

BULLETIN

OF THE

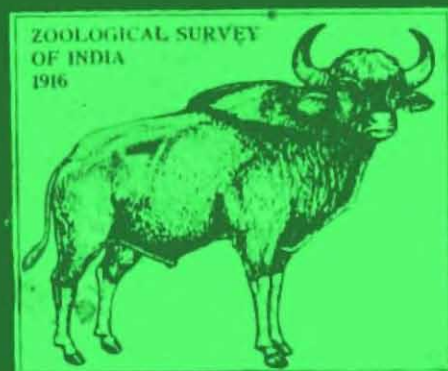
ZOOLOGICAL SURVEY

OF INDIA

Volume 5

Number 2 & 3

1984



© Government of India, 1984.

Published : July, 1984

Price : Rs. 50·00

£ 6·00

\$ 10·00

BULLETIN OF THE ZOOLOGICAL SURVEY OF INDIA

CONTENTS

Response of Blackflies (Diptera : Simuliidae) to certain Coloured Light Sources — <i>M. Datta, D. K. Choudhuri and B. Dasgupta</i>	1
Notes on some Dermaptera present in Zoologisk Museum, Copenhagen — <i>G. K. Srivastava</i>	7
Chromosomes and Phylogeny of Coleoptera II. <i>Meloidae</i> — <i>Parmjit S. Dua and R. K. Kacker</i>	19
On a Collection of Chironomids (Diptera : Chironomidae) from Tibet — <i>D. K. Guha and P. K. Chaudhuri</i>	23
On a new species of the genus <i>Danio</i> Hamilton from Burma (Pisces : Cyprinidae) — <i>R. P. Barman</i>	31
Some observation on the seasonal activity of Earthworms (Oligochaeta : Annelida) in Hill Forest Soil — <i>J. M. Julka and R. N. Mukherjee</i>	35
A new <i>Tephrella</i> (Diptera : Tephritidae) from Meghalaya, India — <i>C. Radhakrishnan</i>	41
Blood Parasites of some birds from West Bengal, India — <i>N. C. Nandi, A. K. Mandal and A. Choudhury</i>	45
Studies on Indian Calanoids III. On a new species of <i>Tropodiptomus</i> Kiefer (Calanoida : Diaptomidae) from Nilgiri District of Southern India — <i>Tusharendu Roy</i>	53
The Population and Production Ecology of a Freshwater Snail <i>Bellamya bengalensis</i> (Lamarck) (Gastropoda : Viviparidae) in an artificial lake of Calcutta, India. — <i>Rashid A. Khan and Supriya Chaudhuri</i>	59
On the Taxonomic Status of <i>Lepidocephalus thermalis</i> (Valenciennes) in relation to <i>Lepidocephalus guntea</i> (Hamilton) (Cobitidae) — <i>Raj Tilak and Akhlaq Husain</i>	77
Evaluation of yield losses in Rice due to <i>Hirschmanniella gracilis</i> (de Man, 1880) Luc & Goodey, 1963 (Tylenchida : Nematoda) at Hooghly (West Bengal) — <i>Naseem Ahmad, P. K. Das and Qaiser H. Baqri</i>	85
Nematodes of Vegetables and Pulses from Patna District, Bihar—1 — <i>Y. Chaturvedi and K. C. Kansal</i>	93
Notes on some Dermaptera present in the 'Institut Für Pflanzenschutzforschung Kleinmachnow, Eberswalde-Finow, Ddr' — <i>G. K. Srivastava</i>	103
On three abnormal specimens of <i>Mystus cavasius</i> (Hamilton) (Family : Bagridae) — <i>(Miss) Anuradha Chakravarti</i>	109

Merophysiinae (Coleoptera : Merophysiidae) from India and Sri Lanka — <i>T. Sengupta and T. K. Pal</i>	113
Garra Menoni, a new Cyprinid Fish from Silent Valley, Kerala, South India — <i>K. Rema Devi and T. J. Indra</i>	121
A new genus of Paederinae : Staphylinidae (Coleoptera) with description of a new species from Nepal — <i>D. N. Biswas and T. Sen Gupta</i>	123
Studies on Indian Calanoids II. Description of a new Calanoid Copepod <i>Neodiaptomus sewelli</i> sp. nov. (Calanoida : Diaptomidae) from Nilgiri District — <i>Tusharendu Roy</i>	133
The Protozoa <i>Haemogregarina colisa</i> sp. nov. from the Fish <i>Colisa fasciatus</i> and <i>Haematractidium</i> sp. from <i>Arius sona</i> in India — <i>A. K. Mandal, R. Ray, N. C. Sarkar and R. Kahali</i>	139
Adaptive role of Pectoral Fin in fishes of Hill-streams — <i>G. M. Yazdani</i>	145
On some fossil Cryptocerata (Heteroptera : Insecta) with description of a new genus et species — <i>K. V. Lakshminarayana</i>	153
On a new genus of Dermaptera (Insecta) with Notes on <i>Pterygida</i> Verhoeff — <i>G. K. Srivastava</i>	159
The food and feeding habits of some Freshwater Crustacean Zooplankton — <i>Rashid A. Khan</i>	165
A new species and new records of Brachyderinae (Curculionidae : Coleoptera) from India — <i>P. Mukhopadhyay</i>	175
 SHORT COMMUNICATION	
<i>Orthetrum mathewi</i> Singh and Baigal 1954, A synonym of <i>Pantala flavescens</i> (Fabr.) (Odonata : Libellulidae) — <i>Raja Ram and V. D. Srivastava</i>	181
On the natural distribution and Taxonomy of <i>Gerres macracanthus</i> Bleeker (Pisces : Gerreidae) — <i>P. K. Talwar and P. Mukherjee</i>	183
On the occurrence of <i>Mesopodopsis orientalis</i> (W. M. Tattersall) (Crustacea : Mysidacea) in Freshwater — <i>L. P. Gupta and P. D. Gupta</i>	185
New host and locality record for the genus <i>Orientodiscus</i> Srivastava, 1938 (Trematoda : Paramphistomidae) — <i>A. K. Bansal and P. D. Gupta</i>	187
On a small collection of Termites (Isoptera, Insecta) from Bangladesh, with notes on distribution — <i>G. Bose and P. N. Roy</i>	189
Natural History of a Succineid Snail, <i>Indosuccinea Semiserica</i> (Gould) — <i>S. K. Raut and K. C. Ghose</i>	191
On the occurrence of the Giant Sea Anemone <i>Paracondylactis</i> sp. from Digha Coast, West Bengal, with a note on secondary oral disc — <i>A. Misra</i>	195

RESPONSE OF BLACKFLIES (DIPTERA : SIMULIIDAE) TO CERTAIN COLOURED LIGHT SOURCES

M. DATTA, D. K. CHOUDHURI* AND B. DASGUPTA**

Zoological Survey of India, Calcutta

ABSTRACT

The photophilic behaviour of six species of blackflies (Diptera : Simuliidae) of Darjeeling, viz., *Simulium (Eusimulium) praelargum* Datta, *S. (E.) gracilis* Datta, *Simulium (Simulium) himalayense* Puri, *S. (S.) grisescens* Brunetti, *S. (S.) rufibasis* Brunetti and *Simulium (Gomphostilbia) tenuistylum* Datta, was tested with five different coloured lights. Blackflies appeared to be more attracted to snow-white light than to any other coloured light. The incidence percentage of a given species varied from colour to colour, and the sequence except in the case of *praelargum*, was as follows: snow white, chrome yellow, dark red, forest green and dark blue. *S. (E.) praelargum* was found to be least attracted to forest green light. The reason for decreasing incidence of different species of blackflies to different coloured lights is discussed.

INTRODUCTION

Blackflies are known to be positively phototropic insects (Williams and Davies, 1957; Datta, 1972; and others). Taking advantage of this behaviour a series of experiments were conducted at Darjeeling to study the relative attractiveness, if any, of six species of blackflies to different five coloured light sources (Datta, Dey and Paul, 1973), the photophilic behaviour being considered in terms of the co-efficient of apparent sensitivity to different chromatic effects.

MATERIAL AND METHODS

The material consisted of six species of blackflies of Darjeeling, viz., *Simulium (Eusi-*

mulium) praelargum Datta, *S. (E.) gracilis* Datta, *Simulium (Simulium) himalayense* Puri, *S. (S.) grisescens* Brunetti, *S. (S.) rufibasis* Brunetti and *Simulium (Gomphostilbia) tenuistylum* Datta. These were collected by means of light traps. A Chinsura light trap (Banerjee and Basu, 1956) was operated simultaneously for the control experiment beside the usual light trap device (Datta and Dasgupta, 1972) meant for the treated experiments. A 200 watt lamp was used as the light source of each of the traps which were turned on daily at 7.00 P. M., and the trapping continued till 5.00 A. M. of the following day. The experiment was conducted at Darjeeling Government College campus

* *Burdwan University, Burdwan*

** *Darjeeling Government College, Darjeeling*

for 68 nights during March-October of 1968, 1969 and 1970. The light source of the treated trap was wrapped by transparent cellophane papers of desirable colour, while the control trap emitted ordinary white light as usual throughout the series of experiment. The incidence of blackflies taken in the treated series was compared with that of the control one in order to observe any possible colour preference of these insects.

RESULTS

The incidence of six species of blackflies under investigation are given below (Tables I-V).

The incidence of blackflies in the control trap was slightly greater than that of the treated trap except the case of *gracilis* and *tenuistylum*. The former species taken in the treated trap showed a slightly higher incidence, while the latter occurred in equal proportions in both the traps (Table I).

The incidence of all the blackflies taken in the treated trap using dark red light was always lower (much below 50%) than that taken in the control trap. *S. (G) tenuistylum*, however, showed the incidence only above 30% level (Table II).

The incidence of blackflies except *prae-*

TABLE I. Blackflies taken in the treated trap with chrome yellow light source as against the control trap tested for 14 days.

Species	Number of specimens taken in the light trap		Percentage of incidence in chrome yellow light
	Control	Treated	
<i>praelargum</i>	14	12	46.1
<i>gracilis</i>	10	11	52.4
<i>himalayense</i>	20	16	44.4
<i>grisescens</i>	7	4	36.4
<i>rufibasis</i>	13	12	48.0
<i>tenuistylum</i>	5	5	50.0

TABLE II. Blackflies taken in the treated trap with dark red light source as against the control trap tested for 17 days.

Species	Number of specimens taken in the light trap		Percentage of incidence in dark red light
	Control	Treated	
<i>praelargum</i>	20	15	42.9
<i>gracilis</i>	12	9	42.9
<i>himalayense</i>	22	17	41.0
<i>grisescens</i>	10	7	41.2
<i>rufibasis</i>	11	9	45.0
<i>tenuistylum</i>	4	2	33.3

TABLE III. Blackflies taken in the treated trap with forest green light as against the control trap tested for 15 days.

Species	Number of specimens taken in the light trap		Percentage of incidence in forest green light
	Control	Treated	
<i>praelargum</i>	20	7	26.0
<i>gracilis</i>	14	6	30.0
<i>himalayense</i>	31	14	31.1
<i>griseescens</i>	15	7	31.8
<i>rufibasis</i>	18	8	30.8
<i>tenuistylum</i>	7	2	22.2

TABLE IV. Blackflies taken in the treated trap with dark blue light as against the control trap tested for 12 days.

Species	Number of specimens taken in the light trap		Percentage of incidence in dark blue light
	Control	Treated	
<i>praelargum</i>	17	7	29.2
<i>gracilis</i>	11	2	15.4
<i>himalayense</i>	24	9	27.3
<i>griseescens</i>	15	5	25.0
<i>rufibasis</i>	18	6	25.0
<i>tenuistylum</i>	7	1	12.5

TABLE V. Blackflies taken in the treated trap with snow white light as against the control trap tested for 10 days

Species	Number of specimens taken in the light trap		Percentage of incidence in snow white light
	Control	Treated	
<i>praelargum</i>	12	17	58.6
<i>gracilis</i>	8	14	63.6
<i>himalayense</i>	27	34	55.7
<i>griseescens</i>	9	12	57.1
<i>rufibasis</i>	15	16	51.6
<i>tenuistylum</i>	6	7	53.8

largum and *tenuistylum* taken in the treated trap with forest green light was found to be 30% or just above 30% level, while *praelargum* and *tenuistylum* showed lower incidence below 30% level. In all cases, however, the appearance of females in the treated trap was scarce (Table III).

The incidence of blackflies taken in the treated trap using dark blue lamp was very poor. The two species *gracilis* and *tenuistylum* showed the incidence at 15.4% and 12.5% levels respectively, while the others registered this incidence between 25% and 30% levels. The most important feature of this experiment was that the treated trap captured only the

DISCUSSION

It was observed that blackflies were more attracted to snow white light than to any other coloured light. Vargas (1945) reported that blackflies were more attracted to blue than to yellow light. Further, Frost (1954) and, Grebelsky, Kovrov and Byaenkova (1963) found high incidence of female blackflies taken in ultra-violet light. It was probable that snow white light, like green (Doby, Bernard and David, 1956) and ultra-violet (Frost, 1954 ; Grebelsky et al., 1963) stimulated and concentrated the flies towards the light source and upon heat-shock the flies fell to the liquid medium of the trap showing

TABLE VI. Incidence-percentage of blackflies taken in the treated trap tried for 5-coloured light sources in 68 nights.

Species	Chrome yellow	Dark red	Forest green	Dark blue	Snow white
<i>praelargum</i>	46.1	42.9	26.0	29.2	58.6
<i>gracilis</i>	52.4	42.9	30.0	15.4	63.6
<i>himalayense</i>	44.4	41.0	31.1	27.3	55.7
<i>grisescens</i>	36.4	41.2	31.8	25.0	57.1
<i>rufibasis</i>	48.0	45.0	30.8	25.0	51.6
<i>tenuistylum</i>	50.0	33.3	22.2	12.5	53.8

female specimens instead of admixture of both the sexes as evidenced in other experiments (Table IV).

The incidence of blackflies taken in the trap with snow white light source was quite different in that all the species showed higher incidence in the treated trap than in the control one and the percentage of females captured was always above 50 (Table V).

The incidence percentage for all the species of blackflies taken in the treated series of experiments tried for five desirable colours with which the relative attractiveness of these insects was tested is given (Table VI).

the incidence. The colours used in the experiments apparently had little to do with spontaneous landing like purple, maroon, red and blue colours (Davies, 1971). However, the incidence percentage of a given species varied from colour to colour and the sequence of attractiveness for all but *praelargum* was as follows :—snow white, chrome yellow, dark red, forest green and dark blue. In contrast to other species, *praelargum* was least attracted to forest green light. The incidence of *tenuistylum* occurred in equal proportions taken in the control and in the treated traps with chrome yellow light source, probably because of the scanty population of

the species, and this sort of variation in incidence was also reported by Kohler and Fox (1951) who experimented with *Culicoides* in Puerto Rico and demonstrated that the yellow trap made consistently higher catches than the forest green one, if the population was not extremely low.

The reason of decreasing incidence in the treated series might be correlated to the limited dispersion of light rays from the coloured envelope of the treated traps which were probably beyond the span of these insects' activity in nature in certain cases, if not to speak of the blackflies' natural sensitivity to different chromatic lights. Moreover, two sexes of a species behaved in an opposite way and this was probably due to certain physiological factors (cf. Davies, 1971). Thus, as the incidence of a species began to decline with the above trend of attractiveness, more and more female specimens were to appear in the treated trap except in the case of green light. According to Davies and Williams (1962) two sexes of a given species or two species of a given population of blackflies might be attracted to light differentially. Davies (1951, 1961) held that females of *Simulium venustum* Say were attracted more to dark blue cloth than to other coloured ones. It might be possible that females of a species would be influenced by the excitement to one colour and not to another, which might be preferable or otherwise to the other sex, depending upon the physiological conditions of the individual insect.

ACKNOWLEDGEMENTS

The authors are indebted to Dr. B. K. Tikader, Director, Zoological Survey of India, for the publication facilities given by

him and also express their heart-felt gratitude to Prof. D. M. Davies of the McMaster University, Hamilton, Ontario, Canada, and to Dr. L. Davies of the University of Durham, England, for kindly providing them with some pertinent literature. Financial assistance in part from the University Grants Commission, New Delhi, is also duly acknowledged.

REFERENCES

- BANERJEE, S. N. AND BASU, A. C., 1956. The Chinsura light trap. *Proc. zool. Soc. Calcutta*, **9** ; 27-32.
- DATTA, M., 1972. The Taxonomy and Bionomics of blackflies (Simuliidae : Diptera) of the Darjeeling area. *Ph. D. Thesis, North Bengal University*.
- DATTA, M. AND DASGUPTA, B., 1972. On the collection and rearing of black flies (Simuliidae : Diptera) of Darjeeling. *Indian Biol.*, **4** : 54-59.
- DATTA, M., DEY, R. K. AND PAUL, A. K., 1973. On the photophilic behaviour of some blackflies (Simuliidae : Diptera) of Darjeeling. *Proc. 60th Indian Sci. Congr.*, **3** : 516.
- DAVIES, D. M., 1951. Some observations of the number of blackflies (Diptera, Simuliidae) landing on coloured cloths. *Can. J. Zool.*, **29** : 65-70.
- DAVIES, D. M., 1961. Colour affects the landing of blood sucking blackflies (Diptera : Simuliidae) on their hosts. *Proc. ent. Soc. Ont.*, **91** : 267-268.

- DAVIES, D. M., 1971. The landing of blood-seeking female black flies (Simuliidae : Diptera) on coloured materials. *Proc. ent. Soc. Ont.*, **102** : 124-155.
- DAVIES, L. AND WILLIAMS, C. B. 1962. Studies on blackflies (Diptera : Simuliidae) taken in a light trap in Scotland. Part I. *Trans. R. ent. Soc. Lond.*, **114** : 1-20.
- DOBY, J. M., BERNARD, C. AND DAVID, F., 1956. Observations sur le phototropisme expérimentale de *Simulium decorum* Walker, 1848 et de *Simulium ornatum* Meigen, 1818. *Bull. Soc. scient. Bretagne*, **31** : 117-124.
- FROST, S. W., 1954. Response of insects to black and white light. *J. econ. Ent.*, **47** : 275-278.
- GREBELSKY, S. G., KOVROV, B. G. AND BYAENKOVA. V. N., 1963. Catching blood-sucking flies (Simuliidae) by ventilator trap with ultra-violet light of variable strength. *Ern. Siberian Biol. Inst., Acad. Sci. U. S. S. R. Publ., Irkutsk* : 54-64.
- KOHLER, C. E. AND FOX, I., 1951. The relative attractiveness of New Jersey light traps painted (a) green and (b) yellow to Puerto Rican *Culicoides*. *J. econ. Ent.*, **44** : 112-113.
- VARGAS, L. 1945. Simulidos del nuevo mundo. *Monogr. Inst. Salubridad Enferm. Trop. Mexico*, **1** : 1-241.
- WILLIAMS, C. B. AND DAVIES, L. 1957. Simuliidae attracted at night to a trap using ultra-violet light. *Nature, Lond.*, **179** : 924.

NOTES ON SOME DERMAPTERA PRESENT IN ZOOLOGISK MUSEUM,
COPENHAGEN

G. K. SRIVASTAVA

Zoological Survey of India, Calcutta

ABSTRACT

Altogether 36 species (excluding one determined up to generic level) under 28 genera are dealt with, of which two species are described as new. A new combination *Gelotolabis formosae* (Borelli) is proposed.

INTRODUCTION

The present paper is based on a small collection of Dermaptera, mostly from various countries in the Oriental Region with a few exception from Palaearctic Region. Altogether 36 species (excluding one identified upto generic level which is represented by female only) under 28 genera are recognised of which one species each under the genera *Euborellia* and *Forficula* are described as new to science. Besides, *Euborellia formosae* Borelli is transferred under the genus *Gelotolabis* Burr.

Family PYGIDICRANIDAE

Subfamily PYGIDICRANINAE

Cranopygia vicina Hincks

Cranopygia vicina Hincks, 1959, *Syst. mono. Dermaptera* : 85.

Material examined.—JAVA : 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 1908 (*Hj. Jensen*).

Subfamily ECHINOSOMATINAE

Echinosoma horridum Dohrn

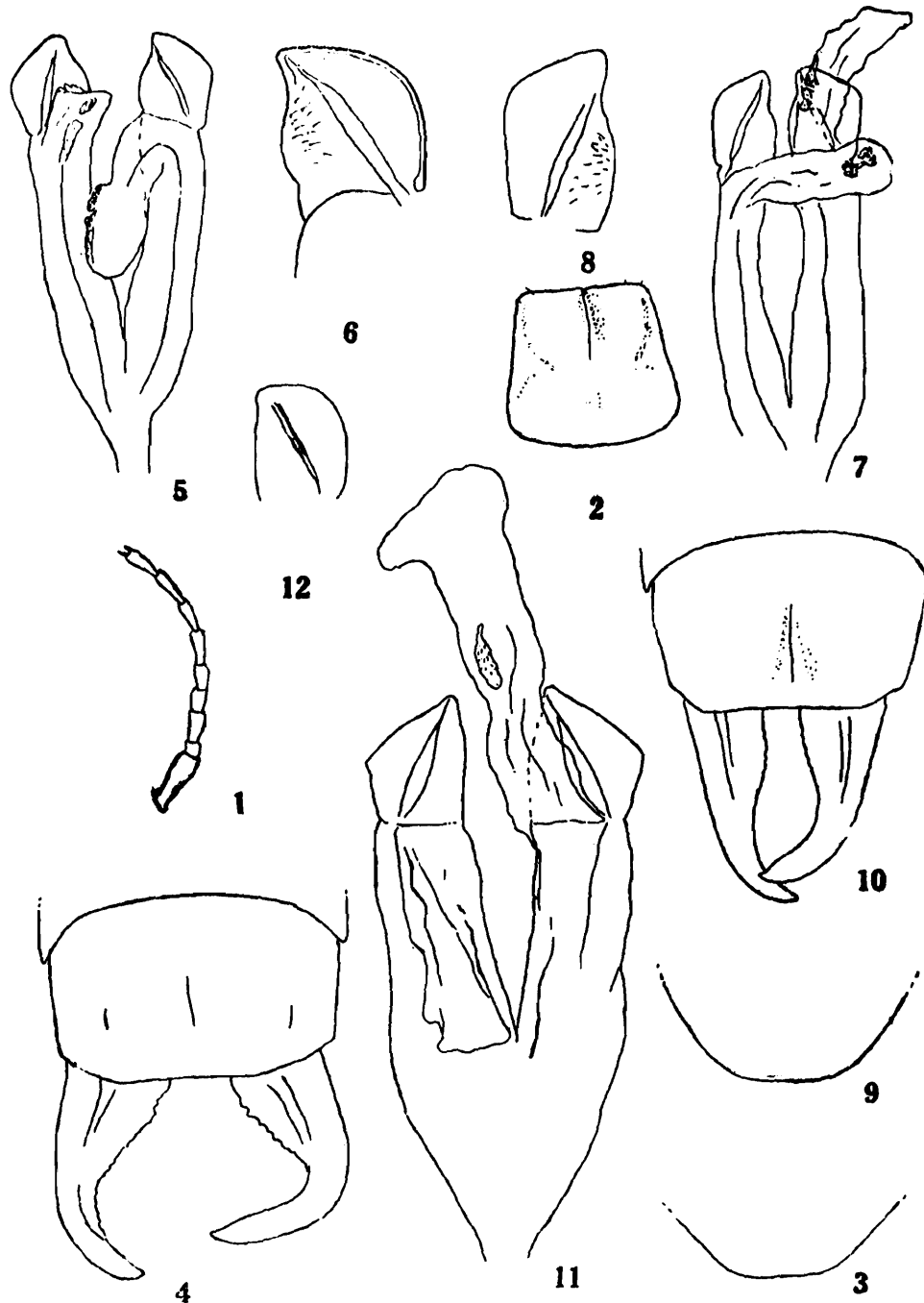
Echinosoma horridum Dohrn, 1863, *Stettin. ent. Ztg.*, 24 : 66.

Material examined.—JAVA : 2 ♂ ♂ (genitalia mounted between two coverslips and pinned with the specimen), 1904 (*Hj. Jensen*).

Echinosoma burri Hincks

Echinosoma burri Hincks, 1959, *Syst. mono. Dermaptera* : 158.

Material examined.—JAVA : Buitenzorg, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 1 ♀, 1904 (*Hj. Jensen*).



Figs. 1-12. *Euborellia burmensis* sp. n. Holotype ♂, 1. A few basal antennal segments, 2. Pronotum, 3. Posterior margin of penultimate sternite, 4. Ultimate tergite and forceps, 5. Genitalia, 6. Paramere enlarged; Paratype ♂, 7. Genitalia, 8. Paramere enlarged; *Gelotolabis formosae* (Borelli) ♂, 9. Posterior margin of penultimate sternite, 10. Ultimate tergite and forceps, 11. Genitalia; *Euborellia anulipes* (Lucas) ♂, 12. Paramere.

Subfamily PROLABISCINAE

Prolabisca infernalis (Burr)*Chaetospania infernalis* Burr, 1913, *Ent. Mitt.*, 2 : 6.*Material examined*.—SUMATRA : Goal,
1500 m, 1 ♂, 1.xi.1916 (*O. Hagerup*).

Family CARCINOPHORIDAE

Subfamily CARCINOPHORINAE

Euborellia burmensis sp.n.

(Figs. 1-8)

Male : General colour brownish black, mouth parts, sides of pronotum, and legs yellowish brown, abdomen and forceps shaded with black.

Head longer than broad, hind margin slightly emarginate in middle, frons convex, smooth, sutures feebly marked. Eyes slightly shorter than post-ocular length. Antennae 15-segmented or more, a few preapical segments yellow, 1st segment slightly shorter than the distance between antennal bases, narrowed at base ; 2nd small, about as long as broad ; 3rd long and slender ; 4th and 5th subconical, remaining segments gradually increasing in length successively but each segment narrowed basally. Pronotum slightly longer than broad, gently widened posteriorly, sides straight, gently reflexed, anterior margin straight, hind margin rounded, median sulcus distinct, prozona raised and well differentiated from flat metazona ; mesonotum and

metanotum transverse, former with hind margin straight and latter concave. Legs typical for the genus, hind metatarsus almost equal in length to pro- and mesotarsus together. Elytra and wings absent. Abdomen moderately depressed, punctulate, enlarging posteriorly up to 9th tergite, sides of segments 5th to 9th acute angled but longitudinal carina present on 6th to 9th only and rugosely punctate. Penultimate sternite narrowed posteriorly, hind margin in middle truncate with faint emargination in the centre, sides oblique and straight. Ultimate tergite transverse, more strongly punctulate above, laterally with an oblique carina, median sulcus distinct along the whole length, hind margin in middle straight, thickened and area just above forceps depressed and striate, sides oblique and concave. Forceps with branches remote at base, trigonal above in basal on third, afterwards narrowed, depressed, right branch more strongly curved than the left, inner margin serrated. Genitalia with parameres of *Euborellia* type *i.e.*, about as long as broad, outer apical angle rounded and internally near apex concave ; parameres of Paratype ♂ slightly longer than broad but basic structure same.*Female* : Agress with males in most characters except that the sides of abdominal segments obtuse, penultimate sternite triangular, ultimate tergite narrower posteriorly and forceps simple and straight.

Measurements.—(in mm)

	Holotype		Paratypes	
	♂	♂	3 ♀	♀
Length of body	13.7	12.1	13.2-13.9	
Length of forceps	3.00	2-3	1.9-2.75	

Material examined.—THAILAND : Rangoon,

Holotype ♂ (genitalia mounted between two coverslips and pinned with the specimen),

Paratypes 1 ♂, 3 ♀ ♀ and 1 nymph, Res-landing fra (*Lovendal*), no further data ; all types deposited in Zool. Mus. DK Copenhagen, except Paratypes 1 ♂, 1 ♀ with the author at the Zoological Survey of India, Calcutta.

Remarks.—Amongst the apterous species of the genus *Euborellia* Burr, known from the Oriental Region, the described species comes close to *E. annulipes* (Lucas) and *E. rajasthanensis* Srivastava (1977) but it can be easily separated from both by its larger size and distinctive parameres in males which are about as long as broad with apical margin slightly oblique and forming a rounded angle at the point of junction with the lateral margin and the inner apical concavity deep and short. Parameres in case of *E. annulipes* are about as long as broad but inner concavity is feeble whereas in *E. rajasthanensis* inner concavity is broad but not so deep and oblique inner margin in apical half together

with oblique apical margin make the parameres look like a triangular plate in upper half.

Anisolabis maritima (Bonelli)

Forficula maritima Bonelli in Gene, 1832, *Ann. Sci. Regno Lombards-Veneto*, 2 : 221.

Material examined.—EGYPT : Quati, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), x.46 (*Lathea*).

Remarks.—Probably due to the immature condition of specimen, both the distal lobes of genitalia are flexed forward.

Gonolabis electa Burr

Gonolabis electa Burr, 1910, *Fauna Brit. India Dermoptera* : 79.

Material examined.—MAURITIUS : 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen) ; 15.ix.1929 (*Th. Mortensen*).

Gelotolabis formosae (Borelli) comb. nov.

(Figs. 9-11)

Anisolabis formosae Borelli, 1927, *Boll. Lab. Zool. gen. agr. Portici*, 20 : 69.

Material examined.—TAIWAN : Shanghai, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 1 ♀, 25.ii.05 (ex. coll. *Houschild*).

Remarks.—On account of projecting external apical angles of parameres it is transferred to the genus *Gelotolabis* Burr.

Subfamily BRACHYLABINAE

Isolabis ocellata Srivastava

Isolabis ocellata Srivastava, 1978, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 82 : 325.

Material examined.—JAVA : 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 1904 (Hj. Jensen).

Remarks.—Hitherto described from Burma and is recorded from Java for the first time.

Family LABIDURIDAE

Subfamily ALLOSTETHINAE

Allostethus setiger Verhoeff

Allostethus setiger Verhoeff, 1904, *Arch. Naturgesch.*, 70 : 117.

Material examined.—JAVA : 2 ♂♂ (1 ♂ with genitalia mounted between two coverslips and pinned with the specimen), 1 ♀ and 1 nymph, 30.iii.1908 (Hj. Jensen).

Remarks.—Wings are yellow and scarcely projecting beyond the elytra. Apical third of femora is yellow.

Gonolabidura piligera (Bormans)

Anisolabis piligera Bormans, 1899, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 20 : 453.

Material examined.—SUMATRA : Somban, Djollo, 1200 m, 1 ♂, 1 ♀ and 1 nymph, Sept., 1916 (O. Hagerup); JAVA : 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 2 ♀♀ and 1 nymph, 1904 (Hj. Jensen).

Subfamily NALINAE

Nala lividipes (Dufour)

Forficula pallipes Dufour, 1820, *Ann. Gener. Sci. Phy. Bruxelles*, 4 : 316.

Forficula lividipes Dufour, 1828, *Ann. Sci. Nat.*, 13 : 340 (new name proposed).

Material examined.—INDIA : Karnataka, Mudigera area, ca 900 m, 2 ♂♂, 14 ♀♀, 2-10.xi.1977; Bihar, Santal Parganas, 1 ♂, 1 ♀, 20.xi.1929 (Dr. Bögghed).

THAILAND : Bangkok, 1 ♂, 4.ix.11.

SUMATRA : Padang, 1 ♀, 2.iv.82 (Klein); Vedi, Klathen, 3 ♂♂, 3 ♀♀, (Skoogcad).

Nala basalis Bey-Bienko

Nala basalis Bey-Bienko, 1970, *Zool. Zshurn.*, 49 : 1841.

Material examined.—SIAM? (now THAILAND) : 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 1 ♀, no further data.

Remarks.—First record from the area.

Subfamily LABIDURINAE

Labidura riparia (Pallas)

Labidura riparia Pallas, 1773, *Reise Russ. Reichs.*, 2 : 727.

Material examined.—BURMA : Inlakka, marines feusen, 1901, Tailen, Redn., 2 ♂♂; JAVA : 1 ♀ (no further data); SOUTH INDIA : Karnataka, Mudigera area, ca 900 m, 3 ♀♀, 2-10.xi.1977; Jersopa (Jog falls), 1 ♂, 19-24.xi.1977.

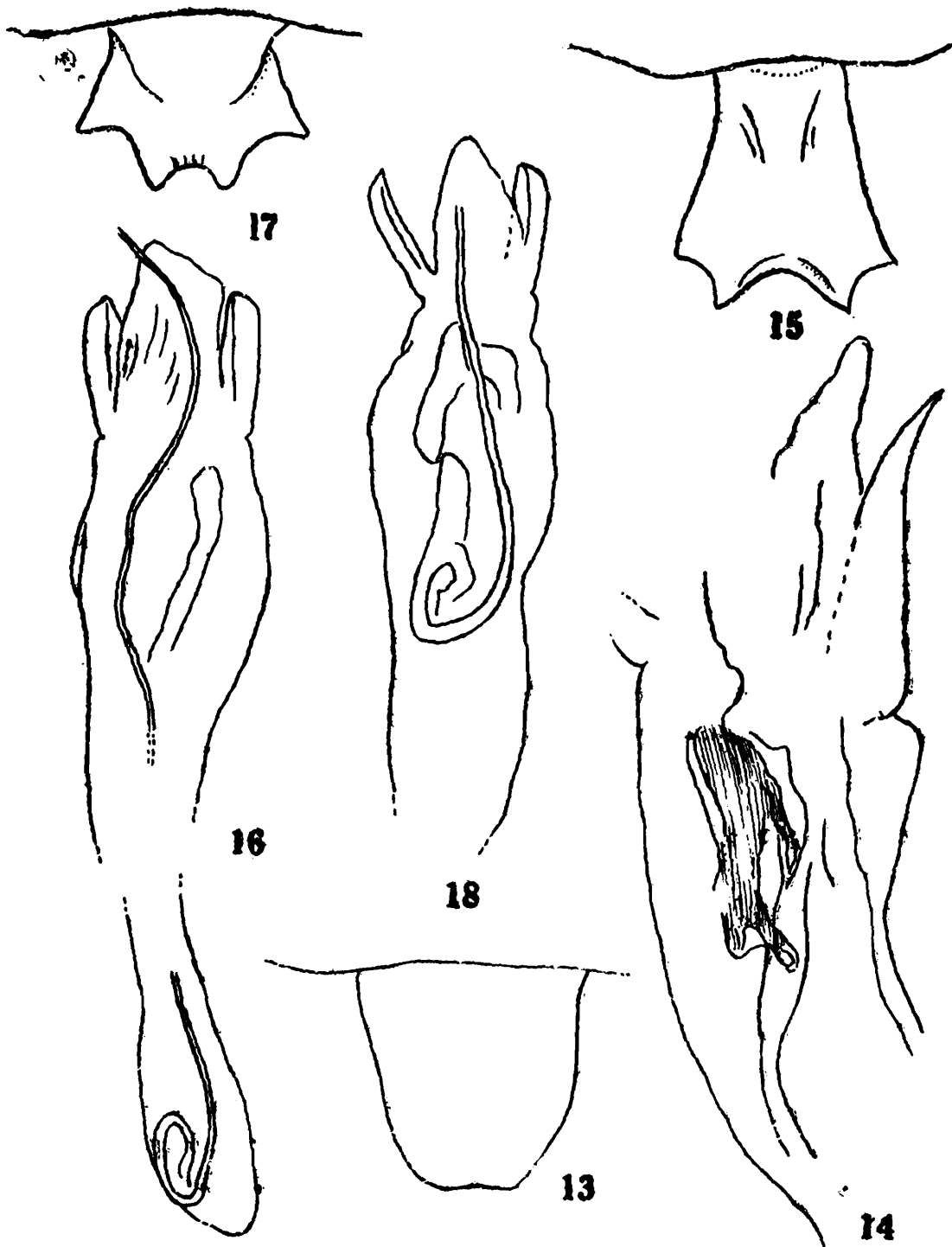
Forcipula quadrispinosa (Dohrn)

Forcipula quadrispinosa Dohrn, 1863, *Stetten. ent. Ztg.*, 24 : 311.

Material examined.—SIAM (now THAILAND) : Prae (Poul Fough Coll. Rosenberg), 1 ♂ (no further data).

Forcipula trispinosa (Dohrn)

Forcipula trispinosa Dohrn, 1863, *Stettin. ent. Ztg.*, 24 : 310.



Figs. 13-18 : *Nesogaster rufices* (Erichson) ♂, 13. Pygidium, 14. Genitalia (left paramere not shown); *Irdex pygidiata* (Dubrony) ♂, 15. Pygidium, 16. Genitalia; *Irdex stella* (Bormans) ♂, 17. Pygidium, 18. Genitalia.

Material examined.—INDIA : U. P., Dehra Dun Valley, ca 700 m, 1 ♂, 4-13.viii. 1978.

Forcipula tuberculata Srivastava

Forcipula tuberculata Srivastava, 1977, *Dtsch. Ent.*, N. F. 24 (4-5) : 289.

Material examined.—Bengalen (INDIA : West Bengal), Hugli, Galathea ; 1 ♀ (no further data).

Family LABIIDAE

Subfamily NESOGASTRINAE

Nesogaster ruficeps (Erichson)

(Figs. 13-14)

Forficula ruficeps Erichson, 1842, *Arch. Naturgesch.*, 8 : 246.

Material examined.—Nyholland (AUSTRALIA), 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen).

Remarks.—Male genitalia and pygidium are figured.

Subfamily SPONGIPHORINAE

Irdex nitidipennis (Bormans)

Spongophora nitidipennis Bormans, 1894, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 14 : 382.

Material examined.—JAVA : Tjibodas, 1 ex. (hind portion of body missing), 1 ♂, 2 ♀ ♀, 25.iii.1910 (*Schorjeo*).

Irdex pygidiata (Dubrony)

(Figs. 15-16)

Labia ? pygidiata Dubrony, 1879, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 14 : 364.

Material examined.—JAVA : Tjibodas, 1 ♂, (genitalia mounted between two coverslips and pinned with the specimen), 14-22.viii.1922 (Dr. Th. m).

Remarks.—Pygidium and male genitalia are figured.

Irdex stella (Bormans)

(Figs. 17-18)

Spongiphora stella Bormans, 1899, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 20 : 454.

Material examined.—S. SIAM (= THAILAND) : Bangabao, Bandon, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 31.i.1941 (*A. M. Hemingsen*).

Remarks.—The material referred to *I. pygidiata* by Srivastava (1976) from Philippines belongs to this species. Pygidium and male genitalia are figured here.

Spongovostox semiflavus (Bormans)

Spongophora semi-flava Bormans, 1894, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 14 : 385.

Material examined.—JAVA : 2 ♀ ♀ (ex. *Mus. Westerman*)—no further data.

Marava arachidis (Yersin)

Forficula arachidis Yersin, 1860, *Annl. Soc. ent. Fr.*, (3) 8 : 509.

Material examined.—BURMA : Skibmed Ris fra Akyab Köbenhavn, 11 ♂ ♂, 20 ♀ ♀, 20 nymphs, 23.x.1878 (*flamen K. Lovendal*) ; NEW BRITANNIA : Matufi, 1 ♂, 1 ♀ (Capt. Hertmann).

Remarks.— All specimens are brachyp-terous.

Subfamily LABIINAE

Labia curvicauda (Motschulsky)

Forficesila curvicauda Motschulsky, 1863, *Bull. Soc. Imp. Moscou*, 36 : 2.

Material examined.—NORTH THAILAND : Doi Sutep, 1100 m, 1 ♂, 19.ix.1958 (*B. Degerb + l leg.*).

Labia lutea (Bormans)

Spongophora lutea Bormans, 1894, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 14 : 383.

Material examined.— India Orient, Kofod, 1 ♀, (*Mus. Sch. V T L.*)

Family CHELISOCHIDAE

Subfamily CHELISOCHINAE

Chelisoches morio (Fabricius)

Forficula morio Fabricius, 1775, *Syst. Ent.* : 270.

Material examined.— CEYLON : Kalutara, 1 ♂, 26.x.1951 (Dr. H. Lemche) ; JAVA : 1 ♂ (no further data), 1 ♂, 1 nymph (*Hedermann*, 1860) ; 2 ♀ ♀, 1904 (*Hj. Jensen*) ; Amboma, 1 ♂, ii.1922 (*Th. Mortensen*).

Proreus simulans (Stål)

Forficula simulans Stål, 1860, *Eug. Resa. Ins.* : 302.

Material examined.— THAILAND : Bangkok, 1 ♀, 1-8.ii. ; 1 ♀, 20.ii.1929 (*Christian Shamm ded*) ; JAVA : Tjiboda, 1 ♂ (no further data).

Remarks.— The ♂ from Java has short forceps which represent mesolabis form.

Proreus sp.

Material examined.— JAVA : 1 ♀, 1904 (*Hj. Jensen*).

Remarks.— In the absence of a ♂ it is not possible to determine it up to specific level.

Hamaxas semiluteus (Bormans)

Chelisoches semiluteus Bormans in Burr, 1899, *Ann. Mag. nat. Hist.*, (7) 4 : 259.

Material examined.— JAVA : 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 1904 (*Hj. Jensen*).

Euenkrates elegans (Bormans)

Chelisoches elegans Bormans, 1899, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 20 : 464.

Material examined.— JAVA : Tjibodas, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen) ♀ (no further data).

Family FORFICULIDAE

Subfamily ANECHURINAE

Anechura bipunctata (Fabricius)

Forficula bipunctata Fabricius, 1781, *Spec. Ins.*, 1 : 340.

Material examined.— USSR : Tadzhikistan, Province Shungan, at Amu Darja, 2 ♂ ♂, 2 ♀ ♀, ...x.1899 (*Ove Paulsen leg.*)

Subfamily FORFICULINAE

Elaunon bipartitus (Kirby)

Sphingolabis bipartitus Kirby, 1891, *Trans. Linn. Soc. London*, 11 (1) : 526.

Material examined.— SOUTH INDIA : Karnataka, Nandi Hills, 1200-1500 m, 2 ♀ ♀, 28.x.1977.

Forficula beelzebub (Burr)

Chelisoches beelzebub Burr, 1900, *Ann. Soc. ent. Belg.*, 44 : 51.

Material examined.— INDIA : U. P., Mussoorie, ca 1500-2200 m, 1 ♂, 3-14.viii. 1978.

Forficula lurida (Erichson)

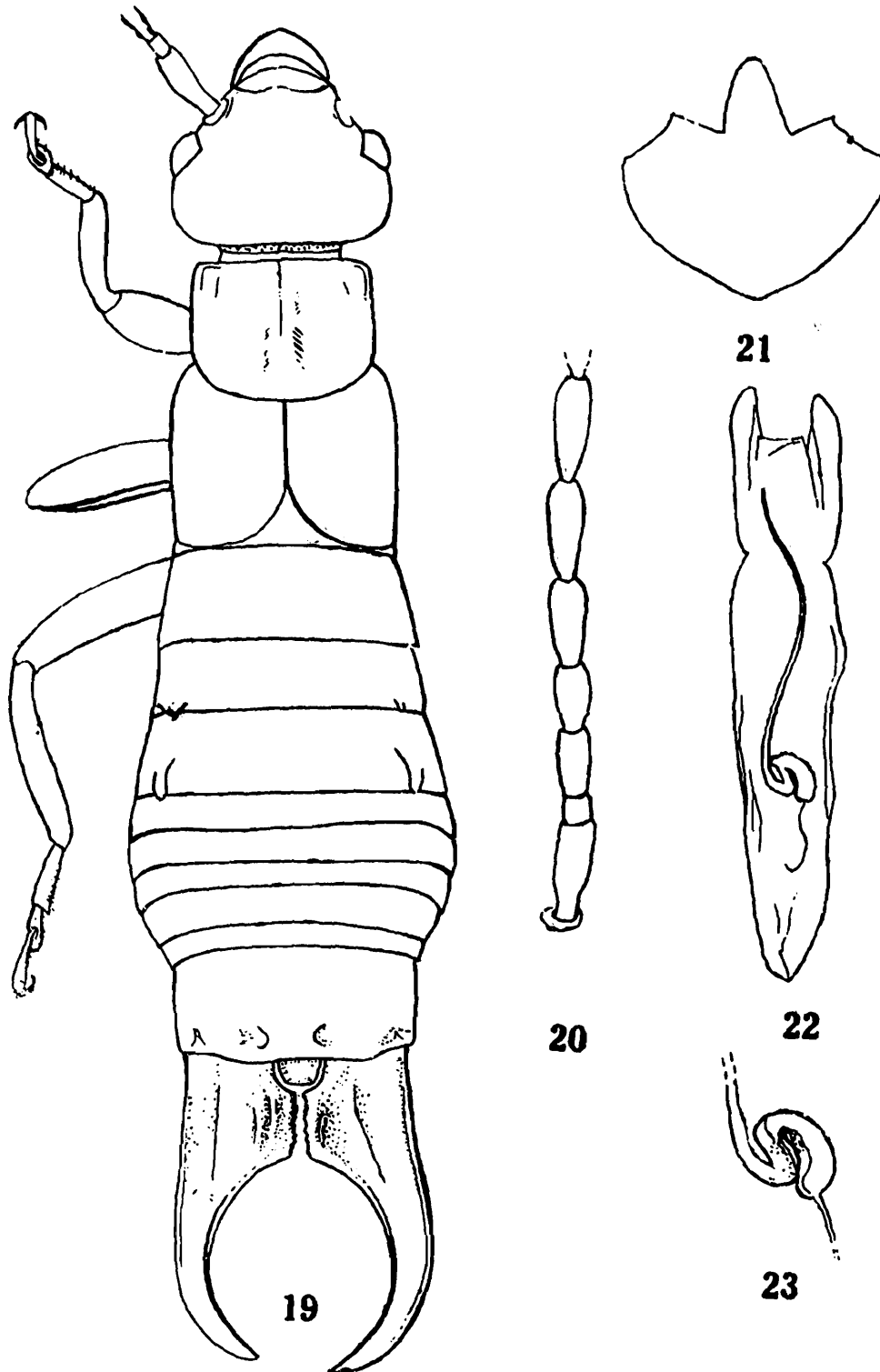
Forficula lurida Fischer, 1853, *Orth. Eur.* : 75.

Material examined.— IRAN : Shah Bazair, ca 80 km NE Dezful, Lok 53, 5 ♂ ♂, 2 ♀ ♀, 15.iv.1937 (*E. W. Kaiser*).

Forficula kashmirensis sp. n.

(Figs. 19-23)

Male : General colour yellowish brown



Figs. 19-23 : *Forficula kashmirensis* sp. n. Holotype ♂, 19. Dorsal view, 20. A few basal antennal segments, 21. Penultimate sternite, 22. Genitalia, 23. Basal vesicle:enlarged.

with shades of black in parts in the middle of pronotum, abdominal tergites and forceps ; head except mouth parts, ultimate tergite, and the pygidium complete black.

Head slightly longer than broad, convex above in middle, sutures obsolete, smooth, hind angles rounded and margin straight. Eyes about half as long as the post-ocular length. Antennae 12-segmented (or more because a few apical segments appear to be broken), 1st antennal segment stout, narrowed basally, slightly shorter than the distance between antennal bases ; 2nd about as long as broad ; 3rd long, slender, about as long as 5th ; 4th shorter than 3rd but stouter and narrowed basally, 6th onwards segments gradually increasing in length, mostly segments stout except one or two apical ones thinner. Pronotum slightly broader than long, smooth, anterior and lateral margins straight, hind angles and margin rounded, prozona moderately raised with faint median sulcus and not much differentiated from weakly raised metazona. Elytra abbreviated, only slightly longer than the pronotum, shoulder not prominent, meeting along the sutural margin, hind margin with inner angles rounded off ; wings absent. Legs typical. Abdomen spindle shaped, convex, faintly punctulate, sides of segments obtusely rounded, punctulations comparatively more pronounced, lateral tubercles on 3rd tergite weakly and on 4th well marked. Penultimate sternite transverse, faintly punctulate, hind margin rounded but obtuse in middle posteriorly. Ultimate tergite transverse, longitudinal stripes of punctulate and smooth areas alternating, sides straight, slightly raised posteriorly above the bases of forceps, hind margin slightly emarginate in middle, laterally weakly oblique and emarginate. Pygidium subvertical, slightly longer

than broad, narrowed apically with apex convex. Forceps depressed in basal one third with its inner margin straight and finely crenulate, afterwards gradually narrowing, cylindrical and moderately curved with apices gently hooked and pointed, not meeting with that of opposite side. Genitalia as seen in figure 22.

Measurements.—(in mm)

	Holotype
	♂
Length of head	1.7
Width of head	1.7
Length of pronotum	1.2
Width of pronotum	1.4
Length of elytra	1.4
Length of body	8.3
Length of forceps	2.6

Material examined.—INDIA : Kashmir, Gulmarg, ca 2600-3000 m, *Holotype* ♂ (genitalia mounted between two coverslips and pinned with the specimen), 1.viii.-5.ix.1978 (Copenhagen Zool. Mus. Exp.) ; deposited in Zool. Mus. DK, Copenhagen.

Remarks.—The described species comes close to *Forficula beebei* Burr (1911), *F. lucens* Brindle, *F. distendens* Brindle (1975) and *F. jayarami* Srivastava (1972), all known from India and adjacent countries on brachypterous forms with the exception of *F. beebei*, in which macropterous form (fully winged) is also met with. All these species can be easily separated by the following key.

- 1(4). Size larger (14.5 to 15.5 mm including forceps), pronotum strongly transverse
- 2(3). Abdomen greatly distended, parallel sided ; forceps almost straight, inner dilation of forceps extending in less than basal half, afterwards branches almost straight, cylindrical*F. distendens* Brindle

- 3(2). Abdomen greatly enlarged in middle, forceps with inner dilation extending in basal half or beyond, afterwards branches strongly curved with a faint, obtuse projection, a little before apex
.....*F. jayarami* Srivastava
- 4(1). Size smaller (8.5 to 11 mm including forceps), pronotum transverse
- 5(6). Pygidium distinct, rectangular, subvertical, sides almost straight, hind angles projecting in the form of minute point and in middle with another point; forceps with branches curving gradually from base to apex, slightly broader at base with faint tubercle or ridge close to inner margin above
.....*F. beebei* Burr
- 6(5). Pygidium short obtuse; forceps deplanate in basal one third to half, afterwards branches tapering.
- 7(8). Head orange, sutures distinct; pronotum with hind margin rounded, feebly obtuse in middle; abdominal tergites strongly punctate; ultimate tergite strongly transverse; forceps slender with basal dilation extending in basal half*F. lucens* Brindle
- 8(7). Head black, sutures obsolete; pronotum with hind margin briefly rounded, abdominal tergites finely punctulate; ultimate tergite transverse; forceps stouter with basal dilation extending in basal one third only
.....*F. kashmirensis* sp. n.

Subfamily EUDOHRNINAE

Eudohrnia metallica (Dohrn)

Forficula metallica Dohrn, 1865, *Stettin. ent. Ztg.*, 26 : 90.

Material examined.—INDIA : Dehra Dun Valley, ca 700 m, 1 ♀, 13.viii.1978.

Subfamily OPISTHOCOSMIINAE

Eparchus insignis (Haan)

Forficula insignis Haan, 1839-1844, *Verh. Nat. Ges. nederl. Overzee. Bezitt.*, : 243.

Material examined.—SOUTH INDIA : Mudi-

gera area, ca 900 m, 1 ♂, 2-10.xi.1977; JAVA : 1 ♂, (no further data), Buitenzarg, 1 ♂, 1907 (*Hj. Jensen*).

Cordax forcipatus (Haan)

Forficula forcipata Haan, 1839-1844, *Verh. Nat. Ges. nederl. Overzee. Bezitt.*, : 242.

Material examined.—JAVA ; 1 ♂, 1904 (*Hj. Jensen*); Tjibodas, 1 ♀, 14-22.viii.1922 (*Dr. Th. m.*)

Remarks.—Both the specimens are without wings.

ACKNOWLEDGEMENTS

I am thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for providing necessary facilities and to Dr. Henrik Enghoff, Zoologisk Museum, Copenhagen, Denmark for placing this interesting collection at my disposal.

REFERENCES

- BRINDLE, A. 1975. Ergebnisse der Bhutan—Expedition 1972 des Naturhistorischen Museums in Basel, Dermaptera. *Ent. Basil.* 1 : 1-59.
- BURR, A. 1911. Contribution to our knowledge of Indian Earwigs. *J. Asiat. Soc. Beng. (N.S.)*, 7 : 771-800.
- SRIVASTAVA, G. K. 1972. Notes on a collection of Dermaptera from NEFA, India. *Rec. zool. Surv. India*, 66 (1-4) : 129-142.
- SRIVASTAVA, G. K. 1976. Studies on the Dermaptera of the Philippines. *Pacif. Insects*, 17 (1) : 99-138.
- SRIVASTAVA, G. K. 1977. Indian species of *Euborellia* and *Liparura* (Dermaptera) with description of six new species. *Oriental Ins.* 11 (2) : 181-194.

CHROMOSOMES AND PHYLOGENY OF COLEOPTERA
II. MELOIDAE

PARMJIT S. DUA* AND R. K. KACKER

*Cytotaxonomy Research Laboratory,
Zoological Survey of India, Calcutta, India.*

ABSTRACT

Karyotype analysis of two congeneric species of *Meloidae* namely *Mylabris himalayica* and *M. pustulata* has been carried out. Both are found to have the diploid number $2n=22$. Chromosomes of six species all belonging to the subfamily *Meloinae*, have been compared using quantitative methods such as relative percentage lengths of the chromosomes ($L^R\%$) and tentative conclusions have been drawn regarding chromosomal affinities between species.

INTRODUCTION

Present report is in continuation of the series on the Chromosomes and Phylogeny of Coleoptera I. Chrysomelidae, and deals with the description of chromosomes in 2 species.

In all 23 species are known chromosomally in *Meloidae*. The diploid number varies from 20-24. The morphometric data such as relative percentage lengths of the chromosomes ($LR\%$) of only six species could be utilized in the present cytotaxonomical analysis (Table I).

MATERIALS AND METHODS

Two species namely *Mylabris himalayica* Saha and *M. pustulata* Thunberg constituted

the materials for the present chromosome analysis. The techniques of squash preparations, staining and microphotography are essentially those described earlier (Dua and Kacker, 1981).

OBSERVATIONS

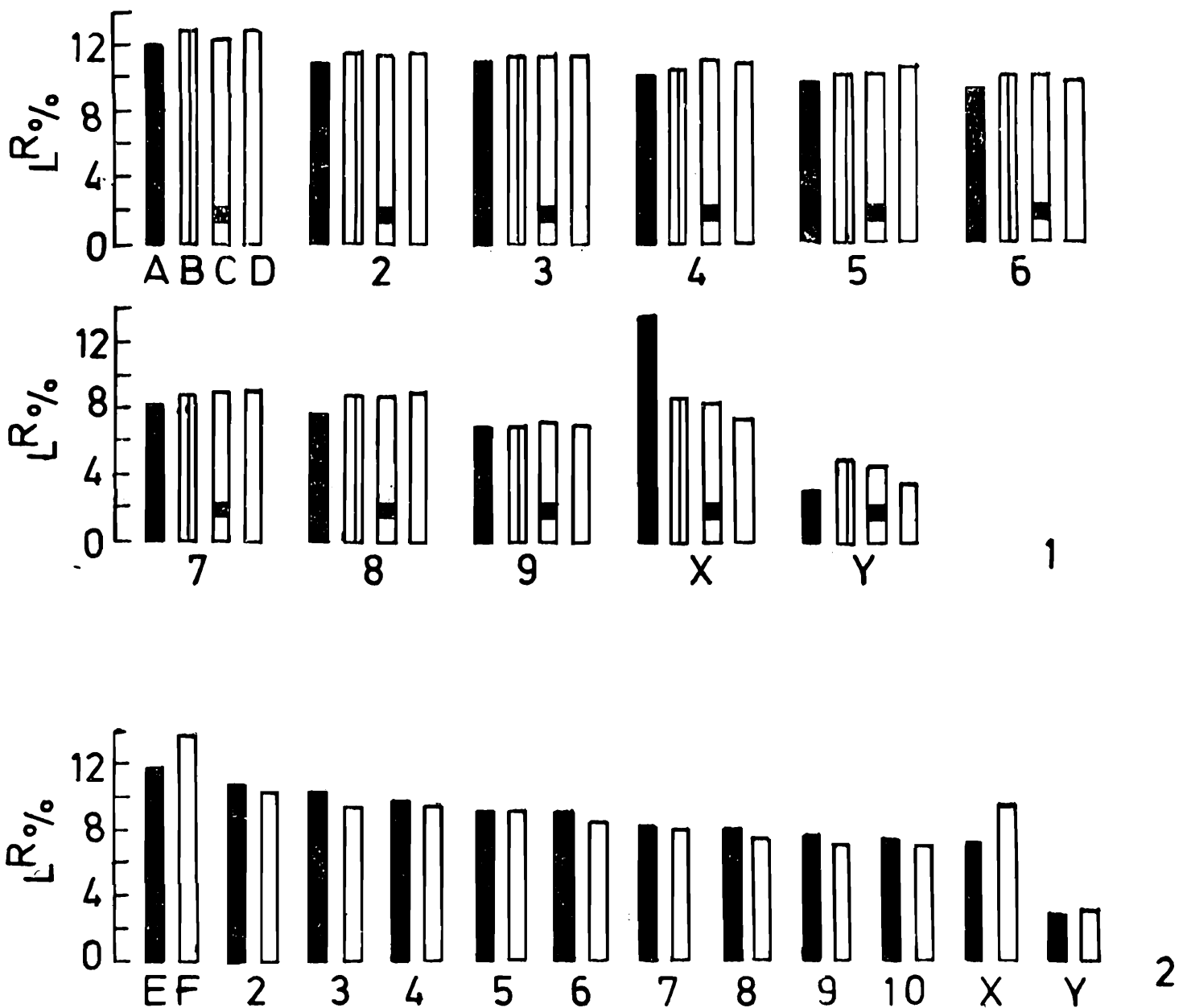
Mylabris himalayica Saha

The testes from two males studied provided only a few spermatogonial metaphases, the most frequently encountered stage in the tissue being the first meiotic metaphases (MI). The presence of 22 elements in spermatogonial cells and 10 autosomal bivalents plus Xyp type of sex chromosomes at MI indicate the diploid chromosome number to be 22.

*Present Address : Department of Zoology, Khalsa College, Amritsar, India.

TABLE I. List of the species employed in the cytological analysis.

Species	Diploid Number 2n	Reference
<i>Epicauta cineria</i>	20	Stevens, 1909
<i>Psalydolytta</i> sp. nr. <i>rouxi</i>	20	Kacker, 1971
<i>Cyaneolytta</i> sp.	20	Kacker, 1971
<i>Meloe</i> sp.	20	Asana <i>et al</i> , 1942
<i>Mylabris pustulata</i>	22	Asana <i>et al</i> , 1942
<i>Mylabris thunbergi</i>	22	Agarwal, 1962.

Fig. 1. Idiogram of A- *Epicauta cineria*, B- *Psalydolytta* sp. nr. *rouxi*, C- *Cyaneolytta* sp. and D- *Meloe* sp.Fig. 2. Idiogram of E- *Mylabris pustulata* and F- *M. thunbergi*.

LR% - Relative percentage length.

***Mylabris pustulata* Thunberg**

The chromosome studies were carried out in two male individuals. Meiosis, was already over in the testicular follicles which, however, contained a large number of metaphase I and a few Anaphase I stages. Spermatogonial metaphases were absent, the diploid chromosome number was ascertained from 100 clearly countable metaphase I cells. The presence of 10 autosomal and one sex bivalents in all the metaphase I stages, indicate the diploid number is 22.

DISCUSSION

Relative percentage lengths of the chromosomes of six species, all belonging to the subfamily Meloinae, could be utilized in the present study. Chromosomally, these six species fall in to two distinct groups, four species—*Epicauta cineria* (A), *Psalydolytta* sp. nr. *rouxi* (B), *Cyaneolytta* sp. (C), and *Meloe* sp. (D) have $2n=20$, and belong to the first group, while two species *Mylabris pustulata* (E) and *Mylabris thunbergi* (F) having $2n=22$ are included in the second group. In the four species A, B, C and D all the autosomes show uniform relative size with no significant difference, the only marked difference being in the size of X chromosome. It assumes a larger size in A, whereas the remaining three species have almost equal sized X chromosomes. (Fig. 1). The Y chromosome is always dot like. Taxonomically species A and B are placed in the tribe Epicautini while C and D in the tribes Lyttini and Meloini respectively but chromosomally, B, C and D seem to be more close to each other than A.

In the second category two congeneric species *Mylabris pustulata* (E) and *M. thunbergi* (F) do not show any significant size difference in their chromosomes. The only

variation noted is in pair 1 and X chromosome which are slightly larger in species F than the corresponding ones in E (Fig. 2).

Considering the available data on the relative percentage length of chromosomes in Meloidae, it becomes obvious that karyotypic evolution in this family has been very conservative. The changes in the diploid count in this family may be due to centric fission or fusion.

ACKNOWLEDGEMENTS

The authors are grateful to Prof. S. P. Ray-Chaudhuri, Emeritus Scientist, Genetic Research Unit, Department of Zoology, Calcutta University for generous help and valuable suggestions in many ways. Our thanks are due to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for award of Research Fellowship to Parmjit S. Dua.

REFERENCES

- AGARWAL, U. 1962. Studies on the structure and behaviour of the chromosomes of five species of Indian Coleoptera. *Jap. J. Genet.*, **37** : 57-65.
- ASANA, J. J., MAKINO, S. & NIYAMA, H. 1942. A Chromosomal survey of some Indian Insects IV. on the sex chromosomes of some species of beetles (Coleoptera). *Cytologia*, **12** : 187-205.
- DUA, P. S. & KACKER, R. K. 1981. Chromosomes and Phylogeny of Coleoptera I. Chrysomelidae. *Genetica* (sent for publication).
- KACKER, R. K. 1971. Cytology and Cytotaxonomy of Coleoptera. Studies on the chromosomes of thirtyone species of Indian coleoptera. Ph. D. thesis, Banaras Hindu University.
- STEVENS, N. M. 1909. Further studies on the chromosomes of Coleoptera. *J. exp. Zool.*, **6** : 101-121.

ON A COLLECTION OF CHIRONOMIDS (DIPTERA :
CHIRONOMIDAE) FROM TIBET

D. K. GUHA*

Zoological Survey of India, Calcutta

AND

P. K. CHAUDHURI

Department of Zoology, University of Burdwan

ABSTRACT

Three new species, *Chironomus sinuosus* n. sp., *Paratanytarsus sinensis* n. sp. and *Tanytarsus pectus* n. sp. are described from a collection of Tibet (China.)

INTRODUCTION

Whilst studying the collections of chironomid midges at the Zoological Survey of India, Calcutta, the senior author was requested to go through a collection of unidentified pinned insects from Tibet. On enquiry, it was reported that the insects were deposited as such by a team of Ramkrishna Mission led by Swami Pranavananda which visited Tibet (now in China) in May 1946. Some of the insects were mounted on microslides in the usual manner (Chaudhuri, Guha, and Das Gupta, 1981) and the others were kept as such. The chironomid midges were found to belong to three species of genera such as *Chironomus* Meigen, *Paratanytarsus* Bause and *Tanytarsus* van der Wulp.

The slide-mounts and the others are now in the collection of insects at the Zoological Survey of India, Calcutta.

In describing the species the works of Guha and Chaudhuri (1980) and Saether (1980) have been followed.

Chironomus sinuosus n. sp.

(Figs. 1a-c)

Male : Body length 8.19 mm

Head : Vertex with 29 (postocular 16, outer verticals 10 and inner verticals 3) setae. Corona without seta. Clypeal ratio 1.0. Maxillary palp yellow, length ratio of palpomeres 1-V 4 : 4 : 18 : 18 : 25, L/W 4.5, Eyes bare, reniform with a short dorsal extension. Frontal tubercle elongated 0.36 mm.

*Present address : Department of Zoology, Vivekananda College, Burdwan 713103, W.B.

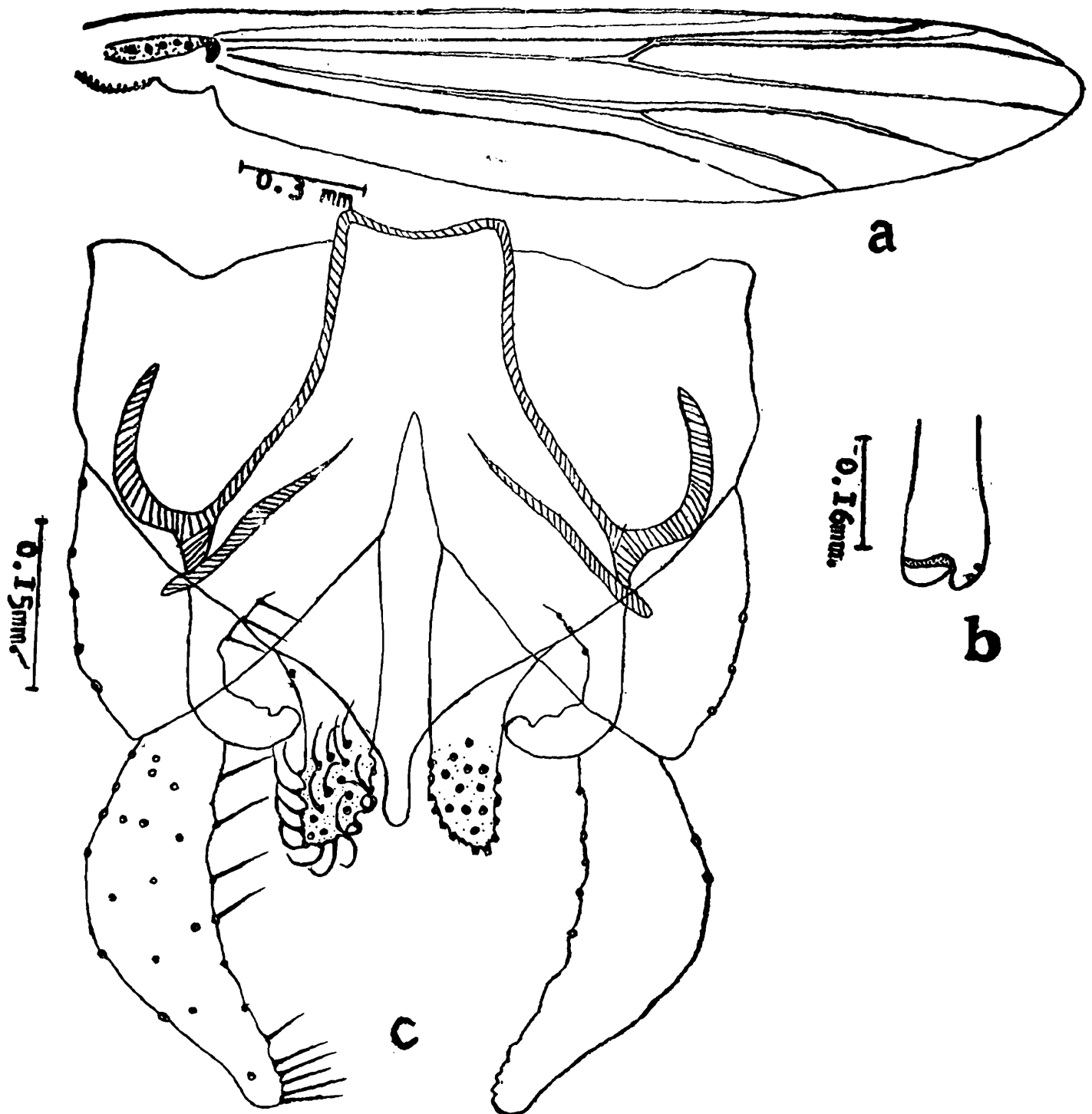


Fig. 1.

Figs. 1a-c. *Chironomus sinuosus* n. sp. (♂) a. wing, b. fore tibial scale and c. hypopygium.

Antenna densely setaceous, last flagellomeres unusually long, length ratio of flagelloemeres 1-XI 3 : 2 : 1 : 5 : 1.5 : 1.5 : 1.5 : 1.5 : 1 : 1 : 1 113, AR 7.01.CA 0.4, CP 1.5.

Thorax : Dark brown in colour. Anteprenotum collar-like with a dorsal emargination. Acrostichals 80-85 in rows, dorsocentrals 50-55 and prealars 8. Scutellum with 90-95 setae, postscutellum bare.

Wings (Fig. 1a) : Hyaline. Brachiolum with 5 setae. R with 10-12, R₁, 2-4 and R₄₊₅ with 2-4 setae ; R₂₊₃ ends close to R₁ ; r-m proximal to f-cu ; An ends below f-cu. Squama with 30-35 setae. Haltere brown and bare. CR 0.98, VR 1.07.

Legs : Brown in colour. Fore tibial scale (Fig. 1b) blunt bearing 2 setae. Spurs of mid tibia small, equal and those of hind tibia unequal, inner spur shorter. Pulvilli large. LR 1.28 in fore, 0.55 in mid and 0.59 in hind legs. TR of hind leg 1.45.

Abdomen : Dark brown in colour with uniformly distributed setae.

Hypopygium : (Fig. 1c) : Anal point blunt with 6-7 setae on each basal margin. Gonocoxite with 15-20 setae ; gonostylus attenuated towards distal bearing 15-20 long setae over it and 6 setae at its inner apical margin. Appendage 1 slender, blunt and incurved, appendage 2 stout and straight with 25-30 curved setae. HR 1.26, HV 2.27.

Female : Unknown

Holotype : ♂ (Z.S.I. Reg. 6602/46), Harm Lake (4481 m above sea level), Tibet (China), 12.v.1946, Coll. P. I. R. M.

Paratype : 4 ♂ ♂, data same as holotype, in the department of Zoology, University of Burdwan.

Remarks : This is a dark coloured

medium to large sized insect of the genus *Chironomus* Meigen. In certain morphological features, especially concerning the male hypopygium, such as the slender abrupt attenuation of gonostylus and appendage 2 shows closeness with *C. bipunctus* Johannsen (1932) from Java, *C. congolensis* Goetghebuer (1936). *C. sinuosus* comes close to *C. linearis* Kieffer (1911) in shape of the gonocoxite, chaetotaxy of appendage 1. Similarly the shape of anal point and shape of appendage 2 of *C. formosipennis* draws affinities with *C. sinuosus*. Number of setae on vertex, reniform dorsally extended eye, elongated frontal tubercle, chaetotaxy on thorax, brachiolum with 5 setae, squama with 30-35 setae, number of setae on veins, blunt fore tibial scale with 2 apical setae, large pulvilli ; shape of gonostylus with 8 apical setae, blunt, incurved slender appendage 1 and stout straight appendage 2 with 25-30 setae, blunt anal point, readily mark its consideration as a new species quite different from others described prior to it.

Paratanytarsus sinensis n. sp.

(Figs. 2a-c)

Male : Body length 3.93 mm

Head : Dark brown colour. Vertex dark brown with 8 (postoculars 2, outer verticals 2 and inner verticals 2) setae. Corona with 4 setae. Maxillary palp brown, length ratio of palpomeres I-V 2 : 3 : 12 : 10 : 10 ; L/W 6.0. Eyes bare and extended dorsally. Frontal tubercle absent. Antenna brown, length ratio of I-XIII 4 : 2 : 2 : 2.5 : 3 : 3 : 3 : 3 : 5 : 4 : 4 : 4.5 : 52, Ar 1.1. Pedicel ratio 1.1 CA, 0.3, CP 1.0.

Thorax : Brown in colour having dark brown patches. Acrostichals 12-14 in

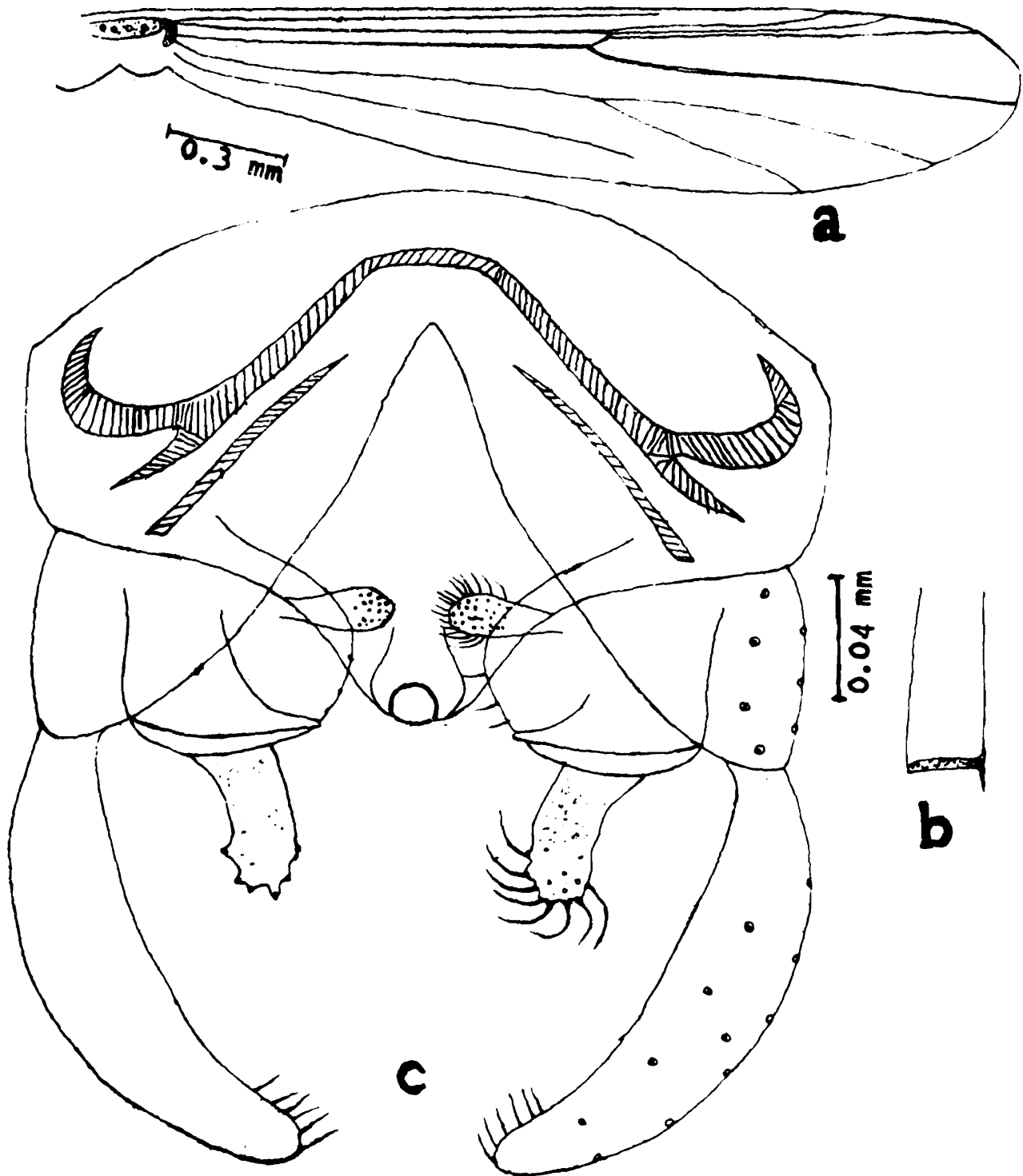


Fig. 2

Figs. 2a-c. *Paratanytarsus sinensis* n. sp. (♂) a. wing, b. fore tibial scale and c. hypopygium.

pairs dorsocentrals 12-14, humeral 1 and prealars 3. Scutellum with 8-10 setae, postscutellum bare.

Wing (Fig. 2a): Wing membrane with macrotrichia at the apex. Brachiolum with 4 setae. R with 15, R_1 , 5 and R_{4+5} with 4 setae; R_{2+3} scarcely visible; r-m a little proximal to f-cu; An ends distal to f-cu. Squama bare. Haltere brown and bare. CR 1.1, VR 1.06. Wing length 3.0mm, breadth 0.69 mm.

Legs: Brown in colour. Fore tibial scale (Fig. 2b) with a short spine. Mid and hind tibia with 1 seta at each comb, LR0.9 in fore, LR0.4 in mid and LR0.5 in hind leg.

Hypopygium (2c): Anal point short with a bubble like crest. Appendage 1 more or less clubbed, appendage 2 long bearing curved setae; appendage 1a beak-like with 2-3 setae at its base, appendage 2a stout bearing unbranched setae at its apex. Gonocoxite short; gonostylus elongated and bent bearing 6 setae at its inner apical margin. HR 0.7, HV 0.5.

Female: Unknown

Holotype ♂ (Z. S. I. Reg. 6603/46), Harm lake (4481 m above sea level), Tibet (China), 12.v.1946, Coll. P. I. R. M.

Paratype 3 ♂♂, date same as holotype, in the department of Zoology, University of Burdwan.

Remarks: The present species appears to be closely related to *Paratanytarsus paivus* Glover and *P. jefferyi* Glover (1973) from Australia in distribution of macrotrichia on wing and structure of gonocoxite and gonostylus. But the characters like, i) absence of frontal tubercle ii) with dark brown patches on the thorax, iii) number of macrotrichia on the wing membrane, iv) R_{2+3}

scarcely visible, v) brown and bare haltere, vi) fore tibial scale with a short spine, vii) long gonostylus, viii) short anal point with a bubble like crest, ix) more or less clubbed appendage 1, beak like appendage 1a with 2-3 setae at base; appendage 2 long bearing curved setae etc. separate *sinensis* from all other described species.

Tanytarsus pectus n. sp.

(Figs. 3a-c)

Male: Body length 4.3 mm

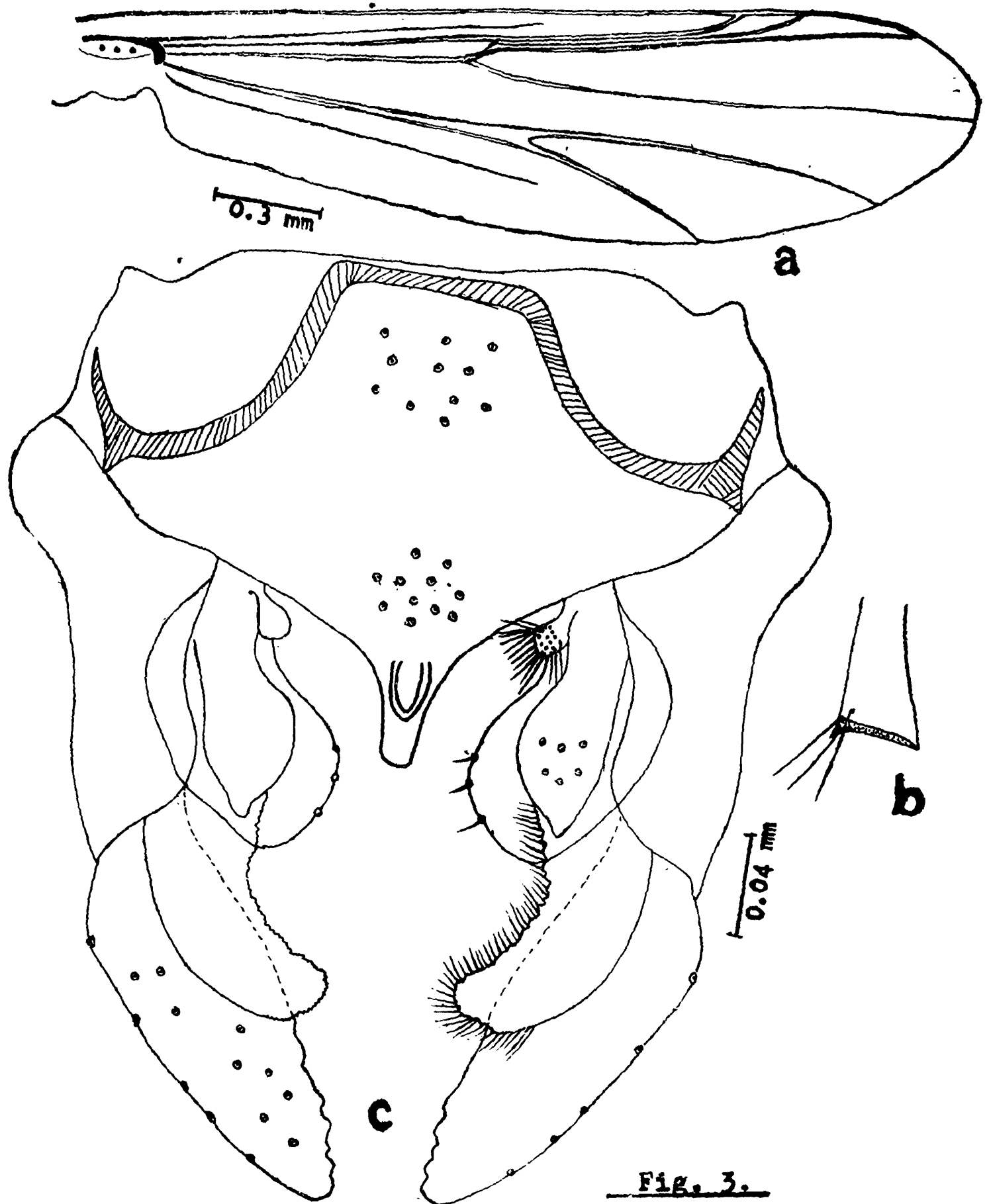
Head: Dark brown in colour. Vertex with 12 (postoculars 2, outer verticals 4 and inner verticals 6) setae. Corona with 4 setae in two rows. Clypeal ratio 1.2. Maxillary palp brown, length ratio of palpomeres I-V 2 : 3 : 11 : 10 : 6, L/W 2.1. Eyes bare with dorsal extension 0.09 mm long. Antenna brown, length ratio of flagellomeres I-XIII 11 : 5 : 5 : 4 : 4 : 5 : 5 : 6 : 6 : 6 : 6 : 7 : 205, AR 2.9. Pedicel ratio 1.4. CA 0.1, CP 0.9.

Thorax: Dark brown in colour. Acrostichals 10, dorsocentrals 6, humeral 1 and prealars 4. Scutellum with 8 setae, postscutellum dark brown and bare.

Wing (Fig. 3a): Wing membrane with a few macrotrichia towards the apex of cells R_{4+5} and M_1 . Brachiolum with 3 setae. R with 6, R_1 , 4 and R_{4+5} with 1 seta; R_{2+3} ends one-third of the distance of R_1 and R_{4+5} ; r-m just above f-cu; Cu_1 straight; An ends distal to f-cu. Squama bare. CR 1.09, VR 1.0.

Wing length 3.2 mm, wing breadth 0.75 mm.

Legs: Brown in colour. Fore tibial scale (Fig. 3b) without seta but with a short projection bearing 3 setae at its base. Mid and hind tibia with 1 small spur at each comb.

Fig. 3.

Figs. 3a-c. *Tanytarsus pectus* n. sp. (♂) a. wing. b. fore. tibial scale. and c. hypopygium.

Hypopygium (Fig. 3c) : Anal point small, blunt and bare bearing 8 setae well behind its base. Gonocoxite and gonostylus stout with numerous setae. Appendage 1 broad with 3 setae, appendage 2 stout, bent setae bearing comb at its inner margin ; appendage 1a broad and prominent bearing a few setae, appendage 2a short having a bunch of setae. HR 1.1, HV 2. 1.

Female : Unknown

Holotype ♂ (Z. S. I. Reg. No. 6604/H6), Kala Lake (4481m above sea level), Tibet (China), 12. v. 1946, Coll. P. I. R. M.

Paratypes 3 ♂ ♂, data same as holotype in the department of Zoology, University of Burdwan.

Remarks : The male of the present species agrees with *Tanytarsus paskevillensis* Glover (1973) from Australia in the presence of a few macrotrichia towards the apex of cells R_{4+5} and M_1 , in the shape of anal point and shape of appendage 2a. But the characters like vertical setae, clypeal ratio, antennal ratio, chaetotaxy of thorax, brachiolum with 3 setae, arrangement of setae on wing veins, small, blunt and bare anal point bearing 8 setae well behind base, broad appendage 1 with 3 setae, stout appendage 2 bears setae like comb, appendage 1a broad and prominent with a few setae confirm *T. pectus* as a new species in genus *Tanytarsus*. The character presented by this species seem a little deviation from a typical *Tanytarsus* but we think it is wise to regard this species as a new member of *Tanytarsus* rather than creating a new genus. The following combination of the characters like 13 segmented antenna of male, wing membrane with macrotrichia at apex of cells R_{4+5} and M_1 , bare squama, absence of pulvilli, 4 pairs of appendage on male

hypopygium and appendage 2a with simple unbranched hairs disapprove its formation of a new genus in the tribe Tanytarsini.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for permission to study the material from the collection of insects lying at the Zoological Survey of India. They are thankful to Prof. D. K. Chaudhuri, Head of the department of Zoology, University of Burdwan for laboratory facilities and helpful criticisms.

REFERENCES

- CHAUDHURI, P. K., GUHA, D. K. AND DAS GUPTA, S. K. 1981. Taxonomic studies of Chironominae (Diptera : Chironomidae) from India. Genus *Polypedilum* Kiffer. *Tijdschr Ent.*, **124** (4) : 111-147.
- GUHA, D. K. AND CHAUDHURI, P. K. 1981. Record of three genera of Chironominae (Chironomidae : Diptera) from India. *Bull. zool. Surv. India.* **3** (3) : 159-165.
- GOETGHEBUER, M. 1936. Chironomides du Congo Belge. *Revue Zool. Bot. afr.* **28** : 53-92.
- GLOVER, B. 1973. The Tanytarsini (Diptera : Chironomidae) of Australia. *Aust. J. Zool. (Suppl.)* **23** : 403-478.
- JOHANNSEN, O. A. 1932. Chironominae of the Malayan subregion of the Dutch East. *Arch. Hydrobiol. (Suppl.)* **9** : 491-507.
- KIEFFER, J. J. 1911. Diptera, Chironomidae der Seychellen. Inseln, aus der Sammlung von Mr. H. Scott. *Trans. Linn. Soc. Lond. (Zool.)*. **14** : 331-366.
- SAETHER, O. A. 1980 Glossaary of chironomid morphology terminology (Diptera : Chironomidae) *Ent. Scand. (Suppl)* **14** : 1-51.

ON A NEW SPECIES OF THE GENUS *Danio* HAMILTON FROM BURMA
(PISCES : CYPRINIDAE)

R. P. BARMAN

Zoological Survey of India, Calcutta

ABSTRACT

A lot of 14 specimens labelled erroneously as *Danio (Brachydanio) shanensis* Hora was found to be referable to a hitherto undescribed species. It is related to *Danio (Brachydanio) feegradei* and *Danio (Brachydanio) shanensis* from which it differs in the lateral line scale count and absence of barbels. The species is named as *Danio (Brachydanio) jayarami* and fully described with a photograph.

INTRODUCTION

During the course of the revisionary studies on the Cyprinid fishes of the genus *Danio* from India and Burma, 14 uncatalogued specimens of a species referable to this genus under subgenus *Brachydanio* were found labelled as *Danio shanensis* Hora. When compared with the eight species belonging to subgenus *Brachydanio* known from the Indian region (Jayaram, 1981), they proved to be a hitherto undescribed species. The species is described here and named after Dr. K. C. Jayaram, Deputy Director, Zoological Survey of India, Calcutta and one of the prominent workers of the fishes of India of the present decade.

SYSTEMATIC ACCOUNT

Order —CYPRINIFORMES
Family—CYPRINIDAE

Genus —**Danio** Hamilton

Danio (Brachydanio) jayarami sp.
nov.

Material : *Holotype* (Fig. I) : 46 mm. in standard length. Reg. No. Z. S. I. FF. 1805.

Locality : Streams near Mongyai, N. Shan States, Burma, Coll. B. N. Chopra & H. S. Rao, date : Jan. 1927.

Paratypes : 13 examples, 40 mm.-43 mm. in standard length. Reg. Nos. Z. S. I. FF. 1806-FF 1818. Locality, Collector and date same as in holotype.

Diagnosis : Lateral line scales 39-41, complete ; least height of caudal peduncle 2.5 times in its own length ; anal rays 18-19 ; conical snout, 3.74 (3.66-4.00) in head length ; eye diameter 3.21 (3.14-3.42) in head length ; depth of body 4.17 (4.00-4.30) in standard length.

DESCRIPTION

Danio (Brachydanio) jayarami sp. nov.

D. 2/7, A. 3/15-16, P. 12, V. 7, C. 20,
L. 1.39-41, L. tr. $7\frac{1}{2}/1\frac{1}{2}$

Head conical structure, length 3.79 (3.63-3.90) in standard length, height considerably

concave. The commencement of the dorsal fin nearer to caudal base than to the tip of snout, its height 5.34 (5.00-5.75) in standard length, it contains two spines and seven branched rays. The origin of pelvic fin nearer to the tip of snout than to the caudal base. The distance between origin of the pelvic to

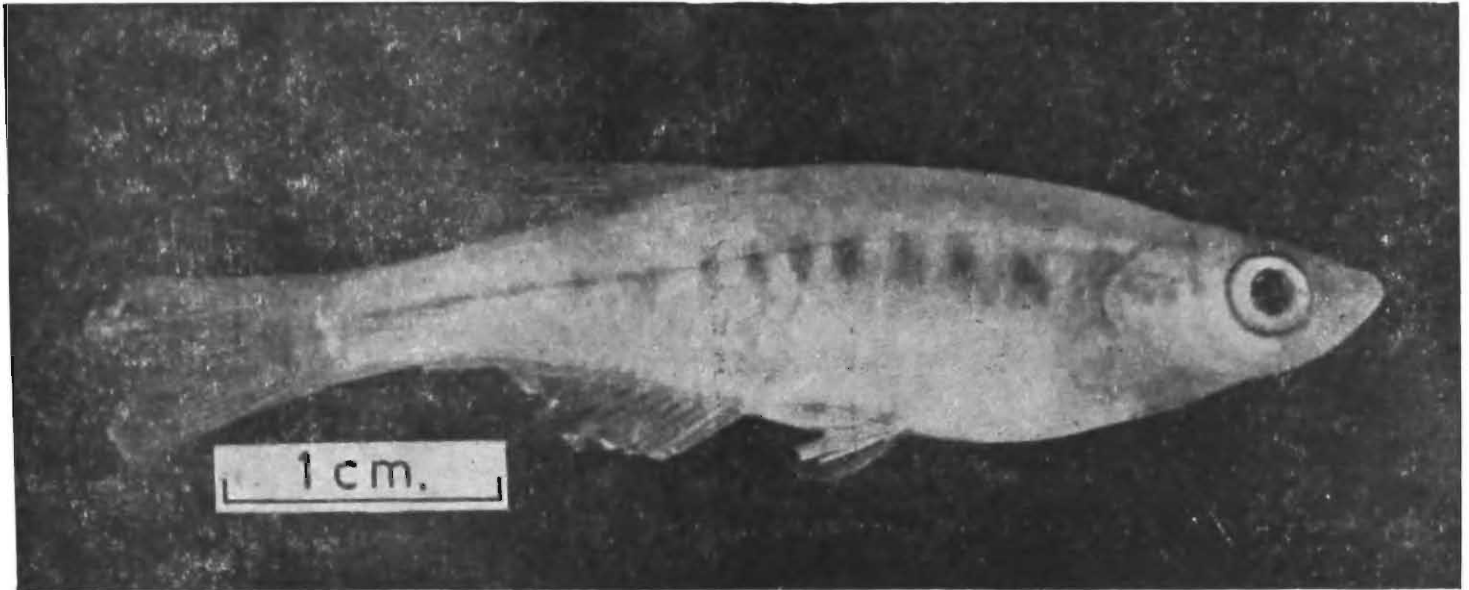


Fig. 1. *Danio (Brachydanio) jayarami* sp. nov.

shorter than head length, width shorter than the height of the head. Eyes large, dorso-lateral, anterior, diameter 3.21 (3.14-3.42) in head length, greater than the snout length and 1.07 (1.00-1.14) in the interorbital width. Mouth obliquely directed upwards and moderate width, lower jaw longer than upper jaw. No barbels. Body depth 4.17 (4.00-4.30) in standard length, shorter than head length. Lateral line scales 39-41 and lateral transverse scales 9 rows ($7\frac{1}{2}/1\frac{1}{2}$). Predorsal scales 18-19.

The dorsal profile rises gently from the tip of the snout to the origin of dorsal fin, beyond which it slopes downwards in the manner of a convex plan. The convex ventral profile extending upto the commencement of anal fin, beyond which it becomes

tip of snout 1.27 (1.23-1.35) in distance between origin of pelvic to base of caudal fin. The length of pectoral is shorter than the head length. The length of pelvic is shorter than that of the pectoral and the height of the anal is greater than that of pelvic. Caudal length 5.18 (5.11-5.37) in standard length, emarginate. The least height of caudal peduncle 2.5 (2.5-2.5) in its length and there are 12 scales round the caudal peduncle.

The colour pattern of this species is peculiar. There are 12-13 transverse brown colour spots which progressively decrease in size posteriorly.

Frequency distribution of some meristic characters are given in Table No. 3.

AFFINITIES

Danio (Brachydanio) jayarami is characterised by the presence of 39-41 lateral line scales and absence of barbels. The new species is closely related to *Danio (Brachydanio) shanensis* Hora and *Danio (Brachydanio) feegradei* Hora from Burma. This present new species may be easily distinguishable from the former species in having lateral line scales 39-41 vs. 34, anal rays 18-19 vs. 13-15, body depth 4.17 (4.00-4.30) vs. 3.50 (3.30-3.70) in standard length, snout length 3.74

(3.66-4.00) vs. 4.87 (4.50-5.50) in length of head and height of caudal peduncle 2.5 (2.5-2.5) vs. 1.76 (1.60-1.90) in its own length. From *Danio (Brachydanio) feegradei* this new species may be separated in the absence of barbels vs. rostral and maxillary barbels present-maxillary being as long as head or longer than head, greater number of anal rays vs. lesser number of anal rays (18-19 vs. 15) and height of caudal peduncle 2.5 times vs. 1.5 times in its own length. A comparison of the new species is given in table No. 2.

TABLE No. 1

Proportions	Range	Mean
Standard length/Head length	3.63-3.90	3.79
Standard length/Body length	4.00-4.30	4.17
Standard length/Predorsal distance	1.53-1.68	1.61
Standard length/Prepelvic distance	2.15-2.35	2.22
Standard length/Caudal peduncle length	4.00-4.60	4.27
Standard length/Least height of caudal peduncle	10.00-11.25	10.60
Caudal peduncle length/least height of caudal peduncle	2.50-2.50	2.50
Head length/Eye diameter	3.14-3.42	3.21
Interorbital width/Eye diameter	1.00-1.14	1.07
Head length/height of head	1.25-1.50	1.38
Head length/width of head	2.00-2.20	2.14
Head length/Snout length	3.66-4.00	3.74
Interorbital width/Snout length	1.16-1.33	1.20
Standard length/height of dorsal	5.00-5.75	5.34
Standard length/height of Anal	5.71-6.57	5.98
Standard length/Pectoral length	4.44-4.60	4.58
Standard length/Pelvic length	7.66-8.60	8.27
Standard length/length of caudal fin	5.11-5.37	5.18

TABLE 2. Comparison of *Danio (Brachydanio) jayarami* with related species.

	<i>Danio (Brachydanio) jayarami</i> sp. nov.	<i>Danio (Brachydanio) shanensis</i> Hora	<i>Danio (Brachydanio) feegradei</i> Hora
Lateral line scales	39-41	34	39
Barbel	absent	absent	present
Depth of body in standard length	4.00-4.30	3.30-3.70	3.9-3.9
Head length in standard length	3.63-3.90	3.80-4.00	3.9-3.9
Snout length in head length	3.66-4.00	4.50-5.50	3.66-3.66
Height of caudal peduncle in its own length	2.5-2.5	1.60-1.90	1.50-1.50
Anal rays	3/15-16	3/10-12	3/12
Lateral line	complete	incomplete	complete

TABLE 3. Frequency distribution of some meristic characters of *Danio (Brachydanio) jayarami*

Lateral line scales			Predorsal scales		Anal rays	
39	40	41	18	19	18	19
9	3	2	8	6	9	5

ACKNOWLEDGEMENT

The author is grateful to Dr. B. K. Tikader, Director, Zoological Survey of India and to Dr. P. K. Talwar, Superintending Zoologist, Zoological Survey of India for their sustained encouragement during the course of this work. He is indebted to Dr. N. C. Datta, Reader, Dept. of Zoology, Calcutta University, for his constant guidance. Thanks are also due to Drs. K. C. Jayaram, Joint Director and T. K. Chatterjee, Asstt. Zoologist, Zoological Survey of India for going through the manuscript.

REFERENCES

- DAY, F. 1889. *The Fauna of British India, including Ceylon & Burma*, Fishes, I. Taylor & Francis, London, XX + 548.
- HORA, S. L. 1928. Notes on Fishes in the Indian Museum. XV—Notes on Burmese Fishes, *Rec. Indian Mus.*, 30 : 37-40.
- HORA, S. L. & MUKERJI, D. D. 1934. Notes on fishes in the Indian Museum, XXII. On the collection of fish from the S. Shan States and the Pegu Yomas, Burma. *Rec. Indian Mus.*, 36 : 123-138.
- HORA, S. L. 1937. Notes on the Fishes in the Indian Museum, XXXI—On a small collection of Fish from Sandoway. Lower Burma. *Rec. Indian Mus.*, 39 : 323-331.
- JAYARAM, K. C. 1981. *The Freshwater Fishes of India, Pakistan, Bangladesh, Burma & Sri Lanka*, Govt. of India, XXII + 475, plates XIII.

SOME OBSERVATION ON THE SEASONAL ACTIVITY OF EARTHWORMS (OLIGOCHAETA : ANNELIDA) IN HILL FOREST SOIL

J. M. JULKA AND R. N. MUKHERJEE

High Altitude Zoology Field Station, Zoological Survey of India, Solan

ABSTRACT

Data gathered during the period July 1978—June 1979 indicate seasonal fluctuations in the population size of earthworms in hill forest soil at Solan, Himachal Pradesh, India. Significant positive correlation exists between changes in the population size of *Octolasion tyrtaeum* (Savigny), the most predominant species, and soil moisture, but not between soil temperature and the seasonal abundance of this species. The seasonal distribution by age groupings of *O. tyrtaeum* and *Drawida japonica* Michaelsen is also given.

INTRODUCTION

Ecological studies on oriental earthworms have remained neglected. Few detailed investigations on their seasonal activity and population dynamics are those of Roy (1957), Gates (1961), Bhatti (1962), Dash and Patra (1977), Kale and Krishnamoorthy (1978), Reddy and Alfred (1978), Senapati *et al.*, (1979, 1979a), Chauhan (1980) and Dash and Senapati (1980). This article presents preliminary observations on the influence of soil temperature and soil moisture on the earthworm population in an ash-tree stand during the course of a year.

STUDY AREA

An area of 10 × 10 m was selected for the present study in a forest (Shilli Forest) at an altitude of 1480 m, about 4 km from

Solan on way to Jaunaji. The site was close to the Forest Nursery of the local College of Agriculture. Vegetation of the site was primarily composed of *Fraxinus americana* Linn. (Ash), *Quercus incana* Roxb. (Oak) and *Pinus roxburghii* Sarg. (Pine) and some grasses on the edge of the forest.

The study area experienced four distinct seasons viz. spring (late February to April), summer (May to August), autumn (September to middle of November) and winter (middle of November to middle of February).

MATERIAL AND METHODS

During the present study, earthworms were extracted from soil by formaldehyde solution as described by Raw (1959) since the digging and hand-sorting method is very time consuming. Every month ten samples,

each 25 cm × 25 cm quadrat, were taken during the period July 1978—June 1979 by random sampling method. Soil temperature and moisture were measured respectively by a soil thermometer and by oven-drying method for the surface soil at 5 cm depth. Rainfall data was obtained from the local College of Agriculture, Himachal Pradesh Krishi Vishva Vidhyalaya.

OBSERVATIONS

Rainfall and Physico-Chemical Factors of the Soil

The seasonal changes in the rainfall, soil moisture and soil temperature are depicted in Fig. 1. The pH of the soil ranged from 7.0 to 7.4.

Species Diversity and Dominance

Octolasion tyrtaeum (Savigny), *Bimastos parvus* (Eisen) (Fam. Lumbricidae), *Drawida japonica* Michaelsen (Fam. Moniligastridae) and *Plutellus* sp. (Fam. Acanthodrilidae) were recorded in the samples. *O. tyrtaeum* with an annual percentage of 92.9 showed a marked predominance, followed by *D. japonica* (6.7%), *B. parvus* (0.2%) and *Plutellus* sp. (0.2%).

Seasonal Activity

Population of *O. tyrtaeum* showed two maxima and two minima in a year (Fig. 1). Population increased in late February and the trend continued upwards through the spring until the peak (118.4/m²) was reached in July at the beginning of summer rains. The number dropped rapidly in August and continued to decrease during the autumn until November. Coinciding with the onset of

winter rains in late December, the number rose again but did not reach the previous level. Population declined to the lowest level of 30.4/m² in January.

Seasonal distribution of *O. tyrtaeum* by age groupings is illustrated in Fig. 2. The autumn and winter populations were predominantly made up of adults. During the spring in April, there was a considerable increase in the percentage of juveniles, a significant decline in percentage of a clitellate adults and clitellate adults. During the summer, the percentage of juveniles decreased slightly in May and June but increased very significantly in July at the beginning of the rainy season. This species seems to reproduce throughout the year with the reproduction peak in the autumn and winter, decreasing through the spring and summer.

A definite trend in the seasonal activity of *D. japonica* could not be drawn due to its low population. This species was not encountered during the winter and early summer. Beginning in February, the number increased to a minor peak (11.2/m²) in March followed by a significant decline in April (Fig. 1). A second build-up in the population occurred in June which was also the maximum (25.6/m²) for the year. The population was at the lowest level from middle of the summer through the autumn.

The main reproductive period in *D. japonica* appears to be from late summer rainy season to the autumn (Fig. 2). During this period, the population was exclusively made up of clitellate adults. In late winter and early spring, only juveniles and a clitellate adults were found. There was a significant decrease in the percentage of juveniles and a

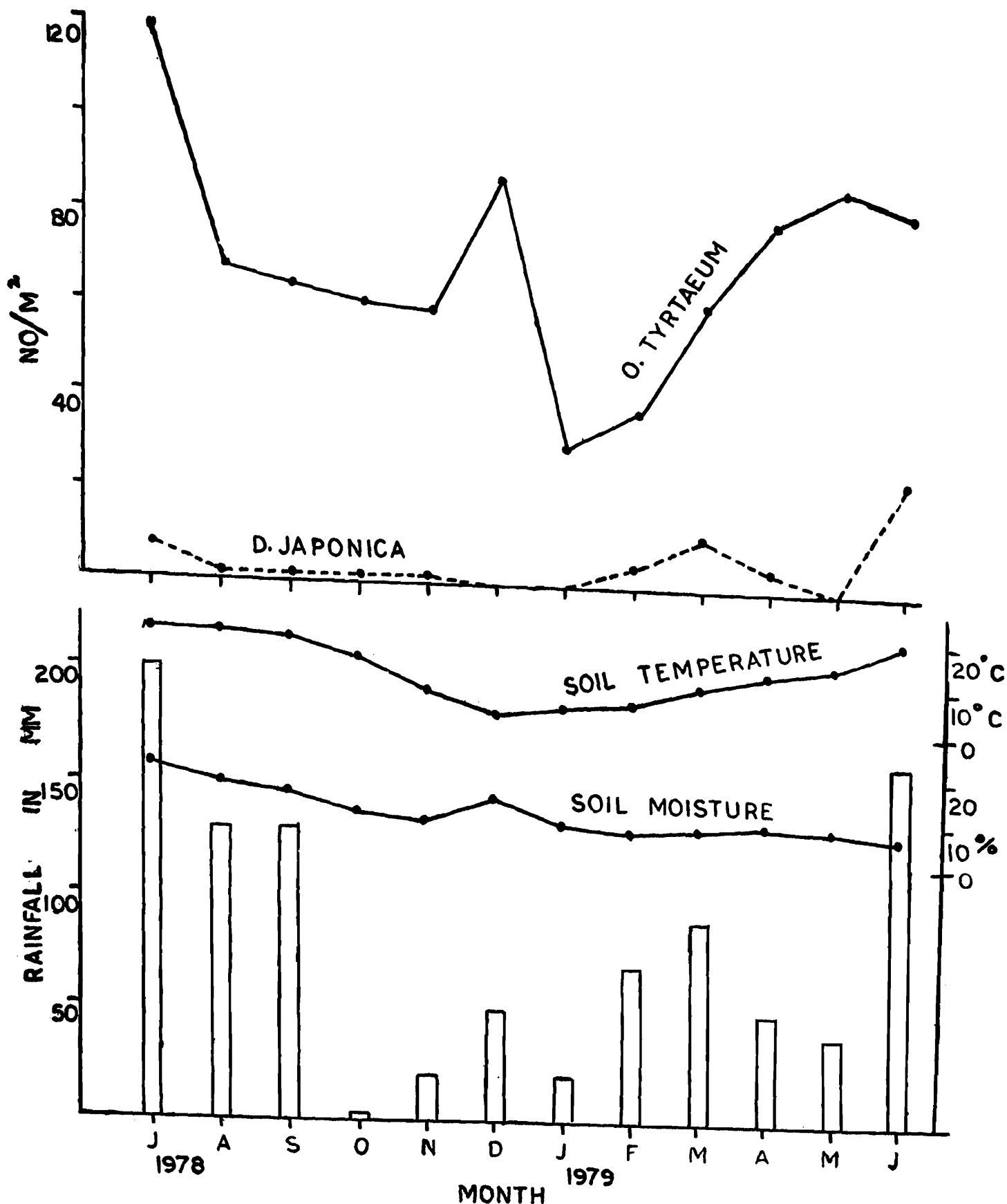


FIG. I

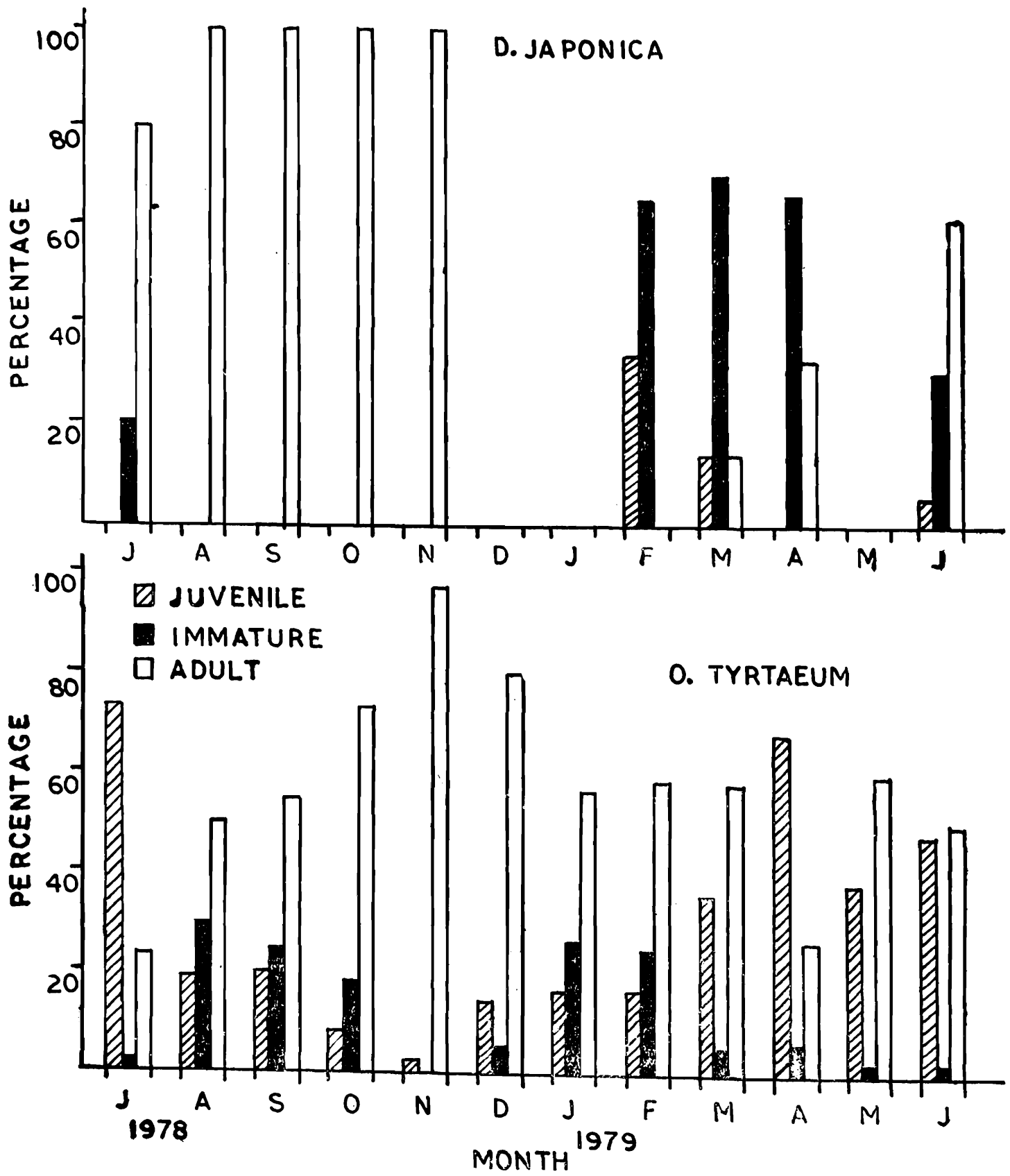


FIG.2

slight increase in the percentage of acitellate adults during the spring.

Bimastos parvus (Eisen) and *Plutellus* sp. were recorded only on one occasion and their seasonal activity cannot be ascertained.

DISCUSSION

Two most important factors that affect seasonal activity of earthworms are soil temperature and soil moisture (Evans and Guild, 1947 ; Reynolds and Jordan, 1975 ; Edwards and Lofty, 1977). The influence of these two parameters on the seasonal activity of *O. tyrtaeum*, the most predominant species, was analysed statistically. A significant positive correlation ($r=0.564$; $p<0.05$) between soil moisture and abundance of this species was obtained. According to Michon (1949) and Grant (1955), *O. lacteum* (a synonym of *O. tyrtaeum*) cannot survive very dry conditions. The earthworm density pattern in direct proportion to soil moisture was also recorded by Evans and Guild (1947), Satchell (1967) and Reynolds (1972).

Gates (1961), Dash and Patra (1977) and Dash and Senapati (1980) reported that earthworms were mainly active during the summer rains between May and October in the tropical climate of Burma and subtropical climate of India. The soil temperature and moisture largely controlled the seasonal trend in their population densities. These studies were mainly based on the non-lumbricid earthworms. On the contrary, *O. tyrtaeum* (a lumbricid) was observed to be active throughout the year with phases of high population density coinciding with the early

summer rains and early winter rains. The low soil temperature at the beginning of the winter rainy season was not found to be a limiting factor in the seasonal abundance of this species at Solan having a temperate-like climate. The effect of soil temperature was also non-significant statistically ($r=0.498$). Like other Indian lumbricids, excepting *B. parvus*, the original home of *O. tyrtaeum* is in temperate Europe and possesses an inherent ability to withstand the rigors of low soil temperature (Gates, 1958, 1972). The Indian lumbricids are presumed to have been transported from Europe by man unintentionally in soil around roots of exotic plants and could colonize successfully only in the hilly areas with a temperate-like climate (Gates, 1958).

The reproduction peak in *O. tyrtaeum* occurred in autumn and winter. However, Reynolds *et al.*, (1974) recorded the maximum reproductive activity for this species during the autumn, winter and spring periods in North America. The main reproductive period in *Drawida japonica* was from late summer rainy season to autumn which more or less agrees with the observations of Senapati *et al.*, (1979a) on *Drawida calebi* Gates.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for providing necessary facilities. They are also thankful to Dr. Asket Singh, Officer-in-Charge, High Altitude Zoology Field Station, Zoological Survey of India, Solan for encouragement.

REFERENCES

- BHATTI, H. K. 1962. Seasonal occurrence and local distribution of earthworms of Lahore City Corporation area. *Pakist. J. scient. Res.*, **14** : 34-44.
- CHAUHAN, T. P. S. 1980. Seasonal changes in the activities of some tropical earthworms. *Comp. Physiol. Ecol.*, **5** : 288-289.
- DASH, M. C. AND PATRA, U. C. 1977. Density, biomass and energy budget of a tropical earthworm population from a grassland site in Orissa, India. *Revue Ecol. & Biol. Sol.*, **14** : 461-471.
- DASH, M. C. AND SENAPATI, B. K. 1980. Cocoon morphology, hatching and emergence pattern in tropical earthworms. *Pedobiologia*, **20** : 316-324.
- EDWARDS, C. A. AND LOFTY, J. R. 1977. *Biology of earthworms*. Chapman and Hall, London (2nd edition) : 1-333.
- EVANS, A. C. AND GUILD, W. J. Mc. L. 1947. Studies on the relationship between earthworms and soil fertility. I. Biological studies in the field. *Ann. appl. Biol.*, **34** : 307-330.
- GATES, G. E. 1958. Contribution to a revision of the earthworm family Lumbricidae. II. Indian species. *Breviora*, No. 91 : 1-16.
- GATES, G. E. 1961. Ecology of some earthworms with special reference to seasonal activity. *Am. Midl. Nat.*, **66** : 61-86.
- GATES, G. E. 1972. Burmese earthworms. An introduction to the systematics and biology of megadrile oligochaetes with special reference to South East Asia. *Trans. Am. phil. Soc.*, **62** (7) : 1-326.
- GRANT, W. C. 1955. Studies on moisture relationships in earthworms. *Ecology*, **36** (3) : 400-407.
- KALE, R. D. AND KRISHNAMOORTHY, R. V. 1978. Distribution and abundance of earthworms in Bangalore. *Proc. Indian Acad. Sci.*, **87 B** (3) : 23-25.
- MICHON, J. 1949. Influence of desiccation on diapause in lumbricids. *C. r. hebd. Sea'nc. Acad. Sci., Paris*, **228** (18) : 1455-1456.
- RAW, F. 1959. Estimating earthworm population by using formalin. *Nature, Lond.*, **184** : 1661.
- REDDY, V. AND ALFRED, J. R. B. 1978. Some observations on the earthworm population and the biomass in a sub-tropical pine forest soil. In *Soil Biology and Ecology in India, UAS Tech. Ser., Bangalore*, No. 22 : 78-82.
- REYNOLDS, J. W. 1972. The activity and distribution of earthworms in Tulip Poplar stands in the Great Smoky Mountain National Park, Seiver County, Tennessee (Acanthodrilidae, Lumbricidae and Megascolecidae). *Bull. Tall Timb. Res. Sta.*, No. 11 : 41-54.
- REYNOLDS, J. W., CLEBESCH, E. E. C. AND REYNOLDS, W. M. 1974. Contributions to North American earthworms (Oligochaeta). No. 13. The earthworms of Tennessee (Oligochaeta). I. Lumbricidae. *Bull. Tall Timb. Res. Sta.*, No. 17 : 1-133.
- REYNOLDS, J. W. AND JORDAN, G. A. 1975. A preliminary conceptual model of megadrile activity and abundance in the Haliburton Highlands. *Megadriologica*, **2**(2) : 1-8.

- ROY, S. K. 1957. Studies on the activities of earthworms. *Proc. zool. Soc., Calcutta*, 10(2) : 81-98.
- SATCHELL, J. 1967. Lumbricidae. In : Burges and Raw (eds.) : *Soil Biology*, Academy Press, London and New York : 259-322.
- SENAPATI, B. K., MISHRA, B. K., MISHRA, V. AND MISHRA BIDYUT, K. 1979. Earthworm distribution in pasture soils. *Geobios*, 6 : 28-29.
- SENAPATI, B. K., DASH, H. K. AND DASH, M. C. 1979a. Seasonal dynamics and emergence pattern of a tropical earthworm, *Drawida calebi* (Oligochaeta). *Int. J. Invert. Rep.*, 1 : 271-277.

A NEW *TEPHRELLA* (DIPTERA : TEPHRITIDAE) FROM MEGHALAYA, INDIA.

C. RADHAKRISHNAN

Eastern Regional Station, Zoological Survey of India, Shillong, Meghalaya, India.

ABSTRACT

A new species under the Genus *Tephrella*, *T. variegata* of the Dipterous Family Tephritidae is described and illustrated from Meghalaya, INDIA.

The following apparently undescribed species of *Tephrella* was reared from large galls formed by the flies on the stem of the plant *Inula cappa* (Dc) of the family Asteraceae.

***Tephrella variegata* n. sp.**

(Figs. 1-13)

This species is more allied to *heringi* Hardy from Bismark Islands than to *dicipiens* Bezzi from India and *sexincisa* Malloch from Solomon Islands, under this Genus. Like *heringi* this species has also got 4 pairs of inferior fronto-orbital bristles whereas *dicipiens* and *sexincisa* have 3 and 2 pairs respectively. As in *heringi* this species also possess 3 hyaline indentations in cell R_1 and cell 2nd M_2 for 2 in *dicipiens* and *sexincisa*. It differs from *heringi* by one pair of dorso central bristles (2 pairs in *heringi*), all leg segments yellow (coxae and femora yellow brown, tibiae and tarsi yellow in *heringi*., coxae dark, mid and posterior femora black, front

femora yellow but black on upper surface in *dicipiens*), cubital cell lobate (straight in *heringi*), piercer gently tapering towards apex (spear headed like in *heringi*), and proboscis black (yellow in *heringi* and *dicipiens*).

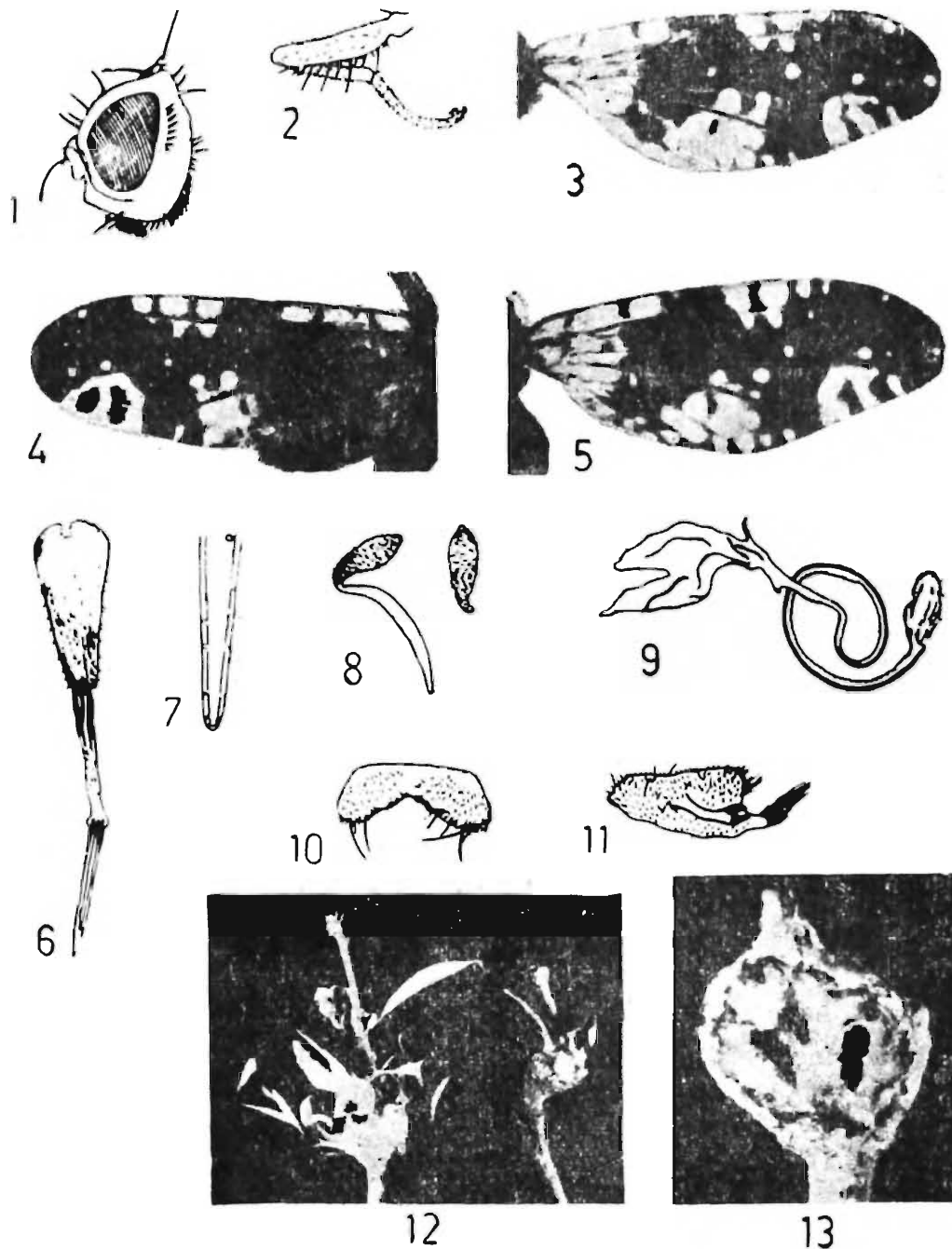
♀ Head (Fig. 1) : Approximately as long as high, the front gently sloping with antennae situated slightly above middle of head. Eyes dark, almost oval, occiput slightly swollen below. Face gently concave as seen in direct lateral view. Front rather broad, about as wide as long. Front with 4 pairs of inferior fronto orbital bristles. Ocellar bristles strong, about $1\frac{1}{2}$ times longer than lower superior fronto-orbitals. All the head bristles including genal except the post verticals and occipital row brownish. Post verticals, occipital row, all other head bristles and setae are yellow-white and scale like but sharply pointed at the apices. General colouration of head yellow with a tinge of brown on frons and rufous median portion of occiput. Antennae and palpi yellow, proboscis black. Third antennal segment short,

about 2 times longer than wide. Arista short pubescent at base, otherwise bare.

Thorax :—Largely black in ground colour tinged with yellow to rufous on parts of the pleura, covered with flat yellow-white scale-like setae. All bristles brownish. Two strong

scutellar bristles present, and one pair of dorsocentral bristles situated well behind the suture. Humeri brownish with many yellow-white setae. Scutellum yellow tinged with brown. Halteres yellow, squamulae yellow.

Legs : All segments yellow. Front femora



Figs. 1—13. 1.—Head. 2.—Fore leg. 3, 4 & 5—Wings. 6.—Ovipositor. 7.—Apex of Piercer. 8.—Spermathecae. 9.—Male Aedeagus. 10.—Male Fifth Sternum. 11.—Male Surstylus. 12.—Host plant with gall formed by the fly. 13.—Cross section of gall with pupae.

with a row of strong yellow-white bristles beneath (Fig. 2) middle tibiae with a single black spur.

Wings (Fig. 3) : Broadly hyaline at the base to the stigma and to the basal cross-vein, there is a black colouration on the costa at the upper end of the humeral cross-vein and a mark through middle of the sub-costal cell ; stigma is black with a small yellowish spot at the basal lower angle and a little before apex. The hyaline indentations are 3 in cell R_1 just after the stigma, triangular in shape, the first two almost of equal size projecting in to cell R_3 up to vein R_{4+5} , while the third comparatively smaller is confined to cell R_1 . There are two round hyaline spots in cell R_3 , one below the small hyaline wedge and one at the apex of the vein R_{2+3} . There are three hyaline indentations in cell 2nd M_2 . A large hyaline area of irregular margins in the cell M_4 with a small dark spot in the centre projects into cell 1st M_2 as two ovoid spots. 5 round hyaline spots are present in cell R_5 beyond r-m cross vein, and one before the r-m cross vein. A small ovoid hyaline spot is present in the cell M_4 just after the anal cell. r-m cross vein is situated near apical four-fifths of cell 1st M_2 . Apex of the cubital cell lobate.

It should be noted that some specimens show considerable variation in the markings on the wing (Figs. 4 & 5). In addition to the three hyaline indentations in the cell R_1 , sometimes a fourth comparatively smaller and confined to the cell R_1 , just after the third is present. The hyaline spots in cell R_3 also show some variation in some specimens. The 3 hyaline indentations in cell 2nd

M_2 are sometimes fused together at their apices towards the vein M_{1+2} . The hyaline markings in cells R_5 , 1st M_2 , 2nd M_2 and M_4 are quite variable and are not of a definite pattern.

Abdomen : Entirely polished dark brown. Sixth tergum shorter than fifth ; oviscapae shining black with short black hairs ; slightly longer than terga 4 to 5 ; on dorsal margin oviscapae measures about 1.5 m.m ; piercer slender gradually tapering towards the apex (Fig. 7) and about 1.9 m.m long. The extended ovipositor (Fig. 6) viewed from dorsal surface measures about 5.2 m.m ; spermathecae as in Fig 8.

Length : Body, excluding ovipositor, about 7.2 m.m ; wings about 6.4 m.m.
♂ :—Fitting the description of the ♀ except for genital characters ; 5th sternum and genitalia as in figures 9, 10 & 11.

Holotype ♀, India, Meghalaya, Shillong, Risa Colony, 2-vi-1980 ; *Allotype* ♂, same locality, 24-v-1980 ; 13 *paratypes*, 3 ♂♂, same locality, 21-v & 24-v-1980 ; 10 ♀♀, same locality, 21-v to 26-v-1980. All reared from the galls by the author.

Holotype for the present retained in the collections of the Eastern Regional Station of the Zoological Survey of India, Shillong, Meghalaya, and will be deposited in the National Collection of the Zoological Survey of India, Calcutta.

Host Plant : The flies form large galls on the stem of the plant *Inula cappa* (Dc) of the family Asteraceae. (Figs. 12 & 13).

ACKNOWLEDGEMENTS

The author expresses his gratitude to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for the facilities and encouragement, Dr. Kumar D. Ghorpade, Editor and Publisher of the journal *Colemania*, Bangalore for the co-operation and to Dr. D. Elmo Hardy, Sr. Professor of Entomology, University of Hawaii for having kindly previewed the manuscript.

REFERENCES

- BEZZI, M. 1913. Indian Trypaneids (Fruit-flies) in the collection of the Indian Museum. *Mem. Indian Mus.*, 3 : 53-175. Pls. VIII to X.
- HARDY, D. E. 1970. Tephritidae (Diptera) collected by the Noona Dan Expedition in the Philippine and Bismarck Islands. *Ent. Meddr.* 38 : 71-136.

BLOOD PARASITES OF SOME BIRDS FROM WEST BENGAL, INDIA

N. C. NANDI

Zoological Survey of India, Kakdwip, West Bengal.

A. K. MANDAL

Zoological Survey of India, Calcutta.

AND

A. CHOUDHURY

Dept. of Zoology, Calcutta University, Calcutta.

ABSTRACT

Prevalence of blood parasites in 128 birds (30.8%) of 23 species was observed out of a total of 418 birds belonging to 77 species and subspecies surveyed during the year 1974-1977 from Calcutta, Nadia, Sagar Island and Darjeeling of West Bengal. Infections with *Haemoproteus* (in 116 birds (27.7%) of 17 species), *Plasmodium* (in 15 birds (3.5%) of 8 species), *Trypanosoma* (in 6 birds (1.4%) of 4 species), *Lankesterella* (in 4 birds (0.9%) of 3 species) and microfilaria (in 23 birds (5.5%) of 11 species) were encountered. Double and multiple infections were quite common. Ten species of *Haemoproteus* viz., *H. bennetti*, *H. columbae*, *H. danilewskii*, *H. dicruri*, *H. fringillae*, *H. garnhami*, *H. oryzivora*, *H. pastoris*, *H. syrni* and *H. thereicerycis*; 3 species of *Plasmodium* viz., *P. relictum*, *P. circumflexum* and *P. nucleophilum*; 1 species and 1 subspecies of *Trypanosoma* viz. *T. avium* and *T. avium bakeri* have been recorded. Some protozoan parasites and larval nematodes are yet to be specifically determined. Occurrence of blood parasites was greatest at Nadia. The infections of *Haemoproteus* was predominant. *Ploceus philippinus* sampled exclusively at Nadia was accounted for 51.5% of infected birds. *Haemoproteus syrni*, *Plasmodium circumflexum* and *P. nucleophilum* are reported herein for the first time from India. New host-parasite records are indicated by asterisks(*).

INTRODUCTION

In the early part of this century, the blood parasites of Indian birds received considerable attention and many species of haematozoa were described (*vide* Bhatia, 1938). From such published accounts, little is known regarding the abundance and distribution of blood parasites in Indian avifauna. In recent

years extensive surveys on avian haematozoa have been carried out in the Zoological Survey of India from different parts of the country in an effort to gather informations on the level of blood parasitism in wild birds of this sub-continent. The present survey represents the analysis of blood parasites from four avian populations of West Bengal.

MATERIALS AND METHODS

A total of 418 wild birds belonging to 77 species and subspecies were examined for the blood parasites. The birds were either trapped or shot during the year 1974-1977. Some of the trapped birds were brought to the laboratory and kept alive for parasitological study. Blood was examined thrice in a week from these birds, at different intervals, before declaring them negative for blood parasites. Bone-marrow and various other organs of some birds were examined at autopsy.

Blood smears and organ-imprints were stained with Leishman, Wright or Giemsa's stain. The smears were first scanned under low power of a microscope (400x) for 5 min. and then searched under oil immersion (1000x) for 10 min. or until satisfaction.

Birds were obtained from four ecologically distinct locations as follows :

Calcutta—22°5' N ; 88°4' E. From urban and suburban environs ; collected usually by shooting in the vicinity of Budge Budge, Barasat and Barrackpore *ca.* 25 km around south and north of Calcutta. Mean annual rainfall of 200 cm and mean maximum daily humidity of 87%. Mosquitoes present in great numbers all year round.

Nadia—23°6' N ; 88°8' E. From rural environs around Balia and Chakdah *ca.* 80 km north of Calcutta ; collected usually by netting. Mean annual rainfall of 180 cm and mean maximum daily humidity of 86%. Mosquitoes always present in large numbers.

Sagar Island—21°6' N ; 88°3' E. From the coastal environs of deltaic Sunderbans around mangrove swamps ; collected by netting as well as shooting. Mean annual

rainfall of 250 cm and mean maximum daily humidity of 86%. Mosquitoes are fairly common.

Darjeeling—27°4' N ; 88°5' N. From the Himalayan range at Sandakphu *ca.* alt. of 3630 m, collected by shooting. Mean annual rainfall 34 cm and mean maximum daily humidity 90%. Biting flies are common in occurrence.

RESULTS AND DISCUSSION

Of the 418 birds of 77 species and subspecies (Table 1) examined, 128 birds (30.8%) comprising 23 species were found to harbour one or more parasites (Tables 1, 2). The most frequently encountered genus was *Haemoproteus*, occurring in 116 birds (27.7%) of 17 species i.e. in about 80% of the infected birds. *Plasmodium* infection was found in 15 birds (3.5%) of 8 species, *Trypanosoma* in 6 birds (1.4%) of 4 species, *Lankesterella* in 4 birds (0.9%) of 3 species and microfilariae in 23 birds (5.5%) of 11 species. Infection with *Leucocytozoon*, a cosmopolitan avian Haemosporidia, was not encountered. Double and multiple infections with parasites of one genus or of different genera were quite common.

Ten species of *Haemoproteus* viz., *H. bennetti*, *H. columbae*, *H. danilewskii*, *H. dicruri*, *H. fringillae*, *H. garnhami*, *H. oryzivorae*, *H. pastoris*, *H. syrinii*, and *H. thereicerycis* were recorded in the present venue of investigation along with two other species yet to be specifically determined. *H. columbae* was noted in 100 percent of pigeons examined from West Bengal. Singh *et al.* (1951) obtained a rate of 22% of 214 *Columba livia* from Delhi. *Haemoproteus bennetti* was recently described by Greiner, Mandal and Nandi (1977) from *Picus*

TABLE 1. Blood parasites in birds from Calcutta, Nadia, Sagar Island and Darjeeling of West Bengal. Data is expressed as total number examined/number infected.

ALCEDINIDAE. *Alcedo atthis* (Linnaeus) : Calcutta-3/0. *Halcyon smyrnensis* (Linnaeus) : Calcutta-4/0. *Pelargopsis capensis* (Linnaeus) : Calcutta-1/0. Total : 8/0.

ACCIPITRIDAE. *Accipiter nisus melaschistos* Hume : Darjeeling-1/0. Total : 1/0.

ARTAMIDAE. *Artamus fuscus* Vieillot : Calcutta-1/0. Total : 1/0.

ARDEIDAE. *Ardeola grayii* (Sykes) : Sagar Island-6/0. Total : 6/0.

APODIDAE. *Apus affinis* (J. E. Gray) : Calcutta-2/0. Total : 2/0.

ALAUDIDAE. *Ammomanes phoenicurus* (Pennant) : Sagar Island-1/0. *Mirafra assamica* Horsfield : Calcutta-1/0. *Mirafra erythroptera* Blyth : Calcutta-2/0. Total : 4/0.

CAPITONIDAE. *Megalaima asiatica asiatica* (Latham) : Darjeeling-1/1 ; *Haemoproteus thereicercyis**. *Megalaima haemacephala* (P.L.S. Muller) : Nadia-2/1 ; *Haemoproteus thereicercyis*, *Plasmodium* sp.*, microfilaria. *Megalaima zeylanica* (Gmelin) : Calcutta-2/0. Total : 5/2.

CAPRIMULGIDAE. *Caprimulgus macrurus albonotus* Tickell : Calcutta-1/0. Total : 1/0.

CHARADRIIDAE. *Capella gallinago* (Linnaeus) : Calcutta-5/0. *Capella stenura* (Bonaparte) : Calcutta-3/0. *Tringa hypoleucus* Linnaeus : Calcutta-1/0. *Vanellus indicus* (Boddaert) : Calcutta-6/0. Total : 15/0.

COLUMBIDAE. *Columba hodgsonii* Vigors : Darjeeling-1/0. *Columba livia intermedia* Strickland : Total : 12/12. Calcutta-8/8 ; eight with *Haemoproteus columbae*, one *Plasmodium relictum**. Nadia-4/4 ; four with *Haemoproteus columbae*. *Streptopelia chinensis* (Scopoli) : Sagar Island-9/0. Total : 22/12.

CORACIIDAE. *Coracias benghalensis* (Linnaeus) : Nadia-6/0. Total : 6/0.

CORVIDAE. *Corvus macrorhynchos* Wagler : Nadia-7/0. *Corvus splendens* Vieillot : Total : 8/1. Calcutta-6/1 ; *Plasmodium relictum**, *Haemoproteus danilewskii**. Sagar Island-2/0. *Dendrocitta vagabunda* (Latham) : Total : 17/3. Nadia-14/3 ; two with *Trypanosoma avium bakari**, three with *Haemoproteus danilewskii**, one with *Plasmodium circumflexum**, two with *Plasmodium* sp., one with microfilaria. Calcutta-3/0. Total : 32/4.

CUCULIDAE. *Cacomantis merulinus querulus* Heine : Calcutta-1/0. *Eudynamis scolopacea* (Linnaeus) : Nadia-2/0. Total : 3/0.

DICRURIDAE. *Dicrurus adsimilis* (Bechstein) : Total : 6/4. Nadia-5/4 ; four with *Haemoproteus dicruri*, one with *Trypanosoma avium** and two with microfilaria. Sagar Island : 1/0. *Dicrurus hottentottus* (Linnaeus) : Calcutta-1/0. Total : 7/4.

FRINGILLIDAE. *Carpodacus pulcherrimus* (Moore) : Darjeeling-1/0. *Leucosticte nemoricola nemoricola* (Hodgson) : Darjeeling-1/0. Total : 2/0.

LANIIDAE. *Lanius schach* Linnaeus : Nadia-5/1 ; microfilaria. Total : 5/1.

MOTACILLIDAE. *Anthus hodgsoni* Richmond : Calcutta-1/0 ; *Anthus novaeseelandiae* Gmelin : Calcutta-1/0. *Anthus novaeseelandiae richardi* Vieillot : Calcutta-6/0. Total : 8/0.

TABLE 1. (Concluded)

- MUSCICAPIDAE. *Acrocephalus agericola* (Jerdon) : Total : 5/0. Calcutta-2/0 ; Sagar Island-3/0 ; *Acrocephalus dumetorum* Blyth : Total : 9/3. Calcutta-5/2 ; two with *Trypanosoma avium** and *Haemoproteus* sp.* Sagar Island-4/1 ; one with *Haemoproteus* sp.* *Acrocephalus stentorius* Hemprich & Ehrenberg : Calcutta-8/0 ; *Chrysoma sinensis* (Gmelin) : Calcutta-1/0 ; *Copsychus saularis* (Linnaeus) : Total : 7/3. Calcutta-2/1 ; *Haemoproteus fringillae* and *Haemoproteus oryzivorae*. Nadia-4/2 ; two with *Haemoproteus fringillae* and *Haemoproteus oryzivorae*. Sagar Island-1/0. *Erithacus calliope* (Pallas) : Calcutta-8/0. *Erithacus svecicus* (Linnaeus) : Total : 14/0. Calcutta-9/0 ; Sagar Island-5/0. *Monarcha azurea* (Boddaert) : Sagar Island-5/0. *Monticola solitarius* (Linnaeus) : Nadia-1/0. *Muscicapa parva* Bechstein : Total : 14/1. Calcutta-10/1. *Haemoproteus* sp.* Sagar Island-4/0. *Orthotomus sutorius* (Pennant) : Calcutta-1/0. *Phoenicurus ochruros rufiventris* (Vieillot) : Calcutta-1/0. *Phylloscopus collybita tristis* Blyth : Sagar Island-6/0. *Phylloscopus fuscatus fuscatus* (Blyth) : Sagar Island-8/1 ; microfilaria.* *Saxicola torquata* (Linnaeus) : Calcutta-1/0. *Saxicoloides fulicata* (Linnaeus) : Nadia-1/1 ; microfilaria. *Turdoides striatus* (Dumont) : Sagar Island-4/1 ; *Haemoproteus oryzivorae** Total : 94/10.
- NECTARINIIDAE. *Nectarina asiatica* (Latham) : Nadia-1/0. Total : 1/0.
- ORIOLOIDAE. *Oriolus xanthornus* (Linnaeus) : Sagar Island-2/0. Total : 2/0.
- PHASIANIDAE. *Arborophila atrogularis* (Blyth) : Darjeeling-1/0. Total : 1/0.
- PICIDAE. *Dinopium benghalense* (Linnaeus) : Nadia-1/0. *Picoides mahrattensis* (Latham) : Nadia-1/0. *Picus flavinucha* Gould : Darjeeling-1/1 ; *Haemoproteus bennetti*. Total : 3/1.
- PLOCEIDAE. *Lonchura malabarica* (Linnaeus) : Total : 20/3. Calcutta-5/1 ; *Haemoproteus garnhami* and *Trypanosoma avium*. Nadia-15/2 ; two with *Haemoproteus garnhami*. *Lonchura punctulata* (Linnaeus) : Calcutta-4/3 ; three with *Haemoproteus garnhami** *Passer domesticus* (Linnaeus) : Nadia-18/3 ; two with *Lankesterella* sp., two with microfilaria. *Ploceus benghalensis* (Linnaeus) : Nadia-2/0. *Ploceus megarhynchus* Hume : Nadia-3/0. *Ploceus philippinus* (Linnaeus) : Nadia-75/66 with *Haemoproteus oryzivorae** five with *Plasmodium relictum*, two with *Plasmodium* sp. one with *Lankesterella* sp.* nine with microfilaria. Total : 122/75.
- PSITTACIDAE. *Psittacula krameri* (Scopoli) : Sagar Island-5/0. Total : 5/0.
- PYCNONOTIDAE. *Pycnonotus cafer* (Linnaeus) : Nadia-4/1 ; microfilaria Total : 4/1.
- RALLIDAE. *Amaurornis phoenicurus* (Pennant) : Sagar Island-6/0. *Gallinula chloropus* (Linnaeus) : Calcutta-1/0. Total : 7/0.
- ROSTRATULIDAE. *Rostratula benghalensis* (Linnaeus) : Calcutta-1/0. Total : 1/0.
- STRIGIDAE. *Asio flammeus* (Pontoppidan) : Darjeeling-1/0. *Athene brama* (Temminck) : Sagar Island-2/0. *Otus scops* (Linnaeus) : Nadia-1/1 ; *Haemoproteus syrnii** and *Plasmodium* sp.* *Strix aluco nivicola* (Blyth) : Darjeeling-1/0. Total : 5/1.
- STURNIDAE. *Acridotheres tristis tristis* (Linnaeus) : Nadia-7/1 ; microfilaria. *Sturnus contra* Linnaeus : Nadia-22/12 ; Eight with *Haemoproteus pastoris** two with *Plasmodium* sp.* three with microfilaria.* *Sturnus malabaricus* (Gmelin) : Total : 8/4. Nadia-5/3 ; three with *Haemoproteus pastoris*, one with *Plasmodium nucleophilum** one *Lankesterella* sp.* Sagar Island-3/1 ; *Haemoproteus pastoris*. Total : 37/17.
- TRUNICIDAE. *Turnix suscitator* (Gmelin) : Nadia-8/0. Total : 8/0.

* New host-parasite records,

TABLE 2. Prevalence of haematozoa from four different localities of West Bengal.

	Total examined	Total infected	Number of bird infected with				
			Haemo.	Plasm.	Tryp.	Micro	Lank.
Calcutta	118	17	17	2	3	—	—
percent :		14.4	14.4	1.7	2.5	—	—
Nadia	214	105	94	13	3	22	4
percent :		49.0	43.9	6.0	1.4	10.2	1.8
Sagar Island	77	4	3	—	—	1	—
percent :		5.1	3.8	—	—	1.3	—
Darjeeling	9	2	2	—	—	—	—
percent :		22.2	22.2	—	—	—	—
Total	418	128	116	15	6	23	4
percent :		30.8	27.7	3.5	1.4	5.5	0.9

Haemo.=*Haemoproteus* ; Plasm.=*Plasmodium* ; Tryp.=*Trypanosoma* ; Micro.=microfilaria ; Lank.=*Lankesterella*.

flavinucha from Darjeeling. *Haemoproteus syrnii* in *Otus scops* is reported herein for the first time from India. Other haemoproteid species viz., *H. danilewskii*, *H. dicruri*, *H. fringillae*, *H. garnhami*, *H. oryzivorae*, *H. pastoris* and *H. thereicerycis* were previously recorded from this subcontinent by a number of investigators (de Mello, 1937a ; Bhatia, 1938 ; Grewal, 1964 ; Nandi, 1976 ; Nandi and Mandal, 1977a).

Three species of *Plasmodium* viz. *P. relictum*, *P. circumflexum* and *P. nucleophilum* and a few undetermined species were encountered in this survey. Previously *P. relictum* was reported on several occasions from Indian birds by Chakravarty and Kar (1945), Singh *et al.* (1952) and Nandi and Mandal (1977a). However, it appears from Garnham (1966) that *P. circumflexum* and *P. nucleophilum* in *Dendrocitta vagabunda* and *Sturnus malabaricus* respectively, are reported herein for the first time from India and constitute new host-parasite records.

Trypanosoma avium and *T. avium bakeri* were known from India (Grewal, 1963 ; Chatterjee and Ray, 1971). But *T. avium* in *Dicrurus adsimilis* and *Acrocephalus dumetorum*, and *T. avium bakeri* in *Dendrocitta vagabunda* seem to be new records.

Lankesterella infection was noted in *Passer domesticus*, *Ploceus philippinus* and *Sturnus malabaricus*. These parasites are yet to be diagnosed as to species. However, these organisms are reported for the first time from the latter two hosts.

Infections with microfilariae, the larval nematodes, were observed in 11 avian species. De Mello (1937b) and Choudhury *et al.* 1972, however, reported earlier the occurrence of microfilariae from *Acridotheres tristis*, *Dendrocitta vagabunda*, *Dicrurus adsimilis*, *Lanius schach*, *Pycnonotus cafer* and *Saxicoloides fulicata*. Microfilariae from five other avian hosts are reported in the present communication for the first time from India.

A wide variety of haematozoa was found

in birds from West Bengal, whereas parasites belonging to the genera *Haemoproteus* and *Plasmodium* were only recorded from Godavari River Basin (Nandi, 1976) and Orissa (Nandi and Mandal, 1977a). But, the birds from Kashmir (Nandi and Mandal, 1978) showed rich and varied haematozoa including a number of species of *Leucocytozoon* which was not recorded in wild birds from West Bengal. However, infection with *Leucocytozoon sabrazei* was noted in a domestic fowl from Darjeeling (Nandi and Mandal, 1977b). Absence of *Leucocytozoon* infection may be due to small size of the sample from Darjeeling and for possible absence of simuliid vectors from the vast plains of West Bengal as they require running water (hill streams) for the development of immature stages.

In Calcutta, a total of 118 birds of 35 species were examined; 17 birds (14.41) harboured blood parasite, primarily species of *Haemoproteus*. In Nadia, a total of 214 birds of 24 species were examined; 105 birds (49%) were infected of which a weaver bird, *Ploceus philippinus* shared more than 60% of all the infected birds sampled from Nadia. In Sagar Island, 77 birds of 19, species were examined; only 4 birds were infected, three with *Haemoproteus* and one with microfilaria. In Darjeeling, a small sample of 9 birds of 9 species was examined; only two birds showed infections with *Haemoproteus*.

The prevalence of blood parasites in birds of West Bengal other than Nadia was found not to vary significantly from region to region and in regard to parasite genera involved. The occurrence of more varied types of haematozoa and their higher prevalence (49%) at Nadia can be attributed partly to examination of blood smears as

well as organ-imprints from a number birds and partly due to one species of bird, *Ploceus philippinus*, taken exclusively at Nadia, accounted for 51.5% (66 of 75 birds, Table 1) of all the infected birds recorded in this paper. The same is true with the overall higher prevalence of *Haemoproteus* centred around Nadia in West Bengal. This particular bird, *Ploceus philippinus*, was infected with a number of parasite too (Table 1) which suggests that this avian species proves to be susceptible for blood parasites. If the Nadia data is subtracted from the overall results, the remaining infections may not be very dissimilar to that recorded for the Godavari River Basin (Nandi, 1976) and Orissa (Nandi and Mandal, 1977a), considering the variations in the general ecology and topography of the areas sampled.

ACKNOWLEDGEMENTS

The authors (N. C. N. and A. K. M.) are thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, for facilities provided. They are also thankful to Dr. Gordon F. Bennett and Dr. Ellis C. Greiner of International Reference Centre for Avian Haematozoa (IRCAH), Memorial University of Newfoundland, Canada, for their help in determining some of the parasite species. Thanks are also due to fellow colleagues in the Bird Section for their various help in relation to hosts. The cooperation of Susama Devi Choudhurani Marine Biological Research Institute at Sagar Island is thankfully acknowledged.

REFERENCES

- BHATIA, B. L. 1938. *Fauna of British India. Protozoa: Sporozoa.* pp. xx + 497. Taylor and Francis, London.

- CHAKRAVARTY, M. M. and KAR, A. B. 1945. Studies on Haemosporidia from Indian birds series II. *Proc. Indian Acad. Sci.*, 22 B(2) : 63-69.
- CHATTERJEE, D. K. and RAY, H. N. 1971. Some observations on the morphology and developmental stages of *Trypanosoma avium bakeri* sp. nov. from the red-whiskered bulbul (*Otocompsa jocosa*). *Parasitology*, 62 : 331-333.
- CHOUDHURY, A., MISR, K. K. and MAJUMDAR, G. 1972. Microfilariae from the black headed shrike. *Trans. R. Soc. trop. Med. Hyg.*, 66 : 671-672.
- GARNHAM, P. C. C. 1966. *Malaria Parasites and other Haemosporidia*. pp xviii + 1114. Blackwell, Oxford.
- GREINER, E. C., MANDAL, A. K. and NANDI, N. C. 1977. *Haemoproteus bennetti* sp. n. and a review of the haemoproteids from the Picidae (Woodpeckers). *J. Parasit.*, 63 : 651-656.
- GREWAL, M. S. 1963. Studies on the blood parasites of the white-throated munia, *Uroloncha malabarica* Linnaeus, (A) *Trypanosoma avium* Danilewsky, 1885(B) *Trypanosoma delhiense* sp. nov. *Indian J. Malar.*, 17 : 55-64.
- GREWAL, M. S. 1964. Studies on the blood parasites of white-throated munia, *Lonchura malabarica* Linnaeus. Status of *Haemoproteus wenyoni* Sergent and Sergent, 1948. (Protozoa : Sporozoa). *Proc. zool. Soc. Calcutta*, 17 : 21-25.
- DE MELLO, I. F. 1937a. On haemoprotozoa of Indian birds. *C. R. 12th. Congr. Int. Zool.* (Lisbon), 2 : 1391-1445.
- DE MELLO, I. F. 1937b. On blood microfilaria of Indian birds, *C. R. 12th. Congr. Int. Zool.* (Lisbon), 3 : 1533-1550.
- NANDI, N. C. 1976. Avian haematozoa from upper stretches of Godavari River Basin, Nasik and Ahmednagar districts, Maharashtra. *Indian J. Anim. Hlth.* 15 : 137-138.
- NANDI, N. C. and MANDAL, A. K. 1977a. Studies on some avian haematozoa from Orissa, India. *Indian J. Anim. Sci.*, 47 : 558-561.
- NANDI, N. C. and MANDAL, A. K. 1977b. The occurrence of *Leucocytozoon sabrazei* Mathis and Legar, 1910 (Leucocytozoidae : Sporozoa) in a domestic fowl from Darjeeling, West Bengal. *Proc. zool. Soc. Calcutta*, 30 : 67-71.
- NANDI, N. C. and MANDAL, A. K. 1978. Studies on some avian haematozoa from Jammu and Kashmir. *Bull. zool. Surv. India*, 1 (2) : 103-106.
- SINGH, J., KRISHANAN, K. S. and DAVID, A. 1952. Natural infection of *P. relictum* in weaver bird, the baya (*Ploceus philippinus*) *Indian J. Malar.*, 6 : 471-473.
- SINGH, J., NAIR C. P. and DAVID, A. 1951. Five year's observation on the incidence of blood Protozoa in house Sparrow (*Passer domesticus* Linnaeus) and in pigeons (*Columba livia* Gmelin) in Delhi. *Indian J. Malar.*, 5 : 229-233.

STUDIES ON INDIAN CALANOIDS III. ON A NEW SPECIES OF
TROPODIAPTOMUS KIEFER (CALANOIDA : DIAPTOMIDAE) FROM
NILGIRI DISTRICT OF SOUTHERN INDIA

TUSHARENDU ROY

Zoological Survey of India, Calcutta

ABSTRACT

Genus *Tropodiaptomus* includes forty five species, of which eight species were reported from India. The ninth species, *T. chauhani* sp. nov. revealed from examination of the collections from various fresh water bodies in the Nilgiri District in southern India, is described and figured and its close similarities with the species *T. orientalis* and *T. processifer*, discussed.

INTRODUCTION

Genus *Tropodiaptomus* was established in 1932 by Kiefer to accommodate the species of *orientalis* (= *D. orientalis* Brady-Sars, 1886/1889) from Ceylon. Literature on various species of the genus is much scattered. Brehm (1953) has pointed out that there are at least thirty species belonging to this genus. Humes (1960) reported forty or more species which have been ascribed to the genus. After going through scattered literature of recent and past, reveals that this genus is now represented by at least forty five species of which eight species are known from India. These are : *T. doriai* (Richard, 1894) ; *T. hebereri* Kiefer, 1930 ; *T. mutatus* Kiefer, 1930 ; *T. vicinus* Kiefer, 1930 ; *T. euchaetus* Kiefer, 1936 ; *T. informis* Kiefer, 1936 ;

T. nielsenii Brehm, 1953 and *T. lakhimpurensis* Reddiah, 1964.

Study of plankton collections from fresh water bodies in the Nilgiri District of southern India, continues to reveal species of Copepods which is new to science. The present report includes the third new species in the series and ninth of the genus *Tropodiaptomus* collected by the author.

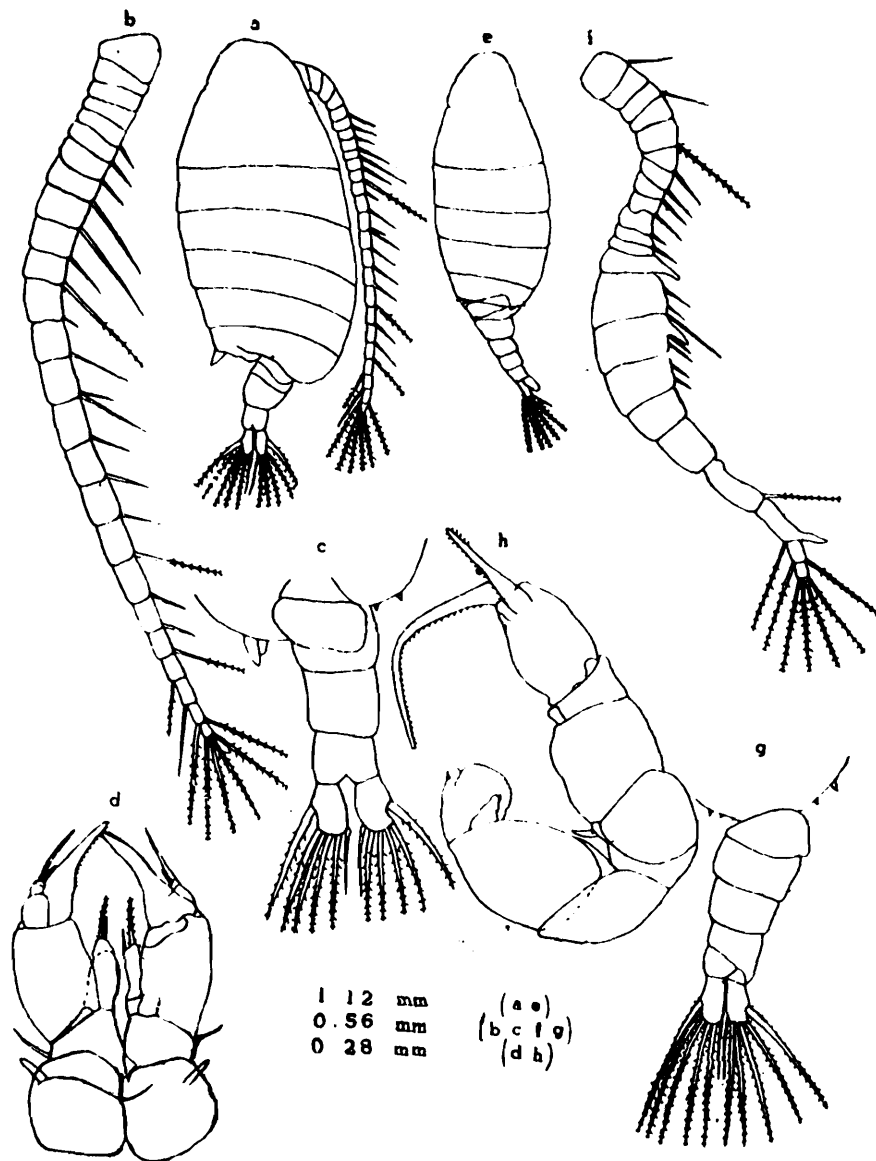
MATERIAL AND METHODS

Specimens used in this study consisted of plankton samples collected with relatively fine mesh net (0.5 mm to 1.0 mm mesh size) from a pool containing a few emergent and floating vegetation in the Mudumalai Wild life sanctuary in the Tamilnadu State during Nilgiri District Faunistic Survey by the

Zoological Survey of India in January-February, 1971. All the type and non type specimens preserved in 85% Ethyl alcohol (C_2H_5OH) including 2/3 drops of Glycerine. Line drawings were made from Glycerine-

mounted specimens with the aid of an ocular micro-meter. The magnification of each line drawing is indicated in the figure by a letter under the appropriate scale.

The specific name of the new species,



Tropodiptomus chauhani sp. nov.

Fig. 1. a—d, adult female ; e—h, adult male

- | | | |
|---------|--------------|------------------------------------|
| Fig. a | adult female | dorsal view |
| Fig. b. | „ „ | first antennule |
| Fig. c. | „ „ | urosome with last thoracic segment |
| Fig. d. | „ „ | fifth pair of legs |
| Fig. e. | adult male | dorsal view |
| Fig. f. | „ „ | right antennule |
| Fig. g. | „ „ | urosome with last thoracic segment |
| Fig. h. | „ „ | fifth pair of legs |

chauhani is after in honour of Dr. B. S. Chauhan, a renowned Zoologist and former Deputy Director, Zoological Survey of India, Calcutta.

Tropodiaptomus chauhani sp. nov.
(Figures : 1 a-d, adult female ;
e-h, adult male)

Material—Holotype : Adult male, Pool at Mudumalai Wild-life sanctuary, Nilgiri District, Tamilnadu State, INDIA, 13.2.1971 (*T Roy* Coll.) Regd. No. C 2589/2. **Allotype** : Adult female, with the same data as the holotype, Regd. No. C 2590/2. **Paratypes** : Two males and three females with the same data as the holotype, Regd. Nos. C 2591-92/2. All the specimens including non types have been deposited in the National Collections of the Zoological Survey of India, Calcutta.

Description of the adult male :

The body of the adult male (Fig. e) excluding the caudal setae is 1.30 mm. The urosomal segment (Fig. g) is about 1/3rd of the prosome. The wings of the last metasomal segment are symmetrical and bear two small spines postero-laterally. Spines of the left lobe are closer than the right lobe. The urosome (Fig. g) is five segmented. The proportional length of the segments are as follows (A) :

(A) Segments	-1	-2	-3	-4	-5	caudal rami	=100
	19	21	17	10	12	21	

(B) Segments	1	:	2	:	3	:	4	:	5	:	6	:	7	:	8
	53	:	38	:	31	:	38	:	46	:	38	:	31	:	23
	9	:	10	:	11	:	12	:	13	:	14	:	15	:	16
	27	:	34	:	16	:	19	:	31	:	69	:	60	:	62
	17	:	18	:	19	:	20	:	21	:	22	:	22	:	1000
	57	:	84	:	104	:	78	:	38	:	23	:	23	:	

The caudal rami (Fig. g) are longer than the fifth urosomal segment and symmetrical. Each ramus bears six setae of which the innermost naked seta is the smallest. Further, it is thinner with sclerotised knee a short distance from the base. The other five caudal setae are equal in length with feather-like arrangement of the thickened setules.

The first antennule : The first antennule (Fig. f) consists of 22 segments. The spines and setae are arranged as shown in the figure. The proportional length of the segments are shown in 'B' marked segments.

Segments 13 and 15 bear strong and highly chitinised spine. Segment 19 is the longest and the terminal segment is the smallest of all. The terminal process of the antepenultimate segment reaches beyond the distal end of the 21st segment and is a little recurved distally. The setae of the ultimate and penultimate segments are feathered with fine setules.

Fifth leg : The fifth leg (Fig. h) is asymmetrical. The tip of the left leg reaches almost beyond the end of the first exopod segment. The size and shape of the segments of the fifth leg are as shown in the figure.

The right fifth leg : The right fifth leg (Fig. h) consists of two basipods, three exopods and one endopod segment. The first

basipod segment is nearly circular and bears a strong spine on its inner margin. The second basipod segment is larger than the first. The first exopod segment is the smallest and has a short thick process at its outer distal corner. The second exopod segment originates from the terminal region of the first exopod segment and is cylindrical. It tapers distally and has a fairly long spine ornamented with fine hairs completely in the inner margin and a little on the outer margin. It originates very close to the base of the third exopod segment (claw). The third exopod segment forms a claw which bends inside. The endopod is very short and it does not reach beyond the distal end of the first exopod segment. It arises from the dorso-lateral region of the inner margin of the second basipod segment.

The left fifth leg : The left fifth leg (Fig. h) consists of two basipods, one exopod and one endopod segment. The first basipod segment is smaller than its counter part of the right leg. The second basipod segment is almost equal in size. The first exopod

with rounded lobe on the posterior aspect. The endopod is single-segmented with a bluntly rounded extremity. A row of fine setae are present on its anterior face.

Description of the adult female : The body (Fig. a) is robust, moderately long and wide. The total length of the body excluding the caudal setae is 1.58 mm. The last metasomal segment has two asymmetrical lateral wings. The postero-lateral wing of the left lobe bears two strong hyaline spines and the right lobe with two small spines. All the spines of both lobes of the metasomal segment are pointing downwards. The prosome is nearly three times longer than the urosome.

The urosome (Fig. c) is three segmented. The third segment is the smallest of all. Caudal rami (Fig. c) are symmetrical. Each ramus possesses six setae of which the innermost is naked and smaller than the rest. The other four setae are almost equal in size except the outermost which is a little thicker. All setae possess thickened setules and are plumose. The proportional length of the urosomal segments are as follows :

Segments	-1	-2	-3	urosome	
	32	24	22	22	=100

segment is a semicircular lobe which bends a little inside. The free edge of the inner margin of the lobe is shaped like a saw with striations and the outer distal extremely small

The first antennule : The first antennule (Fig. b) consists of 25 segments. The size of the segments and the arrangement of the setae are as shown in the figure.

Segments	1	:	2	:	3	:	4	:	5	:	6				
	56	:	19	:	25	:	25	:	28	:	25				
	7	:	8	:	9	:	10	:	11	:	12				
	31	:	31	:	44	:	44	:	38	:	50				
	13	:	14	:	15	:	16	:	17	:	18	:	19	:	20
	50	:	56	:	59	:	56	:	56	:	56	:	50	:	44
	21	:	22	:	23	:	24	:	25						
	38	:	31	:	38	:	31	:	19	=1000					

Fifth leg : The fifth leg (Fig. d) is well developed and symmetrical. The size and shape of the fifth leg are as shown in the figure.

The right fifth leg : The right fifth leg (Fig. d) consists of one basipod, three exopods and one endopod segment. The basipod segment is almost circular. It bears a strong spine on its dorso-lateral region. First exopod segment is smaller than the basipod segment. A thin spine originates on its outer margin. The second exopod segment is cylindrical and a little wider than its counter part of the left leg. The third exopod segment originates from the terminal portion of the second exopod segment and forms a claw. It is knobbed at its base and bears two unequal spines on its outer edge. About 2/3rd of the inner margin of the claw is finely serrated. The endopod is one-segmented and cylindrical and about 2/3rd in length of the second exopod segment. The endopod arises from the distal lateral corner of the first exopod segment and is tipped with two unequal setae. The larger seta is serrated and the smaller one is naked.

The left fifth leg : The left fifth leg (Fig. d) is almost identical in shape and structure of the right fifth leg except for the difference in size of the second exopod segment.

REMARKS

As the genus *Tropodiptomus* is representing a large number of species and the meagreness of the descriptions of the several species which have been assigned to this genus from various parts of the world at different times, it is extremely difficult to make in details comparative study of all the known species. However, the present specimens of *T.*

chauhani show very close resemblance to *T. orientalis* described by Brady-Sars 1886/1889 and *T. processifer* described by Kiefer (1927) even in the minute details of the appendages. It could be distinguished from *T. orientalis*, in the presence of setae on the lateral spine of the second exopod segment of the right male fifth leg and on the inner and outer edges of the claw of the third exopod segment of the right male fifth leg and from *T. processifer*, in the larger setal arrangement on the terminal portion of the endopods of the female fifth leg and more circular in shape of the first exopod segment of the left female fifth leg. In the male, it differs in the small claw and larger spine with fine hairs on the second exopod segment of the right fifth leg.

New species, *T. chauhani* is quite distinct enough from all other species in the shape and structure of the second exopod segment of the left male fifth leg and in the structure of the claw of the female fifth leg.

ACKNOWLEDGEMENT

Author is sincerely thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta, for providing all facilities to carry-out the work. Thanks are also due to Dr. K. Reddiah, Deputy Director, Zoological Survey of India for his comments on an earlier version of the validity of the new species and providing literature.

REFERENCES

- BREHM, V., 1930. Über Südasiatische Diaptomiden. *Arch. Hydrobiol.*, 22 : 140-161.

- BREHM, V., 1953. Indische Diaptomiden, Pseudodiaptomiden und Cladoceren. *Öster. Zool. Zs.*, **4** : 241-345.
- GAUTHIER, H., 1951. Contribution à L' 'étude de la faune des eaux douces au Sénégal (Entomostracés) : 1-169 (Alger).
- GREEN, J., 1962. Zooplankton of the river Sokoto. The Crustacea. *Proc. zool. Soc. Lond.*, **138** (3) : 415-543.
- HUMES, A. G., 1960. On two species of *Tropodiaptomus* from Upper Volta and the Ivory Coast. *Bull. Inst. fr. Afr. noire*, (A) **22** (1) : 152-163, pl. 1-6.
- KIEFER, F., 1927. Beiträge zur Copepodenkunde (IV), *Zool. Anz.*, **69** : 21-26.
- KIEFER, F. 1928. Beiträge zur Copepodenkunde (VIII). *Zool. Anz.*, **76** : 5-18.
- KIEFER, F., 1930. Zur Kenntnis der freilebenden Copepoden Madagaskars. *Zool. Anz.*, **87** : 42-45.
- KIEFER, F., 1930. Beiträge zur Copepodenkunde (XIV), *Zool. Anz.*, **87** : 118-124.
- KIEFER, F., 1933. Voyage de Ch. Alluaud et P. A. Chappuis en Afrique Occidentale française. V. Freilebende Binnengewässer copepoden. Diaptomiden und Cyclopiden. *Arch. Hydrobiol.*, **26** : 121-142.
- KIEFER, F., 1938. Contribution à l'étude du Plancton d'eau douce d'Angola II. Freilebende Ruderfusskrebse (Crustacea Copepoda) aus Angola. *Arch. Hydrobiol.*, **32** : 470-485.
- KIEFER, F., 1939. Scientific results of the Yale North India expedition. Biol. Rep. 19. Freilebende Ruderfuss-krebse (Crustacea Copepoda) aus Nord-west und Süd-Indien. *Mem. Indian Mus.*, **13** (2) : 83-203.
- REDDIAH, K. 1964. The Copepod fauna of Assam (India). 2. Description of *Tropodiaptomus lakhimpurensis* n. sp. *Crustaceana*, **7** : 254-258.
- SHEN, C. J. AND TAI, A. Y. 1962. The Copepoda of the Wu-Li Lake, Wu-Sih, Kiangsu Province I. Calanoida. *Acta zool. sin.*, **14** (1) : 99-118.

THE POPULATION AND PRODUCTION ECOLOGY OF A FRESHWATER
SNAIL *BELLAMYA BENGALENSIS* (LAMARCK) (GASTROPODA : VIVI-
PARIDAE) IN AN ARTIFICIAL LAKE OF CALCUTTA, INDIA.

RASHID A. KHAN AND SUPRIYA CHAUDHURI

Zoological Survey of India, Calcutta.

ABSTRACT

Studies on various aspects of the life cycle, population dynamics, biomass, secondary productivity and turnover ratio of the freshwater viviparid gastropod, *Bellamya bengalensis* (Lamarck), were carried out in a large artificial lake of Calcutta, India. There was marked sexual dimorphism in growth pattern. Two generations in a year were observed with maximum life span of 18 months for females and 15 months for males. The growth rate was rapid at early ages but slowed down as the age increased. Males grew at slower rates and attained a smaller size than females. Two periods of active reproduction were observed, one in April and a second one in October. Fully developed young snails were released directly by females. The sex ratio showed a preponderance of females (average ♂ : ♀, 1 : 2.115). Fecundity was amazingly low, but at the same time mortality was also low (10%). The total population density and total standing crop biomass (all generations combined) were high throughout the year, with peaks in April and October resulting from active reproduction. Minimum values were observed in monsoon months (45/m² in 1978 and 95/m² in 1979), which were due to flooding of the lake and consequent removal of littoral vegetation. Maximum values were observed in April of both years (345/m² in 1978 and 295/m² in 1979). *Bellamya bengalensis* constituted about 40% of the total gastropod population. Middle-aged individuals dominated the composition of the population almost throughout the year.

The total production of a single generation based on standing crop biomass and mortality data was determined. The mean daily productivity and turn-over (Biomass : Production) ratios of this generation were found to be 4.56 mg C/m²-day and 2.821 respectively.

INTRODUCTION

Freshwater gastropods, which constitute the bulk of the littoral fauna of ponds, reservoirs and rivers in India, play an important role in the dynamics of aquatic ecosystems. Although sufficient work has been done abroad on population dynamics, growth, reproduction, life cycle and bioenergetics of a number of

gastropod species (Dewitt, 1955 ; Duncan, 1959 ; McCraw, 1961 ; Russel-Hunter, 1961a, b ; Eisenberg, 1970 ; Gillespie, 1969 ; Clappitt, 1970 ; Eckblad, 1973 ; Hunter, 1975 ; McMahan, 1975 ; and Browne, 1978), there is a general lack of information on any of these aspects of Indian gastropods, which differ markedly from temperate species. Except for a general account of the biono-

mics of *Bellamya bengalensis* by Annandale and Sewell (1921), a preliminary report on seasonal variations in density of same species in a pond of West Bengal by Michael (1968) and a recent report on the productivity and energetics of *Pila globosa* by Haniffa (1978), no other account is available on the population dynamics and ecology of any Indian gastropod species.

In this study, the life cycle, growth, reproduction, population density, standing crop biomass, production and turnover ratio of a common prosobranch viviparus snail, *Bellamya bengalensis* (Lamarck), were examined in a large artificial lake (Dhakuria lake) of Calcutta, India.

Bellamya bengalensis is a very common snail of ponds and reservoirs of this region and generally occurs in the littoral zone on a muddy bottom under dense littoral vegetation not far from the shore. In contrast to hermaphroditic pulmonates, many prosobranch, including *B. bengalensis*, are dioecious, resulting in separate patterns of growth and life cycles for the male and female parts of the population.

MATERIALS AND METHODS

The studies were carried out for 2 years between the period January 1978 to December 1979 in Dhakuria Lake. The snails were collected from the littoral zone of 3 different centres of the lake at fortnightly intervals. As no significant differences were noticed in the distribution of snails at different centres, the data of the 3 centres were pooled so as to obtain only one set of data for a sampling date. An area of 2.5 m² was demarcated by a frame of 0.5 × 0.5 m and all the vegetation and the upper most layer of the sub-

strate (2 cm) were removed and flooded with water in a tray. All snails were separated and sorted out according to species. Since individuals of *Bellamya bengalensis*, even the smallest ones, were of fairly large size, separation was done by the naked eye alone. All live and dead snails were counted separately and the total density was expressed as No./m². The individuals were divided into 4 age groups, Juvenile-I (less than 9 mm), Juvenile-II (9-16 mm), Adult-I (16-22 mm); and Adult-II (above 22 mm) and density of each group was calculated so as to get an idea of the composition of various age groups. Beside this, density according to sex was also calculated.

The investigation of growth and the life cycle followed the general method of Russel-Hunter (1961a). Shell length (maximum distance from the apex to the outer edge of the aperture) of both live and dead shells were measured to the nearest 0.5 mm with a dial caliper and grouped into size classes of 2 mm intervals. The results of these shell measurements for each sample was plotted as a size frequency distribution graph, expressed in terms of percentage of each size group in the sample. Dead shell density and size distribution were determined for mortality assessment.

By following the growth of group size classes which corresponded to cohorts of animals from the same breeding period, each sample was divided into distinct generations, and the mean shell length and standard deviation were calculated for each generation. Sample means were smoothed by averaging three consecutive means arithmetically weighted for the number of individuals in the sample. From the differences between succe-

ssive smoothed means in shell length, growth rates were calculated. Size at first maturity and brood size were studied regularly by dissecting the animals. Embryo number was determined by direct uterine count of about 15-20 females in each month covering the entire range of mature sizes.

The dry weight (with shell) was determined by drying about 100 snails of different sizes at 85° C for 4 days and weighing separately on a chemical balance. The relationship between mean shell length and dry weight (with shell) was determined by regression analysis and a regression equation (significant at 1%) was worked out. Once the relationship was established, the dry weight of all snails was determined by the regression equation.

The rate of population change or instantaneous rate of population growth 'r' was calculated from :—

$$r = \frac{1n N_t - 1n N_0}{t}$$

where N_t and N_0 are the numbers in the population at the time of sampling and t days earlier respectively.

The specific growth rate in length and weight were calculated for the two sexes separately from :—

$$g = \frac{1n L_t - 1n L_0}{t} \text{ and } g = \frac{1n W_t - 1n W_0}{t}$$

where L_t and W_t are mean length and weight at the time of sampling and L_0 and W_0 , mean length and weight t days earlier respectively.

Mean biomass in a sample was determined by multiplying the number of individuals in each size class with the mean dry weight of the size class and summing them. Biomasses for different generations were also determined separately. Production was estimated by

standing crop biomass data of live and dead snails following Russell-Hunter (1970).

DESCRIPTION OF THE STUDY AREA

Dhakuria lake of Calcutta is a large artificial reservoir with an area of 72 acres and is elongated in shape. The maximum length is about 1770 metres while the width at the broadest point is 282 metres. The lake is fed by rain water and is used for recreational purposes. The entire littoral zone is heavily vegetated by *Chara fragilis*, *Ceratophyllum demersum* and *Hydrilla verticillata*. The algae *Chara fragilis*, was the most dominant plant species occurring throughout the period of study and contributed about 80% of the total vegetation of the littoral zone.

TAXONOMIC POSITION

Class	: GASTROPODA
Sub-class	: PROSOBRANCHIA
Order	: MESOGASTROPODA
Family	: VIVIPARIDAE
Sub-family	: BELLAMYINAE
Genus	: BELLAMYA
Sp.	: B. Bengalensis (Lamarck)

Although Annandale and Sewell (1921) recognised 11 forms of this species, (as *Viviparus bengalensis*), only form *typica* *Bellamyia bengalensis* form *typica* (Lamarck) occurs in this region.

Salient features :

The shell is oval as a whole and acuminate. The upper part of the shell is slightly conoidal rather than conical. The spire and body whorl (seen dorsally) are of equal height. The body whorl is evenly convex in profile. The aperture is sub-circular

and has a narrow black margin. It is nearly as high as the spire and slightly oblique. The umbilicus is narrow. The colouration varies considerably, but it is never very brilliant. The ground colour is greenish and opaque. The dark bands are variable and irregular. The operculum is moderately thin and of a deep brownish colour. The external surface is concave, the outer margin strongly curved,

the inner margin slightly sinuate and the posterior extremity bluntly pointed. The animal gives birth to fully developed youngs.

RESULTS

Annual Life Cycle :

The life cycle of *Bellamya bengalensis* was traced for 2 consecutive years (1978 and 1979). The annual pattern is evident from

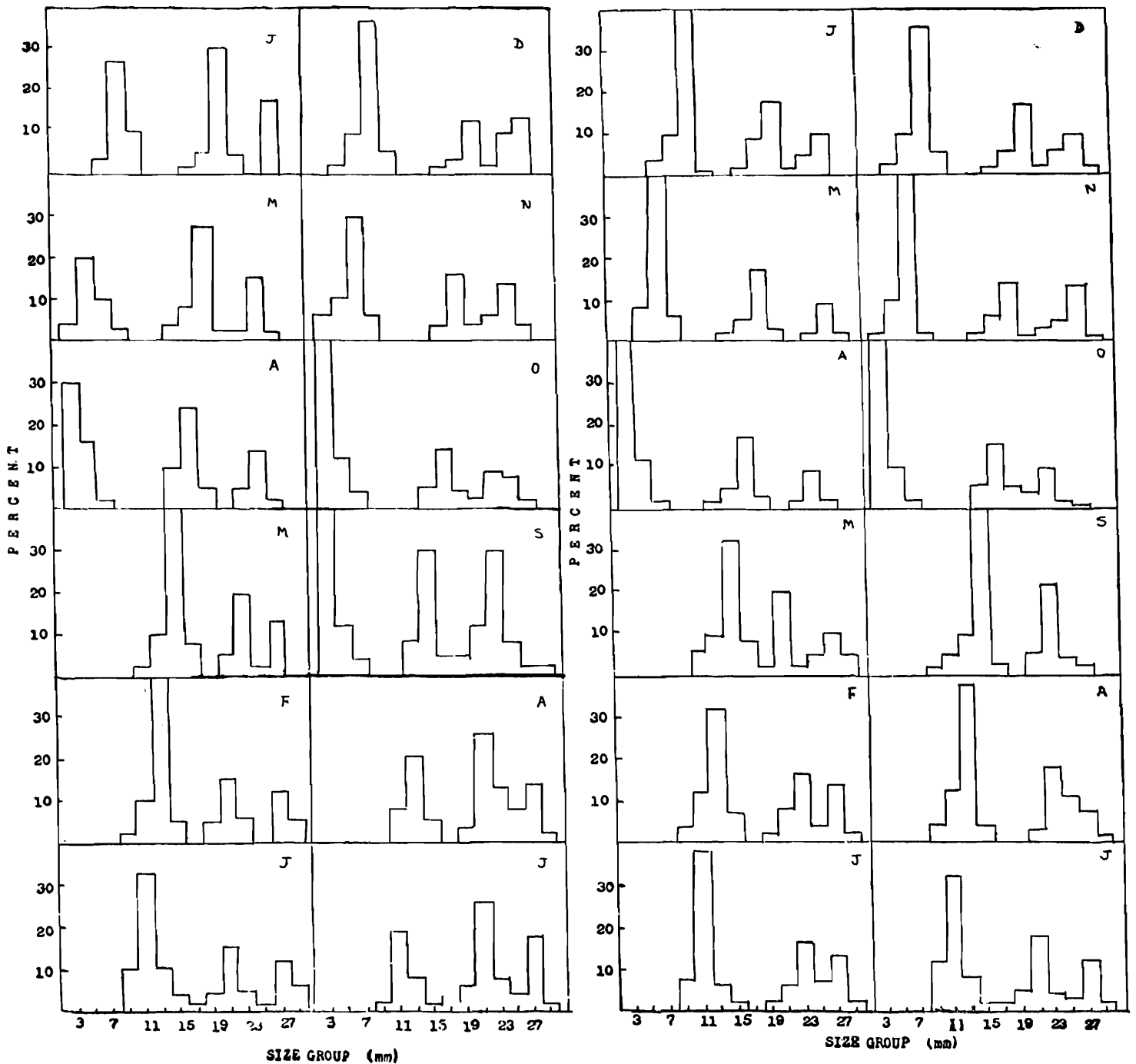


Fig. 1. Size frequency distribution of *B. bengalensis* during 1978 and 1979.

the shell length frequency distribution diagram (Fig. 1). In January 1978, when studies commenced, the population consisted of the adults (A1 and A2) and late Juveniles (J2). Three distinct size groups with modes at 11 mm, 21 mm and 27 mm were visible. In February, the three groups grew, but in March only 2 modes were observed, the third mode, which represented the largest size individual of the population, was absent. In

April, a batch of young snails entered in the population and formed a mode at 3 mm, besides the two already existing modes. From May to August, there was not much change except that the individuals of the 3 groups gained in size and their modes shifted forward gradually. In September, the individuals of the largest size groups were again absent followed once more by the entrance of new individuals in the population in October.

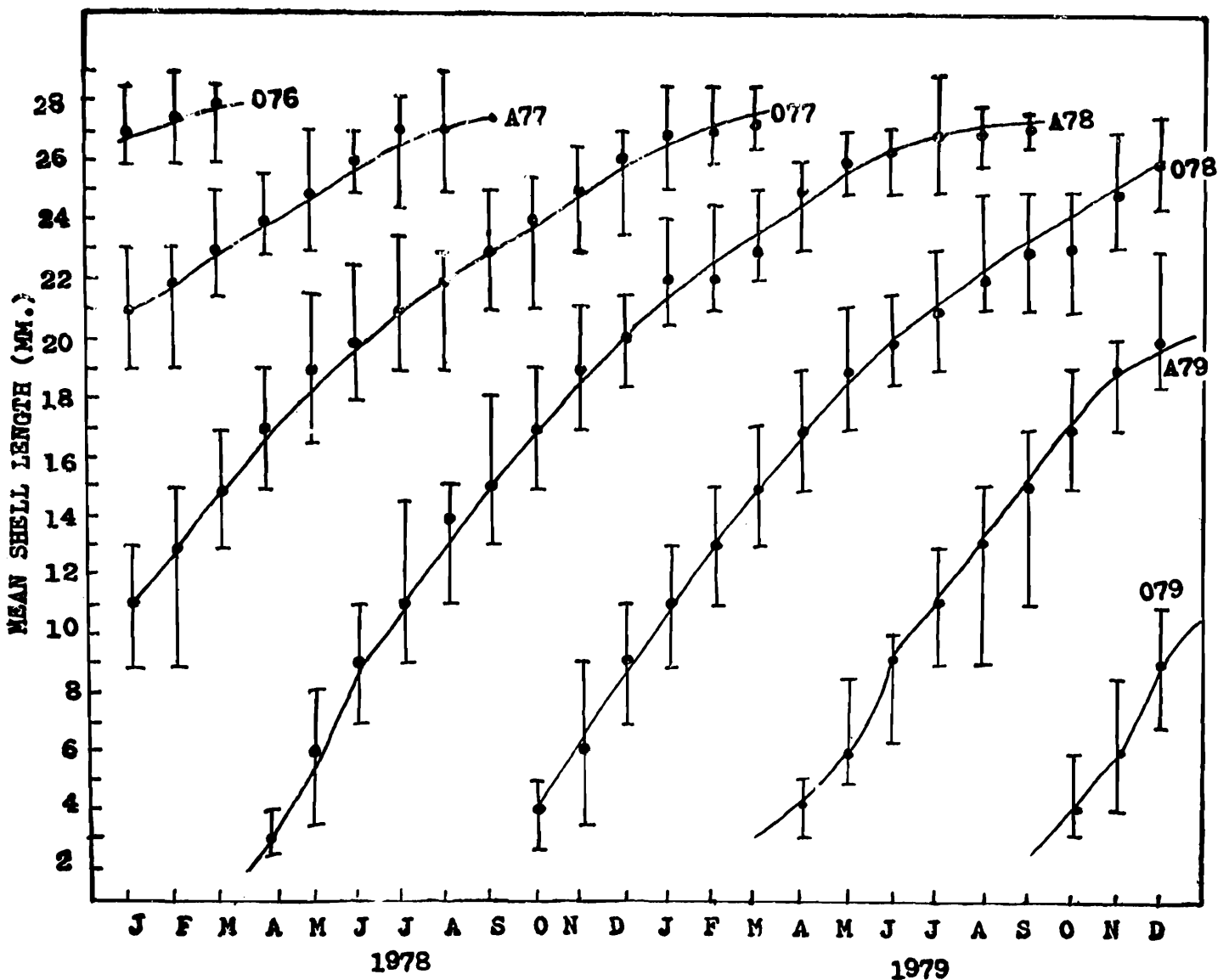


Fig. 2. Mean shell length and standard deviation in relations to months for generation sample of *B. bengalensis*. Different generations have been designated according to their tentative birth time. 076=October 1976, A 77=April 1977, and so on. Solid circles represent means and vertical bars standard deviations.

Significant changes were again noticed in March 1979, when heavy mortality of the oldest group occurred, resulting in their elimination from the population, followed by active reproduction in April. The three batches of adults which died out during the 15 months (January 1978 to March 1979) were born before the commencement of the study. Mortality of individuals which were born in April 1978, was observed in

late August and early September 1979 (Fig. 2) after attaining the mean size of 27.5 mm, as revealed by their absence in September 1979 samples. Like previous years, active reproduction took place again in October.

By following the growth of group size classes, which corresponded to cohorts of animals from the same breeding period, samples were divided into distinct generations.

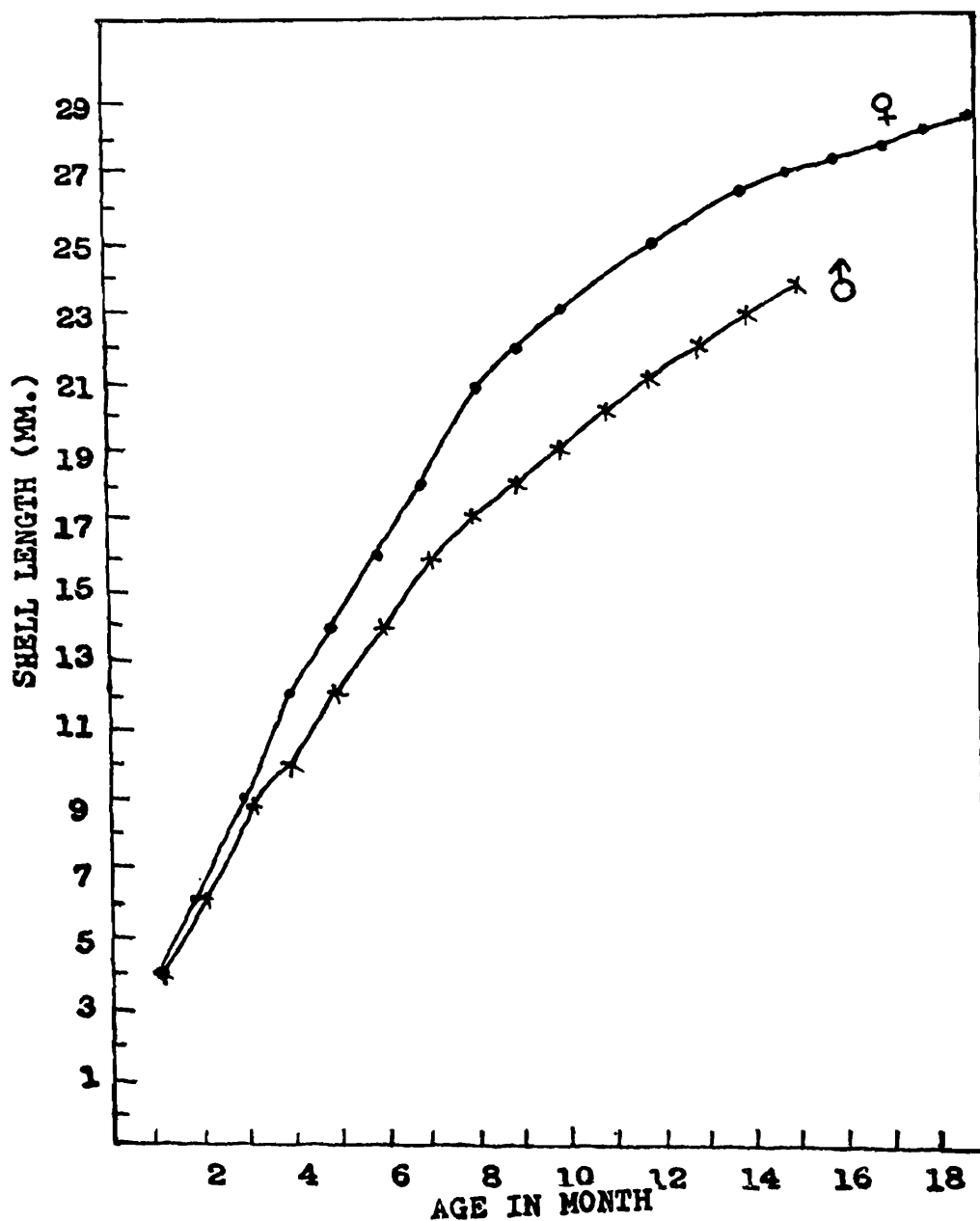


Fig. 3. Mean shell length at various age groups.

A non-overlapping clear pattern is visible in Fig. 2. In a single year, e.g. 1978, two distinct reproductive periods occurred, the first in April and the second in October. The individuals produced in April 1978 also reproduced in October 1978. This shows that 2 generations of *Bellamyia bengalensis* developed in a year. An almost similar pattern was noticed in 1979. The individuals of the generation which was produced in April 1978 died out by August 1979 (Fig. 2), having a total life span of 18 months. Based on the various groups present in the population at the time of commencement of the study and onwards, each generations has been designated according to its birth period.

Age and growth rate :

The shell lengths of individuals at the time of birth were about 3 mm. In early stages, the growth rate was rapid (Fig. 3) and at the end of 6 months period average size was 15 mm. In the next 6 months, their growth was moderate and at the end of 12 months the average size was 23 mm. However, the growth rate slowed down after 12 months, although it continued until death, as evident from their specific growth rate (Table 1). The maximum shell length recorded during the present investigation was 28.1 mm.

There was a marked sexual disparity in the length of life and growth rate of *Bellamyia bengalensis*. The maximum life span (Fig. 3

TABLE 1. Specific growth rate in length and dry weight of *Bellamyia bengalensis*

Age in months	Length				Weight Combined	
	Female		Male		mean dry weight (mg)	growth rate
	mean size (mm)	growth rate	mean size (mm)	growth rate		
1	4	0.01350	4	0.01350	5	0.19500
2	6	0.01350	6	0.01350	9	0.02650
3	9	0.00950	9	0.00350	21	0.02147
4	12	0.00513	10	0.00870	40	0.01959
5	14	0.00445	13	0.00240	72	0.01560
6	16	0.00396	14	0.00470	115	0.01200
7	18	0.00513	16	0.00200	165	0.00880
8	21	0.00155	17	0.00190	215	0.00366
9	22	0.00148	18	0.00180	240	0.00740
10	23	0.00142	19	0.00173	300	0.00417
11	24	0.00136	20	0.00160	340	0.00540
12	25	0.00131	21	0.00155	400	0.00390
13	26	0.00123	22	0.00148	440	0.00560
14	27	0.00024	23	0.00000	520	0.00580
15	27.2	0.00000	23.2	0.00000	620	0.00000
16	27.2	0.00036	—	—	620	0.00322
17	27.5	0.00060	—	—	705	0.00032
	28.0	—	—	—	740	—

and Table 1) of males was 15 months and that of females was 18 months, which resulted in the largest and oldest individuals always being females. Females also attained larger sizes not only because of their longer life spans, but also by faster growth rate as revealed by their specific growth rates (Table 1). Females were found to be 12.5% larger in weight than males at the age of 6 months, and the difference increased to 14.7% by the time the snails reached 15 months of age (the

maximum life span of males). However, there was not much difference between the growth rate of the two sexes at early stages. The pattern of growth in weight (dry weight) was almost similar to the growth in length, the growth rate decreased gradually as the age increased (Table 1).

Length weight relationship

The relationship between mean shell length and mean dry weight was statistically

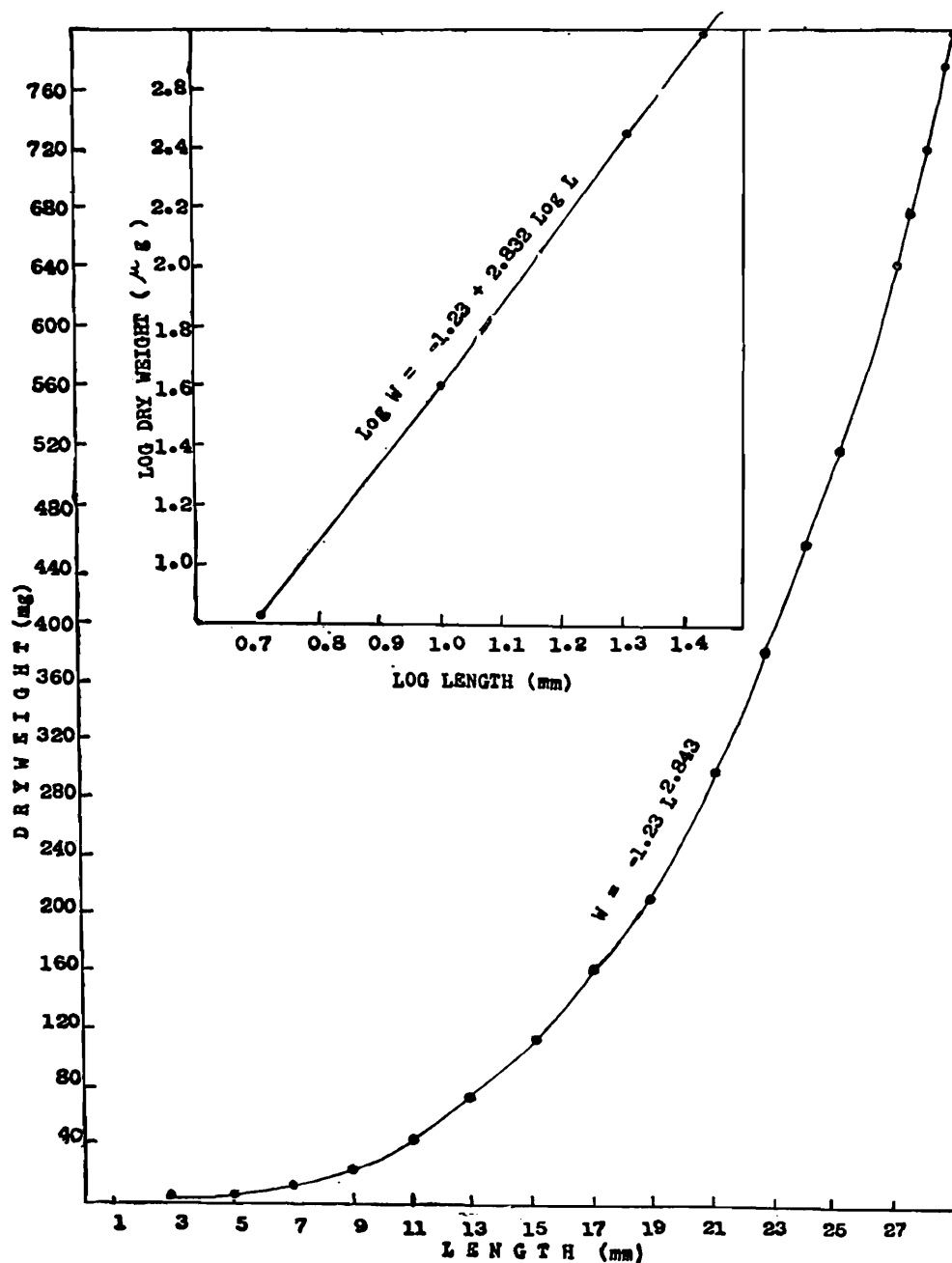


Fig. 4. Length-weight (dry weight with shell) relationship of *B. bengalensis*,

established. Weight was found to be exponentially related to length (Fig. 4), and when the values were converted to logarithms, a straight line relationship (Fig. 4) was observed with regression coefficient 'b' 2.843. The value of 'b' was very close to the values worked out for the majority of animals and followed the Cube Law. The regression coefficient was highly significant (probability less than 1%) and the length weight regression equation was :—

$$\text{Log } W = -1.23 + 2.843 \text{ Log } L$$

$$\text{or } W = -1.23 L^{2.843}$$

where W and L are dry weight in mg and shell length in mm respectively.

Reproduction

Size at first maturity :

Being viviparus, females discharged fully developed young. Like other parameters, the size and age at first maturity of the two sexes differed. Males matured earlier than

females. The smallest size and youngest age at which males were found to carry mature spermatozoa was 13.5 mm (shell length) and 5 months respectively, while the values for females were 16 mm and 6 months respectively. Males of the A 78 generation (born in April 1978) were found to mature by early August 1978, while females were recorded carrying fully developed embryos in September. Half (50%) of the males matured at the size of 14.5 mm and half of the females at the size of 17.5 mm.

Sex ratio :

The sex ratio differed considerably from 1 : 1 throughout the year, with a preponderance of females (Fig. 6). The percentage of males varied between 18-46% with a mean of 29.8% in 1978 and between 25-48 with a mean of 36.4% in 1979, the highest percentage being in the months when active reproduction took place and the lowest at old age. As

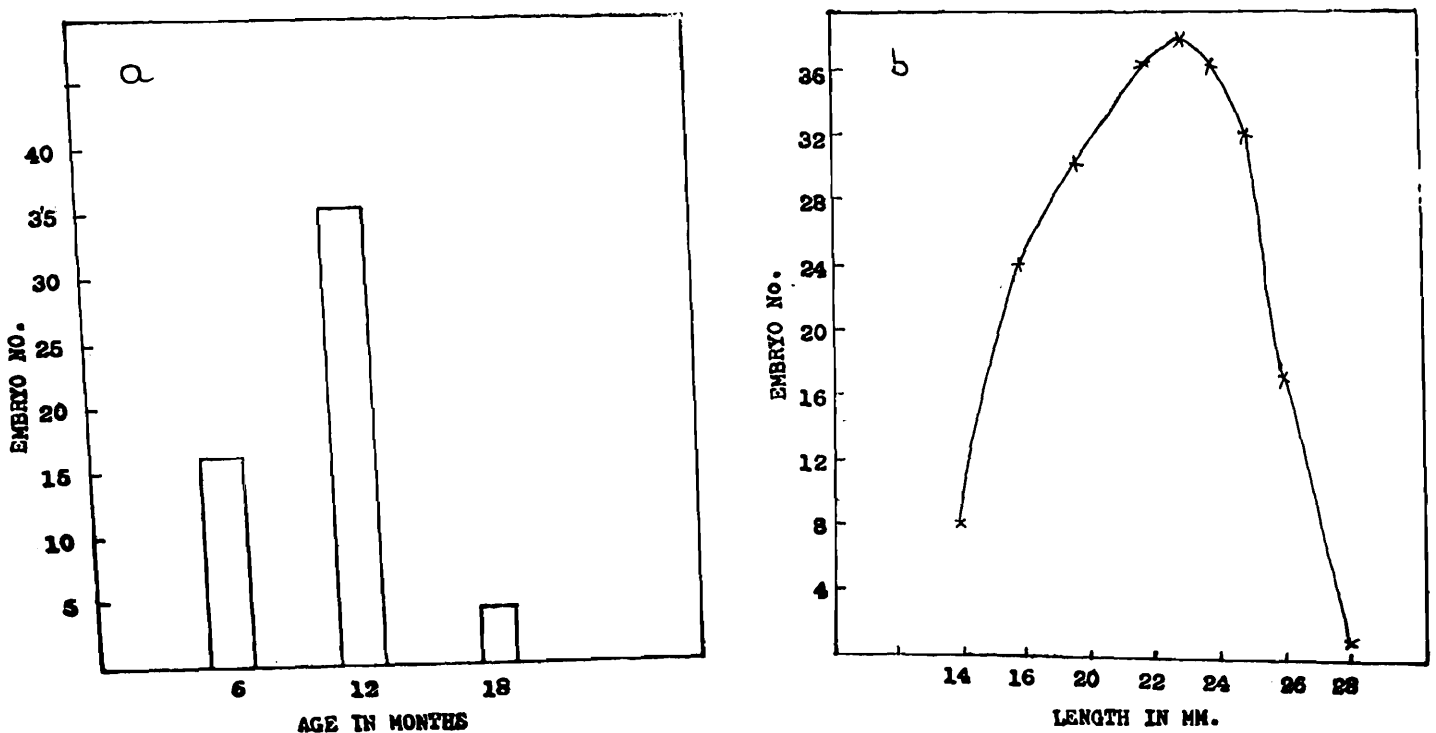


Fig. 5. Relationship between fecundity and (a) age and (b) size of *B. bengalensis*.

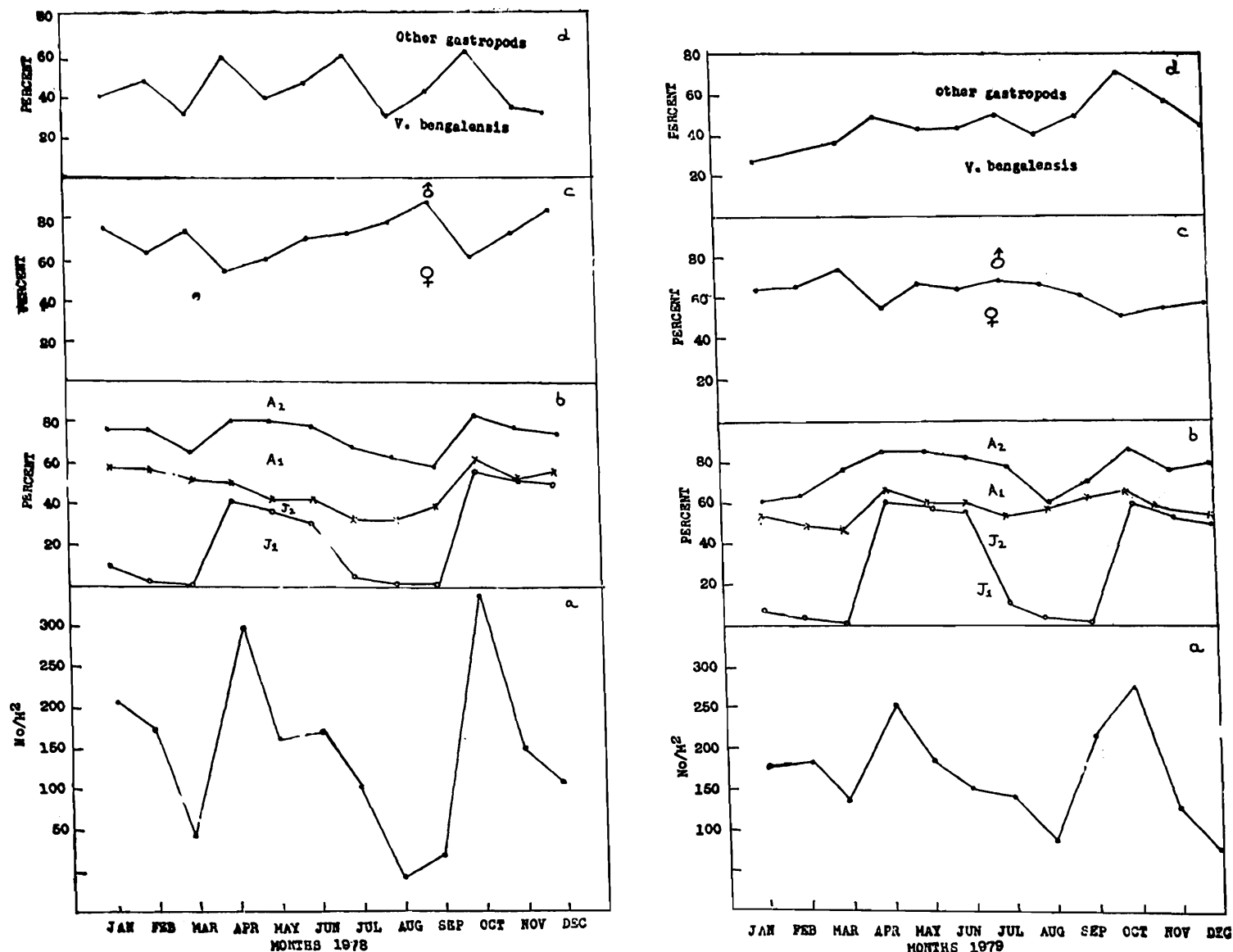


Fig. 6. Seasonal variations in population density of *B. bengalensis*. (a) total density, (b) percentage of various age groups (J_1 early juveniles, J_2 late juveniles, A_1 early adults and A_2 late adults), (c) percentage composition of males and females, (d) percentage composition of *B. bengalensis* to total gastropods.

already mentioned, the males did not attain a very old age, and largest individuals in the population were always females. The average sex ratios ($\delta : \text{♀}$) observed were 1 : 2.438 in 1978 and 1 : 1.747 in 1979. The heterogeneity was highly significant (probability less than 1%) as revealed by Chi Square test in both years.

Breeding season :

Two reproductive periods, as already

mentioned, were found during both years, the first in April and the second in October. Each individual was found to take part in active reproduction generally 2 times in its life span, first at the age of 6 months and secondly at 12 month. Individuals born in April 1978 took part in reproduction in October 1978 and April 1979. No traces of embryonic development in the uterus of females were found after 14 months of their

life, revealing that for the rest of their lives they remain barren.

Embryo production :

Embryo number determined by direct uterine count after dissecting about 15-20 females each month. The maximum number of young snails produced by an individual female was 38, but within the population it varied between 8-38 with a mean of 27.5. The highest fecundity occurred in 12-month-old individuals and the lowest in the oldest age class animals (Fig. 5a). Fecundity gradually increased with increasing shell length (Fig. 5b) up to 24 mm, and thereafter it decreased suddenly with almost no embryos in the largest sized animals (above 26 mm).

Population Density and Cycle :

Bellamya bengalensis was the most abundant gastropod of Dhakuria Lake throughout the period of study (Fig. 6) and it alone contributed to 40.33% and 45.37% of the total gastropods in the lake during 1978 and

1979 respectively. Its density varied between 45 and 390/m² with a mean of 195.4/m² in 1978 and between 95 and 275/m² with a mean of 160.3/m² in 1979. Two distinct peaks of population density were recorded in both years, the first in April and the second in October. These peaks were due to the entrance of large number of new individuals into the population following active reproduction. As already mentioned, females always dominate in number over males. The pattern of population fluctuation was nearly similar in both years, except that in the second year the density as a whole was lower when compared to the first year.

The late juveniles (J2) and early adults (A1). i.e., middle age groups, formed the most stable proportion of the population in almost every month, without much fluctuation. They contributed nearly 50% of the total population. The late adults (A2) never formed a sizeable proportion, while early juveniles (J1) were highly periodic in their abundance (Fig. 6).

TABLE 2. Population density and rate of population change (r) of *Bellamya bengalensis*

Months	1978		1979	
	Density (no/m ²)	Rate of change (r)	Density (no/m ²)	Rate of Change (0)
January	250	-0.0051	160	0.0020
February	215	-0.0309	170	-0.0100
March	85	0.0467	125	-0.0224
April	345	-0.0166	295	-0.0090
May	210	-0.0015	185	-0.0070
June	220	-0.0116	150	-0.0010
July	155	-0.0412	145	-0.0140
August	45	-0.0147	95	-0.0272
September	70	0.0572	215	0.0082
October	390	-0.0222	275	-0.0250
November	200	-0.0074	130	-0.0013
December	160		125	

The rate of population increase 'r' (Table 2) shows that except after recruitment in April and October, population growth rate was negative during most of the year, with some exceptions.

Standing crop biomass

The combined standing crop biomass of all animals of all cohorts and all generations present on a sampling day is shown in Fig. 7. Although this does not reflect the biomass and contribution of a single generation, it gives an idea of total biomass production of *Bellamyia bengalensis* in Dhakuria Lake at any time. Biomass was fairly high during both years and was influenced greatly by density in

1978 with two peaks (in April and in October) corresponding to the entrance of new individuals in to the population. This direct influence of density on biomass was probably due to the considerably fewer number of older individuals in the population during the year. The average biomass for 1978 was 44.450 gm d.w./m². In 1979, the trend was not as clear, but corresponding to density, the biomass was also less (37.217 gm/m²).

Production

The presence of at least 3 cohorts in the population any time and twice-a-year breeding made it difficult to assess production rate of the entire population of *Bellamyia bengalensis*.

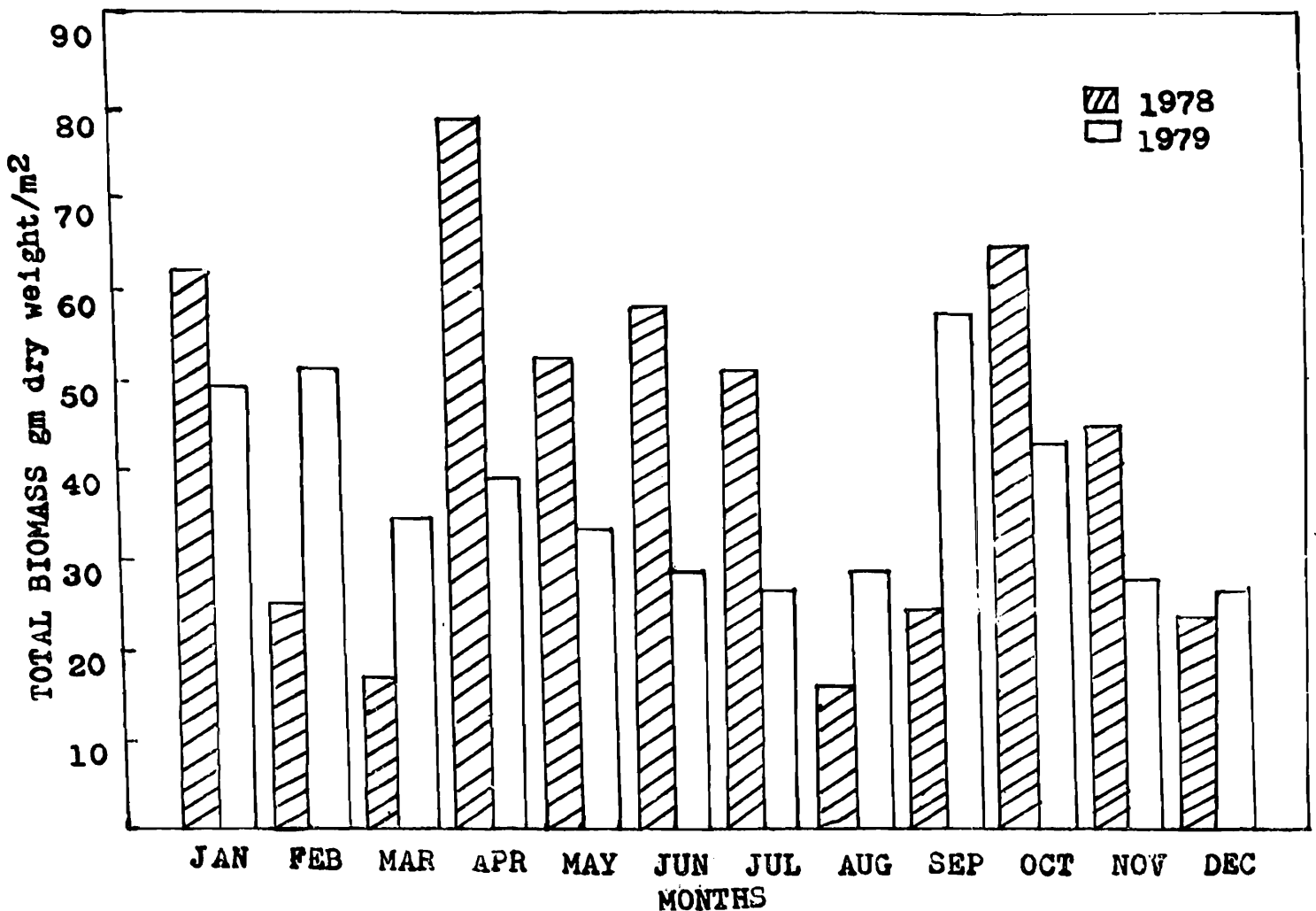


Fig. 7. Standing crop biomass of all animals of all cohorts combined during different months.

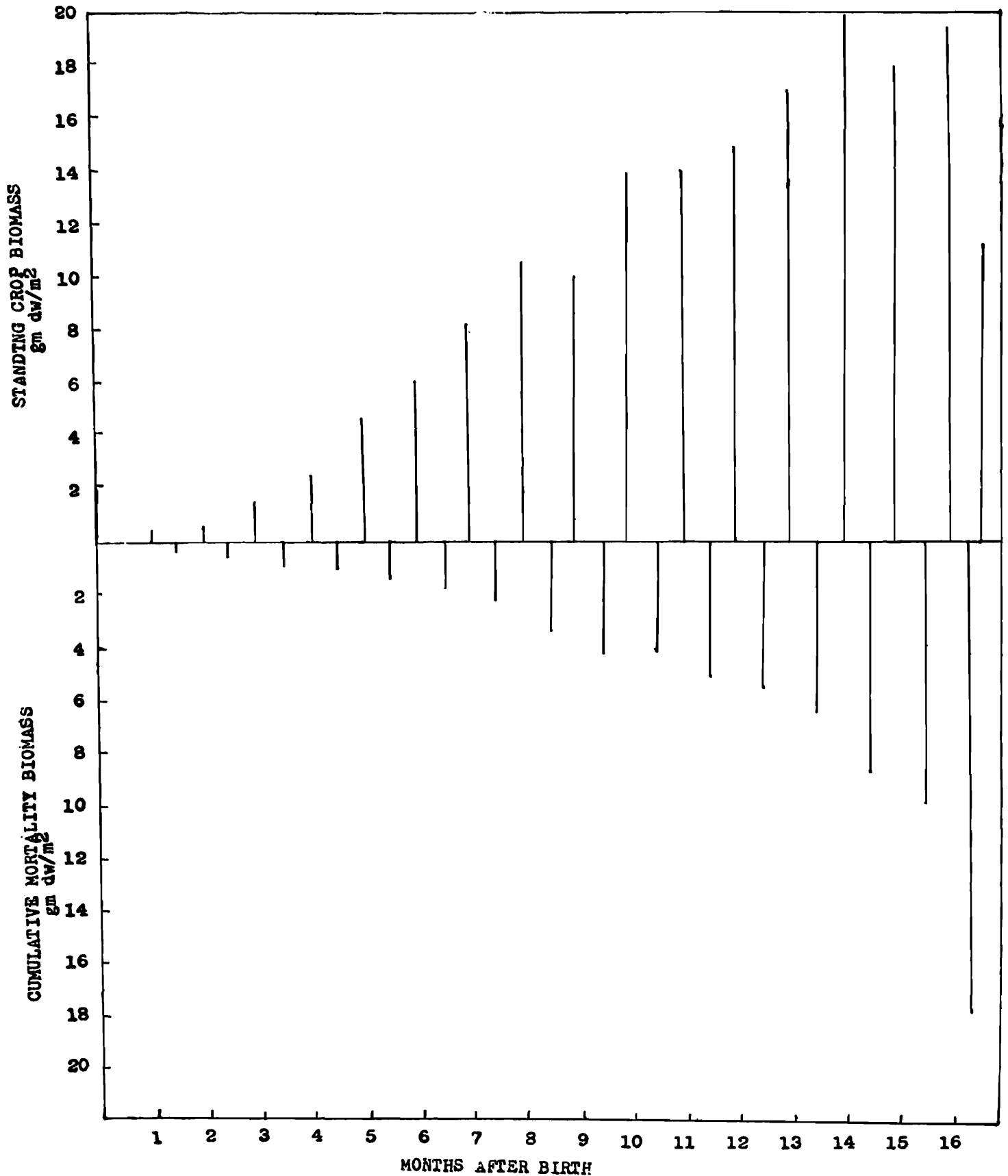


Fig. 8. Standing crop biomass and cumulative mortality biomass of *B. bengalensis*. The histograms above the line represent the standing crop of each specific age and histograms below the line represent the cumulative biomass of snails which have died between successive sample.

The removal summation method of Hamilton (1969) was not found suitable. Therefore, like many of the earlier workers (Hunter, 1975; Browne, 1978), the population rate based on standing crop biomass and cumulative mortality of a single generation was determined. The generation which was produced in April 1978 (A 78) was selected as it completed the cycle within the period of the study.

The biomass of live snails of this generation in terms of dry weight was calculated in each sample, starting from April 1978 to August 1979 when all animals of the generation died. The other contribution to the assessment of production came from mortality data. Mortality was assessed from the number of dead shells. Their biomass was calculated from mean shell weight as for live samples. Using the convention of Russell-Hunter (1970), the standing crop biomass of live snails was plotted above the line and the cumulative biomass for the snails which died (mortality), below the line (Fig. 8). At any point along the line, the sum of the standing crop biomass of live snails and the cumulative mortality biomass provided the cumulative production up to that point. The cumulative production at any time was divided by time lapsed and net productivity rate per unit time was calculated. The productivity of the A 78 generation at the end of their life was 29.090 mg d. w./m² for 17 months. The annual, monthly and daily rates computed were 20532 mg/m²-year, 1711 mg dw/m²-month and 57.03 mg dw/m² day respectively.

The mean biomass value during the period was 103.12 gm dw/m². When the production biomass ratio or turnover ratio was calculated, it was found to be 2.83.

DISCUSSION

Life cycles and total life spans of freshwater gastropods have been reported to vary considerably, both within and between species (Russell-Hunter 1964). Even different populations of the same species may show entirely different patterns of life cycle in different water bodies. The pattern based on number of generations per year and seasonal changes in mean shell size ranges from a simple one-generation pattern to 3 generations per year. Throughout the temperate latitudes, a single annual life cycle is most common, especially in pulmonates. Prosobranchs, however, have been reported to have multi-year life cycles. Hubendick (1948), Samochwalenko and Stanczykowska (1972) and Young (1975) observed that females of *Viviparus viviparus* have a life span of 4 years, while Browne (1978) found that females of *V. georgianus* live up to 36 months. Similar results have been reported for *V. (=Cipangopaludina) malleatus* from Canada (Stanczykowska *et al* 1971). Compared to these species of temperate regions, *Bellamya bengalensis* in Dhakuria Lake has a shorter life span of 18 months with a 2-generations-per-year pattern. Earlier studies on this species by Annandale and Sewell (1921) from Calcutta showed that it can grow up to 2 years. This shows that the life span of the same species may vary even at the same latitude at different times and in different water bodies.

Unlike many pulmonate species of temperate waters where growth ceases during winter, the viviparids in both temperate and tropical waters have been found to grow continuously throughout the year, as revealed by the present study on *Bellamya bengalensis*. This difference has been related to differences

in feeding habits and fluctuation in the availability of food supply in temperate waters (Browne 1978). However, in tropical waters where conditions are different from temperate waters and food supply remains moderate throughout the year, continuous growth is automatically expected. This was reflected from the unaffected growth rate of *B. bengalensis* in Dhakuria Lake during different months. Being a highly eutrophic water body, food was never in short supply in Dhakuria Lake (Khan 1979, 1980). The temperature in this region of the country also does not fluctuate much from month to month and was never limiting for *B. bengalensis*. These findings are in contrary to many observations made on temperate species where little growth is observed during winter months (McCraw, 1961 ; Clampitt, 1970 ; Eckblad, 1973).

However, the growth rate was found to be affected by the physiological state of the animals. The rate was high at early ages, moderate at middle ages and considerably slower at old age. The pattern of life cycle and growth of *Bellamya bengalensis* was somewhat similar to those observed by Annandale and Sewell (1921).

Like all other viviparids studied (*V. viviparus*, *V. georgianns*, etc.), marked sexual dimorphism has been found in length of life and growth rate of *Bellamya bengalensis*. In all viviparid species, including *B. bengalensis*, females attain larger sizes and longer life spans as compared to males. The males of *B. bengalensis* attained maturity earlier, took active part in reproduction during 2 successive breeding seasons and died well before the commencement of the third breeding season, whereas females were present just before the commencement of the third breeding season.

Therefore, the sex ratio of the older age groups were considerably heterogenous, with a definite preponderance of females. It is not only the early mortality of the males which is responsible for the differential sex distribution, but females were also born in larger numbers than males. The differential life span and growth rate has helped in the successful adaptation of the species. Selection probably drives females towards larger sizes than males as a consequence of viviparity. The larger sizes of females are advantageous as they may maintain a large number of embryos in the uterus (Browne 1978).

Reproduction in *Bellamya bengalensis* is viviparous. Viviparity is a relatively rare occurrence in invertebrates. Among fresh-water molluscs, it occurs in sphaeriid bivalves, viviparid gastropods and thiarids. This viviparity has resulted in extremely low fecundity of *B. bengalensis*. As a rule, the fecundity is smaller where chances of juvenile mortality is less. The release of sufficiently large-sized juveniles, presumably reduces the length of time that fragile young snails are exposed to external environmental fluctuations (Avolizi 1976), which in turn reduces the chances of early mortality. This high rate of survival has resulted in a very low selection ratio of 10 : 1. Similarly low selection ratios have also been observed in other species of *Viviparus*, 12 : 1 in *V. viviparus* (Samochwalenko and Stanczykowska 1971) and between 15 : 1 to 4 : 1 in *V. georgianus* (Browne 1978). On the other hand, ratios as high as 50,000 : 1 for the salt marsh snail *Melampus bidentatus* (Apley 1967) and 1400 : 1 and 1000 : 1 for *Lymnaea* (= *Radix*) *peregra* and *Planorbis corneus* respectively (Russell-Hunter 1953), have been reported.

The high population density throughout

the year with the dominance of juveniles II and adults I indicated that the species was well adjusted and had a stable population in Dhakuria Lake. The lower density in August may be related to two factors. First, the heavy mortality of the oldest age class took place in this month, and second, due to heavy rains the lake was flooded, thereby removing the snails as well as vegetation from the littoral zone.

The productivity of gastropods also vary considerably between species and populations in relation to space and time. Productivity values ranging from 0.002 mg C/m²-day to as high as 23 mg C/m²-day have been reported from temperate waters (Gillespie, 1969 ; Mason, 1971 ; Mattice, 1972 ; Eckblad, 1973 ; Hunter, 1975 ; McMahan, 1975 ; and Browne, 1978). Most of these values are reported in terms of carbon and for the sake of comparison the dry weight (with shell) values of *Bellamya bengalensis* were also converted in terms of carbon. It has been estimated roughly that the carbon values of *B. bengalensis* are about 8% of the dry weight (with shell). Dry shell-free weight is approximately 18% of the dry weight with shell, and carbon is about 45% of the shell-free dry weight. The converted values for mean daily productivity was 4.56 mg C/m²-day. When compared to other species, the value fell in a middle range. This shows that in spite of high biomass, the productivity of *B. bengalensis* in Dhakuria Lake was not as high as expected. In the allied species, *B. georgianus*, Browne (1978) reported that values vary between 0.91 and 8.30 mg C/m²-day. Very high productivity values (19.28 mg C/m²-day, when converted) have been reported in *Pila globosa* from a pond of Madurai, India, by Haniffa (1978), the only account available from Indian tropical waters.

Another measure of productivity which has been used by many workers is turnover ratio (ratio of production to mean standing crop) or P/B ratio. Waters (1969) has discussed in detail the application of turnover ratio and reported that in a number of benthic invertebrates, the ratio is rather constant and varied between 2.5 and 5.0. Eckblad (1973) supported his view on the basis of turnover ratios of *Lymnaea* (= *Stagnicola*) *palustris* (2.69) and *Physa* (= *Physella*) *integra* (2.94). Hunter (1975) found that the ratio varied from 5.63 to 5.82 in the population of *S. palustris*. The turnover ratio of *Bellamya bengalensis* (2.82) seems to agree with the contention of waters.

ACKNOWLEDGEMENT

The authors are thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, for providing necessary facilities. Thanks are also due to the staff of Calcutta Improvement Trust at Ravindra Sarobar (Dhakuria Lake) for their help in the collection of samples.

REFERENCES

- ANNANDALE, N. AND SEWELL, R. B. S. 1921 : The banded pond snail of India. *Rec. Indian Mus.*, **22** : 215-292.
- AVOLIZI, R. J. 1976. Biomass turnover in populations of Viviparus sphaerid Clams : Comparisons of growth, fecundity, mortality and biomass production. *Hydrobiologia*, **51** (2) : 163-180.
- APLEY, M. L. 1967. Field and experimental studies on pattern and control of reproduction in *Melampus bidentatus* (Say) Ph. D. Dissertation Syracuse Univ, Syracuse.

- BROWNE, R. A. 1978. Growth, mortality, fecundity, biomass and productivity of four lake populations of the prosobranch snail, *Viviparus georgianus*. *Ecology*, **59** (4) : 742-750.
- CLAMPITT, P. T. 1970. Comparative ecology of the snails *Physa gyrina* and *Physa integra* (Basommatophora : Physidae). *Malacologia*, **10** : 113-151.
- DEWITT, R. M. 1955. The ecology and life history of the pond snail *Physa gyrina*. *Ecology*, **36** : 40-44.
- DUNCAN, C. J. 1959. The life cycle and ecology of freshwater snail *Physa fontinalis* (L). *J. Anim. Ecol.*, **28** : 97-117.
- ECKBLAD, J. W. 1973. Population studies of three aquatic gastropods in an intermittent backwater. *Hydrobiologia*, **41** : 199-212.
- EISENBERG, R. N. 1970. The role of food in the regulation of the pond snail, *Lymnaea elodes*. *Ecology*, **51** : 680-684.
- GILLESPIE, D. M. 1969. Population studies of four species of molluscs in the Madison River, Yellowstone National Park. *Limnol. Oceanogr.*, **14** : 101-114.
- HAMILTON, A. L. 1968. On estimating annual production. *Limnol. Oceanogr.*, **14** : 771-782.
- HANIFFA, M. L. 1978. Secondary productivity and energy flow in a tropical pond. *Hydrobiologia*, **59** : 49-66.
- HUBENDICK, B. 1951. Recent lymnaeidae, their variation and morphology, taxonomy, nomenclature and distribution. *K. Seven Vetenskapsakad. Handb.*, (4) **3** : 1.
- HUNTER, R. D. 1975. Growth, fecundity and bioenergetics in three populations of *Lymnaea palustris*. *Ecology*, **56** : 50-63.
- KHAN, R. A. 1979. Primary productivity and trophic status of two tropical waterbodies of Calcutta, India. *Bull. zool. Surv. India*, **2** : 129-138.
- KHAN, R. A. 1981. Secondary production and biomass of zooplankton and its relationship to trophic status of a tropical artificial lake. *Bull. zool. Surv. India*, **4** : 181-189.
- MASON, C. F. 1971. Respiration rates and population metabolism of Woodland snails. *Oecologia*, **7** : 80-94.
- MATTICE, J. S. 1972. Production of a natural population of *Bithynia tentaculata* L. (Gastropoda : Mollusca). *Ekol. pol.*, **20** : 525-538.
- McMAHAN, R. F. 1975. Bioenergetics variation in three natural populations of the freshwater limpet *Levapex fuscus*. *Proc. malac. Soc. Lond.*, **42** : 331-351.
- McCRAW, B. M. 1961. Life history and growth of the snail *Lymnaea bumilis* Say. *Trans. Am. microsc. Soc.*, **80** : 16-27.
- MICHAEL, R. G. 1968. Studies on the bottom fauna in a tropical freshwater fish pond. *Hydrobiologia*, **31** : 203-230.
- RUSSELL-HUNTER, W. 1953. On the growth of the freshwater limpet, *Ancylus fluvialis* Muller. *Proc. zool. Soc. Lond.*, **123** : 623-636.

- RUSSELL-HUNTER, W. 1961a. Annual variations in growth and density in natural populations of freshwater snails in the west of Scotland. *Proc. zool. Soc. Lond.*, **136** : 219-253.
- RUSSELL-HUNTER, W. 1961b. Life cycles of four freshwater snails in limited populations in Loch Lomond, with a discussion of intraspecific variation. *Proc. zool. Soc. Lond.*, **137** : 135-171.
- RUSSELL-HUNTER, W. 1964. Physiological aspects of ecology in nonmarine molluscs. p. 83-126 in K. M. Wilber and C. M. Young (ed) *Physiology of Molluscs* Vol. 1. Academic Press, London.
- RUSSELL-HUNTER, W. 1970. *Aquatic productivity*. Macmillan Company, New York. 306 p.
- SAMOCHWALENKO, T. AND STANCZYKOWSKA, A. 1972. Fertility differentiation of two species of Viviparidae (*Viviparus fasciatus* Muller and *V. viviparus* L.) in some environments. *Ekol. pol.*, **20** : 479-492.
- STANCZYKOWSKA, A., MAGNIN, E. AND NUMOUCHEL, A. 1971. Studies of three *Viviparus malleatus* populations of the Montreal region 1. Growth, fecundity, biomass and annual production. *Can. J. Zool.*, **49** : 1431-1441.
- WATERS, T. F. 1969. The turnover ratio in production ecology of freshwater invertebrates. *Am. Nat.*, **103** : 173-181.
- YOUNG, M. R. 1975. The life cycles of six species of freshwater molluscs in the Worcester-Birmingham Canal. *Proc. malac. Soc. Lond.*, **41** : 533-548.

ON THE TAXONOMIC STATUS OF *LEPIDOCEPHALUS THERMALIS*
(VALENCIENNES) IN RELATION TO *LEPIDOCEPHALUS GUNTEA*
(HAMILTON) (COBITIDAE)

RAJ TILAK AND AKHLAQ HUSAIN

Zoological Survey of India, Dehra Dun.

ABSTRACT

Tilak and Husain (1981) have recently made a detailed study of the Indian species of the genus *Lepidocephalus* and during this study, clearly differentiated *Lepidocephalus guntea* and *Lepidocephalus thermalis* on the basis of the pattern of scalation of the head and body in addition to a large number of other features; these authors treated them as valid species. In the meanwhile, Babu Rao and Yazdani (1980) have relegated *L. thermalis* to the synonymy of *L. guntea* on rather weak grounds. A reassessment of the taxonomic features of both these species has been done in this paper in the light of the statement made by Babu Rao and Yazdani (1980) and brought out trenchant differences between these species in a large number of their features such as the shape of snout and mental lobes, barbels, length of head, depth of body, shape of the caudal peduncle, shape of the pectoral fin, lepidosis on head and body, colouration etc., indicating an independent specific status for these species. *L. thermalis* is, therefore, taxonomically valid and a species independent from *L. guntea*.

INTRODUCTION

Hamilton (1822) described *Cobitis guntea* and *C. balgara* from ponds and freshwater rivers of Bengal and Kosi river respectively. The two species were found conspecific by subsequent authors (Banarescu and Nalbant, 1968; Srivastava, 1968; Menon, 1974; Tilak and Husain, 1975, 1981; etc.). Day (1878) considered *balgara* as a subspecies of *Lepidocephalus guntea* while Guenther (1868) treated them at a specific level. The present authors (Tilak and Husain, 1975, 1981) considered *L. guntea* as the female and *balgara* as the male of the same species. During a recent study, the present authors (Tilak and Husain, 1981) while studying the Indian species of the genus *Lepidocephalus*

Bleeker, treated *L. thermalis* (Valenciennes) as a separate species well differentiated from *L. guntea* (Hamilton).

Babu Rao and Yazdani (1980) pointed out that colouration of body is highly variable in this group of fishes and might be associated with the habitat. This statement holds good for both the species, *L. guntea* and *L. thermalis* and each of these two species has separately a range of variability in colouration. The range of variation of colouration, when taken along with other taxonomic characters of each species, serves as a good specific character. Babu Rao and Yazdani (1980) contended that the scales in these species are very minute, deciduous and difficult to count, when present. It is

true that the scales are minute but they are not deciduous, rather embedded in the skin; they might appear to be absent or deciduous, if not carefully examined. They can even be counted, when examined under a stereomicroscope. On the contrary, the distribution of the scales on the head and body has been discovered by the present authors (1981) as an important taxonomic character.

Since the present authors have already clearly differentiated *L. guntea* and *L. thermalis* on the basis of the pattern of scalation on the head and the body in addition to a large number of other features, it is felt that relegating of *L. thermalis* to the synonymy of *L. guntea* is not valid. Babu Rao and Yazdani (1980) have probably

not understood the exact taxonomic limits of the two species because of the earlier descriptions of the species being deficient in details. In view of this, it has been felt desirable to re-evaluate the taxonomic status of these two species through a study of the vast material of the species collected from different parts of India. The present study brings on record a large number of important points of difference between the two species.

OBSERVATIONS

The vast amount of material of *L. guntea* and *L. thermalis* has been studied here and the differences in their morphometry have been given in a table (Table 1) and the points of their difference are enumerated below.

TABLE 1. Showing morphometric measurement in *Lepidocephalus guntea* and *L. thermalis*

Morphometric measurements	<i>L. guntea</i> (Hamilton)	<i>L. thermalis</i> (Valenciennes)
(1) Length of head/width of head	1.50-1.78	1.82-2.09
(2) Total length/depth of body	5.66-7.00	7.46-9.71
(3) Standard length/depth of body	4.69-5.84	6.00-6.67
(4) Length of head/depth of body at anal origin	1.11-1.35	1.51-1.80
(5) Length of head/length of pectoral (male)	0.89-0.95	1.00-1.16
(6) Distance between pectoral & ventral fins/length of pectoral fin (male)	1.46-1.66	1.83-1.84
(7) Standard length/Length of pectoral fin (male)	4.63-5.18	5.12-5.20
(8) Length of head/Length of ventral fin (female)	1.36-1.50	1.54-1.76
(9) Distance between ventral & anal fins/length of ventral fin (female)	2.06-2.30	1.80-1.88
(10) Length of head/length of ventral fin (male)	1.11-1.32	1.44-1.64
(11) Standard length/length of ventral fin (male)	6.17-6.46	7.36-7.37
(12) Length of head/anal fin height (male)	1.15-1.32	1.37-1.64
(13) Total length/length of caudal fin	5.82-6.18	5.11-5.71
(14) Standard length/length of caudal fin	4.82-5.18	4.11-4.71
(15) Standard length/height of caudal peduncle	7.07-8.16	9.09-10.00
(16) Total length/distance between ventral & anal fins	4.00-4.59	5.08-5.44
(17) Standard length/distance between ventral & anal fins.	3.35-3.83	4.11-4.42
(18) Total length/postventral distance of body	2.31-2.56	2.66-2.92
(19) Height of caudal peduncle/length of ventral fin (female)	1.00-1.04	0.79-0.92
(20) Depth of body/length of pectoral fin (female)	1.22-1.38	0.86-1.07

(1) **Snout** : In *L. thermalis*, the snout is compressed and skinny so as to form a narrow ridge dorsally and pointed anteriorly (similar to that of *L. annandalei* Chaudhuri). In *L. guntea*, on the other hand, the snout is moderately compressed, fleshy and obtuse in front. (Figs. 1a, 2a, 3a, 3b)

(2) **Mental lobes** : The shape of the mental lobes is different in the two species. In *L. thermalis*, each lobe is like an oval nodule whose tip is produced into a minute thread-like structure. In *L. guntea*, the mental lobes are extensive, fleshy, subdivided into 2-3 lobules, each produced into stumpy

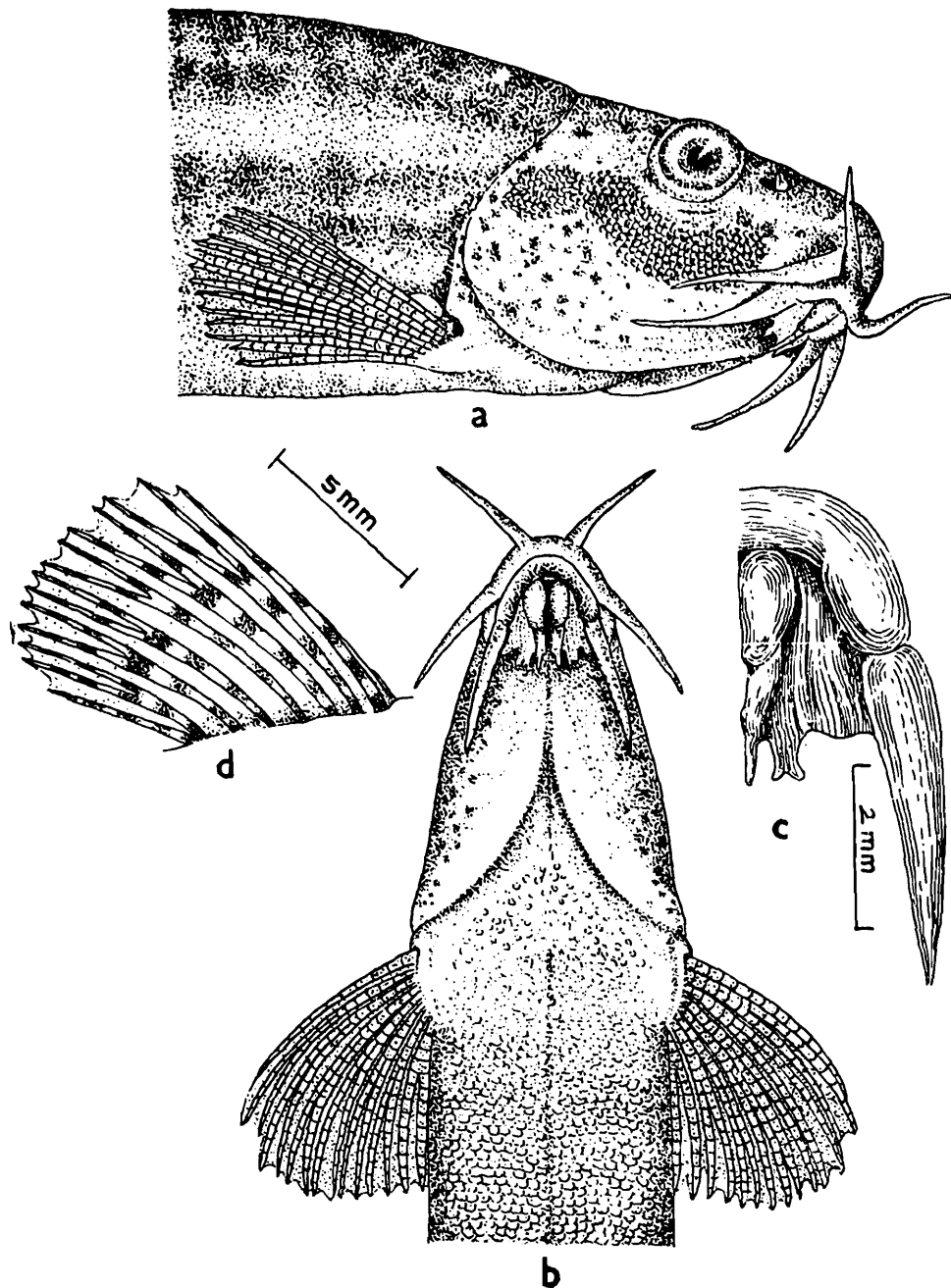


Fig. 1. *Lepidocephalus guntea* (Hamilton)

(a) lateral view of head and anterior part of body (b) Ventral view of head and anterior part of body (c) mental lobe and maxillo-mandibular barbel (enlarged view) (d) dorsal fin

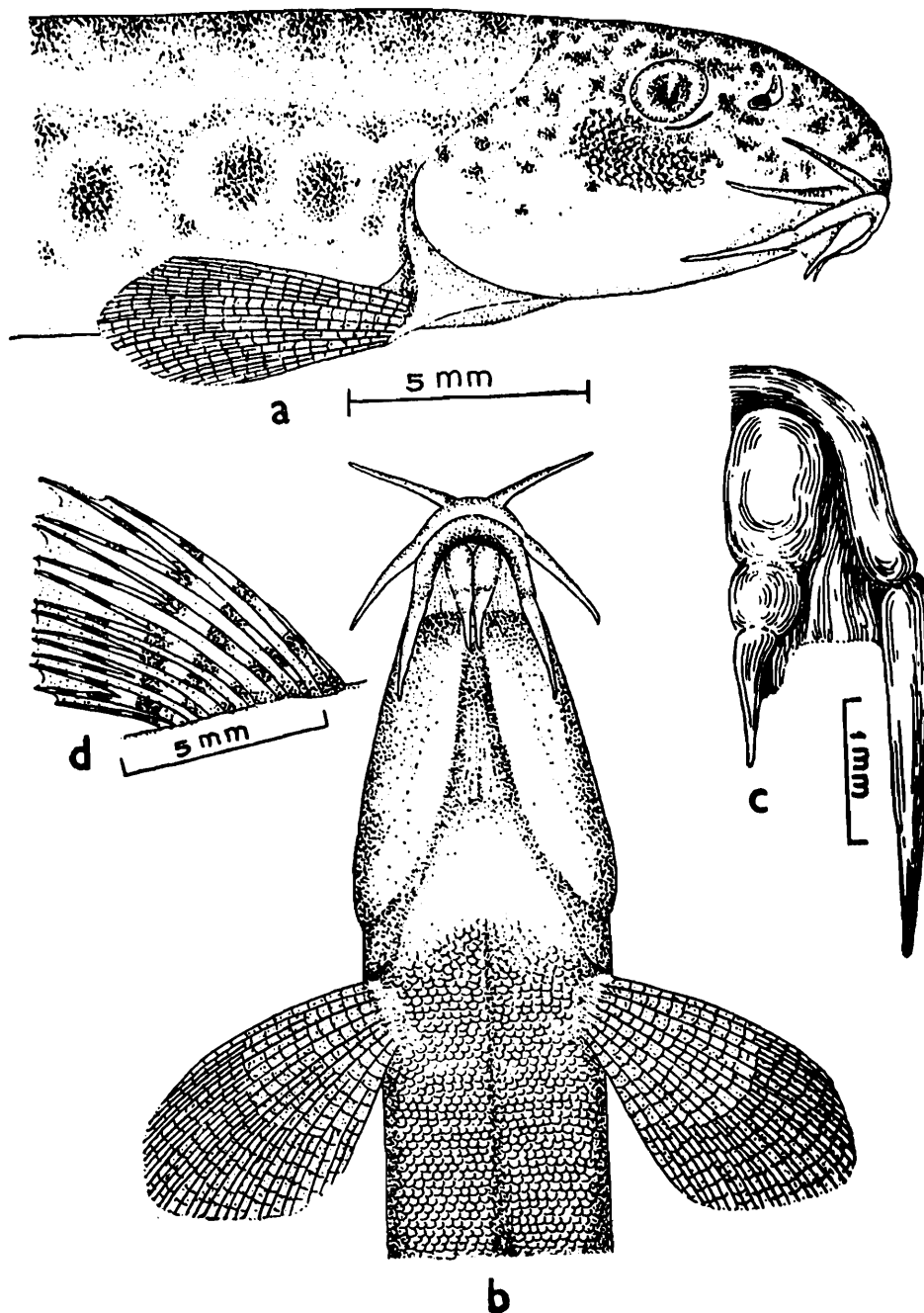


Fig. 2. *Lepidocephalus thermalis* (Valenciennes)

(a) lateral view of head and anterior part of body (b) ventral view of head and anterior part of body (c) mental lobe and maxillo-mandibular barbel (enlarged view) (d) dorsal fin

projections and the inner edge of each mental lobe is directed ventrally. (Figs. 1c, 2c)

(3) **Barbels** : The barbels are thick and longer than eye diameter in *L. guntea*. In *L. thermalis*, the barbels are fine and compara-

tively much smaller than those of the former i.e. equal to or smaller than eye diameter.

(4) **Head** : In similar sized specimens, the head is comparatively longer in *L. thermalis* than that of *L. guntea*. The

TILAK & HUSAIN

PLATE I

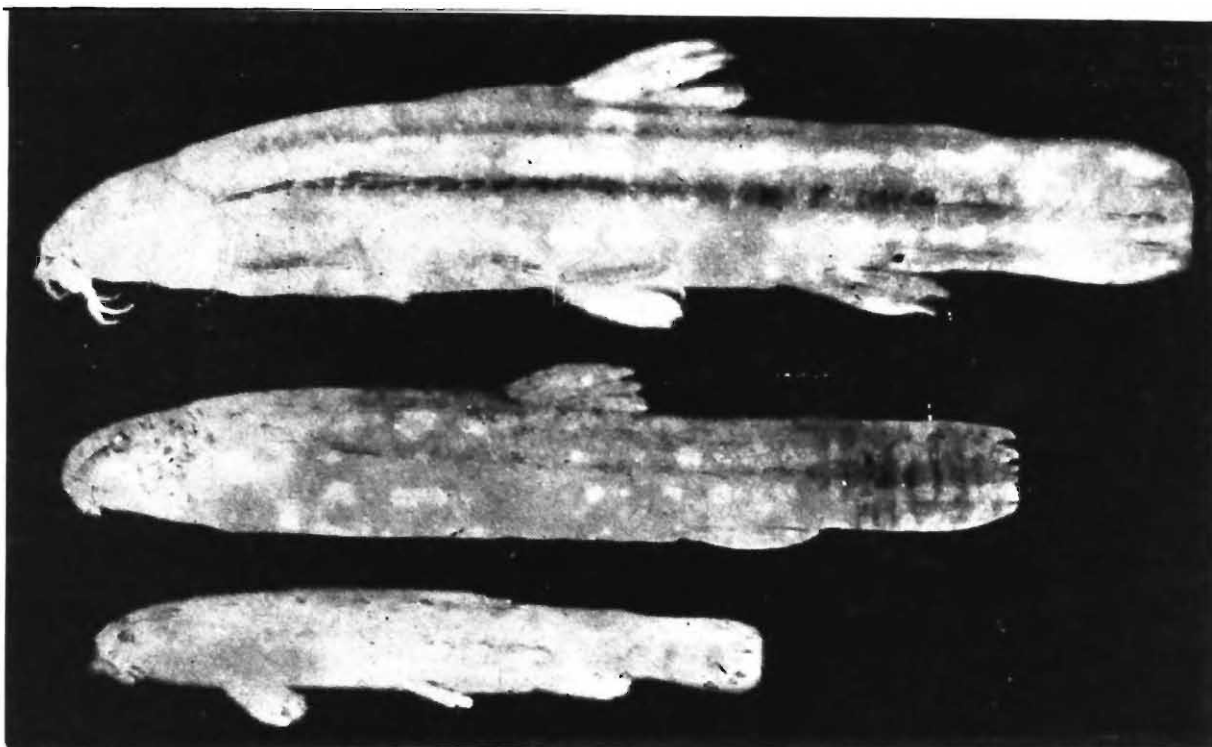


Fig. 1. *Lepidocephalus guntea* (Hamilton)
Top is male and the rest are female

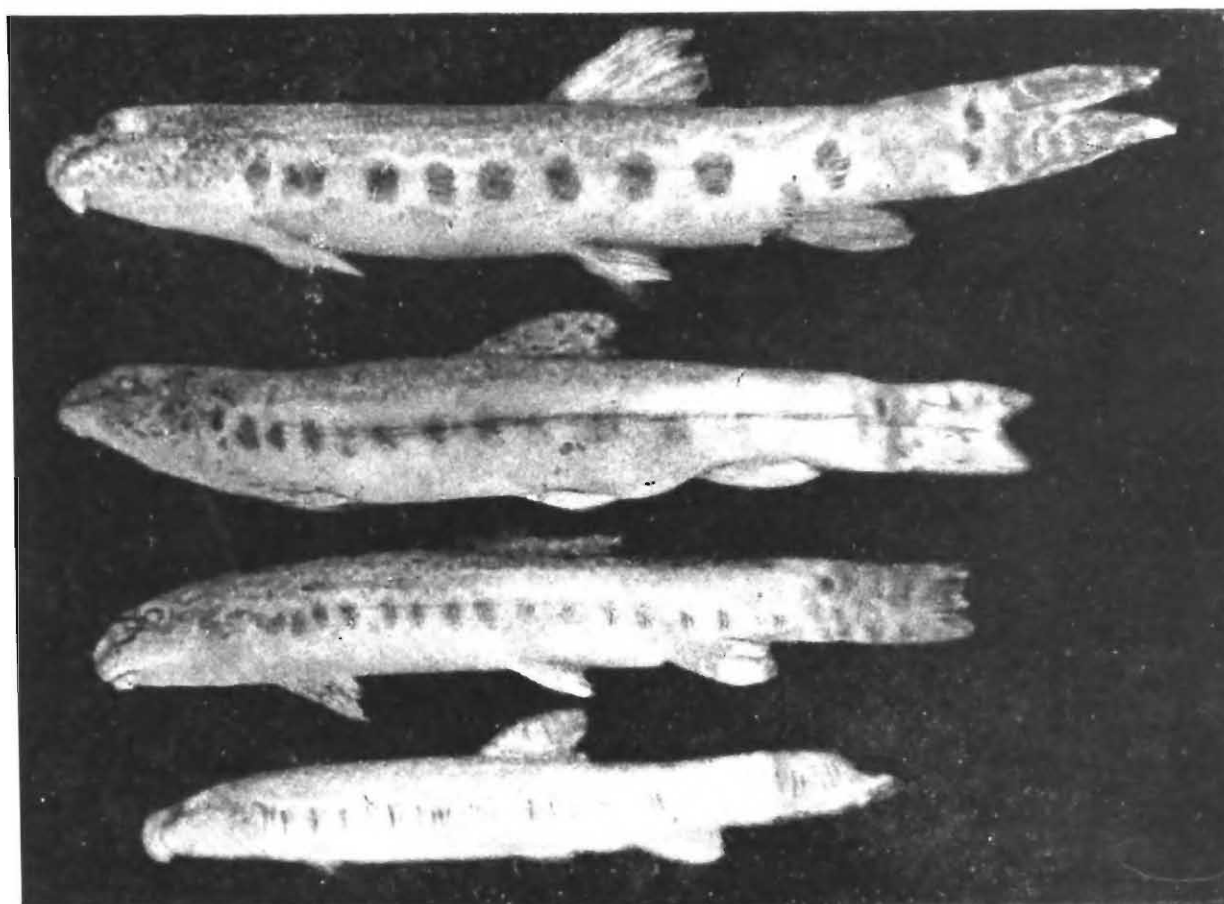


Fig. 2. *Lepidocephalus thermalis* (Valenciennes)

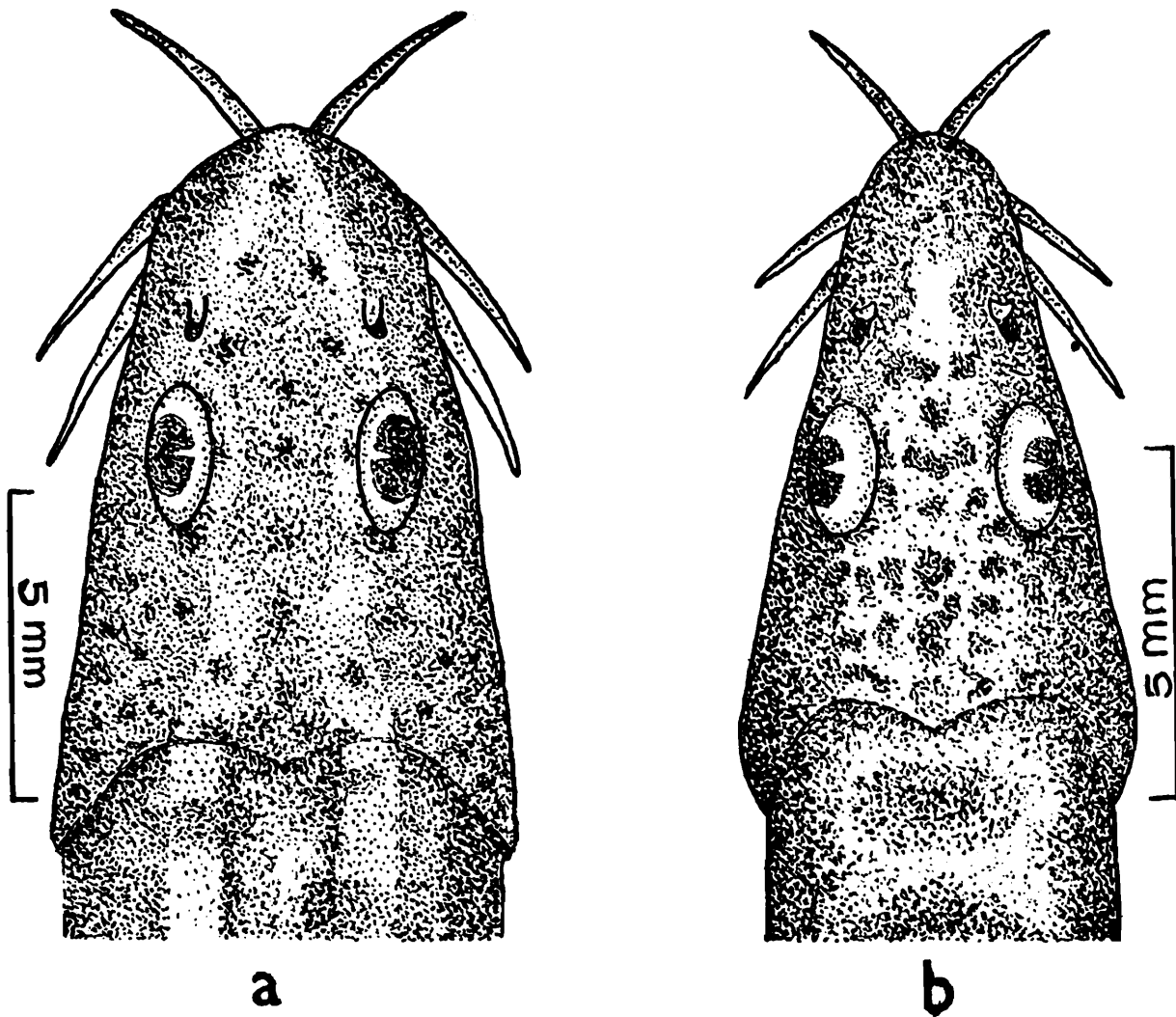


Fig. 3. (a) Dorsal view of head of *L. guntea* (Ham.) (b) Dorsal view of head of *L. thermalis* (Val.)

maximum of the range of variation in the proportion of head to the total or standard length in *L. thermalis* overlaps the lowest of the same range in *L. guntea* (5.57-6.28 in total length and 4.48-5.12 in standard length in *L. thermalis*, 5.88-6.80 in total length and 4.91-5.71 in standard length in *L. guntea*).

(5) **Depth of body** : *L. guntea* is a deep bodied fish while *L. thermalis* is comparatively more streamlined. The depth of body is 5.56-7.00 times in total length and 4.69-5.84 in standard length in *L. guntea* while it is

7.46-9.71 in total length and 6.00-6.67 in standard length in *L. thermalis*. (Plates I, II).

(6) **Caudal peduncle** : The caudal peduncle is narrower in *L. thermalis* and somewhat squarish in *L. guntea*. The least height of the caudal peduncle is always less than its length in *L. thermalis* (1.06-1.50) while it is equal, less or slightly more in *L. guntea* (0.93-1.22) (Pl. I, II).

(7) **Dorsal fin** : In *L. thermalis*, the anteriormost branched rays are almost 2 times longer than the last ray of the same fin.

When the fin is adpressed against its base, the anterior rays completely cover the tips of the last rays. The upper margin is obliquely truncate. In *L. guntea*, the anterior rays are comparatively shorter, being less than 2 times the length of the posteriormost ray. When adpressed, the anterior rays do not completely cover the tips of the posteriormost rays of the same fin. The upper edge of the fin is convex. (Figs. 1d, 2d)

Babu Rao and Yazdani (1980) have mentioned 7-8 branched rays in the dorsal fin and 6-7 branched rays in the anal fin in *L. guntea*. In the present study, it has been observed that there are only 6-7 branched rays in the dorsal fin and 5 in the anal fin.

(8) **Pectoral fin**: In *L. thermalis*, the tip of the second branched ray is slightly produced and therefore, the pectoral fin appears fusiform. In *L. guntea*, the second branched ray is also longest but not produced. The expanse of the fin in *L. guntea* is much wider than that of *L. thermalis*. Accordingly, there is difference in the shape of this fin of the two species. In males of *L. guntea*, the pectoral fin is longer than the head while it is not so in *L. thermalis* (Figs. 1b, 2b)

(9) **Caudal fin**: The caudal fin is emarginate in *L. thermalis*, although there are a few examples where the caudal fin is cut square with pointed corners. In *L. guntea*, on the other hand, the caudal fin is convex or cut square with rounded corners. (Pls. I, II)

(10) **Lepidosis**: The scales are minute and embedded in the skin; they are imbricately arranged. Those of *L. guntea* are comparatively longer than those of *L. thermalis*. Accordingly, there are 25-30 rows of scales between the base of the anal fin and

middorsal sides of the body in *L. guntea* and 30-37 rows in *L. thermalis*. On the head, scales are absent except for a semilunar patch posterior to the suborbital spine and below the posterior margin of eye in *L. thermalis* and a large suborbital patch together with a small patch of scales on the upper part of operculum which may sometimes be contiguous with the suborbital patch in *L. guntea*. The opercular patch of scales is absent in *L. thermalis*. The scales on the ventral side of head extend beyond the isthmus in *L. guntea* while they may or may not do so in *L. thermalis*. (Figs. 1a, b, 2a, b).

(11) **Colouration**: *Lepidocephalus guntea* (Pl. I, Figs. 1a, 1d)

The colouration of the body is highly variable and differs with age, size and sex. In young individuals, the ground colour is sandy yellow. Along the lateral sides of the body, there is a series of nearly 10-12 dark grey spots connected with one another through a very thin dark band. As the fish grows in size, the lateral spots also grow in size and tend to fuse with one another. Just above the lateral dark spots and the band, there is another thinner dark band parallel to it and separated from it as well as the colouration of the back by a band of the ground yellowish colour. The dorso-lateral dark band is infuscated with dark spots in the female and clear in the adult male. As a result of the stippling of the ground colour in the female and its absence in the adult male, the yellow colour band in the latter is very bright and prominent. This difference is correlated with the lengthening of the pectoral fins and ossification of the innermost two rays of this fin in adult males; in the female, the pectoral fin is comparatively smaller and there is no

ossification of the inner rays of this fin. The intensity of the lateral band in the male and that of the continued row of spots of the lateral band in the female is increased by the presence of a sub-dermal dark band.

A light band, edged with dark, runs on the dorsal side between the head and the origin of the dorsal fin. On the sides of this band as well as on the body behind the dorsal fin, there are distant transversely disposed dark stripes which are sometimes almost completely submerged with the general dark pigmentation. There is a minute black spot on the upper half of caudal base. There are 6-7 rows of spots on the dorsal fin and a similar number on the caudal fin. The pectoral, ventral and anal fins are lightly stippled. The ventral sides of head and body are uniformly pale or yellowish. There is a dark stripe extending from the antero-ventral side of the eye to the lateral side of the snout tip. The dorso-lateral side of the head is reticulated and the pigmentation is submerged under a thick epidermal layer. Barbels are also pigmented.

Lepidocephalus thermalis (Pl. II, Fig. 2a, 2d)

The ground colour of the body is yellowish. There are 12-15 (6-7 predorsal, 2 subdorsal, 4-6 postdorsal) spots on the middorsal surface of the body. There are 11-15 squarish, rectangular, triangular or oval spots on the lateral sides of the body. These spots are encircled by a ring of yellowish ground colour. The subdermal colour band, running below these spots, is thin. The lateral spots are never confluent. Similar spots may be present on the dorsal side of the body. The dorso-lateral part of the body between the back and lateral row of spots is

reticulated with small spots although in some specimens, there is an indication of the presence of a thin light yellowish band in this region. There is a row of small spots below the lateral row of spots. The ventral side of body is yellowish. The dorsal fin bears 6-7 rows of spots. There are 5-6 complete '<' shaped bands on the caudal fin. The upper and lower extremities of this fin bear 2-3 additional bands which remain discontinuous due to emarginate nature of this fin. The pectoral, the ventral and the anal fins are stippled with fine dots which are, in some cases, differentiated into bands particularly in the anal fin. There is a vertical dark spot at the base of the upper part of the caudal fin ; it is surrounded by a white ring. The dorsal and lateral sides of the head bear small irregular spots which invariably get connected with one another in an irregular manner forming a reticulation. The colouration of the dorsal sides of the head is much clearer than that of *L. guntea*. There is a dark streak, running between the anterior edge of the eye and the side of the tip of snout.

REMARKS

Babu Rao and Yazdani (1980) stated that Day (1878) has based his description of *L. thermalis* on young examples which according to them could be young of *L. guntea*. On the contrary, Day (op. cit.) has clearly mentioned that he found 2,500 eggs in a female specimen of *L. thermalis*, indicating thereby that his material consisted of adult examples. The statement of Babu Rao (1980) in this respect is, therefore, a misquotation.

The material of *L. thermalis*, studied here, has been from Poona and Periyar lake and

river (Kerala). The large number of differences mentioned above clearly indicate that *L. thermalis* is a species independent from *L. guntea*.

Sexual Dimorphism : There is a marked sexual dimorphism in both *L. guntea* and *L. thermalis* (Day, 1865, 1878 ; Nalbant, 1963 ; Banarescu and Nalbant 1968 ; Tilak and Husain, 1975, 1981). The last two pectoral rays are ossified and fused proximally to form a vertical ridge in the male. This ridge is not formed in the female. Babu Rao and Yazdani (1980) were doubtful about the sexual dimorphism in these species. The pectoral fin is longer than the head in the male while it is not so in the female.

ACKNOWLEDGEMENTS

The authors feel grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta and Officer-in-Charge, Northern Regional Station, Zoological Survey of India, Dehra Dun for encouragement. Thanks are also due to Shri Tara Singh, Artist, Northern Regional Station, Z. S. I., Dehra Dun for making the figures for this paper.

REFERENCES

BABU RAO, M. and YAZDANI, G. M. 1980. Specific identity of *Lepidocephalus guntea* (Hamilton) (Cypriniformes : Cobitidae) with considerations of *L. thermalis* (Val.) as its synonym. *J. zool. Soc. India*, 30(1) : 13-17, pl., figs. 1-8.

- BANARESCU, P. and NALBANT, T. T. 1968. Cobitidae (Pisces, Cypriniformes) collected by the German India Expedition. *Mitt. Hamburg, Zool. Mus. Inst.*, 65 : 343-347, pl. II, figs. 17-20, 22.
- DAY, F. 1865. *The Fishes of Malabar*. London : 204.
- DAY, F. 1878. *The Fishes of India*. London : 609, pl. CLV, fig. 4, pl. CLV, fig. 12.
- GUENTHER, A. 1868. *A catalogue of the Fishes of the British Museum*. 7 : 363, 365.
- HAMILTON, F. 1822. *An account of the fishes of the river Ganges and its branches*. Edinburgh : 355, 356, 394.
- MENON, A. G. K. 1974. A check-list of the fishes of the Himalayan and the Indo-Gangetic plains. *Inland Fish. Soc. India*, Spl. publ. No. 1 : 52.
- NALBANT, T. T. 1963. A study of the genera of Botiinae and Cobitinae (Pisces, Ostariophysi, Cobitidae). *Trav. Mus. "Gr. Antipa" Bucarest*, 4 : 356, 366.
- SRIVASTAVA, G. J. 1968. *Fishes of Eastern Uttar Pradesh*. Varanasi : 62.
- TILAK, R. and HUSAIN, A. 1975. Further studies on the sexual dimorphism in *Lepidocephalus guntea* (Hamilton) (Family : Cobitidae). *Newsl. zool. Surv. India*, 1(4) : 75.
- TILAK, R. and HUSAIN, A. (1981). On the systematics of the Indian fishes of the genus *Lepidocephalus* Bleeker with keys to the species of the genus and genera of the subfamilies Botiinae and Cobitinae (Cobitidae : Cypriniformes). *Rec. zool. Surv. India*, Misc. Publ., 32 : 1-42.

EVALUATION OF YIELD LOSSES IN RICE DUE TO *HIRSCHMANNIELLA GRACILIS* (de MAN, 1880) LUC & GOODEY, 1963 (TYLENCHIDA : NEMATODA) AT HOOGHLY (WEST BENGAL)

NASEEM AHMAD, P. K. DAS AND QAISER H. BAQRI
Zoological Survey of India, Calcutta

ABSTRACT

During monsoon season in 1979, an experiment was conducted at Chinsurah Rice Research Station, District Hooghly (West Bengal) to estimate the yield losses in paddy crop due to *Hirschmanniella gracilis*. The seedlings of 'Jaya' variety of rice were transplanted on 18th August, 1979. The field was divided into 24 subplots (4×4 m each) in which the following treatments were replicated six times and randomized : T₁=Treated with carbofuran granules, T₂=Native population of *H. gracilis*, T₃=Inoculation to soil by incorporating 500 gm/subplot infested chopped roots (4300 nematodes), T₄=Inoculation to soil by incorporating 1 Kg/subplot infested chopped roots (8600 nematodes).

The loss was again estimated during the monsoon season in 1981 by applying the same dose of carbofuran granules. This time, the chopped roots were not incorporated in the main field because of their insignificant role in 1979. Instead of T₃ and T₄ treatments mentioned above in 1979, a new treatment was introduced in 1981 by treating half of the seed bed by carbofuran granules.

The results reveal that the application of carbofuran granules brings down the population of *H. gracilis* in soil as well as in roots significantly. In treated subplots, the significant improvement in the root and shoot length, plant and root weight and the yield has been found directly related with the decline of *H. gracilis* population in soil and roots. The loss in yield due to native/inoculated population of *H. gracilis* has been calculated 12.05 to 13.61% in 1979 and 18.33 to 19.22% in 1981.

INTRODUCTION

During recent years, a considerable work has been done on different aspects of nematode pests associated with paddy crop in India (Das & Rao, 1970 ; Mathur & Prasad, 1971, '74a', '74b', '74c' ; Muthukrishnan, *et al.*, 1979 ; Prasad & Rao, 1974 ; Ramana & Rao, 1977 ; Rao, 1970. Mathur & Prasad (1971) reported that *Hirschmanniella oryzae* (Soltwedel, 1889) Luc & Goodey, 1963 occurs at least in 12 states

of the Indian union. Recent reports from different research centres have revealed that *Hirschmanniella* spp. are most serious and widely distributed pests of rice. Baqri *et al.*, (1983) have reported that every paddy field in Burdwan district of W. Bengal was found infested by *Hirschmanniella gracilis* (de Man, 1880) Luc & Goodey, 1963.

Several field experiments have been conducted by various workers at Thailand and Japan to evaluate the yield losses in rice

caused by the rice root nematodes by applying different dosages of different chemicals (DD, EDB, DBCP, etc.). In India, Panda & Rao (1971) and Rao & Biswas (1974) have estimated the yield losses in rice under inoculated conditions in pots caused by *Hirschmanniella mucronata* (Das, 1960) Luc & Goodey, 1963 and *Meloidogyne incognita* (Kofoid & White, 1919) Chitwood, 1949 respectively.

The present investigations were initiated in 1979 at Chinsurah Rice Research Station, Hooghly (W. Bengal) by applying carbofuran granules and inoculating *H. gracilis* in an already infested field from the same species. Applying the same dose of carbofuran granules, the results were confirmed in 1981.

Carbofuran was selected because it has been reported to be effective against various plant parasitic nematodes by bringing down their population (Di Sanzo, 1969 ; Di Sanzo, 1973 ; Siddiqui & Khan, 1974 ; Overman & Jones, 1975 ; Bonnemaïson, 1975 ; Verma *et al.*, 1978 ; Varma, Prasad & Mathur, 1980 ; and others). Moreover, carbofuran in granular form is not only less expensive but also easily available in the market.

MATERIALS AND METHODS

The nursery bed of 'Jaya' variety was prepared in an adjacent field during July 1979. The main field was divided into 24 subplots (4 × 4 m each) which were separated from each other by 0.5 m bund. One month old seedlings were transplanted on 18th August, 1979 at 15 × 20 cm space. Recommended cultural practices of rice were followed. No other pesticides or weedicides were applied in the field during the present course of investigation. In the main field,

the following four treatments were replicated six times and randomised :

T₁ = Treatment with carbofuran granules 1 Kg. a.i./ha, one day before seedlings transplantation and 50 days after seedlings transplantation.

T₂ = Native population in the soil.

T₃ = Inoculation to soil by incorporating 500 gm/subplot infested chopped roots (4300 nematodes).

T₄ = Inoculation to soil by incorporating 1 Kg./subplot infested chopped roots (8600 nematodes).

The loss assessed in 1979 was confirmed by conducting another experiment at Chinsurah during the monsoon season in 1981. The same dose of carbofuran granules was applied in the main field. This time, a new presowing treatment was introduced by treating half of the seed bed by carbofuran granules (1 Kg. a.i./ha). The seed bed treatment was introduced to assess the loss in growth of seedlings due to rice root nematodes. T₃ and T₄ treatment, mentioned above, were not taken into consideration because the inoculation of *H. gracilis* by incorporating infested chopped roots did not make any significant difference in 1979. The following three treatments were replicated eight times and randomised in 1981.

T₁ = Main field treated with carbofuran granules, seedlings from carbofuran treated seed bed.

T₂ = Main field with native population, seedlings from carbofuran treated seed bed.

T₃ = Main field with native population, seedlings from untreated seed bed.

The soil samples were collected from five spots at random from each subplots for counting *H. gracilis* population a day before inoculation or first application of carbofuran granules. 30 days after seedlings transplantation, prior to second application of carbofuran granules and prior to harvesting. The *H. gracilis* population was counted from 200 ml soil. From each subplot, 10 plants were rooted out on the day of each sampling to note the length of root and shoot (cm), number of flowering/nonflowering tillers, weight of total plant and roots separately (gm) and also the nematode population in 5 gm roots.

The extraction of nematodes was done through modified Baermann funnel technique. From roots, the nematodes were recovered by placing chopped roots through blender over Baermann funnel.

RESULTS AND DISCUSSION

All the results obtained in 1979 have been analysed in Table I. The initial population of *H. gracilis* was counted 70/200 ml soil. It is evident from the results that *Hirschmanniella* population in soil becomes considerably low in treated subplots on 30th day after transplanting seedlings whereas it increases in untreated/inoculated subplots (12 against 94-158). It appears that the application of carbofuran granules in soil also checks the penetration of *Hirschmanniella* into the roots because 7 nematodes/5 gm roots were recovered against 34-86/5 gm roots from untreated or inoculated subplots. A marked improvement in shoot and root length, root weight and plant weight from treated subplots was noted over the untreated or inoculated subplots.

The sampling prior to second application of carbofuran granules revealed that the *Hirschmanniella* population has increased in the treated soil and the differences in the population among treated and untreated/inoculated subplots did not remain significant except T_4 over T_1 , T_2 and T_3 at 5% level. During this period the root population also increased in T_1 subplots and the differences among the different treatments did not remain significant. The length and weight of roots and shoots in the plants from treated subplots continued to be significant over the plants from T_2 , T_3 and T_4 subplots.

The third or pre-harvesting sampling again confirmed the efficacy of carbofuran, since the soil and root population of *Hirschmanniella* declined after the second application of this pesticide in T_1 subplots. The soil and root population of *H. gracilis* became significantly low in T_1 subplots. The number of flowering tillers was significant in the treated subplots. In addition to this, shoot length, root weight and plant weight were also noted significant in T_1 subplots. Though at this stage the weight of roots and shoots do not remain of much importance because the plants have to prepare for the grain yield.

Finally, the following results of yield grain were recorded from the four treatments : $T_1 = 6.575$ Kg., $T_2 = 5.983$ Kg., $T_3 = 5.683$ Kg., $T_4 = 5.783$ Kg.

It is evident that the enhanced grain yield in T_1 subplots over T_2 , T_3 and T_4 subplots is obtained due to the application of carbofuran granules which checks the population of *Hirschmanniella* at low level. Since the increase in yield is due to controlled population of *Hirschmanniella* sp. in T_1 subplots,

TABLE I. Losses in paddy yield due to *Hirschmanniella gracilis*

Time of sampling	Treatments	No. of non-flowering tillers*	No. of flowering tillers*	Shoot height (cm)*	Root length (cm)*	Plant Wt* (gm)	Root Wt.* (gm)	Population* of <i>H. gracilis</i> in root (5 gm)	Population* of <i>H. gracilis</i> in soil (200 ml)	Yield (Kg)
At the time of inoculation		—	—	—	—	—	—	—	78	—
30 days after transplanting seedlings	T ₁	10.6	—	57	19	35	6	6.6	12	—
	T ₂	10.8	—	50	16	23	2.5	34	94	—
	T ₃	10	—	48	16	17	2.4	36	158	—
	T ₄	12	—	51	16	22	2.3	86	158	—
C. D. at 1%		N.S.	—	5.92	2.3	10.97	0.83	49.27	71.46	—
C. D. at 5%		N.S.	—	—	1.66	—	—	—	51.67	—
Prior to second application of carbofuran	T ₁	9	0.56	76	16	83	8.3	48	141	—
	T ₂	6	0.48	71	14	56	5.9	56	155	—
	T ₃	9	0.35	67	15	57	6.1	87	138	—
	T ₄	10	0.21	73	13	75	7.0	79	255	—
C. D. at 1%		N.S.	N.S.	7.77	N.S.	19.23	2.07	N.S.	N.S.	—
C. D. at 5%		N.S.	N.S.	5.62	1.95	—	—	N.S.	92.08	—
Prior to harvesting	T ₁	—	8.5	85	10	76	4.0	4	45	—
	T ₂	—	9.0	80	10	68	2.9	7	69	—
	T ₃	—	9.0	82	11	79	3.4	13	91	—
	T ₄	—	8.5	82	11	76	3.6	18	214	—
C. D. at 1%		—	0.29	N.S.	N.S.	N.S.	0.83	N.S.	142.75	—
C. D. at 5%		—	—	3.37	N.S.	10.63	—	11.81	103.27	—
Post harvesting	T ₁	—	—	—	—	—	—	—	—	6.575
	T ₂	—	—	—	—	—	—	—	—	5.983
	T ₃	—	—	—	—	—	—	—	—	5.683
	T ₄	—	—	—	—	—	—	—	—	5.783
C. D. at 1%		—	—	—	—	—	—	—	N.S.	
C. D. at 5%		—	—	—	—	—	—	—	0.34	

Loss in yield (%)

T₂=12.05T₃=13.61T₄=12.05

*Mean of six replications

TABLE II. Nematode population at the time of nursery sowing 353/200 ml of soil.

Plant growth and nematode population at the time of transplanting (Average of ten seedlings)								
Treatments	Shoot length (cm)	% increase untreated control.	Fresh root weight (gm)	% increase untreated control.	Nematode Population in soil/200 ml,	%de-crease.	Nematode population of root/5 gms.	%de-crease.
Untreated control.	24.35		0.18		170		27	
Carbofuran treated nursery @ 1 Kg/ha.	33.15	26.55%	0.24	25%	100	41.18	10	62.96

TABLE III. Losses in Paddy yield due to *Hirschmanniella gracilis*

Time of Sampling	Treatments	No. of non-flowering tillers	No. of flowering tillers	Shoot* height (cm)	Root* length (cm)	Plant Wt.* (gm)	Root Wt* (gm)	Population* of <i>H. gracilis</i> in root (5 gm)	Population* of <i>H. gracilis</i> in soil (200 ml)	Grain* yield (Kg.)
At the time of transplanting		—	—	—	—	—	—	—	280	—
30 days after transplanting seedlings	T ₁	8.94	—	60.62	19.69	30.76	3.88	33.5	54.29	—
	T ₂	8.75	—	59.3	18.02	27.35	2.76	40.13	77.14	—
	T ₃	8.47	—	58.78	17.98	25.69	3.03	41.75	122.86	—
C.D. at 1%		N.S.	—	N.S.	N.S.	N.S.	N.S.	N.S.	39.44	—
C.D. at 5%		N.S.	—	N.S.	N.S.	N.S.	0.48	N.S.	28.28	—
Prior to second application of carbofuran	T ₁	8.97	1.24	70.57	15.72	62.8	5.86	39.5	50.0	—
	T ₂	9.2	1.45	66.91	13.5	58.74	3.65	43.87	63.75	—
	T ₃	8.87	1.14	66.94	13.35	53.75	4.04	30.79	119.03	—
C.D. at 1%		N.S.	N.S.	N.S.	N.S.	N.S.	1.07	N.S.	45.33	—
C.D. at 5%		N.S.	N.S.	N.S.	N.S.	N.S.	—	N.S.	32.96	—
Prior to harvesting	T ₁	1.46	8.55	79.37	—	55.5	2.56	11.87	121.25	—
	T ₂	1.18	8.25	77.92	—	40.83	2.0	22.87	240.0	—
	T ₃	0.88	8.91	78.46	—	41.15	1.95	18.0	215.0	—
C.D. at 1%		0.03	N.S.	N.S.	—	3.48	N.S.	N.S.	N.S.	—
C.D. at 5%		0.02	0.09	N.S.	—	2.51	N.S.	N.S.	53.19	—
Post harvesting	T ₁	—	—	—	—	—	—	—	—	2.51
	T ₂	—	—	—	—	—	—	—	—	2.01
	T ₃	—	—	—	—	—	—	—	—	2.05
C.D. at 1%		—	—	—	—	—	—	—	—	N.S.
C.D. at 5%		—	—	—	—	—	—	—	—	N.S.

Loss in yield (%)

*Mean of eight replications

T₂ = 19.22

T₃ = 18.33

the decline in the yield from T_2 , T_3 and T_4 subplots has been considered as loss due to *H. gracilis*.

The loss has been assessed 12.05%, 13.61% and 12.05% in T_2 , T_3 and T_4 subplots respectively.

The results of the second experiment conducted in 1981 have been analysed in Table II and III. The seed bed results have been furnished in Table II which show that the rice root nematode population in soil and root declined 41.18% and 62.96% respectively. In general, the seedlings from treated seed bed were healthier than the untreated seed bed.

Table III analyses the results from the main field. The results obtained from first sampling (30 days after transplanting), 2nd sampling (prior to second application of carbofuran granules) and 3rd sampling (prior to harvesting) are not discussed just to avoid the repetition. Finally the grain yield was noted and it was found that T_1 subplots (main field treated with carbofuran granules, seedlings from treated seed bed) gave better yield than T_2 and T_3 subplots in which the loss has been calculated 19.22% and 18.33% respectively.

ACKNOWLEDGEMENTS

We are thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for providing research facilities. Thanks are due to the authorities of Chinsurah Rice Research Station for allotting the field in which the experiment was conducted and also for their co-operation during the course of investigations. The financial assistance from the I.C.A.R. under the All India Co-ordinated

Research Project on Nematode pests, is also acknowledged.

REFERENCES

- BAQRI, Q. H., JANA, A., AHMAD, N. AND DAS, P. K. 1983. Nematodes from West Bengal (India) VIII. Qualitative and Quantitative study of plant and soil inhabiting nematodes associated with paddy crop in Burdwan district. *Rec. zool. Surv. India*, **80** : 331-340.
- BONNEMAISON 1975. Protection of sugarbeet against animal pests by localised soil treatment or treatment of seeds. In International plant protection congress (8th) Moscow. Reports and Information Section III, Part I : 86-93.
- DAS, P. K. AND RAO, Y. S. 1970. Life history and Pathogenesis of *Hoplolaimus indicus* in rice. *Indian Phytopath.*, **23** : 459-464.
- DI SANZO, C. P. 1969. Some observations on the effect of carbofuran on three plant parasitic nematodes. *J. Nematol.*, **1** : 285 (Abstr.)
- DI SANZO, C. P. 1973. Nematode response to carbofuran. *J. Nematol.*, **5** : 22-27.
- MATHUR, V. K. AND PRASAD, S. K. 1971. Occurrence and some distribution of *Hirschmanniella oryzae* in the Indian Union with the description of *H. mangaloriensis* sp. n. *Indian J. Nematol.*, **1** : 220-226.
- MATHUR, V. K. AND PRASAD, S. K. 1974a. Embryonic development and morphology of larval stages of the rice root nematodes *Hirschmanniella oryzae*. *Indian J. Nematol.*, **2** (1972) : 146-157.

- MATHUR, V. K. AND PRASAD, S. K. 1974b. Role of the rice root nematode, *Hirschmanniella oryzae* in rice culture. *Indian J. Nematol.*, 2 (1972) : 158-168.
- MATHUR, V. K. AND PRASAD, S. K. 1974c. Control of *Hirschmanniella oryzae* associated with paddy. *Indian J. Nematol.*, 3 (1973) : 54-60.
- MUTHUKRISHNAN, T. S., RAJENDRAN, G., RAMAMURTHY, V. V. AND CHANDRASEKRAN, J. 1979. Pathogenecity and control of *Hirschmanniella oryzae*. *Indian J. Nematol.*, 7 (1977) : 8-16.
- OVERMAN, A. J. AND JONES, J. P. 1975. Carbofuran in a systematic approach to pest management in tomato. *Nematoropica*, 5 : 26-27.
- PANDA, M. AND RAO, Y. S. 1971. Evaluation of losses caused by the root nematode *Hirschmanniella mucronata* Das in rice (*Oryza Sativa* L.) *Indian J. agric. Sci.*, 41(7) : 611-614.
- PRASAD, K. S. K. AND RAO, Y. S. 1974. Chemotherapy of the rice plant against the infestation by the stunt nematode (*Tylenchorhynchus* sp.). *Indian J. Nematol.*, 3 (1973) : 80.
- RAMANA, K. V. AND RAO, Y. S. 1977. Histopathogenesis in rice roots infested by *Hoplolaimus indicus*. *Indian J. Nematol.*, 5 (1975) : 232-234.
- RAO, Y. S. 1970. Study of plant parasitic nematodes affecting rice production in the vicinity of Cuttack (Orissa) India. Final Technical Report (Mimeog). Indian Council or Agricultural Research 1-115.
- RAO, Y. S. AND BISWAS, H. 1974. Evaluation of yield losses in rice due to the root-knot nematode *Meloidogyne incognita*. *Indian J. Nematol.*, 3 (1973) : 74.
- SIDDIQUI, Z. A. AND KHAN, A. M. 1974. Evaluation of nematicides for the control of *Tylenchorhynchus brassicae* Siddiqui, 1961. *Indian J. Nematol.*, 3 (1973) : 31-33.
- VARMA, M. K., SHARMA, H. C. AND PATHAK, V. N. 1978. Evaluation of systemic granular nematicides against *Tylenchorhynchus* spp. parasitic on cabbage. *Indian J. Nematol.*, 8 : 59-60.
- VARMA, M. K., PRASAD K. S. AND MATHUR, V. K. 1980. Efficacy of carbofuran and Aldicarb sulfone seed treatment on plant growth and against *Meloidogyne incognita* on sugarbeet. *Indian J. Nematol.*, 10 : 130-134.

NEMATODES OF VEGETABLES AND PULSES
FROM PATNA DISTRICT, BIHAR—1

Y. CHATURVEDI AND K. C. KANSAL

Gangetic Plains Regional Station, Zoological Survey of India, Patna.

ABSTRACT

The present communication deals with eighteen species of nematodes found associated with vegetables and pulses in Patna district, Bihar. Most of the species have been recorded for the first time from Bihar and many new hosts are also reported. The heteromorphic tail in *Hoplolaimus* is dealt with.

INTRODUCTION

Only a few stray papers dealing with nematodes of Bihar have been published by workers like those of Sen (1960), Mathur & Prasad (1971), Mulk & Jairajpuri (1974) etc. The present studies have been taken up to improve our knowledge of plant parasitic nematode fauna of Bihar.

Three surveys were conducted covering different parts of the Patna district, Bihar, in 1978-1979. In the course of surveys 46 villages were visited and 137 rhizosphere samples from about 40 hosts of vegetables and pulses (a few other crops eg. paddy, castor etc.) were collected from several fields. The present communication deals with eighteen species of tylenchid nematodes. As very little is known about nematodes of Bihar state, most of the species constitute new records of their occurrence in the region.

SYSTEMATIC ACCOUNT

Family TYLENCHIDAE Filipjev, 1934

1. *Tylenchus filiformis* Bütschli, 1873

Tylenchus filiformis Bütschli, 1873, *Nova Acta Acad. Caesar. Leop. Carol.*, 36(5) : 1-144.

Dimensions : ♀ ♀ (4) : L = 0.42-0.56 mm, a = 33-37, b = 5.7-6.9, c = 4-5, c' = 8-12, V = 62-65, stylet = 10-13 μ m.

♂ ♂ (6) : L = 0.37-0.57 mm, a = 30-36, b = 4.2-5.8, c = 4-7, c' = 8-15, stylet = 12-13 μ m, spicula = 11-13 μ m, gubernaculum = 5-6 μ m.

Description : *Female*—Body slender, tapering towards extremities, straight, cuticular striations very fine, interrupted by lateral field; latter marked with four incisures. Head continuous, narrower than neck. Oesophagus tylenchoid, median bulb valvate. Vulva postequatorial, gonad anterior, outstretched. Tail filiform, longer than vulva-anus distance.

Male—General characters same as those of females except male characters. Spicula tylenchoid, bursa adanal.

Remarks—The species seems to be widely distributed.

Host—Radish, smoothgourd, eggplant, chilli, pigeonpea, gram and castor.

Locality—Patot, Kanpa, Umerabad, English, Baikatpur, Bakhtiyarpur, Mosimpur, Nukunpura, Metra, Hathidah.

2. *Psilenchus* sp.

Dimensions : j ♀ ♀ (2) : L=59-61 mm, a=38-40, b=5-6, c=6-7, c'=8, V=?, stylet=13 μm.

♂ (1) : L=0.85 mm, a=43, b=6.5, c=6, c'=10, stylet=13 μm, spicula=26 μm.

Description : Juvenile Female—Body slightly curved ventrally after thermal killing. Cuticle transversely striated, striae fine, lateral field occupying more than $\frac{1}{4}$ of body width, with four incisures. Head continuous with body. Stylet with round knobs. Procorpus longer than metacarpus and bulb together. Excretory pore opposite nerve ring, 80-98 μm from anterior end. Tail elongate, filiform, tip clavate. Vulva not developed. Gonads not developed, however, a cluster of germinal cells at about mid body.

Male—General characters same as those of female. Spicula tylenchoid ; gubernaculum thin, trough like. Bursa small, adanal.

Remarks—This genus is recorded from Bihar for the first time.

Host—Tomato, smooth gourd. Latter is a new host.

Locality—Maner, Lai.

3. *Ditylenchus* sp.

Dimensions : ♀ (1) : L=0.58 mm, a=30, b=6, c=8, c'=7, V=66, stylet—11 μm.

Description : Female—Body cylindroid, tapering on either end, arcuate ventrally. Cuticle finely striated transversely. Lateral field about $\frac{1}{4}$ of body width, only two incisures discernible. Head continuous with body contour, cephalic framework feeble. Stylet short with round knobs. Procorpus 31 μm long, median bulb 8 μm joining posterior bulb through a narrow isthmus. Posterior bulb overlapping intestine more than one body width. Isthmus alongwith posterior bulb 38 μm. Nerve ring 57 μm and excretory pore 77 μm both from anterior end.

Vulva flush with body surface, post-equatorial. Gonad mono-prodelphic, post-uterine sac about half the vulval body width long. Vulva-anus distance slightly less than twice the length of tail. Tail elongate, tapering to a subacute terminus.

Host—Coriander. This is a new host record.

Locality—Hardasbigha.

4. *Ditylenchus* sp.

Dimensions : ♀ (1) : L=0.75 mm, a=29, b=7, c=15, c'=4, V=81, stylet=10 μm.

Description : Female—General morphology same as described in previous case. Procorpus 33 μm, median bulb 13 μm long, oval ; posterior bulb including isthmus 47 μm long. Nerve ring 65 μm and excretory pore 87 μm both from anterior end. Vulva much posterior. Postvulval sac more than one and half vulval body width long.

Remarks—The above two specimens were collected from the same host and same locality (one sample) yet they differ in their body size, size of post vulval sac position of vulva and the values of c and c' . However, with only one specimen of each type at disposal species could not be determined.

Host—Coriander.

Locality—Hardasbigha.

5. *Pseudhalenchus indicus* Sethi nad Swarup, 1967

Pseudhalenchus indicus Sethi & Swarup, 1967, *Indian Phytopath.*, 20(1) : 26-28.

Dimensions : ♀ (1) : $L=0.64$ mm, $a=35$, $b=7$, $b'=4.3$, $c=14$, $c'=9$, $V=88$, = stylet $13 \mu\text{m}$.

♂ ♂ (2) : $L=0.39-0.63$ mm, $a=30-40$, $b=5.7-6.0$, $b'=5$, $c=10.0-11.3$, $c'=5.3-6.0$, stylet = $12-13 \mu\text{m}$, spicula = $15.6 \mu\text{m}$, gubernaculum = $6.5 \mu\text{m}$.

Description : *Female*—Almost straight and long body. Cuticle finely striated. Lateral field occupying $\frac{1}{3}$ of body width, with four smooth incisures. Head continuous. Oesophagus typical of the genus. Vulva posterior, ovary single, anterior and outstretched. Postvulvar sac about one and half body width long. Tail conoid, tapering with acute terminus.

Male—General characters as in females. Spicula and gubernaculum as found in the genus. Bursa ending subterminally.

Remarks—Present specimens tally in all respect with the original description of the species by Sethi & Swarup (1967). However, these specimens show slightly longer spicule ($14 \mu\text{m}$ —Sethi & Swarup). This difference is considered as intraspecific difference

between two populations occurring in widely separated areas.

The present record of the species from Bihar is new.

Host—Mustard, tomato and castor.

Locality—Nukunpura, Nirpur, Bidhipur.

6. *Pseudhalenchus anchilisposomus* Tarjan, 1958

Pseudhalenchus anchilisposomus Tarjan, 1958, *Proc. helminth. Soc. Wash.*, 25(1) : 20-25.

Dimensions : ♀ (1) : $L=0.49$ mm, $a=35$, $b=4.7$, $c=12$, $c'=5$, $V=82$, stylet = $8 \mu\text{m}$.

Description : *Female*—Body straight, cuticle finely striated. Lateral field about $\frac{1}{3}$ of body width having six incisures. Tail elongate-conoid with pointed tip. Postvulvar sac $\frac{2}{3}$ the vulva—anus distance.

Remarks—This is a new record of the species from Bihar.

Host—Pigeonpea.

Locality—Patot.

Family TYLENCHORYNCHIDAE (Eliava, 1964)
Golden, 1971

7. *Tylenchorhynchus mashhoodi* Siddiqi & Basir, 1959

Tylenchorhynchus mashhoodi Siddiqi & Basir, 1959, *Proc. Indian Sci. Congr.* : 35; Siddiqi, 1961, *Z Parasitkde.*, 21 : 46-64.

Dimensions : ♀ ♀ (4) : $L=0.53-0.62$ mm, $a=26-34$, $b=4.8-5.6$, $c=13-16$, $c'=3.0-3.3$, $V=53-56$, stylet = $13-16 \mu\text{m}$.

♂ ♂ (2) : $L=0.52-0.55$ mm, $a=30$, $b=4.7-5.2$, $c=14.8-15.7$, $c'=2.7$ stylet = $12 \mu\text{m}$, spicula = $18-22 \mu\text{m}$, gubernaculum = $9-10 \mu\text{m}$.

Description : *Female*—Body cylindrical, narrowing towards either ends. Cuticular striations moderat. Head continuous with

body. Lateral field marked with four incisures, occupying about $\frac{1}{8}$ of body width. Tail cylindrical, tapering posteriorly, having a maximum of 30 annules on ventral side. Last annule large.

Male—General characters same as in female.

Remarks—The specimens fit in well with the original description of the species and those given by Chaturvedi & Khera (1979). The variations noted by Baqri & Jairajpuri (1970) were also observed in the present specimens.

The species is widely distributed in the eastern part of the district and associated with a large number of hosts.

Host—Okra, banana, onion, "sonf", tomato, "bakla", potato, Indian bean, coriander, cauliflower, eggplant, chilli, pea, mustard, pigeonpea, "masur" and castor.

Onion, "sonf", 'bakla', coriander and 'masur' are new hosts.

Locality—Kanpa, Nukunpura, Dargahitola, Baikatpur, Chhatarpur, Hardasbigha, Athmalgola, Nirpur, Pandarak, Bakhtiyarpur, Bidhipur, Hathidah, Adimpur, Aunta, Bahpura, Metra, Sahnaura.

8. *Tylenchorhynchus dubius* (Bütschli, 1873) Filipjev, 1936

Tylenchus dubius Bütschli, 1873, *Nova Acta Acad. nat. Curios.*, 36(5) : 1-124.

Dimensions : ♀ ♀ (8) : L=0.48-0.75 mm, a=24-36, b=4.9-6.8, c=12-16, c'=2.3-3.5, V=53-54, stylet=12-14 μ m.

♂ ♂ (5) : L=0.51-0.62 mm, a=30-36, b=5.1-5.9, c=13-16, c'=2.4-3.2, stylet=12-16 μ m, spicula=18-22 μ m, gubernaculum=9-12 μ m.

Description : *Female*—Body cylindroid, straight or curved ventrally after thermal killing, tapering on both ends. Cuticle with transverse striations, striae interrupted by lateral field. Latter about $\frac{1}{8}$ of body width, marked with four incisures, which continue on tail. Phasmid in the anterior one third of tail. Tail cylindrical, tip round and striated, comprising 24-40 annules on ventral side. Head offset, hemispherical, consisting of 5-6 annules. Cephalic framework weakly sclerotized. Stylet knobs round, sloping posteriorly. Oesophagus typical of the genus. Vulva flush with body surface, gonads amphidelphic. Spermatheca functional.

Males—Except male characters all characters are same as those of females.

Remarks—The specimens fit well with the description of the species by Thorne (1961). The species is being recorded for the first time from Bihar.

Host—Eggplant, smooth gourd, tomato, "sonf", chilli, coriander, pigeonpea and castor. Smooth gourd, 'sonf' and coriander are new hosts.

Locality—Lai, Hardasbigha, Athmalgola, Nirpur, Nukunpura, Dargahitola, Bidhipur.

9. *Tylenchorhynchus clarus* Allen 1955

Tylenchorhynchus clarus Allen, 1955, *Univ. Calif. Publ. Zool.*, 61(3) : 129-166.

Dimensions : ♀ ♀ (2) : L=0.46-0.56 mm, a=32-33, b=4.1-5.5, c=15-17, c'=2.7, V=54-56, stylet=14-16 μ m.

Male not found.

Description : *Female*—Body curved ventrally. Head continuous with body contour, comprising 5 annules. Cuticle striated, lateral field $\frac{1}{8}$ of body width, incisures four.

Cephalic framework weakly developed. Stylet knobs round. Procorpus cylindrical, 30-37 μm long, median bulb subspherical 9-12 μm in diameter, terminal bulb with isthmus measuring 43-48 μm in length. Nerve ring 65-67 μm and excretory pore 70-72 μm both from anterior end. Intestinal sac present.

Vulva postequatorial, ovaries two, opposite and outstretched. Oöcytes arranged in a single row except in multiplication zone. Tail cylindrical, narrow behind, 28-35 annules on ventral side. Tail tip striated and pointed.

Remarks—The specimens fit well with the descriptions of the species by Allen (1955) and Tarjan (1964). This is the first record of the species from Bihar and "mung" and chilli are new hosts.

Host—Eggplant, chilli and "mung".

Locality—Hardasbigha, Patot, Metra.

Family BELONOLAIMIDAE (Whitehead, 1959)
Golden, 1971

10. *Telotylenchus indicus* Siddiqi, 1960

Telotylenchus indicus Siddiqi, 1960, *Nematologica*, 5 : 73-77.

Dimensions : ♀ (1) : $L = 0.59$ mm, $a = 30$, $b = 5.5$, $b' = 5$, $c = 15$, $c' = 2.6$, $V = 56$, stylet = 13 μm .

♂ (1) : $L = 0.52$ mm, $a = 33$, $b = 5.6$, $b' = 5$, $c = 16$, stylet = 13 μm , spicula = 19 μm , gubernaculum = 11 μm .

Description : Female—Body long, cylindrical, straight after fixation. Lateral field occupying $\frac{1}{3}$ of body width, marked with four incisures. Phasmid in anterior one third of tail. Head continuous, narrow than neck. Oesophagus as described for the genus. Ovaries two, opposite and out-

stretched. Tail subcylindrical having approximately 50 annules ventrally, tip round.

Male—Male similar to female in general characters. Spicules tylenchoid, gubernaculum thin and curved. Phasmid tubular, in anterior half of the tail. Bursa entire.

Remarks—The species is being recorded for the first time from Bihar and castor is a new host.

Host—Tomato and castor.

Locality—Maner and Nirpur.

Family PRATYLENCHIDAE (Thorne, 1949)
Siddiqi, 1963

11. *Pratylenchus pratensis* (De Man, 1880) Filipjev, 1936

Tylenchus pratensis DeMan, 1880, *Tijdschr. Ned. Dierk. Ver.*, 5 : 1-104.

Dimensions : ♀ ♀ (3) : $L = 0.48-0.53$ mm, $a = 21-26$, $b = 5.3-6.5$, $b' = 4.6-5.5$, $c = 18-19$, $c' = 2.0-2.4$, $V = 77-79$, stylet = 14-16 μm .

j ♀ ♀ (2) : $L = 0.34-0.44$ mm, $a = 20-26$, $b = 4.0-5.3$, $b' = 3.4-4.0$, $c = 11-13$, $c' = 2.0-2.4$. $V = ?$, stylet = 14-15 μm .

Male not found.

Description : Female—Ventrally curved body, specially posterior region. Head continuous, flat, having three annules. Cephalic framework strongly developed. Lateral field marked with four incisures. Tail cylindrical, tip round. Phasmid at about middle of the tail. Oesophagus pratylenchoid, oesophageal gland overlapping intestine ventrally. Stylet massive, knobs round.

Vulva flush with body surface, posterior ; vagina transverse about $\frac{1}{2}$ vulvar body width long. Vulva to anus distance three times the tail length.

Remarks—In one of the females a single egg measuring $59 \times 17 \mu\text{m}$ was present.

Host—Smooth gourd, cucumber, eggplant and “mung” Except eggplant all others are new hosts.

Locality—Faridpur, Manpura, Lai, Maner, Patot, Baikatpur.

12. *Hirschmanniella oryzae* (Soltwedel, 1889) Luc & Goodey, 1963

Tylenchus oryzae Soltwedel, 1889, *Verlag van de Director vijfde Jversl. Proefstn Milden Java over 1888/1889*, pp. 15-16.

Dimensions : ♀ ♀ (3) : $L=0.65-0.80$ mm, $a=35-38$, $b=6.5-8.5$, $b'=4.2-4.4$, $c=13-16$, $c'=4.1-4.5$, $v=54-57$, stylet= $17 \mu\text{m}$.

Male not found.

Description : *Female*—Body long, cylindrical, curved ventrally in different form. Head continuous, low, round, comprising 3-4 indistinct annules. Cephalic framework strongly cuticularised. Stylet stout, knobs round. Lateral field marked with four incisures, occupying $\frac{1}{8}$ of body width, not aerolated. Phasmid in posterior third of tail. Tail conoid, tapering, annulated up to tip. Tail tip pointed. Vulva posterior to mid-body. Ovaries two, opposite. outstretched.

Remarks—Mathur & Prasad (1971) recorded the species from Bihar from paddy soil.

Host—Paddy.

Locality—Umerabed.

Family HOPILOLAIMIDAE (Filipjev, 1934) Wieser, 1953

13. *Hoplolaimus indicus* Sher, 1963

Hoplolaimus indicus Sher, 1963, *Nematologica*, 9 : 267-295.

Dimensions : ♀ ♀ (8) : $L=0.98-1.24$ mm, $a=27-32$, $b=9-11$, $b'=6.5-8.5$, $c=46-56$,

$c'=0.6-0.9$, $V=53-56$, stylet= $34-35 \mu\text{m}$, $0=11-12$, anterior phasmid= $32-38\%$, posterior phasmid= $62-85\%$

♂ ♂ (3) : $L=1.04-1.05$ mm, $a=35-36$, $b=9.2-9.5$, $b'=6.0-7.3$, $c=40-45$, $c'=1.2-1.5$, stylet= $34-35 \mu\text{m}$, $0=11-12$, spicula= $39-41 \mu\text{m}$, gubernaculum= $14-16 \mu\text{m}$, anterior phasmid= 21% , posterior phasmid= $83-92\%$.

Description : *Female*—Body ‘C’ shaped after thermal killing. Cuticle thick, transversely striated, striae $2.0-2.6 \mu\text{m}$ apart in midbody region. Head set off, sides sloping, comprising three annules. Cephalic framework strongly developed. Lateral field absent, single incisure seen only in caudal region. Phasmids large, placed erratically on either side of vulva. Spear knobs round, anterior margin projecting anteriorly. Excretory pore 4-6 annules above hemizonid, $81-110 \mu\text{m}$ from anterior end. Nerve ring $85-96 \mu\text{m}$ from anterior end. Oesophageal gland with six nuclei, sometime only 4 or 5 discernible. Intestine overlapping rectum. Tail comprising 12 annules ventrally, tip round.

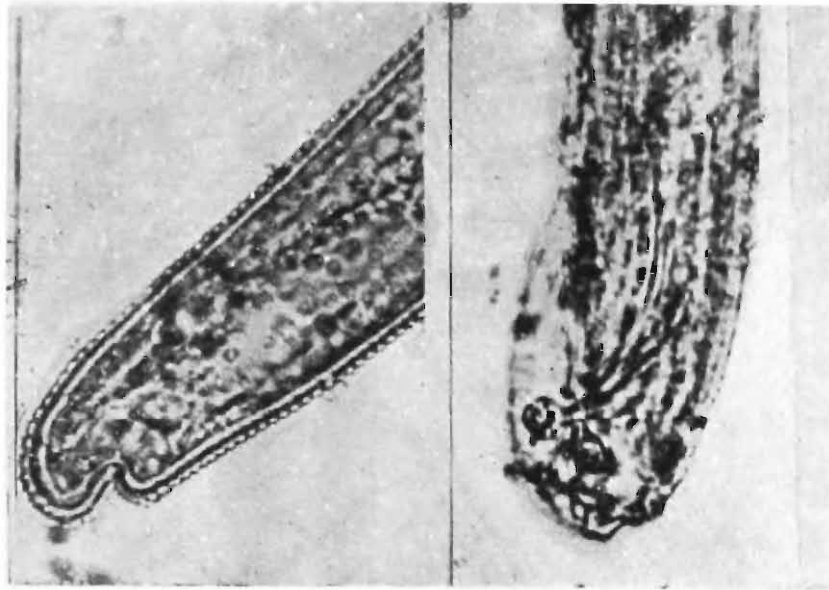
Male—Head more round. Other characters, as in female. Tail conical, bursa enveloping tail.

Remarks—The heteromorphism in tail was observed in two specimens, one juvenile female and other a male. The two specimens showed the following measurements :—

j ♀ (1) : $L=0.69$ mm, $a=26$, $b=7$, $b'=5.3$, $c=47$, $c'=0.7$, $V=?$, stylet= $31 \mu\text{m}$.

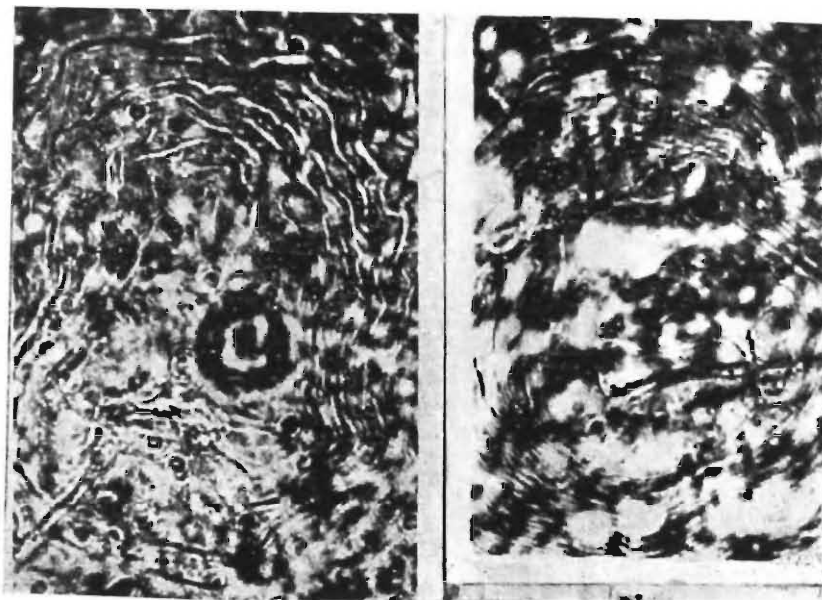
♂ (1) : $L=0.91$ mm, $a=26$, $b=8$, $b'=7$, $c=64$, $c'=0.9$, stylet= $34 \mu\text{m}$, spicula= $36 \mu\text{m}$, gubernaculum= $15 \mu\text{m}$.

The female tail (Plate IIIa) shows a deep notch on its dorsal side. At first glance,



a

b



c

d

Figs. 1a. *Haplolaimus indicus*—Female tail
1b. *Haplolaimus indica*—Male tail
1c. *Meloidogyne incognito*—Perineal pattern
1d. *Meloidogyne javanica*—Perineal pattern

notch gives the impression of anal opening but a careful examination shows that anus is situated on ventral side as in normal specimens. Such abnormalities in female tails have been reported by Gupta & Edward (1974) in *Hoplolaimus* sp. and Mulk & Jairajpuri (1975) in *H. dimorphicus*. However, in Gupta & Edward's specimens anus was reported to be terminal unlike in present case.

In case of male specimen tail (Plate IIIb) has become much shorter ($C = 64$ versus 40-45 in normal ones). There is a deep notch just posterior to anus. The tail tip is flattened with a somewhat conical stump over it. Bursa extends only up to flattened part leaving free the stumpy portion. The abnormal male tail is reported by Mulk & Jairajpuri (1975) which, however, differs from present one in morphological details.

Host—Okra, chilli, banana, onion, tomato, coriander, been, potato, cauliflower, "bakla", eggplant, "sonf", mustard, pea, pigeonpea, gram. 'Sonf', coriander and 'bakla' are new hosts.

Locality—Dariyapur, Kasimpur, Srinagar, Dilawarpur, Kanpa, Chhattarpur, Nirpur, Bakhtiyarpur, Nukunpura, Pandarak, Baikatpur, Athmalgola, Dargahitola, Bidhipur, Hardasbiga, Bahpura, Hathidah, Adimpur, Sahanaura and Metra.

14. *Helicotylenchus indicus* Siddiqui, 1963

Helicotylenchus indicus Siddiqui, 1963, *Z. ParasitKde*, 23 : 239-244.

Dimensions : ♀ (1) : $L = 0.57$ mm, $a = 21$, $b = 5$, $b' = 4.6$, $c = 44$, $c' = 0.8$, $V = 63$, stylet = 23 μ m.

Description : Female—Body curved spirally. Head conoid rounded, comprising 5 indistinct

annules. Cephalic framework moderately developed.

Remarks—The specimen fits well with the description of the species by Sher (1966) and Nandakumar & Khera (1970). This is the first record of the species from Bihar.

Host—Banana.

Locality—Bhedhari-english.

15. *Helicotylenchus multicinctus* (Cobb, 1893) Golden, 1956

Tylenchus multicinctus Cobb, 1893, *Agric. Gaz. N. South Wales*, 4(10) : 808-833.

Dimensions : ♀ ♀ (2) : $L = 0.50-0.58$ mm, $a = 24-26$, $b = 5.2-5.4$, $b' = 4.1-4.4$, $c = 48-49$, $c' = 1.0-1.1$, $V = 62-66$, stylet = 22-24 μ m.

♂ ♂ (3) : $L = 0.46-0.49$ mm, $a = 28-29$, $b = 4.3-4.4$, $b' = 4.0-4.2$, $c = 36-37$, $c' = 1.0-1.1$, stylet = 21-22 μ m, spicula = 16-17 μ m, gubernaculum = 6-7 μ m.

Description : Female—Body curved spirally. Head conoid-round comprising 3-4 annules. Spermatheca functional, sperms seen in one female. Tail 7-8 annules long, terminus hemispherical with a suggestion of ventral projection.

Male—Males are similar to females except in male characters.

Remarks—The species is being recorded for the first time from Bihar.

Host—Banana.

Locality—Chhattarpur.

16. *Helicotylenchus digonicus* Perry, 1959

Helicotylenchus digonicus Perry, 1959, (in Perry, Darling & Thorne), *Univ. Wisconsin Res. Bull.*, 207 : 1-24.

Dimensions : ♀ ♀ (3) : $L = 0.48-0.57$ mm, $a = 23-24$, $b = 4.7-5.5$, $b' = 3.7-5.0$, $c = 39-44$, $c' = 1.0-1.2$, $V = 61-63$, stylet = 23-26 μ m.

Description: Female—Body spiral after thermal killing. Tail 9-11 annules with small ventral projection. Lateral field with four incisures, $\frac{1}{5}$ - $\frac{1}{4}$ of body width. Incisures continuing up to tail tip. Phasmid 6-8 annules anterior to anus.

Remarks—The specimens fit well with the descriptions of the species by Sher (1966) except the head shape which is stated to be truncate by Sher (*loc.cit.*). However, this character is very variable as pointed out by Nanadakumar & Khera (1970) and Siddiqui (1972).

This is the first record of the occurrence of the species in Bihar.

Host—Cucumber, tomato, Indian bean, asparagus bean, eggplant, smooth gourd, bottle gourd, okra, pea and gram.

Locality—Manpura, Maner, Baikatpur, Bakhtiyarpur, Faridpur, Silhoura and Dariyapur.

Family HETERODERIDAE (Filipjev, 1934) Skarbilovich, 1947

17. *Meloidogyne incognita* (Kofoid & White, 1919) Chitwood, 1949

Oxyuris incognita Kofoid & White, 1919, *J. Am. Med. Ass.*, 72(8): 567-569.

Female Perineal pattern—Vulvar width = 16 μ m, vulvar length = 4-7 μ m, anus to tail terminus = 13-16 μ m, anus to centre of vulva = 16-20 μ m.

“*acrita* type” (Plate IIIc)—Striae coarse, widely spaced; dorsal arch high and flat, giving rather rectangular look. Ventral arches close and round. Lateral field absent.

“*incognita* type”—Striae closely spaced. Dorsal as well as ventral arches round. Lateral field absent.

Host—Eggplant, kora.

Locality—Nagwan.

18. *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949.

Heterodera javanica Treub, 1885, *Meded. Land. Voor Dienst. Buitenz.*, 2: 1-39.

Dimensions: ♀ ♀ (3): L = 0.79-0.83 mm, body width = 0.42-0.48 mm, neck = 31.5-33.0 μ m, stylet = 27 μ m, median bulb = 36 × 30 μ m.

♂ (1): L = 1.18 mm, a = 30, b' = 8.3, c = 61, stylet = 19 μ m, spicula = 33 μ m, gubernaculum = 6 μ m.

Female Perineal pattern (Plate III d)—Vulvar width—20 μ m, vulvar length = 7 μ m, anus to tail terminus = 9 μ m, anus to centre of vulva = 14 μ m, interphasmidal distance = 39 μ m.

Striae fine, closely spaced and round. Lateral field wide, marked by two incisures. Anal fold and short striae on the sides of vulva present.

Remarks—Okra roots were found heavily infested by this species, causing very large size composite knots.

Host—Okra.

Locality—Silhoura.

ACKNOWLEDGEMENTS

We are thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta and the Officer-in-Charge, Gangetic Plains Regional Station, Patna for providing necessary facilities for the present work. We are also thankful to Shri R. B. Sharma, Photographer, P. R. Stn., Patna for the photographs.

REFERENCES

- ALLEN, M. W. 1955. A review of the nematode genus *Tylenchorhynchus*. *Univ. California Publ. Zool.*, **61** (3) : 129-166.
- BAQRI, Q. H. & JAIRAJPURI, M. S. 1970. On the intraspecific variations of *Tylenchorhynchus mashhoodi* Siddiqi & Basir, 1959 and an emended key to species of *Tylenchorhynchus* Cobb, 1913 (Nematoda). *Revta bras. Biol.*, **30**(1) : 61-68.
- CHATURVEDI, Y. & KHERA, S. 1979. Studies on taxonomy, biology and ecology of nematodes associated with jute crop. *Zool. Surv. India Tech. Monogr.*, **2** : 1-105.
- GUPTA, P. & EDWARD, J. C. 1974. Heteromorphism in tail shapes of females of *Hoplolaimus* sp. *Indian J. Nematol.*, **4**(1) : 100-101.
- KOSHY, P. K. & SWARUP, G. 1971. Distribution of *Heterodera avenae*, *H. zaeae*, *H. cajani* and *Anguina tritici* in India. *Indian J. Nematol.*, **1** (2) : 106-111.
- MATHUR, V. K. & PRASAD, S. K. 1971. Occurrence and distribution of *Hirschmanniella oryzae* in Indian Union with description of *H. mangalorensis* sp. n. *Indian J. Nematol.*, **1**(2) : 220-226.
- MULK, M. M. & JAIRAJPURI, M. S. 1974. Nematodes of leguminous crops in India. II. Five new species of *Helicotylenchus* Steiner, 1945 (Hoplolaimidae). *Indian J. Nematol.*, **4** (2) : 212-221.
- MULK, M. M. & JAIRAJPURI, M. S. 1975. Nematodes of leguminous crops in India. III. Three new species of *Hoplolaimus* Daday, 1905 (Hoplolaimidae). *Indian J. Nematol.*, **5** (1) : 1-8.
- NANDAKUMAR, C. & KHERA, S. 1970. *Helicotylenchus indicus* Siddiqi, 1963 with certain remarks on the genus *Helicotylenchus* Steiner, 1945 and some of its species. *Indian J. Helminth.*, **22** (1) : 46-52.
- SEN, A. K. 1960. Preliminary studies on parasitic nematodes of vegetable crops in Bihar. *Indian agric.*, **4** : 113-116.
- SETHI, C. L. & SWARUP, G. 1967. *Pseudohelicotylenchus indicus* a new nematode species from India (Tylenchinae : Nematoda). *Indian Phytopath.*, **20** (1) : 26-28.
- SHER, S. A. 1966. Revision of the Hoplolaiminae (Nematoda). VI. *Helicotylenchus* Steiner, 1945. *Nematologica*, **12** : 1-56.
- SHER, S. A. & ALLEN, M. W. 1953. Revision of the genus *Pratylenchus* (Nematoda : Tylenchidae). *Univ. California Publ. Zool.*, **57** (6) : 441-470.
- SIDDIQI, M. R. 1972. On the genus *Helicotylenchus* Steiner, 1945 (Nematoda : Tylenchida) with descriptions of nine new species. *Nematologica*. **18** : 74-91.
- TARJAN, A. C. 1964. A compendium of the genus *Tylenchorhynchus* (Tylenchidae : Nematoda). *Proc. helminth. Soc. Wash.*, **31** (2) : 270-280.
- THORNE, G. 1961. *Principles of Nematology*. McGraw Hill, New York, 553 pp.

NOTES ON SOME DERMAPTERA PRESENT IN THE 'INSTITUT FÜR
PFLANZENSCHUTZFORSCHUNG KLEINMACHNOW,
EBERSWALDE-FINOW, DDR'

G. K. SRIVASTAVA

Zoological Survey of India, Calcutta

ABSTRACT

Altogether 15 species, including a new species of the genus *Cranopygia* from Australia and eight others determined upto generic level are dealt with. Besides, *Labia browni* Hincks, is placed as synonym of *Labia boettcheri* Borelli and lectotype and paralectotypes are designated for *Prolabisca infernalis* (Burr).

INTRODUCTION

The present paper is based on a small collection of Dermaptera received from Institut für Pflanzenschutzforschung Kleinmachnow, Eberswalde-Finow, DDR. It comprises 20 exs. belonging to 15 spp., including 8 determined upto generic level which are either represented by nymphs or females and a new species under the genus *Cranopygia* Burr, from Sydney (Australia). Besides, lectotype and paralectotypes of *Prolabisca infernalis* (Burr) are designated. As a result of reexamination of types of *Labia boettcheri* Borelli, it is found that *Labia browni* Hincks, from Seychells is its synonym. Female syntype of *Chaetospania fulvochracea* Borelli is figured here for the first time.

Family : PYGIDICRANIDAE

Subfamily : PYGIDICRANINAE

Cranopygia sp.

Material examined.—PHILIPPINE Isls., Palawan, Binaluan, 1 ♀, Dez. 1913 (leg. G. Boettcher), det. by Borellia as *Kalocrania* sp.

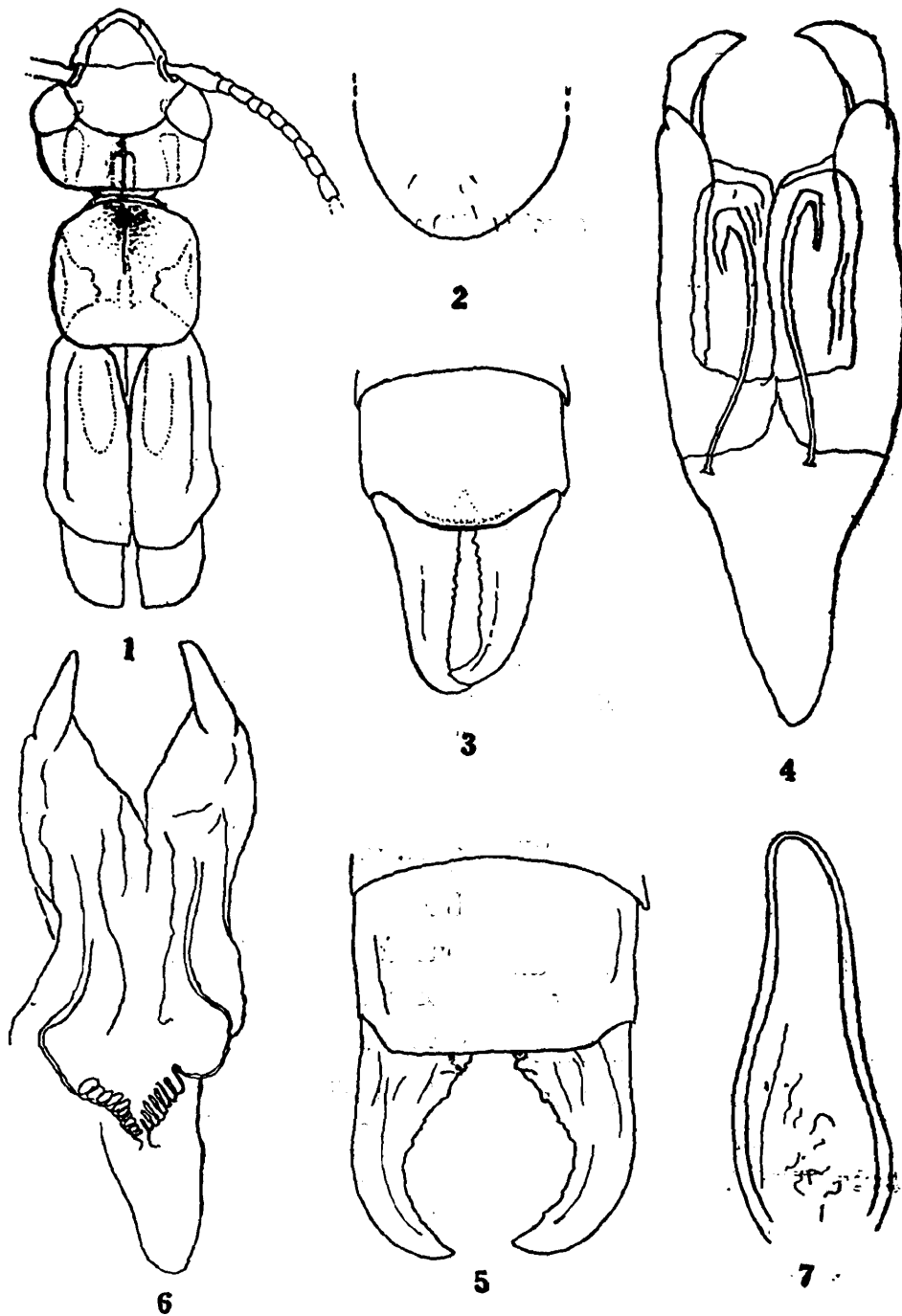
Cranopygia lueddemanni sp. n.

(Figs. 1-4)

Male.—General colour brownish black, mouth parts and antennae yellow, head with a yellow spot close to inner margin of eye, occiput with a pair of dull brownish yellow stripes, inner pair on either side of median suture, pronotum with an oval yellow spot laterally, elytra with an oblong yellow patch in basal half, wings clear yellow and legs yellow but femora with a brownish black streak. Long and short pubescence present, especially on abdomen and forceps. Head longer than broad, smooth, frons feebly raised, straight. Antennae partly broken, 27 segments present on right side and 20 on the left. Eyes as large as genae. Pronotum slightly longer than broad, sides feebly convex, especially posteriorly, hind angles rounded, margin almost straight, median sulcus distinct, prozona raised and metazona depressed. Tegmina and wings well developed, former with anal angles rounded, exposing a small triangular

scutellum. Abomen convex, gradually enlarging posteriorly, pubescent. Ultimate tergite smooth, strongly pubescent except for a triangular area in the middle posteriorly without hairs, median sulcus obsolete, hind

margin feebly sinuate laterally, thickened in middle, laterally with a curved carina. Penultimate sternite narrowed posteriorly with hind margin rounded, without median sulcus. Forceps depressed, almost straight with apices



Figs. 1-7. *Cranopygia lueddemanni* sp. n., Holotype ♂, 1. Anterior portion of body, 2. Posterior margin of penultimate sternite, 3. Ultimate tergite and forceps, 4. Genitalia: *Prolabisca infernalis* (Burr), Lectotype ♂, 5. Ultimate tergite and forceps, 6. Genitalia, 7. Paramere enlarged.

gently hooked and pointed, inner margin below crenate. Genitalia as seen in fig 4.

Female.—Unknown

Measurements.—(in mm)

	Holotype
	♂
Length of body	14.7
Length of forceps	2.9

Material examined.—*Holotype* ♂ (genitalia mounted between two coverslips and pinned with the specimen), Sydney (Australia), coll. *Lüddemann*, no further data; deposited in the collection of Akademie der Landwirtschaftswissenschaften der D. D. R., Institut für Pflanzenschutzforschung Kleinmachnow, Bereich Eberswalde DDR-13 Eberswalde DDR.

Remarks.—This species combines the characters of *Cranopygia ophthalmica* (Dohrn) and *C. daemeli* (Dohrn), both known from Australia, but differs from the former in having the ultimate tergite smooth, longer virga and parameres devoid of external apical projection and from the latter in having a carina on the sides of ultimate tergite and distinctive parameres. The interpretation of above two species is that of Hincks (1959).

Subfamily PROLABISCINAE

***Prolabisca infernalis* (Burr)**

(Figs. 5-7)

Chaetospania infernalis Burr, 1913, *Ent. Mitt.*, 2 : 67, fig (Taihorin, 1 ♂, 7 ♀ and nymphs, excluding 1 ♂ (nec ♀), Kosempo).

Material examined.—*Syntype* ♂ labelled as (i) Taihorin, Formosa, H. Sauter, 1911; (ii) 7. VIII; (iii) Burr det.; (iv) *Syntypus*—printed in black on red label and (v) Type

—printed in black on faint purple label; designated as *lectotype*, ♂ genitalia mounted between coverslips and pinned with the specimen.

Syntypes 1 ♀ and nymph with all the labels as the lectotype except the last one; designated as *paralectotypes*.

Remarks.—Besides above material, *syntype* 1 ♀ labelled as (i) Kosempo Formosa, H. Sauter, VII. 1911; (ii) Burr det.; (iii) *Syntypus*—printed in black on red label, does not belong to this species and is referable to *Labia curvicauda* (Motschulsky).

The original description of the species (Burr, 1913) is adequate. However, the ultimate tergite and forceps and genitalia of lectotype ♂ are figured here.

Family CARCINOPHORIDAE

Subfamily PLATYLABINAE

***Platylabia major* Dohrn**

Platylabia major Dohrn, 1867, *Stettin. ent. Ztg.*, 28 : 347 (♀, Celebes).

Material examined.—Annam (VIETNAM), Phuc Son, 2 ♀ ♀, det. by Menozzi as *Chaetospania* sp. (no further data).

Subfamily CARCINOPHORINAE

***Euborellia* sp.**

Material examined.—CHRISTMAS Island; 2 ♀ ♀, 2 nymphs, 1-IV. 1933 (No further data).

***Anisolabis* sp.**

Material examined.—Annam (VIETNAM), Phuc Son, 1 ♀ (*Früshorfer*).

***Titanolabis* sp.**

Material examined.—AUSTRALIA: Sydney, 2 ♀ ♀ (Coll. *Lüddemann*)—no further data.

Remarks.—Size including forceps is 30 mm. General colour is reddish black with head globose. Elytra and wings are wanting and body is impunctate.

Family LABIDURIDAE

Subfamily LABIDURINAE

Labidura riparia (Pallas)

Forficula riparia Pallas, 1773, *Reise Reichs.*, 2: 727 (Shores of Irtysh River, Western Siberia).

Material examined.—AUSTRALIA, Sydney, 1 ♂, West Riverina, 1 ♂ (Coll. *Liidde-mann*)—no further data.

Remarks.—Wings are concealed in both the specimens.

Labidura sp.

Material examined.—FORMOSA (TAIWAN), Anping, 1 nymph (early instar), VII, 1911 (*H. Sauter*).

Forcipula sp.

Material examined.—FORMOSA (TAIWAN), Chip Chip, 3 nymphs, II. 09 (*H. Sauter*).

Family LABIIDAE

Subfamily SPONGIPHORINAE

Marava feae (Dubrony)

Labia feae Dubrony, 1879. *Annali Mus. civ. Stor. nat. Giacomo Doria*, 14: 368 (Nouvelle Guinée, Ramoi 1 ♂, Iles key 1 ♀)

Material examined.—Brit. New Guinea, 1 ♂ (*Jablovowsky*); AUSTRALIA, Sydney, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen) (Coll. *Liidde-mann*).

Irdeux sp.

Material examined.—FORMOSA (TAIWAN), Sui-Sharyo, 2 ♀ ♀ (*H. Sauter*).

Subfamily LABIINAE

Labia pilicornis (Motschulsky)

Labia pilicornis Motschulsky, 1863, *Bull. Soc. Imp. Nat. Moscou*, 36 (2): 2 (♀; Nura Ellia Mountain, Ceylon).

Material examined.—CHRISTMAS ISLAND Sulu Str., 1 ♀, 3.11.33; Bzusuen Str., 4 nymphs, 28.1.33 (*Alkolov*).

Remarks.—Reported for the first time from the area.

Labia lutea (Bormans)

Spongophora lutea Bormans, 1894, *Annali Mus. civ. Stor. nat. Giacomo Doria*, (2) 14: 386 (♂, ♀; Burma).

Material examined.—TAIWAN, Sokutsu, Banshryo Distr., 1 ex. (hind portion of abdomen missing), 7.VII.1912 (*H. Sauter*).

Remarks.—Even in the absence of hind portion of body the present specimen can be easily identified by the shape of head, pronotum and presence of short stiff hairs on the costal margin of elytra and long and thin tarsal joints.

Labia boettcheri Borelli

(Figs. 8-11)

Labia boettcheri Borelli 1923, *Boll. Musei Zool. Anat. comp. R. Univ. Torino*, 38 (NS. 13): 7 (♂, ♀; N. Palawan).

Labia browni Hincks, 1954, *Proc. R. ent. Soc. Lond.*, (B) 23 (9-10): 159, figs. 1, 2 (♂, ♀ and nymphs; Seychelles—Types in British Museum (Natural History), London)—*Syn. nov.*

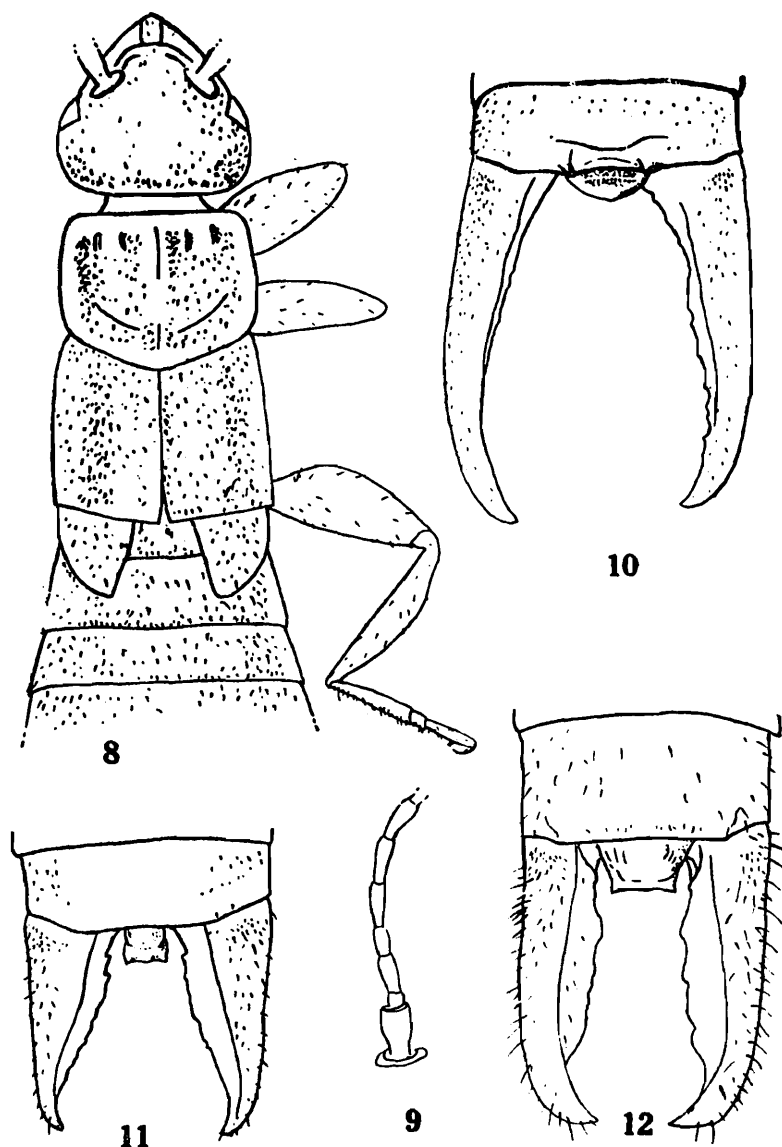
Material examined.—Type ♂ labelled as (i) N. Palawan, Binaluan, Nov.—Dez. 1915; (ii) Borelli det.; (iii) *Labia boettcheri* Type (hand written label by Borelli); (4) *Syntypus*—printed on red label. This specimen may be treated as the Holotype. Genitalia appears to have been taken out earlier.

Paratype ♀ labelled as (i) N. Palawan, Nov.—Dez. 1915; (ii) Borelli det.; (iii) *Labia boettcheri* n. sp., ♀ (handwritten label by Borelli); (iv) *Syntypus*—printed on red label. This specimen is paratype though not labelled as such.

Remarks.—Borelli's original description (1923) is adequate. However, following additional characters are given: Head smooth (impunctate), eyes shorter than genae in

length; 1st antennal segment almost equal to the distance between antennal bases and hind metatarsal segment longer than the combined length of meso and protarsi and its width almost 1/4 of its length.

Labia browni Hincks (1954) described from Seychelles is considered here synonym of this species since the description of both species are almost identical.



Figs. 8-12. *Labia boettcheri* Borelli, Type ♂, 8. Anterior portion of body, 9. A few basal antennal segments, 10. Ultimate tergite and forceps; ♀, 11. Ultimate tergite and forceps: *Chaetospania fulvochracea* Borelli, Syntype ♀, 12. Ultimate tergite and forceps.

Chaetospania fulvochracea Borelli
(Fig. 12)

Chaetospania fulvochracea Borelli, 1923, *Boll. Musei Zool. Ant. comp. R. Univ. Torino*, 38 (N. S. 13) : 8 (♂, ♀, Mindanao and Palawan).

Material examined.—*Syntypes* 2 ♀ ♀ labeled as (i) N. Palawan, Binaluan, Nov.—Dez. 1913, leg. Boettcher ; (ii) Borelli det., (iii) *Syntypus*—printed in black on red label ; (iv) *Chaetospania fulvochracea* sp. n. Borelli—in Borelli's handwriting.

Remarks.—Ultimate tergite and forceps of female are figured here for the first time.

Family CHELISOCHIDAE

Subfamily CHELISOCHINAE

Chelisoches morio (Fabricius)

Forficula morio Fabricius, 1775, *Syst. Ent.*, 70 ("Insulae Otachoita maris pacifici") Tahiti.

Material examined.—CELEBES, Bulhain, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 2 ♀ ♀, 1934 (Coll. *Schaufuss dedic.*).

Remarks.—The male specimen possessess short and stout forceps representing microlab-bic form.

Hamaxas sp.

Material examined.—PHILIPPINE Isls., N. Palawan, Binaluan, 1 ♀, Nov.—Dez., 1913 (leg. *G. Boettcher*) ; det. by Borelli as *Hamaxas* sp. ♀

Bulletin of the Zoological Survey of India

Remarks.—In the absence of male it is not possible to place it under any species.

ACKNOWLEDGEMENTS

I am thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for providing necessary facilities. My thanks are also due to Dr. Günther Petersen, Institute für Pflanzenschutzforschung Kleinmachnow, 13—Eberswalde—Finow, DDR for very kindly arranging for the loan of material for my study.

REFERENCES

- BORELLI, A. 1923. Dermatteri delle Isole Filippine Nota VI. *Boll. Musei Zool. Anat. R. Univ. Torino*, 38 (N. S. 13) : 1-20.
- BURR, M. 1913. H. Sauter's Formosa—Ausbeute : Dermaptera. *Ent. Mitt.*, 2 : 65-70.
- HINCKS, W. D. 1954. Notes on Dermaptera, I-III. *Proc. R. ent. Soc. Lond.*, (B) 23 : 200-204.
- HINCKS, W. D. 1959. *A systematic monograph of Dermaptera of the World, Part II. Pygidicranidae excluding Diplatyinae*. 218 pp. London, British Museum (Natural History).

ON THREE ABNORMAL SPECIMENS OF *MYSTUS CAVASIUS* (HAMILTON)
(FAMILY : BAGRIDAE)

(Miss) ANURADHA CHAKRABARTI*

Zoological Survey of India, Calcutta

ABSTRACT

Three abnormal specimens of *Mystus cavasius* Hamilton (Order Siluriformes : Bagridae) were found during the course of a revisionary study of the fishes of the genus *Mystus* Scopoli. The right maxillary barbel in two specimens are found to be short in length, and dissimilar in girth than its counterpart on the left side. The maxillary bone attachment of the barbel is also very prominent. In the third example the pelvic fin on the left side is rudimentary and not developed. The caudal fin in this specimen is also abnormal with the lobes unequal. These teratological abnormalities are ascribed to disproportionate growth and not due to any injury.

During the course of a world revision of the catfishes of the genus *Mystus* Scopoli three examples of *Mystus cavasius* (Hamilton) were seen to be abnormal with some teratological peculiarities. These are discussed in this paper.

ABNORMAL SPECIMENS

Lot A :

Regd. no. Cat 525, three examples collected from Tenasserim by Major Berdmore.

One example measuring 134.2 mm in standard length has the right maxillary barbel dissimilar in length, girth and point of origin as compared to the maxillary barbel on its left side.

The left maxillary barbel measures 119.1 mm in length from its base to the tip, while the right maxillary barbel measures only 61.4 mm in length. The other two

specimens in the lot are normal, measuring 113.9 mm and 90.1 mm in standard length and have the maxillary barbels 82.8 mm and 78.1 mm or near about in length on both sides respectively. The right maxillary barbel is of uniform normal thickness upto a distance of 5.9 mm from its base. Thereafter it suddenly thins out in the form of a filament.

The maxillary barbel on the right side which is stunted is 57.7 mm shorter in length and is much thinner in diameter than its counterpart on the left side. The fish is normal in all other external features.

The right maxillary barbel does not show any scar in its length nor at its place of insertion, indicating that the abnormality is not due to any injury.

Another notable feature observed in this example is that the maxillary bone support

* *Junior Research Fellow.*

for the barbel is well defined in the form of a hard, rectangular bony plate, measuring 5.9 mm in length and 0.9 mm in width on the right side.

Lot B :

Regd. no. F. 784, one example from Calcutta, purchased from Dr. F. Day.

This example measures 80.7 mm in standard length. In this specimen, the left maxillary barbel measures 72.1 mm in length from its base to the tip, while the right maxillary barbel measures only 31.2 mm in length. The right maxillary barbel is much thinner in diameter than the left maxillary barbel. Barring this, the fish is normal in its external features and there is no sign of external injury.

Lot C :

Regd. no. F. 12139/1, five examples collected from Poona by Mr. C. V Kulkarni, Dept. of Fisheries, Bombay state.

One example measuring 105.1 mm in standard length is found to have the pelvic fin on the left side rudimentary and not developed.

The distance between the pectoral and the rudimentary pelvic fin of the specimen under report is 29.1 mm. The right pelvic fin of the fish is quite normal, having one simple and five branched rays while the left pelvic fin has only two branched rays.

The caudal fin in this specimen is also abnormal in the sense that the two lobes are not uniform. The lower lobe is stunted in growth and considerably shorter, measuring only 15.2 mm while the upper lobe measures 24.6 mm. Generally in *Mystus cavasius* (Hamilton) the upper lobe has seven and

lower lobe eight branched rays. However in this specimen, the upper lobe has five clearly branched rays, the sixth ray is rudimentary, though the branching is discernible. In the lower lobe six rays are clearly branched, the seventh and the eighth rays appear to have become completely fused with that of the sixth ray of the upper lobe.

This specimen as compared to the normal specimens of *Mystus cavasius* (Hamilton) is somewhat brownish in colour, the adipose dorsal fin commences with a small interspace from the rayed dorsal fin, the head is narrower and the body with faint longitudinal stripes. In most specimens of *Mystus cavasius* (Hamilton), that I have examined the colour is uniformly pale, the adipose fin commences without any interspace from the rayed dorsal fin, the head is broader and the body plain without any stripes.

DISCUSSION

In the Teleosts, which are bilaterally symmetrical, the occurrence of asymmetrically paired organs is very rare. Dissimilarity in the growth of paired maxillary barbels is generally exceptional.

Menon (1973) recorded the absence of pelvic fins on both sides in *Tachysturus platystomus* (Day) (= *Arius platystomus*) (Ariidae). Sundarsingh (1975) reported the presence of stunted pectoral spine in *Mystus montanus* (Jerdon) (Bagridae). Absence of pectoral and pelvic fins in two abnormal specimens of *Silonia silondia* (Hamilton) has been reported by Singh (1975) (Schilbeidae). Rahman and Raghavan (1977) reported on a tailless example of the "magur" *Clarias*

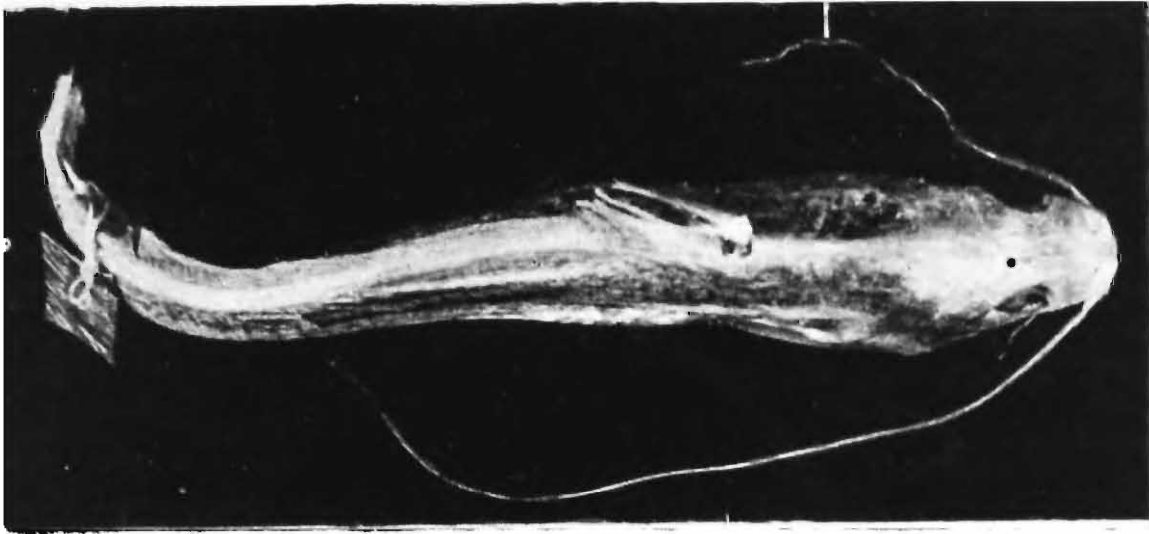


Fig 1. Dorsal view of specimen No. Cat 525 (SL 134.2 mm) showing the stunted maxillary barbel.

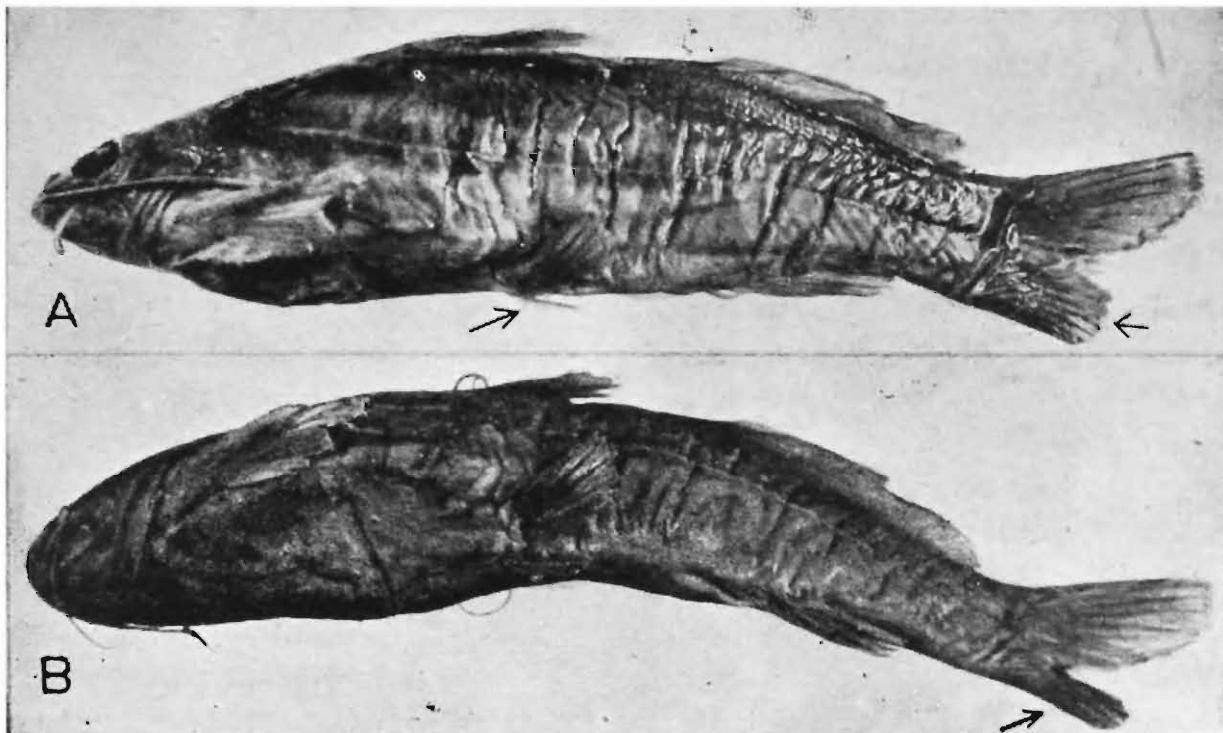


Fig. 2. A. Lateral view of specimen No. F. 12139/1, showing the rudimentary pelvic fin (see arrow).
B. Ventro-lateral view of the same specimen showing the abnormal lower lobe of the caudal fin.

batrachus (Linnaeus) (Clariidae). Chandrasekaran (1979) reported the presence of forked left maxillary barbel in *Tachysurus maculatus* (Thunberg) = (*Arius maculatus*) and the absence of right pelvic fin in *Osteogeneiosus militaris* (Linnaeus) which belong to Ariidae.

It appears that abnormalities of the maxillary barbel on the right side alone in both the examples and the prominent maxillary bone support for the barbel are not due to any injury but may be due to disproportionate growth.

ACKNOWLEDGEMENTS

The author is grateful to Dr B. K. Tikader, Director, Zoological Survey of India for the facilities and to Dr K. C. Jayaram, Joint Director, for his constant encouragement, guidance and kind suggestions in the preparation of this paper.

REFERENCES

- EDWIN CHANDRASEKARAN, G. 1979. Forked barbel and absence of pelvic fin in marine cat fishes of the family Ariidae. *Matsya*, **5** : 78-79.
- MENON, N. GOBINATHA. 1973. Note on a specimen of *Tachysurus platystomus* (Day) without pelvic fins. *Indian J. Fish.*, **20** (2) : 679-681.
- RAHMAN, M. F. and RAGHAVAN, S. L. 1977. Record of a tailless *Clarias batrachus* from Hebbal Tank. *J. Intl. fish. Soc. India*, **8** : 124.
- SUNDARSINGH, M. 1975. Record of a specimen of *Mystus montanus* (Jerdon) with stunted pectoral spine. *Curr. Sci.*, **44** (11) : 388-389.
- SINGH, S. P. 1979. Abnormalities in paired fins of *Silonia silondia* (Hamilton). *J. zool. Soc. India*, **27** (1 & 2) (1975) : 178-180.

MEROPHYSIINAE (COLEOPTERA : MEROPHYSIIDAE) FROM
INDIA AND SRI LANKA

T. SENGUPTA AND T. K. PAL

Zoological Survey of India, Calcutta

ABSTRACT

Systematic position of Merophysiinae is discussed, *Displotera* Reitter has been redefined and *D. grandis* Dajoz has been synonymised with *D. beloni* (Wasmann), *D. beloni* is first time recorded from West Bengal.

INTRODUCTION

Crowson (1955) separated the tribes Merophysiini and Holoparamecini from the Lathridiidae to establish the family Merophysiidae and attributed subfamily status to these former two tribes. He separated the family Merophysiidae from the Lathridiidae on the basis of open front coxal cavities, hidden antennal insertions, antenna with less than 11 segments, 5 pairs of abdominal spiracles, maxilla with distinct lacinia and galea, and long trochanters. He also included the colydiid genus *Anommatus* Wesmael in Merophysiidae which was transferred by Sengupta and Crowson (1973) to the family Cerylonidae. So far only *Coluocera beloni* Wasmann and *Displotera grandis* Dajoz are known from India and Sri Lanka respectively, and Dajoz (1973-75) transferred *beloni* to the genus *Displotera*.

In the present study the genus *Displotera* has been redefined and *D. grandis* Dajoz has been synonymised with *D. beloni* (Wasmann) and this species is first time recorded from the West Bengal.

Genus *Displotera* Reitter

Displotera Reitter, 1887, *Best.-Tab.* 3, ed. 2 : 9 ;
Type-species : *Displotera simoni* Reitter
(= *Coluocera maderae* Wollaston).

Lioclemmus Jeannel, 1934, *Annls Soc. ent. Fr.*,
103 : 172 ; Type-species : *Lioclemmus
petiti* Jeannel (= *Coluocera madae*
Wollaston).

Reitter (1887) established this genus for the species *Displotera simoni* Reitter from West Africa and Hetschko (1926) listed only the above species under this genus. Dajoz (1973-75) synonymised *Lioclemmus* Jeannel with *Displotera*. He also transferred *beloni* Wasmann, *ecitonis* Wasmann and *maderae* Wollaston from *Coluocera* to this genus, synonymised *D. simoni* Reitter with *D. maderae* (Wollaston), and erected the subgenus *Mussardia* Dajoz for the species *D. grandis* Dajoz.

This genus is closely related to *Coluocera* Motschulsky and *Merophysia* Lucas. It can be distinguished from the former genus by the structure of eye which consists of six ocelli in comparison to single ocellus of

Coluocera and from the latter by its larger trochanter, well developed mesocoxal and femoral lines, shape of prosternal process and labrum invisible from dorsal side. *Displotera* can be easily separated from *Reitteria* Leder. Species of the latter genus are blind and bears a transverse prebasal impression on pronotum. Whereas *Evolocera* Sharp unlike *Displotera* possesses following characters: mesocoxae closely situated; mesometasternal junction indistinct; prosternal process small,

narrow, strongly carinate and received in a cavity at meso-metasternal junction; devoid of mesocoxal lines; 2-segmented antennal club; large projecting eyes and transverse prebasal impression on pronotum.

General appearance (Fig. 1) elongate-ovoid, convex, shiny.

Head (Fig. 5) transverse, fronto-clypeal suture somewhat semilunar; eyes poorly developed, consist of six ocelli; anterior part

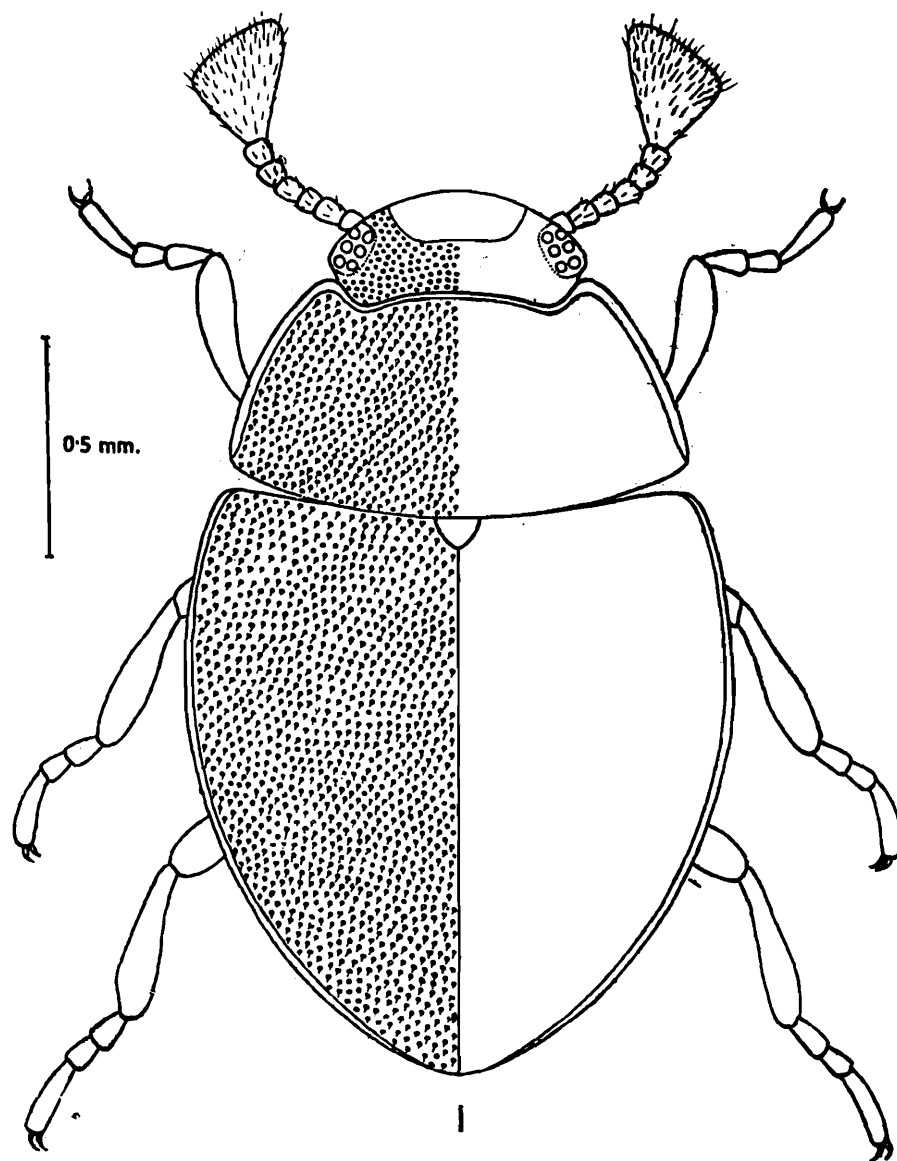


Fig. 1. *Displotera beloni* (Wasmann), Dorsal view.

of gular region with a transverse groove, with longitudinal antennal grooves extending to anterior part of prothorax. Antenna short, 8-segmented, antennal insertion hidden under projection of frons, scape small and globular, pedicel and segment 3 elongate and subequal, segments 4-7 short and subequal ; segment

8 forming a markedly large and triangular club. Labrum (Fig. 5) poorly developed and transverse ; mandible (Fig. 11) with 3 apical teeth and a tridentate tooth beneath apical teeth, mola well developed ; maxilla (Fig. 10) with well developed lacinia and galea, lacinia rather broad and without apical

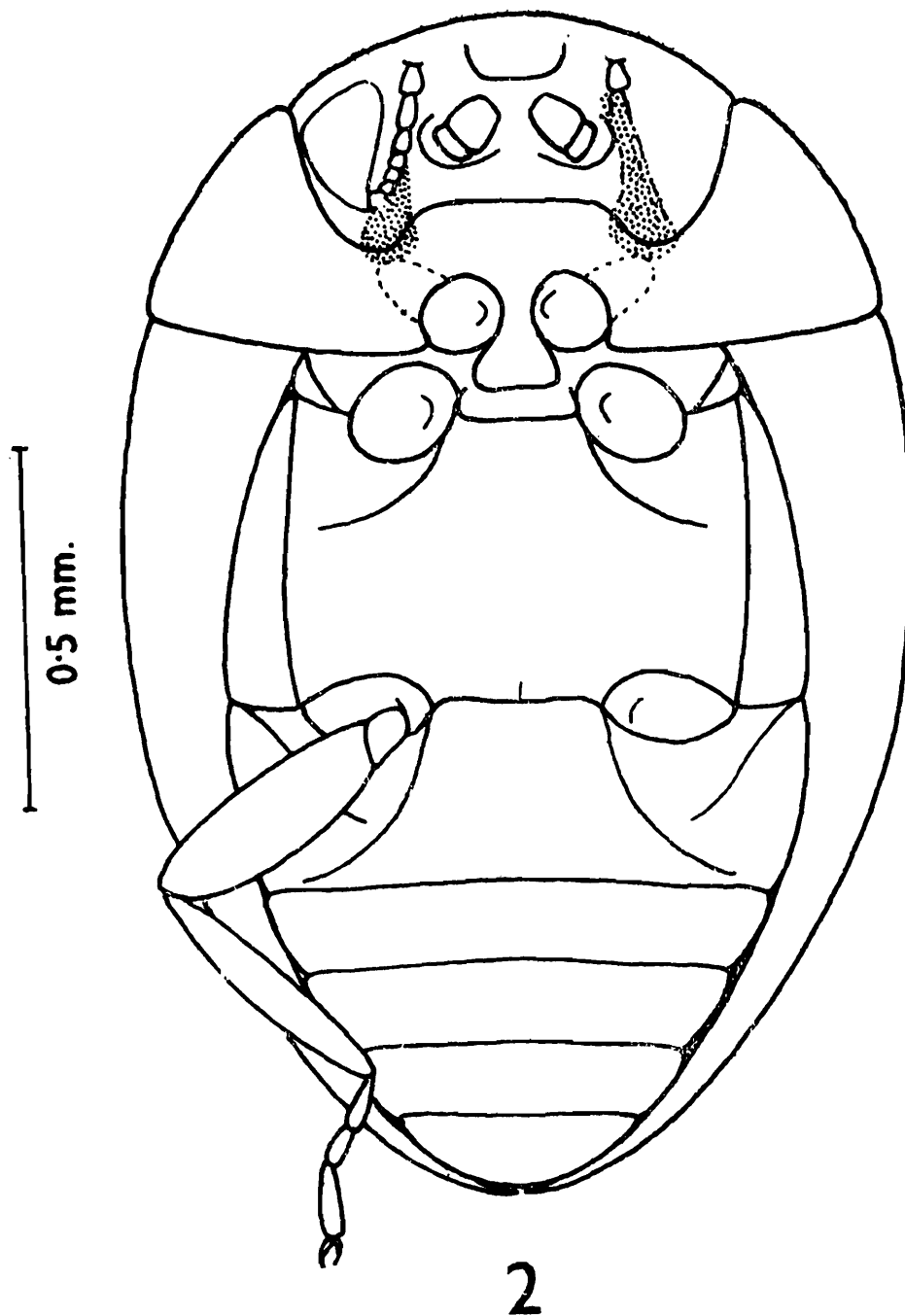


Fig. 2. *Displotera beloni* (Wasmann), Ventral view.

spine, galea normal with hairy apex, palpi with segments 2 and 3 subequal, apical segment longest and fusiform; labium (Fig. 9) with triangular mentum, palpi with segment 1 minute, segment 2 markedly large, apical segment short and transverse.

Prothorax (Fig. 6) transverse, front coxae narrowly separated, cavities externally open and internally closed; prosternal process normal, front margin of prosternal process

with a pair of notches, where antennae rest in repose; prosternum forming a transverse plate in front of prosternal process.

Meso-metathorax (Fig. 7): Mesosternum short and transverse, mesocoxae widely separated, sternal fitting in a straight line, mesocoxal cavities closed outwardly; metasternum with distinct mesocoxal lines, median impressed line short, metendosternite reduced.

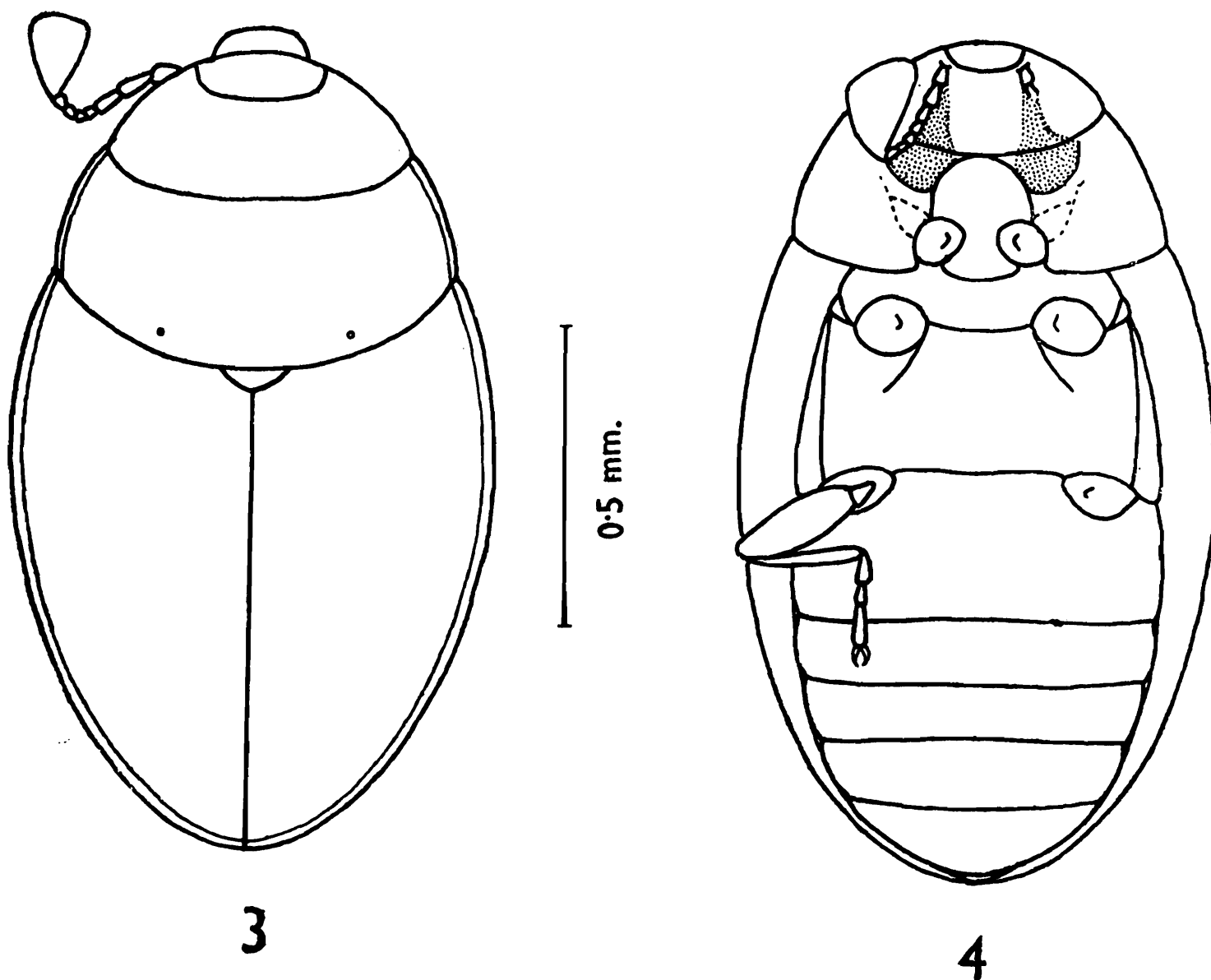
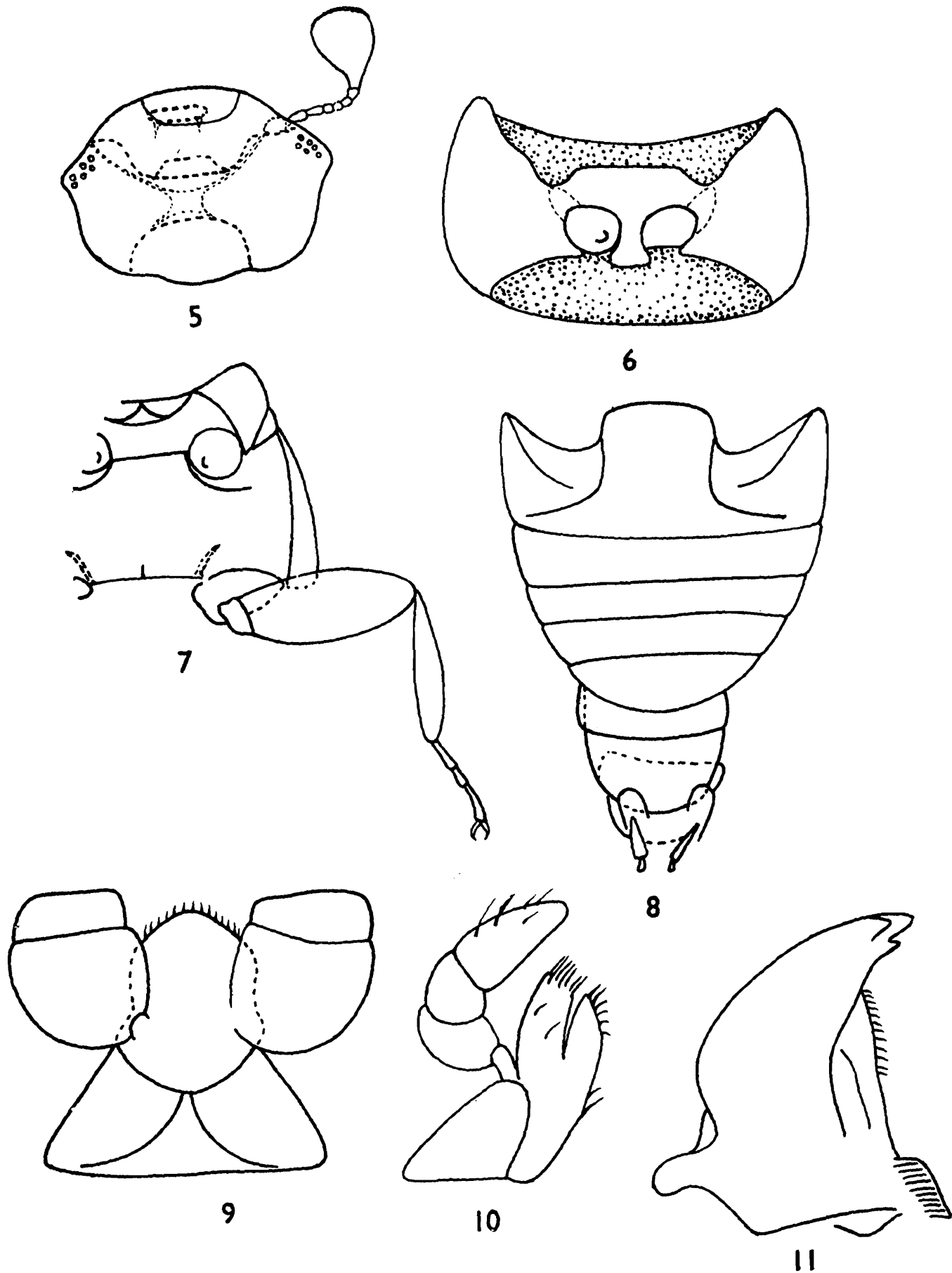


Fig. 3. *Merophysia formicaria* Lucas, Dorsal view.

Fig. 4. *Merophysia formicaria* Lucas, Ventral view.



Figs. 5-11. *Displotera beloni* (Wasmann) : 5, Head, Dorsal view ; 6, Prothorax, Ventral view ; 7, Meso-metathorax, Ventral view ; 8, Abdomen, Ventral view ; 9, Labium, Ventral view ; 10, Maxilla ; 11, Right Mandible, Ventral view.

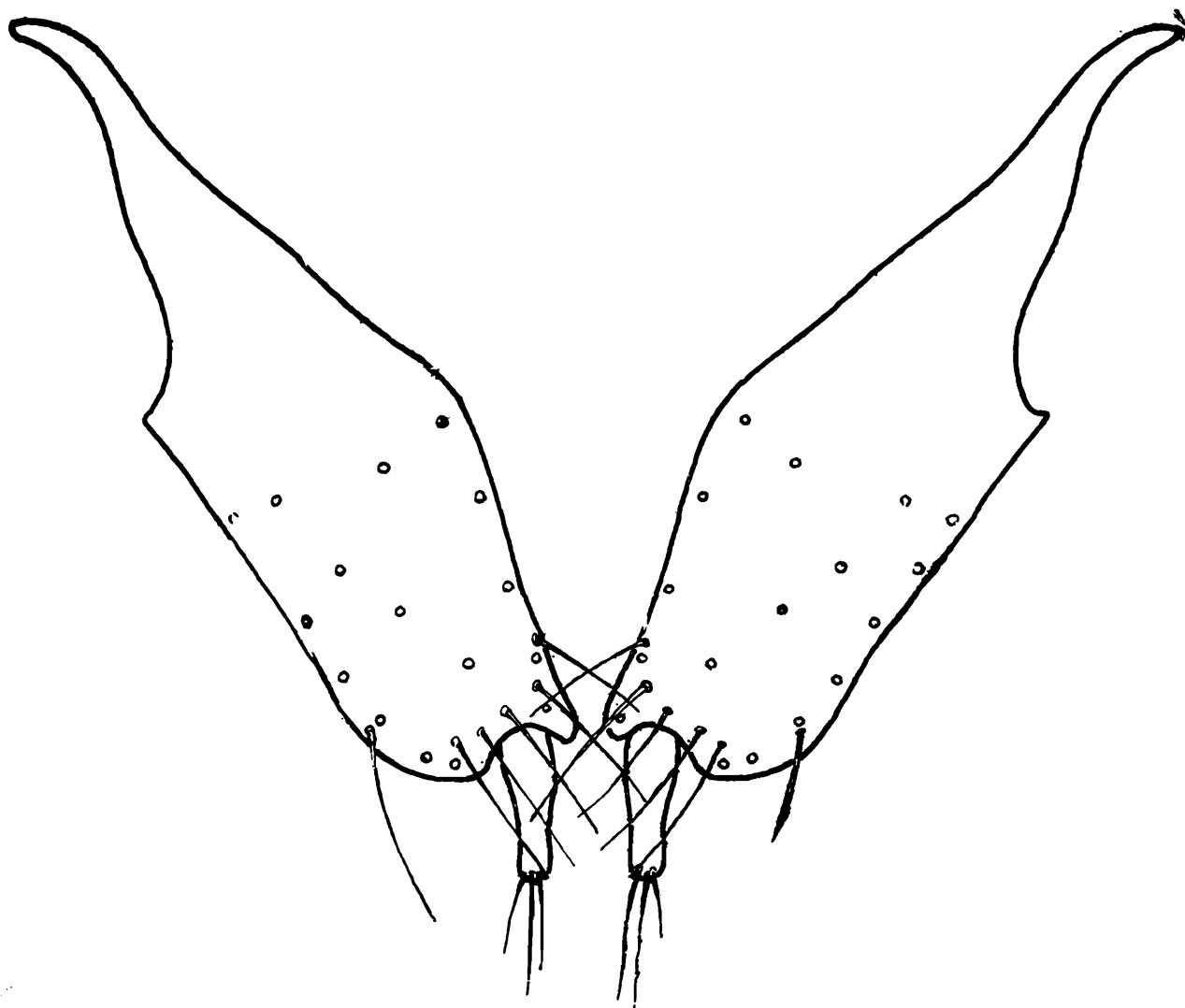
Elytra and wing: Species apterous ; elytra broad. Epipleura complete, markedly broad at base and progressively narrowed posteriorly.

Legs (Fig. 7) with trochanter short, broad and simple ; femora normally swollen in middle ; tibiae narrowed at apex and without apical spurs ; tarsal formula 3-3-3, segments simple, segment 1 slightly longer than segment 2, apical segment longest and claws simple.

Abdomen (Fig. 8) about as long as broad, ventrite 1 longest, intercoxal process broad with apical margin almost straight, femoral lines well developed ; ventrites 2-5 subequal. Ovipositor (Fig. 12) poorly developed ; paraprocts, valvifers and coxites fused, styli short and attached at apex of latter.

Habitat : Myrmecophilous.

Distribution : India, Sri Lanka, Burma, Madeira Is., S. America.



12

Fig. 12. Ovipositor of *Displotera beloni* (Wasmann).

***Displotera beloni* (Wasmann)**

Coluocera beloni Wasmann, 1899, *Dt. ent. Z.* : 160
(India).

Displotera beloni (Wasmann) : Dajoz 1973-75,
Ent. scand. Suppl. 4 : 201.

Displotera grandis Dajoz, 1973-75, *Ent. scand.*
Suppl. 4 : 201 (Sri Lanka) ; *Syn. nov.*

This species is closely related to *Displotera maderae* (Wollaston) but can be distinguished by its prothorax more distinctly narrowed in front, elytra more distinctly wider than prothorax and species larger. Dajoz (1973-75) described *D. grandis* from Sri Lanka. In the present study we have examined the 'types' of *D. beloni*, *D. grandis* along with several specimens collected from Calcutta (India) and found no difference among them. Therefore, *grandis* Dajoz has been synonymised with *beloni* (Wasmann).

General shape (Fig. 1) short-elliptical, convex, shiny, finely punctate-pubescent, uniformly yellowish-brown to reddish-brown. Head markedly transverse, front margin rounded ; eyes formed of 6 ocelli arranged in two longitudinal rows : 3 and 3 ; antenna short, about as long as head, normally resting in antennal cavity in repose. Prothorax strongly transverse, narrowed in front, front margin emarginate, front angles projecting and slightly rounded, hind angles almost right angle, lateral and front margin of pronotum finely bordered. Scutellum transversely triangular, impunctate. Elytra about as broad as long, about as wide as prothoracic base in front, slightly wider in anterior one-third and then narrowed posteriorly, sides evenly rounded and finely bordered, finely punctate-

pubescent. Legs pubescent. Sterna more pubescent than dorsum.

Measurements : Total length 1.52-1.57 mm., width of head across eyes 0.60 mm., length of antenna 0.39-0.40 mm., width of prothorax across base 1.02-1.10 mm. ; length of elytra 1.15-1.24 mm. and width 1.16-1.24 mm.

Material examined : 'Type' of *Coluocera beloni* Wasmann, India (Institut Royal des Sciences Naturelles de Belgique, Brussels).

'Types' of *Displotera grandis* Dajoz : *Type*, Ceylan North Central, Ambagaswewa, 3.ii.1970, Mussard Besuchet Löbl ; *Paratypes* 2 ex., Ceylan Southern, Yala Nat. Park, 24.i.70, Mussard Besuchet Löbl ; *Paratype* 1 ex., Ceylan Northern, Pulian Kulam, 6.ii.1970, Mussard Besuchet Löbl ; *Paratype* 1 ex., Ceylan Northern, Madhu Road, 5.ii.1970, Mussard Besuchet Löbl ; *Paratype* 1 ex., Ceylan Northern, Mullaitivu, 6.ii.70, Mussard Besuchet Löbl (Mus. Hist. Nat., Genève) ; 7 ex., India : West Bengal, Calcutta, 21.xi.1975, P. K. Maiti, ant's nest. The specimens collected from Garcha Road, Calcutta, from the nests of ants belonging to the species *Paratrachina* (*Paratrachina*) *longicornis* Latreille. These beetles were marching with procession of the ants when the latter were transporting their eggs from one nest to the other.

Distribution : India : West Bengal ; Sri Lanka.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. B. K. Tikader, Director, Zoological Survey of India for providing laboratory facilities, to Dr. P.

'Type' referred here is the holotype.

K. Maiti for the material of *D. beloni* along with its behavioural information, to Mr. R. N. Tiwari for identification of ant material. They express their sincere thanks to Dr. I. Löbl of Museum d' Histoire Naturelle, Genève and Institute Royal des Sciences Naturelles de Belgique, Brussels who kindly provided them the opportunity to examine the 'type' material of *Displotera grandis* Dajoz and *Coluocera beloni* Wasmann respectively.

REFERENCES

- CROWSON, R. A. 1955. *The natural classification of the families of Coleoptera*. Nathaniel Lloyd, London.
- DAJOZ, R. 1973-1975. Coleoptera : Lathridiidae de Ceylan 1. *Ent. scand. Suppl.*, 4 : 199-207.
- HETSCHKO, A. 1926. Lathridiidae. In *Coleopterorum Catalogus* 85, W. Junk, Berlin.
- REITTER, E. 1887. *Bestimmungs-Tabelle der europäischen Coleopteren*. 3, ed. 2, Brunn : 9-10 (not seen).
- SENGUPTA, T. AND CROWSON, R. A. 1973. A review of the classification of Cerylonidae (Coleoptera, Clavicornia). *Trans. R. ent. Soc. Lond.*, 124(4) : 365-446.

GARRA MENONI, A NEW CYPRINID FISH FROM SILENT VALLEY,
KERALA, SOUTH INDIA

K. REMA DEVI AND T. J. INDRA

*Zoological Survey of India, Southern Regional Station,
Madras*

ABSTRACT

A new species of *Garra*, *Garra menoni* is being described from Silent Valley, Kerala, and compared with the widely distributed *G. mullya* (Sykes) and *G. lissorhynchus* (Mc Clelland) an Assamese form.

INTRODUCTION

Silent Valley is a tropical evergreen forest in Western Ghats and is drained by the River Kunthi. 334 specimens (adults) and 124 juveniles were collected from River Kunthi, by the team from Zoological Survey of India during the course of a multidisciplinary expedition in 1979. The new species is named after Dr A. G. K. Menon.

Garra menoni sp. nov.

(Plate VI, fig. A and B)

Description.—Depth of body 5.29 (4.39-6.48), length of head 4.23 (3.71-5.23) in standard length. Width of head 1.3 (1.17-1.65); snout 2.01 (1.71-2.38); eye 5.7 (4.0-7.0) in length of head. Eye 2.63 (1.75-3.5) in inter orbital width; 2.85 (2.0-3.5) in snout. Pupil of eye either in the middle or a little behind the middle of the length of head. Snout round and smooth, the males

with fine tubercles. Two pairs of barbels, smaller than the diameter of eye. 7-8 outer gill-rakers in the lower part of the anterior arch. Mental disc well developed, length of the disc 1.46 (1.2-1.7) in its own width. Thirty two to thirty six scales in lateral line, 4.5 from the origin of dorsal to lateral line, 3-3.5 between this and the pelvic. Chest and belly naked. A part of the pre-pelvic region with subcutaneous scales. Dorsal iii/7-8; Pectoral i/12-15; pelvic i/7-8; anal ii-iii/5 and caudal 17-19 rays. Distance from vent to anal fin 3.48 (2.13-5.0) in that between pelvic and anal fin. Width of caudal peduncle 1.35 (1.0-1.82) in its own length. Posterior chamber of air bladder measured in one specimen is found to be 14% in S. L. Colour in formalin, dark brown above, paler beneath. A faint lateral band from gill opening to the base of the caudal fin.

Distribution.—River Kunthi, Silent Valley, Kerala State.

Holotype :—River Kunthi, Silent Valley (Alt. 867 metres), Kerala, 19 January, 1979, 69.0 mm S. L., Coll R. S. Pillai, Reg. No. F. 553.

Paratype :—River Kunthi, Kerala, 19 January 1979, 99 exs. 31.0-69.0 mm S. L. has the same data as that of holotype, Coll. R. S. Pillai.

Type.—All the type specimens are temporarily kept at this Regional Station will be eventually deposited in the Zoological Survey of India, Calcutta.

Relationship.—This form differs from the widely distributed *G. mullya* (Sykes) in colour pattern, in the absence of scales on the chest and belly, and in the marked difference in the position of the vent. It differs from *G. hughi* Silas in the presence of scales in the middorsal streak, and in the lesser number of lateral line scales etc. In certain morpho-

metric characters this species bears resemblance to *G. lissorhynchus* (Mc Clelland), distributed in Assam, Himalaya but it differs from it in its characteristic colour pattern.

ACKNOWLEDGEMENT

We are greatly indebted to Dr. B. K. Tikader, Director, Zoological Survey of India for the publication facilities and to Dr R. S. Pillai, Deputy Director, Southern Regional Station, Zoological Survey of India, Madras for providing the material and for going through the manuscript and to Dr A. G. K. Menon for confirming the identification. Our thanks are also due to Shri S. Vijayaraghavan, photographer.

REFERENCE

- MENON, A. G. K. 1964. Monograph of the Cyprinid fishes of the genus *Garra* Hamilton. *Mem. Indian Mus.* 14 (4) : 173-260.

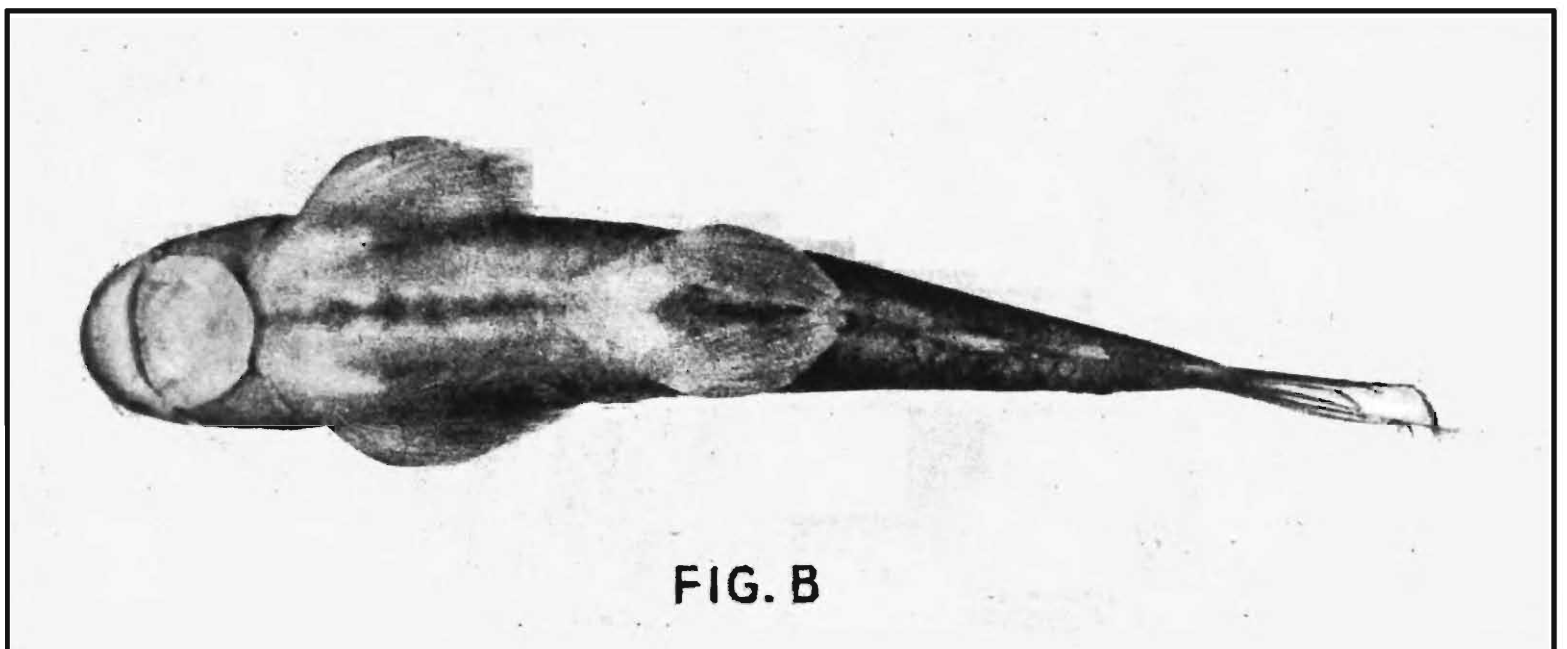
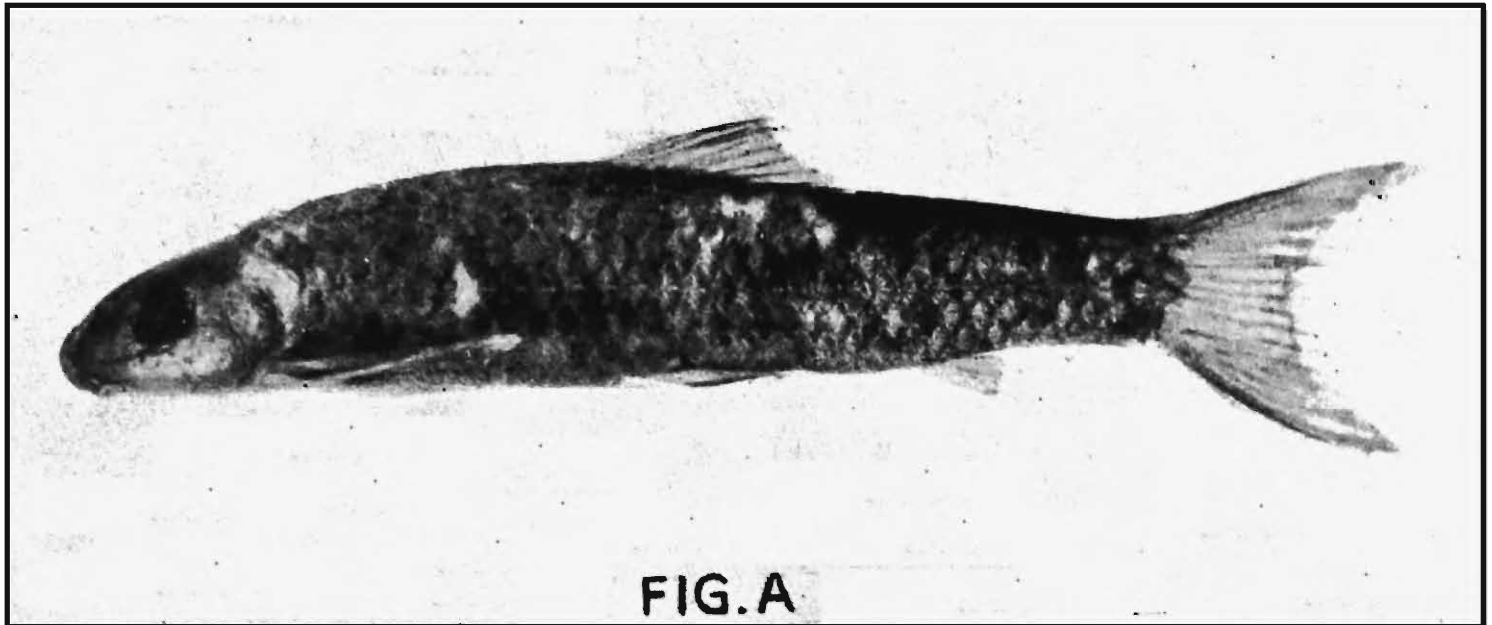


Fig. A. Lateral view of *Garra menoni* sp. nov.
Fig. B. Ventral view of *Garra menoni* sp. nov.

A NEW GENUS OF PAEDERINAE : STAPHYLINIDAE (COLEOPTERA)
WITH DESCRIPTION OF A NEW SPECIES FROM NEPAL

D. N. BISWAS AND T. SEN GUPTA

Zoological Survey of India, Calcutta

ABSTRACT

A new genus *Himastenus* of the subfamily Paederinae : Staphylinidae is established and a new species *H. apterus* from Nepal is described.

Paederinae is a well marked group of the family Staphylinidae. Usually distinguishable by the antennae being inserted under anterior angles of the front margin of head. Cameron (1931) dealt two tribes under the Subfamily Paederinae, Pinophilini Redtenbacher and Paederini Erichson. The tribe Paederini differs from the tribe Pinophilini by its segment 4 of maxillary palpi being small and subulate (Fig. 2) whereas in Pinophilini segment 4 is securiform. He listed twenty-nine genera under the tribe of Paederini from Indian subregion. The new genus described below falls under the tribe Paederini having similar type of maxillary palpi.

The new genus differs from all other genera of the tribe Paederini by its elytra being dilated behind and shorter than prothorax (Figs. 1 & 3), apical margin concave and general appearance comparatively robust (Fig. 1). The new genus has some superficial similarities with American genus

Stilicolina Casey and Indian genus *Scopaeus* Erichson but can be easily separated from the latter genera in having tarsal segment 4 bilobed (Figs. 4, 8 & 9). This new genus is nearest to the genera *Astenus* Stephens and *Dibelonetes* Sahlberg and their chief differences are shown in Table 1.

Himastenus Gen. nov.

(Figs. 1-14)

General appearance (Fig. 1) moderately large, robust, subcylindrical and slightly depressed. Head and pronotum covered with dense, coarse, reticulate punctures and fringed with moderate setae. Elytra narrowed at base and dilated behind (Fig. 1) and colour brownish red.

Head elongate, antennal groove in front of eyes (Fig. 1), anterior margin of labrum with four distinct teeth (Figs. 1 & 7), ventral side of labrum with a median and lateral

TABLE—1. *The chief differences of Himastenus, Astenus and Dibelonetes*

	<i>Himastenus</i>	<i>Astenus</i>	<i>Dibelonetes</i>
1. General appearance	Rather broadly elongated, species apterus.	Narrowly elongated, species winged.	Narrowly elongated, species winged.
2. Puncturation on head and prothorax	Reticulated and not umblicate.	Reticulated-umblicate.	Reticulate-umblicate.
3. Elytra	Narrowed towards base (Fig. 3.).	Rather parallel-sided (Fig. 22).	Rather parallel-sided (Fig. 30).
4. Labrum	Apical margin with two pairs of large teeth (Fig. 7) and ventral side with a median and a pair of lateral grooves (Fig. 7).	Apical margin with a pair of small teeth (Fig. 15) and ventral side with a median groove (Fig. 15) but lateral grooves absent.	Apical margin with three pairs of small teeth (Fig. 23) and ventral side with a median groove (Fig. 23) but lateral grooves absent.
5. Anterior margin of labium	With a median spinous projection and fringed with several setae (Fig. 6).	Devoid of any spinous projection and setae (Fig. 16).	With one pair of membranous lobes and one pair of setae (Fig. 24)
6. Mentum	With two pairs of setae (Fig. 6).	With three pairs of setae (Fig. 16)	Devoid of any setae (Fig. 24).
7. Maxillary palpi	Segment 1 moderately long (Fig. 2).	Segment 1 short (Fig. 18).	Segment 1 short (Fig. 28).
8. Antenna	Long and slender, segment 2 distinctly shorter than segment 3 (Fig. 1).	Shorter and stout, segment 2 almost equal to segment 3 (Fig. 17).	Long and stout, segment 2 slightly shorter than segment 3 (Fig. 27).
9. Prosternal Process	Apical margin pointed (Fig. 4).	Apical margin slightly pointed (Fig. 20).	Apical margin broadly rounded (Fig. 26).
10. Metendosternite	Simple and characteristic as figured (Fig. 5).	Well developed and characteristic as figured (Fig. 21).	Not distinguishable (Fig 31).
11. Anterior leg	Femur with a distinct groove, which fringed with fine hairs (Fig. 4) ; tibia with four grooves, armed with five distinct long setae (Fig. 14).	Femur with a distinct groove, which fringed with fine hairs and a long seta (Fig. 20) ; tibia with two grooves, each armed with a distinct long seta (Fig. 20).	Femur with a distinct groove, which fringed with fine hairs and a long seta (Fig. 29) ; tibia with four grooves which armed with two distinct long setae (Fig. 29).

	<i>Himastenus</i>	<i>Astenus</i>	<i>Dibelonetes</i>
12. Habitat	Under stack of grass.	Leaf litter, leaf garbage and Haystack.	Leaf litter, leaf garbage and Haystack.
13. Distribution	Nepal.	N. & South America, Europe, Australia, Japan, China, Africa, India, Burma, Sri Lanka, Java and Sumatra.	South America, Africa and India.

longitudinal grooves (Fig. 7). Clypeus narrow. Eyes small, convex and finely faceted. Antennae (Fig. 1) long and slender, scape long and stout, pedicel small, segment 3 more than twice as long as pedicel, segments 4-9 elongate and equal, segment 10 slightly shorter and wider than preceding. Neck narrowed and short (Fig. 1). On ventral side gular sutures confluent. Maxillary palpi 4-segmented (Fig. 2), segment 1 well developed, segment 2 almost thrice as long as segment 1, segment 3 slightly longer than segment 2 and widened towards apex, segment 4 minute, narrow and pointed at apex. Labium (Fig. 6) with 3-segmented palpi, apical margin of labium with a median spinous projection and fringed with several strong setae. Mentum (Fig. 6) transverse with two pairs of setae. Mandibles (Fig 12) slender, curve and with four apical teeth.

Prothorax (Fig. 4) narrowed in front and lateral margins curved. Front coxae closely situated, cavities elongate with flat and exposed trochantins. Prosternal process short, broad and its apex pointed (Fig. 4). Front coxal cavities open posteriorly (Fig. 4).

Meso-and metathorax (Fig. 5) with mesosternum broad and transverse, mesocoxae almost contiguous, metasternum slightly

transverse, meta coxae narrowly separated. Metendosternite (Fig. 5) simple and characteristic. Scutellum small and its posterior margin somewhat rounded.

Elytra (Fig. 1) small and as long as broad, narrowed in front and posterior margin concave, species apterus.

Legs (Figs. 4, 8 & 9) long and slender, anterior femur with a transverse groove and anterior tibia with two transverse grooves which fringed with fine hairs and each with distinct long seta, posterior femur longer than anterior and middle femora, tarsal formula 5-5-5 in both sexes, segment 1 as long as segments 2, 3 and 4 together, segment 4 bilobed.

Abdomen (Fig. 10) more or less cylindrical, posterior margins of sternum II to IV of male impressed, posterior margin of sternum V and VI of male emarginate, emargination variable sizes (Figs. 10 and 11). Aedeagus as figured (Fig 13).

Distribution : Nepal : Daman

Habitat : Under stack of grass.

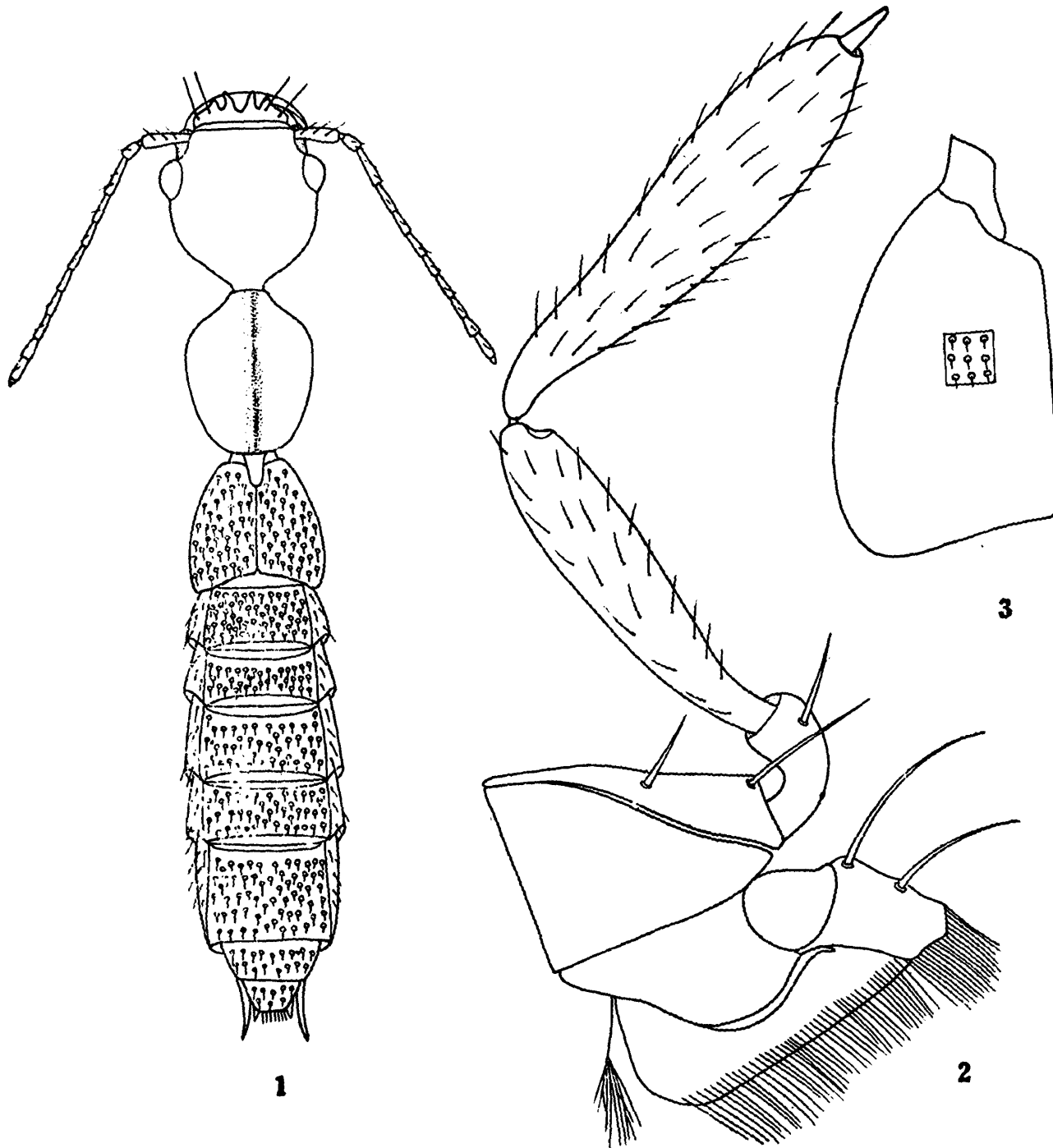
Type species : *Himastenus apterus* sp. nov.

Himastenus apterus, sp. nov.

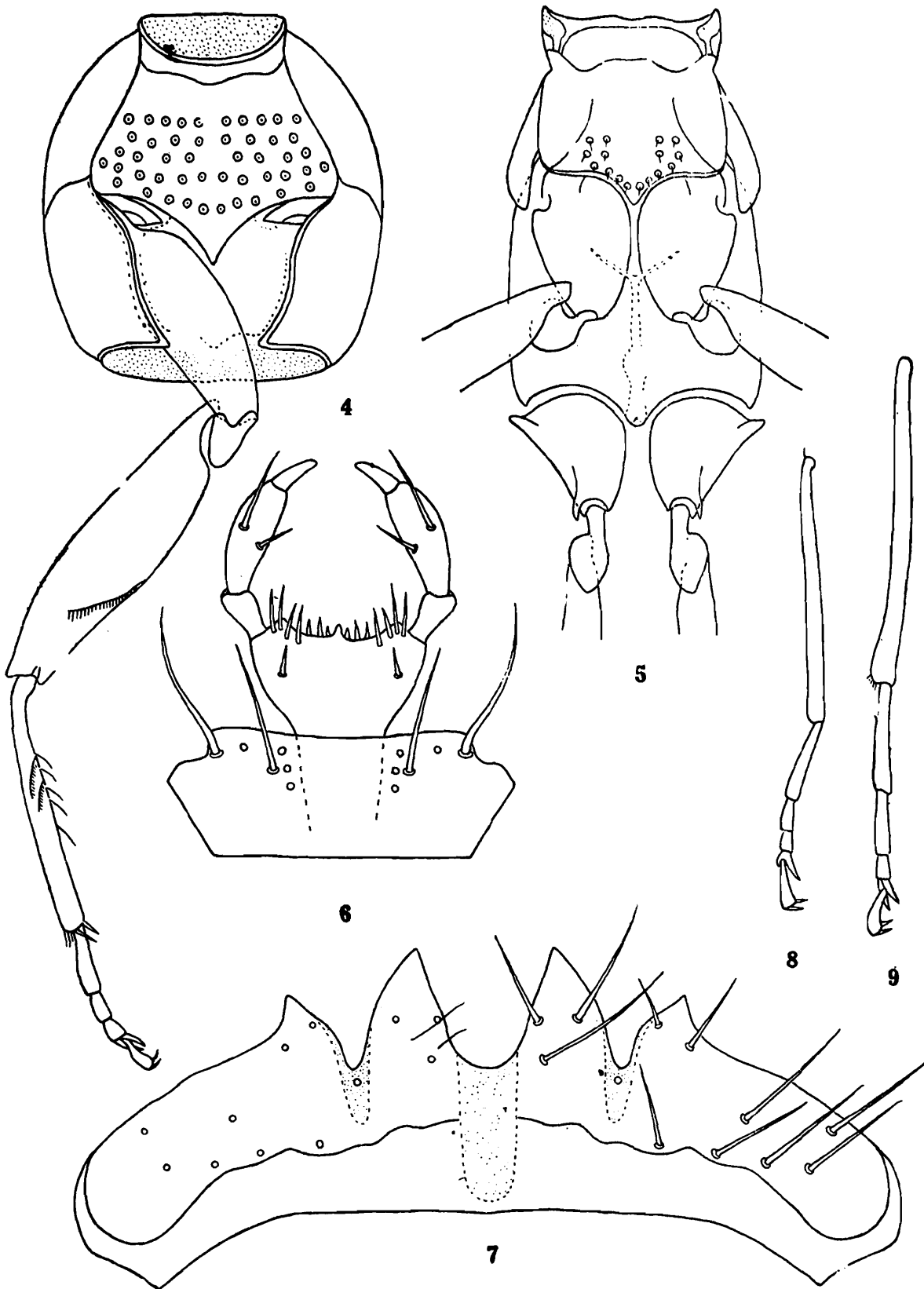
General appearance (Fig. 1) elongate, somewhat robust, subconvex, shining,

brownish black to reddish brown, antennae (segments 2-11), palpi and legs yellowish red, mandibles, labrum and antennal scape reddish brown and elytra narrowed at base and dilated behind.

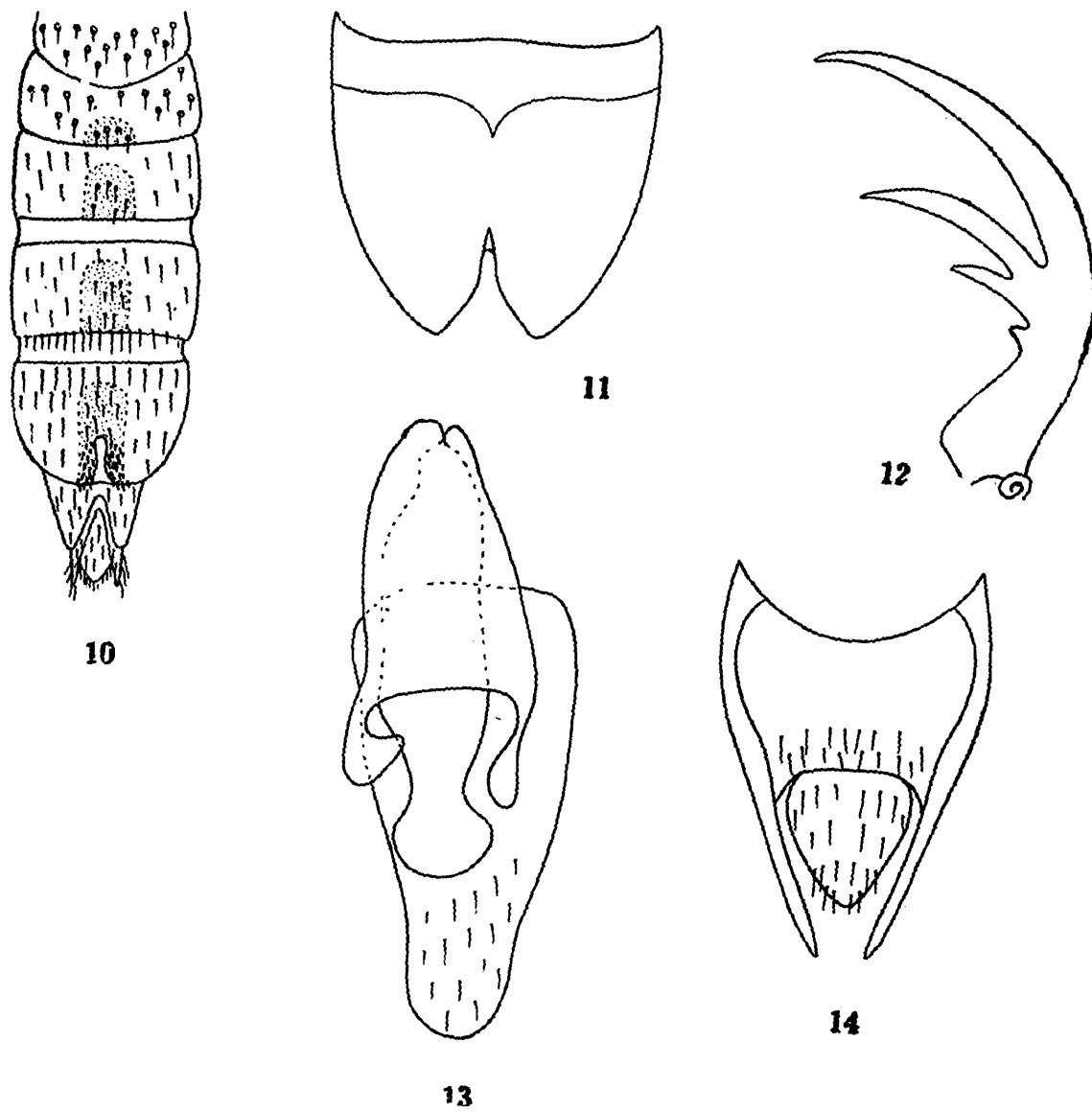
Head slightly longer than broad and as long as prothorax, dorsum of head covered with dense, coarse, deep and reticulate punctured, each puncture with a fine and short seta and lateral margins of head also



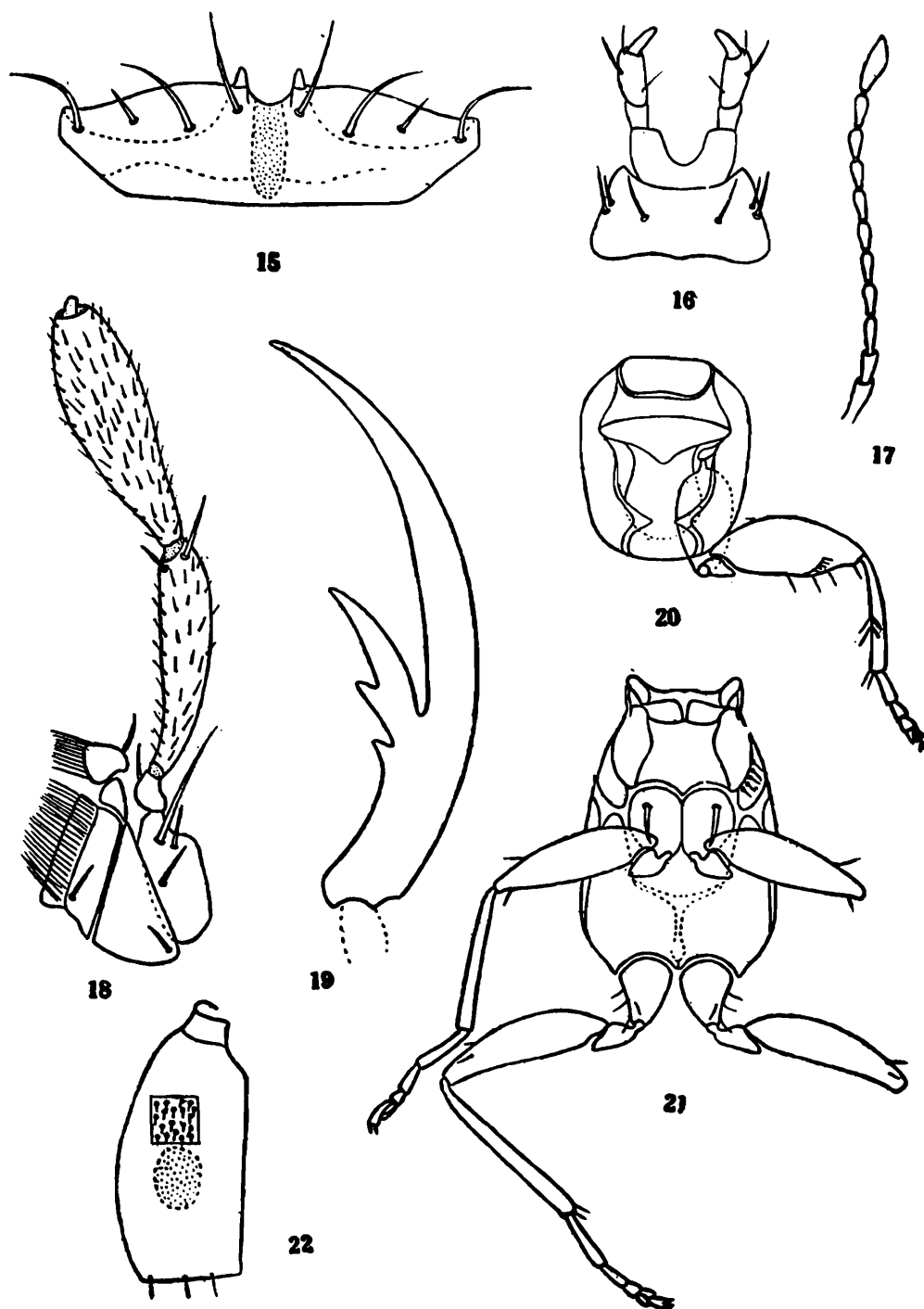
Figs. 1-3. 1. *Himastenus apterus*, sp. nov., dorsal view ; 2. left maxilla ; 3. left elytron, dorsal view.



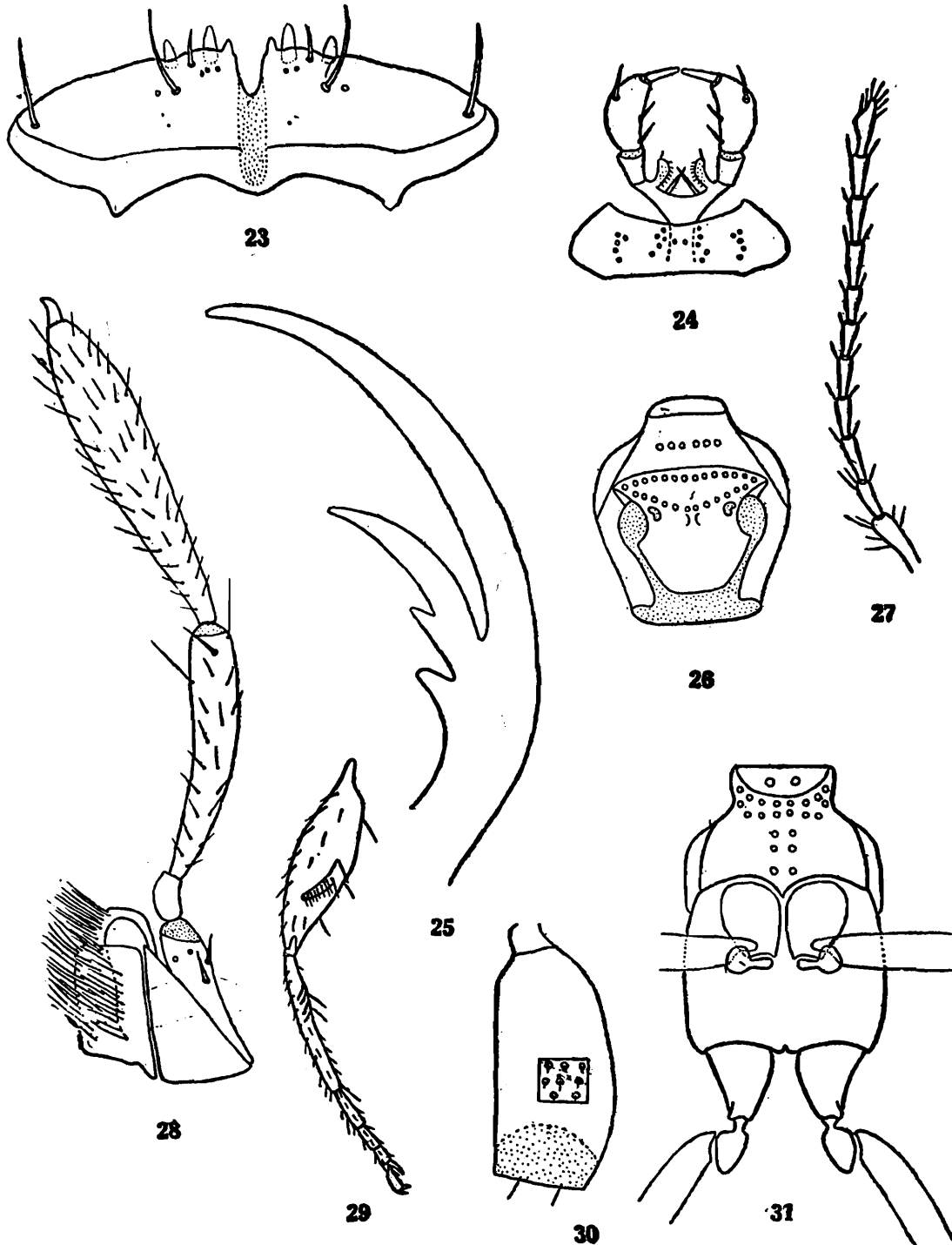
Figs. 4-9. 4. prothorax, ventral view ; 5. meso and metathorax, ventral view ; 6. labium, dorsal view ; 7. labrum, dorsal view ; 8. middle leg ; 9. posterior leg.



Figs. 10-14. 10. abdominal segments, ventral view ; 11. sternum six, male ; 12. right mandible, dorsal view ; 13. aedeagus, dorsal view ; 14. sternum seven, male.



Figs. 15-22. 15. *Astenus* sp., labrum, dorsal view ; 16. labium, dorsal view ; 17. antenna ; 18. right maxilla ; 19. right mandible, dorsal view ; 20. prothorax, ventral view ; 21. meso and metathorax, ventral view ; 22. left elytron, dorsal view.



Figs. 23-31. 23. *Dibelonetes* sp., labrum, dorsal view ; 24. labium, dorsal view ; 25. right mandible, dorsal view ; 26. prothorax, ventral view ; 27. antenna ; 28. right maxilla ; 29. anterior leg ; 30. right elytron, dorsal view ; 31. meso and metathorax, ventral view.

covered with a few distinct, long, black setae along with smaller setae. Prothorax oviform, slightly longer than broad, anterior angles broadly and posterior angles slightly rounded, dorsum of prothorax covered with dense, coarse, deep, reticulate punctures, each puncture fringed with a short seta. Mid longitudinal ridge smooth and extending from anterior margin to posterior margin. Scutellum elongate covered with coarse, deep, setiferous punctures, its basal part depressed. Elytra slightly shorter than prothorax, median portion longitudinally depressed, elytral sutural line black, dorsum of elytra covered with dense, moderate coarse and setiferous punctures. Abdomen with basal part of segment 1-5 transversely rugose punctured and posterior part of segments 1-5 covered with dense, fine setiferous punctures. Sternum VI of male with posterior margin deep, narrow, acute triangular emargination (Fig. 11). Sternum V of male with posterior margin feebly emarginate at middle (Fig. 10), on each side of emargination with arcuate impression and between impression glabrous and in front of emargination an elongate impressed area extending nearly the whole length of segment V (Fig. 10). Sternum II to IV of male with posterior margin bearing an impressed area of variable sizes (Fig. 10). Sternum VI and V of female unmodified.

Measurements of holotype : Total length 5.30 mm ; width of head across the eyes 0.90 mm ; length of prothorax 1.00 mm and width of prothorax 0.80 mm ; length of elytra 0.70 mm and width of elytra 0.70 mm.

Holotype : ♂, Nepal : Daman, 7600 ft., 31. III. 1972 *T Sen Gupta* Collection (mounted on slide). *Paratype*, 1 ♀ collection data same as in holotype. (In the collection of Zoological Survey of India, Calcutta). Z. S. I, Reg. No. 9185/H4A. 9186/H4A.

Habitat : Under stack of grass.

Distribution : Nepal : Daman.

ACKNOWLEDGEMENT

This research was carried out in the Zoological Survey of India. The authors are grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, for providing necessary laboratory facilities.

REFERENCE

- CAMERON, M. 1931. *The Fauna of British India, including Ceylon and Burma. Coleoptera : Staphylinidae*, 2. viii + 257 pp. 2 pls. Taylor and Francis, London.

STUDIES ON INDIAN CALANOIDS II. DESCRIPTION OF A NEW CALANOID
COPEPOD *NEODIAPTOMUS SEWELLI* SP. NOV. (CALANOIDA :
DIAPTOMIDAE) FROM NILGIRI DISTRICT

TUSHARENDU ROY

Zoological Survey of India, Calcutta

ABSTRACT

A new species of the genus *Neodiaptomus* Kiefer is described from the Kargudi of Nilgiri District in Southern India. Affinities with previously described species of this genus, is discussed.

INTRODUCTION

Genus *Neodiaptomus* was established in 1932 by Kiefer to accommodate the species of *schmackeri* (= *D. schmackeri* Poppe & Richard, 1892) from China. Since then, ten species of this genus were described so far. It is interesting to note that the type localities of four species out of ten, are in the Nilgiri District of southern India. These are, *N. physalipus* Kiefer, 1935; *N. diaphorus* Kiefer, 1935; *N. lindbergi* Brehm, 1953 and *N. tiwarii* (Roy, 1981 in press). The remaining six species out of which four of them *N. schmackeri* (Poppe & Richard, 1892); *N. meggitti* Kiefer, 1932; *N. lymphatus* Brehm, 1933 and *N. mephistopheles* Brehm, 1933 are from China, Burma, Celebes and Java respectively. The rest of two species, *N. satanas* Brehm, 1933 and *N. kamakhiae* Reddiah, 1964 are from other parts of India. One more new species (*N. kherai*) was described from Nilgiri District by the author elsewhere.

In the course of studies of the Calanoid Copepods of India, an examination of the

collections from the Nilgiri District of southern India as a part of the general survey of the fauna of Tamilnadu State in January-February, 1971, the species described here was encountered. It was collected from a swampy roadside nullah (below culvert) with emergent bushes.

MATERIAL AND METHODS

Samples of the surface plankton were collected by the author with the help of 29 cm diameter conical (0.5 mm to 1.0 mm mesh size) plankton tow-net for about ten minutes in each haul. All the specimens were preserved in 85% Ethyl alcohol (C₂H₅OH) including 2/3 drops of Glycerine.

The specific name of the new species *sewelli* is dedicated to honour late Dr. R. B. S. Sewell, former Director, Zoological Survey of India, Calcutta and a well known Copepodo-
logist of India.

Neodiaptomus sewelli sp. nov.

(Figs. 1 a-d, adult female; e-h, adult male)

Material-Holotype : Adult female, Nullah

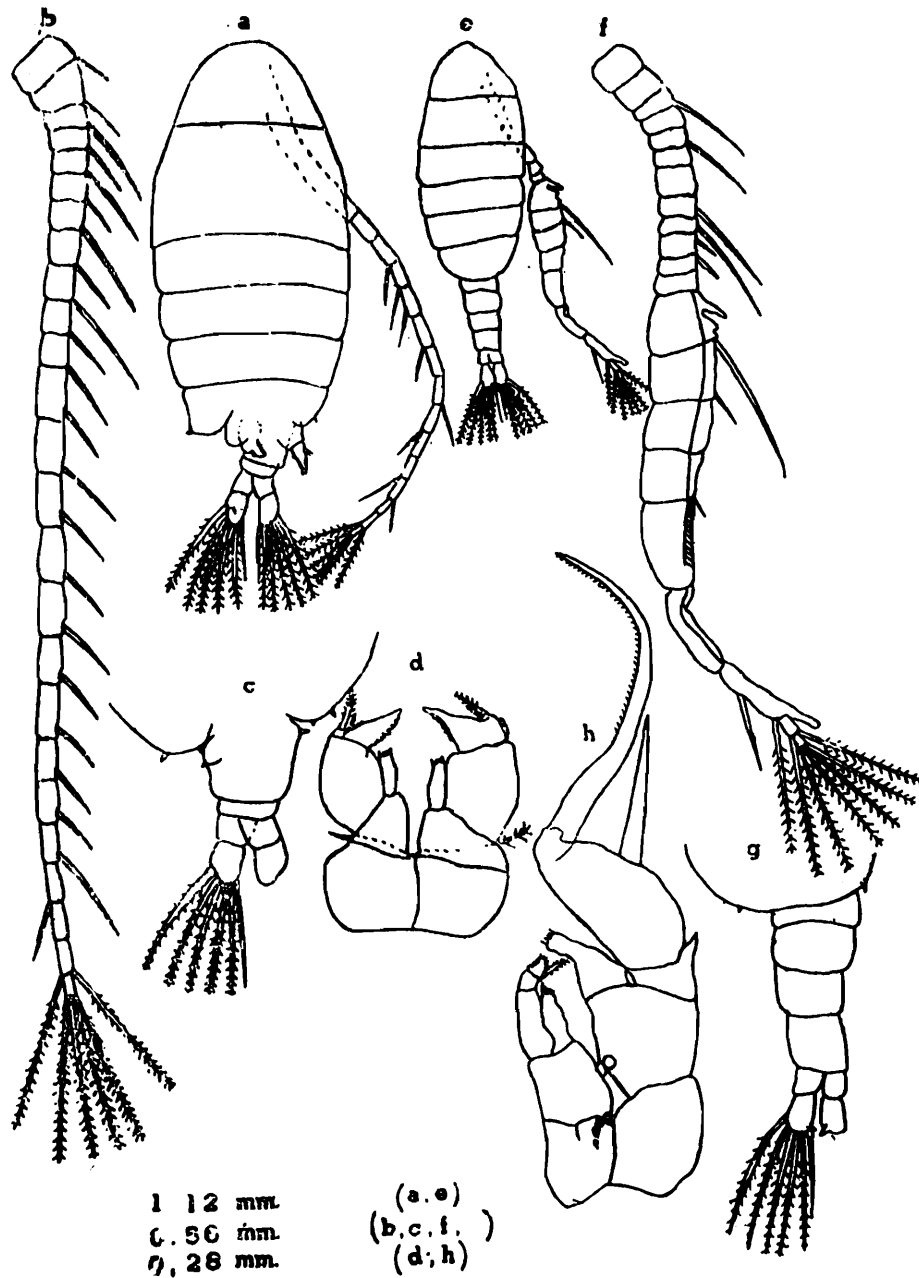


Fig. 1. *Neodiaptomus sewelli* sp. nov.

Fig. 1a—d, Adult female ; e—h, Adult male

a.	Adult female	dorsal view
b.	„ „	antennule
c.	„ „	urosome with last thoracic segment
d.	„ „	fifth pair of legs
e.	Adult male	dorsal view
f.	„ „	right antennule
g.	„ „	urosome with last thoracic segment
h.	„ „	fifth pair of legs

(below culvert) nearly 8 kms. east of Kargudi Forest Rest House, Nilgiri District, Tamilnadu, India, 12.2.1971 (*T Roy* Coll.) Regd. No. C 2578/2. *Allotype* : Adult male, with same data as the holotype, Regd. No. C. 2579/2. *Paratypes* : 178 females and 142 males with the same data as the holotype, Regd. Nos. C 2580-81/2. All the specimens including the non types have been deposited in the National Collections of the Zoological Survey of India, Calcutta.

Description of the adult female :

The body (Fig. a) robust, rounded in the anterior end of the cephalic region. The total length of the body excluding the caudal setae is 1.50 mm. The body is rather long with six imperfect divisions of the prosome. The wings of the last metasomal segment is asymmetrical. The postero-lateral corner of the outer lobe of the left wing has two spines ; similar spines appear on the right lobe but these seem to be closer than those of the left lobe. Cephalosome is about four times longer than the urosome. The urosome (Fig. c) is three segmented and the proportional lengths of the segments are shown in segment A.

Each ramus (Fig. c) bears six setae, excepting the innermost, the other five setae are almost equal in length and are plumose. The innermost naked seta is thin with a sclerotised knee a short distance from the base.

The first antennule :

When it (Fig. b) folds back to the body, it reaches a little beyond the total length of the body including the caudal setae. It consists of 25 segments. The arrangement of the setae are as shown in the figure.¹

The proportional lengths of the segments are shown in segment B.

The setae of the ultimate and penultimate segments are feathered.

Fifth leg :

Fifth legs (Fig. d) are somewhat symmetrical. It consists of two pairs of basipod, two pairs of exopod and one pair of endopod segments, segments of the first and second exopod and the endopod of the right being a little wider than those of the left.

The right fifth leg :

It (Fig. d) consists of two basipod, two exopod and one endopod segments. The first

Segments (A)	-1	-2	-3	caudal rami	=100	
	47	11	20	22		
Segments (B)	1	2	3	4	5	6
	38	44	24	24	29	31
	7	8	9	10	11	12
	38	34	34	36	34	58
	13	14	15	16	17	18
	53	53	53	53	48	53
	19	20	21	22	23	24
	39	43	38	38	38	43
	$\frac{25}{24}$	=1000				

finger-like with a blunt end. The setae of the ultimate and penultimate segments are plumose.

Fifth leg :

The fifth leg (Fig. h) is asymmetrical. It consists of right and left halves.

The right fifth leg :

Right fifth leg (Fig. h) consists of two basipod, three exopod and one endopod segments. The first basipod segment is nearly circular. Inner margin of the second basipod segment bulges out. Proximal 1/3rd of the inner margin of the second basipod segment has one small lateral swelling. Outer margin of it is unornamented. The first exopod segment is small and has one strong spinous process on its outer distal corner. The second exopod segment is the strongest and widest of all. It tapers towards the distal end, and bears a strong spine on the middle of its outer margin. The third exopod segment is a long, stout and recurved claw ; bearing fine hairs on the 2/3rd of the inner margin from distal portion and unornamented on the outer margin of it. The endopod is large and broad-based originating from the distal lateral corner of the inner margin of the second basipod segment and is fringed with fine hairs between the two spinnules on its tip.

The left fifth leg :

The left fifth leg (fig. h) consists of two basipod, three exopod and one endopod segments. The first basipod segment is nearly circular and smaller than its counterpart of the right fifth leg. The second basipod segment bulges on the proximal region of the inner margin and has a small lateral swelling on the middle of it. The first exopod

segment is thin and almost equal in length of the second basipod segment. The second exopod segment is very small and nearly 1/3rd as long as the first. The third exopod segment is represented by a small thick and recurved spine and a seta, both of which arise terminally on the second exopod segment. Both the spine and the seta are set with fine hairs. The endopod is smaller than its counterpart but the margins are more wavy. Tip of the endopod is fringed with a set of fine hairs.

REMARKS

N. sewelli differs from *N. schmackeri* (Poppe & Richard, 1892) in the length of the antennules and in the structure of the claw of the male right fifth leg and the shape and denticulation of the both sides of the claw of the female fifth leg. The new species differs from *N. meggitti* (Kiefer, 1932) in the shape and size of the genital segment of the female. It also differs from *N. lymphatus* and *N. mephistopheles* (Brehm, 1933) in the absence of serrations on the process of the antepenultimate segment of the right antennule of the male and from *N. physalipus* and *N. diaphorus* (Kiefer, 1935) in the shape of the process of the antepenultimate segment of the right antennule of the male and in the shape of the claw of the male and female fifth legs. New species differs from *N. lindbergi* (Brehm, 1953) in the length and ornamentation of the tip of the endopod of the female fifth legs. In the male, it differs in the shape and ornamentation of the tip of the endopod of the right fifth leg. *N. satanas* (Brehm, 1933) differs from the new species in having a serrated process of the antepenultimate segment of the right antennule, a small lateral process at the outer distal corner

in addition to the curved lateral spine of the second exopod segment and in the shape of the endopod of the right fifth leg of the male. In the female, it differs only in the lack of ornamentation at the tip of endopod of the right fifth leg. New species differs from *N. kamakhiae* (Reddiah, 1964) in the position of the lateral spine of the second exopod segment of the right fifth leg and in the shape of the endopod of the right male fifth leg. In the female, it differs only in the shape of the genital segment, shape and denticulation of the claw and in the size of the endopods of the fifth leg. New species differs from *N. tiwarii* (Roy, 1981 in press) in the structure of the claw and endopod of the right fifth leg and in the shape of the process of the antepenultimate segment of the right antennule of the male. In the female, it differs only in the nature of denticulation of the claw and size of the endopods of the fifth leg.

N. sewelli differs from all the species in the structure and degree of denticulation of both sides of the claw of the left fifth leg and in the shape of the genital segment of the female. In the male, it differs in the shape of endopods and in the shape of the process of the antepenultimate segment of the right antennule.

ACKNOWLEDGEMENT

Author is sincerely thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta, for providing all facilities to carry out this work.

REFERENCES

- BREHM, V. 1950. Contributions to the fresh water fauna of India. *Rec. Indian Mus.*, **48**(1) : 1-28.
- BREHM, V. 1953. Indische Diaptomiden, Pseudodiaptomiden und Cladoceren. *Öster. Zool. Zs.*, **4** : 241-345.
- GURNEY, R. 1907. Further notes on Indian fresh water Entomostraca. *Rec. Indian Mus.*, **1**(1) : 21-33.
- KIEFFER, F. 1935. Fünf neue Ruderfusskrebse aus Indien. *Zool. Anz.*, **109** : 113-121.
- KIEFFER, F. 1939. Scientific results of the Yale North India Expedition. Biol. Rep. 19. Freilebende Ruderfusskrebse (Crustacea Copepoda) aus Nordwest und Süd-Indien. (Pandschab, Kaschmir, Ladak, Nilgiri-gebirge) *Mem. Indian Mus.*, **13**(2): 83-203.
- RAJENDRAN, M. 1971. Redescription of the fresh water Calanoid *Neodiaptomus schmackeri* and comments on inter-relationships and distributional pattern of the *schmackeri* group of species. *Crustaceana* **21** : 92-100.
- RAJENDRAN, M. 1973. A guide to the study of fresh water organisms. Copepoda. *J. Madurai Univ.* (Suppl. 1) 126-140.
- REDDIAH, K. 1964. The Copepod fauna of Assam (India). 1. *Neodiaptomus kamakhiae* n. sp. from the Kamrup District. *Crustaceana*, **7** : 161-166.
- ROY, T. 1980. "Studies on Indian Copepods," Ph.D. Thesis, Calcutta University, pp. 287, pls. 38 (Unpublished).
- ROY, T. 1981. Studies on Indian Calanoids I. Description of a new Calanoid Copepod, *Neodiaptomus tiwarii* sp. nov. (Calanoida : Diaptomidae) from the Nilgiri District with ecological observations. (in Press)

THE PROTOZOA *HAEMOGREGARINA COLISA* SP. NOV. FROM THE FISH
COLISA FASCIATUS AND *HAEMATRACTIDIUM* SP. FROM *ARIUS SONA*
IN INDIA

A. K. MANDAL, R. RAY, N. C. SARKAR AND R. KAHALI

Zoological Survey of India, Calcutta

ABSTRACT

Two intraerythrocytic parasites viz. *Haemogregarina colisa* sp. nov. and *Haematractidium* sp. are described from *Colisa fasciatus* (Bloch.) and *Arius sona* (Ham.) respectively from lower Bengal. The mature gamonts of *H. colisa* are 8.5 μm by 2.4 μm with an average area of 14.9 μm^2 . *Haematractidium* sp. is 4.5 \times 1.0 μm . The *Haematractidium* is reported for the first time from Indian subregion whereas the report of *Haemogregarina* from fishes is treated as third of its kind.

INTRODUCTION

The first piscine haemogregarines *Haemogregarina simondi* from *Solea vulgaris* and *H. bigemina* from *Blennius* spp. caught off the coast of France, were described by Laveran and Mesnil (1901). Thereafter Wenyon (1908) briefly reported another haemogregarine, *H. nili*, from a freshwater fish, *Ophiocephalus obscurus* in the Nile River, Egypt. To date, about 40 species of haemogregarines have been described from marine fishes and about 20 species from freshwater fishes of the world (Becker, 1970).

The genus *Haematractidium* was established by Henry (1910, 1913a), who described *H. scomberi* as the type species from a British sea mackerel, *Scomber scomber*. Since then no further work was done on it until Johnston (1975) found *H. scomberi* again and

confirmed by electron microscopy that it was a protozoon.

Plimmer (1914) reported the first haemogregarine infection from India in *Trichogaster* (= *Colisa*) *fasciatus*, a freshwater fish, which had been brought to the Zoological Garden, London. Though Wenyon (1926) and Bhatia (1938) mentioned the occurrence of this haemogregarine, neither of them gave a description of this parasite. de Mello and Vales (1937) described *H. thyrsoidea* in the blood of a freshwater eel, *Thyrsoidea macrurus*, from Nova Goa, India ; it is considered to be the first described species of piscine haemogregarine from this subcontinent.

We came across a haemogregarine in *Colisa fasciatus* once again and described it below. In addition, we found a *Haematractidium* sp. in *Arius sona* which is also described below.

MATERIAL AND METHODS

The fishes were collected from the Hooghly river mouth and some freshwater reservoirs near the Sundarban areas of Lower Bengal and some of them were taken to the laboratory for examination. Blood was generally taken after puncturing the branchial blood vessels. Blood and organ smears were made on clean slides and fixed in 100% methanol. All the smears were stained with Romanowsky type stains. Out of 100 examples of *Colisa fasciatus* and 50 examples of *Arius sona* examined, only 1 (1%) and 2 (4%) were found positive for *Haemogregarina* and *Haematractidium* respectively.

The figures were drawn with the help of a Camera-lucida. In each case ten parasites were measured, the mean was calculated and mentioned hereunder.

The type slides will be deposited to the National Zoological Collection of the Zoological Survey of India, Calcutta.

OBSERVATION

***Haemogregarina colisa* sp. nov.**

(Figs. 1 a-e)

Type-Host	: <i>Colisa fasciatus</i> (Bolch)
Type-locality	: Reservoir near Canning, 24-Par- ganas, West Bengal.
Site of infection	: Erythrocytes.
Vector and life- cycle	: Unknown
Registration No.	: Holotype pt. 1982. Paratypes pt. 1983, 1984.

DESCRIPTION

Young gamonts

(Fig. 1a)

The young forms are elongate, with one end broader than the other; measuring $8.0 \mu\text{m}$ by $2.0 \mu\text{m}$ with an area of $14.0 \mu\text{m}^2$ (N=10). Each gamont is situated on the half of the erythrocyte facing its concave

Fig. 1

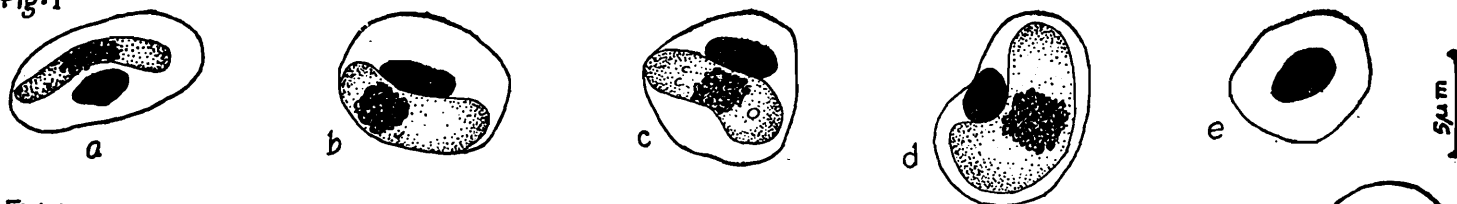


Fig. 2



Figs. 1 & 2

side towards the convex side of the host cell nucleus.

The cytoplasm is homogeneous, granular and faint blue when stained. The granules are more concentrated towards the poles of the parasite. The nucleus is central tubular, $2.5 \times 1.5 \mu\text{m}$ with an area about $4.0 \mu\text{m}^2$, and stains deep red. The chromatin granules are loosely arranged within a thin non-visible nuclear membrane.

Mature gamonts

(Figs. 1b-d)

The mature gamonts are broad, bean-shaped with both ends rounded; occupy almost half of the host's erythrocyte either facing its concave border towards the convex side of the host cell nucleus or vice-versa. They are $8.5 \mu\text{m}$ in length and $2.4 \mu\text{m}$ in width with an average area of $14.9 \mu\text{m}^2$ ($N=10$). The cytoplasm is homogeneous and granulated being more granular towards the poles, and stained deep blue. Sometimes 2 or 3 small vacuoles may be found (Fig. 1c) within the cytoplasm. The rounded or band-shaped nucleus is situated at the middle of the parasite and stains deep red. It is vesicular and contains large number of chromatin granules within a clear unstained nuclear membrane.

Effect of the parasite on the host cell :

The infected erythrocytes became very much distorted and disfigured; they are 8.8 by $6.1 \mu\text{m}$ with an average area of $35.1 \mu\text{m}^2$, being very much hypertrophied. The host cell nucleus is displaced laterally (Figs 1 a, d).

Double infections were never found in an individual blood cell, and there was no

indication of schizogony within the cells of the circulating blood.

Uninfected erythrocyte

(Fig. 1e)

$N=10$. Cell $7.3 \mu\text{m}$ by $5.5 \mu\text{m}$ and $28.7 \mu\text{m}^2$ in area. Cell nucleus $2.2 \mu\text{m}$ by $2.0 \mu\text{m}$ and $4.0 \mu\text{m}^2$ in area.

Haematractidium sp.

(Figs. 2a-e)

Host	: <i>Arius sona</i> (Ham.)
Locality	: Hooghly river mouth, Sagar Islands, 24-Parganas, West Bengal.
Site of infection	: Erythrocytes.
Vector and life-cycle	: Unknown

Description—The youngest ring form is a circular minute cytoplasmic body containing a central chromatin granule. It is $1-2 \mu\text{m}$ in diameter. As the parasite enlarges the chromatin granules divides into two or four. The larger forms are elongated or crescent-shaped, situated beside the host-cell nucleus. They are $4.5 \times 1.0 \mu\text{m}$. The cytoplasm is clear, non-granular and stains pale blue. The chromatin dots are very minute and stain deep red. The staining properties of the host cells are not detectably changed. There were more binucleate or tetranucleate parasites than mononucleate ones. Double infections in a single erythrocyte was never recorded.

DISCUSSION

A thorough review of the literature on piscine haemogregarines revealed that quite

a large number species of haemogregarines have been described both from marine and estuarine fishes of the world (Laveran & Mesnil, 1901; Neumann, 1909; Plimmer, 1914; de Mello and Vales, 1937; Fantham et al., 1942; Saunders, 1958, 1964; Becker, 1962, 1970).

Nearly all "haemogregarines" occurring in the blood of fishes have been described solely by the observation of various intracellular stages occurring in the peripheral circulation. As a diverse group, these forms display numerous morphological variations, but have the common characteristics of cytoplasm and nucleus.

Current diagnosis of the genus *Haemogregarina* (*sensu stricto*) specifies the occurrence of schizogony in the cells of the circulating blood. However, Becker (1970) clearly believed that organisms described as haemogregarines in the blood of fish are broadly separated into two categories those which undergo schizogony within the blood cells, termed the 'Schizohaemogregarines', and those which have no intra-cellular schizogony (Laird 1952, Saunders, 1958b) at present only single intracellular stages are termed as 'haemogregarine' (*sensu lato*). The present haemogregarine is believed to be latter type.

The present parasite seems to deviate from most haemogregarines of marine fishes (Henry, 1912, Laird, 1952) in lacking a crimson staining polar cap. It can also be differentiated from *H. thyrsoidae* de Mello and Vales (1937) by the presence of elongated young forms and the absence of irregularly vacuolated cytoplasm. The present haemogregarine also has homogeneous granulated cytoplasm with a central vesicular multichromatinated nucleus which is absent in *H. thyrsoidae*.

Moreover, the present parasite affects its host cell and host-cell nucleus.

Considering the above facts, it is evident that the species described above is new to science. It is therefore named as *Haemogregarina colisa* sp. nov. The specific name is based on its host generic name.

The genus *Haematractidium* was established by Henry (1910, 1913a) as intraerythrocytic parasite of marine fishes. Subsequently he considered the genus *Haematractidium* an unnamed 'Haemosporidian' (Henry, 1913b). Yet Wenyon (1926) mentioned this genus with Henry's description under 'Intracellular structure of Doubtful nature'. After a long time, Johnston (1973), Newborg and Miller (1975) observed the same parasite in *Scomber scomber* from the U. K. and North America. After studying this parasite both under light and electron microscopes the former clearly considered '*Haematractidium*' to be an eukaryotic protozoon. He also said that, like piroplasms, this organism lies in a parasitophorous vacuole which is not membrane-bound and has a single plasma membrane.

We described *Haematractidium* sp. for the first time in the blood of a catfish, *Arius sona* from India. Due to lack of sufficient material, however, it was not possible to designate the species. Further material is needed for this purpose.

ACKNOWLEDGEMENT

The authors are very much thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for providing laboratory facilities and encouragement during this work.

REFERENCES

- BHATIA, B. L. 1938. 'The Fauna of British India' (Protozoa : Sporozoa) including Ceylon and Burma, pp. 138, 142.
- BECKER, C. D. 1962. A new haemogregarine from the blood of a Fresh-water fish, *Catostomus macrocheilus* Girard. *J. Parasit.*, **48** : 596-600.
- BECKER, C. D. 1970. Haematozoa of fishes, with emphasis on North American record. In symposium on Diseases of fishes and shell fishes. (S. F. Snieszko ed.). *Spec. Publ. No. 5* : 82-100. Am. Fish. Soc. Washington D. C.
- FANTHAM, H. B., PORTER, A., AND RICHARDSON, L. R. 1942. Some haematozoa observed in vertebrates in eastern Canada. *Parasitology*, **34** : 199-266.
- HENRY, H. 1910. On the haemoprotozoa of British sea-fish (a preliminary note). *J. Path. Bact.*, **14** : 463-465.
- HENRY, H. 1912. *Haemogregarina anarrhichadis* from *Anarrhichas lupus*, the catfish. *Parasitology*, **5** : 190-196.
- HENRY, H. 1913a. A new haemosporidian from *Scomber scomber*, the common mackerel. *J. Path. Bact.*, **18** : 228-231.
- HENRY, H. 1913b. The granules shedding of *Haemogregarina simondi* *J. Path. Bact.*, **18** : 240-249.
- JOHNSTON, M. R. L. 1975. Distribution of *Pirhemocyon* Chatton & Blanc and other Possibly Related, Infections of Poikilotherms. *J. Protozool.*, **22** : 529-535.
- LAIRD, M. 1952. New haemogregarines from New Zealand marine fishes. *Trans. and Proc. Roy. Soc. New Zealand.* **79** : 589-630.
- LAVERAN, A. AND MESNIL, F. 1901. Deux haemogregarines nouvelles des poissons. *C. r. Acad. Sci.*, **133** : 572-577.
- DE MELLO, F. AND VALES, C. 1937. *Haemogregarina thyrsoidae* n. sp., parasite of the Indian eel, *Thyrsoidea macrurus* Bleeker. *Proc. Indian. Acad. Sci. (B)*, **4** : 403-404.
- NEUMANN, R. O. 1909. Studien Uber Protozoische Parasiten im Blute von Meeresfischen. *Z. Hyg. Infektkrankh.*, **64** : 1-112.
- NEWBORG, M. AND MILLER, D. 1975. An unusual sporozoan blood parasite named *Haematractidium scomberi* Henry, 1910 from the Atlantic Mackerel, *Scomber scomber* *J. Parasit.*, **61** : 264.
- PLIMMER, H. G. 1914. Report on the deaths which occurred in the Zoological Gardens during 1913, together with a list of the blood parasites found during the year. *Proc. zool. Soc. Lond.* **1** : 181-190.
- SAUNDERS, D. C. 1958a. The occurrence of *Haemogregarina bigemina* Laveran and Mesnil and *H. dasyatis* n. sp. in marine fish from Bimini, Bahamas, BWI. *Trans. Am. microsc. Soc.* **77** : 404-412.
- SAUNDERS, D. C. 1958b. Report on a survey of blood parasites of the marine fishes of the Florida Keys. Year Book. *Am. Phil. Soc.* **1958**. p. 261-266.

SAUNDERS, D. C. 1964. Blood parasites of marine fish of southwest Florida, including a new haemogregarine from the menhaden, *Brevoortia tyrannus* (Latrobe) *Trans. Am. microsc. Soc.*, **83** : 218-225.

WENYON, C. M. 1908. Report of the travelling pathologist and protozoologist, 3rd Rept. *Wellcome. Res. Lab. (Khartoum)* **3** : 121-168.

WENYON, C. M. 1926. '*Protozoology*', 2 vols. Bailliere, Tindall and Cox, London pp. IX + 1563.

ADAPTIVE ROLE OF PECTORAL FIN IN FISHES OF HILL-STREAMS

G. M. YAZDANI

Zoological Survey of India, Gangetic Plains, Regional Station, Patna

ABSTRACT

Observations have been made on the shape, size and position of pectoral fins in different groups of hill-stream fishes. Different functions of pectoral fin among bony fishes have been reviewed and their adaptive role pointed out. Correlation has been established between pectoral fin pattern and mode of living in hill-stream fishes. It has been concluded that in all the bottom-living hill-stream fish the pectoral fin has acquired a particular type of inclination which is quite suitable to utilise the force of water current for pressing the body further against the substratum.

INTRODUCTION

The torrential streams of hills and mountain ranges offer an unusual environment to which many fishes have successfully adapted by evolving mechanical devices to resist the force of current. The structural modifications resulting from such conditions have involved, among others, certain modifications of pectoral fins for taking up entirely new functions such as lateral support at the bottom and development of adhesive structures on their ventral side. In addition, the pectoral fin by virtue of its position and inclination on the body appears to play a definite role, the adaptive significance of which is not properly understood. This paper is mainly concerned with this aspect of pectoral fin function in hill-stream fishes.

MATERIAL AND METHOD

Specimens of the following hill-stream fishes have been examined.

CYPRINIDAE

Barilius bola Hamilton
Schizothorax richardsonii (Gray)
Garra gotyla (Ham.)
Crossocheilus diplochilus (Heckel)

COBITIDAE

Noemacheilus multifasciatus Day

HOMALOPTERIDAE

Bhavana australis (Jerdon)

SISORIDAE

Glyptothorax brevipinnis Hora
Pseudecheneis sulcatus (McClelland)

In most species, mode of living and pectoral fin movements have been observed in the field. In some species, these observations have also been confirmed by keeping specimens in an aquarium. Information on the mode of life of *Bhavana australis* has been obtained from published work (Hora, 1933).

The illustrations have been drawn free hand and are semidiagrammatic. The paired fins are shown partially spread out in the position of rest.

THEORY

Among free-swimming teleosts, pectoral fin is useful in such manoeuvres as climbing, diving, banking and braking. In primitive bony fish such as *Salmo* they are placed low on the body, ventral to the centre of gravity. When the pectoral fins are in this position a fish which brakes by spreading its pectoral fin outwards must either make a pitching movement or else rise bodily in water as it stops. If the pectoral fins are spread vertically so that the force on them consists entirely of horizontal drag it will pitch, with its head sinking and its tail rising. If, however, they are held at such an angle that they produce lift as well as drag, and the resultant force on them acts through the centre of gravity of the fish there will be no tendency to pitch, but the fish will rise in water as it stops. While braking a fish cannot stop without pitching or rising unless other fins are used with the pectorals or the pectorals lie on the same plane as the centre of gravity (Alexander, 1967).

If the pectorals are spread out in such a way that their spine-supported leading edges are higher than the trailing edges, the fish would experience lift during swimming. Similarly, if the pectorals are spread out in such a way that their trailing edges are higher than the leading edges the fish would experience downward pull. Accordingly, the fishes living at the bottom of fast stream are also likely to experience lift or downward pull depending on the inclination of their pecto-

als on the body, because the principle of hydrodynamics is same whether a body moves under water or water moves over a stationary body.

Figure 1 gives a diagrammatic representation of pectoral fin inclination in fishes. The pectorals are shown in resting position and are assumed to lie in the same level as the centre of gravity of the fish. Now suppose the fish in Fig. 1(a) to 1(c) start swimming. If the fish in Fig. 1(a) spreads its pectorals, it would stop without pitching or rising. If the fish in Fig. 1(b) spreads its pectorals, it would either stop with rising or experience lift during swimming. If, however, the fish in Fig. 1(c) spreads its pectorals, it would either stop with sinking or experience downward pressure during swimming. In case the fish in Fig. 1(c) stays at the bottom of a fast stream it would also experience a downward pull so long as its pectorals are spread out.

MODE OF LIVING

Three main factors viz., strength of current, abundance of oxygen and nature of food have been mainly responsible for adaptation and adaptive radiation in fishes of hill-streams (Hora, 1930). Based on the mode of life, these fishes can be conveniently divided under the following two categories :

- I. *Free-swimming fishes* : These fish occur in pools, pot-holes in the bed of stream and along the edges of stream. They are affected by the swiftness of current and on the rush of water seek shelter under rocks and stones at the bottom or hide under crevices along the edges of streams. They are capable of progressing against the current. Examples are species of *Tor*, *Acrossocheilus*, *Barilius* and *Schizothorax*.

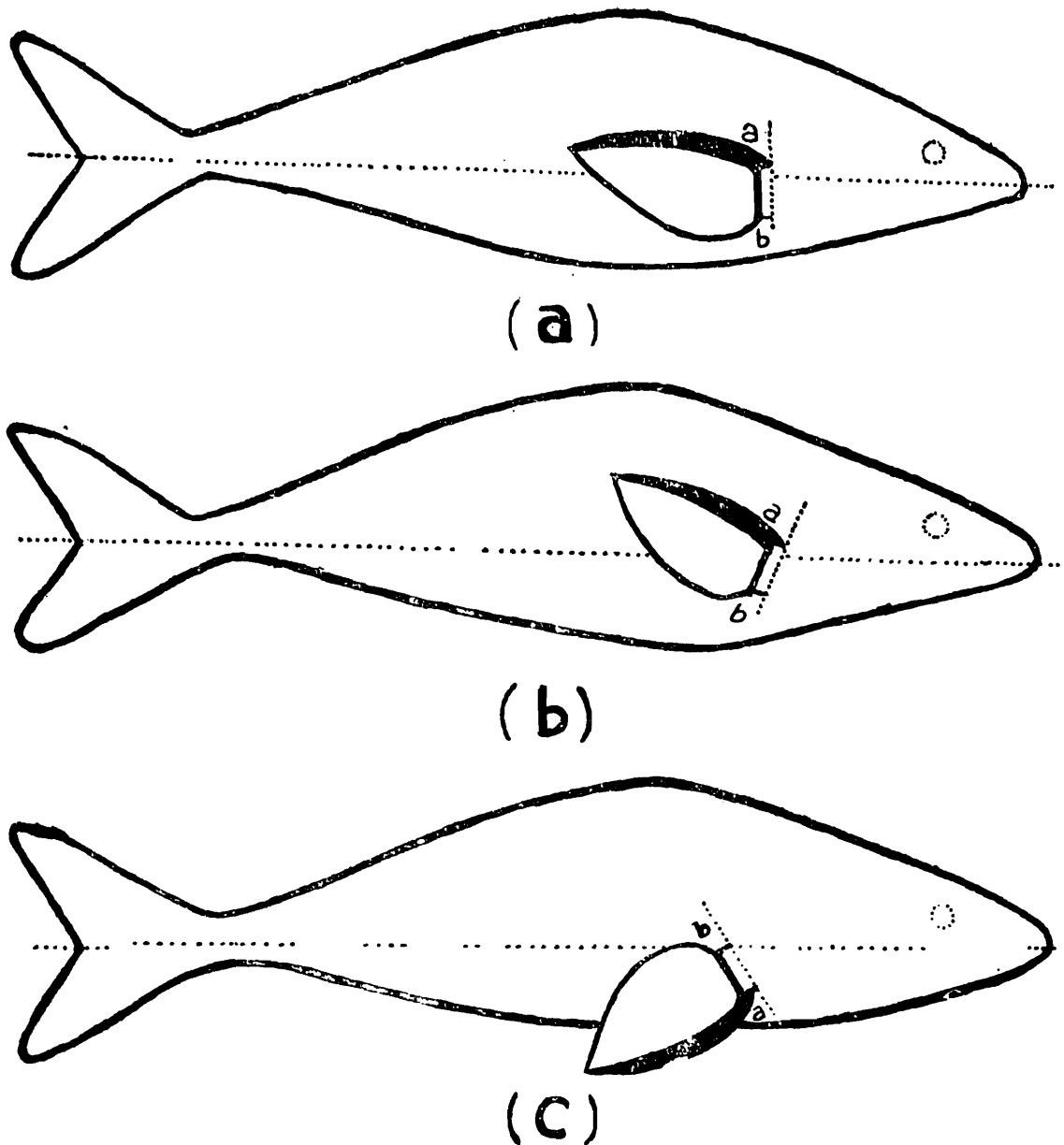


Fig. 1. Diagrammatic lateral view of fishes showing different types of pectoral fin inclination and angle of insertion on the body (a-b, axis of fin insertion). (a), a-b almost at right angles to the body axis ; stiff part of the fin uppermost. (b), a-b at an oblique angle to the body axis, stiff part of the fin uppermost. (c), a-b at an oblique angle to the body axis ; stiff portion of the fin lowermost.

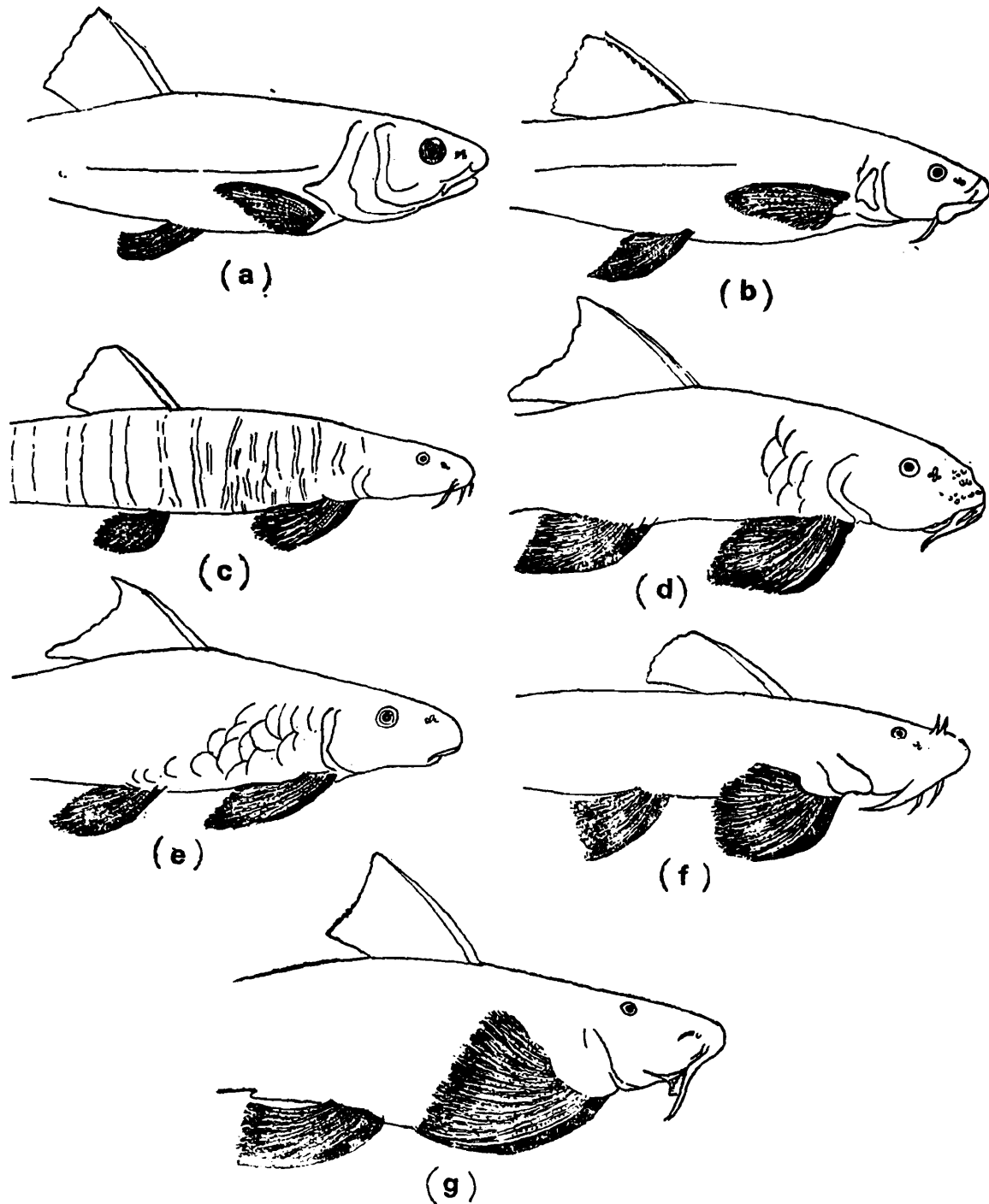


Fig. 2. Lateral view of some hill-stream fishes showing their paired fins. (a) *Barilius bola*, (b) *Schizothorax richardsonii*, (c) *Noemacheilus multifasciatus*, (d) *Garra gotyla*, (e) *Crossocheilus diplochilus*, (f) *Glyptothorax brevipinnis*, (g) *Pseudecheneis sulcatus*.

II. *Bottom-living fishes* : The fishes of this category spend most of their time at the bottom and adhere to the substratum by means of some adhesive device. Examples are species of *Botia*, *Noemacheilus*, *Bhavana*, *Garra*, *Crossocheilus*, *Glyptothorax* and *Pseudecheneis*.

PECTORAL FINS

The pectoral fins of each species will now be described (Fig. 2).

1. *Barilius bola* (Fig. 2a) : The pectoral fin of this fish is situated just near the lower edge of the body. It is moderate in size and contains 13 rays. Its axis of insertion is almost oblique to the body axis. The stiff leading edge of the fin is directed upwards.
2. *Schizothorax richardsonii* (Fig. 2b) : The pectoral fin of this species is rather similar to that of *Barilius bola*.
3. *Garra gotyla* (Fig. 2d) : The pectoral fin of this fish is situated almost on the ventral side. It is fairly well-developed and contains 15 rays. Its axis of insertion is almost parallel to the body axis. The stiff leading edge of the fin is directed forwards.
4. *Crossocheilus diplochilus* (Fig. 2e) : The pectoral fin of this species resembles that of *Garra gotyla*.
5. *Noemacheilus multifasciatus* (Fig. 2c) : The pectoral fin of this loach is situated quite low on the body. It is of moderate size and contains 11 rays. Its axis of insertion is almost parallel to the body axis. The stiff leading edge of the fin is directed almost forward.
6. *Bhavana australis* : The pectoral fin of this south Indian homalopterid fish is situated almost on the ventral side of the body. It is well-developed and contains around 20 rays. Its axis of insertion is oblique to the body axis in such a way that the stiff leading edge is somewhat directed downwards. When spread out, it appears more or less horizontally placed but its trailing soft edge is higher than the stiff leading edge.
7. *Glyptothorax brevipinnis* (Fig. 2f) : The pectoral fin of this species is fairly well-developed and contains strong, broad spine which is sharply denticulated ventrally, and 7 soft rays. It is placed low on the body, almost on the ventral edge. Its axis of insertion is almost horizontal to the long body axis. However, when the fin is spread out, the stiff spine-supported leading edge is somewhat directed downwards.
8. *Pseudecheneis sulcatus* (Fig. 2g) : The pectoral fin of this fish is very well-developed and contains a flattened, pectinated spine and 13 soft rays. Its axis of insertion is oblique to the long axis of the flattened body in such a way that the stiff spine-supported edge is directed downwards. When spread out, the trailing soft edge of the fin is much higher than the leading edge.

DISCUSSION

The pectoral fin of each species of hill-stream fish will now be discussed in relation to its mode of life.

Barilius bola and *Schizothorax richardsonii* have moderate sized pectoral fins. In both

species the axis of fin insertion is oblique to the body axis and the stiff anterior edge is directed upwards. This type of pectoral fin inclination seems well-suited for free-swimming fishes.

In *Noemacheilus multifasciatus*, *Garra gotyla* and *Crossocheilus diplochilus* the axis of pectoral fin insertion is almost parallel to the body axis and the stiff anterior end of the fin is directed forwards. When the fin is spread out, its soft trailing edge is higher than its stiff leading edge, and as a result the fish experiences a downward pull which is advantageous for staying at the bottom of a fast stream. Since the pectoral fin is placed quite low on the body, these fish also appear to obtain lateral support by these fins and thus ensure a more stable equilibrium at the bottom.

In most other bottom-living forms such as *Bhavana australis*, *Glyptothorax brevipinnis* and *Pseudecheneis sulcatus* the pectoral fin inclination is such that the stiff leading edge always rests at the bottom and the soft trailing edge is kept well raised. As a result, these fish get the advantage of downward pull over their bodies in a fast stream. Since the pectoral fins are placed quite low on the body, they also provide lateral support and hence a more stable equilibrium. In some of these fish, certain adhesive structures are also present on their ventral side which provide them a firm grip over the substratum.

CONCLUSION

While evolution of depressed body with a broad and somewhat flat underside in

fishes of hill-streams ensures a stable equilibrium at the bottom, the modification of pectoral fins with inclination shown in Fig. 1(c) further provides lateral support to the body and permits the fast current to hit the expanded pectoral fin in such a way that the fish would experience a downward push. Consequently, other adhesive and frictional structures present ventrally are likely to come into play and strengthen the grip over the bottom. The modification of pectoral fins to utilise the strength of current i.e. for adhering firmly at the bottom, seems to be one of the most remarkable features in the evolutionary history of hill-stream fishes.

Among the strictly bottom-living hill-stream fishes, the pectoral fins have to perform the following functions owing to their modification. 1. lateral support to the body for achieving stability at the bottom. 2. generation of downward pressure by a particular type of inclination of pectoral fin. 3. provision of sufficient space for the development of various frictional and adhesive structures (see Hora, 1930). 4. pumping out water from under side of the fish (see Hora, 1930).

It may now be concluded that among hill-stream fishes, the free-swimming forms possess moderate sized pectoral fins with axis of insertion placed at right angles or at an oblique angle to the long body axis and the stiff spine-supported leading edge directed upwards, whereas the strictly bottom-dwellers have developed rather large sized pectoral fins, with axis of insertion at an angle oblique to the body axis and the stiff spine-supported leading edge directed downwards.

ACKNOWLEDGEMENT

I am thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta, for kindly giving me an opportunity to work on this problem. I am also thankful to Dr. P. D. Gupta, Deputy Director, Gangetic Plains Regional Station, Z. S. I., Patna, for kindly extending necessary facilities.

I also take this opportunity to thank Dr. R. S. Pillai, Deputy Director, Southern Regional Station, Z. S. I., Madras, for kindly sending specimen of south Indian homalopterid fish for my study.

REFERENCES

- ALEXANDER, R. McN., 1967. *Functional design in fishes*. 1-160, London (Hutchinson & Co.)
- HORA, S. L. 1930. Ecology, bionomics and evolution of torrential fauna, with special reference to the organs of attachment. *Phil. Trans. R. Soc.*, London (B), **218** : 171-282.
- HORA, S. L. 1933. Classification, bionomics and evolution of homalopterid fishes. *Mem. Indian Mus.*, Calcutta, **12** (2) : 263-330.

ON SOME FOSSIL CRYPTOCERATA (HETEROPTERA : INSECTA)
WITH DESCRIPTION OF A NEW GENUS ET SPECIES

K. V. LAKSHMINARAYANA

Zoological Survey of India
Southern Regional Station, Madras

ABSTRACT

In this paper some of the fossil species of Nepidae & Belostomatidae examined by the author in different museums in Europe, are outlined and a new genus *et* species of a belostomatid is described.

During a short visit to the Geological Laboratory, Polish Academy of Sciences, Krakow, Mrs Ewa Kwietkowska, Scientist, Dr S. Gasiorowski, the Paleontologist, and Dr S. Kwietkowski, the Director of the Institute, placed before the author some interesting insect fossils from Solenhofen Limestones, or the so-called Bavarian fossils which included some odonates, and two belostomatid bugs. Since one of the belostomatids appeared new, material available in the Museum fuer Naturkunde an der Humboldt Universität, Berlin (G. D. R.), and the Department of Entomology, British Museum (Natural History), London, from the same limestone deposits as well as the extant species available at Berlin Museum were examined for comparison.

Handlirsch (1906) dealt in detail the

insect fossils from Solenhofen limestones and reviewed the earlier records in his famous treatise. Carpenter (1932) discussed on the fossils from the same region available in the museums of Carnegie and Comparative Zoology in the United States. Becker-Migdisova (1962) reviewed the fossil Heteroptera including those from the Bavarian limestones. Our knowledge on the fossil belostomatids remained the same from Handlirsch's times, save the one described from the Tertiaries (Oligocene-Miocene) viz. *Lethocerus sulcifemoralis* Riha & Kukulowa (1967).

The following account deals with not only the belostomatids examined, but also the Nepidae present in the Berlin Museum. The measurements are given in cms.

Superorder : HEMIPTEROIDEA

Order : HETEROPTERA Latreille

Series : CRYPTOCERATA Fieber

(= HYDROCORISAE Latreille)

Family : NEPIDAE Latreille

Mesonepa primordialis (Germar)

Nepa primordialis Germar, 1839. *Nova Acta Akad. Leop. Carol.*, XIX : 206, pl. 22, fig. 7.

Mesonepa primordialis: Handlirsch, 1906. *Foss. Ins.*, : 637, pl. LI, fig. 20.

Handlirsch (1906) transferred Germar's *Nepa primordialis* to a new genus *Mesonepa*. Carpenter (1932) stated that this is an obscure insect, and that he studied two specimens in Carnegie museum, and three in the Museum of Comparative Zoology.

Material examined : 1 ex., 1880, Haeblerlein (with a remark "figured by Handlirsch" ; 1 ex., Ober-Juras., Eichstaedt, coll. *Ruhle v. Lilienstern*.

Measurements : Length, 2.3-2.5 ; Width of Prothorax 0.9 ; Width of abdomen 1.2-1.3.

Remarks : Since there is a note that it was "figured in Handlirsch (1906)" it is possible that Prof. Handlirsch examined both the specimens. Handlirsch (*op. cit.*) also described another species *M. minor* which could not be traced during my short stay and possibly it might have been located there. Carpenter (1932) examined eight examples of the latter species : three in Carnegie and five in Comparative Zoology Museums respectively.

Family : BELOSTOMATIDAE Leach

Mesobelostomum deperditum (Germar)

(Figs. 1-3)

Scarabaeides deperditum Germar, 1839. *Nova Acta Akad. Leop. Carol.*, XIX : 218, pl. 23, fig. 17.

Mesobelostomum deperditum Haase, 1890. *N. J. Miner.*, II : 88 ; Handlirsch, 1906. *Foss. Ins.*, : LI figs. 22-25. ; Carpenter, 1932. *Ann. Carneg. Mus.*, 21 : 119 ; Bokker-Migdisova, 1962. *Osnovy Palaeontologia* : 214, fig. 636.

This is by far the most common aquatic bug among the Solenhofen deposits. The extant forms are all fresh-water inhabitants, but it may be interesting to recapitulate the observations of Carpenter (1932) that



Fig. 1

it was likely that these insects actually lived as adults in the waters that deposited the limestones though they were saline, but might have bred in the nearby freshwater lakes, and flew to these waters as adults. To this, we may add that it is perhaps more possible that bodies of the bugs were washed into these waters through streams. Carpenter (1932) also stated that most of these specimens were poorly preserved, but some, however, show the details of the wings and body structure. This observation

strongly supports the possibility of their transport from a distance and in course of which suffered damage, before deposition.



Fig. 2

Handlirsch (1906) figured the specimens well. Carpenter (1932) examined 11 examples

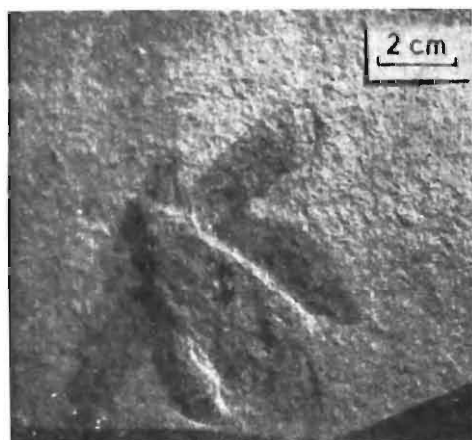


Fig. 3

in the Carnegie Museum, 19 in Museum of Comparative Zoology, obtained one from the Palaeontological Museum of Bavaria, Munich, and another bought from Ward's establish-
ment.

Material : 2 exs. labelled SOK (possibly Solenhafen Oberkreide), 1854 (one of which posteriorly incomplete); 3 exs, Haberlein, 1880 (in Museum fuer Naturkunde an der Humboldt Universität, Berlin) (figs. 1 & 2); 1 ex. In. No. 44297 labelled as *M. deperditum* from Lithographic stones, Solenhofen, Bavaria, colls. 1862 with a remark "figured by Popov, Y A. 1971. *Trud. Pal. Inst.*, 129., pl. 2, fig. 3) (in Department of Entomology, British Museum (Nat. History), London), 1 ex., in Geological Laboratory, PAN, Krakow (fig. 3).

Measurements : Length 4.7-4.95 or 5.0; Width of Pronotum 1.2-1.4; Width of abdomen 1.4-1.9.

Remarks : The Berlin Museum specimens were also preserved incompletely as stated by Carpenter (*op. cit.*). This species comes very close to the modern *Belostoma* or *Lethocerus*. The specimens from Berlin Museum and Krakow Geological Laboratory are given in figs 1-3.

Stanislawia n. gen.

(Figs. 4-6)

Type species : *Stanislawia ewaee* n. sp.

In all the extant and the fossil belostomatid species known, the prothorax is more or less trapezoidal, with rounded anterolateral angles. In the second belostomatid example from the Geological Laboratory, PAN, Krakow, the prothorax is not distinctly trapezoidal, the anterior margin finely sinuate, and the anterolateral angles are drawn into spinous protruberances (figs. 4-6), which makes it distinct from all the hitherto known genera *et* species (both extinct & extant) and hence accommodated in a new genus *Stanislawia*.

Stanislawia ewaae n. sp.

(Figs. 4-6)

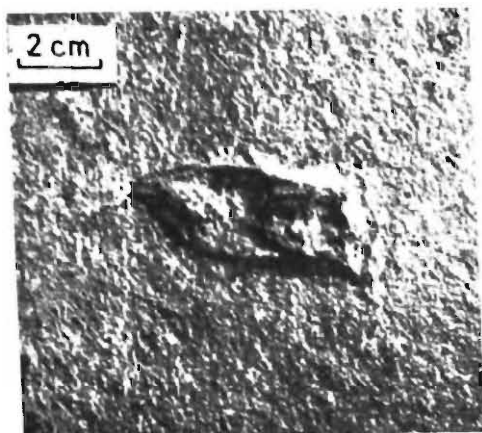
Description : Body very large as in

Fig. 4

Belostoma, or *Lethocerus*, and *Mesobelostoma*, nearly elliptical; head not visible in the specimen; prothorax with anterior margin

finely sinuate and provided with spinous protruberances to the anterolateral angles; scutellum nearly as broad as its length; hemelytra or wings not clear; no trace of legs except parts of the third femora.

Measurements

Length of the prothorax upto the anterior margin of the scutellum	0.8
Width of the prothorax to the tips of the spinous processes	3.5
Length of the scutellum	1.9
Width of the scutellum	2.0
Length of the abdomen	5.3
Width of the abdomen	2.4

Material : 1 ex. (*Holotype*) Solenhofen limestones, coll. xxxxx, In Geological Laboratory, PAN, Krakow.



Fig. 5

Etymology : The new genus is named after the first names of Drs S. Gasiorowski, the well known paleontologist, and Dr S. Kwietkowski, the Director of Geological Laboratory, Krakow, while the specific appellation is after Mrs Dr Ewa Kwietkowska, Scientist in the same laboratory, who remembered about the purchase of these fossil specimens years back and traced them from the unidentified deposits in the laboratory.

Remarks : The new genus *et species* can be easily distinguished from extinct *Mesobelostomum* Hasse of the Jurassic, the extinct species of *Lethocerus* of the Tertiaries, and



Fig. 6

the extant genera of *Belostoma* Latreille, or *Lethocerus* Mayr, *Diplonychus* Laporté (= *Sphaerodema*), *Benacus* Stal, *Abedus* Sta., at the first sight by the sinuate anterior margin and spinously tuberculated anterolateral angles.

Diplonychus sp.

Material : 1 ex., labelled as "*M. belostomum* gen. Fischersche Sammlung, Dorsal and Ventral hlb.," in the Museum fuer Naturkunde an der Humboldt Universität, Berlin.

Remarks : From the general facies, it appears to be a *Diplonychus* rather than a *Mesobelostomum*, or may be a juvenile of the latter. Oppenheim (1888) however reported *Sphaerodema jurassicum* in the fossil state.

ACKNOWLEDGEMENTS

The author is indebted to Dr. S. Khera, formerly Jt. Director in-charge. Zoological Survey of India, and the Secretary, Department of Science and Technology, Govt. of India, New Delhi, for his visits to the different museums in Europe, to Dr B. K. Tikader, Director, Drs S. K. Bhattacharyya and R. S. Pillai, Deputy Directors of the Zoological Survey of India for all facilities and encouragement ; to Drs S. Kwietkowski, Director, S. Gasiorowski, Mrs Ewa Kwietkowska, Scientists, Geological Laboratory, PAN, Krakow, Prof. Wd. Eichler, and Dr Mrs Erika Pietrzeunik of Museum fuer Naturkunde an der Humboldt Universität, Berlin, to the authorities of the Polish Academy of Sciences (PAN), Poland, German Democratic Republic, and the Department of Entomology, British Museum (Natural History), London for the cultural exchange Programme of specialists, and for various other courtesies. His sincere thanks are also due to Prof. M. S. Mani, the first Indian insect paleontologist for going through the manuscript and valuable suggestions.

REFERENCES

- BEKKER-MIGDISOVA, YE. E. 1962. Heteroptera.—In B. B. Rodendorf ed. *Osnovy Palaeontologia*, [Akad. Nauk, SSSR], Moskova : 208-224, figs. 612-670.
- CARPENTER, F. M. 1932. Jurassic insects from Solenhöfen in the Carnegie Museum and the Museum of Comparative Zoology.—*Ann. Carneg. Mus.*, 21 : 97-129, 11 figs.
- HANLIRSCH, A. 1906. *Fossilen Insekten und die phylogenie derrezenten Formen*, Leipzig : I-IV (illus.)
- OPPENHELM, P. 1888. Die Insectenwelt des lithographischen Schiefers in Bayern.—*Paleontographica*, 36 : 215-247.
- RIHA, P. & KUKALOVA, J. 1967. Eine neue Tertiaere wasserwanze aus dem Bechlejovicer Diatomit (Heteroptera, Belostomatidae).—*Acta ent. bohemslov.*, 64 (3) : 259-260, 181 pl., 2 figs.

ON A NEW GENUS OF DERMAPTERA (INSECTA) WITH
NOTES ON *PTERYGIDA* VERHOEFF

G. K. SRIVASTAVA

Zoological Survey of India, Calcutta

ABSTRACT

The genus *Neopterygida* is erected for the reception of *Forficula circulata* Dohrn, 1865. Besides, the genus *Pterygida* Verhoeff, is redefined synonymising *Kosmetor* Burr and placed under the Subfamily Eudohrniinae. *Kosmetor punctata* Srivastava, is synonymised under *P. jagori* (Dohrn).

INTRODUCTION

Verhoeff (1902) erected *Pterygida* and included under it two species, viz., *Forficula jagori* and *Forficula circulata*, both described by Dohrn (1865). Subsequently Kirby (1904) designated former as the type species.

As a result of re-examination of type of both the species it is found they are not congeneric. Therefore a new genus is erected for the reception of *F. circulata* which appears to be quite distinct from other species of Forficulidae in having strongly depressed body and other morphological peculiarities.

Borelli (1918) correctly redefined *Pterygida* Verhoeff, redescribing *P. jagori* on the material from Philippines. This species, on the basis of antennae, sternal plates and other morphological details fits well in the genus *Kosmetor* Burr (1907). For this reason *Kosmetor* is placed as synonym of *Pterygida* which is transferred under the subfamily

Eudohrniinae. Though the type of former, *Forficula annandalei* Burr (1904), has not been examined, the detailed diagnostic characters provided by Burr (1907, 1910, 1911) are sufficient to justify above action.

Family : FORFICULIDAE
Subfamily : ANECHURINAE
Genus : **Neopterygida** nov.

Pterygida Verhoeff, 1902, *Zool. Anz.*, 25 (665) : 197
(Partim).

Size medium (29.2 mm including forceps). Head depressed, sutures marked by faint depression. Antennae (broken, only basal segment remaining in the type) with basal segment narrowed basally, about as long as the distance between scapi. Pronotum about as long as broad, quadrate. Elytra and wings well developed, former smooth and ecarinate along the costal margin. Legs long and slender; hind 1st tarsal segment slightly

longer than 3rd and 2nd lobed with hind margin deeply emarginate. Prosternum longer than broad, gently narrowed apically; mesosternum transverse with hind margin entire and metasternum beyond hind coxae projecting as narrow lobe with hind margin faintly emarginate. Abdomen enlarged in middle and strongly depressed; ultimate tergite not sloping backwards. Penultimate sternite rounded posteriorly but with a deep cleft in middle, a small median ridge present apically. Pygidium transverse, subvertical, deeply emarginate in middle. Forceps gently arcuate, compressed.

Type species : *Forficula circulata* Dohrn, 1865.

Remarks : On account of general facies and shape of sternal plates this genus is included under the subfamily Anechurinae. It is not possible to verify the shape of antennal segments which are used in the separation of various subfamilies of Forficulidae. It can, however, be easily distinguished from various genera of Anechurinae and Opisthocosmiinae by strongly depressed body, shape of pygidium and penultimate sternite.

Neopterygida circulata (Dohrn)

(Figs. 1-2)

Forficula circulata Dohrn, 1865, *Stettin. ent. Ztg.*, 26 : 95 (Type ♂; India : Madras).

Apterygida circulata : Bormans, 1900, *Das Tierreich*, 11 Forficulidae : 116, fig. 42.

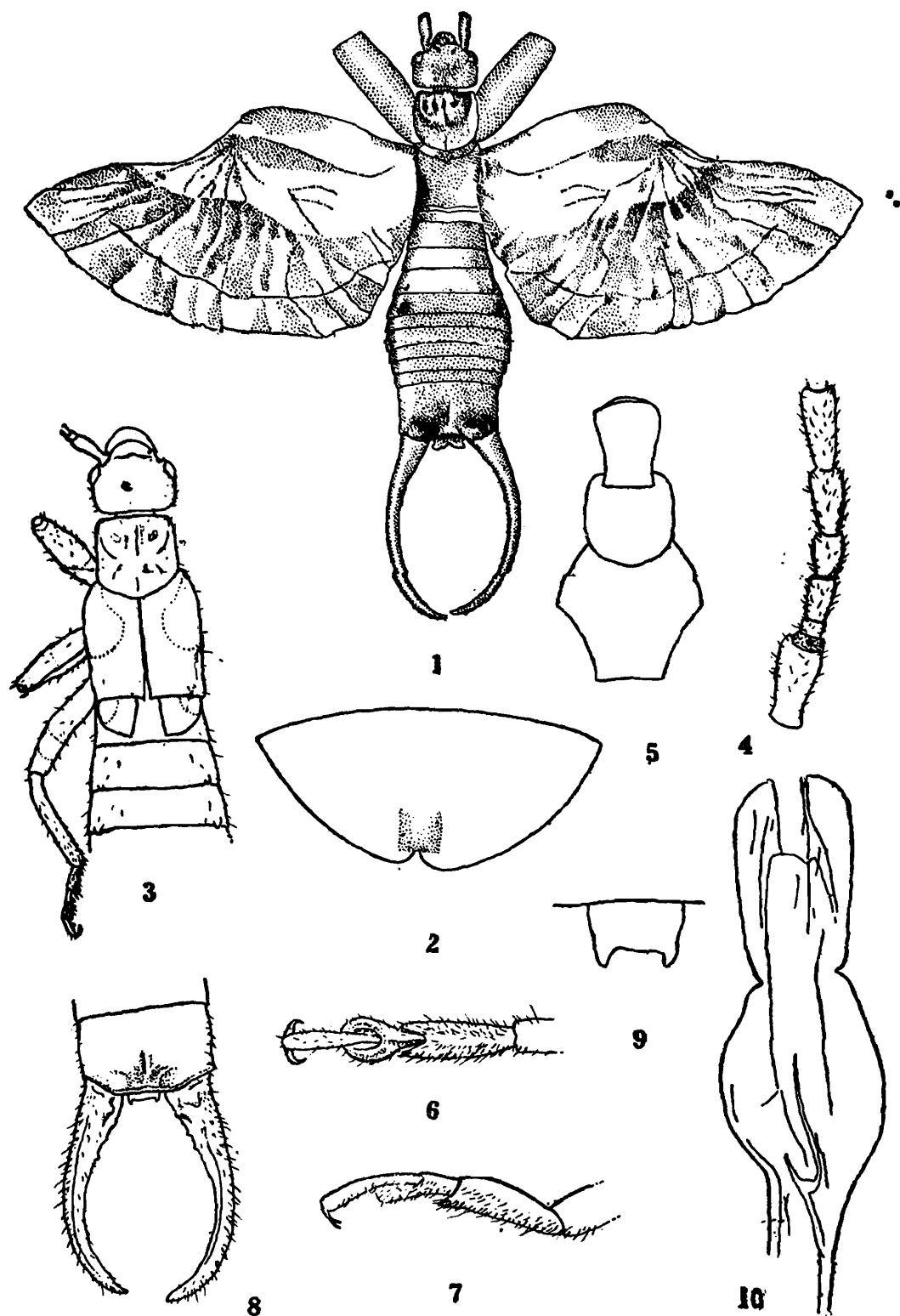
Pterygida circulata : Verhoeff, 1902, *Zool. Anz.*, 25 (665) : 197; Kirby, 1904, *Syn. cat. Orth.*, 1 : 44; Burr, 1910, *Fauna Brit. India. Dermoptera* : 158, pl. 10, fig. 96; Burr, 1911, *Genera Insect.*, 122 : 72; pl. 6, figs. 16a, b; Burr, 1912, *Annln naturh. Mus. Wien*, 26 : 97.

Material examined : 1 ♂ (Type), Coll. nat. Mus. Wien; Derm. Inv. Nr. 216, Mus. Caes Vind., Ind. Orient; *A. circulata* Det. Dohrn; Det. Burr *Pterygida circulata*, ♂ (Naturhistorisches Museum, Wien).

♂ : Head, pronotum and abdomen up to middle black; basal antennal segment, posterior half of abdomen and forceps reddish brown (or brick red); legs with femora black; tibiae and tarsi somewhat reddish; ultimate tergite with four, faint blackish longitudinal stripes. Elytra yellowish brown, wings yellow in apical half and black in remaining half.

Head smooth, triangular, slightly longer than broad, moderately depressed, sutures marked by faint depression. Antennae broken; only basal segments remaining, about as long as the distance between antennal bases.

Eyes shorter than the post-ocular length of head. Pronotum about as long as broad, anteriorly straight, sides gently convex, hind angles and margin broadly rounded; prozona weakly raised and metazona flat, median sulcus distinct. Elytra ample, impunctate, shoulder somewhat prominent, hind margin truncate; wings projecting well beyond the elytra. Legs long and slender, hind 1st tarsal segment slightly longer than 3rd; 2nd lobed with hind margin deeply emarginate. Abdomen strongly depressed, enlarged in middle, contracted anteriorly as well as posteriorly, punctation rather obscure, giving an impression of microreticulations, sides of segments convex, lateral tubercles on 3rd tergite poorly and on 4th somewhat distinctly marked. Penultimate sternite broadly rounded posteriorly with a deep emargination in middle, a faint small



Figs. 1-10 : *Neopterygida circulata* (Dohrn) comb. nov., Holotype ♂ 1. Dorsal view, 2. Penultimate sternite ; *Pterygida jagori* (Dohrn), Lectotype ♂, 3. Anterior portion of body, 4. A few basal antennal segments, 5. Thoracic sternal plates, 6. Hind tarsi in dorsal view, 7. Hind tarsi in profile, 8. Ultimate tergite and forceps, 9. Pygidium enlarged and 10. Genitalia.

median ridge present posteriorly. Ultimate tergite transverse, smooth, depressed, above the roots of forceps with a lobular fold and the area in the middle with a slight depression, hind margin in middle straight, laterally oblique and concave. Pygidium subvertical, transverse, divisible into two triangular lobes. Forceps remote at base, regularly curved, tapering apically, branches compressed. Genitalia not examined.

♀ : Unknown.

Measurements : (in mm)	Type
	♂
Length of head	2.3
Width of head	2.2
Length of pronotum	2.1
Width of pronotum	2.3
Length of elytra	3.7
Length of ultimate tergite	1.8
Width of ultimate tergite	3.5
Length of body	14.0
Length of forceps	6.2

Distribution : India (Madras and North India).

Remarks : This species, besides type, is known from a single ♂ from North India which is deposited in the Hope Entomological Collections, University Museum, Oxford (U.K.). Due to strongly depressed body and posteriorly emarginate penultimate sternite which is provided with a short median ridge in apical third, this species appears to be quite distinctive.

Subfamily : EUDOHRNIINAE

Genus *Pterygida* Verhoeff

Pterygida Verhoeff, 1902, *Zool. Anz.*, 25 (665) : 197 (Partim);—Kirby, 1904, *Syn. cat. Orth.*, 1 : 44 (*Forficula jagori* Dohrn—designated as the type),

Kosmetor Burr, 1907, *Trans. R. ent. Soc. Lond.*, 1907 : 123 (Type-*Opisthocosmia annandalei* Burr, 1904—Paris Museum) SYN. NOV.

Size medium ; body moderately convex. Build slender, pubescent.

Head smooth, convex or moderately depressed, sutures distinct or obsolete. Eyes shorter than post-ocular length. Antennae stout, generally 12-segmented or more, 1st about as long as the distance between scapi, narrowed basally ; 2nd short about as long as broad ; 3rd long and slender ; 4th almost equal to preceding but stouter in being gently expanded apically, remaining gradually increasing in length and each gently narrowed at base. Pronotum anteriorly equal to head in width, almost as long as broad or longer. Elytra and wings well developed and smooth. Legs with forefemora usually swollen, femora smooth above ; tarsi short, hind 1st tarsal segment compressed, stout ; 2nd lobed with posterior margin entire ; 3rd slender, narrowed basally, almost equal to 1st. Prosternum longer than broad, posteriorly truncate ; mesosternum quadrate, about as long as broad with hind margin rounded ; metasternum projecting as narrowed lobe beyond hind coxae with hind margin truncate. Abdomen convex ; ♂ ultimate tergite transverse or subquadrate. Pygidium short, obtuse or prominent, transverse. Forceps generally remote at base, long and slender, sometimes gently curved, internally variously armed. In ♀ pygidium short, obtuse ; ultimate tergite gently narrowed posteriorly and forceps simple and straight.

Type species : *Forficula jagori* Dohrn, 1865,

***Pterygida jagori* (Dohrn)**

(Figs. 3-10)

Forficula jagori Dohrn, 1865, *Stettin. ent. Ztg.*, 26 : 94 (♂, ♀ ; Luzon).*Apterygida jagori* : Bormans, 1900, *Das Tierreich*, 11 Forficulidae : 116.*Pterygida jagori* : Verhoeff, 1902, *Zool. Anz.*, 25 (665) : 197 ; Kirby, 1904, *Syn. cat. Orth.*, 1 : 44 ; Burr, 1911, *Genera Insect.*, 122 : 72 ; Borelli, 1916, *Boll. Musei Zool. Anat. comp. R. Univ. Torino*, 31 (715) : 6 ; Borelli, 1918, *Boll. Musei Zool. Anat. comp. R. Univ. Torino*, 33 (726) : 2 (redescription).*Kosmetor punctata* Srivastava, 1976, *Pacif. Insects*, 17 (1) : 129, figs. 69-71 (♂, ♀, Philippine Is. : Luzon—Holotype ♂ and Paratypes ♂, ♀, at B. P. Museum, Hawaii, U. S. A. and paratypes 1♂, 1♀ at Zoological Survey of India, Calcutta) SYN. NOV.**Material examined :**

1. Syntype ♂ labelled as : (i) *Jagori Dohrn Luzon Jagor*—A yellow label, handwritten by Dohrn ; (ii) 3242 ; (iii) *Pterygida jagori* ♂ (Dohrn, 1865) des. K. K. Günther, 1980—handwritten label and (iv) Syntypus—Pink label, printed ; genitalia mounted between two coverslips and pinned with the specimen (designated as *Lactotype*) (Museum für Naturkunde der Humboldt Univ., DDR—Berlin).

2. Syntype ♀ labelled as : (i) Katnt. 3242—handwritten ; (ii) *Pterygida jagori* ♀ (Dohrn), des. K. K. Günther, 1980 handwritten ; and (iii) Syntypus—Pink label, printed (designated as *Paralectotype*) (Museum für Naturkunde der Humboldt Univ., DDR—Berlin).

Dohrn (1865) refers to ♂, ♀ in the original description giving locality records. Number of specimen is not mentioned.

3. 1 ♂ da Imugin N. Viscaya ; 1 ♀ da

Baguio Benguit Det. By Borelli as *Pterygida jagori* (Dohrn) (Museo ed Istituto di Zoologia Sistemica della Universita di Torino).

Though Borelli's (1918) redescription of the species and the detailed description of *Kosmetor punctata* Srivastava, a synonym of this species, are adequate, type does not seem to have been figured earlier. A brief diagnosis together with the figures from the type are provided.

Head and pronotum black. Antennae with a few basal segments yellowish and remaining brownish black, legs with fore-femora black but yellow near base only, middle femora yellow, black in apical half ; hind femora yellow with a broad black band extending from middle to a little before knee joint ; tibia yellow but lightly shaded with black and tarsi complete black. Elytra and wings black, former with a broad yellow humeral spot and latter with a yellow spot basally. Head moderately depressed, smooth, sutures obsolete. Eyes shorter than the post-ocular length. Abdomen, pygidium and forceps light blackish brown. Body sparsely pubescent, more pronounced on sides of abdomen, forceps and underside of tarsi. Abdomen shallowly and sparsely punctulate, gradually enlarging posteriorly, lateral folds on 3rd tergite weakly and on 4th strongly developed. Penultimate sternite broadly rounded posteriorly. Pygidium transverse, subvertical, postero-lateral angle produced into triangular point. Forceps remote at base, long, tapering and gradually curving apically, internally with numerous teeth and near base above with a large triangular tooth. Genitalia as in fig. 10.

♀ : Agrees with male in most characters except secondary sexual characters.

Remarks: The above brief description is based on the lectotype ♂ which possesses 11 antennal segments on the left and 8 on the right but altogether 13 segments were recorded by Borelli (1. c.) and Srivastava (1. c.) for *K. punctata*. Pubescence appears to have been brushed off. Some variations in colour, especially black band on femora which may be often reduced, are noted. Wings in some specimens are complete yellow with a small black spot apically.

ACKNOWLEDGEMENTS

I am thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for providing necessary facilities and to Dr. Kurt K. Günther, Museum für Naturkunde der Humboldt-Univ., DDR Berlin and Dr. A. Kaltenbach, Naturhistorisches Museum, Vienna for the loan of type of *Forficula jagori* Dohrn and *Forficula circulata* Dohrn, respectively. I am also indebted to Dr. P. Passerin d' Entreves, Curator, Museo ed Istituto di Zoologia Sistemica della Università di Torino, Torino for the loan of 1 ♂, 1 ♀ of *P. jagori* and to Dr. M. W. R. de V. Graham, Curator, Hope Entomological Collections, University Museum, Oxford (U. K.) for supplying the photographs of *Pterygida circulata* Dohrn, ♂.

REFERENCES

- BORELLI, A. 1918. Dermatteri delle Isole Filippine. Nota V. *Boll. Musei Zool. Anat. comp R. Univ. Torino*, 33 (726) : 1-5.
- BURR, M. 1904. Observations on Dermaptera, including revision of several genera and description of New Genera and species. *Trans. R. ent. Soc. Lond.*, 1904 : 277-322.
- BURR, M. 1907. A preliminary revision of the Forficulidae (Sensu Stricto) and of the Chelisochidae, families of the Dermaptera. *Trans. R. ent. Soc. Lond.*, 1907 : 91-134.
- BURR, M. 1910. *Fauna of British India including Ceylon and Burma*, Dermaptera, xviii, 217pp., 10 pls.
- BURR, M. 1911. *Genera Insectorum*, Wytsman, Fasc. 122, Dermaptera, 112 pp., 9 pls.
- DOHRN, H. 1865. Versuch einer Monographie der Dermapteren. *Stettin. ent. Ztg.*, 26 : 68-99.
- KIRBY, W. F. 1904. *A synonymic catalogue of Orthoptera*, 1 : 1-55 (London).
- SRIVASTAVA, G. K. 1976. Studies on the Dermaptera of Philippines. *Pacif. Insects*, 17 (1) : 99-138.
- VERHOEFF, K. W. 1902. Über Dermapteren. *Zool. Anz.*, 25 (665) : 181-208.

THE FOOD AND FEEDING HABITS OF SOME FRESHWATER
CURSTACEAN ZOOPLANKTON

RASHID A. KHAN

Zoological Survey of India, Calcutta

ABSTRACT

The food and feeding habits of some freshwater zooplankton of this region were studied. The filter feeders, cladocera (*Ceriodaphnia cornuta*, *Daphnia carinata*, and *Moina micrura*) and calanoida (*Heliodyptomus contortus* and *Heliodyptomus viduus*) were found to be strictly herbivorous, feeding upon detritus, phytoplankton and bacteria. Cladoceran exhibited a tendency towards fine detritus particles and smaller phytoplankton species while calanoids fed mainly on coarse detritus and larger algal species. Cyclopoid exhibited a variety of feeding types. *Mesocyclops leuckarti* and *Thermocyclops hyalinus* were highly predacious, *Microcyclops varicans* fed equally on plant and animal matters and *Eucyclops rubescens* was strictly herbivorous. Some evidence of food selection was found in calanoida, cladocera and cyclopoida. Blue green algae were definitely avoided by all species.

INTRODUCTION

Though filtration is the main mode of feeding in planktonic crustacea, a variety of other feeding habits has also been observed. Great majority are herbivorous and obtain their energy for growth and reproduction from first trophic level. The calanoids and cladocerans are filter feeder, feeding upon suspended materials comprising both phytoplankton and detritus (Hutchinson 1967). The majority of cyclopoids and some cladocera belonging to Haplopoda are siezers, some are omnivorous or herbivorous while most others are carnivorous (Fryer 1957).

The feeding ecology of crustacean zooplankton has been the subject of consi-

derably advanced and sophisticated researches during recent years. However, majority of the works deal with filtration rate of cladocera and calanoida, relationship between body size and the size of food particle and the role of food ingested in the energy transformation etc., mostly under experimental conditions (Richman 1958, Rigler 1961, McMohan 1965, Burns 1968, 1969, Schindler 1968, Arnold 1971, Buikema 1973, Kersting and Leeuw-Leegwater 1976 etc.). The basic works on the qualitative and quantitative composition of food, its variation with age, season and habitat and relative importance of different kinds of food in the diet, specially of non-filter feeders, are fewer. Most of the important works done on the

food selection of filter feeders are on marine copepods (Marshall and Orr 1962, Conover 1966, Mullin 1966). Generally the works on freshwater species are scattered and yield diverse information (Nauwerck 1963, Tappa 1965, Saunders 1969, Anderson 1970, McQueen 1970, Confer 1971), except that of Fryer's (1957) who dealt in length the food of feeding habits of cyclopoid copepods. In India no such work has been carried out. The objective of the present paper is to report the quantitative and qualitative composition of food of some important crustacean zooplankton of this region.

MATERIALS AND METHOD

Zooplankton samples were collected mainly from Dhakuria lake, Indian Museum Pond and Monohar Das Pond of Calcutta during 1975-79 period. Sampling was always done between 9 to 11 A.M. Gut contents analysis was carried out on live animals shortly after their collection. The technique of Fryer (1957) was followed with some modifications. Single specimen was put in a drop of water on a glass slide and covered with a cover glass. By manoeuvring the cover glass, the specimen was positioned on its side and carefully pressed. This caused the rupture of cephalothorax and extrusion of gut contents. Gut contents, which came out in the form of a compact mass, were further pressed and contents smeared across the field of vision. Though the technique was a tedious one, after considerable practice it gave satisfactory results. The number of guts having particular type of food has been expressed as percentage of total guts analysed of the particular species. The food of following species were analysed (i) *Ceriodaphnia*

cornuta Sars, *Daphnia carinata* King, *Moina micrura* King, *Heliodiaptomus contortus* Gurney, *Heliodiaptomus viduus* (Gurney), *Mesocyclops leuckarti* (Claus), *Thermocyclops hyalinus* (Rehberg), *Microcyclops varicans* (Sars) and *Eucyclops rubescens* Brady. Copepods were divided into three classes, nauplii, copepodites and adults and cladocerans were divided into two classes, juveniles and adults.

RESULTS

Details of gut having different kind of foods expressed in terms of percentage have been presented in Figs. 1 (cladocera), 2 (calanoida) and 3 (cyclopoida). Among cladocera most stereotype feedings have been observed in all the species, both in adults and juveniles, as far as the quality of the food is concerned. The gut contents of 210 specimens of *C. cornuta*, 175 specimens of *D. carinata* and 110 specimens of *M. micrura* were analysed. The food composed of fine detritus, phytoplankton and bacteria. Fine detritus (below 50μ in size) was the most important food constituting more than 40μ in all the species and their juveniles. However, its contribution was slightly more in juveniles. The coarse detritus (above 50μ) was found only in few guts. Among phytoplankton, which were no less important than detritus, the smaller and unicellur algae formed the bulk of the plant matter. The occurrence of filamentous green algae, blue green algae and larger diatoms were rare. Bacteria were always very insignificant comprising merely 8-10% and never occurred alone in any gut. No animal remain could be detected but some guts were always having indeterminate mush which might have been composed of

masarated vegetable matter. Not much significant difference was noticed in phytoplankton composition of adults and juveniles.

plankton and bacteria but the composition varied greatly from that of cladocera. The gut contents of 135 specimens of *H. contortus* and 115 specimens of *H. viduus* were analysed. In calanoids, coarse detritus were found to occur in abundance. However, there was a

The calanoids were always found to subsist on similar kind of food, detritus, phyto-

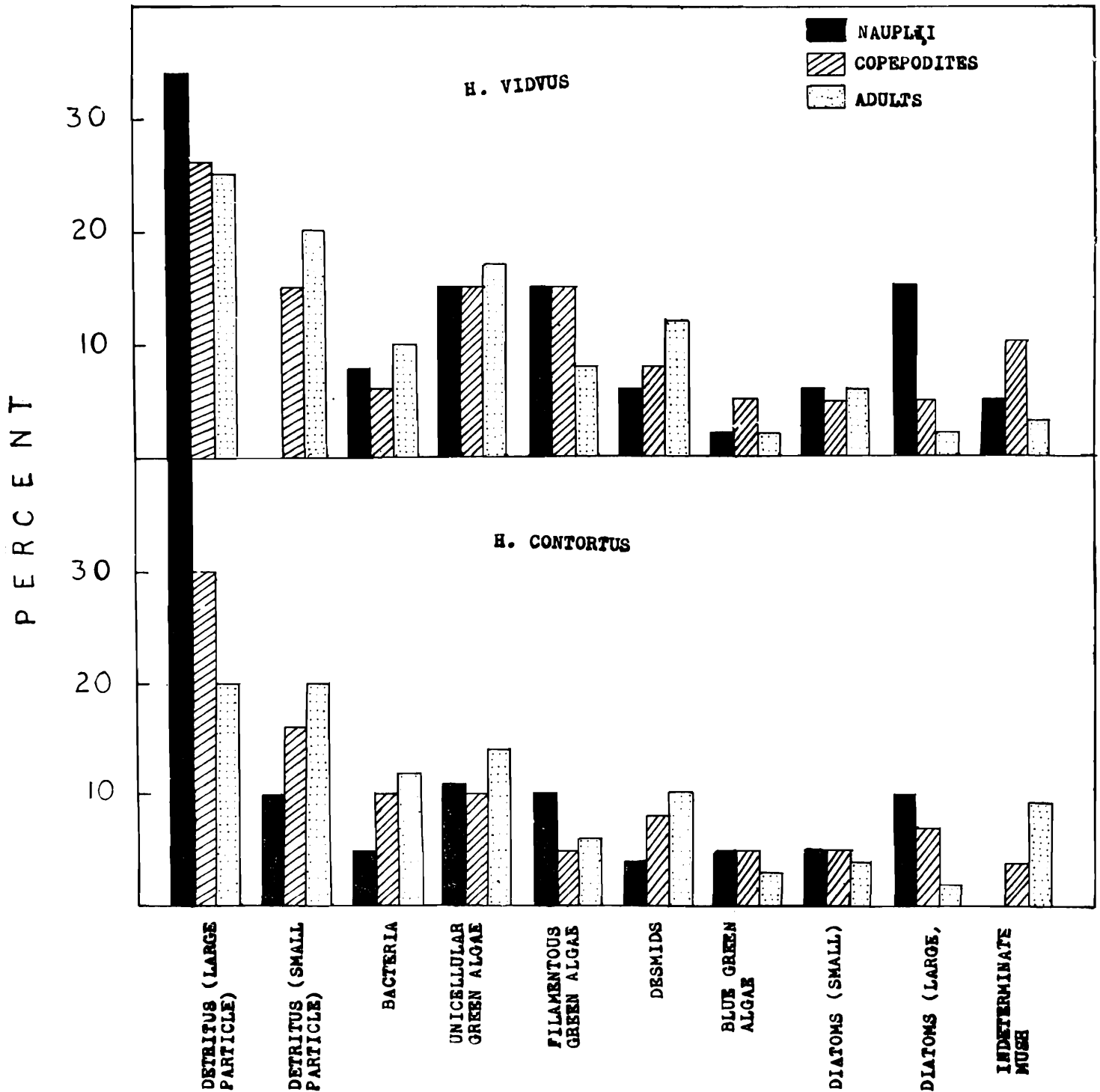


Fig. 1. The food of Cladocera expressed as percent of guts having different types of food.

tendency of changing over from fine detritus to coarse detritus with increasing age in both species (Fig. 2). Similarly, among phytoplankton, filamentous algae and larger diatoms were more common than the other algae. Bacteria did not constitute significant proportion in calanoids too.

The most varied feeding habits were observed in cyclopoda. Gut contents of 165 specimens of *M. leuckarti* 130 specimens of *T. hyalinus*, 95 specimens of *M. varicans* and 80 specimens of *E. rubescens* were analysed. *M. leuckarti* and *T. hyalinus* appear to be carnivorous species containing

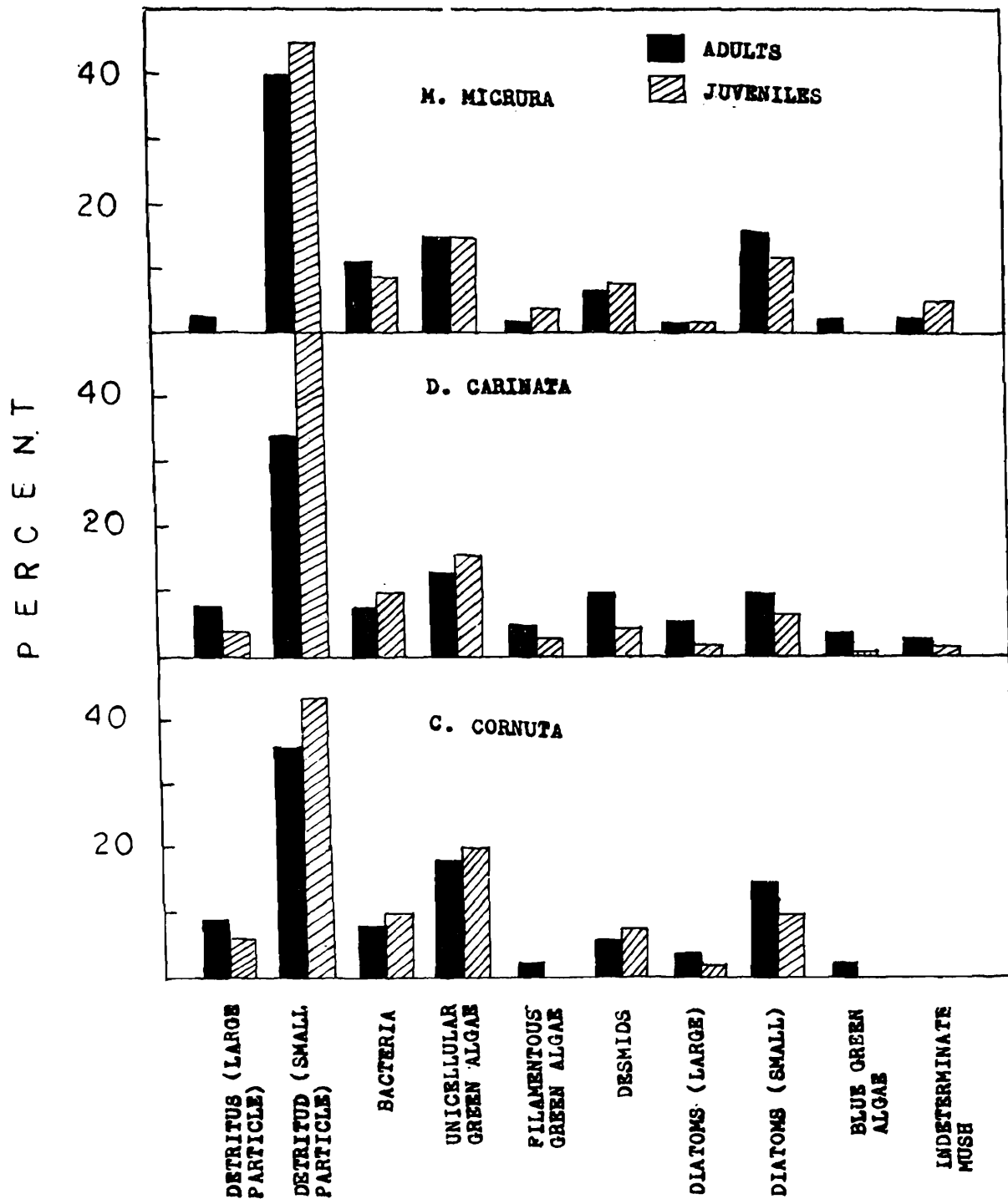


Fig. 2. The food of Calanoida expressed as percent of guts having different types of food.

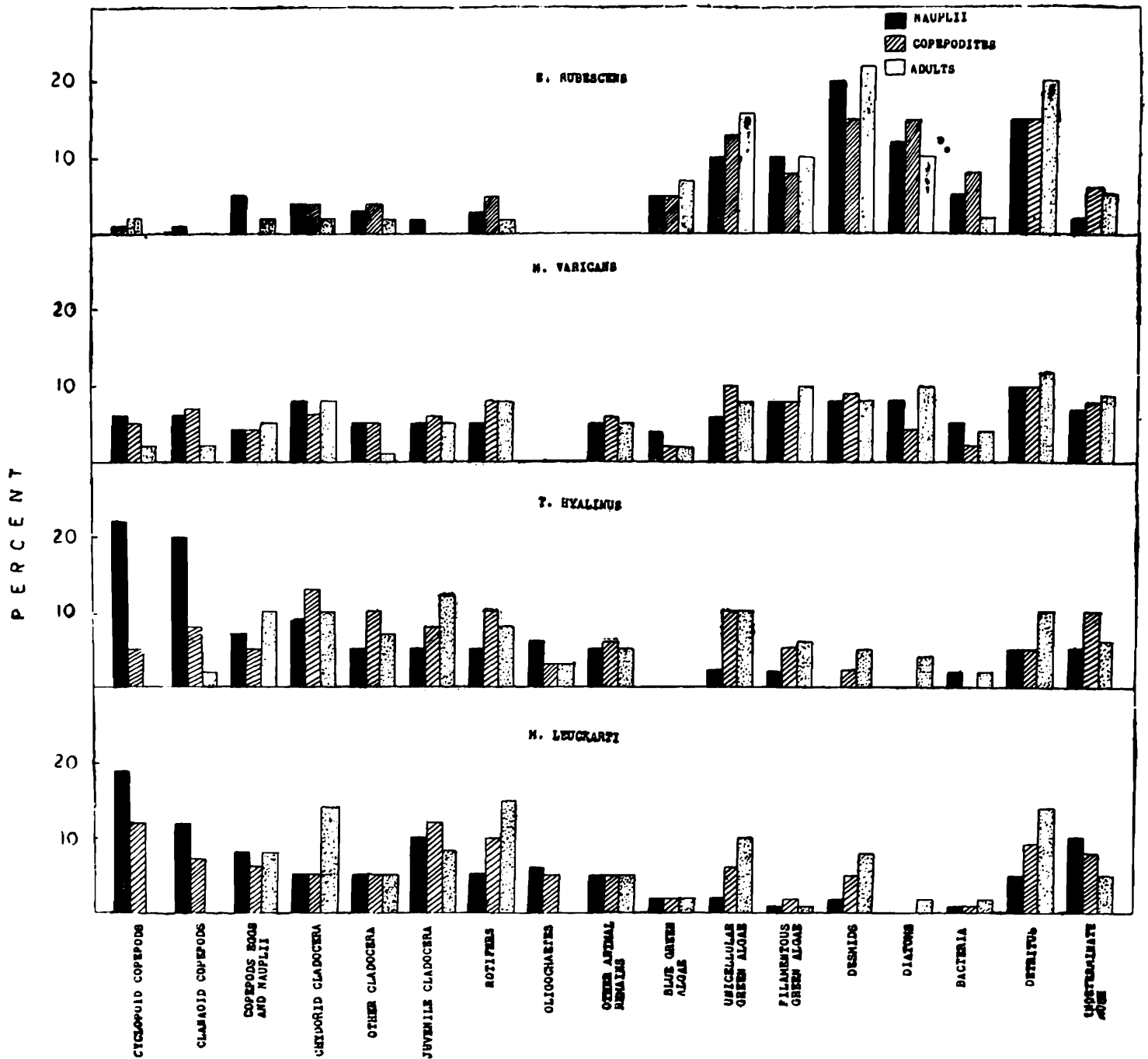


Fig. 3. The food of Cyclopoida expressed as percent of guts having different types of food.

more than 75% of animal matter. Cyclopoid copepods, calanoid copepods, their eggs, nauplii and copepodites, cladocerans, rotifers and oligochaetes etc., formed the bulk of the diet of two species. Plant matter and detritus were always in negligible quantities and most of the algae were within the prey species ingested. However it is interesting to note that the contribution of phytoplankton and detritus was more in immature stages than adults of the two species. Taking into consideration the feeding habits of the species it may be said that the indeterminate mush belongs mostly to animals remain. *M. varicans* appears to be omnivorous where both animal and plant matters were found to contribute almost equally (Fig. 3). The fourth species *E. rubescens* appear to be mainly herbivorous where phytoplankton and detritus constituted the bulk of the food. Animal matter was always in negligible quantities.

DISCUSSION

From the food spectrum of cladocera and calanoida, it is clear that all the species of both groups are strictly herbivorous, feeding mainly on detritus and phytoplankton. Similar observations have been reported by Tappa (1965) who observed that detritus constituted about 50% of the food of Daphnids and Nauwerck (1963) who found in case of *Eudiaptomus graciloides* that it could not subsist on phytoplankton alone and the detritus was the main component of the diet. The low percentage of bacteria in the diet revealed that it plays very negligible role in the diet of all the herbivorous species as also observed by Saunders (1969). Cyclopoids exhibited a variety of feeding. Two most common species of the region, *T. hyalinus*

and *M. leuckarti* are highly predacious, feeding upon cyclopoid and calanoid copepods and their developmental stages, cladocera and rotifers and even oligochaetes which are much larger than the feeding animal itself. Canibalism has also been observed in *M. leuckarti*. Fryer (1957) also reported that carnivorous cyclopoids feed upon prey larger than their own size. As far as occurrence of some algae in the guts of these two species are concerned, the conclusion of Fryer (1957) seems to be valid that some of these may be ingested along with the prey animal which has inturn eaten the algae. This phenomenon was also observed in laboratory. Specimens of *M. leuckarti* were kept in pond water from which all rotifers and crustaceans were filtered out by No. 25 cloth and it contained only phytoplankton. Periodic observations showed that the guts of animals remained empty even after 48 hours. In contrary to present results where cladoceran formed the sizeable portion of the diet of carnivorous species, Confer (1971) observed that *Mesocyclops edax* does not feed upon cladocera.

Microcyclops varicans was found to be omnivorous as both animal and plant matters contributed almost equally. Such omnivorous feeding habits among cyclopoids is rare. The herbivorous feeding habit, as observed in *E. rubescens*, has also been reported for other *Euclops* species like *E. agilis*, *E. macruroibes* and *E. macrurus* by Fryer (1957). This shows that *Eucyclops* are mainly herbivorous. One thing is very interesting to note that both *M. varicans* and *E. rebescens* avoided blue green algae.

The literature regarding food preference of filter feeder cladocera and calanoida has

been very contradictory. Rigler (1971) reports that the cladoceran and some calanoids possess little ability of food selectivity and if any selection occurs in cladocera, it must be passive and in the form of bolus rejection. On the other hand Gliwicz (1968) has concluded that different species of cladocera and calanoida select different particle size. The selectivity phenomenon in calanoids has more definitely been demonstrated than cladocera. McQueen (1970) has shown that blue green algae is definitely rejected by *Diaptomus oregonensis*. Main (1962) as cited by Lane (1975) also reported that omnivorous *Epischura lacustris* avoids cladoceran and rotifers and consumes calanoid nauplii etc., and also has a definite preference for larger species of phytoplankton. Though food selectivity in cladocera has not been definitely demonstrated but Richman (as cited by Lane, 1975) has substantiated this phenomenon. Generally the size of food particle ingested has been related to size of animal particularly size of filtering apparatus (Burns 1968, Egloff & Palmer 1971), thus during the life span of cladocera it may vary (Gulati 1979).

Levins (1968) and Lane (1975) have concluded that major mechanism for competitive coexistence of filter feeders is habitat selection not the resource allocation. From the present study though not very clear pattern is observed, evidences are there for the food preference by cladocera and calanoida. As far as the size of the detritus is concerned, it may be seen that cladoceran always preferred fine detritus and calanoids coarse particles as also reported by Hutchinson (1967). Similarly in case of algae, cladoceran showed certain preferences towards smaller forms while calanoids for larger

forms. Blue green algae have definitely and equally been avoided by all species as their percentage was always low like in *Diaptomus oregonensis* of McQueen (1970). The importance of blue green algae in the diet of aquatic animals has always been the subject of question. Fryer (1957) noted that many blue green algae and also green algae were found undigested in the rectum of *Acanthocyclops bisetosus*. Kersting (1979) observed that algal cells can pass the gut of *Daphnia magna* several times before completely digested. Similarly Vass and Hofstede (1962) also found that blue green algae pass undigested from the alimentary canal of the fish *Tilapia mossumbica*. Khan and Siddiqui (1973) have also observed similar phenomenon in the major carp *Labeo rohita* where not only blue green algae but certain green algae like *Scenedesmus* and *Ankistrodesmus* were found quite fresh in the hind gut. Detail report regarding the importance of certain algae in the diet of freshwater animals will be presented elsewhere.

Definite food selection has been observed in Siezers, the cyclopoida. Various species existing together mainly have different feeding habits. Some are carnivorous, some omnivorous and some herbivorous. In Dhakuria lake the high density of the carnivore species *M. leuckarti* was associated with the abundance of *M. varicans* and sometimes, *E. rubescens*, former omnivorous and later herbivorous. During the period of abundance of the other carnivorous species *T. hyalinus*, population of *M. leuckarti* was found to decrease but no effect was noticed on either *M. varicans* or *E. rubescens*. This revealed that resource allocation played some role in the competitive coexistence of various

cyclopoid species. However as many of the cyclopoid species show definite vertical migration (Khan 1981), it may be said that both these factors, habitat selection and resource allocation, act in coordination for alleviating competition. Further extensive studies are required in a variety of habitats to bring a clear picture of this important phenomenon of zooplankton dynamics.

ACKNOWLEDGEMENT

The author is thankful to Dr. B. K. Tikader, Director, Zoological Survey of India for providing necessary laboratory facilities.

REFERENCES

- ANDERSON, R. S. 1970. Predator prey relationship and predation rate of crustacean zooplankters for some lakes in Western Canada. *Can. J. Zool.* **48** : 1229-1240.
- ARNOLD, D. E. 1971. Survival and reproduction of *Daphnia pulex* fed blue green algae. *Limnol. Oceanogr.* **16** : 906-920.
- BUIKEMA, A. J. Jr. 1973. Some effects of light on the growth, molting, reproduction and survival of the cladoceran *Daphnia pulex*. *Hydrobiologia.* **41** : 391-418.
- BURNS, C. W. 1968. The relationship between body size of filter feeding cladocera and the maximum size of the particle ingested. *Limnol. Oceanogr.* **13** : 675-678.
- BURNS, C. W. 1969. Relation between filtering rate, temperature and body size in four species of *Daphnia*. *Limnol. Oceanogr.* **14** : 693-700.
- CONFER, J. L. 1971. Introzooplankton predation by *Mesocyclops edax* at natural prey densities. *Limnol. Oceanogr.* **16** : 663-667.
- CONOVER, R. J. 1966. Feeding on large particles by *Calanus hyperobreous* (Kroyer) in H. Barnes (ed) *Some Contemporary studies in marine sciences.* Allen and Unwin, Lond. p. 187-194.
- EGLOFF, D. A. and PALMER, D. S. 1971. Size relation of the filtering area of two *Daphnia* species. *Limnol. Oceanogr.* **16** : 900-906.
- FRYER, G. 1957. The food of some freshwater cyclopoid copepods and its ecological significance. *J. Anim. Ecol.* **26** : 263-286.
- GLIWICZ, 1968. Studies on the feeding of pelagic zooplankton in lakes with varying trophy. *Ekol. pol. Ser. B.* **17** : 663-708.
- GULATI, R. D. 1979. The ecology of common planktonic crustacea of the freshwaters in the Netherlands. *Hydrobiologia*, **59** : 101-113.
- HUTCHINSON, G. E. 1967. *Treatise on Limnology* Vol. II. John Wiley and Sons, N. Y.
- KERSTING, KEES. 1979. Some feature of feeding respiration and energy conversion of *Daphnia magna*. *Hydrobiologia*, **59** : 113-120.
- KERSTING, K. and LEEUW LEEGWATER. 1976. Effects of food concentration on the respiration of *Daphnia magna*. *Hydrobiologia*, **49** : 137-142.

- KHAN, R. A. 1981. Effect of total solar eclipse 1980 on zooplankton. *Abs. Int. Symp. on Total Solar Eclipse*, 1981 New Delhi (Int. Nat. Sci. Acad.).
- KHAN, R. A. and SIDDIQUI, A. Q. 1973. Food selection by *Labeo rohita* (Ham.) and its feeding relationship with other major carps. *Hydrobiologia*, **43** : 429-442.
- LANE, P. A. 1975. The dynamics of aquatic systems, A comparative study of the structure of four zooplankton community. *Ecol. Monogr.*, **45** : 307-336.
- LEVINS, R. 1968. *Evolution in changing environment* Princeton Univ. Press Princeton 120 p.
- * MAIN, R. H. 1962. The life history and food relations of *Epischura lacustris* Forbes (Copepoda, Calanoida) Ph. D. Thesis, Univ. Michigan. 142p. Diss. Abst. 23 : 1835-36.
- MARSHALL, S. M. and ORR, A. P. 1962. Food and feeding in copepoda. *Rapp. P. V. Cons. Int. Explor. Mer.* **153** : 92-98.
- MCMOHAN, J. W. 1965. Some physical factors influencing the feeding behaviour of *D. magna*. *Can. J. Zool.* **43** : 608-611.
- MCQUEEN, D. J. 1970. Grazing rates and food selection in *Diaptomus oregonensis* (Copepoda) from Marion Lake, British Columbia. *J. Fish Res. Bd. Canada*, **27** : 13-20.
- MULLIN, M. M. 1966. Selective feeding by calanoid copepods from Indian Ocean. In H. Barnes (ed) *some contemporary studies in marine science*. Allen and Unwin Lond. 547-554.
- NAUWERCK, A. 1963. Die Beziehungen zwischen zooplanktons und phytoplankton im Sec Erken. *Symb. Bot. upsal* **17** : 5-163.
- RICHMAN, S. 1958. The transformation of energy by *Daphnia pulex*. *Ecol. Monogr.* **28** : 273-291.
- RIGLER, F. H. 1961. The relation between concentration of food and feeding rate in *Daphnia magna straus*. *Can. J. Zool.* **39** : 857-868.
- RIGLER, F. H. 1971. Quantitative methods for studying the feeding of planktonic crustacea. In W. T. Edmondson (ed) *A Manual on Methods for the Assessment of Secondary Productivity in Freshwaters. I.B.P. Handbook No. 17* Blackwell S. P. Lond.
- SAUNDERS, G. 1969. Some aspects of feeding in Zooplankton. In *Eutrophication. Causes consequences, corrective p. 556-573. Natl. Acad. Sci. Publ. 1700*.
- SCHINDLER, D. W. 1968. Feeding assimilation and respiration rates of *Daphnia magna* under various environmental conditions and their relation to production estimates. *J. Anim. Ecol.* **37** : 369-385.
- TAPPA, D. W. 1965. The dynamics of the association of six limnetic species of *Daphnia* in Azisloos Lake, Marine. *Ecol. Monogr.* **35** : 395-423.
- VASS, F. K. and HOFSTED, A. E. 1962. Studies in *Tilapia mossambica* Peters in Indonesia. *Cent. Int. Fish Res. St. Bogov.* **1** : 1-88.

* Not consulted in original.

A NEW SPECIES AND NEW RECORDS OF BRACHYDERINAE
(CURCULIONIDAE : COLEOPTERA) FROM INDIA

P. MUKHOPADHYAY

Zoological Survey of India, Calcutta

ABSTRACT

This paper deals with unnamed collection of Brachyderinae present in Zoological Survey of India, Calcutta. It comprises five species belonging to the genera *Blosyrus* Schönh and *Blosyrodes* Jek., of which, the species *Blosyrus unisulcatus* Mshl., *Blosyrus bengalensis* Mshl, and *Blosyrus asellus* Oliv. recorded for the first time from Andhra Pradesh, Karnataka and West Bengal respectively and a new species of the genus *Blosyrodes* Jekel from Arunachal Pradesh is described.

In course of sorting out the unnamed collection of beetles made by different survey parties of Zoological Survey of India, Calcutta author has come across 19 examples of Brachyderinae belonging to the family Curculionidae. Marshall (1916) in 'The Fauna of British India' divided the subfamily Brachyderinae into five groups viz. Blosyrides, Naupactides, Cneorrhinides, Cyphides and Tanymecides. So far, the group Blosyrides includes two genera, namely, *Blosyrus* Schönherr and *Blosyrodes* Jekel and the species belonging to them are apterous, slow moving and can be easily recognized by its shape combined with its short, broad, flattened rostrum, with a groove at junction with head and are terrestrial in their habits, sometimes found under stone. Of the two genera, the genus *Blosyrus* is moderately a large genus

and Van Emden (1939) in *Coleopterorum Catalogus* listed 53 species from the World, of which, most of the species are described from Africa, 8 species from Indian subregion and two species from China and one species from Japan whereas, the genus *Blosyrodes* is a small genus and so far eight species were described from North East India and Burma. Later Haaf (1958) revised the African species of the genus *Blosyrus*. In his work he dealt 32 species with the description of a new species from Angola together with 12 new sub species from the region. In the present study a new species under the genus *Blosyrodes* is described and the species *Blosyrus unisulcatus* Marshall, *Blosyrus bengalensis* Marshall and *Blosyrus asellus* Olivier are recorded for the first time from Andhra Pradesh, Karnataka and West Bengal respectively.

Blosyrus unisulcatus Marshall

Blosyrus unisulcatus Mshl., 1916, *Fn. Brit. India*,
Col : curculionidae, 1 : 32, 38.

Material examined : 1 ex., INDIA : Tamil Nadu : Madras, 5.ix.1962, S. N. Murty ; 3 ex., Tamil Nadu : Madras : Krishna bank, 30.vii.1962, S. N. Murty ; 8 ex. Andhra Pradesh Nagarjunkonda : Dam Survey : Nagarjun hill, 2.x.1963, B. Nath, under stone.

Distribution : INDIA : Maharashtra, Tamil Nadu, Andhra Pradesh.

So far, this species was recorded from Maharashtra and Tamil Nadu, now is being recorded for the first time from Andhra Pradesh.

Blosyrus bengalensis Marshall

Blosyrus bengalensis Marshall, 1916, *Fn. Brit. India.*,
Col. : Curculionidae, 1 : 32, 36.

Material examined : 1 ex. INDIA : Karnataka : Mysore : Manasa Gangotri, 6. ix. 1979, D. R. Anasuya.

Distribution : INDIA : Bihar, Karnataka.

So far, this species was recorded from Bihar (Chhotonagpur, Barwa), now it is being recorded for the first time from Karnataka.

Blosyrus inaequalis Boh. in Schönh.

Blosyrus inaequalis Boheman in Schönh., 1845, *Gen. Curc.*, 8 : 402, pt. 2 ; Labrum & Imhoff, 1845, *Gen. Curc.*, Ic.2, no. 40.

Blosyrus spongifer Boh. in Schönh., 1845, *Gen. Curc.* 8 : 403.

Blosyrus tuberculatus Redtenbacher, 1867, *Reise Novara*, 2 : 145.

Blosyrinus inaequalis Jekel, 1875. *Col. Jekel*, pp. 147 & 149.

Material examined : 1 ex., INDIA : Tamil Nadu, Eastern Ghat : Nadurca, Javadi Hills, altitude 540m, 26-30. vi. 1929, H. S. Pruthi.

Distribution : INDIA : Maharashtra, Tamil Nadu. SRI LANKA. INDONESIA.

This species is closely related to *B. bengalensis* Mshl. but can be easily recognized by its prothorax being more transverse and rugose ; humeral angle of elytra distinct and a transverse row of 6 tubercles present across the top of declivity.

Blosyrus asellus Olivier

Curculio asellus Olivier 1807, *Ent.*, 5 : 356, t 24, f. 347 ; Fahraeus, Schönh., 1839, *Gen. Curc.*, 5 : 909.

Blosyrus philippinensis Jekel, 1875, *Col. Jekel* 2 : 153.

Blosyrus superciliosus Chevrolat, 1822, *Le Natural*, 2 : 93.

Material examined : 1 ex., INDIA : West Bengal : Calcutta : Canning, Gorosthan, 18. x. 1965, A. N. T. Joseph ; 1 ex., West Bengal : Calcutta : Lakshmikantapur, 15. x. 1965. S. R. C. & K. D. C.

Distribution : INDIA : West Bengal, Assam, Andaman Island. BANGLADESH. BURMA. INDONESIA. PHILIPPINES. CAMBODIA. MALACCA.

So far this species was recorded from Assam and Andaman Island, now it is being recorded for the first time from West Bengal.

Blosyrodes nigricorporis sp. nov.

(Fig. 1)

General appearance (Fig. 1) oblong, black, dorsal surface rather thinly and sparsely covered with whitish brown scales. Head longitudinally rugose and with a indistinct outwardly curved sulcus, rugae on either side, lateral sulci and puncturation indistinct. Rostrum with distinct longitudinal rugae, narrowed at middle and its width at base and apex equal, median carina and lateral grooves

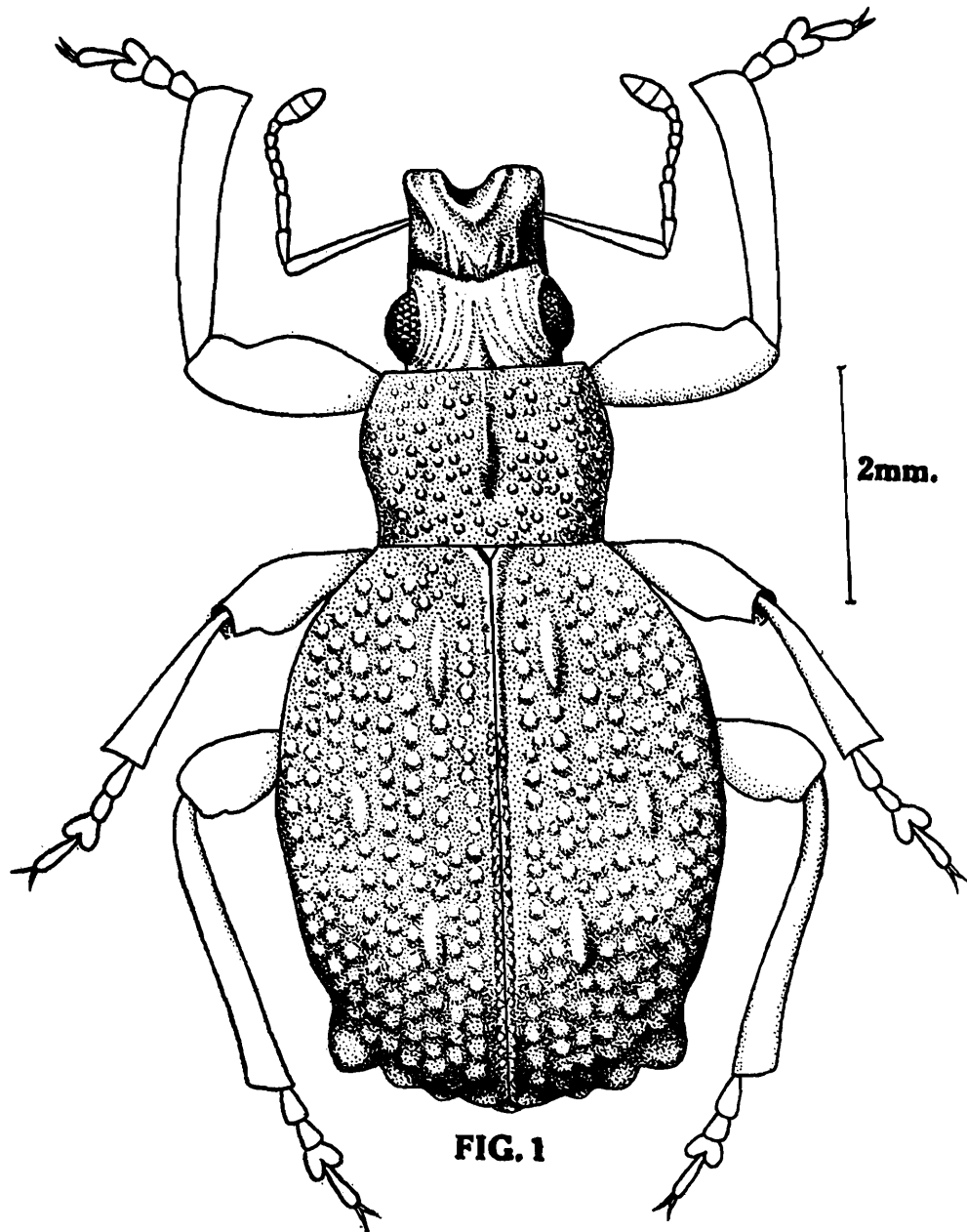


Fig. 1. Dorsal view of *Blosyroides nigricorporis* sp. nov.

absent. Antennae reddish brown except the apex of the scape and club brownish black, scape elongated and reaching the hind margin of the eye, funicle with segment 2 slightly longer than segment 1, segments 3-7 subequal, club three segmented and compact. Mandibles pincer like, obtuse and with a scar, Scrobes of the rostrum forming a sublinear

furrow which is curving downwards in front of the eye. Rostrum separated from the head by concave furrow. Eyes large, black, convex and moderately coarsely faceted. Prothorax 1.4 times broader than long, lateral margin slightly sinuated behind the middle, median carina broad, shiny and extending almost from base to apex, uniformly covered with

small rounded granules. Elytra oblong-oval, basal margin truncate, lateral margin slightly rounded and upper surface with irregular rows of large but shallow punctures. Each elytron with three rows of tubercles, of which, inner two rows at anterior half somewhat indistinct. In flexed margin of elytron with two shallow sulci containing regular rows of large punctures. Intercoxal process of

ventrite 1 slightly narrowed and rounded anteriorly. Ventrites 2-4 subequal, ventrite 5 distinctly longer than ventrite 3 & 4 together. Legs stout, unarmed, piceous brown and densely covered with whitish brown setae.

Measurements: Total length including rostrum 7.8 mm; width of head across eyes 1.7 mm; length of antenna 2.6 mm; length of prothorax 1.4 mm; width of prothorax

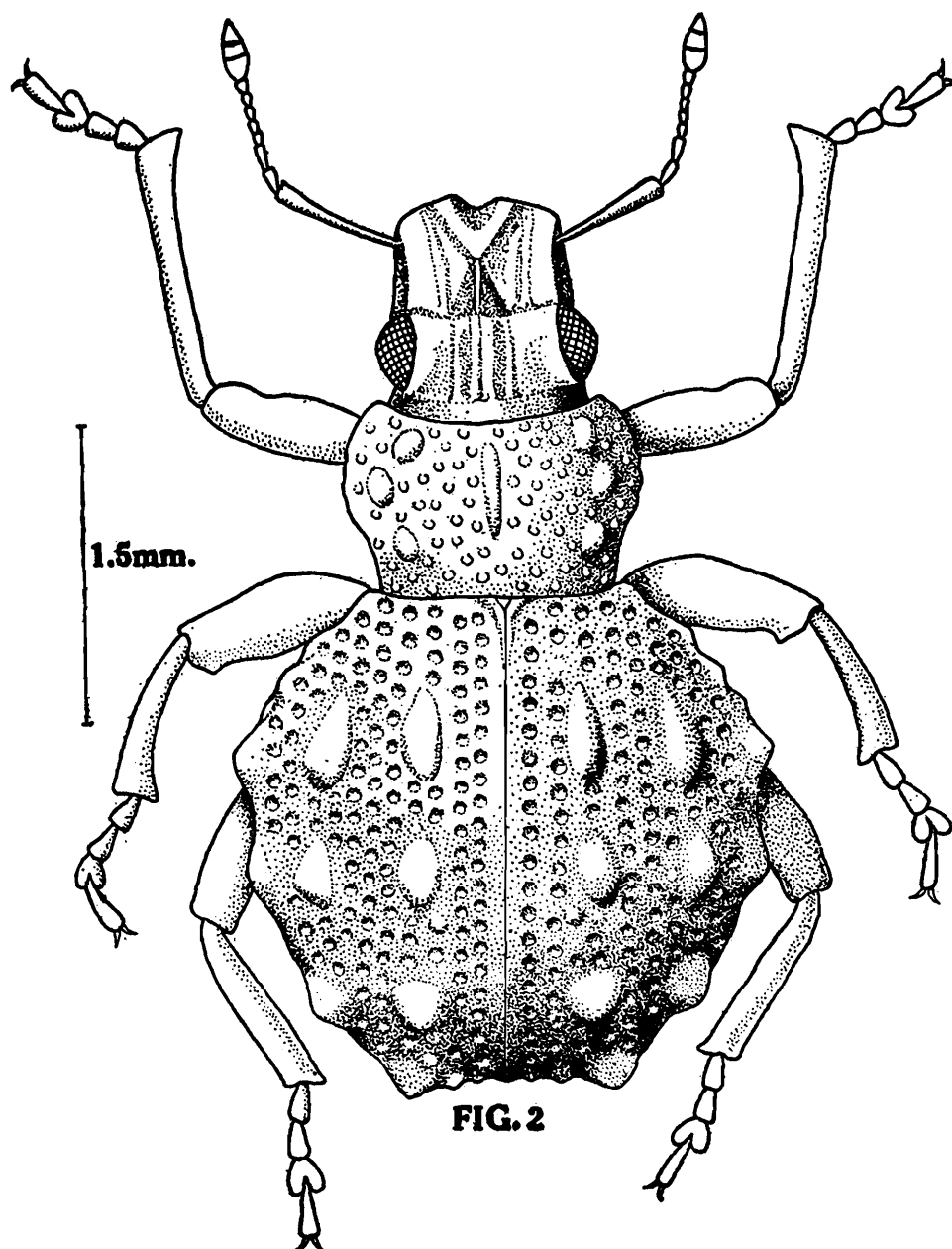


Fig. 2. Dorsal view of *Blosyodes verrucosus* Marshall.

<i>Blosyodes nigricorporis</i> sp. nov.	<i>Blosyodes verrucosus</i> Mshl.	<i>Blosyodes nodulosus</i> Mshl.
1. Dorsal surface black, rather thinly and partly covered with whitish brown scales	Dorsal surface black, rather thinly covered with brown scales with copery reflexion	Dorsal surface black and covered with uniform brown scales
2. Head with an indistinct median sulcus and not extending upto base and lateral sulci on either side indistinct	Median sulcus and two distinct lateral sulci extending upto base	Head with a short, distinct median sulcus.
3. Rostrum dilated towards the apex	Rostrum gradually narrowed from base to apex	Rostrum dilated towards the apex
4. Median carina on rostrum absent but with a depression	Median carina on rostrum distinct	Median carina on rostrum rather fine
5. Central carina on prothorax broad and extending almost from base to apex	Central carina on prothorax short, narrow and less shiny	Prothorax with a broad shiny central carina at base
6. Prothorax uniformly covered with small rounded granules	Prothorax covered with somewhat irregular large granules	Prothorax uneven and rugosely punctate above.

across middle 2.0 mm ; length of elytra 4.5 mm ; width of elytra across middle 3.8 mm.

Holotype 1 ex., INDIA : Arunachal Pradesh ; Kameng : Moshing, altitude 2250m. 26. iii. 1961, *KCJ*. *Paratypes* 2 ex. 1 ex, INDIA : Arunachal Pradesh : Kameng : Moshing, altitude 2250m, 26. iii. 1961, *KCJ* ; 1 ex, Sikkim : Changu, altitude 3693m., 22. v. 1962, *G. Ramakrishna* (deposited in Zoological Survey of India, Calcutta).

Distribution : INDIA : Arunachal Pradesh ; Sikkim.

Remarks : This species is closely related to Burmese species *Blosyodes verrucosus* Marshall (Fig. 2) with somewhat little affinity with north western species *Blosyodes nodulosus* Marshall (Uttar Pradesh : Allahabad) which can easily separated from both species by the following characters :

ACKNOWLEDGEMENTS

This work has been carried out in Zoological Survey of India, Calcutta. Author

is grateful to Dr B. K. Tikader, Director, Zoological Survey of India, for laboratory facilities and highly indebted to Dr T. Sengupta, Officer-in-charge of Coleoptera Section for going through the manuscript and Mr S. N. Aich for helping in drawings.

REFERENCES

- HAAE, E. 1958. Über die Systematik, verbreitung und Schädlichkeit der *Blosyrus* Arten der aethiopischen und madagassischen Region (Col. : Curculionidae). *Ent. Arb.*, Munich 9 : 936-1067, 74 figs, 3 maps.
- MARSHALL, G. A. K. 1916. *The fauna of British India, including Ceylon and Burma. Coleoptera, Rhynchophora, (Part I)*. xv + 367pp., 108 figs. London (Taylor and Francis).
- VAN EMDEN, F. ET. M. 1939. Curculionidae : Brachyderinae III. Junk et Schenkling. *Coleoptm. Cat.*, 27 (pars 164) : 197-327.

SHORT COMMUNICATION

Bull. zool. Surv. India, 5 (2 & 3) : 181, 1984

ORTHETRUM MATHEWI SINGH AND BAIJAL 1954, A SYNONYM OF *PANTALA FLAVESCENS* (FABR.) (ODONATA : LIBELLULIDAE)

While consulting the literature on *Orthe-trum mathewi* Singh and Baijal (1954) it was found that the description of the species was based on female specimen and Holotype designated was also female but illustrations were all with caption of male.

To clarify the position, Holotype of the species in question present in Zoological Survey of India collection (Reg. No. 1431/H8) was examined in detail. Study revealed that the type examined, description and illustrations of the species agree well with the *Pantala flavescens* (Fabr.). Species possesses incomplete antenodal nervures in the fore wings as already shown in the figures by the authors. Nodal index examined is $\frac{9 - 13\frac{1}{2}/13\frac{1}{2} - 7}{10 - 7/7 - 9}$ instead of complete antenodal nervures in the fore wings described by authors as $\frac{14 - 13/9 - 7}{13 - 12/6 - 7}, \frac{7 - 7/9 - 10}{7 - 7/7 - 8}$. Struc-

ture of prothorax is also identical to *Pantala flavescens*. Species also agrees well with identified specimens present in Z. S. I. collection.

Owing to these points this species does not come under the genus *Orthe-trum* Newman (1833) but is referable to *Pantala* Hagen (1861).

It is therefore considered that *O. mathewi* Singh and Baijal is referable to *Pantala flavescens* (Fabr.).

REFERENCES

- SINGH, S. AND H. N. BAIJAL, 1954. Entomological Survey of the Himalayas II.—On a collection of Odonata, *Agra Univ. J. Res.*, 3(2) : 391-393.
- FRASER, F. C. 1936. *Fauna of British India*, Odonata, 3 : 414-416.

Zoological Survey of India

Calcutta-700 012

RAJA RAM

AND

V. D. SRIVASTAVA

ON THE NATURAL DISTRIBUTION AND TAXONOMY OF *GERRES*
MACRACANTHUS BLEEKER (PISCES : GERREIDAE)

During a recent survey the Long-rayed mojarra, *Gerres macracanthus* Bleeker, belonging to the family Gerreidae, was surprisingly observed to be a fairly common component along with *G. filamentosus* Cuvier, in the commercial catches at Ratnagiri (Maharashtra). Both are locally called 'charbat'. While the latter species is widely distributed in the Indo-west Pacific, the former species has hitherto been recorded only from the Palk Bay, the East Indies, New Guinea and the Philippines. New information about *G. macracanthus* is desirable since its taxonomic status is most uncertain. In the present communication the natural distribution of the species is extended to the Arabian Sea and its nomenclature discussed. Its synonymy and characters are :

***Gerres (Pertica) macracanthus* Bleeker**

? *Gerres punctatus* Cuvier, 1830, *Hist. nat. Poiss.*, 6 : 480 (type-locality : Pondicherry).

Gerres macracanthus Bleeker, 1854, *Nat. Tijdschr. Ned.-Indie*, 6 : 195 (type-locality : Batavia, Java); Venkataraman and Badrudeen, 1977, *Indian J. Fish.*, 22 : 290, fig. 1.

Gerres filamentosus Menon (*nec* Cuvier), 1966, *Rec. Indian Mus.*, 59 (4) : 392 (Pondicherry).

Material : 6 ex., 87-120 mm in standard length, Ratnagiri (Maharashtra), 10 May 1981, coll. P. K. Talwar & P. Mukherjee; Zoological Survey of India regd. no. F.7732/2.

Description : Dorsal rays IX 10; anal III 7; pectoral i 15; pelvic I 5; branched caudal fin rays 8+7; scales in lateral line 46

to 48; scales between dorsal-fin origin and lateral line 5, from lateral line to anal-fin origin 10-11; gill-rakers 6+8 on first branchial arch.

Body deep and moderately compressed, its depth 37.7-43.0% of standard length. Length of head 28.5-33.3, length of pectoral fin 30.0-35.8, length of second dorsal spine 40.8-51.1; all in % of standard length. Eye-diameter 34.2-39.2, snout length 31.6-37.2, interorbital width 29.2-35.8; all in % of head length. Predorsal distance distinctly more than the depth of body.

Mouth small, strongly protrusible; mandibular profile concave. Teeth in villiform bands in both jaws; no teeth on vomer, palatines, or tongue.

Second dorsal spine flattened, greatly elongated into a filament, longer than the head. Pectoral fins long, extending to or beyond anal-fin origin.

Scales conspicuous, completely covering head and body.

Colour : in life, silvery with glittering scales but dark grey when viewed from above, with 8 to 10 dusky vertical bars on back and sides of body. Dorsal fin slightly dusky, with a row of dark spots in the middle of the membranous portion; other fins yellowish.

Taxonomy : Barnard (1927) relegated *Gerres macracanthus* Bleeker, 1854, along with *G. filamentosus* Cuvier, 1830, to the

synonymy of *G. punctatus* Cuvier, 1830. Fowler (1928) was of the opinion that *G. macracanthus* was based on immature examples of *G. filamentosus*. Weber & de Beaufort (1931), however, considered *G. macracanthus* distinct from *G. punctatus*, but *G. filamentosus* as a junior synonym of the latter species based on Sauvage's (1891) examination of the types of the latter two species. Fowler (1933) and recently Fischer & Whitehead (1976), considered both *G. punctatus* and *G. macracanthus* conspecific with *G. filamentosus*, and showed that the latter species was first described by Cuvier in 1829 and not 1830 as earlier contended. Munro (1967) distinguished *G. macracanthus* Bleeker from *G. filamentosus* Cuvier, 1829, and this was followed by Venkataraman & Badrudeen (1977) on the basis of new material from the Palk Bay. While it is clear that two distinct deep-bodied species of *Gerres* with a greatly elongated second dorsal spine, are undoubtedly involved, the imperfectly described *Gerres punctatus* Cuvier from Pondicherry is most likely a senior synonym of *G. macracanthus* Bleeker from Batavia (Java). The junior author's collecting in the same general region disclosed the latter species and it seems probable that all specimens from India formerly identified as *G. macracanthus* in reality represent *G. punctatus* Cuvier.

Species of the genus *Gerres* are all very much alike in general appearance. *G. filamentosus* and *G. macracanthus* are, however, separated from all other species of Gerreidae by the greatly elongated second dorsal spine. Since this character is shared by no

other species, the allocation of these two species to a separate subgeneric group is warranted. For this group the generic name *Pertica* Fowler, 1904, is fortunately available.

The authors are grateful to Dr. B. K. Tikader, Director, and Dr. K. C. Jayaram, Deputy Director, Zoological Survey of India, for their encouragement.

REFERENCES

- BARNARD, K. H. 1927. A monograph of the marine fishes of South Africa, Part II. *Ann. S. Afr. Mus.*, **21** : 419-1065.
- FISCHER, W. AND P. J. P. WHITEHEAD (Eds), 1974. FAO species identification sheets for fishery purposes. Eastern Indian Ocean (fishing area 57) and Western Central Pacific (fishing area 71). Vol. II. Rome.
- FOWLER, H. W. 1928. The fishes of Oceania. *Mem. Bernice P. Bishop Mus.*, **10** : 1-486.
- FOWLER, H. W. 1933. Contributions to the biology of the Philippine archipelago and adjacent regions. *Bull. U. S. natn. Mus.*, (100) **12** : 1-465.
- MUNRO, I. S. R. 1967. *The Fishes of New Guinea*. Dept. of Agriculture, Stock and Fisheries. Port Moresby, New Guinea.
- SAUVAGE, H. 1891. Histoire naturelle des poissons. In : *Histoire physique naturelle et politique de Madagascar*. **16** : 1-543. Grandidier, A (Ed.). Paris.
- VENKATARAMAN, G. AND M. BADRUDEEN. 1977. A new distributional record of *Gerres macracanthus* Bleeker from Indian waters. *Indian J. Fish.*, **22** : 290-293.

Zoological Survey of India,
27, Jawaharlal Nehru Road,
Calcutta-700 016

P. K. TALWAR
AND
P. MUKHERJEE

Bull. zool. Surv. India, 5 (2 & 3) : 185, 1984

ON THE OCCURRENCE OF *MESOPODOPSIS ORIENTALIS* (W. M. TATTERSALL)
(CRUSTACEA : MYSIDACEA) IN FRESH WATER

The authors collected five berried females of *Mesopodopsis orientalis* from the Ganges near Semaria Ghat, Begusarai, District Bihar, in October, 1977, and two females from Tilaya dam, Bihar in June, 1981. The length of the specimens varied from 5-6 mm. Though this species has been previously recorded from several estuarine areas (W. M. Tattersall, 1908, 1915, 1922 ; O. S. Tattersall, 1960 and Pillai, 1969) as far as the authors know the present record is the first from purely fresh water localities. The presence of brood pouch containing embryos indicates that this species can live and reproduce in fresh water.

The authors are grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for encouragement and Dr. K. K. Tiwari, Ex-Director, Zoological Survey of India for his helpful suggestions.

REFERENCES

- PILLAI, N. K. 1969. A revision of the genus *Mesopodopsis* Czerniavsky (Crustacea : Mysidacea). *J. zool. Soc. India*, 26 (1 & 2) : 6-24.
- TATTERSALL, W. M. 1908. The fauna of brackishwater ponds at port Canning, Lower Bengal. *Rec. Indian Mus.*, 2 : 233-239.
- TATTERSALL, W. M. 1915. Fauna of the Chilkalake, Mysidacea. *Mem. Indian Mus.* 5 : 149-181.
- TATTERSALL, W. M. 1922. Indian Mysidacea. *Rce. Indian Mus.* 24 : 445-504.
- TATTERSALL, O. S. 1960. Report on a small collection of Mysidacea from Singapore waters, *Proc. Zool. Soc. London*, 135 : 165-181.

Zoological Survey of India,
G. P. R. S., Patna-16

L. P. GUPTA
AND
P. D. GUPTA

Bull. zool. Surv. India, 5 (2 & 3) : 187, 1984

NEW HOST AND LOCALITY RECORD FOR THE GENUS *ORIENTODISCUS*
SRIVASTAVA, 1938 (TREMATODA : PARAMPHISTOMIDAE)

While studying the amphistome trematodes of Patna, the authors came across one specimen of *Orientodiscus* Srivastava, 1938 which proved to be a new host and locality record for this genus.

So far seven species of the genus *Orientodiscus* have been described. *O. lobatum* Srivastava, 1938 and *O. Jumnai* Srivastava, 1938 were collected from the piscine host *Silundia gangetica*. *O. fernandoi* Rhode, 1963 and *O. hendricksoni* Rhode, 1963 from Singapore and Malaya *O. linguiformis* Siddiqui, 1965, *O. buckleyi* Siddique, 1965 and *O. constrictus* Siddique, 1965 from Aligarh (U. P.) are parasites of chelonians. The present material has been collected for the first time from an amphibian host *Rana tigrina* (Daud). So far all the Indian species have been described from the U. P., but our material extends the distribution of the genus *Orientodiscus* to Bihar.

ACKNOWLEDGEMENT

The authors are thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for the facilities extended during this work.

REFERENCES

- RHODE, K., 1963 "*Orientodiscus fernandoi* n. sp. and *O. hendricksoni* n. sp. (Trematoda : Paramphistomata) from the intestine of *Trionyx* spp. in Malaya". *J. Helminth*, 37 : 349-358.
- SRIVASTAVA, H. D., 1938. "Studies on the amphistomatous parasites of Indian food fishes. Part I. Two new genera of amphistomes from an Indian fresh water fish *Silundia gangetica* Cuv. and Vall. *Indian J. Vet. Sci.*, 8 : 369-374.
- SIDDIQUI, A. H., 1965. "Three new species of *Orientodiscus* (Trematoda : Paramphistomata) from fresh water Turtles. *J. Helminth.*, 39 : 377-382.

Gangetic Plains Regional Station,
Zoological Survey of India,
Patna-800 016.

A. K. BANSAL
AND
P. D. GUPTA

SHORT COMMUNICATION

Bull. zool. Surv. India, 5 (2 & 3) : 189-190, 1984

ON A SMALL COLLECTION OF TERMITES (ISOPTERA, INSECTA) FROM BANGLADESH, WITH NOTES ON DISTRIBUTION

Akhtar (1975) has reported 55 termite species from Bangla Desh. A small collection of termites from that country, present in the Zoological Survey of India, was studied and eight species determined, as follows :

Family : KALOTERMITIDAE

1. *Cryptotermes havilandi* (Sjöstedt)

This is a widely distributed species in the Indian subcontinent and elsewhere, for details vide Chhotani (1970). From Bangla Desh it was so far reported from Chittagong and Sundarbans. It is reported here from around Dacca.

Family : RHINOTERMITIDAE

2. *Coptotermes heimi* (Wasmann)

This species is very common in the subcontinent and is very destructive. It is reported here from Dacca and Rajoir (about 64 km. south of Faridpur). Akhtar (1975) reports it from a number of other localities in Bangla Desh and Roonwal and Chhotani (1962) have given detailed distribution of the species.

3. *Heterotermes indicola* (Wasmann)

This is also a very destructive termite. It is widely distributed above 20° North

latitude in the subcontinent. From Bangla Desh it was known only from Khulna, and here it is reported from around Dacca.

Family : TERMITIDAE

4. *Odontotermes assmuthi* Holmgren

From Bangla Desh, it was reported from Dinajpur and Rajashahi Districts, and here we report it from Rajoir (Faridpur District). It is also a common species of the subcontinent.

5. *Odontotermes feae* (Wasmann)

It is recorded here from Rajoir, Faridpur District. It is reported from a number of localities by Akhtar (1975) in Bangla Desh. It is also found to occur in other parts of eastern India, Burma, Thailand and Vietnam.

6. *Odontotermes obesus* (Rambur)

This species is the most common species in the Indian subcontinent. From Bangla Desh it was reported from a number of localities (Akhtar, 1975), and here it is reported from Rajoir (Faridpur district).

7. *Odontotermes parvidens* Holmgren & Holmgren

This is a fairly common species in the

northern parts of the Indian subcontinent. From Bangla Desh also it has been reported from a number of localities (Akhtar, 1975), and here it is reported from Rajoir (Faridpur district).

8. *Odontotermes redemanni* (Wasmann)

It is a common mound-building termite in Sri Lanka and southern and eastern India, and is reported here from around Dacca in Bangla Desh. Akhtar (1975), however, does not report it from Bangla Desh. This species, along with *O. obesus*, poses some problems in respect of determination as they are very close to each other.

REFERENCES

- AKHTAR, S. M. 1975. Taxonomy and zoogeography of the termites (Isoptera) of Bangla Desh. *Bull. Dept. Zool. Univ. Punjab* (N.S.), Art.7 : 1-199.
- CHHOTANI, O. B. 1970. Taxonomy, zoogeography and phylogeny of the genus *Cryptotermes* (Isoptera : Kalotermitidae) from the Oriental Region. *Mem. zool. Surv. India*, 15 (1) : 1-81.
- ROONWAL, M. L. AND CHHOTANI, O. B. 1962. *Indian Species of Termite Genus Coptotermes*. ix+115 pp. Delhi (*Indian Counc. Agric. Res. Entom. Monogr. No.2*). Manager of Publ., Govt. India.

*Zoological Survey of India,
Calcutta-700 012*

G. BOSE
AND
P. N. ROY

Bull. zool. Surv. India, 5 (2 & 3) : 191-193, 1984

NATURAL HISTORY OF A SUCCINEID SNAIL,
INDOSUCCINEA SEMISERICA (GOULD)

Succineid molluscs are interesting from the point of view of their habitat. Majority of them are fully terrestrial and live at quite a good distance from water and high up on trees, while others are found in moist area close to water and aquatic vegetation, and still others are amphibious in nature. Our knowledge is limited to the taxonomical account of the Indian succineids (Rao, 1924, 1925); egg and egg laying habits of some midwestern Succineidae (Guglar, 1963) and the production of viable eggs, without mating in the succineid snails of United States (Patterson, 1970). In the present study an attempt has been made to gain knowledge on the natural history of Indian succineid snail, *Indosuccinea semiserica*.

Observations on feeding, breeding and aestivation of *I. semiserica* were carried in snail infested gardens in and around Behala, 24-Parganas district, West Bengal regularly for a period of two years, 1979 and 1980. In laboratory the snails were kept in light and dark for varying periods to ascertain their responses to the natural day and night period.

I. semiserica is a tree dweller. Apparently, it is very specific for hard wood trees. During day hours the snails are found in quiescent

state on the shaded side of the trees or on the lower surface of the leaf.

The snails feed upon lichens, algae and mosses growing on the bark of host plants. They also consume decomposed or semidecomposed leaves with fungal growth stuck to the branches and trunk of the tree. Foliage and other live parts of the host plant are never attacked.

With the approach of darkness the snails emerge from their hidden shelters and start searching for food. Feeding starts following dusk and may extend up to 03-00 hrs. The behavioural response seems to be fixed, since regardless of exposure to different photo-periodic regimes in the laboratory, the quiescent and active periods of the snail correspond to those in their natural habitat.

With the advent of adverse climate snails become sluggish. The aestivation period in south West Bengal extends from November to June. *I. semiserica* usually aestivate in a concealed place on the plant on which they live. Prior to aestivation they secrete mucocalcareous substance which on drying form thick, whitish epiphragm closing the shell aperture perfectly, and at the same time securing the shell firmly to the tree trunk. The anchoring was so strong that any attempt to

remove them resulted either in the separation of a chunk of bark of the tree or damage of the shell. They aestivate singly and the perfect matching of the colour (colour of the body as visible through the semitransparent shell) with that of the bark of the plant suggests a degree of camouflage in the species.

I. semiserica is hermaphrodite. Snails start laying eggs at the shell size 4.2×3.1 mm. Eggs (24–86, the average being 54, $N=138$) are laid on the dorsal surface or on the ventral of the leaf with a good amount of transparent, thick mucoid substance, which soon turns to a gelatinous mass of round shape (Pl. VII, figs. 1A–1C) in which eggs remain embedded. The egg-nest measures 8–15 mm in diameter and 5–7 mm thick. Eggs are transparent, round, measure 1.3 mm in diameter and are irregularly arranged in the egg-nest (Pl. VII, figs. 1A–1C). The transparent nature of the egg-nest and eggs facilitates studies on the eggs and developing embryos. The incubation period ranges from 12–19, on the average 13.8 days ($N=32$). Newly hatched snails crawl to the ventral surface of the leaf and after rest for a few hours start feeding on microorganisms.

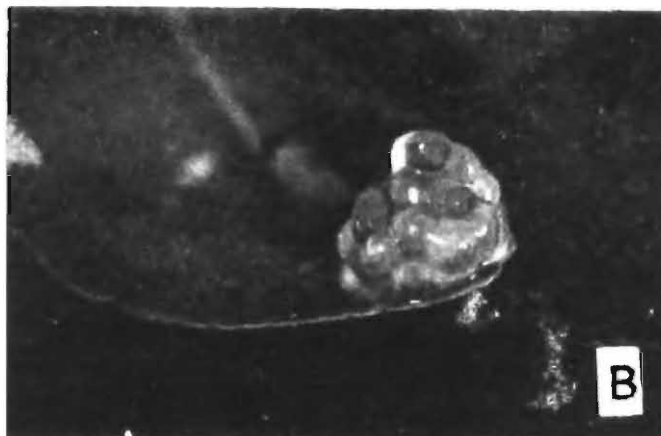
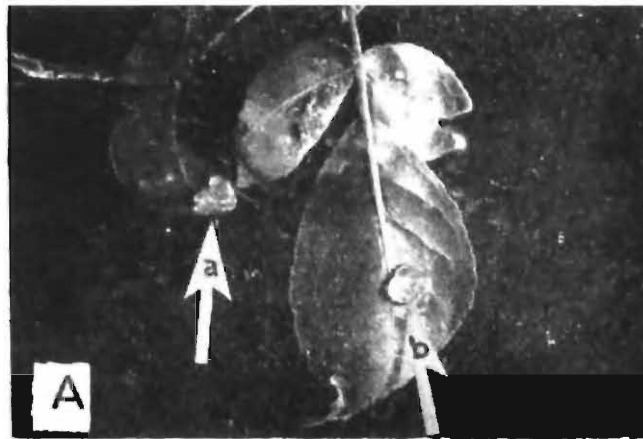
The high degree of adaptability of *I. semiserica* to an arboreal life is not on record. They restrict themselves mostly to the hard wood plants presumably due to their specialised feeding habits since the young feed exclusively on the microorganisms and the adults on the algae, fungi and mosses growing on the bark of such plants. Similar observations have been made on U. S.'s tree snails *Liguus fasciatus* (Modlin, 1975). Terrestrial pulmonates viz. *Discus rotundatus* (Chatfield, 1972), *Arion empiricorum*, *Rumina decollata* (Frömming, 1954, 1956), *Achatina fulica* and

Macrochlamys indica (Raut and Ghose, 1983) feed upon such materials occasionally because Angiosperms are their chief food source. Chatfield (1976) believes that feeding of microorganisms and mosses is associated with the nutrition of the species concerned. Apart from nutritional requirements the habit of feeding on lichens, algae and mosses in *I. semiserica* may be considered as an important adaptation for arboreal life. It appears that the snails adapted for arboreal life did not consider the plant as their food, probably not to degrade the habitation.

The colour of the mantle (as seen through the transparent shell) blends perfectly with that of the bark of the tree, and the ability to produce a highly protective nest might be considered as adaptations to arboreal life.

Among the tree living snails, the peculiar egg laying habits by rolling of leaves in *Cochlostyla leucophthalma* (Sarasin and Sarasin, 1899) and by plastering leaves in *Amphidromus purus* and *Nanina javana* (Paravicini, 1921) are on record. Nesting on the dorsal surface of the leaf as in *I. semiserica*, however, has not been reported from other tree living snail species.

I. semiserica breeds in the rainy season and the possibility of getting sunlight is comparatively less due to cloudy weather. Being located on the dorsal surface of the leaf the nests are directly exposed to sunlight and the heat received from the latter helps in maintaining a higher temperature, which may in turn accelerate the development rate of the embryos. The gelatinous egg-nest absorbs moisture from the humid air during the rainy season. Direct rainfall also helps in the process and desiccation of eggs is effectively



Figs. A-C. A. Egg-nest of *I. semiserica*

B and C. The same magnified (refer corresponding markings 'a' and 'b' in Fig, A).

prevented. The nesting habit is presumably an important adaptation for the tree life style of the snail *I. semiserica*.

ACKNOWLEDGEMENT

The authors are thankful to Dr. B. K. Tikadar, Director, Zoological Survey of India for facilities provided. The senior author is grateful to Dr. N. V. Subba Rao and Mr. S. Chatterjee for their cooperation in this work.

REFERENCES

CHATFIELD, J. E. 1972. Observations on the ecology of *Monacha cantiana* (Montagu) and associated molluscan fauna. *Proc. malac. Soc. Lond.* 40 : 59-69.

CHATFIELD, J. E. 1976. Studies on food and feeding in some European land molluscs. *J. Conch. Lond.*, 29 : 5-20.

FRÖMMING, E. 1954. Biologie der mitteleuropäischen Landgastropoden. Dunker and Humbolt, Berlin.

FRÖMMING, E. 1956. Biologie der mitteleuropäischen Susswasserchnecken. Dunker and Humboldt, Berlin.

GUGLAR, C. W. 1963. The eggs and egg-laying habits of some Midwestern land snails. *Trans. Kans. Acad. Sci.*, 66(2) : 195-201.

MODLIN, R. F. 1975. The U. S.'s only tree snail. *Of Sea and Shore*. 6 (1) : 20, 52.

PARAVICINI, E. 1921. Die Eiablage zweier javanischer Landschnecken. *Arch. Mollusken*, 53 : 117-126.

PATTERSON, C. M. 1970. Self-fertilization in the land snail family Succineidae. *J. Conch. Lond.*, 3 : 61-62.

RAO, H. S. 1924. Asiatic Succineidae in the Indian Museum. *Rec. Indian Mus.*, 26 : 367-407.

RAO, H. S. 1925. On certain succineid molluscs from the Western Ghats, Bombay Presidency. *Rec. Indian Mus.*, 27 : 385-400.

RAUT, S. K. AND GHOSE, K. C. 1983. Food preference and feeding behaviour in two land snails, *Achatina fulica* and *Macrochlamys indica*. *Rec. zool. Surv. India*, 80 : 421-440.

SARASIN, P. AND SARASIN, F. 1899. Die Susswassermollusken von Celebes. Wiesbaden.

Zoological Survey of India
8, Lindsay Street
Calcutta-700 016

Department of Zoology
Calcutta University
35, Ballygunge Circular Road
Calcutta-700 019

S. K. RAUT*
AND
K. C. GHOSE

* Present Address : Department of Zoology, Calcutta University.

ON THE OCCURRENCE OF THE GIANT SEA ANEMONE *PARACONDYLACTIS* SP. FROM DIGHA COAST, WEST BENGAL, WITH A NOTE ON SECONDARY ORAL DISC

During a survey of the intertidal region along the Digha coast, West Bengal, an abnormal specimen of a giant-sized sea anemone with two oral discs was collected on 13th February, 1978 from sandy mid-littoral zone of the beach at low tide period. The specimen identified as *Paracondylactis* sp. was kept alive in the laboratory of the Zoological Survey of India, Calcutta, and was maintained in a closed-system marine aquarium for further observations.

On examination the oral end showed the presence of two oral discs. The original disc was large and circular and had five whorls of long tentacles. The secondary disc was ovate covering one side of the oral end of the animal and was situated just below the outer whorl of largest tentacles of the original oral disc. The tentacles of the secondary disc which lie just below the pseudospherules of the original disc were much shorter and smaller in comparison with the rest of the tentacles. The movements and functions of both the oral discs and their tentacles have been observed to be independent of each other as shown in Plate VIII, figs. 1, 2 & 3.

In fig. 1, it can be observed that the animal when left undisturbed, kept its ten-

tacles of both the discs well expanded. Fig. 2 shows the reaction of the secondary disc of the animal on stimulation with a piece of black paper (cut in the shape of an arrow) by converging its tentacles towards the mouth. Fig. 3 shows the converged tentacles of the secondary disc and the tentacles and mouth of the original disc that remained unchanged on stimulation given to the secondary disc.

Instances of such double oral discs are available in literature (Child, 1903-1908 ; Stephenson, 1928 ; Hyman, 1940 ; MacGinitie and MacGinitie, 1968). A double animal (anemone with two oral discs with independent stalks and a common scaphus) occurs either due to certain disturbances in early development or due to partial longitudinal fission that was left incomplete (Carlgren, 1925). A secondary oral disc develops in an anemone when a deep puncture occurs on the suboral region at the oral end (Stephenson, 1928). Hyman (1940) also observed that a superficial cut made on the column of an animal heals but when cut involves the actinopharynx also, then a crown of tentacles or a oral disc with tentacle may develop.

Specimen is provided with 12 pairs of

large, perfect mesenteries and 12 pairs of small, imperfect ones. The secondary disc with only 12 pairs of small mesenteries and with a short pharynx which opens into the original actinopharynx. The coelenteric cavity is common for both the discs. There is no record on the function of the secondary disc as to whether it acts either independently or in unison with the original disc. The anatomical evidence collected during the present study shows that the secondary disc acts independently because of the presence of separate actinopharynx of its own.

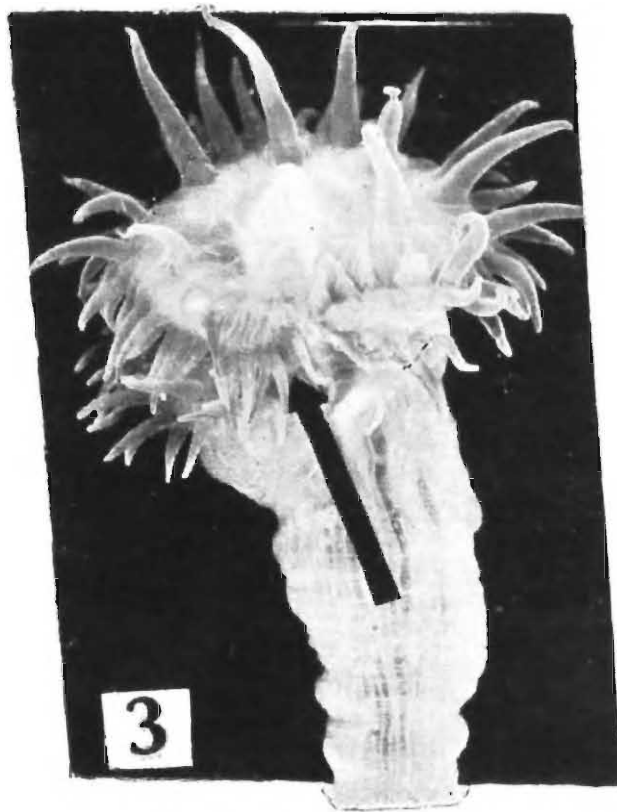
The present account is the first instance of the natural occurrence of secondary oral disc recorded for *Paracondylactis* sp. and also the first description of independent function of the secondary oral disc.

ACKNOWLEDGEMENT

I am grateful to Dr. B. K. Tikader, Director, Zoological Survey of India for his kind permission in carrying out this work. I am also indebted to Mr. P. Dhandapani, Zoologist for providing his marine aquarium during my study.

REFERENCES

- CARLGRÉN, O., 1925. Zur Regeneration der Actiniarien. *Z. Morph. Okol. Tiere*, Berlin, 5 : 150-154.
- CHILD, C. M. 1903. Form regulation in *Cerianthus*, VIII. Supplementary partial discs and heteromorphic tentacles, *Biol. Bull.*, 8 (2) : 93-122.
- CHILD, C. M. 1908. Form regulation in *Cerianthus aestuari*.—*Biol. Bull.*, 15 (1) : 27-53.
- HYMAN, L. H. 1940. The Invertebrates : Protozoa through ctenophora : xii+1-126, McGraw—Hill Book Company.
- MACGINITIE, G. E. AND MACGINITIE, N. 1968. Natural History of Marine Animal (2nd ed.) : xii+1-523, McGraw—Hill Book Company.
- STEPHENSON, T. A. 1928. The British Sea Anemones Vol. 1 : xiv+1-148, , pl. 14, Roy Soc., London.



Figs. 1-3. 1. *Paracondylactis* sp. With a secondary oral disc, undisturbed.
2. Secondary disc of *paracondylactis* sp., stimulated.
3. Original disc of *paracondylactis* sp. remains unchanged.