elevated *Pleurogenoides orientalis* Srivastava, 1934 to the rank of a new genus, *Indopleurogenese*, distinct from both the above genera in characters like absence of oesophagus, vitellaria extending over the ceca and the genital pore having gone to the level of oral sucker. The authors have studied a large number of specimens belonging to the *Pleurogenoides-Indopleurogenes* complex and observed variations in characters population-wise. In an attempt to solve the confusion on the basis of this study it would be better to consider *Pleurogenese* Looss, 1896 as a monotypic genus (type species : *P. claviger*) in which massive coils of uterus come between acetabulum and testes throwing the latter near the hind end of the body. The rest of the species in which the coils of uterus do not come between the two organs and consequently the testes remain in the acetabular zone should be brought under the genus *Pleurogenoides* Travassos, 1921. In view of the variations observed in the specimens collected from Puri, Konarak and Gopalpur (Orissa State), the type species of *Indopleurogenes* Yamaguti, 1971, *I. orientalis* (Srivastava, 1934) falls as a synonym of *Pleurogenoides gastroporus* Lühe, 1901. Therefore *Indopleurogenese* becomes untenable and synonymous

with *Pleurogenoides*. *Alloindopleurogenes* Kalyankar and Palladwar, 1977 is probably based on distorted specimens of *P. gastroporus*.

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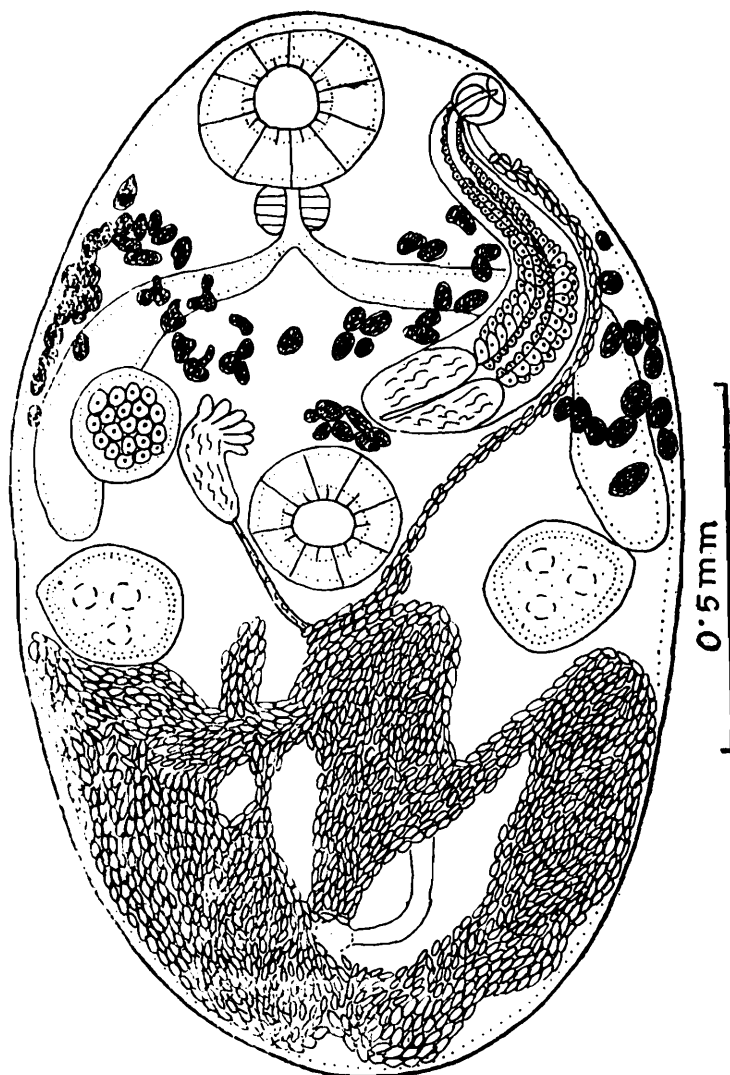


Fig. 4. *Pleurogenoides gastroporus* Luhe, 1901. Ventral View.

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DISTRIBUTION PATTERN OF BARNACLES (CRUSTACEA : CIRRIPIEDIA) IN
ESTUARINE SYSTEMS OF INDIA

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ABSTRACT

The distribution pattern of the thoracic cirripedes in some major estuarine systems namely, Hooghly-Matla, Hukitola, Chilka Lake, Godavary, Krishna, Pulicat Lake, Ennore Backwaters, Adyar River, Vellar of the east coast and Cochin Backwaters in Kerala of the southwest coast of India is presented in the paper. The factors influencing the distribution of the various species of barnacles in the estuarine systems are also dealt with.

INTRODUCTION

The thoracic cirripedes are a diverse group of marine crustaceans, with only a few species occurring in the estuarine environment, and no species known to complete its life-cycle in freshwater or terrestrial conditions although some species spend as much as ten months per year in fresh water, and others spend sufficient time in air during the changes in tide to be included among the semi-terrestrial Crustacea (*vide* Newman, 1967). Due to their relative abundance, sessile mode of existence and conspicuousness, the distribution and ecology of intertidal and estuarine barnacles in the temperate waters of America, Europe and Britain have been studied extensively (Bousfield, 1955 ; Hedgepeth, 1957 ; Moore, 1958 ; Newman, 1967). In the tropics, the distribution of barnacles and their larvae in the estuarine area of Jakarta, Indonesia have been studied recently (Kasijan Romimohtarto and

Okto Haryanto Arinardi, 1977). In the Indian region, their distribution in the marine environment are known to some extent (Annandale, 1909 ; Stubbings, 1936 ; Nilsson Cantell 1938 ; Daniel, 1955, 1967, 1972). However, very little published information is available on the species occurring in the estuarine environment (Annandale, 1907, 1915 ; Daniel, 1962 ; Balasubramanyam and Menon, 1963 ; Balakrishnan Nair, 1967). The study of barnacle fouling in estuarine areas has gained importance in recent years, since in coastal areas close to estuaries electric power generators/thermal stations have been established and the flow of water in their cooling system is impeded by heavy barnacle settlement and growth.

In the present paper, the distribution pattern of the thoracic cirripedes in some major estuarine systems of the east and southwest coasts of India is presented, based on

extensive survey, collections, test-panel and test-pole studies made by the author, collections available in the Zoological Survey of India and all published records.

OBSERVATIONS

Hooghly-Matla Estuary: The distribution pattern of the cirripedes occurring in the Hooghly-Matla estuarine system is presented in Fig. 1. At the mouths of the rivers Hooghly and Matla at 'Sandheads' and nearby regions, 15 species and subspecies of barnacles occur. These are, *Lepas anserifera* Linné, *Conchoderma virgatum hunteri* (Owen), *Octolasmis warwickii* Gray, *Octolasmis cor* (Aurivillius), *Octolasmis orthogonia* (Darwin), *Chthamalus malayensis* Pilsbry, *Europlia withersi* (Pilsbry), *Balanus patellaris* (Spengler), *Megabalanus tintinnabulum tintinnabulum* (Linné), *Balanus amphitrite amphitrite* Darwin, *Balanus variegatus* Darwin, *Balanus variegatus cirratus* Darwin, *Chirona amaryllis euamaryllis* (Broch), *Chirona amaryllis nivea* (Gravel) and *Chelonibia testudinaria* (Linne). The first really sharp faunal break appears to occur in this region. Beyond this region, only five species extend into the estuarine system. These are, *Octolasmis cor*, *Chthamalus malayensis*, *Europlia withersi*, *Balanus patellaris* and *Balanus amphitrite amphitrite*. In the river Hooghly, these five species extend up to Palta, and in the river Matla, up to Port Canning. In this area of the estuarine system, the second faunal break occurs (Fig. 1).

Balanus amphitrite amphitrite and *B. patellaris* extend further inside, from polyhaline conditions into waters of very low salinity and even fresh water.

B. amphitrite amphitrite and *B. patellaris* are found both subtidally and intertidally in

the upper part of the estuary. As conditions become marine, they become restricted mainly to the intertidal zone. In the river Matla *B. patellaris* is the dominant species, whereas in the river Hooghly, *B. amphitrite amphitrite* is more abundant. In both species, successful settlement occurs throughout the year, although it is not known whether adults closest to the freshwater environment survive through the entire annual cycle.

Chthamalus malayensis and *Europlia withersi* are both intertidal outer coastal forms. In this estuarine system, both the species are inconspicuous and occur in the high intertidal region, nearer the marine environment *E. withersi*, however, progresses subtidally into the system, whereas, *C. malayensis* occurs only in the intertidal region even in the inner regions of the system.

Octolasmis cor, occurring on the branchiae primarily of the edible crab *Scylla serrata* (Förskal), is the only pedunculate cirripede, extending from marine conditions into the polyhaline waters of the estuary. In the marine environment, this species has also been found in the gill chambers of *Panulirus* sp. It does not occur on *Scylla serrata* obtained from very low salinity areas, although the larvae are able to hatch from eggs and live for some hours in fresh tap water, under laboratory conditions.

Hukitola Estuary: The distribution pattern of the cirripedes in this estuary is presented in Fig. 2. *Octolasmis cor* occurs on the gills of *Scylla serrata* collected from the mouth of the river Mahanadi, whereas, *B. amphitrite amphitrite* appears to have progressed further, from polyhaline waters into waters of lower salinity. Specimens from this locality are rather small, never exceeding 9 mm in diameter, although sexually mature. It appears

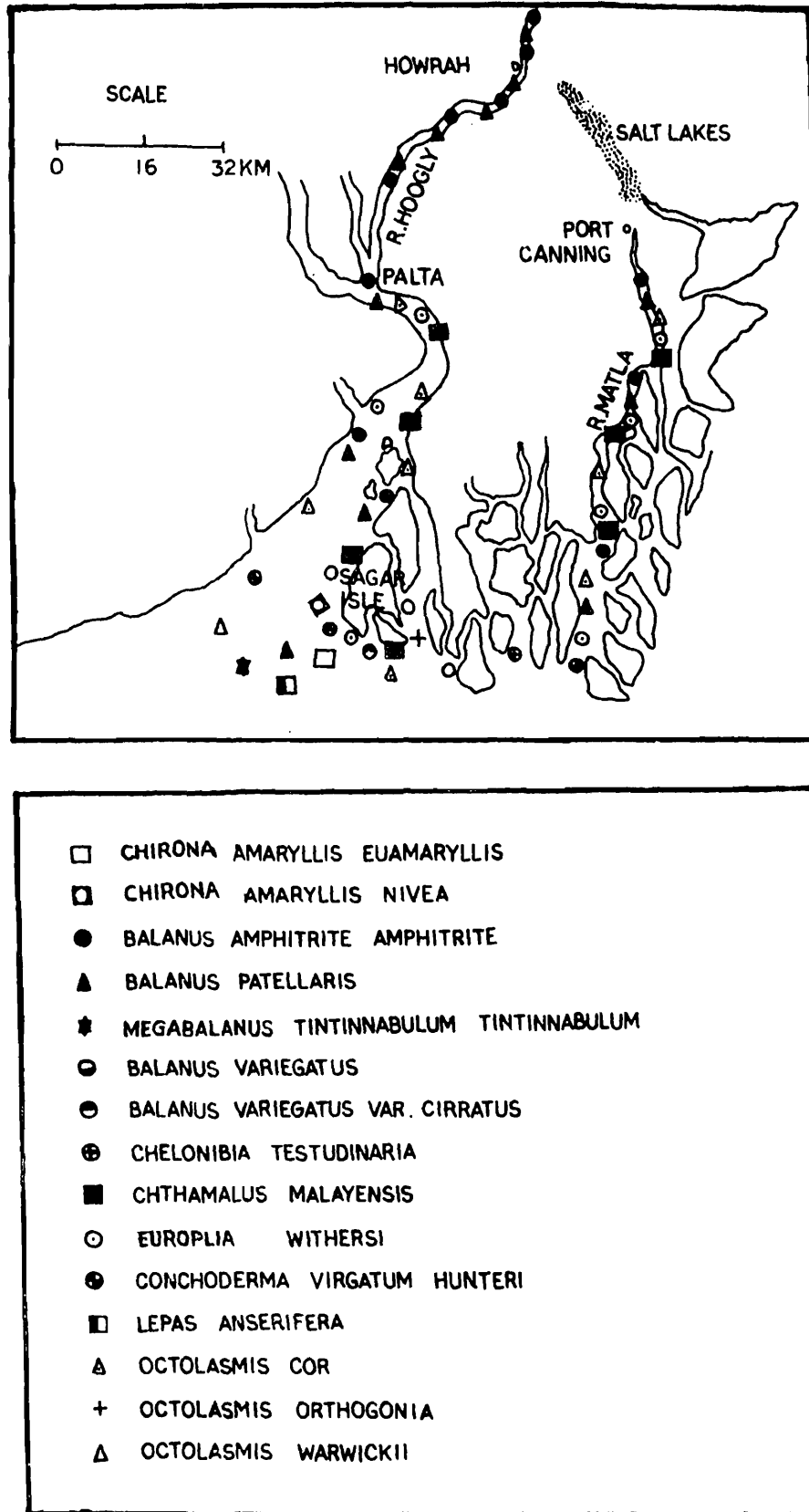


Fig. 1. Map of the Hooghly-Matla estuarine system showing the distribution of the thoracic cirripedes.

to occur predominantly in the subtidal region, and very rarely intertidally, at the mouth region. In the open coast in the Bay of Bengal, this species is very common in the intertidal region.

Chilka Lake : *Octolasmis cor* is found commonly attached to the branchiae of *Scylla serrata* collected from the outer channel (see Fig. 2) but has never been found on individuals from the main area of the lake. *Balanus amphitrite amphitrite* is abundant on oyster shells, fish traps, and wooden posts in the outer channel of the lake, where it grows to a diameter of 15-16 mm (see also Annandale, 1915). This species also occurs singly or in small numbers on the shells of *Potamides*, other gastropods and lamelli-branches. In the main area of the lake a few solitary individuals of small size (5-6 mm) occur on rocks subtidally, mostly at the end of the dry season. The species rarely occurs in Rhamba bay in low salinity condition (Fig. 2).

Godavary and Krishna Estuaries : *Lepas anserifera* has been reported to occur in these estuaries. However, the specimens were taken in a dead or moribund condition from floating sticks and therefore can hardly be included in the fauna of these estuaries. *O. cor* occurs in the estuarine regions in the vicinity of the sea ; *B. amphitrite amphitrite* alone extends subtidally further inside, into waters of low salinity.

Pulicat Lake, Ennore Backwaters and Adyar River : In the Pulicat Lake, Ennore Backwaters and Adyar River *O. cor* and *B. amphitrite amphitrite* occur in situations similar to those of the Godavary and Krishna estuaries. However, *Chelonibia patula* (Ranzani) occurs on the carapace of *Scylla serrata* in the Pulicat lake in inconspicuous numbers.

Vellar Estuary : In this estuary 14 species and subspecies of thoracic cirripedes (see Fig. 2) occur at the mouth of the River Vellar. These are *Octolasmis warwickii*, *Octolasmis cor*, *Megabalanus tintinnabulum tintinnabulum* and *Balanus amphitrite amphitrite* which also occur at the mouth of the River Hooghly ; and *Lepas anatifera indica* Annandale, *Trilasmis minuta* (Gravel), *Trilasmis amygdalum* (Aurivillius), *Octolasmis tridens* (Aurivillius), *Octolasmis grayii* (Darwin), *Octolasmis lowei* (Darwin), *Octolasmis angulata* (Aurivillius), *Semibalanus sinnurensis* Daniel, *Balanus hoekianus* Pilsbry and *Membranobalanus longirostrum* which have not so far been recorded at the mouth of the River Hooghly.

In this estuary a faunal break appears to occur at the mouth, as at the mouth of the Rivers Hooghly and Matla.

Balanus amphitrite amphitrite and *Octolasmis cor* extend further into the estuary ; the former occurring dominantly and penetrating to a greater extent. *Semibalanus sinnurensis* also extends riverward, but is rather inconspicuous and cannot be definitely termed as a member of the estuarine faunal complex.

Cochin Backwaters in Kerala : In the Cochin Backwaters near Ernakulam in Kerala, on the South-west coast of India, *Balanus amphitrite amphitrite* occurs abundantly throughout the major part of the year (see also Balasubramanyan and Menon, 1963 and Balakrishnan Nair, 1967). *Octolasmis cor* is also an important constituent of the barnacle fauna, whereas *B. amphitrite cochinensis* Nilsson-Cantell, is rare and inconspicuous.

REMARKS

A detailed analysis of the barnacle fauna of the estuarine system of India reveals that

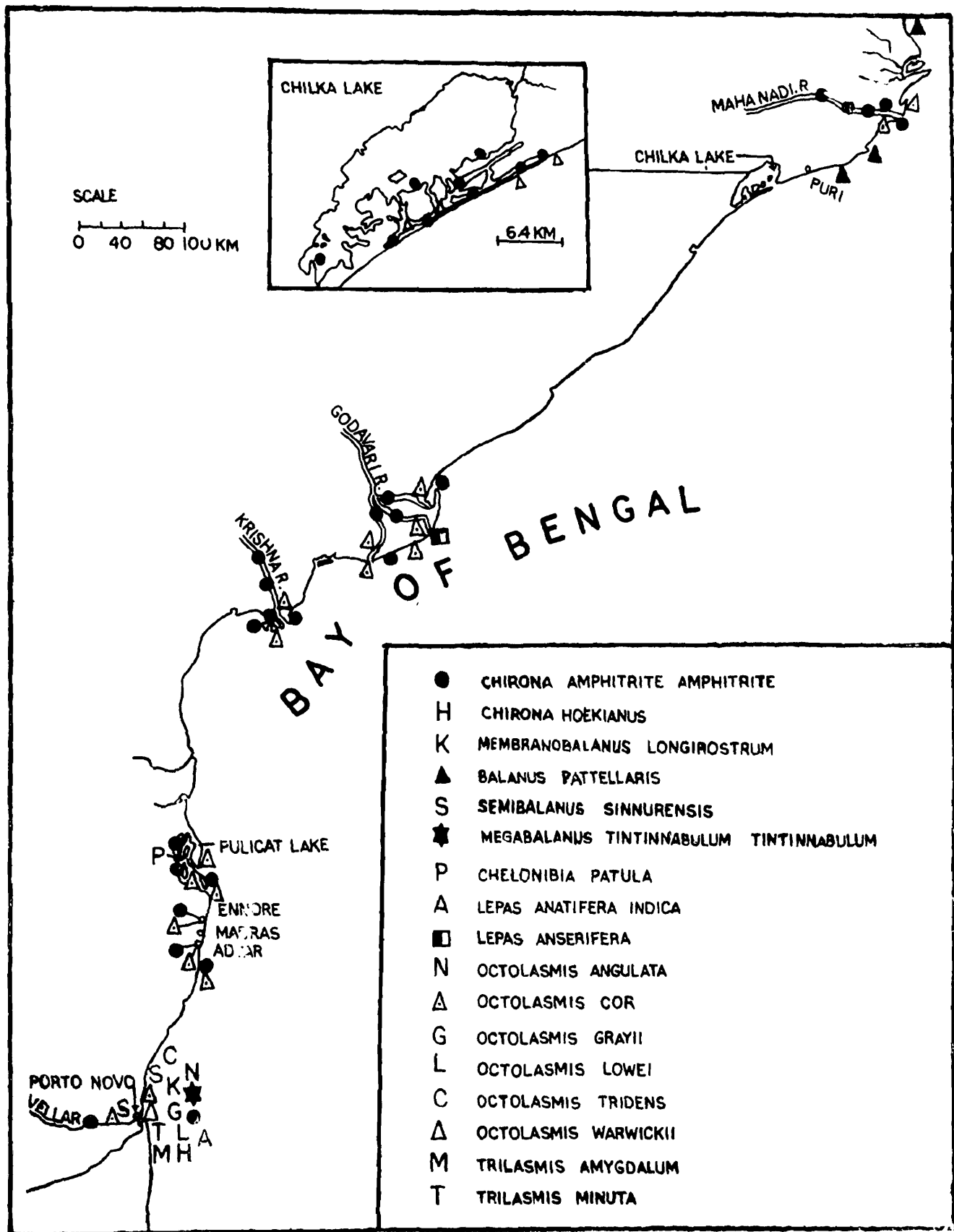


Fig. 2. Map showing distribution of the thoracic cirripedes in the estuarine systems of the east coast of India.

as one progresses from the marine environment into polyhaline waters of an estuary, the number of species diminishes rapidly, and when conditions become predominantly mesohaline, none are found. There are no truly fresh water forms, and those found in the estuaries are not confined to the estuarine environment as they also occur on the outer coast, and therefore, should be considered as marine invaders which tolerate estuarine conditions.

In all the estuaries of the Indian region studied, the pedunculate barnacle *Octolasmis cor* and the operculate barnacle *Balanus amphitrite amphitrite* are common but vary in the degree of penetration within the system. The occurrence of *O. cor* in the estuarine system is noteworthy, since no other pedunculate barnacle is known to tolerate estuarine conditions. *B. patellaris*, a predominant species in the Matla River, is confined to the Hooghly-Matla estuarine system, although in the marine zone it extends southwards up to Puri Beach in the Orissa coast. *C. malayensis* and *E. withersi* occurring inconspicuously in the Hooghly-Matla estuarine system are not known to penetrate into the other estuarine systems, although these occur in the marine environments in these areas.

Further, it is seen that *B. a. amphitrite*, *B. patellaris* and *E. withersi* which are predominantly intertidal forms in the marine environment, occur in the subtidal zone in the Hooghly-Matla estuarine system. Similarly, in the Hukitola Estuary also, *B. a. amphitrite* occurs predominantly in the subtidal zone. These suggest that stratification patterns of the watermasses in these estuaries may have played an important role in influencing the vertical distribution pattern of these species. Similarly, the subtidal predators and/or com-

petitors may also be influenced by the stratification patterns of the watermasses.

The distribution of the adult barnacles in the various estuarine systems of India suggests that degree of penetration and vertical range is a reflection of the degree to which larvae are retained and distributed by currents and stratification patterns within the system, and the ability of the respective adults to tolerate dilution.

Further work is necessary on the physiology, behaviour, breeding and the reactions of the larvae of barnacles at the time of settlement in estuarine environments in India.

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SECONDARY PRODUCTION AND BIOMASS OF ZOOPLANKTON AND THEIR RELATIONSHIP TO TROPHIC STATUS OF A TROPICAL ARTIFICIAL LAKE

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ABSTRACT

Biomass, secondary production and P/B ratio of crustacean zooplankton have been studied in a tropical artificial lake for 2 years (October 1976-September 1978). Mean daily biomass varied between 363.75 mg dw/m³ and 547.00 mg dw/m³ and daily production between 31.20 mg dw/m³-day and 52.10 mg dw/m³-day in 1976-77 and 1977-78, respectively. The mean daily P/B ratio of both years were very close to each other (0.0858 in 1976-77 and 0.0952 in 1977-78). Copepod formed the bulk of total crustacean zooplankton biomass (78.50% in 1976-77 and 61.42% in 1977-78) and production (79.83% and 48.38% for the two years respectively). Cladoceran contributed little to biomass but their production was high as compared to biomass. The ratio of secondary production to primary production (energy transfer efficiency) varied between 0.078 in 1976-77 to 0.083 in 1977-78. No significant relationship was found between mean daily P/B and mean daily temperature revealing the insignificant role of temperature in production process of the lake.

On the basis of P/B and energy transfer efficiency, the lake appears to be eutrophic, but results loosely supported Patalas (1970) hypothesis. However, good support was found for Hillbricht-Ilkowska (1972) hypothesis that energy transfer efficiency is less in eutrophic waterbodies.

INTRODUCTION

Eversince Lindeman (1942) proposed his well known trophic dynamic model of ecosystem, the quantitative assessment of organic production and flow of energy at various trophic levels have been central points of investigations in the researches pertaining to the dynamics of aquatic ecosystem. A number of pioneer workers have attempted from various angles (Juday 1940, Odum 1957, Teal 1957, Slobodkin 1962) and the concept has somewhat been refined but the progress in this direction has been slow. Although works on primary production of phytoplankton and

macrovegetation in freshwaters have started much earlier and sufficient amount of knowledge has been gathered regarding the rate and amount of solar energy fixed, respired and produced by plants in various freshwater bodies, the knowledge of secondary production of Zooplankton and bottom fauna, which are integral components of the food chain and occupy almost middle position in channelisation of energy, is still preliminary. This is because of difficult and less developed techniques and owing to complex life histories of these invertebrates often involving metamorphosis and long period of more or less continuous reproduction (Mann 1969).

Though the work on quantitative assessment of the rate of secondary production of zooplankton and bottom fauna started a little earlier in Russia (Greze and Baldina 1964, Petrovich *et al.*, 1964, Pechan and Sushkina 1964, Klekowsky and Sushkina 1966) where techniques have been developed, it came in the knowledge of general aquatic ecologists of the world only, when IBP took initiative and published its hand book on secondary production (Edmondson & Winberg 1971) and when translations of some important Russian works specially that of Winberg (1971) were made available. Some serious attempts have been made during recent years and secondary productivity of some freshwaters in quantitative terms has been worked out (Hall *et al.* 1970, Patalas 1970, Hillbricht-Ilkowska 1972, Schindler 1972, Schindler and Noven 1971 and Pederson *et al.* 1976).

In India work has yet not been started on the secondary production of freshwater zooplankton. The present work has been carried out in order to determine production and energy flow at various trophic levels in some freshwater impoundment of this region of the country. In an earlier paper (Khan 1979), the primary productivity and trophic status of two impoundments have been discussed. The present communication deals with the zooplankton biomass, secondary production, P/B ratio and ratio of secondary production to primary production *i.e.*, efficiency of energy transfer in an artificial lake of Calcutta (Dhakuria lake). The trophic status of the lake has also been discussed based on secondary production, P/B ratio and energy transfer efficiency.

MATERIALS AND METHOD

The study was conducted for a period of two years (October 1976 to September 1978)

in an artificial lake, Dhakuria lake of Calcutta, which has already been described (Khan 1979). Zooplankton samples were collected generally at fortnightly intervals, excepting, when detailed study on daily changes in the population composition and developmental duration of various life history stages of some important species was carried out. Sampling was done at 3 different stations of the lake with the help of a standard plankton net of No. 21 cloth. Two replicate vertical hauls were made from 3 meter depth at each station at a speed of 30 cm./sec. approximately. Samples of all the three stations were mixed so as to obtain only two replicate samples of a particular sampling day and screened through several cloths of varying mesh sizes in order to facilitate species or sizewise separation. Since rotifers constituted always less than 5% of the total biomass and involved great difficulty in biomass determination only crustacean, which constituted the rest of the zooplankton biomass, were taken into consideration. Samples were preserved in 4% formalin.

Identification, enumeration, size measurement and further separation were done simultaneously under a binocular with the aid of an ocular micrometer and varying magnification objectives after suitably diluting the samples and expressed in terms of cubic meter.

Copepods were divided into 7 groups *viz.*, eggs, nauplii I-III, nauplii IV-VI, copepodite I-III, copepodite IV-V, adult females and males. Similarly, Cladoceran were divided into 5 groups *viz.*, eggs, neonates, juveniles, adult I and adult II. Biomass was determined by multiplying the number of animals in each group to the mean dry weight of an individual of that group (W). The mean individual dry

weight was determined as follows : Approximately 300 adults of each group were dried at 50° C for 2 days and weighed on an electrical microbalance and mean weight of one individual was calculated. Two or three replicate samples were weighed and a mean was obtained.

For the calculation of production of the population data were required on composition of various age or size group (N) in the population at a given time, developmental duration of each group (T), and standing crop biomass (B) at frequent intervals. Mean number (N) of each group of each species was determined by the analysis of samples throughout the period. Duration of development was determined in laboratory as well as by the field data by observing time lag either between the maxima (Comita, 1972) or between the first appearance of two subsequent groups (Gehrs and Robertson, 1975). The growth increment in weight of each group was determined by calculating the differences between the average mean weight of two subsequent groups.

Production was calculated by the following equation based on Petrovich *et al*, (1964) and Ivonova's result given in Edmondson and Winberg (1971).

$$P = \frac{N_i W_i}{T_i} + \frac{N_{ii} W_{ii}}{T_{ii}} + \frac{N_n W_n}{T_n}$$

where P is the production in weight per day, N_i , N_{ii} , N_n are the mean number of respective groups in the sample. W_i , W_{ii} , W_n are weight increment during particular stage, T_i , T_{ii} , T_n are duration of development in days of respective groups. This gives daily production rate and production for longer periods was calculated as follows :

$$P = \frac{P_1 + P_2}{2} (t_2 - t_1) + \frac{P_2 + P_3}{2} (t_3 - t_2) + \dots + \frac{P_{n-1} + P_n}{2} (t_n - t_{n-1})$$

where P is summation of production from time $t-t_n$.

Besides this, primary production measurements and physicochemical analysis of the water were carried out as a routine by the methods already described (Khan, 1979). Energy transfer efficiency has been determined by working out the ratio of secondary production to primary production as follows :

$$e = \frac{\text{Secondary production}}{\text{Primary production}}$$

this e is same as ecological efficiency of Slobodkin (1962) expressed in terms of percentage. Coefficient of correlation (r) between mean daily P/B and mean daily temperature was worked out by least squares method. The dry weight was converted into carbon values.

RESULTS

Mean daily biomass of total crustacean zooplankton was quite high throughout the period of study, though it varied greatly between the two years (October 1976—September 1977, October 1977—September 1978). It ranged from 169.70 mg dw/m³ to 797.50 mg dw/m³ with a mean of 363.75 mg dw/m³ in 1976-77 and 120.00 mg dw/m³ to 800.00 mg dw/m³ with a mean of 547.00 mg dw/m³ in 1977-78 (Table 1). In spite of great variation in mean daily accumulation of biomass during the two years, the seasonal pattern almost followed the similar trend. Three distinct peaks, first in November, second in March and third in June were noticed in both years (Fig. 1).

TABLE—1. Zooplankton, Mean daily and Annual Biomass, Productivity, P/B and percentage composition of Copepoda and Cladocera.

	Mean Daily Biomass (B) mg dw/m ³	Mean Daily Productivity mg dw/m ³ -day	Daily P/B	Percent B P	Total Annual Production mg dw/m ³
<i>1976-77</i>					
Cladocera	78.45 (16.40-241.50)	6.300 (1.12-28.90)	0.0802 (0.004-0.175)	21.50 20.17	2300
Copepoda	285.30 (122.00-700.80)	24.90 (4.35-57.00)	0.0873 (0.02-0.167)	78.50 79.83	9100
Total	363.75 (169.70-797.50)	31.20 (4.52-61.00)	0.0858 (0.02-0.1713)		11400
<i>1977-78</i>					
Cladocera	211.00 (40.00-878.00)	26.15 (0.90-64.20)	0.1239 (0.021-0.142)	38.58 61.62	9565
Copepoda	336.00 (24.00-888.00)	25.95 (1.02-55.20)	0.0772 (0.0127-0.136)	61.42 48.38	9400
Total	547.00 (120.00-800.00)	52.10 (1.92-179.70)	0.0952 (0.016-0.1406)		18965

The daily production of total crustacean zooplankton was also high and ranged from 4.52 mg dw/m³-day to 61.00 mg dw/m³-day with a mean of 31.20 mg dw/m³-day in 1976-77 and 1.92 mg dw/m³-day to 179.70 mg dw/m³-day with a mean of 52.10 mg dw/m³-day in 1977-78. The annual production varied from 11400 mg dw/m³-year in 1976-77 to 18965 mg dw/m³-year in 1977-78 (Table 1). Trend of seasonal pattern closely followed the biomass pattern except that the third peak in 1976-77 occurred one month earlier, *i.e.*, in May (Fig. 1). While there were great fluctuations in production and biomass from year to year, the average daily P/B ratio of total crustacean zooplankton (Table 1) differed very little. These values ranged from 0.0200-0.1713 (mean 0.0858) in 1976-77 and 0.0160-0.1406 (mean 0.0952) in 1977-78. Four distinct peaks were observed in both years but during different months (Fig. 1). The biomass and productivity of copepods were higher than cladocerans. Cladocerans biomass ranged from 16.40-241.50 (mean 78.45) mg dw/m³ in 1976-77 and 40.00-878.00 (mean 211.00) mg dw/m³ in

1977-78. The biomass of copepods ranged between 122.00 and 700.80 (mean 285.30) mg dw/m³ and between 24.00 and 888.00 (mean 336.00) mg dw/m³ in 1976-77 and 1977-78 respectively. The mean daily production of cladocera was 6.3 mg dw/m³-day (range 1.12-28.90) in 1976-77 and 26.15 mg dw/m³-day (range 0.9-64.2) in 1977-78, while that for copepods were 24.90 (range 4.35-57.00) and 25.95 (range 1.02-55.20) mg dw/m³-day for 1976-77 and 1977-78, respectively. The mean P/B ratio for cladocera were 0.0802 and 0.1239 and for copepods 0.0873 and 0.0772 for 1976-77 and 1977-78 respectively.

While cladoceran contributed less to total zooplankton biomass (38%). In 1977-78, their production was sufficiently high and was almost equal to copepods production (Table 1). In 1976-77 its contribution to biomass was almost proportionate to its production (mean daily biomass 21.5% and mean daily production 20.17%). However, the bulk of biomass was produced by copepods during both years (78% and 61.4% during two years

respectively). The daily P/B ratio was almost equal in 1976-77 but cladoceran got an edge over copepods in 1977-78.



Fig. 1. Seasonal variations in mean daily biomass, production and P/B of total crustacean zooplankton.

Figure 2 and 3 display the seasonal pattern of mean daily biomass, production and P/B ratio of cladocerans and copepods respectively while Fig. 4 depicts the variation in percentage composition of the two groups. It is clear that during 1976-77 the November peak of total zooplankton biomass was due to the abundance of copepods while March and June peaks were due to both cladocerans and copepods. In 1977-78 November peak was due to cladocera, when a condition resembling to swarming or bloom formation of

Ceriodaphnia cornuta occurred between November 1977-January 1978. Another peak of cladoceran abundance, this time contribution by another species, *Daphnia carinata*, combined with sufficient abundance of cyclopoid *Mesocyclops leuckarti* resulted in high daily biomass production of total zooplankton in June, while March peak was mainly due to copepods. As far as cladoceran production is concerned, in 1976-77 only one peak was observed, i.e., in May 1977 due to the presence

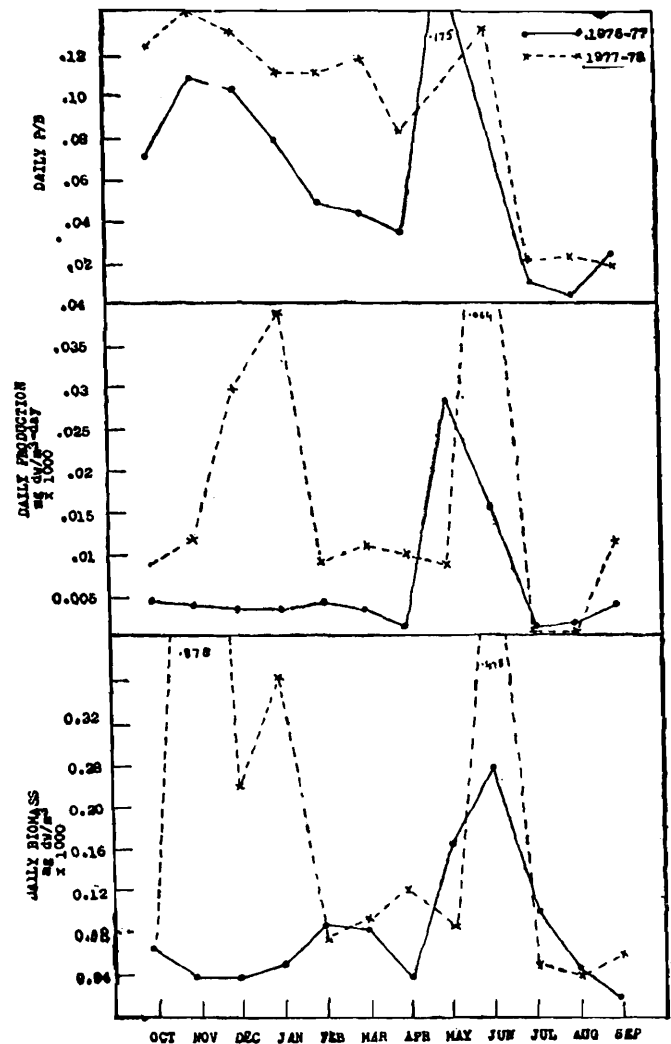


Fig. 2. Seasonal variations in mean daily biomass, production and P/B of cladocerans.

of sufficient number of youngs of *Daphnia carinata* in the population which resulted in high biomass during subsequent months when

adult dominated. In 1977-78 peaks of production were noticed in January 1978 following abundance of *C. cornuta* and in June when *D. carinata* reproduced excessively resulting in bloom formation. In copepod temporary bloom formation was never noticed even though biomass and production were high in

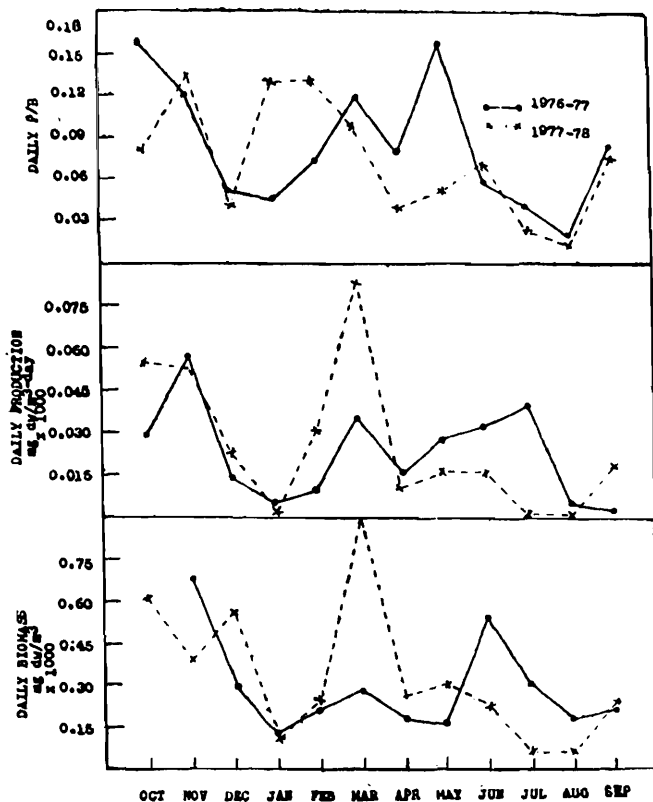


Fig. 3. Seasonal variations in mean daily biomass production and P/B of copepods.

both years (Figs. 3 & 4) with three peaks in 1976-77 (November, March and July) and only two distinct peaks, (October and March) in 1977-78.

The mean daily primary production rate for the two years were 176.00 mg C/m³-day and 275.00 mg C/m³-day for 1976-77 and 1977-78 respectively. When efficiency of energy transfer was calculated it varied between 0.078 or 7.8% in 1976-77 to 0.083 or 8.3% in 1977-78.

When the relationship between mean daily P/B of total zooplankton and mean daily temperature was worked out, a highly insigni-

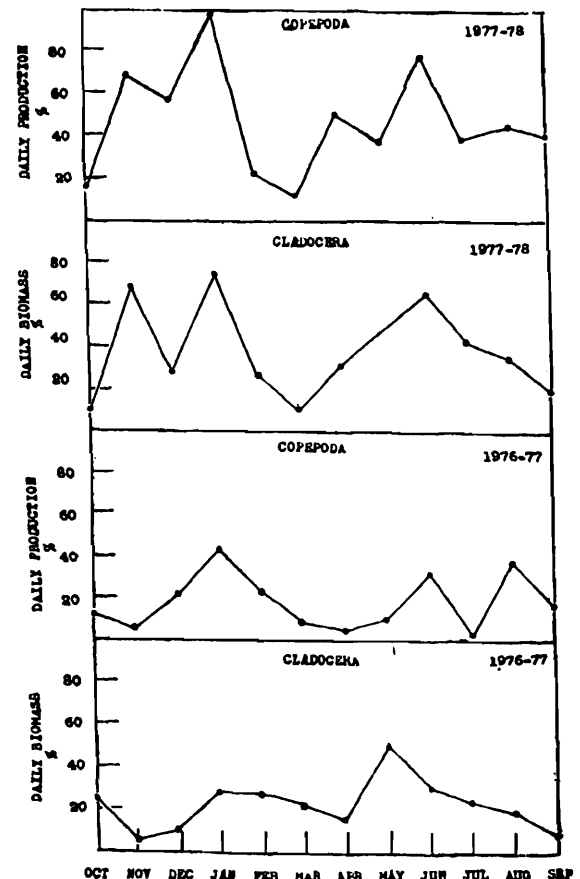


Fig. 4. Percentage composition of cladocera and copepoda in total zooplankton biomass, production and P/B.

ficant relationship were observed during both years ($r=0.25$, DF 11 in 1976-77 and $r=0.35$, DF 11 in 1977-78).

DISCUSSION

The standing crop biomass as well as production of crustacean zooplankton in Dhakuria lake were quite high throughout the year, as compared to freshwaters of temperate regions reported in literature (Patalas 1970, Schindler 1972, Pederson *et al.* 1976). This is quite expected as production is a continuously active process throughout the year in tropical water bodies unlike to temperate freshwaters

where active production occurs only during ice free growing season.

Copepod played an important role in the biomass as well as production of total crustacean zooplankton of Dhakuria lake during both years. In 1976-77 more than three-fourth and in 1977-78 about two-third of the biomass of total zooplankton was formed by them. Similarly their production was also higher than cladoceran in both years. This revealed the stability of copepod in the production dynamics of the lake.

It is interesting to note that the bulk of biomass as well as production of total zooplankton was formed by only few species. Two species of copepods, one calanoid, *Haliodyptomus contortus* and one cyclopid, *Mesocyclops leuckarti* and two species of cladocera, *Daphnia carinata* and *Ceriodaphnia cornuta* were responsible for all the peak of biomass and production, though each species of cladocera and calanoida dominated during different period. It is further interesting to note that during the period when calanoida dominated, the contribution of cladoceran was at lowest ebb and vice versa. However, during the abundance of cyclopoids, cladocerans were not affected. This is probably due to the fact that both cladocera and calanoida were filter feeder and involved in active competition which either entirely eliminated one group or suppressed considerably its activities. Since cyclopid, *M. leuckarti* was a seizer and mainly carnivore, it did not compete with cladocera.

The relationship between secondary production specially P/B and trophic status of the lakes has been discussed by many workers during recent years. Patalas (1970), after comparing an eutrophic lake receiving thermal effluent with a similar eutrophic lake as a control alongwith studies on some other

lakes, put forward a hypothesis that P/B of crustacean zooplankton tended to increase in proportion to the productivity of the lake hence its eutrophication. Pederson *et al.* (1976) working on the lakes of Lake Washington watershed could not confirm Patalas's hypothesis. Values of crustacean zooplankton P/B in Dhakuria lake were close to the values obtained by him for eutrophic lakes but being a highly eutrophic water body as revealed by primary productivity, a very high P/B was expected from Patalas standard which was not so. Since no other information is available from tropical freshwaters, no comparison could be made and hence Patalas's hypothesis can not be definitely confirmed.

Another hypothesis regarding the relationship of secondary production to trophic status of freshwaters has been put forward by Hillbricht-Ilkowska (1972). She postulated that the zooplankton food supply in lakes is used less efficiently as the trophic status moves towards eutrophy, hence the ratio of primary production to secondary production decreases as the trophic status increases. This phenomenon has been attributed to the greater percentage of blue green algae in the richer lakes. These algae are either too large to be efficiently grazed or they pass through the alimentary canal of the grazers without being digested. Results of Hall *et al.* (1970) in experimental ponds and Pederson *et al.* (1976) support this hypothesis. This seems to be quite true in Dhakuria lake where efficiency of energy transfer was only 0.08 or 8%, close to the values reported for high nutrient experimental ponds by Hall *et al.* (1970). Like any other tropical eutrophic water body, the blue green algae formed sizeable proportion of phytoplankton biomass in Dhakuria lake which might have resulted in low transfer efficiency.

One of the very important findings of the present studies is that production process was not at all related to temperature as revealed by insignificant relationship between mean daily water temperature and mean daily P/B in Dhakuria lake. P/B fluctuated throughout the year irrespective of temperature. This is in contrast of majority of the earlier works in temperate waters (Hall *et al.* 1970, Patalas 1975, Duncan 1975, Janieki and De Costa 1977). In fact temperature in tropical freshwaters specially in this region of the country did not fluctuate much from season to season (Dhakuria lake mean daily water temperature $29+4^{\circ}\text{C}$, except for very very brief period) and consequently it did not play any important role. Similar insignificant relationship between phytoplankton primary production and temperature has already been reported (Khan 1979).

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STUDIES ON HEAD PORES OF SOME INDIAN SPECIES OF CHYDORIDS
(CLADOCERA : CHYDORIDAE)

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ABSTRACT

The present study, being first of its kind from India, deals with head pore studies of 20 species (spread over two subfamilies and 12 genera) of the largest Cladoceran family Chydoridae. The pore arrangement in the reported genera of the subfamily Chydorinae is characteristic. On the other hand, subfamily Aloninae showed a diversity in the numbers and arrangement of head pores in the presently recorded genera. Furthermore, differences in size, shape and sculpturing of head shields and in the details of the pore arrangement and their morphology have also been found to be useful for distinguishing the examined species. A key to the recorded genera of this family, based on the present investigations, is also given.

INTRODUCTION

The studies on head pores in Chydoridae, the largest family of Cladocera, are found to have taxonomic and phylogenetic significance. Warner (1924), first of all, suggested that the large head pores occurring in the Chydoridae may be of taxonomic value. Frey (1959, 62, 67) examined the general appearance of these structures in this family and mentioned the possibility of their use in establishing phylogenetic relationships. Frey (1959) also pointed that the pore arrangement and their morphology in chydorids appeared to be conservative character subjected to little ontogenic change.

The present work, being first of its kind from India, deals with head pore studies of

20 species of chydorids (spread over two subfamilies and 12 genera) collected from Calcutta and its environs, West Bengal. Based on this study, a key to the presently recorded genera has also been given.

MATERIAL AND METHODS

The material for the present investigations was collected from various water bodies from Calcutta and its adjacent areas (some localities in 24-Parganas District), West Bengal. The specimens preserved in 5% formalin were used for this study. For disarticulation of head shields, the technique suggested by Megard (1965) was employed. Disarticulated head shields were mounted in Polyvinyl alcohol-lectophenol mixture and examined

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under a stereoscopic binocular-microscope. The drawings were made using a camera lucida.

LIST OF EXAMINED SPECIES

Class : CRUSTACEA
 Subclass : BRANCHIOPODA
 Order : CLADOCERA
 Family : CHYDORIDAE Stebbing, 1902

Subfamily : CHYDORINAE Stebbing, 1902

Pleuroxus denticulatus Birge, 1879
Pleuroxus similis Vavra, 1900
Chydorus sphaericus (O.F. Müller,
 1785)
Chydorus barroisi (Richard, 1890)
Chydorus eurynotus Sars, 1901
Dunhevedia crassa King, 1853

Subfamily : ALONINAE Frey, 1967

Alona rectangula Sars, 1862
Alona davidi Richard, 1895
Alona pulchella King, 1853
Kurzia latissima (Kurz, 1875)
Kurzia longirostris (Daday, 1898)
Acroperus harpae (Baird, 1843)
Camptocercus rectirostris
 Schoedler, 1862
Leydigia acanthocercoides (Fischer,
 1854)
Biapertura affinis (Leydig, 1860)
Biapertura karua (King, 1853)
Oxyurella tenuicaudis (Sars, 1862)
Oxyurella singalensis (Daday,
 1898)
Euryalona orientalis (Daday,
 1898)
Indialona globulosa (Daday, 1898)

RESULTS

Frey (1967) recognised four subfamilies of family Chydoridae. However, in the examined material, only two of them *i. e.*, Chydorinae and Aloninae are represented. The former is represented by the genera *Pleuroxus*, *Chydorus* and *Dunhevedia* while the latter includes the genera *namley*, *Alona s. str.*, *Kurzia*, *Acroperus*, *Camptocercus*, *Leydigia*, *Biapertura*, *Oxyurella*, *Euryalona* and *Indialona*.

Subfamily : CHYDORINAE Stebbing, 1902

The arrangement of head pores in the different genera of this subfamily is characteristic : two separate main pores situated in the median line of the head shield and two small pores situated between the main pores.

Pleuroxus : Head pores typical of the subfamily : the distance from the posterior margin of the head shield more than the distance between the main pores.

The two examined species of this genus, *P. denticulatus* and *P. similis* differ little in the shapes of their head shields (Figs. 1 & 2).

Chydorus : Smirnov (1971 : 277) pointed the head pores to be apparently absent in *C. barroisi*. However, Fernando (1974) figured head pores in this species and the same have also been observed in the presently examined specimens (Fig. 3). In *C. sphaericus*, the head shield is having broadly rounded posterior margin and pointed rostral projection (Fig. 4). The head shield of another chydorid species, *C. eurynotus* is shown in Fig. 5.

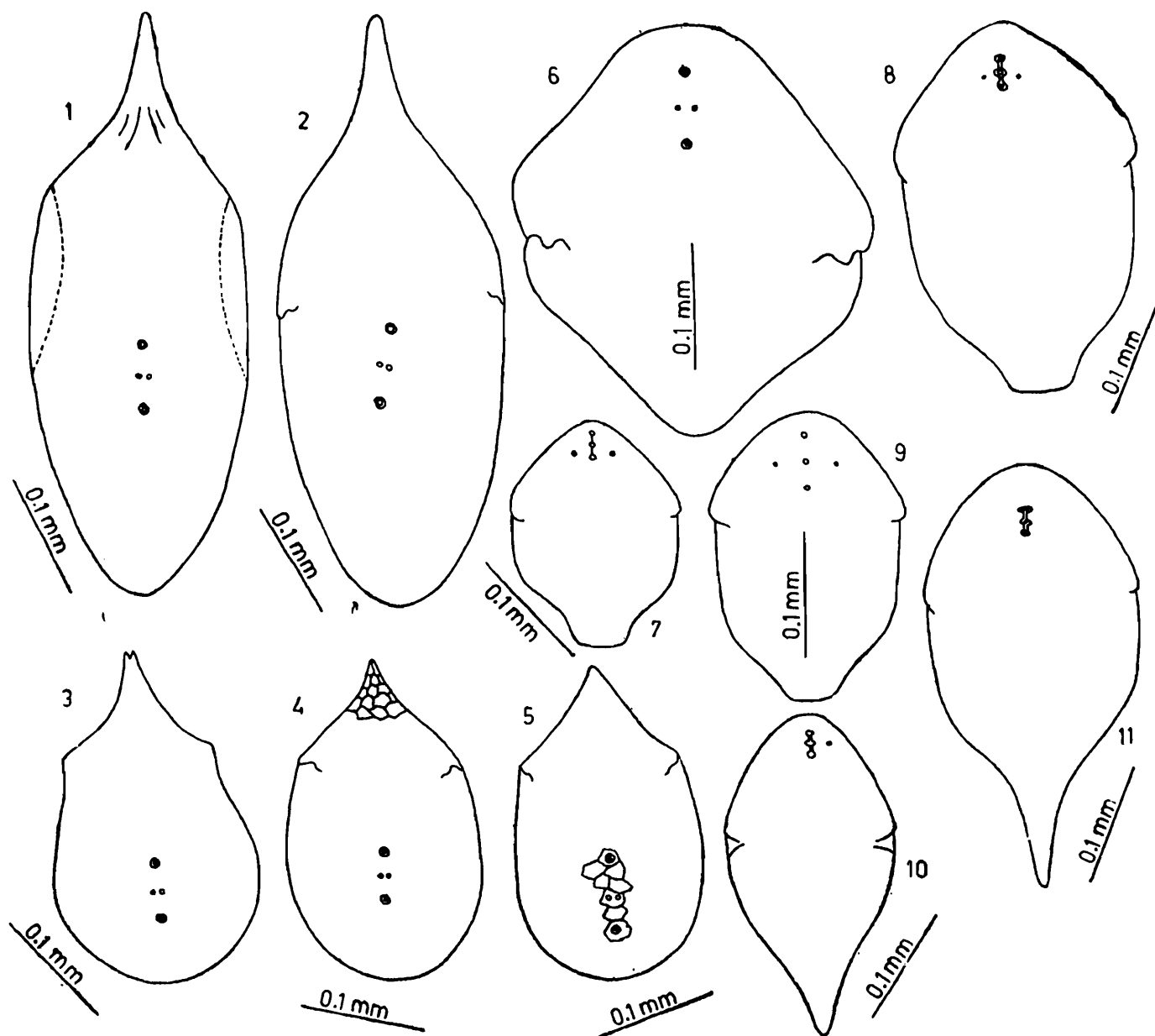
Dunhevedia : Distance from the head pores to the posterior margin of head shield shorter than the distance between the main pores.

In the examined species of this genus, *D. crassa*, head shield is with rounded anterior and posterior margins (Fig. 6).

Subfamily : ALONINAE Frey, 1967

This subfamily exhibits a diversity in the number and arrangement of head pores. Of the five main categories mentioned by Smirnov (1971), only four have been noticed in the present material. These categories are :

1. Three main head pores with a narrow connection between them ;



Figs. 1-11. *Pleuroxus denticulatus* Birge, Head shield ; 2. *Pleuroxus similis* Vavra, Head shield ; 3. *Chydorus barroisi* (Richard), Head shield ; 4. *Chydorus sphaericus* (O. F. Müller), Head shield ; 5. *Chydorus eurynotus* Sars, Head shield ; 6. *Dunhevedia crassa* King, Head shield ; 7. *Alona rectangula* Sars, Head shield ; 8. *Alona davidi* Sars, Head shield ; 9. *Alona pulchella* King, Head shield ; 10. *Kurzia latissima* (Kurz), Head shield ; 11. *Kurzia longirostris* (Daday), Head shield.

2. two main head pores with a narrow connection between them ;

3. two separate main head pores with two small pores between them and two small pores situated laterally ;

4. a single pore.

Furthermore, Smirnov (1971 : 336) broadly grouped all the genera of Aloninae into five categories depending upon the nature of head pores. Again, only four such groups are recorded in the examined material :

- i. Three main head pores : *Alona* s. str., *Kurzia*, *Acroperus*, *Camptocercus* and *Leydigia* ;
- ii. two main head pores with a narrow connection between them : *Biapertura* ;
- iii. two separate head pores : *Oxyurella* and
- iv. one main head pore : *Euryalona* and *Indialona*.

Considering the great phylogenetic significance of the structure of head pores, Smirnov (1971) revised the previously least well defined genus *Alona*. Leaving aside the species with three main head pores, the forms with two main head pores with a narrow connection were transferred into the newly erected genus *Biapertura*. In the present material, the genus *Alona* is represented by three species : *rectangula*, *davidi* and *pulchella*. Of these, the former two species (Figs. 7 & 8) showed the head pore arrangement typical of the genus but they differed in the shapes of their head shields. However, in *Alona pulchella*, three main head pores were not connected with each other (Fig. 9). Such a deviation has also been mentioned by Smirnov (*loc. cit.*).

The recorded species of the genus *Kurzia* i. e., *K. latissima* and *K. longirostris* could be differentiated (Figs. 10 & 11) by the relative length of the rostral projections. Moreover, in *K. longirostris* the posterior head pore is laterally expanded.

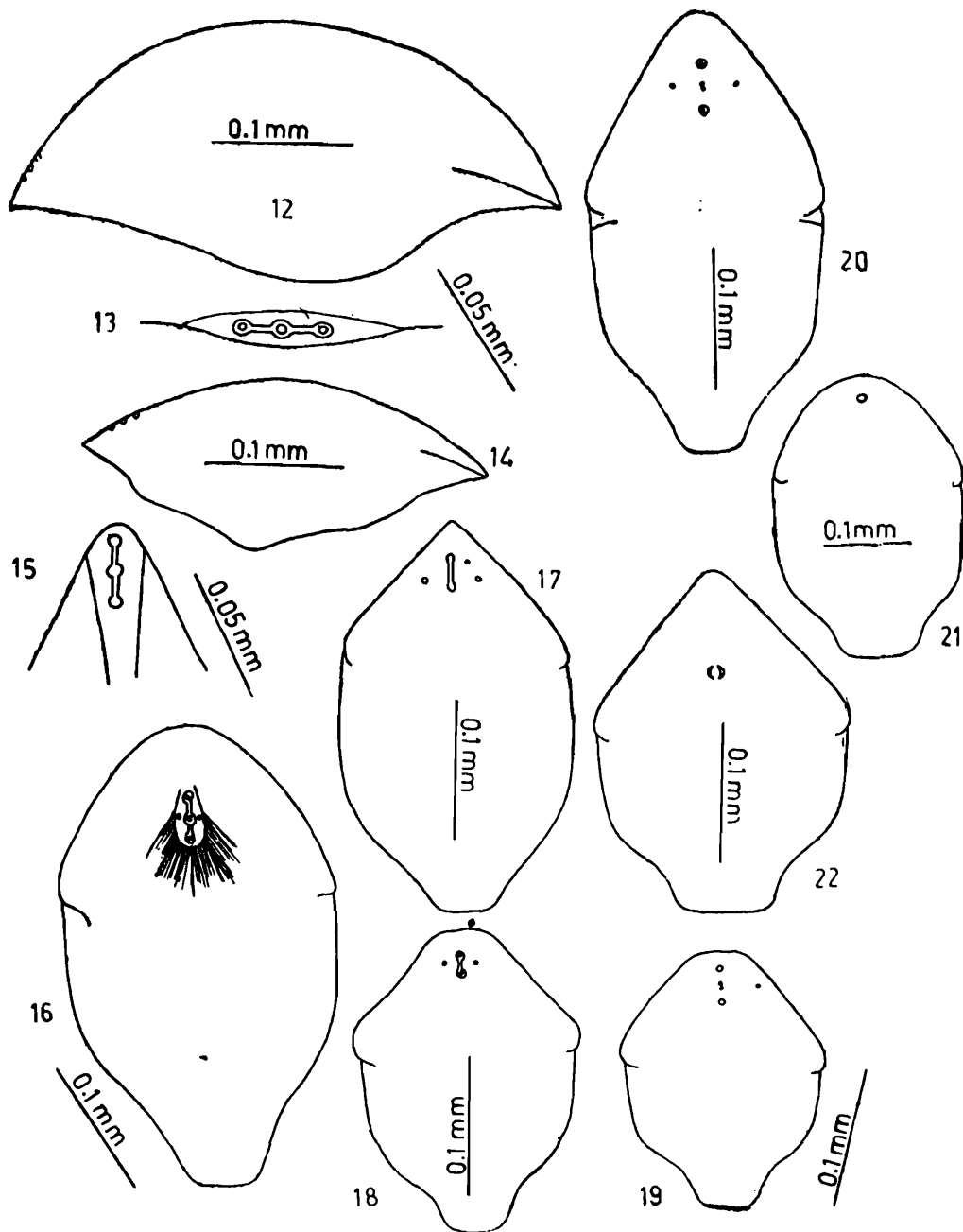
In *Acroperus harpae* (Figs. 12 & 13) and *Camptocercus rectirostris* (Figs. 14 & 15), the head shields are sharply keeled and three connected head pores are situated on the crest of the head shields near the posterior margin.

In *Leydigia acanthocercoides* (Fig. 16), three main head pores are connected by a narrow channel and lateral pores are very close to the main pores. In addition, the surface of the head shield is also marked by fine striae.

The genus *Biapertura* is represented by *B. affinis* and *B. karua* in the present material and they differ in the shapes of their head shields. In *B. affinis* (Fig. 17), the posterior margin of the head shield is pointed while it is rounded in *B. karua* (Fig. 18).

The two examined species of *Oxyurella* i. e., *tenuicaudis* and *singalensis* show identical arrangement of head pores but differ in the size and shapes of their head shields (Figs. 19 & 20).

Two other genera of Aloninae, *Euryalona* and *Indialona* fall in the same category because of the presence of a single main pore. The sole examined species of the former genus i. e., *E. orientalis* is known to have a single head pore and head shield is with blunt anterior margin and rounded posterior margin (Fig. 21). In *I. globulosa* the head shield shows angular posterior margin (Fig. 22).



Figs. 12-22. 12 & 13. *Acroperus harpae* (Baird)
 12. Head shield (lateral view) ;
 13. Head pores (enlarged) ;
 14 & 15. *Camptocercus rectirostris* (Schoedler)
 14. Head shield (lateral view) ;
 15. Posterior part of head shield (enlarged) showing head pores ;
 16. *Leydigia acanthocercoides* (Fischer), Head shield ;
 17. *Biapertura affinis* (Leyding), Head shield ;
 18. *Biapertura karua* (King), Head shield ;
 19. *Oxyurella tenuicaudis* (Sars), Head shield ;
 20. *Oxyurella singalensis* (Daday), Head shield ;
 21. *Euryalona orientalis* (Daday), Head shield ;
 22. *Indialona globulosa* (Daday), Head shield,

KEY TO THE RECORDED GENERA OF FAMILY
CHYDORIDAE, BASED ON THE
PRESENT STUDY :

- 1 (8). Two main head pores, separate and situated in the median line of the head shield ; two small pores situated between main pores ; if there is a single pore then it is situated far from the posterior margin of head shield. ... CHYDORINAE
Stebbing, 1902
- 2 (6). Distance from the posterior head pore to the posterior margin of head shield more than the distance between main pores.
- 3 (4). Rostrum long. Distance from the apex of rostrum to the posterior end of fornix slightly longer than distance from the posterior end of fornix to posterior margin of head shield ... PLEUROXUS
Baird, 1843
- 4 (5). Rostrum short. Distance from apex of rostrum to posterior end of fornix larger than distance from posterior end of fornix to posterior margin of head shield. Head shield rarely without pores.
- 5 (4). Rostral part of head shield without combs ... CHYDORUS
Leach, 1816
- 6 (2). Distance from the posterior margin of head shield to the posterior head pore shorter than distance between main head pores.
- 7 (6). Head shield with rounded anterior margin and blunt rostrum ... DUNHEVEDIA King,
1858
- 8 (1). Two or three main pores situated in the median line of head shield, free or united and two small pores situated lateral to main pores ; if the main pore single, it is situated near the posterior margin of head shield ... ALONINAE
Frey, 1967
- 9 (24). Two or three main head pores.
- 10 (22). Main pores connected.
- 11 (20). Three main head pores.
- 12 (17). Small pores located at a moderate distance from the main head pores.
- 13 (16). Anterior margin of head shield blunt, with slightly produced apex.
- 14 (15). Small pores situated at some distance from the main pores ... ALONA Baird,
1843. emend.
Smirnov, 1971
- 15 (14). Small pores located very close to the main head pores ... LEYDIGIA
Kurz, 1875
- 16 (13). Anterior margin of head shield with pointed apex ... KURZIA Dybowski & Grochowski, 1894
- 17 (12). Small pores situated far from the main head pores.
- 18 (19). Distance from apex of rostrum to posterior end of fornix longer than distance from posterior end of fornix to posterior end of head shield ... ACROPERUS
Baird, 1843
emend. Smirnov, 1971

- 19 (18). Distance from posterior end of fornix as long as distance from posterior end of fornix to posterior end of head shield ... CAMPTOCERCUS Baird, 1848
- 20 (11). Two main head pores.
- 21 (20). Main head pores narrowly connected ... BIAPERTURA Smirnov, 1971
- 22 (10). Two main separated head pores.
- 23 (22). Two small pores between main pores and two small pores lateral to them ... OXYURELLA Dybowski & Grochowski, 1894
- 24 (9). One main head pore.
- 25 (26). Head shield with broadly rounded posterior margin and truncate anterior end EURYALONA Sars, 1901
- 26 (25). Head shield with broadly rounded posterior and anterior margins ; if posterior end pointed, anterior margin truncate ... INDIALONA Petkovski, 1966

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NOTES ON THE INDIAN SPECIES OF *NEOCHAULIODES* WEELE
(NEUROPTERA : CORYDALIDAE)

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ABSTRACT

This paper incorporates a rather comprehensive account of the taxonomy of four Indian species of the genus *Neochauliodes* Weele under the family Corydalidae including their key. Over and above, the biogeography with particular reference to a couple of the elements, *Neochauliodes sinensis meridionalis* Weele and *N. simplex* (Walker), which are recorded new for India, is also dealt with.

The Indian specimens of the megalopteran genus *Neochauliodes* Weele under the order Neuroptera have been closely examined. The study is based on the material available in the old National Collections at Zoological Survey of India and also on the unnamed collection received from Dr. J. N. Katiyar, I. C. A. R. Complex, Arunachal Pradesh. Presently, an attempt has been made to communicate in brief some important aspects concerning taxonomical and geographical interests. Besides, a key to the species has also been included.

The genus *Neochauliodes* Weele (1909a) underwent several changes in its systematic position right from the family level. The present-day corydalid members of the genus with the type-species, *Chauliodes sinensis* Walker from China, were earlier treated in *Chauliodes* Latreille (partim.) and *Hermes* Gray (partim.) under a separate family of Sialidae. Weele (1910) placed them under the advanced

and almost cosmopolitan tribe Chauliodini of the subfamily Corydalinae in the family Sialidae. Later, Banks (1940) also retained them in the same family without splitting it into tribe. Finally, Kuwayama (1962) considered the tribe Chauliodini and Neuromini as subfamilies under the family Corydalidae. He (*loc. cit.*) did not, however, take into account the tribal classification of the aforesaid subfamilies.

The genus exhibits a less exotic pattern of distribution in the Old World and is not known from the New World. It includes about a dozen of species being restricted in continental Asia and also in the Malayan and Papuan groups of islands (*vide* Weele, 1909b). Of these, nearly 25% are hitherto known exclusively from the north-eastern extra-peninsular sector of India. Amongst the Indian species, only two are already known to occur in Assam and Meghalaya. Besides, one more species, *Neochauliodes obscurus* Weele

from Manipur, could not be dealt with at the moment due to the lack of material. According to Weele (1909a) the generic position of this aberrant species seems to be somewhat doubtful. Moreover, two other species, hitherto known only from either Bangladesh or China, are presently recorded for the first time from Arunachal Pradesh and Meghalaya. The specific results of the present scientific investigation are briefed hereunder.

Key to the Indian species of *Neochauliodes* Weele

- | | | |
|--|-----|-----------------------------|
| 1. Body yellow to piceous. Wings with a large brown streak before pterostigma, hind pair with spots reduced. Penis short, broad and trapezoid ... | ... | <i>sinensis</i>
(Walker) |
| — Body dull to grey brown. Wings without streak before pterostigma, hind pair with spots never reduced. Penis variable in size and shape ... | ... | 2 |
| 2. Wings of moderate width, with brown spots on either side of pterostigma. Appendix superiores with small basal tubercle ... | ... | 3 |
| — Wings very narrow, hind pair without spot on either side of pterostigma. Appendix superiores with large basal tubercle ... | ... | <i>khasianus</i>
(Weele) |
| 3. Both wings with almost similar markings, a small spot on either side of pterostigma; costal area with indistinct spots; subcostal area immaculate; apical area without white spot. Penis long and slender throughout, with borders narrowly raised; appendix superiores normally truncate ... | ... | <i>simplex</i>
(Walker) |

- Both wings with an elongate spot on either side of pterostigma, otherwise markings quite dissimilar: fore-pair having costal area with distinct vinaceous and round spots in the basal two-thirds; subcostal area maculate and apical area with prominent white spots; hind pair without such markings. Penis broad and stout at base, with borders thickly raised; appendix superiores strongly quadrate ... *indicus*
(Weele)

Neochauliodes sinensis (Walker)

The species, which was hitherto confined in North, South, and West China, was originally described by Walker (1853) under the genus *Chauliodes* Latreille and subsequently considered under *Neochauliodes* by Weele (1909a). It comprises three distinct geographical forms or subspecies, of which *N. sinensis meridionalis* Weele, originally known from South China, is recorded for the first time from India by the single male specimen from Arunachal Pradesh (Basar, 29. ix. 1977, J. N. Katiyar coll.). This Oriental subspecies seems to extend in the Palaearctic region, since Weele (1909a) indicated its locality-range at Mou Pin which comes under the jurisdiction of West China.

The specimen fits well in the subspecies, though some of the additional characters may be noted here. These include epicranium, antennae except the dorsal margins of the two basal segments, frons, mandibles, meso- and metanota all black in colour, epicranium with lateral rows of cilia short and yellowish, first two antennal segments dorsally ringed yellow, femora uniformly dark brown and length of fore- and hind wings, measuring 32 and 29 mm respectively.

Neochauliodes khasianus (Weele)

The species, with which the earlier described *Chauliodes pusillus* Weele (1907) was considered conspecific by the same worker (1909a), hitherto remains endemic in the Khasi Hills of Meghalaya. Its characters have been mentioned in the key after reviewing the literature. Further comments on the form, however, have not been made due to the non-availability of material.

Neochauliodes indicus (Weele)

The species, exclusively known from the hills of North-East India, was originally described by Weele (1907) under the genus *Chauliodes* Latreille and, later transferred by him (1909a) to *Neochauliodes*. Presently, a female specimen has been examined from Meghalaya (Shillong, Mulki, 11. viii. 1973, R. S. Giri coll.). It agrees well with both the description and morphometric data including the length of wings already given by Weele (*loc. cit.*) for the species.

Neochauliodes simplex (Walker)

The species was described by Walker (1853) under the genus *Chauliodes* from Bangladesh (Sylhet) and later, considered by Weele (1907) under *Neochauliodes*. Both these workers could not, however, study the female of the species. The present material, include both the sexes from Meghalaya (Shillong, one ♂ Wards Lake, 12.v.1959, Risa colony, 16.viii. 1973, J. K. Prasad coll. ; 1 ♀, Mawghlang, N. Y. S. Hills, 22. v. 1971, R. S. Pillai coll.). Thus the species constitutes new locality records for India and has an important bearing on its further north-ward extension of the geographical range.

The morphological features of both the sexes presently examined are almost identical with the description of male provided in the literature. Several additional characters have been noted for the species. These include occiput, vertex, eyes, frons, promeso- and metanota and also abdomen all black, clypeus and labrum yellow, antennae excepting for the three apical dark brown segments being concolourous with clypeus and labrum, labium also yellow but the palpi dark brown, legs black-brown partly with golden bristles, pterostigma and costal field of forewing indistinct and rather dark respectively. Length of fore- and hindwing in males vary between 30-36 mm and 25-32 mm respectively, while the corresponding measurements in the female are 32 and 30 mm.

ACKNOWLEDGEMENTS

The author is grateful to the Director, Zoological Survey of India, Calcutta for providing laboratory facilities. He is also thankful to Dr. J. N. Katiyar, I. C. A. R. Complex, Arunachal Pradesh for sending the material to the Department for favour of identification.

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A NEW SPECIES OF *TRIGONOMIMA* ENDERLEIN (DIPTERA : ASILIDAE)
FROM INDIA

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ABSTRACT

A new species of *Trigonomima* Enderlein, *Trigonomima fuscopoda*, is described from N. E. India and a key to Indian species of the genus is given.

INTRODUCTION

Trigonomima Enderlein was recorded for the first time from India by us (1980). Since then we have got another new species, which is described below.

Genus *Trigonomima* Enderlein

Trigonomima Enderlein, 1914, *Wien. ent. Ztg.*, 33 : 164.
Type-species *Trigonomima apipes* Enderlein by original designation.

Key to the Indian species of *Trigonomima* Enderlein

- Legs black and yellow with yellow hairs, aedeagus distinctly trifold ... *anamaliensis*
Joseph and Parui
- Legs uniformly dark brown with mixed concolorous and pale hairs, aedeagus not trifold ... *fuscopoda* sp. nov.

Trigonomima fuscopoda sp. nov.

A medium sized black species with black legs and wings. Male : length 7 mm, wing 7 mm ; female : length 7 mm, wing 7 mm.

Male : *Head* broader than thorax. Head black, nearly devoid of tomentum, mystax

golden yellow ; bristles of ocellarium black, upper occiput bare, postocular occiput bearing sparse pale hairs. Antenna black, segments 1 and 2 with dark brown or brown bristles, segment 1 shorter than the following segment, 3 about twice the combined length of segments 1 and 2, terminal segment bearing double bristle like the other members of the genus. Palpi and proboscis black, the former with yellow or pale yellow hairs.

Thorax black with grey tomentum ; pronotal hairs sparse, pale and restricted to the sides ; mesonotum with the humeri bright orange marked and posterolateral sides yellowish-brown, covering hairs brown and dense posteriorly ; scutellum with a transverse row of three median bristles on the disc ; mesopleuron and sternopleuron pale haired, metanotal callosity with dark brown bristles. Halteres yellowish-brown.

Legs dark brown with concolorous and pale hairs, pale hairs more or less confined to the ventral side, hairs dense on femur and tibia, some of which on the hind tibia elongate.

Wings black, but lighter distally, venation typical of the genus with four posterior cells.

Abdomen dark brown and black with indistinct grey tomentum, pale hairs present on the sides which become lesser and shorter on posterior tergites. Male terminalia (Fig. 1) lighter than the abdomen.

Female : Similar but with the following differences : in some examples grey tomentum of mesonotum more distinct, humeri without

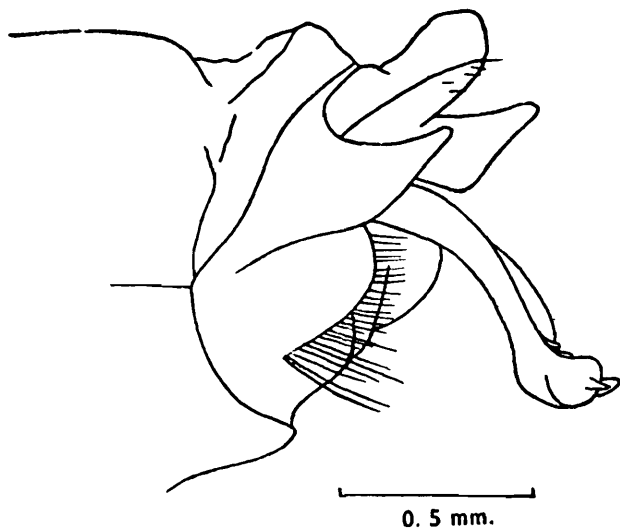


Fig. 1. *Trigonomima fuscopoda* sp. nov., lateral view of male terminalia.

dark orange marking, but in one or two paratypes with dark brown marking, postero-lateral marking not so distinct; scutellar bristles three or four.

The only other known Indian species of the genus *Trigonomima* is *T. anamaliensis*

Joseph and Parui, from which *T. fuscopoda* sp. nov. differs in the uniformly coloured legs and details of male terminalia.

Holotype : ♂, ZSI Reg. No. 6564/H6, N. E. India : Arunachal Pradesh : Kameng : Tipi, 213 m, 6. v. 1966, coll. A. N.T. Joseph.

Paratypes : 3 ♀ ♀, Reg. Nos. 6565/H6-6567/H6, 3. v. 1966, rest of data as in holotype. 2 ♀ ♀, Reg. Nos. 6568/H6 and 6569/H6, N. E. India : Arunachal Pradesh : Subansiri : Kimin, 198 m, 11. v. 1966, coll. A. N. T. Joseph.

ACKNOWLEDGEMENTS

We are grateful to Dr. B. K. Tikader, Director and Dr. S. K. Bhattacharya, Deputy Director, Zoological Survey of India, Calcutta, for encouragements and for placing the material at our disposal.

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OBSERVATIONS ON THE GROWTH RATE OF THE COMMON GARDEN SNAIL
OPEAS GRACILE (HUTTON) [STYLOMMATOPHORA : SUBULINIDAE]

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ABSTRACT

Rates of growth in the shell length and the body whorl of *Opeas gracile* have been studied. The snails 1.84 mm. at hatching grew up to 4.25 mm. while the whorls increased from 3 to 4.68 at the end of 6th week when they became sexually mature. Growth rate was faster in the first two weeks and minimum in the third week.

INTRODUCTION

Opeas gracile the tiny, anthropomorphic garden snail is perhaps the commonest of all terrestrial molluscs of Indian Union, and has been the subject of study by a number of workers (Rahman *et al.*, 1975 ; Mitra *et al.*, 1976 ; Biswas *et al.*, 1976). However, the growth rate of this snail species, which has got a direct influence on its population structure, has not been studied by any of the earlier researchers. Results of our studies on the increase in length and number of whorls are presented here. Further studies involving other parameters like width, height of aperture, length—width ratio are in progress.

MATERIALS AND METHODS

To study the growth rate of *Opeas gracile* 10 newly hatched individuals were released in a terrarium measuring 30×20×20 cm. The floor of the terrarium was covered with loose humus soil, 5 cm. thick, moistened by spraying of water. They were kept active

by supplying food in adequate quantity and also by maintaining required humidity range by spraying water regularly. Growth rate was ascertained by taking measurements of shell length and by counting the number of whorls at the end of each week. The experiment was started on August 14, 1979 and continued upto October 2, 1979, when the snails became sexually mature.

OBSERVATIONS

The newly hatched snails were 1.34 to 2.19 mm. with an average of 1.84 mm. in shell length and the whorls were 2.7 to 3.5, with an average of three in number. The growth was at an increasing rate with the increase in age of the snails. At the end of 6th week, the snails attained a mean shell length of 4.25 mm. and 4.68 whorls (Fig. 1). By the middle of 6th week, six individuals attained sexual maturity as was evidenced by the presence of white eggs inside the uterus, visible through the transparent shell. The

experiment was terminated at the end of 6th week. Growth rate was faster in first two weeks. The snails added 0.84 mm. and 0.54 mm at the end of 1st and 2nd week respectively. However, minimum growth (.09 mm.) was recorded during third week, but thereafter

1976) and *Arion circumscriptus* (Frömming, 1954). It is suggested by all that with the increase in age growth rate decreases. The present observations on *Opeas gracile* tend to corroborate the findings of previous workers almost in all respects.

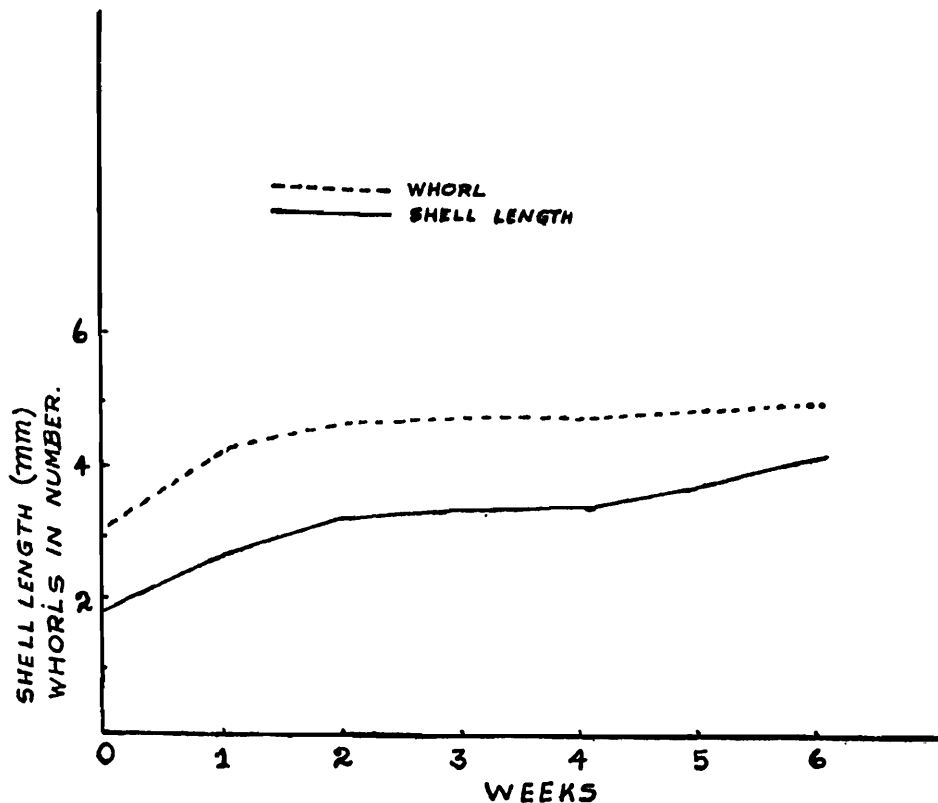


Fig. 1. Rates of growth in the shell length and the body whorl of *Opeas gracile*.

again there was a gradual increase in the rate 0.12, 0.31 and 0.51 mm. being added to the shell length during 4th, 5th & 6th week respectively. Temperature, during the period was between 24°-36°C and 90% or more humidity was maintained in the terrarium throughout.

DISCUSSION

In terrestrial gastropods growth rate seems to be faster for a few weeks after hatching as reported in *Achatina fulica* (Rees, 1950; Ghose, 1963; Kondo, 1964), *Macrochlamys indica* (Raut and Ghose, in press), *Ariophanta maderaspatana* (Masurekar and Bangalkote,

The faster growth rate in land snails may perhaps be associated with their high rate of food consumption. In all known cases the ratio between the amount of food consumed in 24 hours and the body weight is relatively higher in young land snails. It is followed by a gradual fall with age. Higher rate of food intake not only leads to a faster rate of growth but at the same time helps the snails to store reserve materials to tide over the long aestivation period.

ACKNOWLEDGEMENTS

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-

NEMATODES FROM WEST BENGAL (INDIA) X.
A NEW SPECIES OF *ANATONCHUS* (COBB, 1916) DE-CONINCK, 1939
(ANATONCHIDAE : MONONCHIDA)

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Zoological Survey of India, Calcutta

ABSTRACT

Anatonchus sukuli n. sp. is being described from around roots of an insectivorous plant, *Drosera burmanni* at Santiniketan, district Birbhum, West Bengal. The new species is characterized by having L=4.98-4.93 mm, buccal cavity 62-73 × 52-71 μm, distally sclerotized and highly muscular vagina and male with 142-148 μm long spicules.

INTRODUCTION

The present material was sent by Dr. N. C. Sukul, Reader in Zoology Department at Visva Bharati University, West Bengal for identification. These specimens represent a new species of the genus *Anatonchus* (Cobb, 1916) De Coninck, 1939 which is described hereunder as *Anatonchus sukuli*.

This species is named after Dr. N. C. Sukul.

MATERIAL

The type specimens have been registered and deposited with the National Zoological Collection, Zoological Survey of India, Calcutta. *Anatonchus sukuli*: Holotype female on slide WN 448, paratype males on slide WN 449.

Anatonchus sukuli n. sp.

(Fig. 1)

Measurements :

Holotype Female : L=4.93 mm ; a=47 ;
b=5.0 ; c=8 ;
V=1164¹¹.

Paratypes (2 ♂♂) : L=4.38-4.72 mm ;
a=43-46 ; b=5.1-5.2 ;
c=12 ; T=39-42.

Description :

Body ventrally curved in the posterior half upon fixation, tapering slightly anterior to base of oesophagus but markedly posteriorly. Cuticle 3-4 μm thick at mid-body, finely striated. Lateral chords about 1/5th-1/4th of corresponding body-width near middle. Lip region slightly wider than adjoining body, 62-73 μm wide and 18-21 μm high.

Amphids funnel-shaped, apertures 8-10 μm wide. Sensillar pouches 17-18 μm from amphidial slits.

Buccal cavity 62-73 \times 52-71 μm ; its walls are weakly developed. Three medium sized teeth hinged to anterior wall of buccal cavity

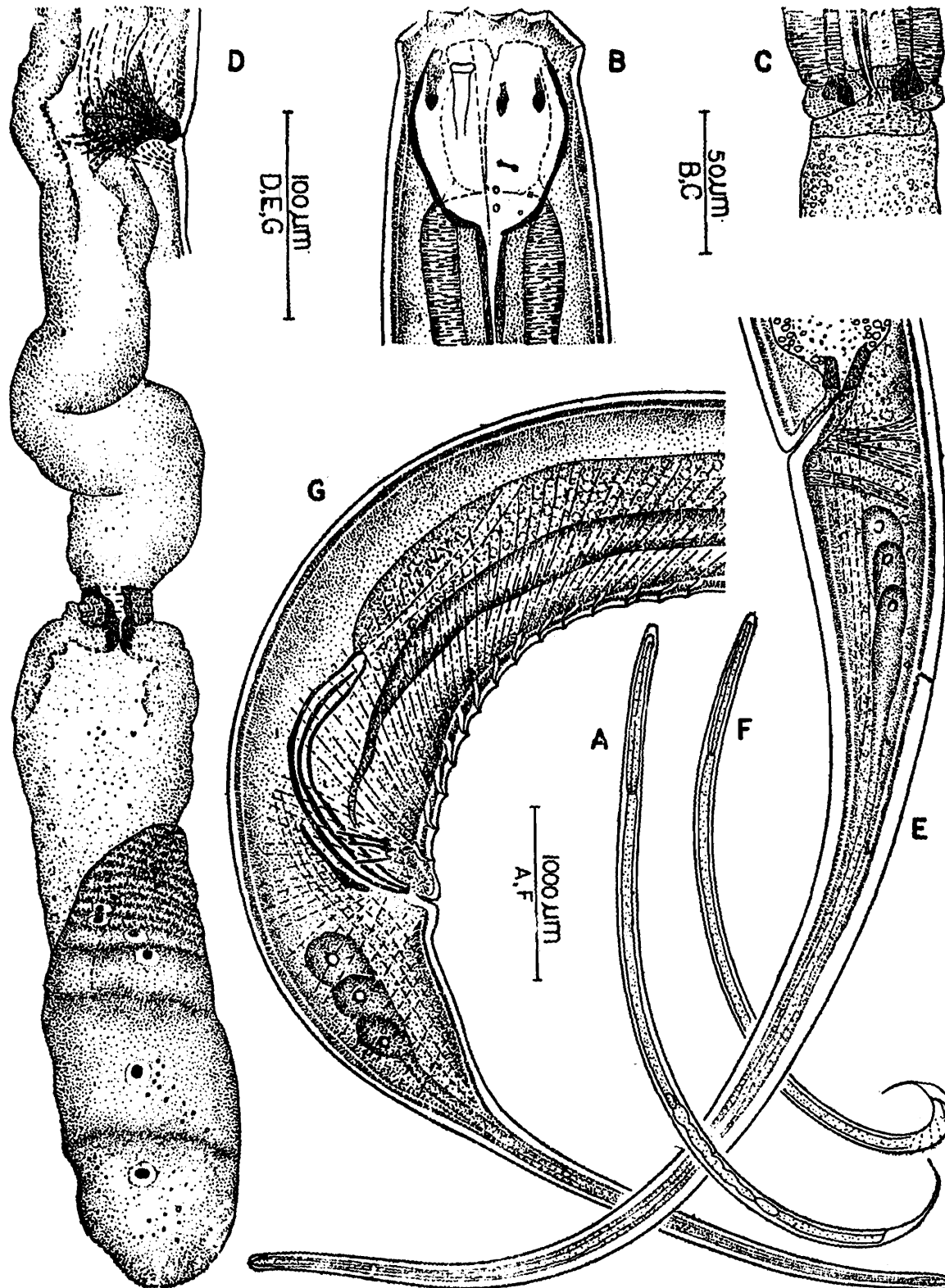


Fig. 1. *Anatonchus sukuli* n. sp. : A—Entire female, B—Head end, C—Oesophago-intestinal junction, D—Female posterior gonad, E—Female tail, F—Entire male, G—Male posterior region.

at 43-50 μm or about 68-71% from base of stoma. Oesophago-intestinal junction tuberculate. Nerve ring 201-225 μm or 23-24% of neck region from anterior end. Rectum 50 μm long.

Female reproductive system amphidelphic. Vulva a transverse slit. Vagina moderately sclerotized distally, extending inwards 41 μm or less than $\frac{1}{3}$ rd of corresponding body-width, marked with muscular bands, surrounded by sphincter. Uterus and oviduct are separated by a well developed sphincter which is almost like a flower. Ovaries reflexed; oocytes arranged in a single row except in growth region. Tail elongate, 590 μm or about 7.5 anal body-widths long. Caudal glands three, leading to a terminal duct.

Male is similar to female in general shape except more curved in posterior third of body. Male reproductive system typical. Spicules 142-148 μm or about 1.6-1.7 anal body-widths long medially. Gubernaculum 45-47 μm and lateral accessory pieces 18-19 μm long. Supplements 14-15, spaced nearly at regular intervals. Copulatory muscles 44-46 in number. Tail similar to female, 360-398 μm or 4.2-4.4 anal body-widths long.

Type habitat and locality : Collected from soil around roots of an insectivorous plant, *Drosera burmanni*, at Santiniketan, district Birbhum, West Bengal (India).

Differential diagnosis : *Anatonchus sukuli* n. sp. comes close to *A. ginglymodontus* Mulvey, 1961 but differs from it in having longer body, differently shaped tail, larger buccal cavity, pre and post-vulval papillae absent, distally sclerotized and highly muscular vagina, and male with longer and differently shaped spicules ($L=2.2-2.9$ mm; tail gradually tapering, buccal cavity 50-63 \times 40-51 μm , pre and post-vulval papillae present, vagina neither distally sclerotized nor marked with muscular bands, and male with 110 μm long spicules in *A. ginglymodontus*).

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OCCURRENCE OF A CORAL BORING BIVALVE *GREGARIELLA COARCTATA*
(CARPENTER) (BIVALVIA : MYTILIDAE) IN THE INDIAN WATERS

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Zoological Survey of India, Calcutta.

ABSTRACT

Hitherto 11 genera and 22 species of Coral boring bivalves were reported from Indian coasts. A further addition is made to the list. *Gregariella coarctata* (Carpenter) is reported for the first time from the Indian Ocean.

During the course of our studies on the molluscs of Gujarat Coast, we came across with a few boring bivalves collected from corals in the Gulf of Kutch.

Report on coral boring molluscs from the Indian Waters was first made by Gardiner (1903) from Maldiva and Laccadive Archipelagos. Recently Appukuttan (1974) reviewed the literature on boring bivalves occurring in the Indian waters. He listed 11 genera and 22 species of coral boring bivalves. The present record is an addition to the list and the genus with its species is reported for the first time from Indian waters.

The genus *Gregariella* Monterosato, 1833 includes 6 species. Soot-Ryen (1955, 1969) dealt with the genus and mentioned its range of distribution as "Mediterranean, North America, and Australia". The occurrence of this genus in Indian waters is interesting and extends its range of distribution.

Class — BIVALVIA

Order — MYTILOIDA Fer'ussac, 1822

Family — MYTILIDAE Rafinesque, 1815

Subfamily—CRENELLINAE Adams & Adams

Genus *Gregariella* Monterosato 1833

Gregariella Monterosato, 1833, *Natural. Sicil.*, 3 : 90 ; Soot-Ryen, 1955, *Allan Hancock Pac. Found.*, 20 (1) : 76 ; Soot-Ryen, 1969, in Moore, ed. *Treatise on Invertebrate Palaeontology*, Part N, Vol. I, Moll. 6 : N 275 ; Macpherson & Gabriel 1962, *Marine Molluscs of Victoria* : 291.

Type species : *Modiolus sulcatus* Risso 1826 (Non Lamarck, 1805).

Distinguishing features : Shell mytiliform, beaks incurved, umbonal keel angulated, radially striated anteriorly and posteriorly, median part smooth and concentrically striated, periostracum hairy with long hairs, hinge with rudimentary oblique teeth, margins crenulated.

Gregariella coarctata (Carpenter, 1856)

Crenella coarctata Carpenter 1856, Catalogue of the Reigen collection of Mazatlan Mollusca, pp. 123-124., Type locality : Mazatlan, Mexico (Designated). *Gregariella coarctata*, Soot-Ryen, 1955. *Allan Hancock Pac. Foundation*, 20 (1) : 77, pl. 9, fig. 48, text-fig. 64.

Material : 5 exs. from coral beds at Pirotan island between light house and Beacon Point, Gulf of Kutch, date 20. 4. 1977 ; coll. K. N. Reddy & Party ; Z. S. I. Regd. No. M 21104/4.

2 exs. from coral at Azad island, Gulf of Kutch ; date 17. 2. 1979 ; coll. M. I. Patel. Z. S. I. Regd. No. M 21105/4,

Measurements

(in mm) :	Maximum (from Azad island)	Minimum (from Pirotan Is.)	Average
Length	15.70	7.95	9.40
Height	6.75	3.90	4.65
Thickness	5.75	3.75	4.20
Length of the keel	14.10	7.60	8.45

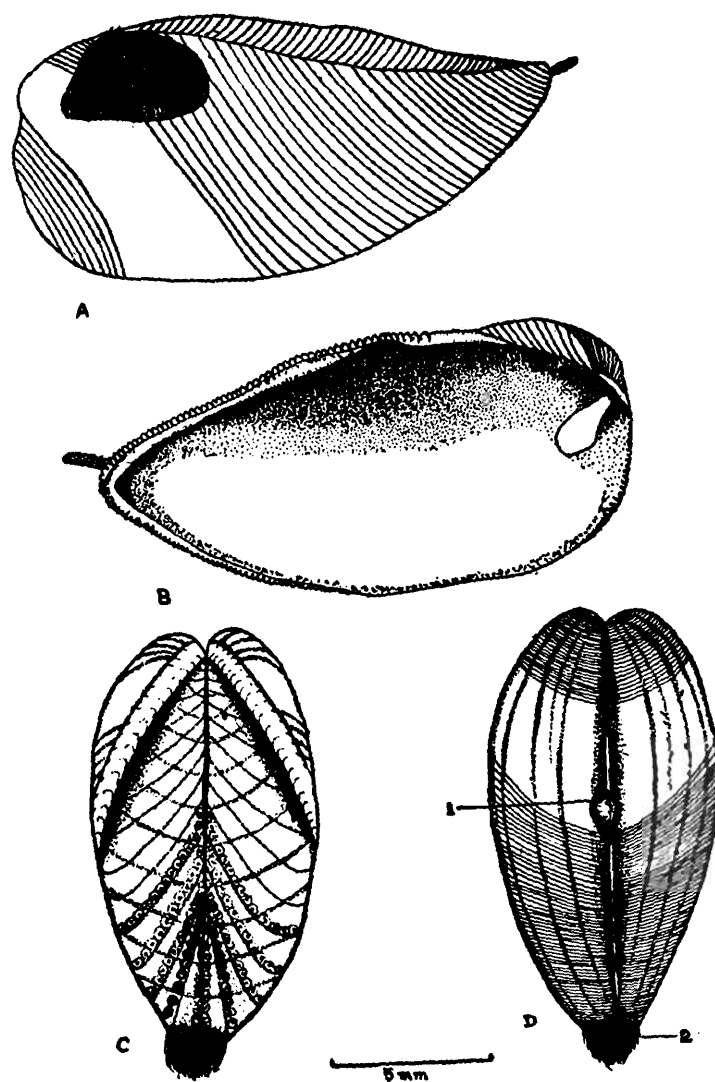


Fig. 1. A. Outer view, B. Inner view, C. Dorsal view D. Ventral view :
1. Byssus, 2. Cluster of longitudinal hairs.

Remarks : Shell small, light yellowish with greenish tinge, shining at the anterior region. Anterior (2.8 mm) and posterior (5.3 mm) portions are radially striated, median part (2.8 mm) smooth with concentric lines. Keel well angulated with divaricating radial ribs

(Fig. C). The posterior margin of the keel thickly coated with fine, long and unbranched hairs. In the present material, the hairs dried up and formed a cluster. Inner side of the valve white in colour, shining. Dorsal and ventral margins crenulated except the hinge

area and the ventral margin of the median smooth area (Fig. D). Impression of the radial striae seen faintly on the inner side of the valve.

In one of the specimen, antero-dorsal portion of the left valve had an oval depression (Fig. A). Another specimen had a serpulid worm attached on its antero-dorsal side.

Carpenter reported that these animals were found burrowing into the shells of *Spondylus calcifer* and *Murex regius* at a depth between 2 to 9 fathoms. The present specimens were collected from an unidentified coral.

Distribution : India : Pirotan island, Azad island, in the Gulf of Kutch. *Elsewhere* : Laguna de scammon, Baja California to Isla Taboga, Panama : the Galapagos islands.

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We are grateful to Director, Zoological Survey of India for the facilities and encouragement. Our thanks are due to Dr. K. C. Jayaramkrishnan, Deputy Director and Shri

S. Biswas, Superintending Zoologist, Zoological Survey of India for the encouragement.

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HAEMOPROTEUS OVALIS SP. NOV. (PROTOZOA : SPOROZOA) FROM AN INDIAN
PADDY-FIELD FROG, *RANA LIMNOCHARIS* WIEGMANN

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AND

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Calcutta*

ABSTRACT

Haemoproteus ovalis sp. nov. is described from an Indian Paddy-field frog *Rana limnocharis* from Balitha, Bankura district, West Bengal, for the first time in India. The parasite shows sexual dimorphism. Its affinities with related species is discussed.

INTRODUCTION

The genus *Haemoproteus* is characterised by pigmented halter-shaped gametocyte in erythrocytes of the circulating blood. The haemoproteid parasites are fairly common in wild and domestic birds and also found in some cold-blooded vertebrates like reptiles and amphibians.

The first member of the genus *Haemoproteus* in Amphibia was described by Fantham *et al.*, (1942). They described three species of *Haemoproteus* viz., *H. laurentae*, *H. lavalia* and *H. lanorailla* in *Bufo americanus* from 3 different localities of eastern Canada. Levine and Campbell (1971) listed the name of the above mentioned three species of *Haemoproteus* of Amphibia in their "Check-list of the species of the genus *Haemoproteus* (Apicomplexa, Plasmodiidae)".

While surveying the blood parasites of Indian Amphibians (Ray, 1979) the authors observed one *Haemoproteus* in the blood of

Rana limnocharis along with a mixed infection of *Haemogregarina berestneffi* Castellani and Willey and described in this present communication for the first time in India.

The type specimens will be deposited in the National Collection of the Zoological Survey of India, Calcutta.

MATERIAL AND METHODS

The frogs were collected from a village viz., Balitha in the Bankura district, West Bengal and brought to the laboratory for examination. The blood smears were generally prepared from the blood obtaining by cutting the finger and toe tips. Some smears were also prepared from lungs, liver, spleen, kidney and heart of the infected frogs.

All smears were air-dried, fixed in 100% methanol, stained with Romanowsky stains and differentiated with neutral distilled water. For sectioning the tissue of lung, liver, kidney

and spleen were fixed in Bouin's fixative and followed by general histological techniques by Pearse (1960). The sections were stained with iron-haematoxylin and eosin.

Each smear was examined for 5 minutes under low magnification ($450\times$) and subsequently under oil immersion ($1000\times$). Measurements were obtained from the camera-lucida drawings drawn on a graph paper (mm division) as it facilitated the area measurements by counting the squares covered. The morphometric parameters were measured after Bennett and Campbell (1972). The photomicrographs were taken with the help of 'Ergavel' C.Z. microscope using PM6 attachment Camera.

OBSERVATIONS

Haemoproteus ovalis sp. nov.

(Pl. IV, figs. 1 & 2 ; Fig. 1, a-c)

Description : *Immature gametocyte* : (Pl. IV, fig. 1 ; Fig. 1a) $N=15$. These are intracorpous rounded to oval parasites, measuring $6\ \mu\text{m}$ in length and μm in width with a

granules (Approx. 10) in the form of small dots or rods, found to be distributed throughout the cytoplasm. Sometimes a small vacuole may be seen at the periphery. The nucleus is rounded to oval, measuring $2\ \mu\text{m}$ in diameter with a mean area about $2.5\ \mu\text{m}^2$ and stained light pink with Leishman and Giemsa. These parasites are situated in close contact with the host cell nucleus at the periphery.

Microgametocyte (Fig. 1b) : $N=15$. These are elongated pyriform parasite, measuring $8\ \mu\text{m}$ in length and $4\ \mu\text{m}$ in width with an average area of $22.0\ \mu\text{m}^2$ and occupy 16.76% of the total host-cell parasite complex. They are situated at one end of the gametocyte or sometimes it pushes the host-cell nucleus at one corner. Cytoplasm is homogeneous, hyaline ; stained light blue with Leishman, finely granulated. The yellowish black pigment granules are about 7 in number, either in the form of small dots or rods and distributed throughout the cytoplasm. The nucleus is fragmented and less compact, measuring $1.8\ \mu\text{m}$ in diameter and sometimes it is not well marked. A small vacuole may

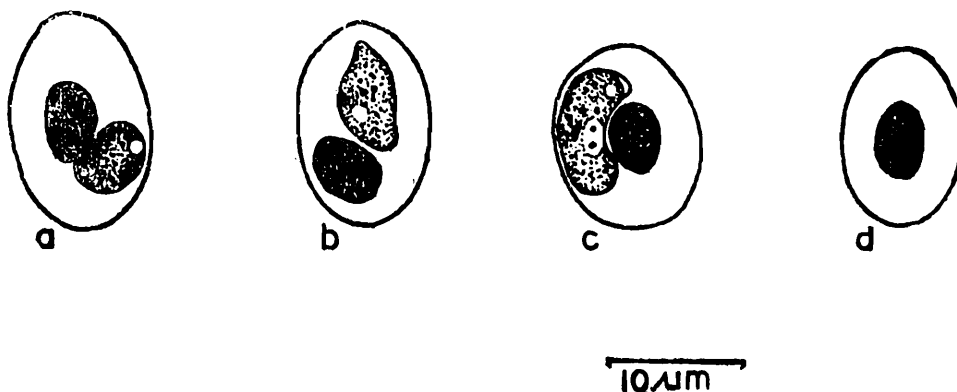


Fig. 1 (a-d). *Haemoproteus ovalis* sp. nov. in *Rana limnocharis* :
a, Immature gametocyte ; b, microgametocyte ; c, macrogametocyte ;
d, uninfected erythrocyte.

mean area about $16.5\ \mu\text{m}^2$, occupying 13.89% of the total host cell-parasite complex. The cytoplasm is homogeneous, stained light blue with Leishman Giemsa. A few pigment

be present. It stained very faint purple with Leishman.

Macrogametocyte : (Pl. IV, fig. 2 ; Fig. 1c) $N=15$. Bean or kidney shaped parasites,

measuring 9 μm in length and 4 μm in width with a mean area about 23.5 μm^2 and occupying 20.88% of the total host-cell-parasite complex. These are situated at one side of the R. B. C. facing its concave side towards the convex margin of the host cell nucleus. The cytoplasm is homogeneous, a little granular and stained deep blue with Leishman and Giemsa stains. Pigment granules are approximately 10 in number and oriented in the same manner as in male gametocytes. They are yellowish black in colour and sometimes 2 or 3 of them congregate to form a bigger mass. One vacuole may be seen in some cases.

Uninfected erythrocyte : (Fig. 1d) N=15. Cell 12.9 μm by 9.1 μm and 86.97 μm^2 in area. Cell nucleus 5.3 μm by 3.3 μm and 13.04 μm^2 in area. NDR=0.95.

Tissue stages and vector is unknown.

Occurrence : Out of 307 examples of *Rana limnocharis* examined, only 2 were found to be infected with this *Haemoproteus* parasite.

Type material : Holotype (Z. S. I. Reg. No. 1951) is designated to a blood smear taken from *Rana limnocharis* Wiegmann from Balitha, Bankura district, West Bengal, India, on 1.7.1977, collected by Sri R. Ray. Paratype (Z. S. I. Reg. No. 1952) collection data same as holotype.

DISCUSSION

A perusal of the literature on Amphibian haematozoa reveals that there is no substantial record of *Haemoproteus* parasites in this craniate class except that of Fantham *et al.*, (1942) who reported 3 species of this genus viz., *H. laurentiae*, *H. lavalia* and *H. lanoraila*

TABLE—1

Parasite and reference	Gametocyte		Nucleus		Host
	Length in μm	Width in μm	Length in μm	Width in μm	
<i>Haemoproteus ovalis</i> sp. nov.					<i>Rana limnocharis</i>
Macrogametocyte	9.0	4.0	2.5	2.0	
Microgametocyte	8.0	4.0	1.8 μm in diameter		
<i>H. laurentiae</i> Fantham <i>et al.</i> 1942	10.1-17.7	3.0-7.2	—	—	<i>Bufo americanus</i>
<i>H. lavalia</i> Fantham <i>et al.</i> 1942	10.8-16.2	5.2-7.8	3.9-6.2	3.0-4.5	<i>Bufo americanus</i>
<i>H. lanoraila</i> Fantham <i>et al.</i> 1942	11.8-16.7	4.4-8.5	3.0-5.2	2.2-3.7	<i>Bufo americanus</i>

Effect of the parasite on their host cell : Infected erythrocytes were little hypertrophied. The host cell-nucleus became distorted and displaced at one pole of the erythrocyte.

from a single host *Bufo americanus* of Eastern Canada.

As no report on *Haemoproteus* is in existence from the family Ranidae in the world, the

authors enjoy the credit to add the fourth *Haemoproteus* species from a Ranid frog, to the literature concerning Amphibian haematozoa.

Among the three *Haemoproteus* parasites described by Fantham *et al.*, (1942), only *H. lavalia* comes to proximity with the *Haemoproteus* species dealt in the present communication. But a comparison of the mesural data of all the four parasites (Table 1), Canadian and Indian, would lead to the assertion that the parasite described from the Indian frog, *Rana limnocharis* would emerge as a distinct species. The authors are able to differentiate the macro- and microgametocytes in the species under discussion in contrast to the observations made by Fantham *et al.*, (1942) where no evidence of sexual dimorphism in any of their *Haemoproteus* parasites could be forwarded.

Judgement of the above contentions leads the authors to declare the present parasite as a new species and hence the name *Haemoproteus ovalis* sp. nov. has been coined after the parasite's body configuration.

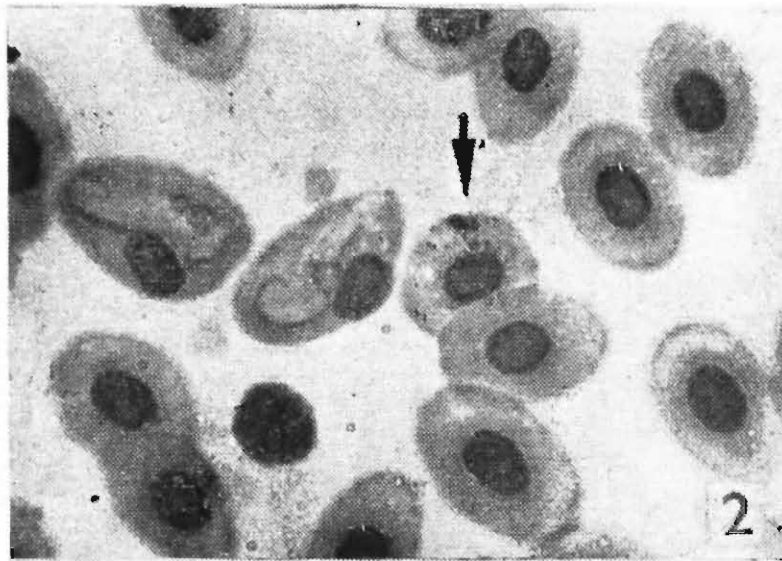
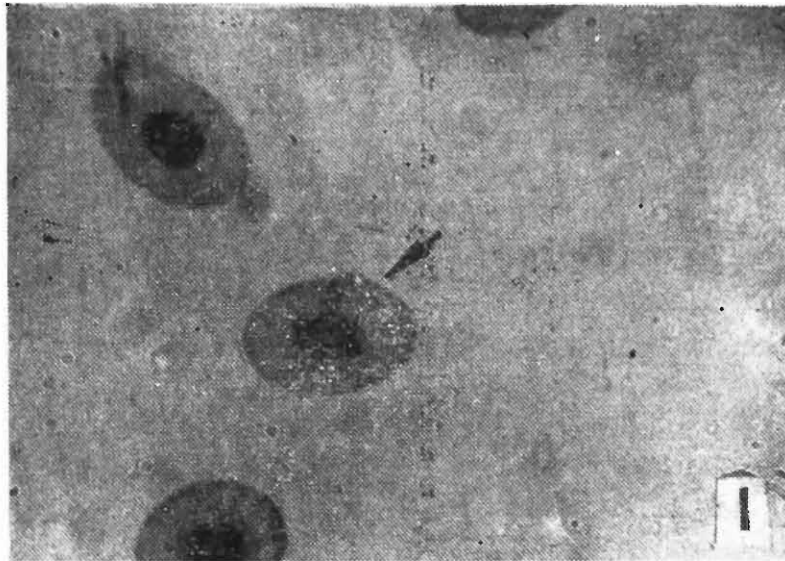
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1. The immature gametocyte (arrow) of *Haemoproteus ovalis* × 1250
2. The mature macrogametocyte (arrow) of the same parasite along with mixed infection of *Haemogarina berestneffi* × 1250

UTILITY OF CAUDAL FIN RAY COUNTS IN CLASSIFICATION OF SUPRAGENERIC CATEGORIES OF INDIAN SILUROID FISHES

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ABSTRACT

The practice of routine counting of branched and unbranched rays of paired and unpaired fins, in fishes have been in vogue since many years. However, in recent years plotting these counts as frequency distribution polygons have yielded a better picture in interpreting the systematic affinities and ultimately the phylogeny of the families themselves. The caudal fin in most genera of catfishes (Order Siluriformes) is forked and the number of principal unbranched rays are usually one on each lobe. An examination of a large series of material of many Indian genera and species have revealed an interesting pattern. It is seen that most families have constantly seven branched rays in the upper lobe of the caudal fin and eight in the lower lobe.

INTRODUCTION

Order Siluriformes comprises thirteen families, 48 genera and about 160 species from India, Pakistan, Bangladesh, Burma and Sri Lanka. Most of them are confined to fresh water except Ariidae and Plotosidae which occur in the sea and brackish water. Many workers have studied the morphology and osteology of catfishes (Bamford, 1948; Bhimachar, 1932, '33; Chranilov, 1929; David, 1935; Eaton, 1948; Gauba, 1962, '66, '67; '70; Jayaram, 1955, '70; Joseph, 1960; Kindred, 1919; Karandikar and Masurekar, 1954; Lenous, 1968; McMurrich, 1884; Masurekar, 1962; Nair, 1938; Nawar, 1954; Reichel, 1927; Sheldon, 1937; Srinivasachar, 1957, '58, '59, '80 and Tilak, 1961, '63, '64, '67). However, not much attention seems to have been paid towards the utility of caudal fin ray count as a possible taxonomic tool,

In recent years, this character has come into prominence for tracing intergeneric and family affinities. Notably many American Ichthyologists have adopted this character profitably. Ginsburg (1945) was the first to demonstrate the utility of different kinds of caudal fin rays in classical taxonomy. Gosline (1961) considered only the branched rays in Cyprinoid fishes and indicate that the round tailed members have the lowest (and apparently the most variable) number of branched caudal fin rays.

Generally, the caudal fin of most Indian genera of siluroid families such as Bagridae (except genus *Pseudobagrus*), Pangasidae, Ariidae, Schilbeidae, Amblycepidae, Sisoridae (except genus *Euchiloglanis*, *Glyptosternum*, *Coraglanis*, *Oreoglanis* and *Pseudecheneis*) and Siluridae (except *Silurus*) is forked. In other families Olyridae, Plotosidae, Chacidae Clarii-

dae, Heteropneustidae and in genera *Silurus* (Siluridae), *Euchiloglanis*, *Glyptosternum*, *Coraglanis*, *Oreoglanis* and *Pseudecheneis* (Sisoridae) and in *Pseudobagrus* (Bagridae), the caudal fin is truncate, rounded or emarginate.

MATERIAL

We have examined the representatives of almost all families of Indian Siluroids excepting Akysidae, 402 specimens falling under

tions. present in the Zoological Survey of India, Calcutta were also examined. Skeletal preparations of the entire caudal vertebral complex besides Alizarine transparencies were made. The different kinds of caudal fin rays enumerated in this study are segmented branched rays, segmented unbranched rays, and unsegmented unbranched rays (=simple rays).

The counts were made on both sides of the caudal fin under a stereoscopic Binocular

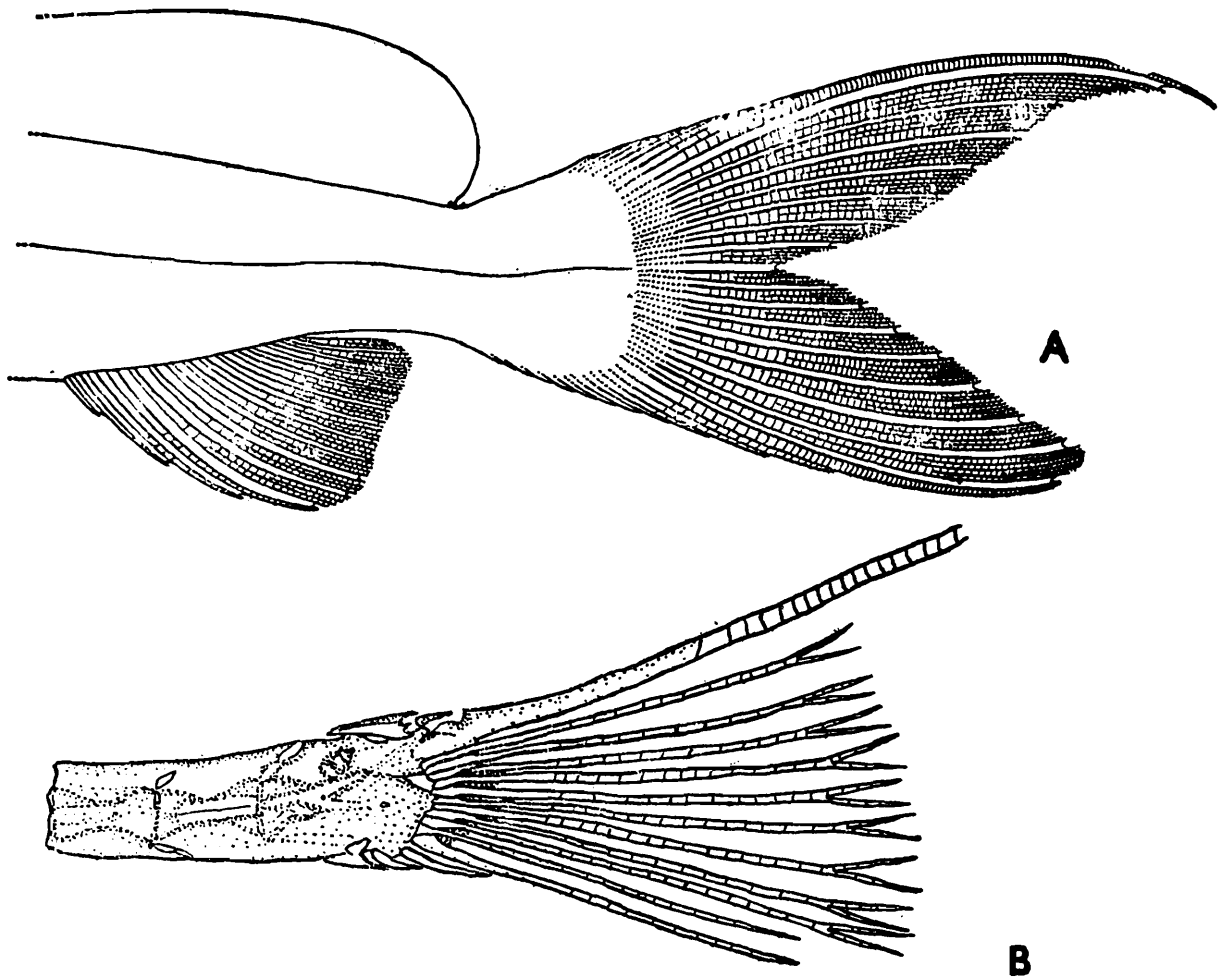


Fig. 1. A. Caudal fin of *Auchenoglanis biscutatus* showing 7+8 segmented branched rays. B. Caudal fin of *Sisor rhabdophorus* showing 4+5 segmented branched rays.

12 families 28 genera and 60 species were studied. Wherever possible fresh specimens were collected and examined. The preserved specimens in the National Zoological Collec-

microscope and the data recorded. In the case of unique specimens, or difficult to obtain species, counts were obtained from X-ray photographs,

RESULTS

Table I presents the general pattern in the material examined. Out of 12 families of Siluroids examined six families (*i.e.*, Amblycepidae, Bagridae, Pangasidae, Schilbeidae, Siluridae and Sisoridae) have 15 segmented branched rays arranged in one pattern, *i.e.*, 7 rays in upper half and 8 in the lower half of caudal fin (see fig. 1 A). This frequency is constant and is not seen varying even up

Clariidae and Heteropneustidae 7+7 (fig. 2C) and Ariidae 6+7 (fig. 2 B) in the upper and lower half respectively. In Plotosidae and Chacidae there is no demarcation of the upper and lower half and all the caudal fin rays originate from a single hypural plate (see fig. 3). As such the total number of branched rays are 9 to 10 in Plotosidae and 10 to 11 in Chacidae.

It may be stated here that some abbera-

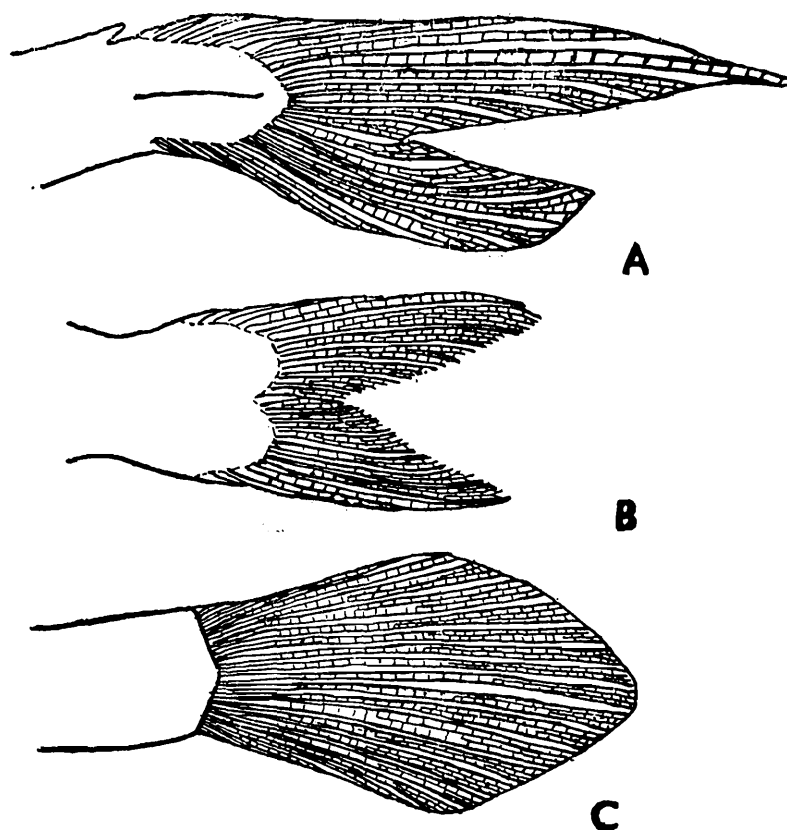


Fig. 2. A. Caudal fin of *Olyra longicaudata* showing 5+6 segmented branched rays. B. Caudal fin of *Tachysurus dussumieri* showing 6+7 segmented branched rays. C. Caudal fin of *Clarias batrachus*, showing 7+7 segmented branched rays.

to family level. The second group of the families (Olyridae, Clariidae, Heteropneustidae and Ariidae) have 11 to 14 segmented branched rays in the caudal fin; but unlike the earlier group the number of rays in the upper and lower half are in three different patterns. Family Olyridae has 5+6 (fig.2A);

tions which appear to be extremely rare and isolated are also seen. Out of 26 specimens of *Clarias batrachus* (Clariidae), three specimens (101 mm, 169 mm and 210 mm in standard length) were found to have 6 instead of 7 branched rays in the lower half of the fin. Similarly, among 16 specimens of *H.*

fossilis (Heteropneustidae), one specimen (150 mm in SL) was found to have 6 branched rays in upper and 6 in lower half instead of 7 branched rays in both the half. The sisorid genus *Euchiloglanis* generally has 7+8 branched rays in the upper and the lower

Considering the fact that the adipose fin is also modified in the form of a spine and the caudal peduncle is narrow like a whip only in this genus as compared to all other Indian Siluroids, the presence of only fewer segmented branched rays is significant. It would seem

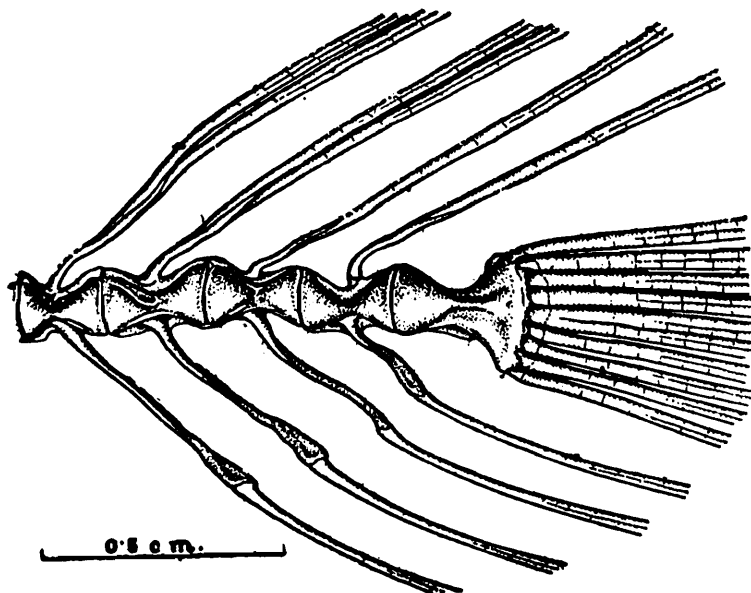


Fig. 3. Caudal fin of *Plotosus lineatus* with some vertebrae showing segmented branched rays.

half of the caudal fin but we have observed 7+7 in one specimen of *E. kamengansis* (52 mm in SL). Six specimens of *Eutropiichthys vacha* (Schilbeidae) examined, one specimen (70 mm in SL) was found to have six segmented branched rays in upper as well as lower half of caudal fin instead of 7 and 8 rays respectively.

Genus *Sisor* presents some interesting results. The upper half of the caudal fin has one segmented unbranched ray and four segmented branched rays; the lower half has two segmented unbranched and five segmented branched rays (see fig. 1 B). The occurrence of nine segmented branched rays in total in the caudal fin of this genus *versus* 15 in all other genera is an interesting findings.

that *Sisor* represents a separate phyletic line from the other sisorids and alone perhaps have to be segregated as a separate family.

DISCUSSION

The analyses of the above frequency distribution of caudal fin ray counts (see Table II) indicate that the Siluroid genera examined by us can be grouped into five groups, based on the number of segmented branched rays. The first group of six families, Bagridae and five other mentioned earlier has 15 (7+8) branched rays in the caudal fin except genus *Sisor* which comprises only 9 branched rays.

Clariidae with Heteropneustidae as second member has 14 (7+7) branched rays; Ariidae,

TABLE—I Frequency distribution of different kinds of caudal fin rays in Indian Siluroid fishes

Family, genera and species	No. of examples	Range of SL in mm	Total number of segmented branched rays in upper & lower half	Total number of segmented unbranched rays in upper and lower half	Total number of unsegmented unbranched rays in upper & lower half
PLOTOSIDAE					
Plotosus					
<i>P. lineatus</i>	9	92-288	9-10	—	—
<i>P. canius</i>	8	74-297	9-10	—	—
CHACIDAE					
Chaca					
<i>C. chaca</i>	12	81-150	10-11	*21-23	—
ARIIDAE					
Tachysurus					
<i>T. arius</i>	18	107.50-345	6+7	2-4+3-4	11-18+11-18
<i>T. maculatus</i>	9	112-315	6+7	3+3-4	13-19+11-19
<i>T. jella</i>	4	130-225	6+7	3+3-4	13-15+11-18
<i>T. gadora</i>	12	198-250	6+7	2-3+3-4	11-15+13-17
<i>T. thalassinus</i>	10	116-610	6+7	2-3+3-4	15-16+12-16
<i>T. caelatus</i>	18	45-190	6+7	2-3+3-4	14-17+15-16
<i>T. dussumieri</i>	20	110-385	6+7	2-4+3-4	13-16+12-16
<i>T. sona</i>	6	95-325	6+7	3+3-4	11-17+11-16
<i>T. sagor</i>	4	145-250	6+7	2-3+3-4	12-15+12-17
<i>T. subrostratus</i>	10	110-235	6+7	4+4-5	11-13+10-12
<i>T. crossocheilus</i>	5	170-245	6+7	3+3-4	17-20+17-20
Osteogeneiosus					
<i>O. militaris</i>	14	75-365	6+7	2+3	12-18+11-16
Batrachocephalus					
<i>B. mino</i>	1	223	6+7	4+5	11+12
CLARIIDAE					
Clarias					
<i>C. batrachus</i>	26	66.5-229.0	7+6** ⁻⁷	1-3+1-3	2-4+2-4
HETEROPNEUSTIDAE					
Heteropneustes					
<i>H. fossilis</i>	16	91-225	6** ⁻⁷ +6** ⁻⁷	1-4+1-2	3-9+1-5
<i>H. microps</i>	1	98.5	7+7	4+2	4+1
BAGRIDAE					
Rita					
<i>R. rita</i>	15	41.5-235.0	7+8	2-4+2-5	12-15+12-16
<i>R. kuturnee</i>	3	143-179	7+8	2+2-4	16-17+11-15

The number with * marks represents the dorsal procurrent part of caudal fin.

Table 1 (contd.)

Family, genera and species	No. of examples	Range of SL in mm	Total number of segmented branched rays in upper & lower half	Total number of segmented unbranched rays in upper and lower half	Total number of unsegmented unbranched rays in upper & lower half
Horabagrus					
<i>H. brachysoma</i>	5	96-137	7+8	2+2-3	10-15+8-14
Mystus					
<i>M. gulio</i>	7	47-106	7+8	2+2-3	12-15+8-14
<i>M. cavasius</i>	5	68-108	7+8	2+2	7+7-8
Aorichthys					
<i>A. aor</i>	5	130-193	7+8	2+2-3	8-10+6-8
SISORIDAE					
Glyptothorax					
<i>G. pectinopterus</i>	14	51-143	7+8	1-2+1-2	6-3+6-12
<i>G. punjabensis</i>	5	42-106	7+8	3+2	2+4
Glyptosternum					
<i>G. reticulatum</i>	4	57-117.5	7+8	2+3	8+8
Euchiloglanis					
<i>E. feae</i>	4	50-110	7+8	2+2	4-7+5-7
<i>E. kamengansis</i>	6	52-115	7+7**8	2+2	5-8+5-8
<i>E. hodgarti</i>	3	85-115	7+8	2+2	5-7+5
Gagata					
<i>G. cenia</i>	10	45-55	7+8	3+3-4	10-12+10-13
<i>G. gagata</i>	2	110-121	7+8	4+5	13-15+12
Nangra					
<i>N. nangra</i>	4	46.5-75	7+8	3+4-5	11-14+13
<i>N. viridescens</i>	2	47-60	7+8	3-4+4-5	12-13+11-14
Pseudecheneis					
<i>P. sulcatus</i>	4	105-128	7+8	2-3+2-3	6-7+5-8
Bagarius					
<i>B. bagarius</i>	4	95.5-141	7+8	2+2-3	8+9-13
Sisor					
<i>S. rhabdophorus</i>	4	78-150	4+5	1+2	1+1
SILURIDAE					
Wallago					
<i>W. attu</i>	8	135-481	7+8	1-2+1-2	2-5+2-3
Ompok					
<i>O. bimaculatus</i>	4	115-207	7+8	1-2+1-2	2-3+1-2
<i>O. pabo</i>	2	106-199	7+8	1+2	2-3+2
Silurus					
<i>S. gangetica</i>	7	75-106	7+8	2+3	14-18+14-15

Table 1 (contd.)

Family, genera and species	No. of exam- ples	Range of SL in mm	Total number of segmented bran- ched rays in upper & lower half	Total number of segmented un- branched rays in upper and lower half	Total number of unsegmented unbranched rays in upper & lower half
PANGASIDAE					
Pangasius					
<i>P. pangasius</i>	24	41-170	7+8	2-3+2-4	12-20+10-16
SCHILBEIDAE					
Clupisoma					
<i>C. garua</i>	10	75-129	7+8	2-3+3-4	6-13+5-13
Eutroplichthys					
<i>E. vacha</i>	6	70-105	6** -7+6** -8	3+4	7-13+7-13
Allia					
<i>A. coila</i>	5	58-81	7+8	3-5+3-4	10-13+13-14
<i>A. punctata</i>	9	69-136	7+8	3-4+2-5	5-16+8-12
Silonia					
<i>S. silondia</i>	8	55-80	7+8	2-3+2-4	13-17+7-13
AMBLYCEPIDAE					
Amblyceps					
<i>A. mangois</i>	18	36-105	7+8	3-6+3-5	9-16+6-13
OLYRIDAE					
Olyra					
<i>O. longicaudata</i>	10	46-90	5+6	3-4+2-3	5-2+6-10

the sole member of the third group has 13 (6+7) branched rays and Olyridae with 11 (5+6) branched rays. The Plotosidae and Chacidae form a separate group with 9-11 branched rays as a single unit.

For a number of years, Regan's (1911) proposition that the Bagridae formed a basic line of evolution of other siluroid families has been accepted. Gosline (1944) considered the evolution of different siluroid families not from a single phyletic line but from several branches. Recent researches such as those of Chardon, 1968 ; Srinivasacher 1980 ; show that there are divergent phyletic groups in Siluroids. Our studies indicate five different

TABLE II—Frequency distribution of segmented branched rays of caudal fin in Siluriformes

	9	10	11	12	13	14	15
PLOTOSIDAE (19)	—	—					
CHACIDAE (12)		—	—				
OLYRIDAE (10)			—				
ARIIDAE (130)					—		
CLARIIDAE (26)						—	
HETEROPNEUSTIDAE (17)						—	
BAGRIDAE (40)							—
SISORIDAE (66)		—					—
SILURIDAE (19)							—
PANGASIDAE (24)							—
SCHILBEIDAE (38)							—
AMBLYCEPIDAE (18)							—

Number in paranthesis after each family indicate the number of specimens examined.

The number with ** marks represents aberrant number.

groupings of the families based on the frequency distribution of the branched rays (see Table II). Of these the family Bagridae appears to have the largest number of allied families compared to Plotosidae or Clariidae. It is also evident that Plotosidae and Ariidae have separate lineages unlike Bagridae. Whether the five trends exhibited by the fin rays reflect the phylogeny or not is debatable but would definitely be indicative. Further work on osteological and myological evidences are being carried out by the authors which may help to adduce definite conclusions.

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IDENTITY OF THE TYPE SPECIMEN OF THE SCYLIIORHINID SHARK, *SCYLLIUM HISPIDUM* ALCOCK

The scyliorhinid shark, *Scyllium hispidum* was described by Alcock (1891) on a young male specimen, 9.5 inches (=240 mm) long collected by the R. I. M. S. *Investigator* from the Andaman Sea. The holotype has surprisingly been claimed as present both in the Zoological Survey of India (Menon and Yazdani, 1968 ; Menon and Rama-Rao, 1975), and the British Museum (Natural History) (Springer and D. Aubrey, 1972 ; Springer, 1979). The objectives of this note are to demonstrate that :

(i) the ZSI specimen is the holotype of *Scyllium hispidum* Alcock and the original of Plate VIII, fig. 3, 3a in *Illustrations of the Zoology of the R. I. M. S. Investigator*, both from its apparent history and study.

(ii) the BM (NH) specimen is one of the specimens also collected by the *Investigator* from the Andaman Sea but from Stn. 233 on 6th December, 1897, a period of six years after the species was described.

(iii) the body length of the type specimen given in the original account of the species, is erroneous.

HISTORICAL RESUME

Alcock (1891 : 21) described *Scyllium hispidum* on a young male specimen, 9.5 inches (=240 mm) long, collected by the *Investigator* from Stn 115 at 118-220 fms (=216-402m).

The specimen figured in *Illustrations of the Zoology of the R. I. M. S. Investigator* (Alcock, 1894, pl. VIII, fig. 3, 3a) is evidently on the above specimen as no further specimens of this species were collected by the *Investigator* upto 1896 (Alcock, 1897 : 310).

Alcock (1899) in the *Descriptive Catalogue of the Indian Deep-Sea Fishes in the Indian Museum*, repeated the original description and refers to additional specimens (with their regd. nos.) and additional locality information, Andaman Sea, 188-220 fathoms, 185 fathoms, 370-419 fathoms, and 405 fathoms ; and the note that '13120 type of male : 119/1 type of female'.

Regan (1908) lists a specimen, 260 mm in total length, of this species in the British Museum.

Menon and Yazdani (1968) followed by Menon and Rama-Rao (1975), catalogued as the holotype the specimen of *Scyllium hispidum* Alcock bearing Indian Museum (now ZSI) registration number 13120 obtained by the *Investigator* from the Andaman Sea, Stn 115 at 188-220 fms on 9th December, 1890.

Springer and D'Aubrey (1972) claimed that the British Museum specimen bearing registration number BMNH 98.7.13.21 (227/1) was the holotype of *S. hispidum* and was previously recognised and segregated as such,

and surmised, "Alcock's type was evidently sent to the British Museum and Regan (1908) stated 'in the British Museum one specimen 260 mm in total length' Rosemary Lowe Mc Connell re-examined the British Museum specimen and noted (in correspondence) that it was the only specimen of the species in the British Museum; that it carried Regan's label, 'Andamans, 185 faths. Indian Museum'; that it had already been separated as the type of *Scyllium hispidum*; and that it was a male, 9.7 inches long with well-calcified claspers projecting 6.4 mm beyond the tips of the pelvic fins. In spite of the discrepancy in lengths given in Alcock's description (1891) as 9.5 inches, in Regan's Synopsis (1908) as 260 mm (=10.25 inches) and the present 9.7 inches we accept the British Museum specimen as the holotype and suspect that the five additional specimens noted in Alcock's later description (1899) as being in the Indian Museum were not available when the original description was published"

DISCUSSION

The fish collections of the R. I. M. S. *Investigator* were deposited in the Indian Museum (Alcock, 1899) and were recorded in two accession registers entitled *Register of Presentations to Indian Museum*, Volume II and Volume III (Talwar, 1977). For each specimen these catalogs give a registration number, name, locality (including *Investigator* station number) and the date of registration; further, there is a comment on their type status. The only modern criterion for *Investigator* types is recognition of those specimens undoubtedly used in the original descriptions. Alcock invariably recorded total length (in inches) and the locality, the depth of capture and sometimes the *Investigator* Station number.

The specimen of *Scyllium hispidum* collected by the *Investigator* upto 1897-98 were accessioned in the Indian Museum (now ZSI) and are listed in Alcock's (1899) *Catalogue*. These are: regd. nos. 13120, F 119/1, F 226/1-F 231/1 and F 382/1-F 385/1. In the *Register of Presentations*, the specimen (13120) is shown as a male from Stn 115, 118-220 fathoms and "n sp type" is indicated against the specific name; no F 119/1 is from Stn 222, 405 fms and indicated as 'Type of female'; F 226-31/1 from Stn 233, 185 fms; and F 382-5/1 from Stn 235, 370-419 fms. A perusal of the details of the *List of Stations*, 1884-1913 of the R. I. M. S. *Investigator* shows that the specimens from Stn. 115 was collected on 9.12.1890, from Stn. 222 on 21.12.1896, from Stn. 233 on 6.12.1897 and from Stn. 235 on 8.4.1898. This data is consistent with the data given in the accession registers. The specimen bearing regd no F 227/1 from Stn. 233, 185 fms, is shown as given to the British Museum in the *Register of Presentations*. This specimen is clearly the specimen which is registered in the British Museum under registration number BM (NH) 98.7.13. 21 (227/1). This registration number is significant and sheds considerable light on the history of this specimen. The BM registration number fortunately bears the Indian Museum registration number (227/1) as a suffix and there, therefore, seems no doubt that these specimens are identical. Since the British Museum specimen of *hispidum* was not the specimen on which the original description of the species was drawn up, it cannot be treated as the holotype as claimed by Springer and D' Aubrey (1972), and Springer (1979). Further, the female specimen bearing ZSI regd no. F 119/1 from Stn 222 collected on 21.12.1896, also cannot

be given type status as contended by Alcock (1899) for the same reason.

The only specimen of *hispidum* that qualifies for type status is the specimen bearing ZSI regd. no. 13120. The data in the *Register of Presentations* is consistent with the data in the original account of the species and further "n sp type" is indicated in the accession register against the specific name *hispidum*. Further evidence of a critical nature is provided by the specimen itself. The specimen is 8.75 inches (=222 mm) (vs 9.5 inches in Alcock) and is a male with the claspers weakly developed and falls 6 mm short of the tips of the pelvic fins. This specimen is clearly the original of Pl. VIII, fig. 3 in the *Illustrations of the Zoology of the Investigator* as it agrees very well with the figure being drawn to the same scale. The specimen is figured in the lateral view and hence the claspers are not depicted. Springer and D' Aubrey (1972) contention, therefore, that the figured specimen is a female is erroneous. There seems to be no doubt that this specimen (13120) is the holotype of *Scyllium hispidum* Alcock, 1891, as this was the only specimen of the species collected by the *Investigator* upto 1896. Alcock's (1891) account that the type specimen of *hispidum* is 9.5 inches (=240 mm) in length is clearly an error.

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SHORT COMMUNICATION

Bull. zool. Surv. India, 4 (2) : 235-238, 1981

A NEW SUBSPECIES OF THE METAD, *MILLARDIA MELTADA* (GRAY, 1837) [RODENTIA : MURIDAE] FROM WEST BENGAL

In connection with the study of field rodents at Singur, Hugli District, West Bengal (c 34 kilometres northwest of Calcutta), the authors collected an adult female specimen and five juveniles of the Metad, *Millardia meltada* (Gray), on the 17th February, 1978. The species was recorded for the first time from West Bengal and its distribution extended further eastward (Mandal and Ghosh, 1980). Subsequently, a good number of specimens of the species were collected from the same area by digging the burrows in the harvested paddy fields. While studying them it was found that they did not fit in any of the known subspecies of the species. They are, therefore, accommodated in a new subspecies.

All the measurements are in millimetres and refer to adult specimens only. The external measurements were taken by the collectors in the field. For cranial measurements, Ellerman (1963) has been followed. Colour names given with initial capital letters in the text have been recognized after Ridgway's (1912) nomenclature.

OBSERVATIONS

Order RODENTIA

Family MURIDAE

Millardia meltada singuri, new subspecies

Holotype : Zoological Survey of India,
Registration Number (Z. S. I. Reg. No.

20457) ; adult female ; Singur, Hugli District, West Bengal ; 17th January 1980 ; collected by Ajoy Kumar Mandal and Santanu Ghosh. Skin and skull deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

Paratypes : Z. S. I. Reg. Nos. 20453♂, 16th January 1980 ; 20454♂, 17th January 1980 ; 20455♂, 17th January 1980 ; 19935♀, 17th February 1978 ; 20456♀, 16th January 1980 ; Singur, Hugli District, West Bengal. All collected by Ajoy Kumar Mandal and Santanu Ghosh. Specimens deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

Description :

Compared with *Millardia m. meltada* and *Millardia m. pallidior*, the new subspecies (*Millardia meltada singuri*) can readily be distinguished by the following combination of characters, viz., dorsal colouration Mouse Gray instead of Smoke Grey in *pallidior* and intermediate between Smoke Grey and Mouse Grey in *meltada*. Ventral colour greyish instead of creamish in *pallidior* and basal part of ventral hairs Blackish Slate instead of Slaty Grey in *meltada*.

Skull more or less similar to that of the other two Indian subspecies, but differs from them in upper molar tooth row and nasal being proportionately longer and smaller respectively as compared to the occipitonasal

TABLE 1. Summary of characters based on external and skull measurements in three subspecies of *Millardia meltada* (Gray)

Characters	<i>Millardia m. pallidior</i>	<i>Millardia m. meltada</i>	<i>Millardia m. singuri</i>
Head & body length	3♂♂ : 110-139 (119.6)* } (121.0) 2♀♀ : 115-130 (122.5) }	3♂♂ : 117-140 (128.3) } (130.9) 2♀♀ : 129-138 (133.5) }	3♂♂ : 107-152 (129.6) } (122.6) 3♀♀ : 111-119 (115.6) }
Tail length	2♂♂ : 86-114 (100) } (105.5) 1♀ : 111 (111) }	3♂♂ : 103-115 (109.3) } (109.4) 2♀♀ : 104-115 (109.5) }	1♂ : 126 (126) } (115) 1♀ : 104 (104) }
Tail length in relation to head and body length	2♂♂ : 78.1-82% (80%) } (82.3%) 1♀ : 84.6% (84.6%) }	3♂♂ : 82.1-88.3% (85.4%) } (83.6%) 2♀♀ : 80.6-83.3% (81.9%) }	1♂ : 82.9% (82.9%) } (85.1%) 1♀ : 87.3% (87.3%) }
Occipitonasal length	3♂♂ : 29.3-32.8 (30.8) } (30.6) 2♀♀ : 29.3-31.6 (30.4) }	3♂♂ : 27.9-33.9 (31.3) } (31.5) 2♀♀ : 29.3-34.3 (31.8) }	3♂♂ : 29.5-35.6 (32.5) } (31.5) 3♀♀ : 29.9-31.4 (30.6) }
Length of palatal foramen in relation to occipitonasal length	3♂♂ : 23.3-25.0% (24.1%) } (23.7) 2♀♀ : 22.5-24.1% (23.3%) }	3♂♂ : 24.2-25.9% (25%) } (24.4%) 2♀♀ : 23.5-24.1% (23.8%) }	3♂♂ : 24.2-25.3% (24.8%) } (24.5%) 3♀♀ : 23.8-24.6% (24.2%) }
Length of upper molar tooth row in relation to occipitonasal length	3♂♂ : 15.6-17.2% (16.4%) } (16.5%) 2♀♀ : 16.1-17.2% (16.6%) }	3♂♂ : 15.6-18.5% (17.4%) } (16.6%) 2♀♀ : 14.7-17.2% (15.9%) }	3♂♂ : 16.2-18.9% (17.3%) } (17.5%) 3♀♀ : 16.6-18.6% (17.7%) }
Length of nasal in relation to occipitonasal length	3♂♂ : 37.5-40% (38.4%) } (39.1%) 2♀♀ : 37.9-41.9% (39.9%) }	3♂♂ : 37.1-40.6% (39%) } (38.3%) 2♀♀ : 34.4-41.1% (37.7%) }	3♂♂ : 37.1-37.9% (37.5%) } (37%) 3♀♀ : 35.4-37.9% (36.6%) }
Length of bulla in relation to occipitonasal length	3♂♂ : 15.6-17.2% (16.4%) } (16.8%) 1♀ : 17.2% (17.2%) }	3♂♂ : 15.6-18.5% (17.4%) } (16.6%) 2♀♀ : 14.7-17.2% (15.9%) }	3♂♂ : 15.6-17.2% (16.6%) } (17.1%) 3♀♀ : 16.6-19.3% (17.7%) }

*Mean values are given in parentheses

length. Characters based on external and cranial measurements of the three subspecies

of *Millardia meltada* (Gray) have been summarised in Table 1.

Measurements :

External :

	Holotype ♀	3 ♂	Paratypes	2 ♀
Head and body	119	130, 107, 152,		111, 117
Tail	104	110+, 65+,		126 76+, 65+
Hind foot	23	26, 24, 25		22, 26
Ear	20	20, 18, 21,		20, 20

Cranial :

	Holotype ♀	3 ♂	Paratypes	2 ♀
Occipitonasal	29.9	32.6, 29.5, 35.6		31.4, 30.9
Condylbasal	28.3	31.5, 28.3, 34.4		30.5, 29.6
Nasal	11.2	12.5, 11.1, 13.5		11.5, 11.6
Interorbital width	4.6	4.7, 4.7, 5.3		4.7, 4.6
Palate	15.2	16.8, 15.2, 18.7		16.4, 15.7
Molar toothrow	5.4	5.4, 5.5, 5.7		5.6, 5.0
Bulla	5.8	5.9, 5.9, 6.3		6.1, 5.7
Diastema	8.2	9.3, 8.1, 10.3		8.8, 8.7
Palatal foramina	7.1	8.1, 7.3, 8.5		7.4, 7.4

Range : So far known only from the type locality.

Habitat : The cultivated paddy fields at Singur, Hugli District, West Bengal.

Habit : A docile creature with large eyes and ears, but an extremely fast runner.

Remarks : Ellerman (1963) has considered *Millardia* as a subgenus of *Rattus*, but Ellerman (1947) and subsequent authors (Misonne, 1969 ; Agrawal, 1970 ; Mishra and Dhanda, 1975) have treated it as a distinct genus. Here also *Millardia* has been recognised as a separate genus.

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Bull. zool. Surv. India, 4 (2) : 239, 1981

EMENDATION OF THE NAME *PERONELLA RULLANDI* (KOEHLER)
(ECHINODERMATA : ECHINOIDEA)

While reporting on the echinoid collections made by the *R. I. M. S. "INVESTIGATOR"*, Koehler (1922, p. 103) described a new species, *Laganum rullandi*, apparently naming the species after the type-locality mentioned by him as "Rulland, 35 fms." Later, Mortensen (1948, p. 300) transferred the species to the genus *Peronella* using the same spelling, *P. rullandi* and stated (p. 301) that he did not find any locality of this name (*i. e.*, Rulland) in any of the maps available to him or in the list of stations of the "*INVESTIGATOR*". An examination by the present author of the labels in the bottle containing the type-specimens (damaged) showed the type-locality printed as "Rutland, 35 fms." The accession register (*Z. S. I. Reg. No. F 89/1*) also reads "Rutland" of the S. Andaman Is. Obviously, Koehler named the species as *L. rullandi* misreading the spelling of the locality "as Rulland" and is a *lapsus calami* within the purview of the *INTERNATIONAL RULES ON ZOOLO-*

GICAL NOMENCLATURE [Art. 32 a (ii)]. In the light of Art. 32 c and Art. 19, the original incorrect name needs to be emended suitably (Mayr, 1969, p. 355). Therefore, *Peronella rullandi* (Koehler, 1922) is emended as *Peronella rutlandi* (Koehler, 1922) *emend. nov.* [Art. 33a (i)]. Dr. R. V. Melville, Secretary of the International Commission on Zoological Nomenclature, has supported this change when applied to (personal communication, letter dated May 4th, 1979 from Miss Ailsa M. Clark).

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