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Dr. J. R. B. ALFRED
Director
Zoological Survey of India

AN APPEAL

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Dr. J. R. B. ALFRED
Director
Zoological Survey of India

RECORDS OF THE ZOOLOGICAL SURVEY OF INDIA

Vol. 101(Part 1-2)

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Pages 1-240

CONTENTS

	<i>Pages</i>
Khan, R. A. — Observations on some aspects of the biology of Horse-shoe crab, <i>Carcinoscorpius rotundicauda</i> (Latreille) on mud flats of Sunderban Estuarine Region ...	1-23
Ramakrishna and Sarker, J. — On the Scyphozoa from East Coast of India, including Andaman & Nicobar Islands ...	25-56
Sanyal, A. K., Susmita Saha and Chakraborty, S. — Three new species of the genus <i>Chaunoproctus</i> pearce (1906) (Acarina Oribatida) from India ...	57-66
Mitra, S. K. — On <i>Lepidonella</i> Yosh, 1960 and <i>Bromacanthus</i> Schött, 1925 complex (Collembola Entomobryidae : Paronellinae) ...	67-86
Bhattacharya, S. B. — First report on the occurrence of <i>Macracanthorhynchus hirudinaceus</i> (Pallas, 1781) and <i>Polymorphus magnus</i> Skrjabin, 1913 (Acanthocephala) in wild pig and garganey teal in India ...	87-91
Gupta, S. K., Sanjib Ghoshal and Choudhury, A. — Life cycle of <i>Amblyseius alstoniae</i> Gupta, at room temperature feeding upon <i>Eotetranychus hicoriae</i> McGregor on guava (<i>Psidium guajava</i>) ...	93-99
Patil, S. G. and Panda, P. — Limnological studies of a freshwater fish tank Bibinagar, Hyderabad (Part II)-Rotifera ...	101-106
Biswas, V. and Raychaudhuri, D. — Wolf spiders of Bangladesh : Genus <i>Pardosa</i> C. L. Koch (Araneae : Lycosidae) ...	107-125
Srivastava, G. K. — Notes on some Dermaptera (Insecta) from North Cachar hills district, Assam ...	127-134
Srivastava, G. K. — On a collection of Dermaptera (Insecta) from Australia with the description of a new species ...	135-138
Achintya Chattopadhyay and Soumyendra Nath Ghosh — Effect of vehicular lead pollution on biodiversity with special reference to ants ...	139-160
Kazmi, S. I., Arora, G. S., Bhattacharyya, A. K. and Mohd. Faisal — On a collection of butterflies (Lepidoptera) at the Desert Regional Station, Zoological Survey of India, Jodhpur ...	161-177

Chandrasekhar, S. V. A. — Ichthyofauna of Kondakarla Lake, Andhra Pradesh	...	179-187
Pattanayak, J. G. — Occurrence of <i>Spongilla lacustris</i> and <i>Eunapius carteri</i> (Demospongiae Spongillidae) from Tripura, India	...	189-193
Rosamma Mathew — On formicidae (Insecta Hymenoptera) of Nongkhyllem wild life sanctuary, Ri-bhoi district, Meghalaya	...	195-207
Venkataraman, K. — Crustacean zooplankton of Damodar river	...	209-229
Sureshan, P. M. — On the Indian species of <i>Halticoptera</i> Spinola (Hymenoptera : Chalcidoidea Pteromalidae)	...	231-237
Radhakrishnan, C. and Muhamed Jafer Palot — First report of a Hitherto unknown larval food plant of the brown king crow, <i>Euploea klugh</i> Moore (Lepidoptera Insecta)	...	239-240

OBSERVATIONS ON SOME ASPECTS OF THE BIOLOGY OF HORSE-SHOE CRAB, *CARCINOSCORPIUS ROTUNDICAUDA* (LATREILLE) ON MUD FLATS OF SUNDERBAN ESTUARINE REGION

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INTRODUCTION

The existing species of horse-shoe crabs, the oldest living animals on the earth, have almost remained unchanged, both morphologically and genetically during a long evolutionary course of more than 350 million years (Price, 1971). There are many fossilized records from different parts of the world related to different geological time scale (Mikkelsen, 1988), which reveal little structural changes from those of existing ones. Due to this fact, they are also called "living fossils"

Apart from their antiquity and uniqueness, which are subjects of deep academic interests, these animals are of tremendous importance in present day biomedical researches. Their 'blue blood' contains an important enzyme 'Lysate' which is highly sensitive to endotoxin of gram negative bacteria and therefore is used as diagnostic tester (Cohen, 1978).

Out of four extant species of the group, known from the world, except *Limulus polyphemus* (Linnaeus), which occur in the coastal waters of U.S.A., the other three species viz. *Tachypleus tridentatus* (Leach), *Tachypleus gigus* (Muller) and *Carcinoscorpius rotundicauda* (Latreille) are Asian species (Sekiguchi and Nakamura, 1979). In India, the group is represented by the latter two species, both confined to north-eastern coasts of Bay of Bengal in the states of West Bengal and Orissa. While *C. rotundicauda* occurs only in Sunderban region of Hugly Matla estuarine system and adjoining coastal waters up to Digha, *T. gigus* has been reported to occur in abundance in the coasts of Orissa and adjoining region of West Bengal, up to Digha. In spite of the earlier records of the coexistence of the two species in Sunderban region, no distributional overlap was noticed during present investigations.

While enormous amount of work has been carried out on various aspects of the abundance, distributional patterns, morphology, life history, population cycle of *Limulus polyphemus* (Barber, 1956; Botton, 1982, 1984a, 1984b, 1984c; Rudole, 1979, 1980, 1981 1985) comparatively little work has been done on Asian species and this includes chiefly the studies of Sekiguchi and Nakamura (1979) and Sekiguchi *et al.* (1976, 1981). In India, the earlier references on horse-shoe crab include the notes of Annandale (1909) and Roonwal (1944), on some aspects of the breeding biology of *T. gigus* (later on confirmed as *C. rotundicauda*). Rama Rao and Surya Rao (1972) also made some observations on the occurrence and breeding habits of *T. gigus* from Digha Coast.

After a long gap, Chatterji *et al.* (1992a, 1992b) published results of detailed studies on the biology of *T. gigus* from Orissa coasts, near Balramgarhi, where this species occur in great abundance. Besides *T. gigus*, Chatterji and Perulekar (1992) and Chatterji *et al.* (1988) have also published some aspects of growth and fecundity of *C. rotundicauda*, based on some material procured from a supplier of Canning town near Calcutta. No survey of the area was carried out by them. This has prompted the present author to undertake the studies on this species in Sunderban region. The present paper reports the results of the studies carried out during the period 1988–92 on the occurrence and abundance of the species in different zones of Sunderban region and on their length-weight relationship, food and feeding habits, spawning behaviour and fecundity.

MATERIALS AND METHODS

A. Description of study area

The Sunderban estuarine and mangrove area lies on the world's largest delta, the Ganga-Brahmaputra delta and exhibits a unique ecosystem. The entire area is situated at the mouth of rivers near Bay of Bengal and is criss-crossed with a large number of estuaries, their creeks and channels (Khals), forming a number of marshy islands. These islands support luxuriant mangrove forests and are subjected to total or partial submersion twice a day during high tides. Vast areas of mud flats appear around these islands during low tides and the intertidal mud flats harbour a variety of fauna.

The Indian Sunderban, which is one third of the total Sunderban (2/3rd in Bangla Desh) is mainly formed by an offshoot of major river-Ganga and its tributaries like Roopnarayan and Haldi etc. This part of the river Ganga, known as Hugly, is the main constituent of Hugly-Matla estuarine system. The entire Sunderban area falls under the administrative districts of North and South 24 Parganas of West Bengal State, near Calcutta, between the latitude 21°40' and 22°45' N and longitude 88°6' and 89°5' and covers an approximate area of 9630 sq. km. Out of this 4262 sq. km are forested and rest reclaimed areas. The forested area includes nearly 45% of water area.

Because of the uniqueness of the estuaries and mangroves, the region has been declared as a Biosphere Reserve which includes both, a Tiger reserve and 2 Bird sanctuaries. The region has also be designated as 'World heritage Site'

The Sunderban estuarine complex is mainly comprised of three major estuaries viz. Hugly-flowing in the extreme west of the region, Thakuran-Matla in the middle region and Harinbhanga-Raimangal forming the eastern boundary. These major estuaries are connected with a number of smaller distributories (Fig. 1).

The tides in the estuarine system is always strong and variable and the tidal limit extends upto 295 km in main river Hugly. The onset and duration of twice a day tides differ from day to day and season to season. The spring tide which occurs during first half of lunar month, lasts for 12-14 days. The neap tide period covers the rest of the lunar month. The intensity of spring tides is always higher.

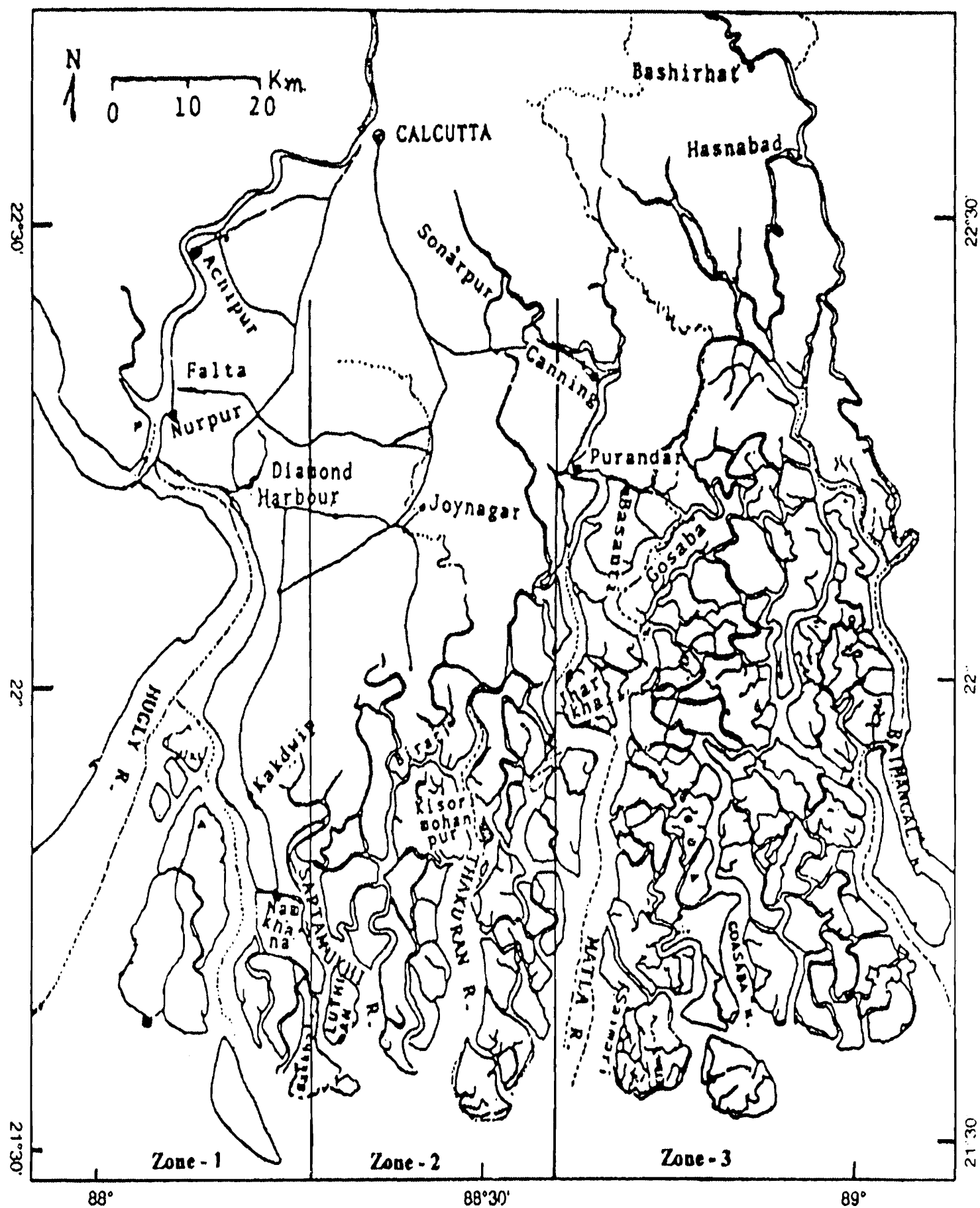


Fig. 1. Sunderban Estuarine Zone of Hugly-Matla System.

The climate in the region is hot and humid during most of the year with mean monthly temperature varying around 30°C except for a brief period in December-January when it drops to around 22°C. This comprises the brief moderate 'winter season'. The climate is chiefly influenced by monsoon and therefore biological seasons are classified as Premonsoon (PRM, March-June), Monsoon (MON, July-Oct.) and Post monsoon (POM, Nov.-Feb.). These are further divided as early (I-the first two months) and late (II-the last two months).

Study Zones and sites

For the purpose of present study, the entire area was roughly divided into following three zones.

ZONE 1. **Hugly-Muriganga Zone.** The areas west of Saptamukhi river.

ZONE 2. **Saptamukhi-Thakuran Zone.** The areas east of Zone 1 and west of river Matla.

ZONE 3. **The Matla-Goasaba Zone.** Areas east of Zone 2 to the Indian boundary of Sundarban region.

B. Survey, Collection and Analysis

Extensive surveys of 40 randomly selected sites covering all zones were carried out as part of the programme on general faunal resources of Sundarban. Surveys were conducted during lowest of low tides on the days of observation, only during day light. At each site, a stripe of 100 m, between the low and high tide marks horizontally were searched thoroughly and occurrence of species was recorded. After carrying out extensive survey of the region for their occurrence, two sites were selected as detail study station, one each in Zone 2 and Zone 3. These were, Station I- Purandar-Canning and Station II- Birati, near Pathar Protima. Studies were made on their movement on mud flats, their courtship and spawning behaviour.

For the study of morphometry, length weight relationships, food and feeding habits and fecundity, specimens were obtained from professional collectors, who sell these in local market for their use as '*Talisman*'. Only telson is used for the purpose and the rest of animal body is of no use to faith healers.

The length and width of carapace and body weight of all species were measured to nearest millimeter and gram respectively. For size frequency distribution and fecundity, about 150 ova were measured and weighted portions were counted. Food and feeding habits were studied by removing the gut contents and sorting out the different food item. Identification was done to lowest possible taxa and their relative percentages were determined. Feeding intensity was calculated by classifying the guts into various stages of fullness. The food selectivity was studied by applying electivity index of Ivlev, as described earlier (Khan and Siddiqui, 1973).

$$E = \frac{r_i - p_i}{r_i + p_i}$$

Where r_i is the relative content of any ingredient in the ration expressed as percentage of total ration and p_i is the relative values of same ingredient in the food complex of the environment.

The values of E (electivity index) range between +1 and -1, former denoting complete positive selection and latter indicating negative selection (avoidance). A value of 0 represents the absence of any selectivity. For this, quantitative collection of macrobenthos were made by removing all animals within the measured area of 0.5x0.5 m with the help of wooden quadrat upto the depth of 15 cm and washed through a sieve of 0.5 mm mesh size. All animals retained on the sieve were picked up. Meiobenthos samples were collected with the help of a metal core sampler by pushing to a depth of 20 cm and drawing a sub samples using a plexi glass core of 0.75 cm diameter. The soil samples were washed thorough 0.5 mm mesh sieve and filtrates were preserved in 5% formalin and examined under a stereo-binocular microscope.

Feeding intensity was determined by observing the guts and arbitrarily classifying into various stages of fullness, as gorged, full, $\frac{3}{4}$ full, $\frac{1}{2}$ full, $\frac{1}{4}$ full, traces and empty. These were converted into three categories viz. active (gorged, full and $\frac{3}{4}$ full), moderate ($\frac{1}{2}$ full and $\frac{1}{4}$ full) and poor (traces and empty).

RESULTS

Taxonomic position and general morphological features

The species is a chelicerate arthropod, the oldest group of arthropoda. Its present taxonomic position is :

Phylum	ARTHROPODA
Sub/Phylum	CHELICERATA
Class	MEROSTOMATA
Sub-class	XIPHOSURA
Order	XIPHOSURIDA
Family	LIMULIDAE
Sub-family	TACHYPLEINAE
Genus	<i>Carcinoscorpius</i>
Speceis	<i>C. rotundicauda</i>

Salient features

Carapace horse-hoof shaped, moderately rounded in anterior region (Fig. 2), chitinous, consisting of two parts, the anterior Prosoma and posterior Opisthosoma. The opisthosoma fits well into the posterior part of prosoma. Well developed spines on dorsal side of prosoma, numbering seven, one just behind the median ocelli. The posterior prosomal region three sided. A short but prominent spine in the middle. The ventral side of the carapace somewhat concave and bears six pairs of thoracic appendages. The chelae or the first pair are smooth, pointed and three segmented, situated just in front of mouth. Rest of the appendages six segmented, with tips reaching near the mouth.

The libia is fringed with flat forked structure. The chilaria is formed by plates joined together near the mouth; opisthosoma almost hexagonal, bearing six pairs of short, curved towards the telson marginal spines, two anterior one comparatively bigger in size than others. The posterior central margin is inflated towards both sides. In males spines are thin, comb or saw shaped and prominent but in females obtuse and not very distinct. Three spines along mid body line. The posterior margin is also three sided, concave but smaller than prosoma. A long pointed spear shaped telson, smooth, subcylindrical in cross section and flattened at the base. The second and third appendages of males are modified into well developed curved claspers. These claspers alongwith dactylopodite form a stout chela. The claspers are strong and blue-black in colour. No modification of thoracic appendages in females.

Under opisthosoma, there are six mesosomatic appendages near the first jointed operculum and genital pores. The genital pores are conical projections in males and broad slits in females. The other five appendages are identical but smaller in sizes and known as gill books. There are 10 gill books, each consisting of over hundred leaf like structure.

The maximum size of the species recorded during present investigations was 205 mm.

Distribution

This is an asian species, confined mainly to China, Japan, Thailand, Malaysia, Singapore, Borneo, Sabah, Brunei and northern Vietnam besides Sunderban region. Details of the distribution have been given by Mickkelsen (1988).

In India the distribution of the species is confined to Sunderban region of Hugly-Matla estuarine system and nearby coastal waters of Bay of Bengal. Ronwal (1946) observed the migration of this species into river Hugly, upto sixty km above the mouth. During present investigations, the species was found to occur only on the mudflats of Sunderban in lower region of the estuarine system near the mouth. It was never recorded from middle or upper zones.

Habitat

The species prefers mudflats in estuarine and mangrove zones and calm seas. While most of the life activity take place in open water, adults for the purpose of breeding migrate towards shores on intertidal flats.

Occurrence and abundance

Several extensive surveys conducted during 1988-92, covering different seasons, revealed that the occurrence of this species was not uniform in all zones and was localised in certain pockets. Out of 40 randomly selected sites, the species occurred only at 14 sites (Table 1). There were certain specific places, where it occurred regularly during different seasons. The species was not observed from most of the areas falling under Tiger Reserve area, inspite of dense mangrove vegetation.

PLATE - I

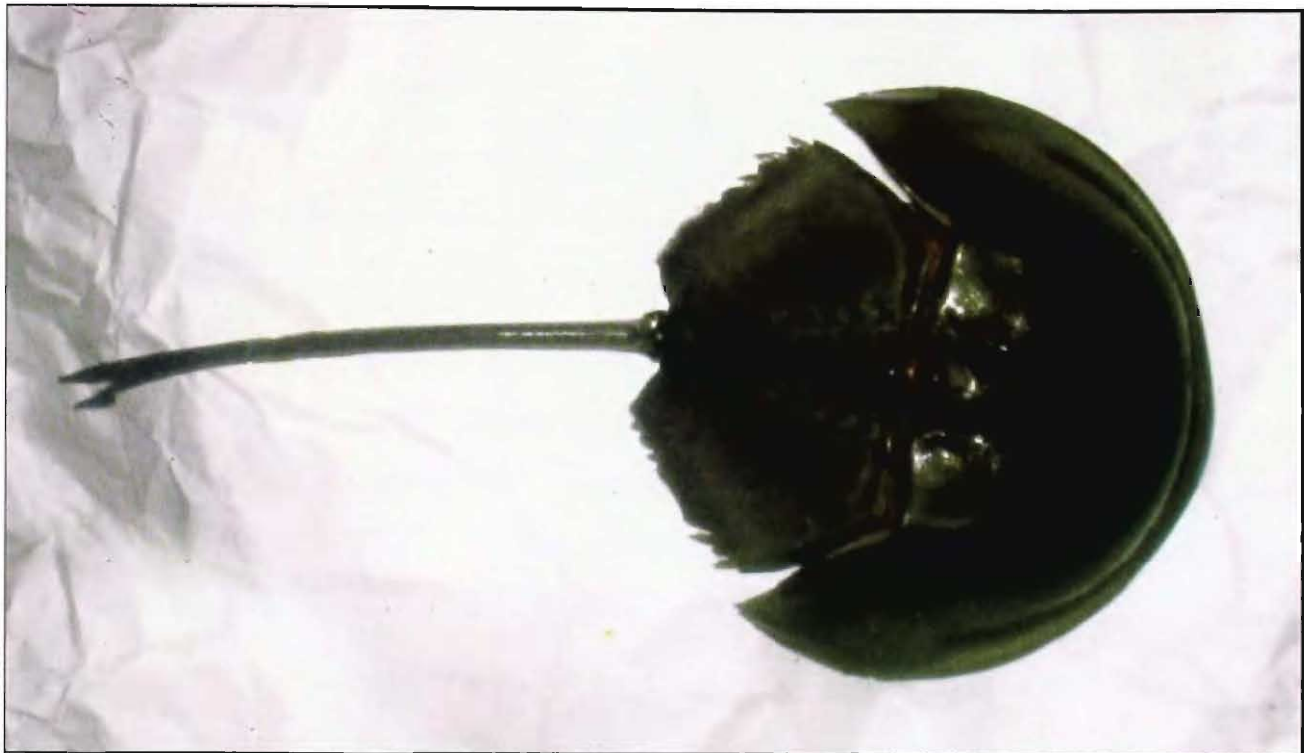


Fig. 2A. *Carcenoscorpius rotundicauda* (Latreille) from Sunderban estuarine system.- Dorsal view.



Fig. 2B. *Carcenoscorpius rotundicauda* (Latreille) from Sunderban estuarine system.- Ventral view.

Table 1. The occurrence of *C. rotundicauda* on intertidal flats of randomly selected sites of Sunderban.

Zones and Sites	Premonsoon	Monsoon	Postmonsoon
ZONE-I			
Site-1. Kakadwip	–	–	–
2. Namkhana	–	–	–
3. Bakkhali	–	–	–
4. Harwood point	–	–	–
ZONE-II			
5. Birati	+	+	+
6. Kishori Mohan Pur	+	+	+
7. Chulkati-Parsemari	–	–	+
8. Ajmalmari-Kaikalmari	+	–	–
9. Dhanchi	+	–	+
10. Printice Island	–	–	–
11. Curzan creek	–	–	–
12. Patahar Protima	–	–	–
13. Thakuran	–	–	–
ZONE-III			
14. Sajnakhali	–	–	–
15. Pirkhali	+	–	–
16. Sudhanyakhali	–	–	–
17. Nidithopani	–	–	–
18. Chamta	–	–	–
19. Saimari	–	–	–
20. Kalas	–	–	–
21. Kedokhal	–	–	+
22. Haldibari	–	–	–
23. Mayadweep	–	–	–
24. Sandeshkhali	+	–	+
25. Panchmukhani	+	+	–

Table 1. Cont'd.

Zones and Sites	Premonsoon	Monsoon	Postmonsoon
26. Gona	–	–	–
27. Chotahardi	–	–	–
28. Kalindi	–	–	–
29. Khatwajhuri	–	–	+
30. Bagna	–	–	–
31. Arbessi	–	–	+
32. Marijhapi, Jhila-1	–	–	–
33. Rajat Jublee	–	–	+
34. Gosaba	–	–	–
35. Rangabelia	–	–	–
36. Dayapur	–	–	–
37. Jamespur	+	–	–
38. Basanti	–	–	–
*39. Purandar	+		+
**40. Jharkhali	+	+	+

*Intensive study Station-1, **Intensive study Station-2

The occurrence in Zone 2 (Saptamukhi-Thakuran) was comparatively higher than Zone-3 (Matla-Goasaba). Out of 9 sites of Zone 2, the species was recorded from five sites. It occurred in all seasons at sites 5 and 6. Juveniles were also recorded from site 6. In zone 3, Purandar-Canning (site 39) and Jharkhali (site 40) were the two stations from where the species was recorded during all the seasons. In Zone 1, the species could not be observed at any of the four selected sites.

Table 2. gives the results of occurrence and abundance recorded from two intensive study station during the years 1990-91 and 1991-92. During first year the species was recorded in all seasons at both stations except during PRM-II, when it was absent from Station 1. Highest number of individuals was recorded during premonsoon period. At station 1, out of a total of 94 individuals observed, 74 occurred in premonsoon. Almost similar condition was noticed at Station-2. The overall density at Station-2 was lesser than Station 1, as only 55 individuals were recorded. During following year too, the occurrence and abundance patterns were marked by the abundance of individuals during premonsoon season at both stations. However, the species was altogether absent during MON-I at both Stations and was represented by only one female, each at the two stations

during MON-II. The overall population density was considerably lower than the previous year at both stations. Only 53 and 46 adult individuals were recorded from Stations 1 and 2 respectively. No juveniles were recorded. Baring one or two, all these were in the form of mating couples. This resulted in almost uniform sex ratio for most of times.

Table 2. Abundance of *C. rotundicauda* on Mudflats of two study stations.

Season	STATION-I				STATION-II			
	No. of males	No. of females	Total	Percent of total density	No. of males	No. of females	Total	Percent of total density
		1990-91						
PRM-I	27	27	54	54.45	16	16	32	58.18
PRM-II	10	10	20	20.20	3	3	6	10.91
MON-I	1	2	3	3.03	—	—	—	—
MON-II	2	4	5	5.05	2	2	4	7.27
POM-I	3	3	6	6.06	2	3	5	9.04
POM-II	5	6	11	11.11	4	4	8	14.54
Total	48	52	99		27	28	55	
		1991-92						
PRM-I	15	15	30	56.60	12	12	24	53.33
PRM-II	6	6	12	22.64	5	5	10	22.22
MON-I	—	—	—	—	—	—	—	—
MON-II	—	1	1	1.88	—	1	1	2.22
POM-I	2	2	4	7.54	2	2	4	8.88
POM-II	3	3	6	11.32	3	4	7	15.55
Total	26	27	53		22	23	45	

PRM-Premonsoon, MON-Monsoon, POM-Postmonsoon; I-early, II-late.

Length-Weight relationship

Measurements of 200 animals (80 males, 120 females) were utilised for the determination of LW relationship. Due to non availability of juveniles in sufficient numbers, their relationship could not be ascertained.

The regression equation calculated on the basis of Log body weight(W) and log carapace length (L) was linear and can be described as

$$\text{Log } W = -2.4431 + 2.2120 \text{ Log } L \text{ (males)}$$

$$\text{or } W = 0.006137 L^{2.2120}$$

$$\text{Log } W = -3.8355 + 2.8464 \text{ Log } L \text{ (females)}$$

$$\text{or } W = 0.006137 L^{2.2120}$$

The body weight of males was higher than females at lower size groups but females became heavier at larger sizes. The length weight curve (Fig. 3) of females crosses the curve of males at

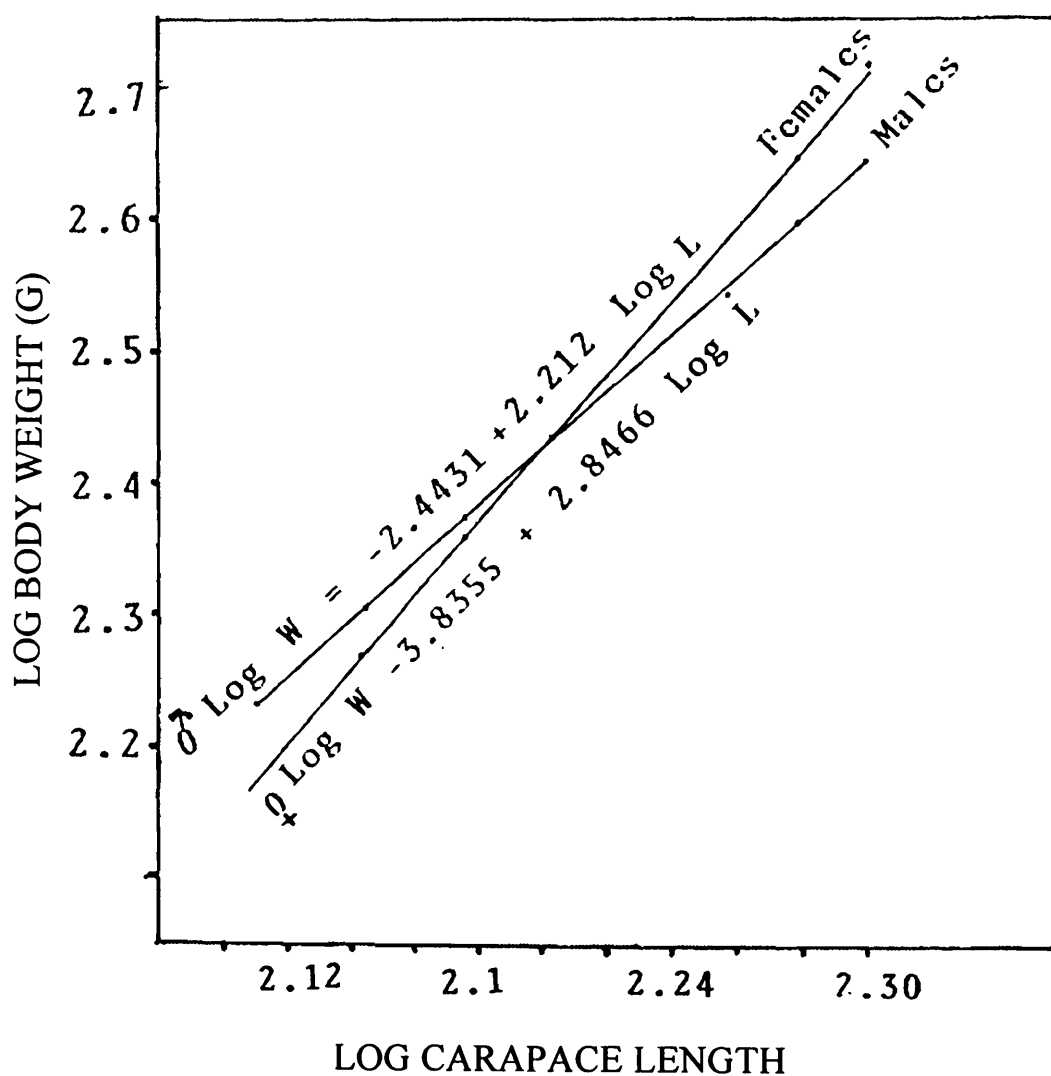


Fig. 3. Length-Weight Relationships of *C. rotundicauda*

155 mm size group. The value of regression coefficient was also higher in females. However, the analysis of variance (ANOVA) revealed insignificant differences between the two sexes (Tables 3a and 3b) and therefore a combined relationship was worked out.

$$\text{Log } W = -3.138 + 2.5929 \text{ Log } L$$

$$\text{or } W = 0.000727 L^{2.5929}$$

Table 3a. Regression data of LW relationship of *C. rotundicauda*.

Sex	N	D.F.	Sum of square and product			b	Error of estimates	
			SX ²	Sxy ²	Y ²		D.F.	S.S.
Male	80	79	0.28	0.6193	1.419	2.212	78	0.492
Females	120	119	0.42	1.1955	3.372	2.846	118	0.0309

Table 3b. Test of Significance.

Sources of variation	D.F.	Sum of squares	Mean squares	Observed	5% F
Davation from individual regression with sex	196	0.801	0.0004	124.97	254.3
Differences between regression	1	0.59	0.5099		
Davation from total	197	0.59			

Food and Feeding habits

(i) Food composition

The food of the species consisted chiefly by gastropods, bivalves, polychaetes and decayed organic matter. These four categories comprised nearly 80% of the diet (Table 4, Fig 4). Decayed organic matter, consisting mainly of plant substance, constituted by far the most abundant food item and its share in the diet varied between 15.8 and 38.3%. This was followed by bivalves (mean 20.7%) and gastropods (mean 19.0%). Polychaetes also contributed significantly (16.4%). The category "other animal groups", which was constituted by several benthic macroinvertebrates like Actinaria, Nemartea, Sipuncula, Echiura, Asteroidea, Ophiuroidea and other unidentified groups, contributed very little. The remaining categories were of little importance and their occurrence appeared to be accidental, particularly nematodes which were dominant component of meiofauna. Mud was an integral component of the diet which was probably ingested along with prey animals.

Marked variations in seasonal composition of the diet were recorded. During POM-I and II and also in PRM-I, molluscs (both gastropods and bivalves) were the chief food. Decayed organic matter contribution was highest during monsoon months. During premonsoon, the contribution of polychaetes was maximum.

Table 4. Seasonal variations in the food composition of (%) *C. rotundicauda*.

	PRM-I	PRM-II	MON-I	MON-II	POM-I	POM-II	Annual Mean
Nematoda	1.7	1.6	2	1.9	2.1	1.6	1.8
Bivalvia	17.5	19.5	15.5	14.5	27.7	29.5	20.7
Gastropoda	27.8	13.5	14.4	15.8	19.2	23.4	19
Polychaeta	23.3	20.8	11.5	14.6	15.5	12.8	16.4
Copepoda	3.3	3	2.5	2	2.3	2.5	2.6
Brachyura	1.6	2.4	2	1.8	2	1.8	1.9
Other Crustacea	0.8	3.7	4.6	4	4.3	3	3.4
Other animals	2	7.1	8.8	4.1	7.5	5	5.8
Decayed organic matter	19.9	25.6	34.5	38.3	15.8	17.6	25.3
Mud	2.1	2.8	4.2	3	3.6	4.8	3.3

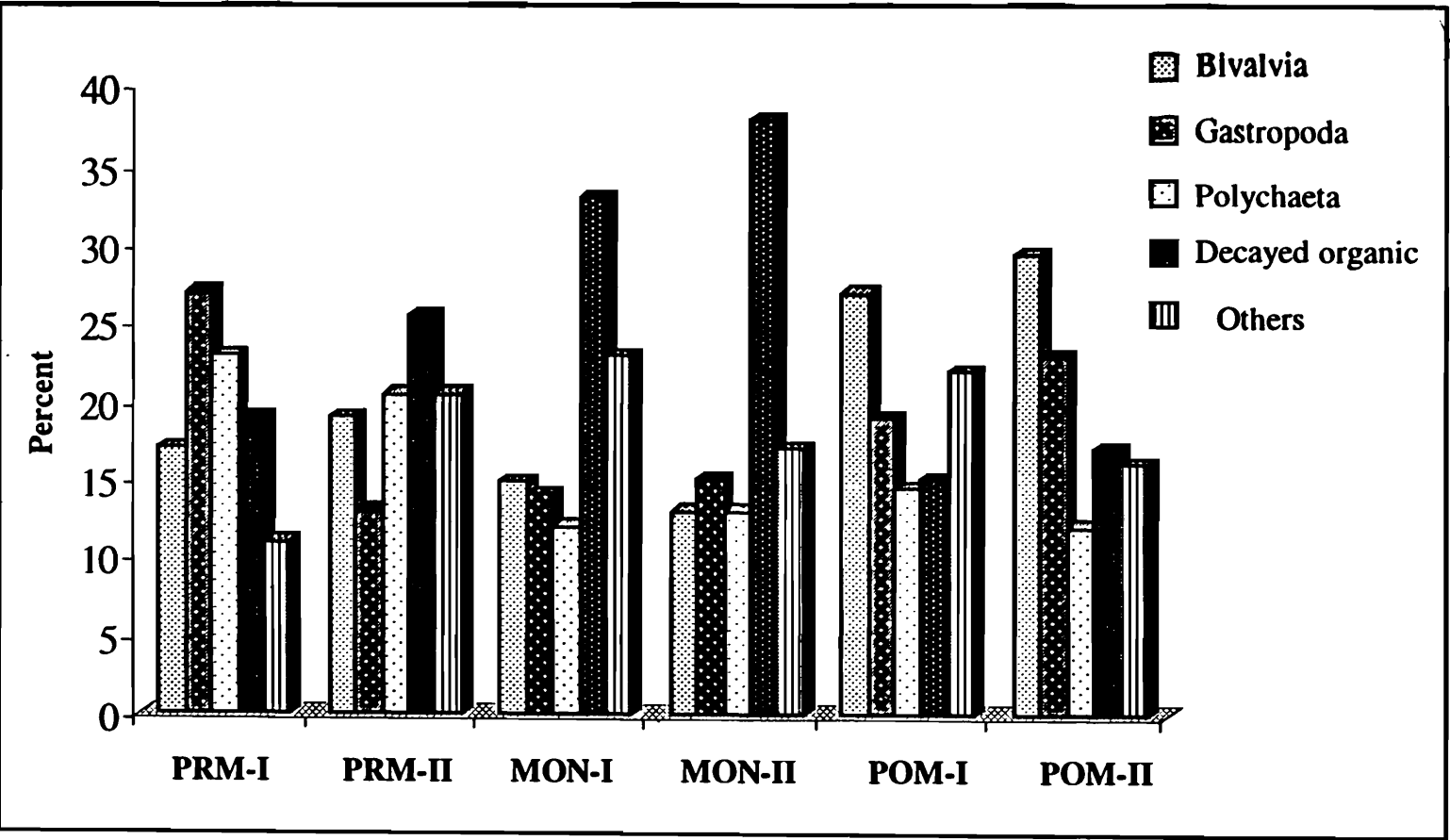


Fig. 4. Seasonal variations in the relative food composition of *C. rotundicauda*.

(ii) Intensity of feeding

Feeding intensity of the individuals studied was not overall good, as percentages of empty guts, guts with traces or $\frac{1}{4}$ full were high. While gorged guts were never observed, full and $\frac{3}{4}$ full guts were observed in small numbers during premonsoon and post monsoon months. The percentage of empty guts were highest during monsoon period, both in early and late part (Fig 5). The feeding intensity categorized as active, moderate and poor (Fig. 6) revealed that the ratio of actively fed individuals was highest in premonsoon which was followed by a sharp drop during monsoon. The highest ratio of poorly fed individuals was observed in monsoon-I. Thereafter conditions improved moderately during postmonsoon.

(iii) Food selection

Definite and strong food selectivity was noticed (Fig. 7). The animals fed on certain items vigorously and avoided some others equally, inspite of latter's abundance in the environment. The index of electivity revealed that out of 9 major categories for which comparable quantitative data were available, only three groups viz. bivalves (+0.619), polychaetes (+0.255) and gastropods (+0.221) were preferred with positive electivity indices. Rest of the categories were avoided, some very strongly, like nematodes (-0.620).

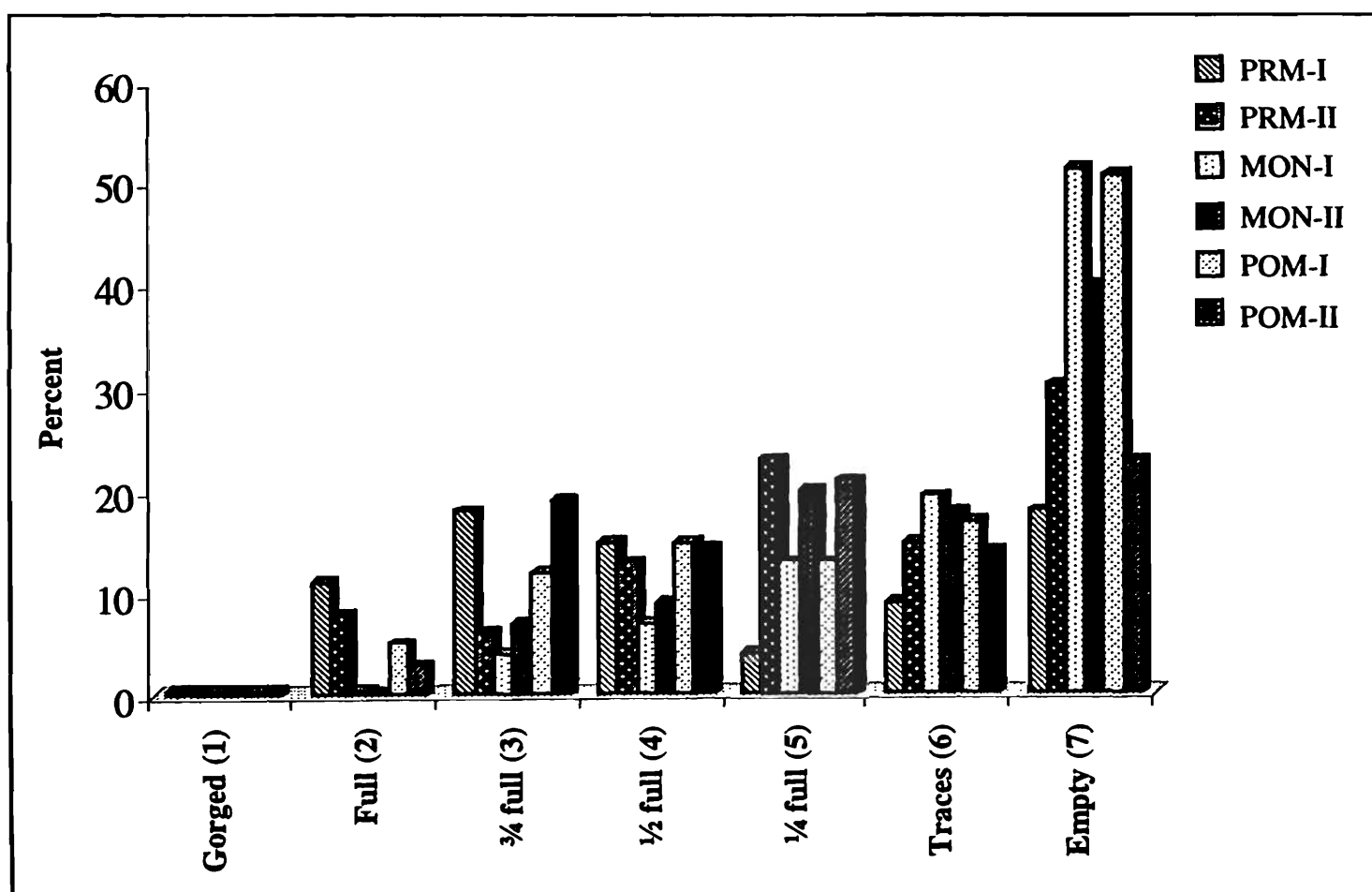


Fig. 5. Seasonal variations in the relative fullness of the guts of *C. rotundicauda*.

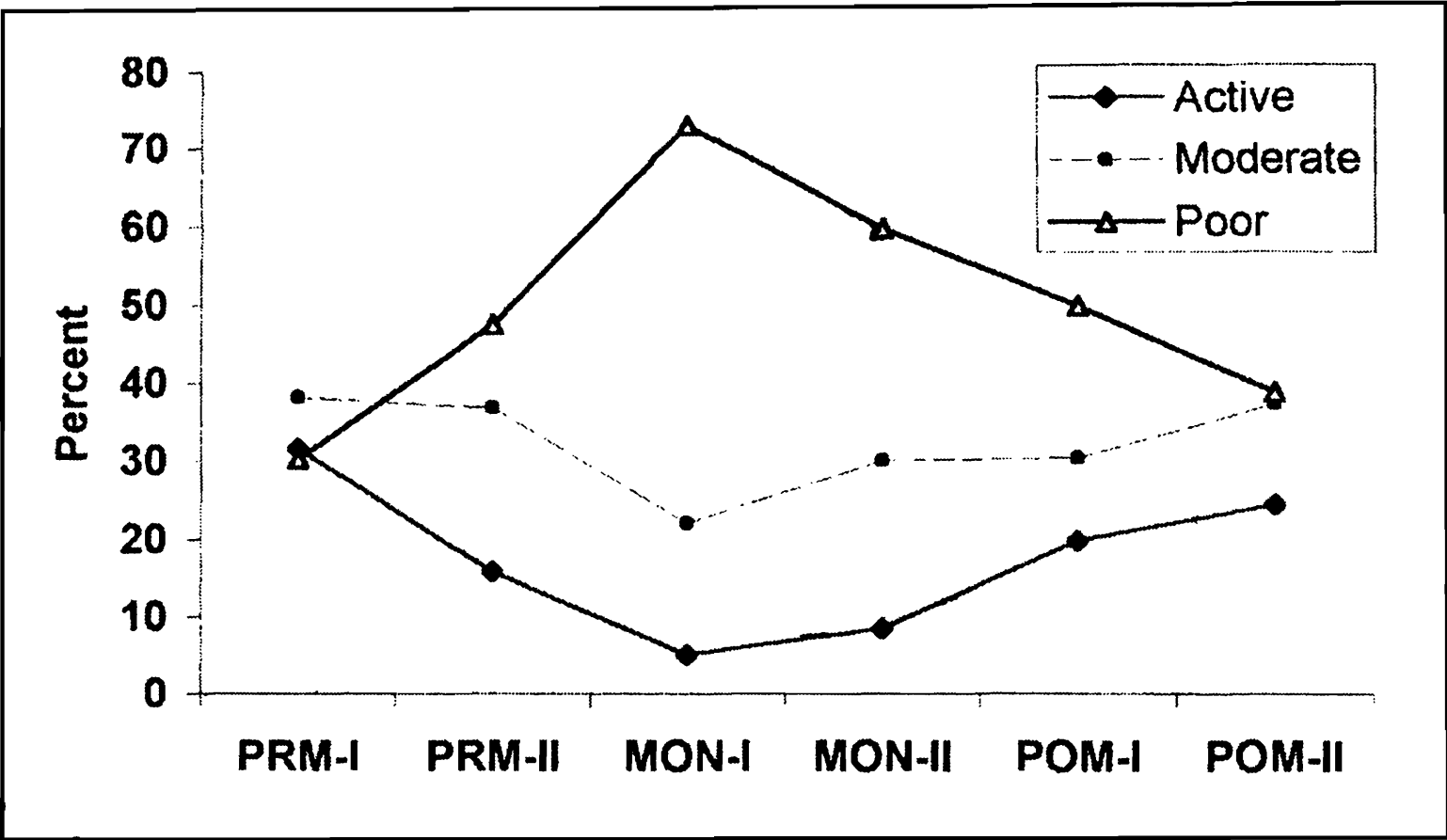


Fig. 6. Seasonal variations in the intensity of feeding of *C. rotundicauda*.

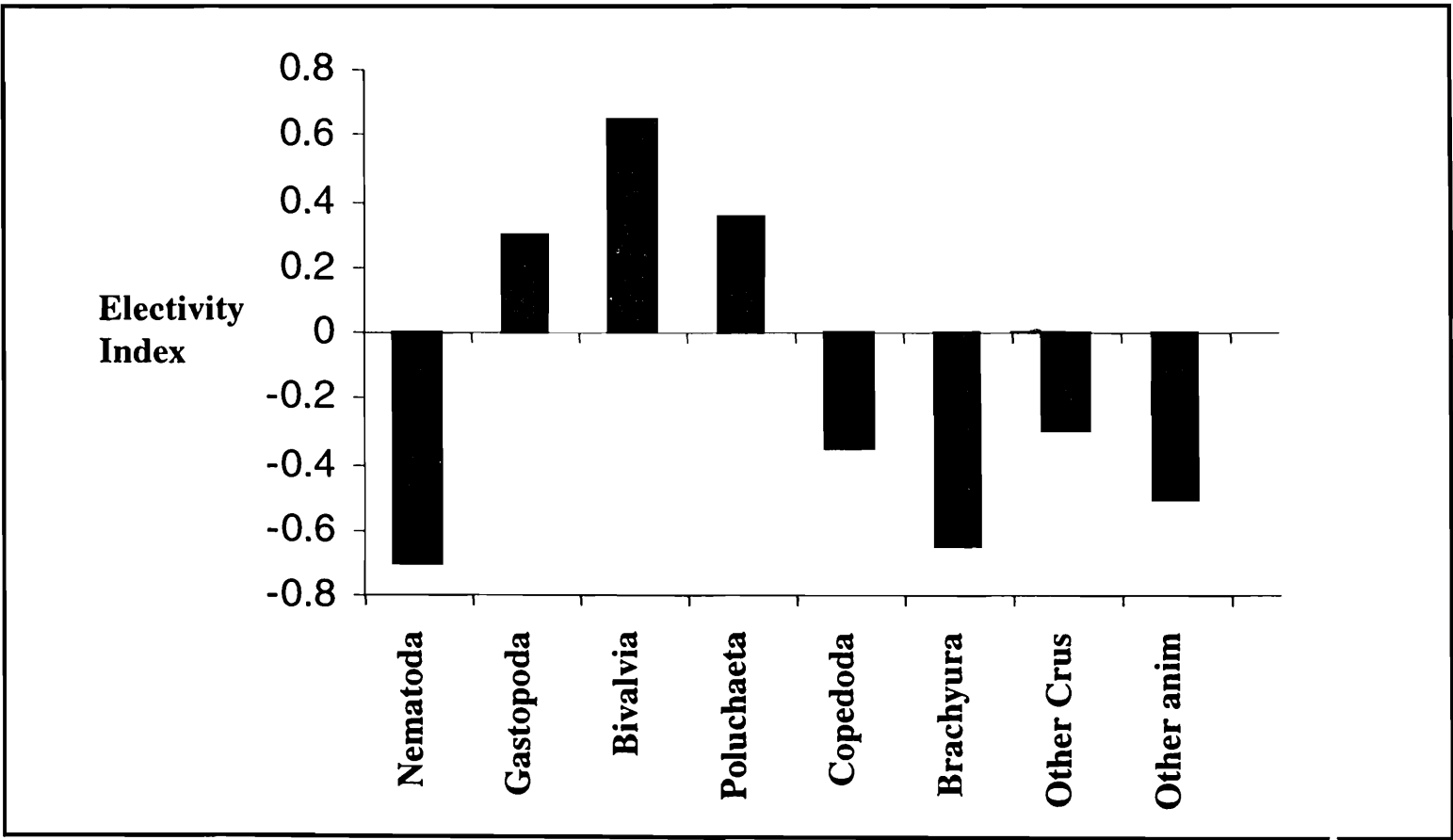


Fig. 7. Food selection in *C. rotundicauda*.

Reproduction

(i) Spawning behaviour

Animals occurred most of the time in spawning couples on mud flats during low tide of full moon period. With gradually receding water marks during low tides, animals were seen slowly coming out of water and crawling on soft mud. While crawling, the animals exhibited a peculiar behaviour. The females were moving while males comfortably positioned themselves on the top of females. They were attached to the prosoma of females completely. After reaching to a site, above mid tidal level, where the mud was not hard and retained some amount of water, the pair stopped. During courtship, males were either on top of female or besides female, sometimes upside down. Females were also seen lying sometimes upside down along with the males. Several turnings from ventral to dorsal and vice versa were noticed. After approximately 1½ or two hours, females started digging the soft mud for nests. Since the soil was soft, it took very little time to make a depression of just about her size in and 12-15 cm deep. The depth was such that after settling of females and males on her top, the entire depression was filled up and only top of the carapace of males was slightly visible from above. With the result, it was difficult to locate the spawning couples in the nest on mud flats. The animals remained in this condition till the next flooding during high tide. No animal was seen at the place of nesting after high tide receded which indicates their return to open waters.

Some females were lifted from the nests just before the flooding in order to examine the eggs laid. Eggs were not found in all the nests. Out of 7 nests examined at Station-1, six contained the eggs and at Station-2, the eggs were present only in three out of 5 nests examined. Eggs were taken out with the help of a spoon and roughly counted after putting little water. After examination, the eggs and females were placed at their original position with minimal disturbance. The number of eggs laid ranged between 20-72 and measured between 1.25-1.50 mm. The non-occurrence of eggs in some nests indicated unsuccessful spawning. After high tide was over, no trace of eggs were found at the place where the nests were made. The fate of eggs could not be followed after the second tide. Because of the soft mud, the nests were also disappeared /distorted after flooding.

(ii) Spanning period

The spawning season was determined on the basis of the occurrence of adult males and females on mudflats involved in courtship. The frequency of occurrence of spawning couples in term of percentage of the total population during different seasons is given in Fig. 8. During premonsoon-I, all observed pairs at both stations were found involved in courtship. During next season also the ratio of spawning couples to total population was moderately high, but after that, both number of individuals and pairs involved in courtship were low.

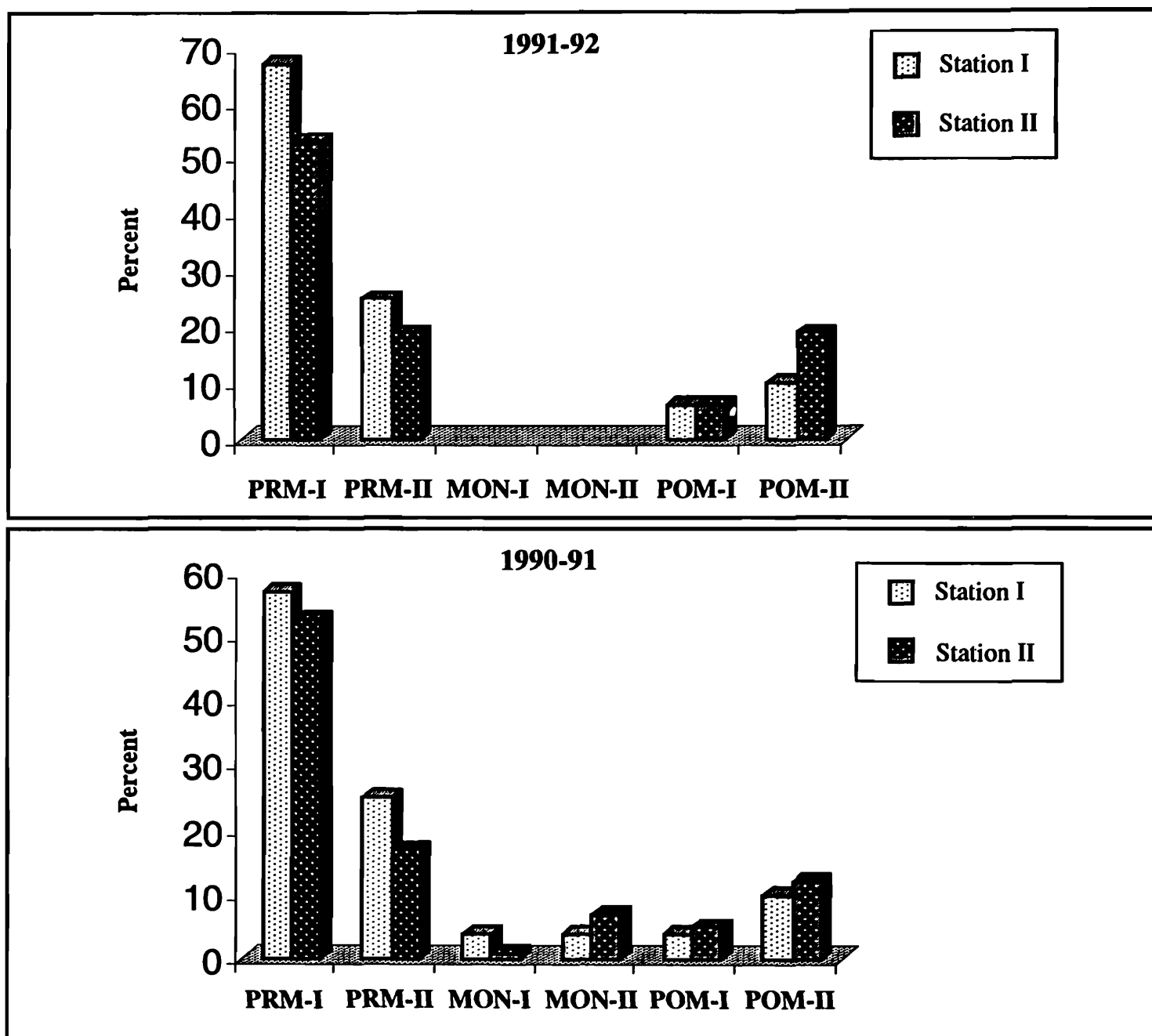


Fig. 8. Frequency of occurrence (percent) of spawning couple of *C. rotundicauda* during different months.

Occurrence of juveniles

During the period of study, juveniles were not seen on mudflats except at site -6, Kishori Mohanpur. The island gets totally submerged during high tides. It indicates the occurrence of juveniles in nearby waters but these generally do not come out of water. The occurrence of juveniles in the fishermen's nest also confirms this conclusion.

(iii) Fecundity

The fecundity of 120 specimens in the size range of 151 to 190 mm, varied between 3540 and 13490 eggs with a mean of 7942.5. The fecundity increased with increasing length and body weight. A significant relationship was observed between log-fecundity and log-body weight.

DISCUSSION

The occurrence and abundance of *C. rotundicauda* on mudflats of Sunderban were highly restricted as the species was recorded from only few specific locations, out of vast area covered under the region. The occurrence of other species of horse-shoe crabs on mud and sand flats at specific places and absence from several other places in the same region/area has also been reported by several earlier workers. Botton *et. al.* (1988) observed the occurrence of *L. polyphemus* in large numbers along the coasts of Delaware but its almost total absence from north beach, just a kilometer away and indicated the existence of very specific reasons for selecting a particular beach. This has been generally assigned to their inherent capabilities of distinguishing between suitable and unsuitable beaches/flats as the ground is to be used for a highly specific purpose of breeding. This innate mechanism of area selection ensures the animals for the survival of their young ones on mud flats. It has been suggested that such characteristics might be responsible for providing evolutionary advantages to the animals for their very long survival.

However, contrary to other species of the group, which occur in great abundance in the areas/beaches of their occurrence, both in this country and other region of the world, the population density of *C. rotundicauda* in Sunderban region was extremely low, which was evident from very poor and almost rare occurrence as compared to vast area covered. Except during peak spawning season of early premonsoon (PRM-1), the number of individuals per transect, hardly exceeded 10 during full moon phase. In case of the other species occurring in Indian region, *T. gigus*, Chatterji *et. al.* (1992) reported the existence of a very dense population on sandy beaches of Balramgarhi, Orissa (Bay of Bengal), both during full moon and new moon. Since, *C. rotundicauda* occurs only in this area of the country, their extremely low population density is of great concern. Earlier reports (Annandale, 1909, Roonwal, 1944) indicate the occurrence of species even in River Hugly upto 60 Km upwards. This definitely indicates that the population density of the species has considerably gone down during last 50 years. The factors responsible for their decline are probably the exploitation of the animals by local people for their use in faith healing, besides the changing conditions of estuarine water and soil of mudflat due to degradation of main feeder river Hugly. As already indicated these animals are highly sensitive and select the beaches/flats for spawning with great degree of precession. The other factor which appears to contribute somewhat to their decline may be the wanton destruction by fishermen when caught in their nets, because of the damage they cause to their nets.

Though not very strictly, like other aquatic animals, the length-weight relationship of *C. rotundicauda* followed the cube law roughly as the weight of the body grew at an approximate rate of cube of length, at least in some stages of the life. The value of 'n' in LW curve (2.846 in females) was very close to theoretical 3. Although the analysis of variance did not show any significant differences in LW relationships of males and females, males were slightly heavier at lower size/age groups but reverse was the case in higher size or age group individuals. Curves of

both males and females crossed at a point near 160 mm carapace length and this point of intersect in LW relationship generally signifies the onset of maturity in animals (Olsen and Merriman, 1946 in case of fish). It may be assumed that *C. rotundicauda* matures around this size range. However, as remarked by Chatterji *et. al.* (1988), in case of both, *T. gigus* and *C. rotundicauda*, it may not be safe to conclude definitely in the absence of smaller sized individuals in sufficient numbers.

Like many of the species of horse-shoe crabs, the molluscs (both gastropods and bivalves) alongwith decayed organic matter and polychaetes constituted the main food of *C. rotundicauda*. Botton (1984a) and Botton and Rope (1989) found that nearly 87% of the total diet of *L. polyphemus* was constituted by molluscs. Among the Indian species, *T. gigus*, Chatterji *et. al.* (1992b) also reported similar food composition, where molluscs and decayed organic matter contributed more than 50% of the diet. However, there were significant differences in the dietary composition of the two species. While molluscs, both gastropods and bivalves, constituted nearly 40% of the diet of *C. rotundicauda*, their share in the diet of *T. gigus* was only 25%. The contribution of arthropods, comprising mainly crustaceans and few insects was higher in *T. gigus* as compared to other species. The consistent occurrence of decayed organic matter comprising mainly of vegetative matters in considerably high quantities, revealed that the species fed actively upon detritus, besides animal matters. Both, *L. polyphemus* (Botton, 1984a) and *T. gigus* (Chatterji *et. al.*, 1992b) also subsisted heavily on vascular plants and detritus. The other food items were of almost no significance and their occurrence in the gut might be due to chance rather than intentional feeding. It appears that while both species feed on similar type of food, the relative share of different groups vary considerably. Probably this was an adaptation to avoid competition for food in the areas where the two species exist together. The occurrence of certain food items in insignificant quantities and others in considerably high quantities as compared to their availability in the environment exhibited the definite food selectivity of the species. Out of nine major categories, the electivity indices were positive for only gastropods, bivalves and polychaetes. Of these, the electivity indices of bivalves were very high. The occurrence of bivalves in Sunderban region is highly patchy and their overall relative density in macrobenthic composition was only 6.5%. It is quite evident that the horse-shoe crabs have to make tremendous efforts in search of this food item. Contrary to this, the electivity indices for other preferred food like gastropod (0.211) and polychaetes (0.255) were considerably lower than bivalves which indicated that these items were opted for only due to non-availability of bivalves in sufficient numbers. It was also noted that the most abundant component of meiobenthos, the nematodes and copepods were almost completely avoided by the species.

The choice of a particular species or set of species as food from the preferred category depends upon a number of factors of which the prey size is very important. The species fed all types of bivalves, provided their sizes were within its reach. Species with large shells like *Crossostrea*, *Saccostrea* and *Placuna* etc. were not found in the gut. Instead, small form like *Meretrix meretrix*, *Anadora granulosa*, *Solen brevis* etc. were of common occurrence. Similarly in case of gastropods, smaller individuals like those of *Assimina*, *Cerithidia* and *Ellobium* were found in the gut.

The preference of bivalves to such a degree, signifies their ability to meet the dietary requirements of *C. rotundicauda* to the maximum, because selection in aquatic organisms can only be expected, as pointed out earlier (Khan and Siddiqui, 1973), if energy lost due to not utilising certain food resources is negligible in comparison to that gained by selection. Thus a predator will feed in a manner to get maximum reward of energy expended (MacArthur and Levins, 1964). The other species of horse-shoe crabs from different parts of the world have also been reported to be selective in their feeding habits. Among preferred category of food items, species specificity has also been observed. Botton (1984a) reported that *L. polyphemus* selected certain species of bivalves and at the same time avoided the other species which was most abundant in the environment. Similarly *T. gigus* (Chatterji *et. al.*, 1992b) preferred *Perna* sp. amongst bivalves.

The breeding activities of *C. rotundicauda* was almost similar to other species of horse-shoe crabs. As reported for *L. polyphemus* (Rudloe, 1980, 1985; Howard *et. al.*, 1984 and Cohen and Brockmann, 1983) and for *T. gigus* (Chatterji *et. al.*, 1992a), the spawning activity of *C. rotundicauda* was also found to be governed by lunar cycle, as maximum number of spawning couples were seen on the day of full moon. In all species of horse-shoe crabs, definite migration takes place from sea and estuaries to shores for spawning activity and *C. rotundicauda* was no exception. However, differences in specific patterns were visible in different species. Mating in *L. polyphemus* was recorded during high tides as against *C. rotundicauda* where it took place during low tides with sufficiently exposed mud flats. Further, spawning in the latter took place during daylight as against the observation of certain authors in case of *L. polyphemus*, which was found to spawn during night (Cavanaugh, 1975). *T. gigus* was also found to spawn during day time. The spawning season of horse-shoe crabs has been reported to vary from region to region and species to species (Sekiguchi and Nakamura, 1979, Rudloe, 1980). *T. gigus* on Balramgarhi coasts was found to breed throughout the year. Mating couples of *C. rotundicauda* were mainly seen during premonsoon-I season which extended to premonsoon-II season. During rest of the period the activity was minimum, indicating the restricted spawning season. Since no other period of increased activity was noticed, it can be concluded that the species on Sunderban mud flats spawns only once in a year during premonsoon period. Contrary to this, Sekiguchi and Nakamura (1979) observed the breeding activity of this species on muddy sides of river beds in Gulf of Siam and Thailand throughout the year.

The selection of nesting sites by horse-shoe crabs is not well understood and it could also not be assessed during the present investigations. It was not clear which factor stimulated the animals to select one point and reject the other, when there were no apparent differences in the physico-chemical and biological nature of water or soil of mud flats in lower Sunderban region (Khan, 1995). Botton *et. al.* (1988) observed that animals detect the beach characteristics on the rising tides and avoid migration towards unsuitable beaches. Chatterji *et. al.* (1992a) related the migration and spawning activities to general sediment characteristics (grain size) in case of *T. gigus*. Many earlier workers have already pointed out the importance of this factor (Williams 1987, Botton and Haskin 1984). Further studies are required in case of *C. rotundicauda* on such lines.

The fecundity and clutch size of horse-shoe crabs differed widely between the species and within species between individuals, depending upon various environmental and biological factors. Novitsky (1984) found that *L. polyphemus* laid about 80,000 eggs in different nests with each nest having approximately 300 eggs. In case of *T. gigus*, Chatterji and Parulekar (1992) reported that total number of ova varied between 1242 and 6565 with a mean of 3748 and there was significant relationship of fecundity with carapace length and body weight. In case of *C. rotundicauda*, these authors reported the range of fecundity as 4217 to 10,982 with a mean of 7438. The fecundity of the species observed during present investigations varied between 3540 and 13490 with a mean of 7942, which was very close to those observed by Chatterji and Parulekar (1992).

SUMMARY

(1) Out of four extant species of horseshoe crabs, one species, *Carcinoscorpius rotundicauda* (Laterille) occur only in Sunderban estuarine region and adjoining coastal waters of Bay of Bengal in Indian region. The occurrence, abundance, seasonal variation, length-weight relationship, food and feeding habits and reproduction of the species were studied on mud flats of the estuarine system between the period 1988-92.

(2) In the vast area of estuarine mud flats surveyed, the species occurred only at few specific sites and that too in small numbers. Out of 40 randomly selected sites, the species was recorded, one time or other, at 14 sites and only at 3 sites it occurred regularly in all seasons.

(3) Detailed studies on their occurrence and abundance were carried out at two study stations for two years, 1990-1991 and 1991-1992. Maximum density was noticed during early premonsoon (March-April), followed by late premonsoon (May-June). During other seasons its abundance was very low. Most of the individuals observed on mud flats were adult pairs. Juveniles were not recorded from these study stations.

(4) Although length-weight relationship of the two sexes did not differ significantly, males were found to be slightly heavier than females at early size groups and reverse was the case at higher size groups.

(5) The food of the species mainly consisted of bivalves, gastropods, polychaetes and decayed organic matter. The intensity of feeding was not generally good except during late post monsoon and early premonsoon seasons. Species was found to feed selectively as electivity indices were considerably higher for certain categories of food items like bivalves, gastropods and polychetes. All other categories were avoided as exhibited by negative indices.

(6) Spawning season of the species was generally confined to early premonsoon season or at the most extending to late premonsoon. Spawning couples migrated to shores, specially during daylight of full moon period, with females carrying the males on their top. After courtship females dug nests, approximately 12-15 cm deep and laid eggs and males fertilized. The entire activity was

completed before the onset of next high tide. Neither adults nor their eggs could be traced during following low tides. The fecundity of the species as determined by the examination of specimen in laboratory varied between 3450 and 13490 with a mean of 7942.

ACKNOWLEDGEMENT

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ON THE SCYPHOZOA FROM EAST COAST OF INDIA, INCLUDING ANDAMAN & NICOBAR ISLANDS

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INTRODUCTION

The class scyphozoa includes the larger medusae (Jelly fish), an exclusively marine planktonic group inhabiting estuarine as well as oceanic waters. Because of their relatively weak swimming ability; currents, tides and wind greatly influence their movements and they maintain themselves in water column by the rhythmic pulsation of their bell. Some of them demonstrate sensitivity to light intensity by surfacing during the morning and late afternoons and descending during midday and in darkness, where as the others react just in opposite manner. They also display a remarkable ability to withstand considerable temperature and salinity changes. Their migration (from open sea to estuary) depends upon their physiological needs, mainly for foraging and spawning.

Medusa (juvenile or mid developmental stages of cnidarians) of 125 species and 82 genera under different classes, orders and families have been recorded so far from Indian coast (Haldar and Choudhury, 1995). But uptil recently, there was no complete and detailed information of the scyphozoan medusae from the east coast of India.

The present study and information is based on the survey work (1996–2000) throughout the east coast of India, including Andaman and Nicobar islands and also from the previous works of Sarkar *et. al.* (1999 and 2002), Haldar & Choudhury (1995); Goswami (1992); Kramp (1961); Menon (1930 & 1936); Rao (1931); and Mayer (1910).

STUDY AREA

STUDY AREA	STATE	STUDY AREA	STATE
Kanyakumari	Tamilnadu	Dolphin's nose beach	Andhra Pradesh
Tuticorin	Tamilnadu	Chilka	Orissa
Mandapam	Tamilnadu	Puri	Orissa
Pamban	Tamilnadu	Gahirmatha (Ekakula)	Orissa
Krusadai Island	Tamilnadu	Chandipur	Orissa
Rameswaram	Tamilnadu	Talsari	Orissa
Dhanuskodi	Tamilnadu	Digha	West Bengal
Madras(Chennai)	Tamilnadu	Shankarpur	West Bengal
Vishakpatnam	Andhra Pradesh	Jalda Khoti	West Bengal
Rishikonda & Lawsons Bay	Andhra Pradesh	Rasulpur	West Bengal
Bheemunipatnam	Andhra Pradesh	Andaman Islands	

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MATERIALS & METHODS

Adult and juvenile scyphozoans are mainly obtained from drag nets and shore siene, operated by local fishermen. Medusae are obtained from estuarine waters, from drag nets and also from 'Bagda' nets (a triangular net operated by a single person to collect post larva of tiger prawn at West Bengal and Orissa coast). Majority of the scyphozoans are examined on beach in more or less fresh condition and parts are collected (for examination under zoom binocular microscope). Few of the specimens finally preserved in 5 % formalin solution.

PRESENT STATUS OF SCYPHOZOA

The number of scyphozoa species estimated world over is around 220 under 75 genera and 23 families, of which 35 species under 24 genera and 18 families are estimated after recent survey from the east coast of India and Andaman group of Islands.

CHECKLIST OF SCYPHOZOA

Phylum CNIDARIA

Class SCYPHOZOA

Order A STAUROMEDUSAE

Family I ELEUTHEROCARPIDAE

1. *Lucernariopsis* sp Panikkar.

Order B CUBOMEDUSAE

Family II CARYBDEIDAE

2. *Carybdea alata* Reynaud.

3. *Tamoya gargantua* Haeckel.

Family III CHIROPIDAE

4. *Chiropsalmus buitendijki* Horst.

5. *Chiropsalmus quadrigatus* Haeckel.

6. *Chiropsalmus quadrumanus* (Muller).

Order C CORONATAE

Family IV ATOLLIDAE

7. *Atolla wyvillei* Haeckel.

Family V NAUSITHOIDAE

8. *Nausithoe punctata* Kolliker.

Family VI PERIPHYLLIDAE

9. *Periphylla periphylla* (Peron & Lesueur)

Order D SEMAEOSTOMAE

Family VII PELAGIIDAE

10. *Chrysaora helvola* Brandt.
11. *Chrysaora melanaster* Brandt.
12. *Chrysaora quinquecirrha* (Desor).
13. *Pelagia noctiluca* (Forskal).

Family VIII CYANEIDAE

14. *Cyanea purpurea* Kishinouye.

Family IX ULMARIDAE

Subfamily AURELIINAE

15. *Aurelia aurita* (Linne).
16. *Aurelia solida* Browne.

Order E RHIZOSTOMEAE

Suborder KOLPOPHORAE

Family X CASSIOPEIDAE

17. *Cassiopea andromeda* (Forskal).

Family XI CEPHEIDAE

18. *Cephea* sp. Kramp.
19. *Netrostoma coeruleescens* Maas.
20. *Netrostoma setouchianum* (Kishinouye).
21. *Netrostoma typhlodendrium* Schultz.

Family XII MASTIGIIDAE

- 22. *Mastigias albiguttatus* Stiasny
- 23. *Mastigias papua* (Lesson)
- 24. *Mastigietta palmipes* (Haeckel)

Family XIII VERSURIGIDAE

- 25. *Versuriga anadyomene* (Maas)

Family XIV THYSANOSTOMATIDAE

- 26. *Thysanostoma thysanura* Haeckel.
- 27. *Thysanostoma loriferum* (Ehrenberg).

Suborder DAKTYLIOPHORAE

Family XV LYCHNORHIZIDAE

- 28. *Lychnorhiza malayensis* Stiansy.

Family XVI CATOSTYLIDAE

- 29. *Acromitus flagellatus* (Maas).
- 30. *Acromitus rabanchatu* Annandale.
- 31. *Crambionella annandalei* Rao.
- 32. *Crambionella orsini* (Vanhoffen).

Family XVII LOBONEMATIDAE

- 33. *Lobonema mayeri* Light.
- 34. *Lobonemoides robustus* Stiansy.

Family XVIII RHIZOSTOMATIDAE

- 35. *Rhopilema hispidum* (Vanhoffen)

Order A STAUROMEDUSAE

A group of polyp-like jelly fishes (medusa) developing directly from scyphistoma, consisting of a calyx and a distinct aboral peduncle with an adhesive disc; typically with adradial marginal lobes carrying hollow and terminally knobbed tentacles. Body shape more or less conical (Scyphistomid).

Remarks : These are chiefly found in the colder waters and remain attached with sea weeds, rocks etc. by adhesive disc. No alternation of generation found in their life cycle.

No poisonous effect reported from representatives under this order.

Family I ELEUTHEROCARPIDAE

Stauromedusae with four simple, perradial stomach pouches.

Genus *Lucernariopsis* Uchida, 1929

1815. *Leucernaria* Lamouroux, *Histoire des Polypiers coralligenes flexibles vulgairement nommes zoophytes* : 472.

1910. *Lucernaria* Mayer, *Medusae of the world* : *Scyphomedusae*, III : 510.

1929. *Lucernariopsis* Uchida, *Jap. J. Zool.*, II : 154.

Diagnosis : Well developed marginal lobes, with eight adradial clusters of hollow, terminally knobbed tentacles; peduncle single chambered, or four chambered in lower portion, without muscles; coronal ring muscle discontinuous in each adradius; no perradial and interrarial marginal anchors of papillae.

Distribution : Indian Ocean, Antarctic Sea, Black Sea, North Sea, English Channel, Plymouth, Adriatic Sea.

1. *Lucernariopsis* sp. Panikkar 1944

Remarks Panikkar recorded this species from Krusadai Island (Gulf of Mannar) in 1944 and after that there is no report of this species from Indian coast.

Order B CUBOMEDUSAE

Free swimming medusae; umbrella margin not cleft into lappets, with four interrarial tentacles or bunch of tentacles situated on gelatinous wing shaped structures, called pedalia; four perradial sense organs situated on the sides of the bell; four wide perradial sacs extending outwards from the central stomach into the subumbrellar cavity, incompletely separated by interrarial septa; four pairs of leaf shaped gonads attached along the inter radial septa and extending into the gastrovascular cavity; opening of the bell cavity partially closed by an annular diaphragm called velarium.

Remarks Scyphozoa under this order are commonly known as 'Box-Jellyfish' due to their cuboidal shape of the bell with four flattened sides. They are strong swimmers and active predators, feeding mainly on small fish. Some of the members have powerful stings which causes weals on the skin and sometimes excruciating pain of the bathers, which may last for 10–12 hours.

These are generally found in open waters of warm seas and migrate in shallow water for spawning. There is no alternation of generation in their life cycle.

Family II CARYBDEIDAE

Cubomedusae with four simple or tripartite interradial tentacles; four stomach pouches without diverticula.

Genus *Carybdea* Peron & Lesueur 1809

1809. *Carybdea* Peron & Lesueur. *Ann. Mus, Hist. nat.*, XIV : 332

1880. *Charybdea* Haeckel, *Sysem der Acraspeden* : 439

1910. *Carybdea* Mayer, *Medusae of the World : Scyphomedusae*, III : 506.

Diagnosis Four simple pedalia; stomach flat; without mesenteries; gastric cirri forming brush-like bundles at the interradial corners of the stomach.

2. *Carybdea alata* Reynaud 1830

1830. *Carybdea alata* Reynaud, *Lessons Centurie Zoologique* : 95, p.33, fig. 1.

1961. *Carybdea alata* : Kramp, *J. mar. biol. Ass. U.K.*, **40** : 304.

Diagnosis : 60–80 mm in height, 50 mm or more wide; ex-umbrella without warts; sensory niches enclosed by a pair of covering scales below and by one above; gastric filaments in crescentic areas extending horizontally at the corner of the stomach; tentacles simple in structure.

Distribution : East coast of India : Madras, Tamilnadu (Menon, 1930).

Elsewhere : Southern Atlantic, West Indies, South Africa, West Africa, South & Tropical Pacific, Hawaiian Islands, Philippines, Sumatra, Florida, Japan, Ceylon, Bermudas, Red sea, Indo-China, Carribean sea.

Poisonous effect : Commonly known as “Sea-wasp” and have powerful stings, which inflict their strong injurious effects upon bathers by nematocysts (Halstead, 1971).

Remarks The present description is based on Kramp (1961). Menon 1930, recorded this species from Madras as *Charybdea madraspatana* n. sp.

Genus *Tamoya* Muller, 1859

1859. *Tamoya* Muller, *Abh. Naturf. Ges. Halle.*, V (I) : 1-12, 3 pls.

1880. *Tamoya* Haeckel, *System der. Acraspeden* : 442.

1910. *Tamoya* Mayer. *Medusae of the world : Scyphomedusae*, III : 512.

Diagnosis : Four simple pedalia; stomach deep, connected with the sub-umbrella by well developed perradial mesenteries; gastric cirri in bands extending vertically along the walls of the stomach, in the interradii.

Remarks The genus is closely related to *Carybdea*, being distinguished only by its large stomach with its perradial mesenteries and its vertical clusters of gastric cirri.

No poisonous effects reported from the representatives under this genus.

3. *Tamoya gargantua* Haeckel, 1880

1880. *Tamoya gargantua* Haeckel, *System der Acraspeden* : 444.

1931. *Tamoya alata* : Rao, *Rec. Indian Mus.*, **33** : 27.

1961. *Tamoya gargantua* : Kramp., *J. mar. biol. Assn. U.K.*, **40** : 306-307.

Material examined : 1 ex. Rishikonda beach, 24.xii.1998.

Diagnosis : Bell 65 mm in height, 45 mm in diameter; length of tentacle 185–198 mm. Pedalia with a sharp outer and inner edge; pyramidal at the base and flattened near apex. 6–9 much branched canal in the velarium of each quadrant. The sense club have large median eyes with conspicuous lens; no lateral eyes. Velarial canals end in trident like distal branches.

Distribution : East coast of India : Vishakapatnam coast, Andhra Pradesh, (present record); Sand head, West Bengal (Halдар & Choudhury, 1995; Rao, 1931); Puri coast, Orissa (Rao, 1931); Ennur, Tamilnadu (Rao, 1931).

Elsewhere : Mergui Archipelago, Arabian sea, North America; Malay Archipelago; New Southwales, Australia; Iranian Gulf; Japan; Samoa Islands; New Guinea.

Remarks : This is a neretic species. According to Mayer (1910), this is an imperfectly known species. Menon (1930) recorded from Madras coast as *Tamoya* sp.

Family III CHIROPIDAE

Cubomedusae with four interradial clusters of tentacles; four stomach pouches with eight diverticula.

Remarks : *Chironex fleckeri* Southcott is the most venomous (may produce death within 3–8 minutes in human) species among marine invertebrates belongs to this family, distribution of which is reported from North Queensland and Australia (Halstead, 1971).

Genus *Chiropsalmus* L. Agassiz, 1862

1862. *Chiropsalmus* L. Agassiz, *Contr. nat. Hist. U.S.*, IV : 174.

1910. *Chiropsalmus* Mayer, *Medusae of the world : Scyphomedusae*, III : 515.

Diagnosis : Finger shaped unbranched; hernia-like pouches which project from the four perradial stomach pouches into the bell cavity; the free margins of the eight leaf-shaped gonads entire and simple.

4. *Chiropsalmus buitendijki* Horst, 1907

1907. *Chiropsalmus buitendijki* Horst, *Notes Leyden Mus.*, **29**(2) : 101, p.2, fig. 1-6.

1910. *Chiropsalmus buitendijki* Mayer, *Medusae of the World : Scyphomedusae*, III : 515.

Material examined : 1 ex., Marina beach, Chennai, 26.I.2000.

Diagnosis : Bell 62 mm in height and wide; each pedaliu with six fingers and tentacles in a leniar series on the outer side of the main shaft : eight long, simple, finger shaped subumbrellar gastric saccules, nearly at the depth of the bell cavity.

Distribution : East Coast of India : Marina Beach, Chennai, Tamilnadu (Present record; Menon, 1930); Krusadai Island (Menon, 1936).

Elsewhere : Java, Malay Archipelago; Australia.

Remarks : Poisonous effect not known.

5. *Chiropsalmus quadrigatus* Haeckel, 1880

1880. *Chiropsalmus quadrigatus* Haeckel, *Sys. der. Acraspeden* : 447.

1910. *Chiropsalmus quadrigatus* Mayer, *Medusae of the world* : Scyphomedusae III : 516.

Diagnosis : 70–100 mm high, 80–100 mm wide or more; bell dome shaped. Pedaliu with 5–9 fingers and tentacles, irregularly placed; eight gastric saccules laterally flattened and cock's comb-shaped.

Distribution : East coast of India : Krusadai Island, Tamilnadu (Menon, 1936).

Elsewhere : Rangoon; Philippines, Northern Australia.

Poisonous effect : Commonly known as 'Sea wasp' and inflict their painful injurious effects upon bathers by their nematocysts (Halstead, 1971).

Remarks : Present description is based on Kramp (1961).

6. *Chiropsalmus quadrumanus* (Muller 1859)

1859. *Tamoya quadrumanus* Muller, *Abh. Naturf. Ges. Halle.*, 5(1) : 1-11, Pls. 2,3, figs. 28–32.

1862. *Chiropsalmus quadrumanus* L. Agassiz. *Cont. Nat. Hist. U S.*, 4 : 174.

Material examined : 1 ex. Marina beach., Chennai, Tamilnadu., 26.i.2000.

Diagnosis : Bell 69 mm in height, 77 mm wide. Bell more or less dome shaped; each pedaliu with six finger like branches and hand shaped. Each of four gastric saccules gives rise to finger shaped, hernia-like sacs.

Distribution : East coast of India : Marina Beach, Chennai, Tamilnadu (Present record); Ennur, Tamilnadu (Rao, 1931); Puri coast, Orissa (Rao, 1931).

Elsewhere : Elphinstone Islands; Mergui Archipelago; Brazil; North Carolina; East coast of US, Sumatra; Australia; S. Amreica; W. Africa.

Remarks : Poisonous effect not known.

Order C CORONATAE

Free swimming scyphomedusae. Umbrella margin cleft into lappets; with a single mouth opening provided with simple lips; with sense organs (rhopalia) and solid marginal tentacles arising from clefts between the lappets; with a circular, coronal furrow in the exumbrella, and peripheral to this a zone of gelatinous thickenings (pedalia) divided by radiating clefts alternating in position with the tentacles and rhopalia.

Remarks : Members of order coronatae generally occur in deeper colder waters of the ocean. Few species found near the surface of warmer waters. No alternation of generation found in their life cycle.

No poisonous effect is reported from the representatives under this order.

Family IV ATOLLIDAE

Rhopalia or marginal sense organs more than eight, alternate with an equal number of tentacles; marginal lappets twice in number of tentacles.

Genus : *Atolla* Haeckel, 1880 .

1880. *Atolla* Haeckel, *System der Acraspeden* : 488.

1961. *Atolla* Kramp, *J. mar. biol. Assn. U.K.*, **40** : 311.

Diagnosis : Eight adradial gonads and four interradial subgenital ostia; disc quite flat, central part lenticular, circular furrow deep. Rhopalia 20–22 alternating with equal number of tentacles.

7. *Atolla wyvillei* Haeckel, 1880

1880. *Atolla wyvillei* Haeckel, *System der Acraspeden* : 488.

1973. *Atolla wyvillei* Fagetti, *Revista Bio. mar.*, **15**(1) : 48–49.

Diagnosis : Diameter of bell varies from 25–100 mm, according to age group. Central lens varies from 20–70 mm in diameter. 20–29 tentacles alternate with many minute rhopaliar pedalia.

Distribution : East coast of India : Off Krishna delta, Andhra Pradesh. Off Gangetic delta (Rao, 1931); Andaman sea (Rao, 1931).

Elsewhere : Lakshadweep sea (Rao, 1931).

Remarks : This is a deep-sea luminescent medusa. The present description is based on Kramp (1961) and Halder & Choudhury (1995).

Family V NAUSITHOIDAE

Eight rhopalia, eight tentacles and sixteen marginal lappets; no sac-like pouches upon the subumbrella; 16 radiating simple stomach pouches.

Genus *Nausithoe* Kolliker 1853

1853. *Nausithoe* Kolliker, *Zeit. fur. wissen. zool.*, 4 : 323.

Diagnosis : Nausithoidae with eight adradial gonads.

8. *Nausithoe punctata* Kolliker, 1853

1853. *Nausithoe punctata* Kolliker, *Zeit. fur. wissen. zool.*, 4 : 323.

1961. *Nausithoe punctata* : Kramp, *J. mar. biol. Assn., U.K.*, 40 : 316.

Diagnosis : 9-15mm wide, discoidal, central disc thick, without radiating furrow finely punctured; gastric filaments not grouped in clusters; large gonads.

Distribution : East Coast of India : Madras, Tamilnadu (Menon, 1930).

Elsewhere : Trivandram (Travancore) Coast and Calicut, Kerala, India; Mediterranean; Japan; Florida; North Australia; East Coast of USA; Malay Archipelago; Galapagos Island; Naples (Cylon); Gulf of Guinea; Maldive Islands; Singapore; West Africa.

Remarks : This is a surface and shallow water species in warm seas. The present description is based on Kramp (1961) and Menon (1930).

Family VI PERIPHYLLIDAE

Four interradial rhopalia and with 4-28 numbers of tentacles.

Genus *Periphylla* Haeckel, 1880

1880. *Periphylla* Haeckel, *Syst der Acraspeden* : 418.

1910. *Periphylla* Mayer, *Medusae of the world : Scyphomedusae*, III : 543.

Diagnosis : 12 tentacles (4 perradial and 8 adradial); 16 marginal lappets, 8 gonads.

9. *Periphylla periphylla* (Peron & Lesueur, 1809)

1809. *Carybdea periphylla* Peron & Lesueur, *Annu. Mus. Hist. nat.*, 14 : 20.

1880. *Periphylla hyacinthina* Haeckel, *Syst der Acraspeden* : 419, Pl. 24, figs. 11-16.

1961. *Periphylla periphylla* : Kramp, *J. mar. biol. Ass. U.K.*, 40 : 320.

Diagnosis : Upto 200 mm in diameter; usually higher than wide, with a pointed or dome shaped apex; gonads U-shaped.

Colour : Stomach and subumbrella purple or violet.

Distribution : East Coast of India : Bay of Bengal (Rao, 1931).

Elsewhere : Laccadive sea and almost all seas.

Remarks : Bathy-pelagic, majority of them are found in cold waters. Present description is based on Kramp (1961) and Rao (1931).

Order D SEMAEOSTOMEAE

Scyphozoan jelly fish with umbrellar margin cleft into lappets; no coronal furrow and pedalia; hollow marginal tentacles may or may not be present, marginal rhopalia present; single central mouth opening, with four large curtain-like or gelatinous lips; gonads situated in sac-like folds of endodermal wall of the subumbrella.

Remarks : They are mainly found in coastal waters, where they may occur in large wind-drifted aggregation. Number of small fishes and other small animals are found to be trapped in tentacles and mucus of bell.

Some of the members have painful stings. The medusa alternates with scyphistoma.

Family VII PELAGIDAE

Central stomach gives rise to completely separated, unbranched radiating pouches; no ring-canal; tentacles arise from umbrellar margin between the clefts of the lappets; oral arms long, pointed and much folded.

Genus *Chrysaora* Peron & Lesueur, 1809

1809. *Chrysaora* Peron and Lesueur, *Annu. Mus. Hist. nat.*, **14** : 364.

1862. *Dactylometra* L. Agassiz, *Cont. Nat. Hist. U.S.*, **4** : 166.

1961. *Chrysaora* : Kramp, *J. mar. biol. Ass. U.K.*, **4** : 323.

Diagnosis : 32–48 or more simple marginal lappets; 8 marginal sense organs; 3–9 tentacles between each successive pair of marginal sense organs; 16 radial stomach pouches; in the marginal zone 8 rhopalar stomach pouches are much narrower than the 8 tentacular pouches; exumbrella with numerous minute nematocyst warts.

10. *Chrysaora helvola* Brandt, 1838

1838. *Chrysaora (Polybostrycha) helvola* Brandt, *Mem. Acad. Sci. St. Petrb. Sci. Nat.* **6**(2) : 384, Pls 15, figs. 1-4.

1961. *Chrysaora helvola* Kramp : *J. mar. biol. Assn. U.K.*, **40** : 324–325.

Diagnosis : Upto 300 mm wide, hemispherical or flatter; rhopalar stomach pouches oval, in middle portion twice as wide, at the margin half as wide as tentacular pouches; three tentacles in each octant.

Colour : Umbrella yellowish-brown or reddish-yellow or bright orange with about 32 rayed chestnut brown stars on exumbrella.

Distribution : East coast of India : Puri coast, Orissa (Rao, 1931). Madras, Tamilnadu.

Elsewhere : East Africa; China; Japan; Pacific coast of N. America.

Remarks : *Dactylometra quinquecirrha* (Chrysaora stage) recorded by Light (1914, *Philip. J. Sci.*, IX : 198) from Philippine and also reported by Menon (1930) from Madras coast, probably a form of *Chrysaora helvola*. According to Menon (1930), this is a common jelly fish of Madras coast.

The present description is based on Kramp (1961) and Rao (1931).

11. *Chrysaora melanaster* Brandt, 1838

1838. *Chrysaora melanaster* Brandt, *Mem Acad. Scie. St. Peterb. Sci. Nat.*, 6(2) : 385.

1961. *Chrysaora melanaster* : Kramp, *J. Mar. Biol. Ass. U.K.*, 40 : 326–327.

Material examined : 3 exs. Talsari, Orissa.; 3.iii.1997.

Diagnosis : Diameter of the bell 93–122 mm; length of the mouth arms 130–300 mm; marginal lappets are more or less equal in size and shape; septa between stomach pouches straight; rhopalar pouches in middle portion some what broader; at margin considerably narrower than the tentacular pouches; 3–5 tentacles in each octant; 32 radiating reddish–brown streaks on subumbrella and 16 radiating brownish streak on subumbrellar below the septa between stomach pouches.

Colour : Brownish.

Distribution East Coast of India : Talsari, Orissa (Present record); Madras coast, Tamilnadu (Rao, 1931).

Elsewhere Trivandrum, Kerala, India; Japan, Alaska, Philippines, California.

Remarks : Poisonous effects not known.

12. *Chrysaora quinquecirrha* (Desor, 1848)

1848. *Pelagia quinquecirrha* Desor, *Proc. Boston. Soc. Nat. Hist.*, 3 : 76.

1862. *Dactylometra quinquecirrha* L. Agassiz, *Cont. Nat. Hist. U S.*, 4 : 125–166.

1961. *Chrysaora quinquecirrha* : Kramp, *J. Mar. biol. Assn. U.K.*, 40 : 327.

Diagnosis : Upto 250 mm wide; marginal lappets semicircular or tongue-shaped; the lappet-clefts of the primary and secondary tentacles deep, the tertiary mere shallow notches, stomach pouches one of equal in width, septa straight, 2–3 large tentacles in each octant.

Colour : Pale yellowish pink.

Distribution : East Coast of India Puri, Orissa (Kramp, 1958); Madras, Tamilnadu (Gravely, 1941).

Elsewhere : Trivandrum coast, India; Brazil; Florida; Philippines; S. China; Java; Woodshole; Malay Archipelago to Japan; Gulf of Guinea; East coast of U S A; Gulf of Siam; England; West coast of Africa.

Poisonous effects These jelly fishes are commonly known as 'Sea Nettle' and inflict injurious wounds on human by their nematocysts (Halstead, 1971).

Remarks : Present description is based on Kramp (1961).

Genus *Pelagia* Peron & Lesueur, 1809

1809. *Pelagia* Peron & Lesueur, *Ann. Mus. Hist. Nat. Paris.*, **14** : 349.

1961. *Pelagia* : Kramp, *J. mar. biol. Assn., U.K.*, **40** : 328.

Diagnosis : 16 marginal lappets; 8 tentacles alternating with 8 marginal sense organs; with 16 radial stomach pouches, all alike, each terminating in a pair of unbranched canals entering the marginal lappets; exumbrella with numerous nematocysts.

13. *Pelagia noctiluca* (Forskall, 1775)

1775. *Medusa noctiluca* Forskall, *Descriptiones animalium avium amphibiorum, Piscium, insectorum, vermium* : 107, Pl. 31.

1809. *Pelagia noctiluca* Peron & Lesueur, *Ann. Mus. Hist. Nat.*, **14** : 349.

Diagnosis : Bell diameter 90 mm (Rao, 1931); on their outer surface the marginal lappets have an elongate conical thickening in which a prolongation of the gastric cavity is present. The rhopalium is conical and pear shaped and is lodged in a deep niche roofed over by a membranous flap of the umbrella at the base of the rhopalar lappets. The tentacles are transeversly wrinkled and thus have a segmented appearance. They arise from the membranous part of the umbrella between the velar lappets.

Distribution : East Coast of India : Madras, Tamilnadu (Menon, 1930).

Elsewhere : Calicut coast, Trivandrum coast, Kerala, India; Tropical Atlantic; Western Pacific from Malayan Archipelago to Japan; Mediterranean; East Coast of U S A; North-east Madagascar; Philippines; Adriatic sea; Chagos Archipelago; Australia; E. Africa; Burmudas; Arabian sea; New Foundland; Irish coast, Colombia; Bay of Biscay; Belgium; W. Africa; North Sea; England; California; Brazil.

Poisonous effect This species is well known for bioluminescence. The species is commonly known as “Sea Blubber” and inflict their injurious effects on man by their nematocyst apparatus (Halstead, 1971).

Remarks : The present description is based on Rao (1931).

Family VIII CYANEIDAE

Central stomach gives rise to radiating pouches which again give rise to branches; blind canals in the marginal lappets; no ring canal; complexly folded gonads, inter-radial eversion of the wall of the subumbrella; tentacles arising from the subumbrella at some distance from the margin.

Genus *Cyanea* Peron & Lesueur, 1809

1809. *Cyanea* Peron & Lesueur, *Ann. Mus. Hist. Nat. Paris.*, **14** : 363.

1961. *Cyanea* : Kramp, *J. mar. biol. Assn. U.K.*, **40** : 331.

Diagnosis : Rhopalia 8 in number; with 8 adradial clusters of tentacles, each of which contains several rows of tentacles; both radial and circular muscles in the subumbrella.

Remarks : Commonly known as “Sea Blubbers” or “Sea Nettle” and only *Cyanea capillata* is known for their poisonous effect (Halstead, 1971).

14. *Cyanea purpurea* Kishinouye, 1910

1910. *Cyanea purpurea* Kishinouye, *J. Cell. Sci. Tokyo.*, **27** : 18, Pl. 4, fig. 18,19.

1961. *Cyanea purpurea* : Kramp, *J. mar. biol. Assn. U.K.*, **40** : 335.

Material Examined : 1 ex., Digha Coast., 10. i. 96; 1 ex. Ekakula, 2. i. 2000.

Diagnosis : 230–265 mm wide; rhopalar & tentacular stomach pouches completely separated; peripheral canals with numerous anastomoses.

Colour : Violet with reddish mouth arm.

Distribution East Coast of India : Digha coast, West Bengal & Ekakula, Orissa (Present record); Madras, Tamilnadu (Menon, 1930).

Elsewhere : Trivandrum, Kerala, India; Japan.

Remarks : Menon (1930) refers the specimen from the Madras coast doubtfully to the *Cyanea purpurea* Kishinouye.

Family IX ULMARIDAE

Simple or branched radial canals and a ring canal; subgenital pits may or may not be present. No poisonous effect is reported from the members of this family.

Subfamily AURELIINAE

Tentacles and lappets arise from the sides of the exumbrella above the margin, gonads invaginated with subgenital pits.

Genus *Aurelia* Peron & Lesueur, 1809

1809. *Aurelia* Peron & Lesueur, *Ann. Mus. Hist. Nat.*, **19** : 357.

1922. *Aurelia* Stiasny, *Vidensk Medd. Dansk naturf. Foren. Kbh.*, **73** : 522.

Diagnosis : 4 unbranched mouth arms; margin of the bell divided into 8 or 16 broad velar lobes; radial canals gives rise to anastomosing branches.

15. *Aurelia aurita* (Linne, 1758)

1758. *Medusa aurita* Linne, *Systema nature*, Ed. 10, *reformata*, **2** : 660.

1816. *Aurelia aurita* Lamarck, *Histoire naturelle des animaux sans vertebres* **2** : 573.

1961. *Aurelia aurita* : Kramp, *J. mar. bio. Assn. U.K.*, **40** : 337.

Diagnosis : Bell diameter 75–122 mm, thickness 7–20 mm, length of mouth arm 30–55 mm (Rao, 1931); 8 broad and simple marginal lappets; mouth arm as long as radius of the disc. Bell stiff, with densely crenulated margins and numerous small tentacles; rhopalar and adradial canals unbranched.

Colour : Light reddish purple. According to Mayer (1910) colour variable : almost colourless–violet–rose red.

Distribution : East Coast of India : Andaman Islands, Indian Ocean (Rao, 1931).

Elsewhere : East coast of U S A; N. Atlantic; Gulf of Iran; North-West Pacific; Philippines; Venezuela; Baltic sea; Japan; Norway; British coast; Gulf of Korea; Netherlands; West coast of Sweeden; Denmark; Bermudas; Canada; Scotland; Gulf of Finland; English Channel; W. Africa; Singapore; S. Australia; Red Sea.

Remarks : The present description is based on Kramp (1961).

16. *Aurelia solida* Browne 1905

1905. *Aurelia solida* Browne, *Fauna & Geogr. Maldive & Laccadive Aarchipelago*, **2** : 960–962. Pl. XCIV.

1910. *Aurelia solida* : Mayer, *Medusae of the world : Scyphomedusae*, III : 627–628.

Diagnosis : Diameter of the bell 80–105 mm, thickness 20–25 mm, length of the mouth arm 40–45 mm (Rao, 1931); jelly solid, hemispherical; 8 simple marginal lobes; canals slender and anastomosing; mouth arm thin; ostia large; each marginal sense club arises from the inner end of a very deep grove and points upward towards the exumbrella.

Colour : Translucent.

Distribution : East Coast of India : Madras, Tamilnadu (Gravely, 1941; Menon, 1930).

Elsewhere : Trivandrum, Kerala, India; Maldiv Islands; South of the Azores; West of Africa.

Remarks : The present description is based Kramp (1961).

Order E RHIZOSTOMEAE

Scyphozoan medusae with umbrella margin cleft into lappets; marginal tentacles absent; no central mouth opening, but with numerous mouth openings upon 8 adradial, fleshy, branched appendages arising from the centre of the subumbrella; rhopalia present between marginal clefts.

Remarks : Members under this order commonly found in shallow warmer waters but a few species occur in temperate sea. These are known to alternate with scyphistoma.

Suborder KOLPOPHORAE

Moutharms dichotomous and triangular or three winged. A net work of anastomosing canals communicate with central gastro-vascular cavity in several places between the radial canals. Rhopalar pits smooth, no radial folds. Subgenital ostia without papillae.

Family CASSIOPEIDAE

Subumbrellar muscles in feather-like arcs. Radial canals usually about twice as many as rhopalia. Ring canal may or may not be present. 4 completely separated sub-genital cavities. Sub genital ostia small and round. Stomach circular. Arm disc octagonal, with four primary canals.

Remarks : No Poisonous effect is reported from the representatives under this family.

Genus *Cassiopea* Peron & Lesueur, 1809

1809. *Cassiopea* Peron & Lesueur, *Ann. Mus. Hist. nat.*, **14** : 356.

1961. *Cassiopea* : Kramp, *J. mar. biol. Assn. U.K.*, **40** : 348.

Diagnosis Mouth arms 8, irregularly branched, with ventral mouth openings. Ring Canal may or may not be present; rhopalar and interrhopalar canals 16 or more.

17. *Cassiopea andromeda* (Forskal, 1775)

1775. *Medusa andromeda* Forskal, *Descriptiones animalium, avium, amphibiorum, piscium, insectorum, vermium.*, 107, Pl. 31.

1829. *Cassiopea andromeda* Eschscholtz, *System der Acalephen* : 43.

1977. *Cassiopea andromeda* : Neumann, *Wilhelm Roux Arch. dev. Biol.*, **183**(1) : 79-83.

Material examined : 1 ex., Jalda khoti, 3.II.1997.

Diagnosis : Bell diameter 80 mm, flat, shield shaped, length of the mouth arm 28 mm, wide and Flat; tree like branches in each arm. Numerous club shaped small and 6 large vesicles present on each arm between the mouth openings.

Distribution : *East Coast of India* Jalda khoti, Midnapur district, West Bengal (present record); Sand head, Ganga estuary (Halder & Choudhury, 1995); Krusadai Island (Menon, 1936); Gulf of Mannar, (Krusadai Island and Rameswaram, Rao 1931); Madras, Tamilnadu (Menon, 1930).

Elsewhere : West coast of India; Maldiv Islands; North Australia; Red sea, Malay Archipelago; Suez Canal; E. Africa.

Family XI CEPHEIDAE

Radial subumbrellar muscles present. 8 rhopalar radial canals. Ring canal absent. 4 subgenital cavities, not clearly separated. Subgenital ostia small and round. Stomach octagonal with 8 primary canals.

Remarks : No poisonous effects reported from the members of this family.

Genus *Cephea* Peron & Lesueur, 1809

1809. *Cephea* Peron & Lesueur, *Ann. Mus. Hist. Nat.*, **14** : 360.

1961. *Cephea* : Kramp, *J. mar. biol. Assn., U.K.* **40** : 352.

Diagnosis : Inter-rhopalar radial canals more than three in each octant; warts present on central portion of exumbrella; long, pointed filaments on mouth arms.

Distribution : *East Coast of India* : Nicobars (Kramp, 1961); Madras, Tamilnadu (Menon, 1930).

Elsewhere : Arabian sea; Philippines; Australia; Japan; W. Africa; Red sea.

18. *Cephea* sp. Kramp 1958

Remarks : The present description is based on Kramp (1961). Menon reported this species as *Cephea* sp. from Madras Coast in 1930, which was also recorded by Kramp as same in 1958 from Nicobar Islands.

Genus *Netrostoma* L. S. Schultze, 1898

1898. *Netrostoma*; Kramp : *J. Mar. biol. Ass. U.K.*, **40** : 355.

1898. *Netrostoma* Schultze, *Denkschr. med. natur. Ges., Jena*, **8** : 457.

Diagnosis : Inter-rhopalar radial canal 3 in each octant; large warts present on central dome of exumbrella; stiff appendages present on mouth-arms and arm-disc.

19. *Netrostoma coerulescens* Maas, 1903

1903. *Netrostoma coerulescens* Maas, *Siboga Exped., Mongr.* II : 35, Pl. 5, fig. 37, 46.

1961. *Netrostoma coerulescens* : Kramp, *J. mar. biol. Ass. U. K.*, **40** : 356.

Diagnosis About 200 mm. wide; central dome with about 10 wart-like projections; 6–8 round edged lappets in each octant; mouth-arm 8, short, massive, laterally compressed, curved outwards, bifurcated at outer ends, with short terminal branches. 2 kinds of appendages between mouth openings—small, thin, tubular and larger, spindle shaped.

Colour : Pale blue or bluish in live. Numerous brown spots are present on its surface.

Distribution : *East coast of India* : Krusadai Island (Menon, 1936), Madras coast, Tamilnadu (Menon, 1930).

Elsewhere : Trivandrum coast, Calicut (West coast of India); Maldiv Islands, Indian ocean; Australia; Malay Archipelago; Philippines; Japan; Arabian Sea.

Remarks : The present description of the species is based on Kramp (1961) and Menon (1930).

20. *Netrostoma setouchianum* (Kishinouye, 1902)

1902. *Microstylus setouchianus* Kishinouye, *J. coll. Sci. Tokyo*, **17** : 11, Pl. 1, 2; Fig. 8-10.

1937. *Netrostoma setouchianum* Stiasny, *Zool. Anz., Bd.* **120** : 110-115, fig. 1, 2.

Diagnosis : Central dome covered completely by more than 50 solid, pointed projections and surrounded by a wide annular furrow; 6–8 flat, rounded velar lappets in each octant; mouth-arms with numerous small, short appendages among the frilled mouths.

Distribution : *East coast of India*; Madras; (Menon, 1930).

Elsewhere : Japan.

Remarks Present description of this species is based on Kramp (1961).

21. *Netrostoma typhlodendrium* Schultze, 1898

1898. *Netrostoma typhlodendrium* Schultze, *Denkschr. med. Natur. Ges. Jena*, **8** : 457.

1961. *Netrostoma typhlodendrium* : Kramp, *J. mar. biol. Ass. U.K.*, **40** : 356-357.

Material examined : 3 exs., Shankarpur, 4.III.97.

Diagnosis : Bell diameter 56–82 mm; length of mouth-arm 28–43mm, central dome more or less flat and covered with number of warts; rhopalar lappets conical, pointed and narrower than velar lappets; velar lappets 7 and rhopalar lappets 2 in each octant; no ring canal, but rhopalar and inter-rhopalar canals connected centrifugally by the extension of anastomoses.

Distribution : *East coast of India* : Shankarpur, West Bengal (Present record); Gangetic delta and canning, W. B. (Rao, 1931a); Prentice Island, river Mooriganga, Matla river and river Saptamukhi; W. B. (Haldar and Choudhury, 1995).

Elsewhere : Mergui Archipelago, Malayan Archipelago.

Remarks : Estuarine species; prefers coastal waters (Halder and Choudhury, 1995); Upto 110 mm wide (Kramp, 1961).

Family XII MASTIGIIDAE

Rhizostomeae, with annular subumbrellar muscles. 8 rhopalar radial canals. Subgenital ostia broad. Arm-disc quadratic, with 4 primary canals. Mouth-arm short, pyramidal, 3-winged, with filaments on arm-disc.

Genus *Mastigias* L. Agassiz, 1862

1862. *Mastigias* L. Agassiz, *Contr. Nat. Hist. U.S.A.*, **4** : 152.

1888. *Mastigias* and *Desmostoma* Vanhoffen, *Bibliotheca zoologica*. I(3) : 33, 35, 44, 45.

Diagnosis : Mouth-arms terminating in a naked, club shaped extremity; Mouth opening not only along the three edges of the mouth arms, but also on their flat, expanded sides; numerous small clubs and filaments between the frilled mouths; intracircular mesh-work of canals with 6–20 canal-roots in each octant, usually communicating with the rhopalar canals.

Remarks : No poisonous effects is reported from the members of this family.

22. *Mastigias albipunctatus* Stiasny, 1920

1920. *Mastigias albipunctata* Stiasny., *Zool. Meded.*, **5** : 224.

1961. *Mastigias albipunctatus* : Kramp, *J. Mar. biol. Assn. U.K.*, **40** : 358.

Diagnosis : Upto 145 mm wide, usually faintly vaulted; ex-umbrella, with a network of nematocyst warts with a whitish accumulation of nematocysts at apex; 6–14 velar lappets in each octant; arm-disc with a very long central filament surrounded by several shorter; mouth arms about as long as disk-radius, their terminal appendages variable in length and shape; 12–14 canal roots in each octant; perradial rhopalar canals shorter and broader than the inter-radial, with few or no anastomoses.

Distribution East Coast of India : Madras, Tamilnadu (Menon, 1930).

Elsewhere : Malay archipelago; Mergui Archipelago.

Remarks : The present description of species is based on Kramp (1961).

23. *Mastigias papua* (Lesson, 1830)

1830. *Cephea papua* Lesson, *Zoologie.*, **2** : 122, Pl. 11, figs. 2,3.

1961. *Mastigias papua* : Kramp, *J. mar. biol. Assn. U.K.*, **40** : 359–360.

Diagnosis : Upto 80 mm wide, usually hemispherical, exumbrella with very fine granulations, gelatinous substance firm; deep furrows between the velar lappets (in each octant); mouth arms

about half as long as bell diameter, the simple upper portion 1.5 times as long as the three winged lower portion; each arm usually, but not always terminates in a club-shaped filament, triangular in cross section; numerous small, club shaped vesicles between mouth; less than 10 canal-roots in each octant; rhopalar canal slender, usually with anastomoses.

Distribution East Coast of India : Gulf of Mannar, Tamilnadu (Jones, 1960).

Elsewhere : Mergui Archipelago; Japan; Philippines; Pelao & Saipan Island; North Australia; Gulf of Siam; Loochoo Island.

Remarks : The description of the species is based on Kramp (1961). In 1960. S. Jones reported this species from Gulf of Mannar, but Kramp (1961) failed to mention this distribution in his publication.

Genus *Mastigietta* Stiansny, 1921

1921. *Mastigietta* Stiansny, *Capita zool.*, I(2) : 100.

Diagnosis : Moutharms without appendages, their upper, undivided portion much reduced, almost rudimentary, and only partly united by 8 membranes.

24. *Mastigietta palmipes* (Haeckel, 1880)

1880. *Crambessa palmipes* Haeckel, *System der Acraspeden* : 620.

1910. *Catostylus palmipes* Mayer, *Medusae of the world : Scyphomedusae*, III : 667.

1921. *Mastigietta palmipes* Stiansny, *Capita zool.*, I(2) : 100.

Material examined : 1 ex., Pamban., 23.i.2000 (Material found partially damaged).

Diagnosis : About 69 mm wide; exumbrella with numerous nematocyst warts, lappet region smooth; 6 velar lappets in each octant; moutharms moderately thick, shorter than radius of the disc, no appendages; arm-disc with filaments; 12–14 canal roots in each octant; rhopalar canals with anastomoses throughout their length.

Distribution : East Coast of India : Pamban beach, Tamilnadu (present record); Krusadai Island (Menon, 1936).

Elsewhere : Malay Archipelago; N Australia.

Family XIII VERSURIGIDAE

With annular subumbrellar muscle. 8 rhopalar radial canals, subgenital ostia broad. Arm-disc quadratic, with 4 primary canals. Mouth arm broad and leaf-shaped.

Remarks : No poisonous effect even reported from the representatives under this family.

Genus *Versuriga* Kramp, 1961

1880. *Versura* Haeckel, *System der Acraspeden* : 606.

1961. *Versuriga* Kramp, *J. mar. biol. Assn. U K.*, **40** : 362-363.

Diagnosis : Mouth arms three winged, broad, with secondary lappets and with clubs and filaments; arm-disc with filaments.

25. *Versuriga anadyomene* (Maas, 1903)

1903. *Crossostoma anadyomene* Maas, *Siboga Exped., Mongr.* **11** : 56 Pl. 7, figs. 65-68.

1931. *Versura anadyomene* : Rao, *Rec. Indian Mus.*, **33** : 46-47.

1961. *Versuriga anadyomene* : Kramp, *J. mar. biol. Assn. U K.*, **40** : 363.

Diagnosis : Umbrella more or less flat, diameter being 110 mm, resembling a watch glass; Velar lappets usually 8 between two rhopalia; velar and rhopalar lappets bearing a prolongation of anastomosing network of canals; length of the winged part of the mouth arm 75 mm, extending beyond the margin of the umbrella.

Distribution : *East Coast of India* : Off Sandheads, Mouth of Ganga; Bay of Bengal, West Bengal (Haldar & Choudhury, 1995).

Elsewhere : Mergui Archipelago, Malayan Archipelago; Gulf of Siam; Philippines; Australia.

Remarks : The present description is based on Rao (1931).

Family XIV THYSANOSTOMATIDAE

Mouth-arm elongate, narrow, lash-like, triangular in cross section; no filaments.

Remarks : No poisonous effect is known from the representatives under this family.

Genus *Thysanostoma* L. Agassiz, 1862

1862. *Thysanostoma* L. Agassiz, *Cont. Nat. Hist. U S.*, **4** : 153.

1910. *Thysanostoma* Mayer, *Medusae of the world : Scyphomedusae*, III : 691.

Diagnosis : Mouth arms may or may not be naked, club-shaped extremities; 8 rhopalar canals all with anastomoses; ring canals distinct.

26. *Thysanostoma thysanura* Haeckel, 1880

1880. *Thysanostoma thysanostoma* Haeckel, *System der Acraspeden* : 625, Pl. 39, figs. 1-9.

1918. *Thysanostoma thysanura* Mayer, *Bull. U S Nat. Mus.*, **I** : 227.

Diagnosis : 100-120 mm wide, exumbrella with polygonal network of nematocysts; velar lappets well separated, without a connecting membrane, shape, size and number variable; arm disc with numerous short, slender filaments; mouth-arms without a naked terminal portion; intracircular canal system with comparatively large, open meshes.

Distribution : East Coast of India : Puri, Orissa (Rao, 1931).

Elsewhere : Malay Archipelago; Australia; Japan; Philippines.

Remarks : The present description is based on Kramp (1961).

27. *Thysanostoma loriferum* (Ehrenberg, 1835)

1835. *Rhizostoma lorifera* Ehrenberg, *Abh. Preuss. Acad. Wiss Berlin*, : 260.

1880. *Himantostoma lorifera* Haeckel, *Syst. der. Acraspeden.*, : 628.

1910. *Lorifera lorifera* Mayer, *Medusae of the World : Scyphomedusae*, III : 694.

1940. *Thysanostoma lorifera* Stiansy, *Dana Rep.*, **18** : 24., figs.4, and 5, Pl. 2.

1961. *Thysanostoma loriferum* : Kramp, *J. mar. biol. Assn. UK.*, **40** : 364.

Diagnosis : Upto 200 mm wide, exumbrella smooth or finely granulated; 6–8 velar lappets in each octant, united by a membrane, mouth arm terminate in a short, oval, naked knob, perradial rhopalar canals; intracircular canal system fine meshed, with upto 30 canal-roots in each octant.

Distribution : East Coast of India : Madras coast, Tamilnadu (Menon, 1930) as : *Lorifera lorifera* Haeckel.

Elsewhere Malayan Archipelago; Philippines; Red Sea.

Remarks : The present description is based on Kramp (1961). In 1930, M. G. K. Menon reported this species from Madras coast as *Lorifera lorifera*, but Kramp (1961) was failed to mention this record in his publication.

Suborder DACTYLIOPHORAE

Mouth arms three-winged. A network of anastomosing canals, issuing from the primary ring canal, does not communicate with the gastral cavity except through the radial canals. Subumbrellar muscles annular. Rhopalar pits with radial folds. Sub-genital ostia narrowed by papillae.

Family XV LYCHNORHIZIDAE

Without scapulets; with permanent ring canal; 16 radial canals broad, much folded mouth arms.

Remarks : No poisonous effect is reported from the representatives of the family.

Genus *Lychnorhiza* Haeckel, 1880

1880. *Lychnorhiza* Haeckel, *Sys. der. Acraspeden* : 587.

1910. *Lychnorhiza* Mayer, *Medusae of the world : Scyphomedusae*, III : 672.

1961. *Lychnorhiza* : Kramp, *J. mar. biol. Assn. UK.*, **40** : 366.

Diagnosis : Mouth-arms three-winged, without axial terminal clubs with or without filaments; 8 radial canals reaching bell margin, 8 only reaching ring canal, in each of the 16 spaces 2–4 centripetal vessels.

28. *Lychnorhiza malayensis* Stiasny, 1920

1920. *Lychnorhiza malayensis* Stiasny, *Zool. Meded.*, **5** : 226.

1961. *Lychnorhiza malayensis* Kramp, *J. mar. biol. Assn. U K.*, **40** : 367.

Diagnosis : 100 mm wide, exumbrella partly smooth and partly with irregular network of nematocysts; eight (2 X 4) pointed velar lappets in each octant; mouth-arms about as long as diameter of disk, without any appendages; 4 blind centripetal canals between adjacent radial canals.

Distribution : *East Coast of India* : Madras coast, Tamilnadu (Menon, 1930).

Elsewhere : Trivandrum, West coast of India; Java; Malay Archipelago.

Remarks : The present description is based on Kramp (1961).

Family XVI CATOSTYLIDAE

Intracircular network of anastomosing canals communicating with the ring canal, but not always with the 16 radial canals; 8 rhopalar canals extending to the umbrella margin, the 8 interrhopalar only to the ring canal; mouth-arms pyramidal.

Genus *Acromitus* Light, 1914

1914. *Acromitus* Light, *Philipp. J. Sci.*, **9** : 212.

1961. *Acromitus* : Kramp, *J. mar. biol. Assn. U K.*, **40** : 368.

Diagnosis : Broad intercircular anastomosing network in direct communication with the radial canal and rhopalar canals; mouth arms each with a terminal whip like filament.

29. *Acromitus flagellatus* (Maas, 1903)

1903. *Himantostoma flagellata* Maas, *Siboga Exped., Mongor.*, **11** : 77, Pl. 10. figs. 87-92. Pl. 11, fig. 101.

1920. *Acromitus flagellatus* Stiasny, *Zool. Meded.*, **5** : 226.

1961. *Acromitus flagellatus* : Kramp, *J. mar. biol. Assn. U.K.*, **40** : 368-369.

Material examined : 2 exs., Digba coast; 10.i.1996; 3 exs., Chandipore, Orissa, 23.xii.1997.

Diagnosis : Diameter of the bell 75-124 mm; brown spots on exumbrella, usually more in central part than that of peripheral region; ostia broad and open; mouth arm more or less equal, stout, and as long as or larger than the radius of the bell. Long filaments from terminal mouth arms.

Distribution : *East Coast of India* : Digba coast, West Bengal (Present record; Sarkar *et. al.*, 1999 and Goswami, 1992); Canning, Sunderban (Haldar and Choudhury, 1995; Rao, 1931); Kakdwip, West Bengal (Haldar and Choudhury, 1995); Chandipore, Orissa (Present record); Puri coast, Orissa (Rao, 1931); Madras, Tamilnadu (Gravely, 1941; Menon, 1930); Krusadai Island (Menon, 1936); Tuticorin, Tamilnadu (Rao, 1931); Gulf of Mannar or Palk Bay (Jones, 1960).

Elsewhere : Cochin backwater, Kerala; Karwar coast, Karnataka; Burma; Malayan Archipelago; Borneo; Java; Gulf of Siam; Japan; China.

Poisonous effect : It is observed that irritation and swelling occur if contact with the hairy surface of the skin, especially on the upper palm (Present Observation).

Remarks : A large number of large sized adult of this species observed to congregate for spawning during December to March and in post monsoon months every year and small medusae also found during same period at Digha coast and its adjoining areas (Sarkar *et. al.* 1999).

In 1910 Mayer described this species as *Lorifera flagellata*.

30. *Acromitus rabanchatu* Annandale, 1915

1915. *Acromitus rabanchatu*, Annandale, *Mem. Indian Mus.*, 5 : 96., Pl.vi,viii, figs. 4-6.

1961. *Acromitus rabanchatu* : Kramp, *J mar. biol. Assn. U K.*, 40 : 369.

Material examined : 3 exs. Digha coast, 10.i.1996; 2 exs. Puri coast, 18. x. 1998.

Diagnosis : Diameter of the bell 72–130 mm; exumbrella fairly granulated; subgenital papillae broad, triangular cones with blunt tips; mouth-arms up to twice of the length of radius of the bell, with comparatively short whip like filaments and long thread-like endings; 2–3 faintly branched anastomoses inside the ring canal.

Distribution East Coast of India : Digha coast, West Bengal (Present record, Sarkar *et. al.*, 1999 and Goswami, 1992); Puri coast, Orissa (Present record); Chilka lake, Annandale, (1915); Rao (1931).

Elsewhere : No Records.

Poisonous effect : It is observed that redness of skin, irritation and slight swelling occur if contact with the hairy surface of the skin, especially on the upper palm (Present observation).

Remarks : A large number of adult and medusae of this species also noticed to congregate along with *A. flagellatus* at Digha and adjoining areas (Sarkar *et. al.*, 1999).

Genus *Crambionella* Stiasny, 1921

1921. *Crambionella* Stiasny, *Capita Zool.*, 1(2) : 129.

1940. *Crambionella* : Kramp, *J. mar. biol. Assn. U K.*, 40 : 373.

Diagnosis : With a narrow, wide-meshed, intracircular anastomosing network, not stretching far towards the centre, and communicating only with the ring canal; mouth-arms short with terminal clubs, no whip-like filaments.

Remarks : No poisonous effects reported from the members of this family.

31. *Crambionella annandalei* Rao, 1931

1931. *Crambionella annandalei* Rao, *Rec. Indian Mus.*, **33** : 50–55, Pl. 3–4, fig. 1, text figs. 4–8.

Material examined : 5 exs. Digha, 26.ii. 1996; 2 exs. Puri, x. 98; 2 exs. Madras coast, Tamilnadu, 27.i.2000; 3 exs. Corbynes cove, 26.i.1999.

Diagnosis : Diameter of the bell 141–268 mm, length of mouth-arm 24–56 mm, Bell more or less dome-shaped; margin more or less incurved, exumbrellar surface finely granulated, minute short furrows and ridge arranged radially, velar lappets 14 in each octant; mouth-arm well developed with stout, long terminal club. Base of the mouth-arm cylindrical, middle part with trifoliate wing. Terminal club about half of entire mouth-arm and devoid of whip-like filaments.

Colour : Light Brownish to redish brownish.

Distribution : *East Coast of India* : Digha, West Bengal (Sarkar *et. al.*, 2002); Puri, Orissa (Present record and Rao, 1931); Vizag, Andhra Pradesh (Rao, 1931), Madras, Tamilnadu (Present record and Rao, 1931); Corbines cove, South Andaman (Present record), Andaman (Rao, 1931).

Elsewhere : Burma.

32. *Crambionella orsini* (Vanhoffen, 1888)

1888. *Mastigias orsini* Vanhoffen, *Bibliotheca zoologica*, **1**(3) : 34,44. Pl. 4, figs.2-4.

1910. *Catostylus orsini* Mayer, *Medusae of the world : Scyphomedusae*, III : 669.

1921. *Crambionella orisini* Stiasny, *Capita zool.*, **1**(2) : 129.

Diagnosis : 100–200 mm wide, plum, massive, hard, and cartilaginous, smooth; 16 small pointed, smooth velar lappets in each octant, seperated by furrows extending upwards on exumbrella, furrows without pigment; mouth-arms about as long as radius of the bell, proximal portion short, one third as long as distal three-winged, large, prismatic portion with a short gelatinous, pyramidal, bluntly pointed, three cornered terminal knob; extra-circular canal system with several radial vessels.

Distribution : *East Coast of India* : Madras, Tamilnadu (Menon, 1930; Krusadai Island, Tamilnadu (Menon, 1936); Pondichery (Ranson, 1945).

Elsewhere : Trivandrum, Kerala; India; Arabian Sea; Red Sea; Iranian Gulf.

Remarks : The present description is based on Kramp, (1961).

Family XVII. LOBONEMATIDAE

Intracircular network of anastomosing canals communicating with the ring canal and with some or all of the 16–32 radial canals, but not with the stomach; with window-like openings in the membranes of the mouth-arms; marginal lappets elongated, tentacle-like.

Remarks : No poisonus effects recorded from the represnetatives under this family.

Genus *Labonema* Mayer, 1910

1910. *Labonema* Mayer, *Medusa of the world : Scyphomedusae*, III : 688.

1961. *Labonema* : Kramp, *J. mar. biol. Assn. U K.*, **40** : 375.

Diagnosis : With a large-meshed intracircular anastomosing network, which communicates with both rhopalar and inter-rhopalar canals and with ring canal.

33. *Lobonema mayeri* Light, 1914

1914. *Lobonema mayeri* Light, *Philipp. J. Sci.* **9** : 217, figs. 7-9.

1961. *Lobonema mayeri* : Kramp, *J. mar. biol. Assn. U K.*, **40** : 375-376.

Diagnosis : Bell flatter than hemisphere and about 305 mm in diameter. Gelatinous substance thick, tough and rigid. Exumbrella regularly studded with erect, gelatinous outgrowths. The largest tubercles are about 30-35 mm high and are centrally placed on exumbrella at a distance about 5 mm from one another. 4 Velar lappets large. Numbers of rhopalia varies. Rhopalia have exumbrellar pits with radiating furrows. The arm-disc large, prominent and thick. Mouth-arms are 160 mm long with fusiform terminal appendages tapering to slender filaments.

Distribution : East Coast of India Madras, Tamilnadu (Menon, 1930).

Elsewhere : Indo-China; Philippines.

Remarks The present description based on Menon (1930).

Genus *Lobonemoides* Light, 1914

1914. *Lobonemoides* Light, *Philipp. J. Sci.*, **9** : 222.

1961. *Lobonemoides* : Kramp, *J. mar. biol. Assn. U K.*, **40** : 376.

Diagnosis : Large-meshed, intracircular anastomosing network, which communicates only with the rhopalar canals and the ring canal.

34. *Lobonemoides robustus* Stiasny, 1920

1920. *Lobonemoides robustus* Stiasny, *Zool. Meded.*, **5** : 227.

1961. *Lobonemoides robustus* : Kramp, *J. mar. biol. Assn. U K.*, **40** : 376-377.

Diagnosis : Bell 85 mm broad, thick in the centre but very much thinned out towards the margin. Numerous conical outgrowths on the exumbrellar surface. Number of rhopalia is variable. Between each pair of rhopalia, there are 4 velar and 2 ocular lappets. The velar lappets are rather large, bluntly triangular and deeply cleft, while the ocular ones are small. Arm-disc is a little less than the radius of the umbrella. Each mouth-arm has at similar appendages are found between the

frilled mouths all along the length of the arm. The terminal filament of each appendage is twice as long as the appendage itself.

Distribution East coast of India : Madras, Tamil Nadu (Menon, 1930).

Elsewhere : Malayan archipelago; Java; Manila; Philippines.

Remarks No example of this species noticed during present survey. The description of the species is presented here in accordance to Menon (1930).

Family XVIII RHIZOSTOMATIDAE

8 pairs of scapulets on upper arms, ring canal may or maynot be present, radial canal 16 4 seperated subgenital cavities; distal portion of arms three ringed, usually with a terminal club.

Remarks : No poisonous effect reported from any representative under this family.

Genus *Rhopilema* Haeckel, 1880

1880. *Rhopilema* Haeckel, *Syst. der. Acraspeden*, : 596.

1961. *Rhopilema* : Kramp, *J. mar. biol. Ass. U.K.* **40** : 379.

Diagnosis : Large scapulets and long manubrium; mouth-arms with numerous clubs or filaments and usually with a large terminal club; usually without a ring canal; canal net work broad with numerous fine meshes; inter-rhopalar canals wide.

35. *Rhopilema hispidium* (Vanhoffen, 1888)

1888. *Rhizostoma hispidium* Vanhoffen, *Bibliotheca Zoologica*, **I**(3) : 32, 43, Pl. 5, figs. 1-2.

1903. *Rhopilema hispidium* Maas, *Siboga Exped., Monogr.*, **11** 73. Pl. 9, figs. 78-81.

Diagnosis Bell higher than a hemisphere, 250–340 mm wide, exumbrella with numerous small, sharp-pointed, conical projections; in each octant about 8 velar lappets, oblong, rounded; mouth arms terminate in a large club-shaped appendage with a faceted, swollen end, other club-shaped appendages between the mouths on the three wings.

Distribution : East Coast of India Puri, Orissa (Rao, 1931); Madras, Tamilnadu (Menon, 1930); Krusadai Island (Menon, 1936); Palk Bay (Panikkar and Prasad, 1951).

Elsewhere : Trivandrum (Travancore) coast, Kerala, India; Japan; Red Sea; Malayan Archipelago; China; Philippines; Swez bay.

Remarks The present description is based on Kramp (1961). The specimen described by Menon (1936) was a juvenile one and a doubtful species.

VALUE OF THE TAXON

The medusae and adult scyphozoa have an important role to maintain the food chain in the marine ecosystem (Fig. 1) and it is proved that they are never considered friend or foe species for fishes (Sarkar *et. al.*, 1999), though medusae of some species are found in the gut of few large fishes.

Prey is usually caught by nematocyst-laden tentacles and the stings of few species make hazards to bathers. This poison is actually hipnotoxin in nature and also have biomedical value. The medicine from jellyfish toxin is known over decades to cure puffyness and rheumatic pain in human beings.

It is observed during recent investigation that the fishermen and tribal communities of coastal areas of Digha-Shankarpur (District : Midnapur, West Bengal) have a regular practice to use the jelly mass (bell portion) of *Acromitus* species to cure the infection of inner ear as local application, which indicates the ethno-biological value of this group. It is also reported to use jelly fish as food in the west coast of the country and in Japan after proper trimming and curing of the umbrellar portion.

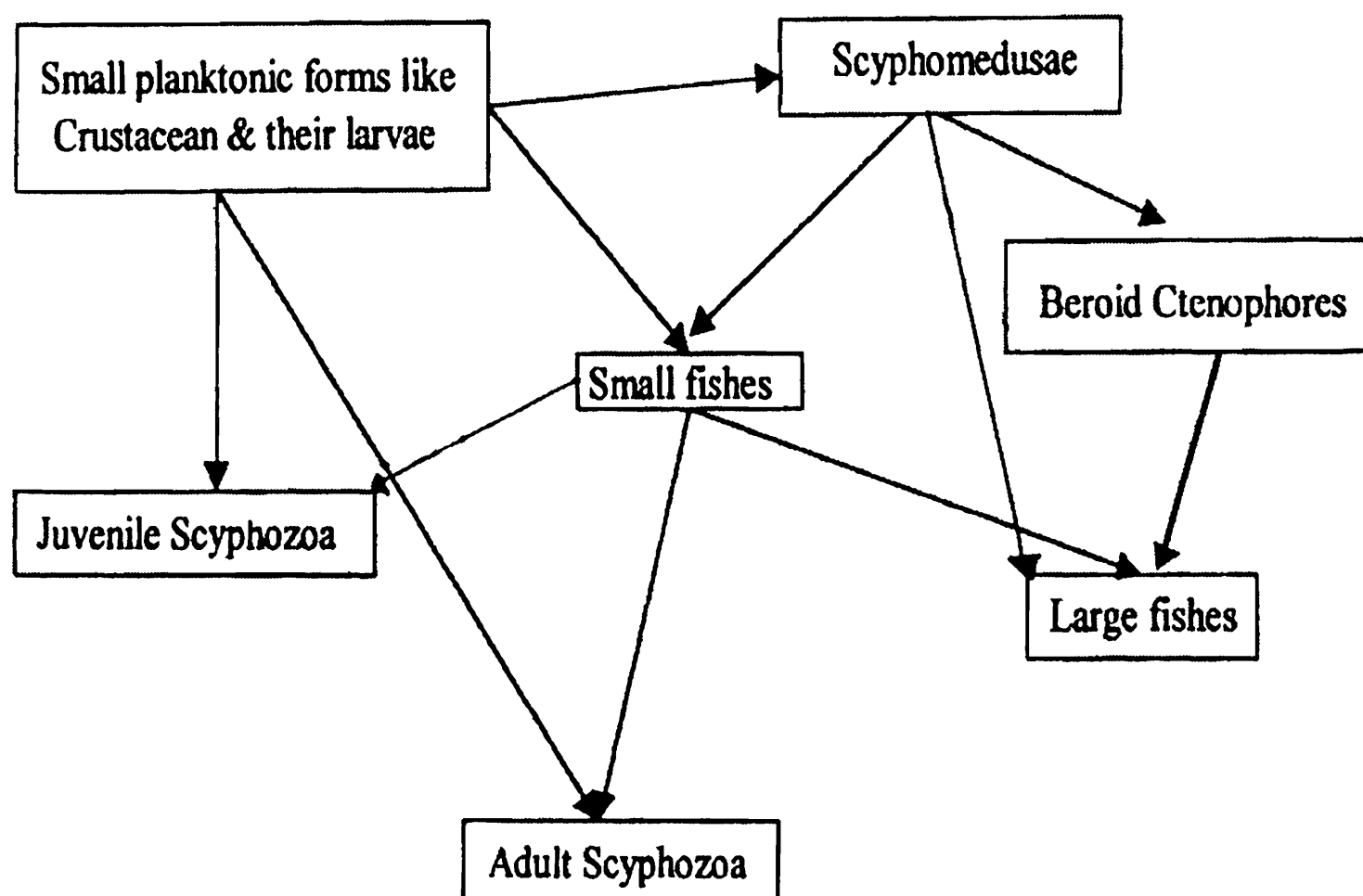


Fig. 1. Prey-predator relationship among scyphozoa with other marine forms.

PRESENT POSITION

Thousands of scyphomedusae, their juveniles and adult forms are destroyed in summer, post monsoon and winter months every year by the local fishermen as cast-off on dry beach from their fishing nets. Death of medusae are also noticed in the brackish water prawn farms by the use of some plant alkaloids to eradicate them.

DISCUSSION

The present findings reveal that uptill recently 35 species of scyphozoan jelly fishes recorded by several workers from eastern coast of India (including Andaman & Nicobar Islands). However, the recent findings indicate a number of species described earlier were absent in the locality of their original description. This negative result of their distribution is probably due to the over exploitation of marine fishery resources, mass mortality in fishing nets and pollution. Besides these, meteorological calamities also affect their migration.

As all scyphozoans species play an essential role in marine ecosystem and some of them have medicinal and edibility value, we must try to conserve them at least by releasing them from fishing nets before landing or by banning the fishing during their mass migration and spawning. Otherwise, in future, some of the species will be threatened or endangered and ultimately will break the ecological balance in marine environment.

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Table 1. : Distribution of Scyphozoa along the East coast, including Krusadai Island and Andaman & Nicobar Islands

No.	Species	West Bengal coast	Orissa coast	Andhra Pradesh coast	Tamilnadu coast	Krusadai Island	Andaman Islands	Nicobar Islands	Remarks
1	<i>Lucernariopsis</i> sp.	-	-	-	-	+	-	-	
2	<i>Charybdea alata</i> Renaud	-	-	-	+	-	-	-	
3	<i>Tamoya gargantua</i> Haeckel	+	+	+	+	-	-	-	
4	<i>Chiropsalmus buitendijki</i> Horst	-	-	-	+	+	-	-	
5	<i>Chiropsalmus quadrigatus</i> Haeckel	-	-	-	-	+	-	-	
6	<i>Chiropsalmus quadrumanus</i> (Muller)	-	+	-	+	-	-	-	
7	<i>Atolla wyvillei</i> Haeckel	+	-	+	-	-	+	-	
8	<i>Nausithoe punctata</i> Kolliker	-	-	-	+	-	-	-	
9	<i>Periphylla periphylla</i> (Peron & Lesueur)	-	-	-	-	-	-	-	Distribution recorded only as : Bay of Bengal.
10	<i>Chrysaora helvola</i> Brandt	-	+	-	+	-	-	-	
11	<i>Chrysaora melanaster</i> Brandt	-	+	-	+	-	-	-	
12	<i>Chrysaora quinquecirrha</i> (Desor)	-	+	-	+	-	-	-	
13	<i>Pelagia noctiluca</i> (Forskal)	-	-	-	+	-	-	-	
14	<i>Cyanea purpurea</i> Kishinouye	+	+	-	+	-	-	-	
15	<i>Aurelia aurita</i> (Linne)	-	-	-	-	-	+	-	
16	<i>Aurelia solida</i> Browne	-	-	-	+	-	-	-	

Table 1. : Cont'd.

No.	Species	West Bengal coast	Orissa coast	Andhra Pradesh coast	Tamilnadu coast	Krusadai Island	Andaman Islands	Nicobar Islands	Remarks
17	<i>Cassiopea andromeda</i> (Forskal)	+	—	—	+	+	—	—	
18	<i>Cephea</i> sp.	—	—	—	+	—	—	—	
19	<i>Netrostoma coerulescens</i> Maas	—	—	—	+	+	—	—	
20	<i>Netrostoma setouchianum</i> (Kishinouye)	—	—	—	+	—	—	—	
21	<i>Netrostoma typhlodendrium</i> Schultze	+	—	—	—	—	—	—	
22	<i>Mastigias albiguttatus</i> Stiasny	—	—	—	+	—	—	—	
23	<i>Mastigias papua</i> (Lesson)	—	—	—	+	—	—	—	
24	<i>Mastigietta palmipes</i> (Haeckel)	—	—	—	+	+	—	—	
25	<i>Versuriga anadyomene</i> (Maas)	+	—	—	—	—	—	—	
26	<i>Thysanostoma thysanura</i> Haeckel	—	+	—	—	—	—	—	
27	<i>Thysanostoma loriferum</i> (Ehrenberg)	—	—	—	+	—	—	—	
28	<i>Lychnorhiza malayensis</i> Stiasny	—	—	—	+	—	—	—	
29	<i>Acromitus flagellatus</i> (Maas)	+	+	—	+	+	—	—	
30	<i>Acromitus rabanchatu</i> Annandale	+	+	—	—	—	—	—	
31	<i>Crambionella annandalei</i> Rao	+	+	+	+	—	+	—	
32	<i>Crambionella orsini</i> (Vanhoffen)	—	—	—	+	+	—	—	
33	<i>Lobonema mayeri</i> Light	—	—	—	+	—	—	—	
34	<i>Lobonemoides robustus</i> Stiasny	—	—	—	+	—	—	—	
35	<i>Rhopilema hispidum</i> (Vanhoffen)	—	+	—	+	+	—	—	

THREE NEW SPECIES OF THE GENUS *CHAUNOPROCTUS* PEARCE (1906) (ACARINA : ORIBATIDA) FROM INDIA

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INTRODUCTION

The genus *Chaunoproctus* was established by Pearce (1906) with *C. cancellatus* as the type collected from Sikkim Himalaya. Berlese (1916) erected a genus *Zetorchella* with *Z. pedestris* as the type species from Somaliland. Balogh (1958) erected another genus *Caloppia* with *C. basilewskyi* as the type from Angola, Africa. Both the genera, *Zetorchella* and *Caloppia* were regarded by Balogh (1965) as synonyms of the genus *Chaunoproctus*, but later in 1972 he considered them as distinct genera.

Recently J. Balogh and P. Balogh (1992) again considered both *Caloppia* and *Zetorchella* as synonyms of the genus *Chaunoproctus*.

The genus was reported from different parts of the world by several workers like Pearce (1906), Balogh (1958, 1959), Wallwork (1961), Higgins (1966), Karppinen (1966), Bhaduri, Bhattacharyya and Chakrabarty (1975), Corpuz-Raros (1979) and Dhali, Bhaduri and Raychoudhuri (1980).

In India Bhaduri, Bhattacharya and Chakrabarty (1975) described two new species, *C. abalai* and *C. clavisetosus* from West Bengal. Chaudhuri and Banerjee (1977), Chakrabarti and Mondal (1983) reported *C. abalai* from West Bengal. Dhali, Bhaduri and Raychoudhuri (1980) described a new species, *C. longisetosus* from Sikkim. Sanyal (1992, 1996) reported the genus from West Bengal and Rajasthan. Sengupta and Sanyal (1986) again reported the genus from Bihar. Recently Bhattacharya and Chakrabarti (1995) reported the genus from Tripura.

The genus is reported here from South District of Tripura having 4 species including 3 new species.

Generic Diagnosis : Apterogasterine; prodorsum shortly pyramidal; lamellae bar like, narrow, marginal, never meeting apically, connected by thin translamella; interlamellar setae long; notogaster rough, foveolated with 10 pairs of thick, setose or club-shaped setae; genital setae 6 pairs; legs long, thin and tridactylous.

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Distribution : INDIA : Bihar, Rajasthan, Sikkim, Tripura, West Bengal. Elsewhere : America, Africa.

Key to the species of the genus Chaunoproctus from Tripura

- 1(2) Interlamellar setae short, club-shaped; sensillus with short stalk and densely barbed rounded head; notogastral setae club-shaped with densely placed bristles *C. orientalis* sp. nov.
- 2(1) Interlamellar setae long; sensillus with long stalk; notogastral setae long
- 3(4) Sensillus with club-shaped head and long thin stalk directed outward and slightly backward; except *ta* all notogastral setae setose *C. longisetosus* Dhali and Bhaduri, 1980
- 4(3) Sensillus long without distinct head; *ta* either smooth or barbed
- 5(6) All prodorsal and notogastral setae barbed; body foveolated *C. sisiri* sp. nov.
- 6(5) All prodorsal and notogastral setae smooth; body punctated and foveolated *C. amarpurensis* sp. nov.

Chaunoproctus orientalis sp. nov.

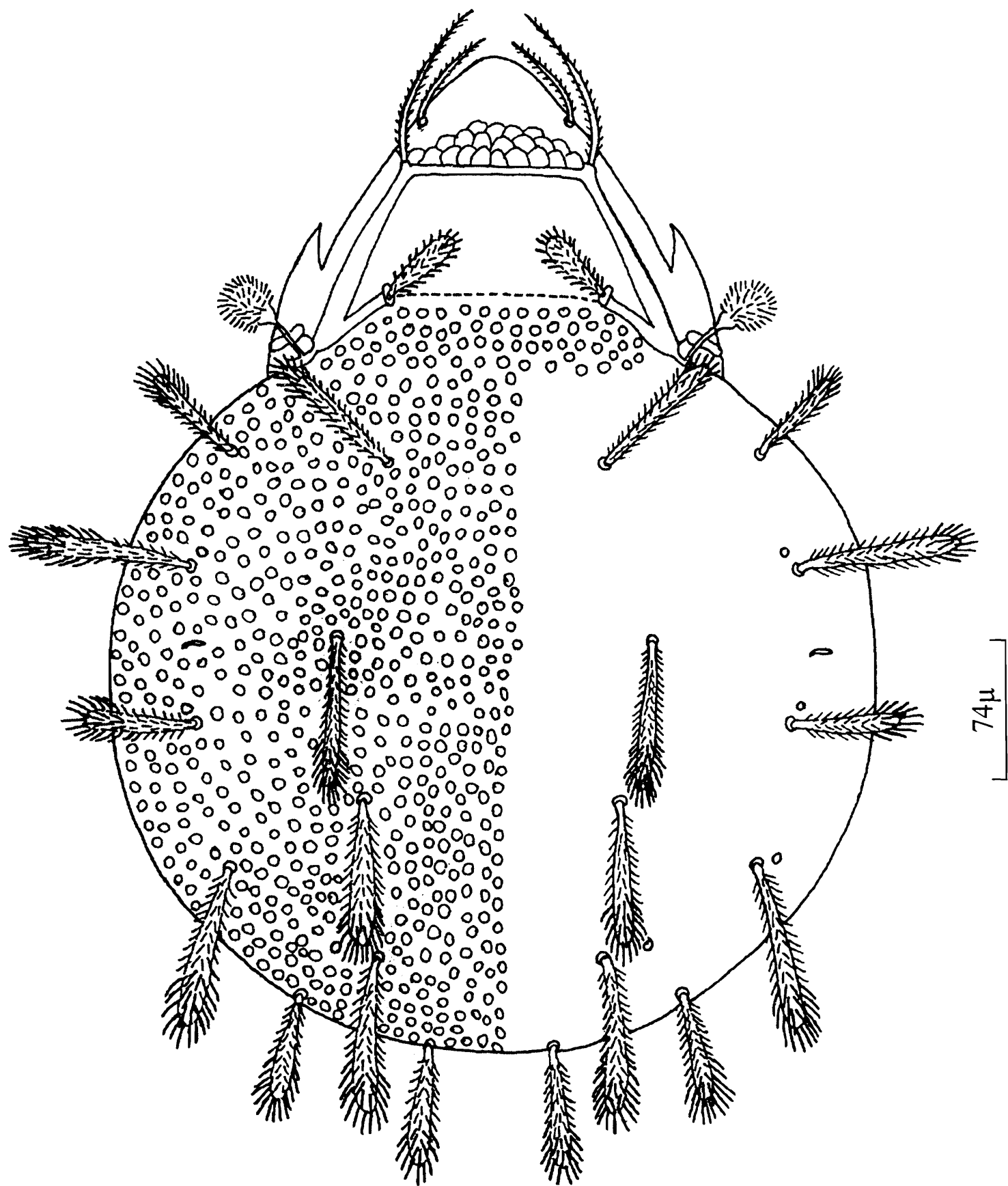
(Figs. 1-2)

Colour : Dark brown.

Measurements (in μ) : Length of the body : 211, width of the body : 326.

Prodorsum : Rostrum broad, rounded; rostral setae moderately long (63), thin, mounted on apophyses on each side of rostrum, bilaterally barbed; narrow bar like lamellae connected by a thin translamella; lamellar-translamellar junction anteriorly directed; lamellar setae (78) longest among prodorsal setae and almost equal to their mutual distance, barbed bilaterally and extended well beyond tip of rostrum; interlamellar setae (30) shortest among prodorsal setae, club-shaped, densely barbed; sensillus with prominent stalk and rounded, densely barbed head; above translamellar line prodorsal region with faint reticulate markings.

Notogaster : Notogaster rounded, surface foveolated with ten pairs of narrowly club-shaped setae, distally with comparatively long and densely placed bristles; *ti*, *ms* and *r*₁ placed at inner row and *ta*, *te*, *r*₃ and *r*₂ located at outer row on notogaster; distance *ti*-*ms*(74) > *r*₁-*ms* (67); *ta* (52) shorter than *ti* (67) and *te* (70), *ta*-*te* (52) < *te*-*r*₃ (70), postero-marginal setae 3 pairs, *p*₁ (55) inserted in posterior margin of notogaster, nearly equal to *p*₃ (48) but much smaller than *p*₂ (70); four pairs of area porosae present on notogaster; fissure *im* an oblique slit placed laterally at middle of notogaster in between insertion of *te* and *r*₃.



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Fig. 1. *Chaunoproctus orientalis* sp. nov., Dorsal view.

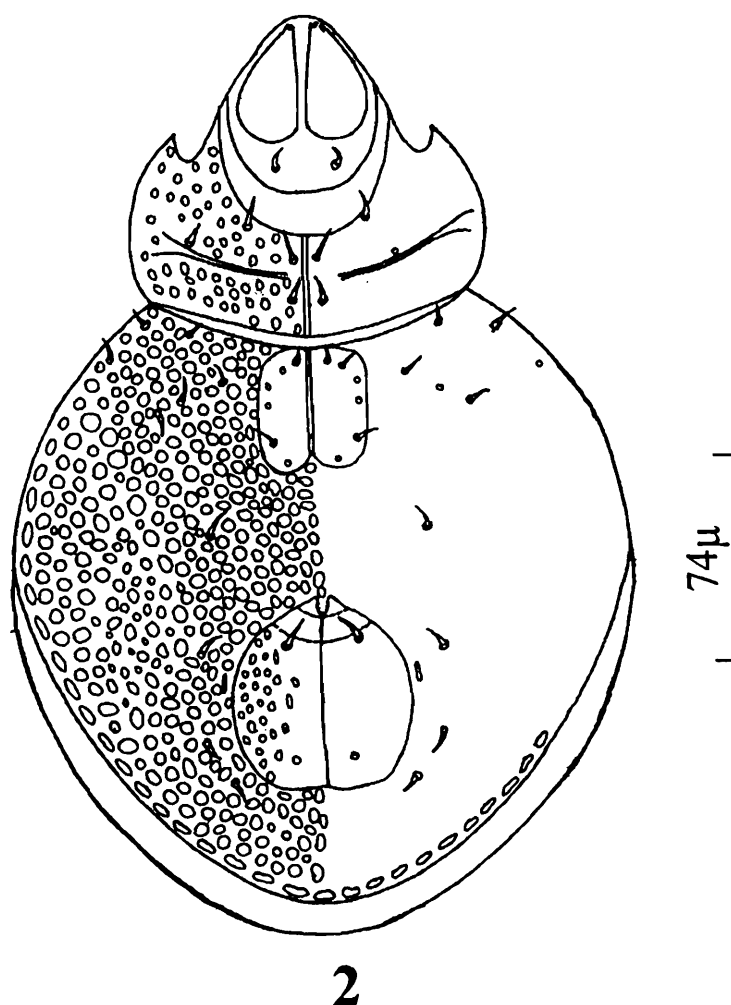


Fig. 2. *Chaunoproctus orientalis* sp. nov., Ventral view.

Epimeral Region : Epimeral region foveolated; epimeral setae simple, short (7-11), fine, setal formula 3-1-3-3.

Ano-Genital Region : Genital plate trapezoidal (length : 59, width : 52) with 6 pairs of setae of which 2 pairs located at anterior margin, 2 pairs at lateral margin and 2 pairs at posterior margin of genital plates; distance between genital and anal plates exactly equal to length of genital plates; anal plates longer (length : 92, width : 78) than genital plates, with 2 pairs of setae; adanal setae 3 pairs, ad_1 located at postero-lateral, ad_2 at latero- median and ad_3 at antero-lateral margin of anal field; ventral plate with foveolae.

Legs : Leg tridactylous, middle claw stronger than lateral ones.

Material Examined : *Holotype* : Adult female, India : Tripura : Amarapur, 4.iii.1992, from litter of rotten leaves of mixed vegetation, coll. S. Saha. *Paratype* : 1 adult female, data same as holotype.

Distribution : INDIA : Tripura (South District).

Remarks : The new species approached close to *C. clavisetosus* Bhaduri *et al.*, 1975 in the shape of body, position of prodorsal and notogastral setae and body foveolation, but can easily be separated from the latter species in having sensillus with rounded and barbed head, short

interlamellar setae not touching the translamellar line, densely barbed notogastral setae and having distance $ti-ms > r_1-ms$.

Chaunoproctus sisiri sp. nov.

(Figs. 3-4)

Colour : Dark Brown.

Measurements (in μ) Length of the body : 677; width of the body : 517.

Prodorsum : Rostrum rounded; rostral setae moderately long (113), thin, inserted laterally on apophyses on either side of rostrum, curved inward and barbed outside with minute setae, pointed at tip; narrow bar like lamellae extend over nearly half of length of prodorsum and joined by a thin translamella; lamellar-translamellar junction anteriorly directed; lamellar setae long (188), slightly thicker than rostral setae, bilaterally barbed, extend beyond tip of rostrum and with pointed tip; interlamellar setae slightly longer (197) than lamellar setae, their mutual distance about half of their length, bilaterally barbed and with blunt tip; bothridium cup-shaped; sensillus long (122), distally thickened, without distinct head, barbed densely on both sides; prodorsum with reticulate markings excepting interlamellar region.

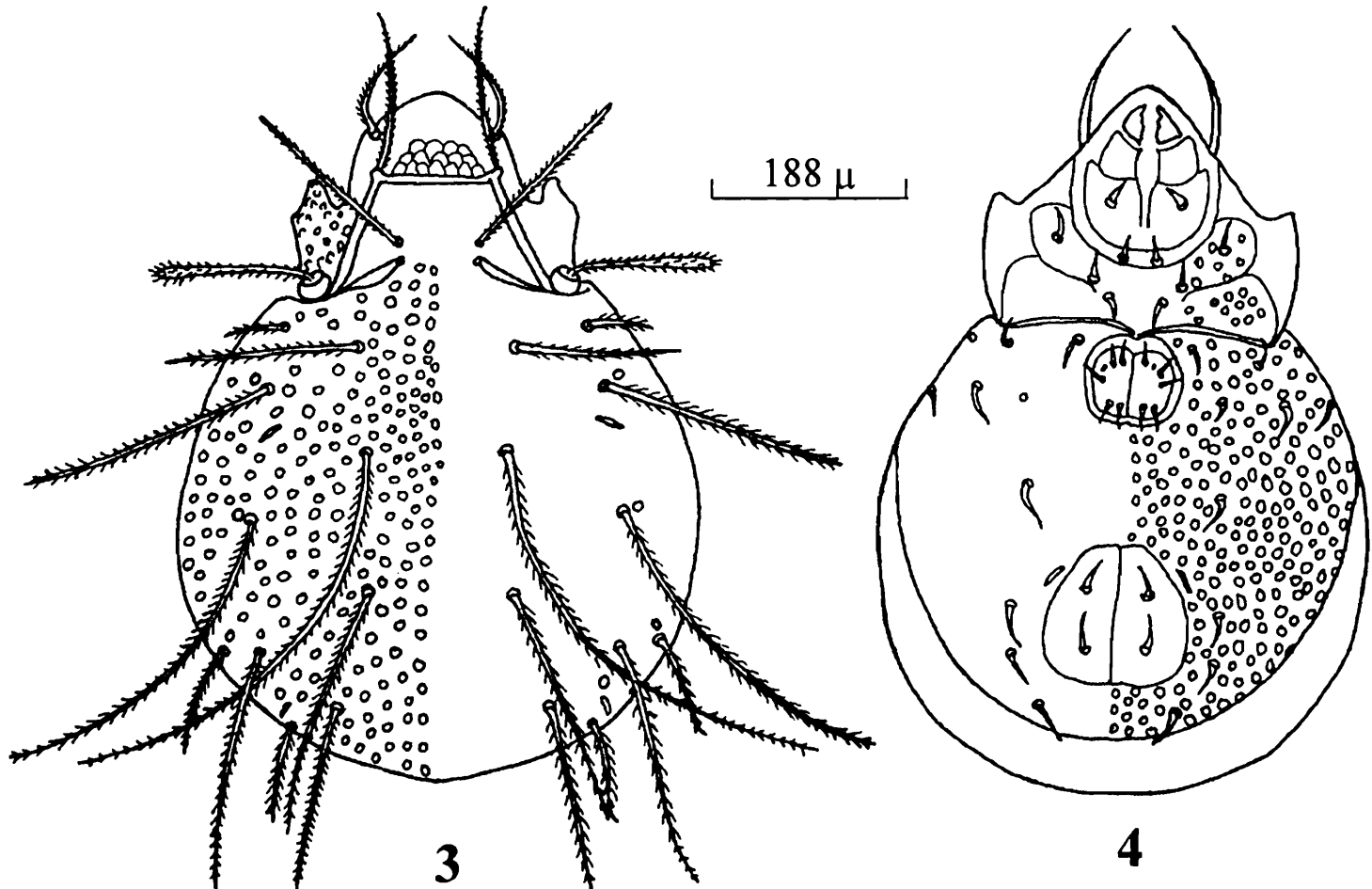


Fig. 3-4. *Chaunoproctus sisiri* sp. nov. Fig. 3. Dorsal view; Fig. 4. Ventral view.

Notogaster Notogaster rounded, surface rough and foveolated, with ten pairs of elongated setose setae, setae ta (66) shortest one and barbed, p_2 (103) and p_3 (113) shorter than p_1 (160), ms (376), r_3 (282) exceptionally long; te and r_2 equal in length (226); distance $t_1-ms < ms-r_1$ and $ta-te$ smaller than $te-r_3$; four pairs of small area porosae on notogaster.

Epimeral Region : Epimeral region foveolated; epimeral setae simple, short (7-10), setal formula 3-1-3-3.

Ano-Genital Region : Genital plate almost rounded (length : 75, width : 75) with six pairs of setae of which 2 pairs located at anterior margin, 2 pairs at lateral margin and 2 pairs at posterior margin of genital plates; distance between genital and anal plates exactly equal to length of anal plates (132); anal plates (length : 132, width : 122) with two pairs of setae; three pairs of adanal setae; ventral plate densely foveolated.

Legs : Leg tridactylous.

Material Examined *Holotype* Adult female, India Tripura : Baikora (Sabrum), 27.iv.1992, from litter below banana plant, coll. S. Saha. *Paratype* : 1 adult female, India : Tripura; Dhuptali (Udaipur), 28.iv.1992, from decomposed soil with loose litter, coll. S. Saha.

Distribution : INDIA : Tripura (South District).

Remarks : The new species is comparable to *C. longisetosus* Dhali and Bhaduri, 1980 regarding body shape and nature of notogastral and prodorsal setae. But it shows dissimilarities with *longisetosus* in having long, barbed sensillus without any distinct head and in possessing barbed setae ta . The species also shows similarities with *C. amarpurensis* sp. nov. in shape of body, long prodorsum and notogastral setae and shape of sensillus. However, it markedly differs from *amarpurensis* sp. nov. in having barbed prodorsal and notogastral setae and without any punctation on the body.

Chaunoproctus amarpurensis sp. nov.

(Figs. 5-6)

Colour : Dark brown.

Measurements (in μ) : Length of the body : 617; width of the body : 503.

Prodorsum : rostral setae moderately long (111), thin, inserted laterally on apophyses on either side of rostrum, curved inward and smooth; narrow bar like lamellae extended over nearly half of length of prodorsum and joined by very thin translamella, lamellar-translamellar junctions rounded; lamellar setae long (170), thin, smooth, tip pointed, directed anteriorly and extended well beyond tip of rostrum; interlamellar setae longest (207) among prodorsal setae, thin, smooth, with pointed tip; sensillus long (78), smooth, directed outward, distally thickened, without distinct head, prodorsum punctated densely.

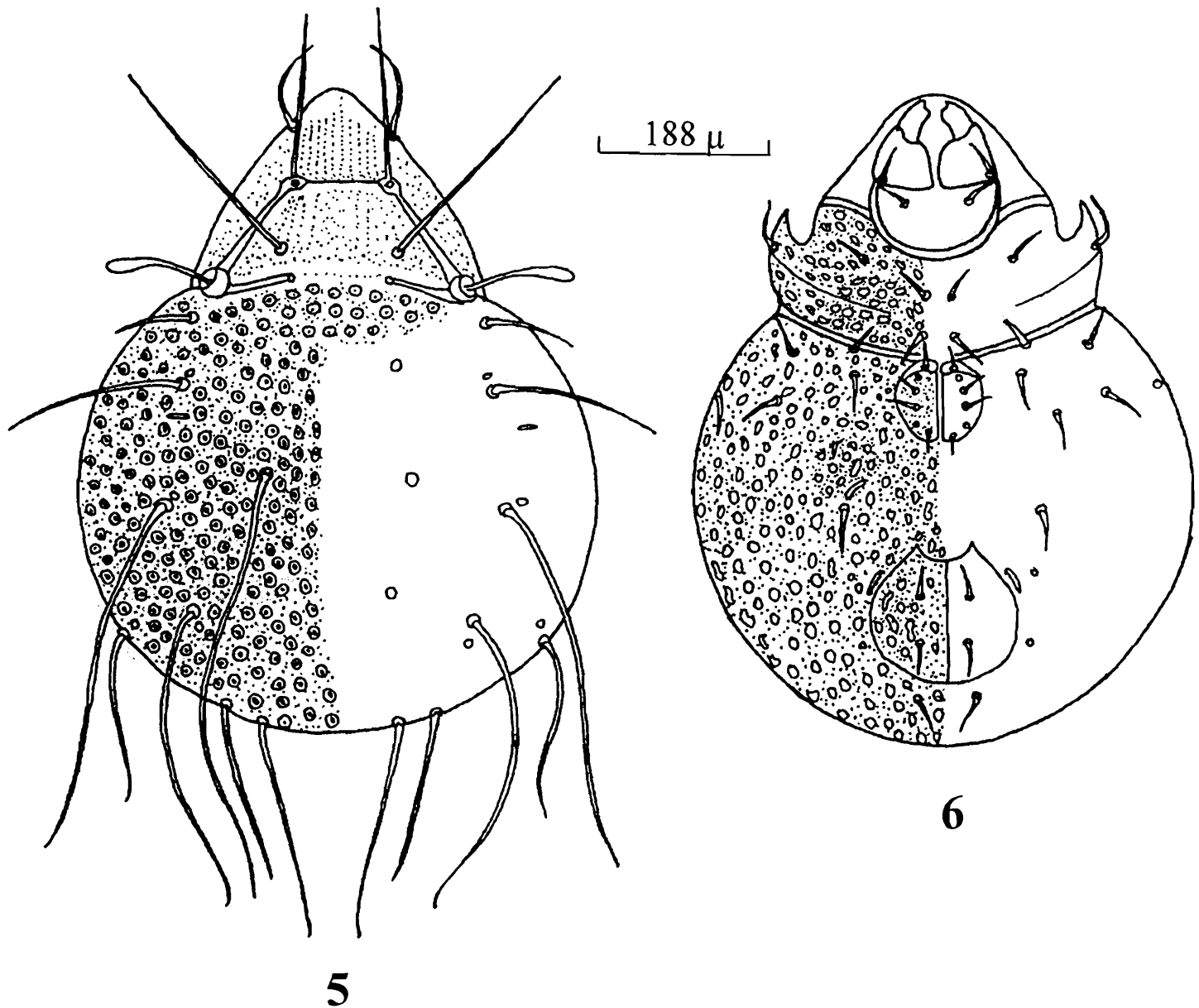


Fig. 5-6. *Chaunoproctus amarpurensis* sp. nov. Fig. 5. Dorsal view; Fig. 6. Ventral view.

Notogaster : Notogaster rounded, surface punctated and foveolated, dark punctation inside all foveolae; ten pairs of elongated, smooth notogastral setae; setae ta (81) smallest and smooth, r_3 (377); ms (388); r_1 (333) are exceptionally long, P_2 (96) and P_3 (111) smaller than P_1 (181); distance t_1-ms more or less equal to $ms-r_1$ and $ta-te < te-r_3$; four pairs of small area porosae present on notogaster.

Epimeral Region : Epimeral region punctated and foveolated; epimeral setae short (7-11), smooth, epimeral setal formula 3-1-3-3.

Ano-Genital Region : Genital plate punctated, trapezoidal (length : 81, width : 78) with 6 pairs of setae; distance between genital and anal plates (111) slightly shorter than length of anal plates; anal plates punctated with irregular foveolae, more or less rectangular in shape (length : 122, width : 174), with two pairs of setae; three pairs of adanal setae, ad_1 placed posteriorly, ad_2 placed postero-laterally and ad_3 in postero-median position; ventral plate punctated and foveolated.

Legs : Leg tridactylous.

Material Examined : *Holotype* : Adult female, India : Tripura : Birganj (Amarpur), 2.i.1992, from litter beside Gomti river, coll. S. Saha. *Paratypes* : 6 adult females, India : Tripura : Jarimura (Amarpur), 2.i.1992, from loose soil with decomposed leaf litter, coll. S. Saha.

Distribution : INDIA : Tripura (South District).

Remarks : The species resembles *C. longisetosus* Dhali and Bhaduri, 1980 in general body shape, in having long prodorsal and notogastral setae and smooth *ta*, but can easily be separated from *longisetosus* in having smooth, thin long prodorsal setae; long, smooth sensillus without distinct head; smooth notogastral setae; punctated prodorsum, notogastral punctation and dark punctated area inside the foveolae and also having punctated, foveolated epimeral and ano-genital region. The new species also shows similarities with *C. sisiri* sp. nov. in shape of body, long prodorsal and notogastral setae and shape of sensillus. But it differs from *sisiri* in having smooth prodorsal and notogastral setae and body punctation.

***Chaunoproctus longisetosus* Dhali and Bhaduri**

1980. *Chaunoproctus longisetosus* Dhali & Bhaduri, *Indian J. Acar.*, **5** : 53.

Colour : Dark Brown.

Measurements (in μ) : Length of the body 592-614; width of the body : 450-468; *ro* : 95-105; *la* : 150-165; *in* 190-197; *ss* : 70-76; length of the notogastral setae : 95-350; length of the genital plates : 70-75; width of the genital plates : 68-73; distance between the genital and anal plates : 101-109; length of the anal plates : 105-112; width of the anal plates : 150-165.

Material Examined : 2 adult females, India : Tripura Ampinagar (Amarpur), 15.xii.1991, from soil and litter below cowdung, coll. S. Saha.

Distribution : INDIA : Sikkim, Tripura (West District and South District).

Remarks : The specimens collected from South Tripura district correspond with drawing and description of *C. longisetosus* Dhali and Bhaduri, 1980 in all the characters.

SUMMARY

Three new species, *Chaunoproctus orientalis* sp. nov., *C. sisiri* sp. nov. and *C. amarpurensis* sp. nov. are described and illustrated alongwith their affinities. A known species *C. longisetosus* Dhali and Bhaduri, 1980 is also reported here from the State. A key to all the four species is also provided.

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ON *LEPIDONELLA* YOSII, 1960 AND *BROMACANTHUS* SCHÖTT, 1925 COMPLEX (COLLEMBOLA : ENTOMOBRYIDAE : PARONELLINAE)

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The species belonging to the genus *Bromacanthus* long ago were confused with the species of the genus *Paronella* (Schäffer, 1898; Börner, 1906). Handschin (1925), however, splitted the complex *Paronella* Schött, 1893 into two broad groups : (a) species having 2 mucronal teeth and (b) more than 2 mucronal teeth and established the genus *Pseudoparonella* for the species having 2 mucronal teeth and transferred the species *Paronella setigera* Börner, 1906 with 2 mucronal teeth to his new genus. He (Handschin, 1925) also fixed an aberrant and widely different species, viz., *Paronella appendiculata* Schött, 1917 as the type-species of *Pseudoparonella* as it possesses 2 mucronal teeth. The same paper (Handschin, 1925) contains description of a new species viz., *Pseudoparonella incerta*, which possesses 4 mucronal teeth.

Although, Handschin (1925) fixed *Paronella appendiculata* as the type-species of his genus, it seems that Handschin (1925) did not examine the type material or representative material of *P. appendiculata* Schött and the concept of his new genus was based on composite generic groups. Thus Handschin's diagnosis of *Pseudoparonella* actually reveals the characters of the species having distinctly round scales on body, dental spines and achaetotic body. Such characters, though common for *Pseudoparonella setigera* (Börner, 1906) *sensu* Handschin and *Pseudoparonella incerta* Handschin, 1925, do not conform to the characters actually present in *Paronella appendiculata* Schött, 1917.

Thus, it appears that the diagnosis of the genus *Pseudoparonella* given by Handschin (1925) was derived from *P. setigera* and *P. incerta* and such diagnosis is not tenable at all for the *appendiculata*-like species-group.

This study on the basis of type material as well as representative material of other species proves that *P. appendiculata* Schött is a good number of the tribe Callyntrurini and phylogenetically widely different from the species like *setigera* and *incerta* which are members of tribe Bromacanthini. It is unfortunate that presently we had to accept the name *Pseudoparonella* for a different group of species (*i.e.*, for *appendiculata* and *appendiculata*-like species and also for *queenstandica* and *queenstandica*-like species) having few *Paronella* like characters, although Handschin (1925) most appropriately proposed the name *Pseudoparonella* for the species (*incerta* and *setigera*) having some *Paronella*-like characters. It is, however, due to Handschin's (1925)

misconception of the species *Paronella appendiculata* Schött, 1917 and fixing the same as the type-species of the genus *Pseudoparonella*.

Subsequently, many species related to *setigera* and *incerta* were described under *Pseudoparonella* (Handschin, 1928, 1930; Womersley, 1937). Schött (1925) proposed a new generic name viz., *Bromacanthus* for his species *handschini* which is related to *setigera* and *orientalis*. The diagnosis of *Bromacanthus*, given by Schött (1925), is not fully conclusive and misleading in the sense that he could neither depict nor describe the important structures like femoral organ, nature of dental spines and mucrones properly. Examination of the syntypes of *B. handschini* from the Swedish Museum Natural History, Stockholm, reveals such discrepancies. To describe femoral organ, Schött (1925) used certain ambiguous language which does not reveal the actual nature of the structure, thus to quote Schött (1925) : “The hind legs consisting of rows of skin pieces. In most of the individuals examined they are spiral shaped and their edges undentate. Only in one specimen they seem to be spoon-shaped with serrated margin” In the syntype of *Bromacanthus handschini* examined, the femoral organ is similar to that what has been depicted by Handschin (1930) in *orientalis* and Yosii (1959) in *Handschinella setigera* (Börner, 1906), although the femoral spines (in the syntype have flattened considerably and the ciliation of those spines have rendered obscure due to preservation on slide (No. 878) for a long time Fig. 1., G, H). It is now evident that “skin pieces” mentioned by Schött (1925) are actually the blunt femoral spines of femoral organ. Börner (1906), although did not name and illustrate the organ on hind femur in *Paronella setigera*, nevertheless, he noted and described the structure very precisely. The description of the organ given by Börner (1906) is as follows : “Hinterschenkel basalwärts auf der Hinterseite mit einer längeren Reihe größerer und 3 kurzen Reihen kleinerer Dornen; davor noch zwei sehr lange, borstenartige Dornen” Schött (1925) described the dental spines in *B. handschini* as “split up at the base in such a way, that they strikingly remind one of an open ear oats (hence the name)” In the syntype along with other examples from Biak, the dental spines do not appear to be such splitted at the base. Instead, each spine in with some complex longitudinal striations on the surface which apparently provide it a sort of serrated appearance. “Splitting up at the base” of spines what Schött (1925) depicted has not been observed in any specimen (Fig. 2, D, E). Womersley (1937) in a species viz., *Pseudoparonella papuanus* related to *incerta* Handschin, mentioned the dental spines distinctly tridentate. The informations and depictions which are now available from the holotype [preserved in the British Museum (Natural History), London, through courtesy of Mr. P. N. Lawrence] indicate that the spines are in reality simple. The edges of the sockets from which spines have fallen give an appearance of “tridentatedness” to the existing adjoining spines (Figs. 3, E, F).

Schött (1925) described the mucro as being tridentate, which is, however, bidentate like *P. setigera* Börner (1906) and *P. orientalis* Handschin (1930). Schött (1925) could not note properly the number of teeth in mucro and mistook the spoon-shaped process of dentes, projected beyond dentes, as one of the teeth of mucro (Figs. 2, E, F).

Yosii (1959b) redescribed the species *setigera* Börner, 1906 and placed it in a new genus viz., *Handschinella*. He discriminated his new genus from *Pseudoparonella* on the basis of round hyaline scales, minutely striated and in the presence of special femoral organ. The characters used by Yosii (1959) exactly conform to the characters present in *Bromacanthus handschini*. Therefore, it is beyond doubt that *Handschinella* Yosii (1959) is a synonym of *Bromacanthus* Schött (1925) [Mitra, 1971]. Yosii (1981) also confirmed *Handschinella* as a synonym of *Bromacanthus*. It is further to be noted, though Yosii (1959) differentiated *Handschinella* from *Pseudoparonella* s. str. on the basis of round scales present in '*H. setigera*' (Börner, 1906), Handschin himself (1925) in a 'footnote' (Treubia, 6 : p. 253) mentioned the presence of larger round scales in *Paronella* and *Pseudoparonella*. Such mention of larger round scales in *Pseudoparonella* by Handschin (1925) is obviously due to the reason, as mentioned earlier, that Handschin (1925) derived the diagnosis of *Pseudoparonella* from the species like *setigera* and *incerta* which possess this typical scales (Fig. 1, A-D).

Handschin (1930) considered the species, like *setigera*, *handschini* and *orientalis*, as belonging to the same group and he criticised the genus *Bromacanthus* Schött, 1925. He also noted that *Bromacanthus* differs from the species like *setigera* Börner, 1906, *appendiculata* Schött, 1917 and *incerta* Handschin, 1925 only in the nature of dental spines. He further observed that all these species (i.e., *setigera*, *appendiculata* and *incerta*) possess identical mucrones, dental spines and scales which clothe the general surface of body. Handschin (1930), however, did not make any mention of the femoral organ found in *Bromacanthus setigera* n. comb. Association of *appendiculata* with the above mentioned species appears to be due to Handschin's nonacquaintance with the specimens of *Paronella appendiculata* Schött (1917) and further as both the species (viz., *appendiculata*, *setigera*) possess similar mucronal ends, Handschin (1925) most probably thought both the species as congeneric. As mentioned earlier, *P. appendiculata* is widely different from the above-mentioned species in many salient and fundamental characters and belongs to an altogether different tribe (Callyntrurini).

Handschin (1925) was able to recognise that some species of *Paronella* possess dental spines while others do not. He, however, was unable to detect other important differences in accordance with the presence and absence of dental spines. It is most possibly for this reason, he (Handschin) was unable to solve the problems of diverse composite generic groups of the Oriental Region related to African *Paronella* Schött. Such confusion seems to have perpetuated in the later works. Thus Womersley (1937) included a species viz., *papuanus* (a member of *Lepidonella*) under *Pseudoparonella*, relying on Handschin's (1925) diagnosis of *Pseudoparonella*. Carpenter (1932) places a species of *Microparonella* under *Pseudoparonella* as the species possesses bidentate mucrones, typical scales and dental spines.

Yosii (1960) described a new genus viz., *Lepidonella* from Solomon islands. Present investigation reveals that though *Lepidonella* has many characters in common with *Bromacanthus*, it is distinctly different from the latter in many salient features.

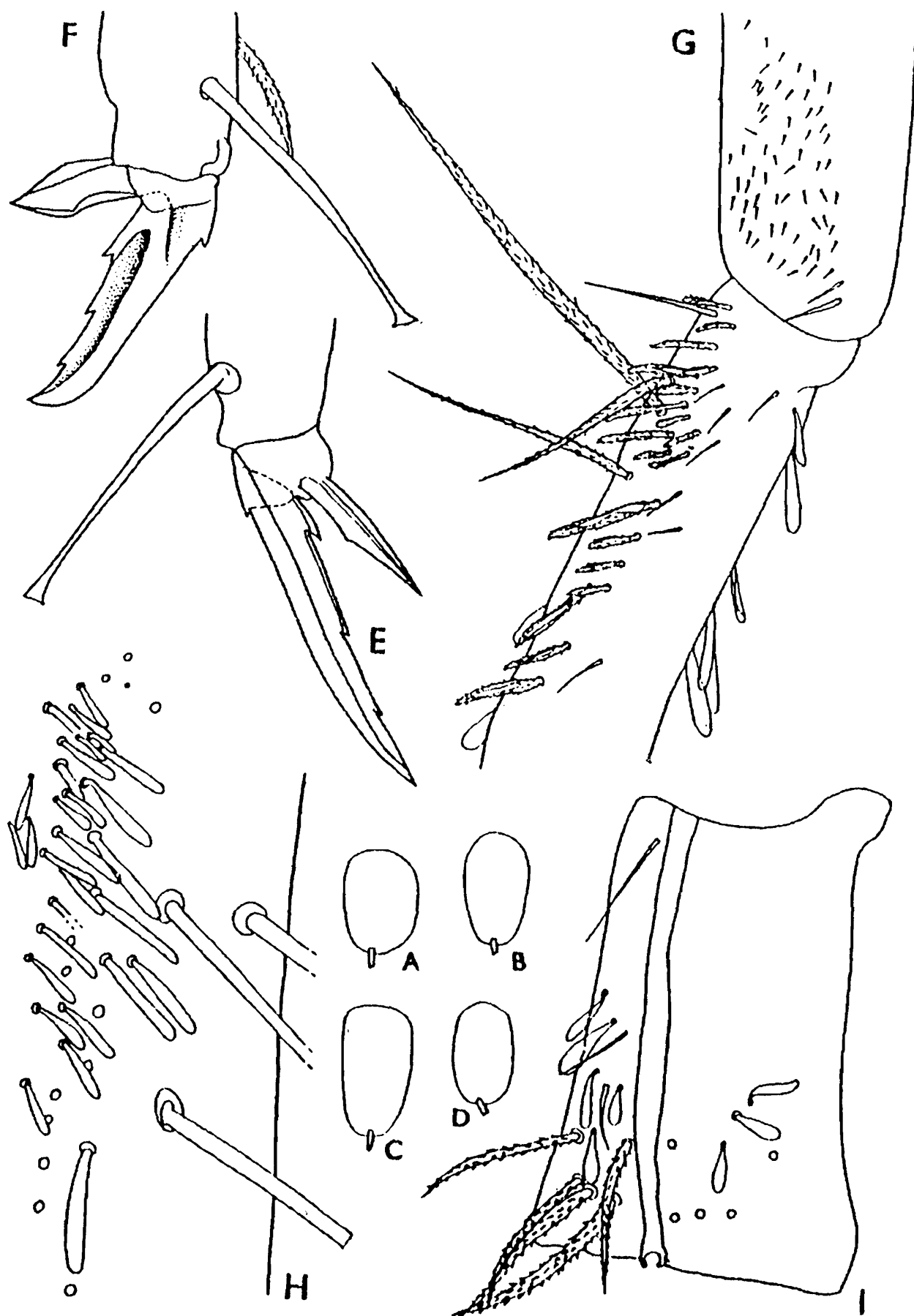


Fig. 1. : *Bromacanthus handschini* Schött. A, C, D : scales from head of the lectotype; B : scales from antennae of the lectotype; E : footcomplex of leg II; F : footcomplex of leg III; G : trochanteral and femoral organ; H : femoral organ of the lectotype; I, chaetotaxy of the anterior face of ventral tube.

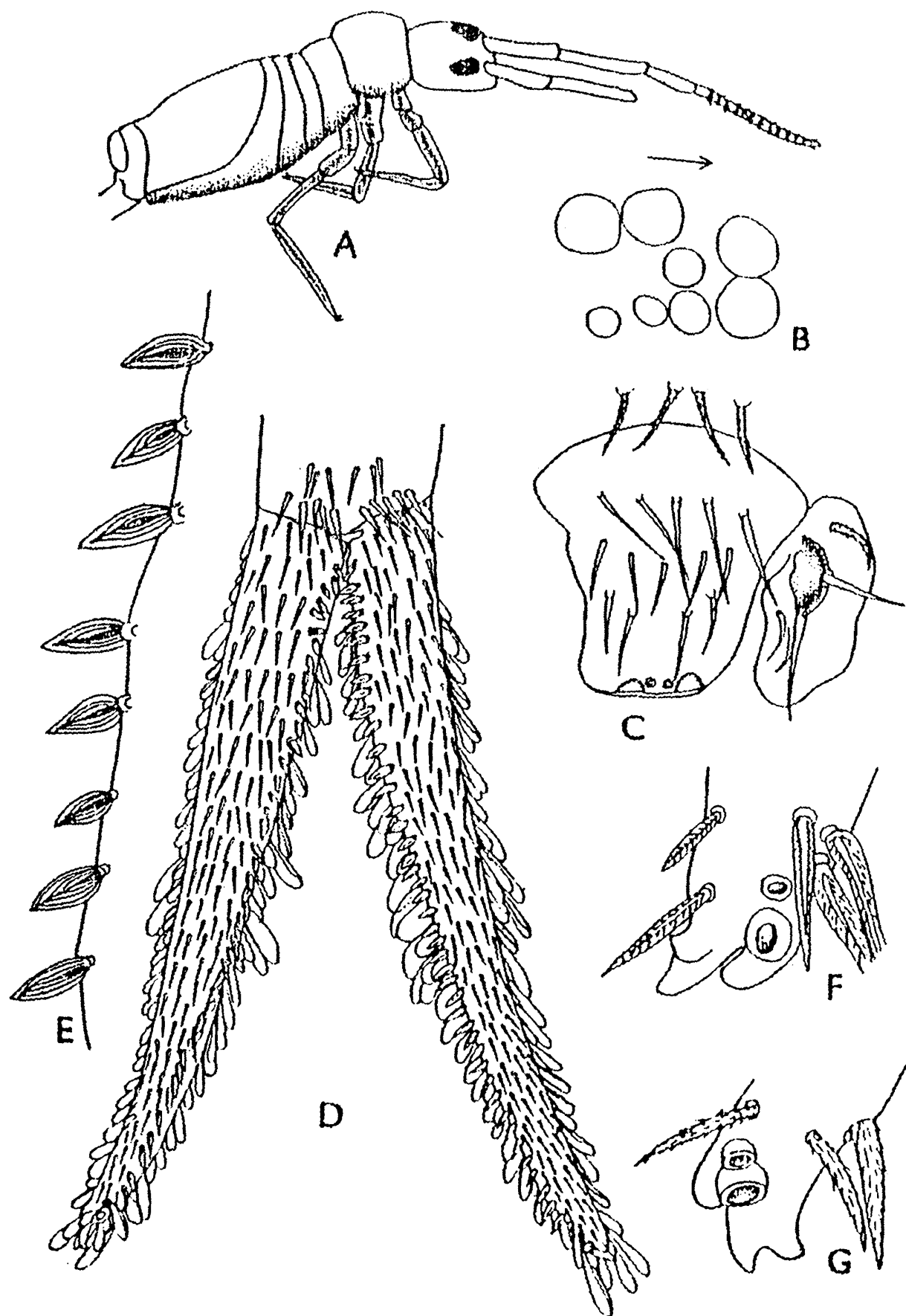


Fig. 2. : *Bromacanthus handschini* Schött. A : profile; B : arrangement of ocelli (from Lectotype); C : labral and labial chaetotaxy; D : distal portion of manubrium with denticles; E : a few dental spines (magnified); F, G : mucrones.

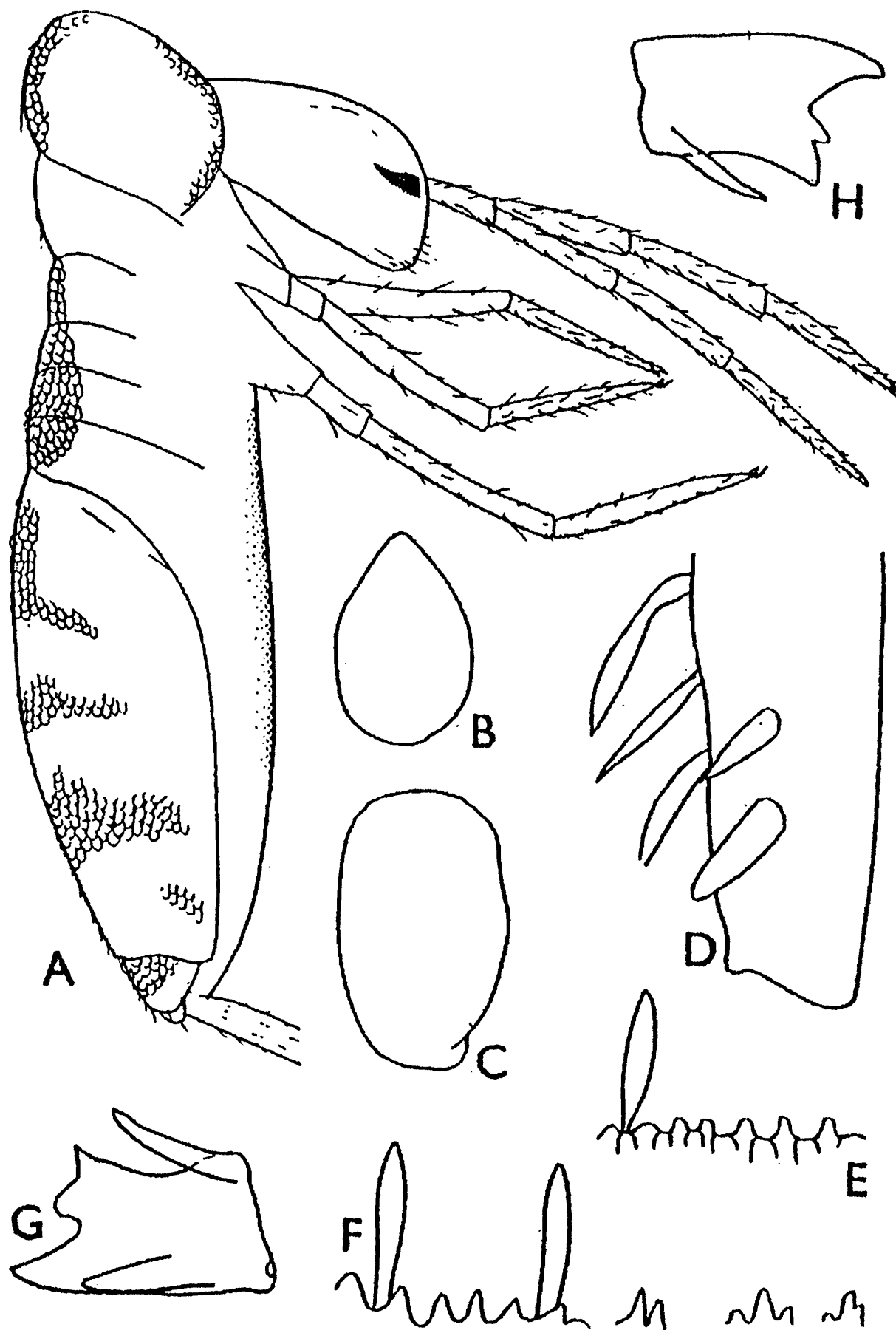


Fig. 3. : *Lepidonella papuanus* (Womersley) New Combination. A : profile; B, C : scales from holotype; D : distal portion of dentes from holotype; E, F : portions of dentes showing spines and adjoining empty sockets of the detached spines (from holotype); G, H : mucrones (from holotype).

Yosii (1960) established *Lepidonella* with the type-species *Lepidonella tokiokai* from Bougainville Island of Solomon islands. He distinguished his new genus from *Paronella* Schött in the achaetoid nature of its body and the nature of arrangement of its ocelli. Nature of arrangement of ocelli in *Lepidonella* is a character which it shares with *Bromacanthus*. It is although distinct from *Paronella* in the arrangement of ocelli, other characters cited by Yosii (1960) like achaetoid body and structure of scales (*i.e.*, typical scales) in *Lepidonella* are also found in *Paronella*. The nature of mucrones, the dental spines and other characters found in *Lepidonella tokiokai* correspond well to the characters of certain species previously described either under *Paronella*, *Pseudoparonella* or *Microparonella* from the Oriental Region. These species are as follows *Paronella picta* Schäffer, 1898; *Pseudoparonella incerta* Handschin, 1925; *Pseudoparonella nigrofasciata* Handschin, 1928; *Pseudoparonella papuanus* Womersley, 1937; *Microparonella* Yosii, 1966a; *Paronella subcarpenteri* Denis, 1948; and *Paronella annulicornis* (Oudemans, 1890) Schött (1903), Denis (1948)]. Although Yosii (*l. cit.*) recognised *L. tokiokai* as different from the species of the genera like *Pseudoparonella*, *Paronella* and *Microparonella*, nevertheless his comparison of *Lepidonella* with its related genera, as it appears now, needs further clarification. In this investigation a detailed comparative study of *Lepidonella* with its related genera is made with a view to finding out the exact relationship of the genus *Lepidonella* Yosii (1960) with its related ones.

Handschin (1925) confused *Lepidonella incerta*, n. comb. with *Bromacanthus setigera* (Börner, 1906) owing to some common features possessed by both the species belonging to two different genera. A few of such characters are : nature of scales clothing body (typical scales), presence of dental spines and arrangement of ocelli. He, however, either overlooked or neglected the nature of mucronal structures and its nature of articulation with dentes and the presence of femoral organ in *setigera*. As mentioned earlier in this study, *Pseudoparonella* Handschin with its type-species *P. appendiculata* Schött (1917) is a good member of the tribe Callyntrurini and thus it is widely different from *Lepidonella*, a member of the tribe Bromacanthini. Schäffer (1898) placed *picta* in the genus *Paronella* relying on the diagnosis of *Paronella* given by Schött (1893). Present comparative study on the basis of type-species of these genera reveals that *Lepidonella* is widely different from *Paronella* and other genera of the tribe Paronellini in the absence of extra ocular structure, nature of arrangement of ocelli, in the nature of mucrones and foot-complex. Over and above, it is specially distinct from *Paronella* in the absence of manubrial spines. *Lepidonella* is distinct from *Microparonella* in the absence of manubrial spines. *Lepidonella* is distinct from *Microparonella* in the presence of full complement of ocelli which are arranged in a circular pattern, in the presence of simple dental spines and moderately striated brownish scales (Hyaline scales in *Microparonella* cf. those of *Cyphoderus* and its other related genera). Furthermore, the nature of mucrones together with unguis and unguiculi in the two genera are different. Yosii (1966) described *Microparonella ceylonica* and proposed that *Lepidonella tokiokai* may be included in *Microparonella*. The genus *Lepidonella* is distinct from *Microparonella* in many salient features as mentioned above and, it is at any rate, can not be considered as a synonym of the latter genus

(Mitra, 2001a, in press). *Lepidonella* has many characters in common with *Bromacanthus*, like the general body facies, nature of arrangement of the ocelli, nature of scales clothing body and the general nature of unguis and unguiculi. It is distinct from *Bromacanthus* in the absence of femoral organ and in the nature of mucrones which are always with more than two teeth and apically located on dentes, in the absence of dental spiny appendages and in the presence of 2 rows of distinct dental spines. Moreover, the nature of dental spines and the nature of chaetotaxy of the anterior face of ventral tube and head are distinctly different in the two cited genera. Denis (1948), however, altogether missed the gulf of difference that exists between *Paronella*-like species of Indochina (now placed under *Lepidonella*) and *Paronella*-like species of the Ethiopian Region. He (l. cit.) most convincingly placed his new species *subcarpenteri* from Indochina in the genus *paronella* Schött and noted that the former group of species from Indochina differs from the latter only in their dark pigmented body. He, therefore (as he stated), named the new species from Indochina as *subcarpenteri* to recall its close phylogenetic affinity with *carpenteri* and other forms (CR I and CR II) of Costa Rica now placed under *Dicranocentruga* (Mitra, 2001b, in press). This investigation records that the two groups of species belong to two different genera which in turn belong to two different tribes. (Mitra, 1992a) stabilised the concept of *Paronella* on the basis of examination of the syntypes of the type-species *Paronella fusca* Schött, 1893 and it was concluded that the long heterogenous *Paronella* is represented by the type-species only. He also resolved the *Pseudoparonella* complex after examination of the type-specimens and other representative collections of the various species involved in this complex (Mitra, 1992b).

Lepidonella is a valid genus of Bromacanthini occurring chiefly in the Oriental South East Asian Islands and in some islands of the Australian Region and is distinct from the genera now placed under Bromacanthini. All the species described or placed under *Micrparonella* by Yosii (1981, 1983, 1989) are to be placed under *Lepidonella*. All the species described or placed under *Micrparonella* by Yosii (1981, 1983, 1989) are to be placed under *Lepidonella* Yosii, 1960.

Lepidonella Yosii, 1960

Lepidonella Yosii, 1960b, *Bull. Osaka Mus. Nat. Hist.*, 12 : 9-38.

Material examined : *Lepidonella picta* (Schaffer, 1898), n. comb. : 40 exs. in spirit in a vial, labelled as "Bismark island, Mussau Talumalus, 23 Jan, 1962, Noona Dan Expedition, 61-62 (caught in Malaise trap)", from the Zoological Museum, Copenhagen. 1 ex. On a slide, labelled as "Forest litter. Solomon is. Unsani River nr. Monitor Creek. 5.VII.1965. Mr. P. N. Lawrence. 43 Roy. Soc. Exped. Brit. Mus. 1966-I. "; 1x. on a slide, labelled as "Leaf litter. Solomon is. Guadalcanal. Umasani River. 2-6.VII.1965. P. N. Lawrence. Roy. Soc. Exped. Brit. Mus. 1966-I. "; 2 exs. on a slide, labelled as "Salomon Is. Guadalcanal. Umasani River. 2-6.VII.1965. P. N. Lawrence. Roy. Soc. Exped. Brit. Mus. 1966-I. P. N. Lawrence"; 1ex. On a slide, labelled as "Forest litter. Solomon Is. Umasani River. Guadalcanal. 2-6.VII.1965. P. N. Lawrence. Roy. Soc. Exped. Brit. Mus. 1966-I."; 1 ex. On a slide, labelled as "thick litter on matted roots. Solomon Is. Guadalcanal. Monitor Creek. Umasani River.

8.VII.1965. 73-86. P. N. Lawrence. Roy. Soc. Exped. Brit. Mus. 1966-I"; 1 ex. On a slide, labelled as "Solomon Is. Guadalcanal. Tenaru River. 24.X.1965. P. N. Lawrence. Roy. Soc. Exped. Brit. Mus. 1966-I."; from the British Museum (Nat. Hist.), London 1 ex. On a slide, labelled as "Solomon Is. Guadalcanal. Mt. Austen. 20.XII.1963. P. Greenslade. 11439"; 1 ex. On a slide, locality as above, date, 28.IV.1966. 22990; 1 ex. on a slide, locality as above, date, 15.IX.1963, 11259; 1 ex. on a slide, labelled as "Solomon Is. Guadalcanal Kukun. 26.II.1963. P. J. Greenslade. 4622."; 1 ex. on a slide, labelled as "Solomon is. Guadalcanal. Mt. Austen. 23.IV.1963, P. J. G. 6890."; 1 ex. on a slide, locality as above, 22.VI.1963. P. J. G. 6783. P. J. G. 6890."; 1 ex. on a slide, locality as above, 22.VI.1963. P. J. G. 6783.", from the Bernice P. Bishop Museum, Honolulu, Hawaii.

Lepidonella tokiokai Yosii (1960) : 1 ex. mounted on a slide, labelled as "Solomon Is. Guadalcanal. Mt. Austen. 20.XII.1963. P. J. G. 11439."; 1 ex. mounted on a slide, labelled as "Solomon Is. Guadalcanal, Kukun. 21.I.1965 P. J. G. 15512."; 1 ex. mounted on a slide, labelled as "Solomon Is. Guadalcanal. Mt. Austen. 7.V.1963. P. J. G. 6277."; 1 ex. on a slide, labelled as "Solomon Is. Guadalcanal. Mt. Austen. 20.V.1963. P. J. G. 6160."; 1 ex. on a slide, labelled as P. N. L. Roy. Soc. Exped. Brit. Mus. 1966-I."; 1 ex. on a slide, labelled as "Thick litter on matted roots"; other details as above, from the British Museum (Nat. Hist.), London. 1 ex. on a slide, labelled as "Solomon Is. Guadalcanal. Mt. Austen. 20.XII.1963. P. J. G. 11439."; 1 ex. on a slide, labelled as above. 9.VII.1963. P. J. G. 1118; 1 ex. labelled as above, 9.VII.1963. P. J. G. 1118; 1 ex. on a slide, labelled as above, 23.IV.1963. P. J. G. 6890, from the Bernice P. Bishop Museum, Honolulu Hawaii.

**Lepidonella* sp. (b) : 2 exs. on a slide, labelled as "Leaf litter. Solomon Is. Guadalcanal. Umasani River. 26.VII.1965. P. N. L. Roy. Soc. Exped. Brit. Mus. 1966-I."; 2 exs. on a slide, labelled as above, date 2-6.VII.1965; 1 ex. on a slide, labelled as above; 1 ex. on a slide, labelled as above, Petero coll. 8.VII.1965, from the British Museum (nat. Hist.), London.

**Lepidonella* sp. © : 4 exs. on a slide, labelled as "Forest litter. Solomon Is. Guadalcanal. Nubu. 28.X.1965. P. N. L. Roy. Soc. Exped. Brit. Mus. 1966-I (1001-1006)"; 1 ex. mounted on a slide, labelled as "Forest Litter. Solomon is. Guadalcanal. Umsani River. 2-6.VII.1965. P. N. L. Roy. Soc. Exped. Brit. Mus. 1966-I.", from the British Museum (Nat. Hist.), London. 1 ex. on a slide, labelled as "Solomon is. Guadalcanal. Mt. Austen. 28.IV.1966. P. Greenslade. 22990.", from the Bernice P. Bishop Museum, Honolulu, Hawaii.

**Lepidonella* sp. (d) : 2 exs. on a slide, labelled as "Forest litter. Solomon Is. Guadalcanal. Nubu. 28.X.1965. 1001-1056. P. N. L. Roy. Soc. Exped. Brit. Mus. 1966-I.", from the British Museum (Nat. Hist.), London.

**Lepidonella* sp. (e) : 2 exs. mounted on a slide, labelled as "Forest litter. Solomon Is. Guadalcanal. Tenaru River. 24.X.1965, P. N. L. Roy. Soc. Exped. Brit. Mus. 1966-I.", from the British Museum (Nat. Hist.), London.

Pseudoparonella papuanus Womersley Holotype from the British Museum Natural History, London., mounted on a slide.

Pseudoparonella incerta Handschin Holotype, mounted on a slide, from Natural History Museum, Basel, Switzerland.

Redefinition Body may be lepidocyrtiform or normal; usually darkly pigmented; antennae sub-equal or shorter than body; trochanteral organ consists of a few well developed spines; hind femur without any specialised setae on inner surface (*i.e.*, femoral organ absent); Ant. II without sensory pegs; ventral tube anteriorly on anterior face with five macrochaetae on either side of the ventral groove, insertion of which characteristic for the genus; dentes with two rows of simple spines, outer row sometime feeble; mucro small, apically located on dentes and not clearly demarcated from it, with 3-4 teeth; dentes does not continue as a spoon-shaped process beyond mucro; dental spiny appendages not distinct; clothed with larger round to elongate typical scales (cf. *Bromacanthus*); flexed macrochaetae on body absent (achaetotic body); lasiotrichia present as on Abd. II (2+2), Abd. III (3+3), Abd. IV (2+2); bases of lastotrichia with some specialised accessory scales, number and arrangement of which fixed.

Type-species : *Lepidonella tokiokai* Yosii, 1960, by original designation.

DESCRIPTION OF THE TYPE-SPECIES

Lepidonella tokiokai Yosii, 1960

(Figs. 4–6)

1960b. *Lepidonella tokiokai*, *Bull. Osaka Mus. Nat. Hist.*, **12** : 9-38.

Material As mentioned above under genus.

Colouration : Ground colour of body whitish when denuded off scales, brownish when scales retained; purple to blue-black pigment present on the tergal margins of Ths. II, III and Abds. I, II in the form of two interrupted stripes; Abd. IV with two pairs of characteristic patches—1 pair located medially covering the bases of lasiotrichia, always conspicuous and the other pair posteriorly near the margin of the segment; the posterior pair of patches on this segment (Abd. IV) often reduced (Yosii, 1960b, although, in illustration indicated the presence of a pair of small patches posteriorly on Abd. IV, he, however, in the description mentioned only a pair of median patches on this segment); median and posterior patches on Abd. IV sometime tend to confluent with each other; Abd. V with a pair of patches, one on either side; Abd. VI devoid of any darker patch; head with two almost circular ocellar patches, interantennal surface dark-black, region posteriorly each ocellar field with a faint blue patch; Ant. I without pigment, Ants. II and III distally and on margins with deep purple pigment, Ant. III may be entirely dark, Ant. IV all along with deep purple pigment; coxae and sub-coxae with purple pigment, trochanter, femur and tibiotarsus usually devoid of pigment, tibiotarsus rarely on inner margin with faint violet pigment; furcula not pigmented.

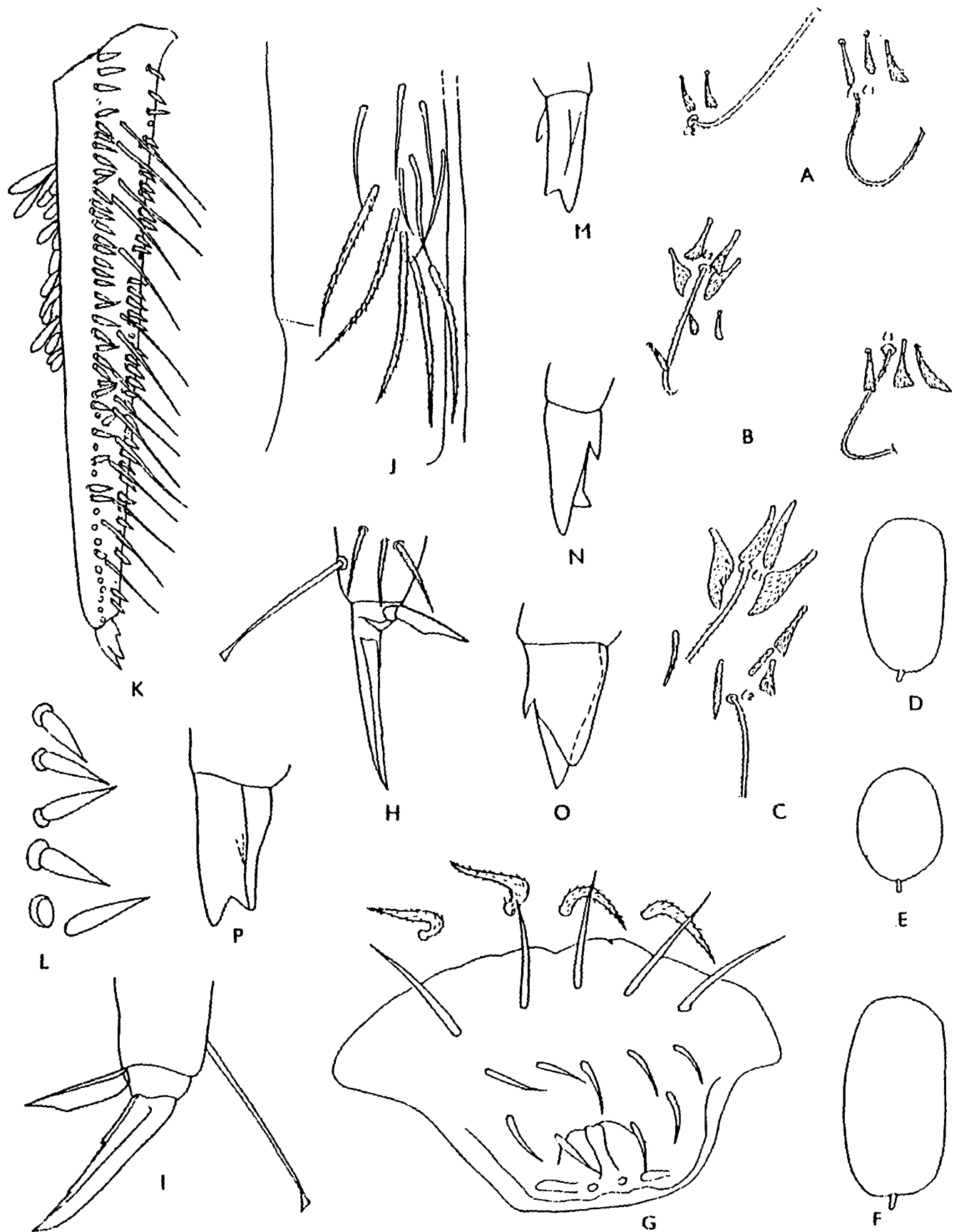


Fig. 4. : *Lepidonella tokiokai* Yosii. A : lasiotricha and accessory scales from abd. II; B : lasiotrichia and accessory scales from abd. III [13 not shows]; G : lasiotricha and accessory scales from abd. IV; D, E, F : scales from body; G : labral chaetotaxy; H : footcomplex of leg I; I : footcomplex of leg II; J : chaetotaxy of the anterior face of ventral tube; K : dentes showing arrangement of spines; L : dental spines (magnified); M-P : mucrones in different views.

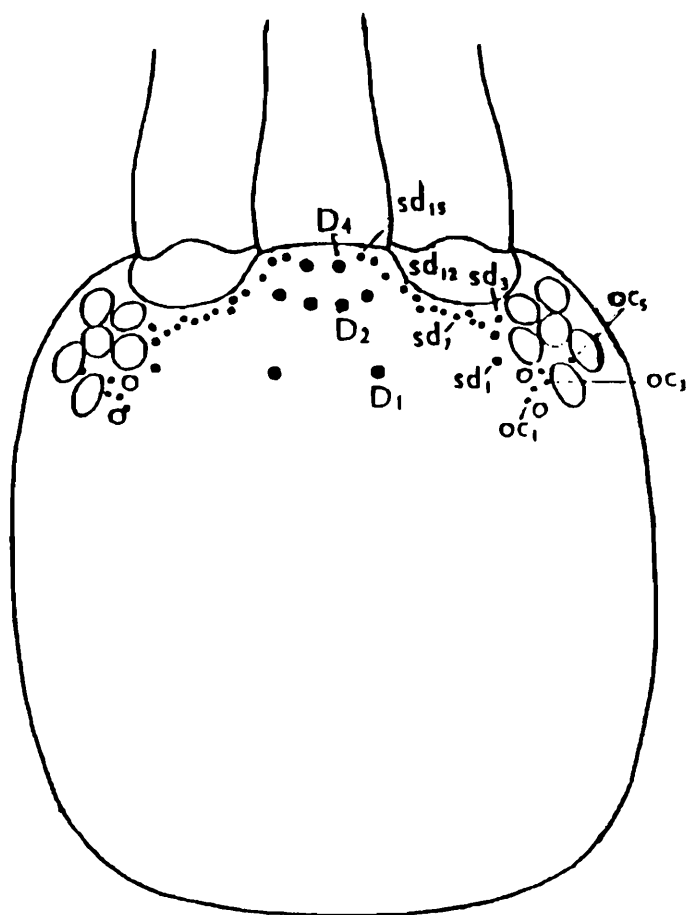


Fig. 5. : *Lepidonella tokiokai* Yosii. Cephalic chaetotaxy.

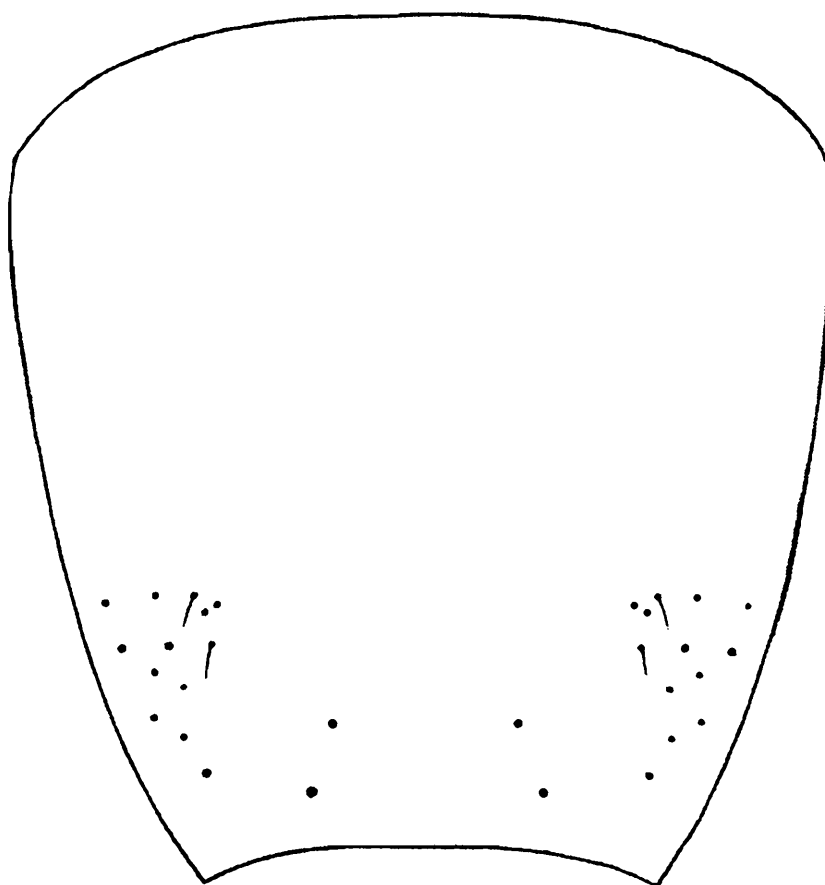


Fig. 6. : *Lepidonella tokiokai* Yosii. Chaetotaxy of Abd. IV.

Clothing : Body clothed with elongate and oval true or typical scales with faint, short striations (Plate Nos, 15, 16, 84); in general achaetotic, Abd. III laterally and Abd. IV posterolaterally with a few long, acuminate setae; lasiotrichia present as on Abd. II (2 + 2), Abd. III (3 + 3) and Abd. (2 + 2), each at its base with some specialised accessory scales, number and arrangement of which fixed thus on Abd. II : 1 (3), 1 (7); Abd. III : 1 (3), 1 (7), 1 (not noted); Abd. IV : 1 (4) (Figs. 4, A, B, C); head with a few short, broad, acuminate setae anterodorsally; antennae clothed with short, acuminate setae, arranged in the form of whorls, apical sense-knob on Ant. IV inconspicuous, Ant. IV in addition to the usual ciliated setae with certain apparently smooth setae; legs clothed with short, acuminate, ciliated setae; furcula clothed with setae similar to those on legs and claviform scales dorsally; chaetotaxy of head and body as in Figs. 5 and 6.

Head : Almost circular when viewed dorsally, frontal spines absent; ocelli 8 + 8, arranged in a circular pattern with ocellus B located almost centrally within each field, ocelli G and H reduced; prelabral setae 4, ciliated, labral setae, 5, 5, 4, smooth (Fig. 4, G); antennae shorter than half the length of body, relative length index of Ants. I : II : III : IV = 3 : 5 : 7 : 6 : 8.

Thorax : Th. II slightly elevated anteriorly, relative length index of Ths. II : III = 35 : 12; unguis and unguiculi on fore legs shortest, those on hind legs longest; each unguis on inner margin with paired basal and a distal unpaired teeth in between paired basal and distal unpaired teeth on fore unguis which, however, not noted in the specimens examined in this study), tenent hair long, elevate (Fig. 4, H, I); trochanteral organ consists of a few (c. 30) well developed spines.

Abdomen : Relative length index Abds. I : II : III : IV : V : VI = 6 : 11 : 10 : 71 : 8 : 5; ventral tube long with protrusible vesicles retracted or everted, anterior face or ventral tube anteriorly with five macrochaetae on either side of the ventral groove, rest of the surface of anterior and posterior faes with microchaetae only (Fig. 4, J); remi of retinaculum each with four teeth, corpus with a median seta; manubrium and dentes sub-equal, dentes does not taper distally, with two rows of nontransiting, simple spines (Figs. 4, K, L); mucrones demarcated or nondemarcated from dentes, principally with two teeth apical and anteapical, innerbasal tooth well developed, a prominent ridge runs from the apex of the anteapical tooth toward the base of mucrone, dental spiny appendages absent (Figs. 4, M-P).

Length (excluding appendages) : c. 1.5 mm.

Type-locality : Bouin, Bougainville, Solomon Islands.

Comparisons : The present investigator examined a number of specimens of the species from many localities of Guadalcanal, Solomon Islands, collected by Mr. P. N. Lawrence of the British Museum (Nat. Hist.), London, during the Royal Society Expedition (1965-66) and Mr. P. J. Greenslade of the Bernice P. Bishop Museum, Honolulu, Hawaii. The species is characterised by the presence of darker patches on targal margins of thoracic and abdominal segments and also in the presence of two pairs of symmetrical patches on either side of Abd. IV. Colour forms of the

species having reduced patches posteriorly on Abd. IV, resemble to some extent to *Lepidonella picta* (Schäffer), n.comb. and *Lepidonella annulicornis* (Oudemans), n.comb. Such colour forms of the type-species, however, retain the darker patches on tergal margins which are absent in *L. picta*. Schäffer (1898) although, did not make a direct mention of the presence of dental spines in his *P. picta*, he however, clearly indicated the presence of very strong obliquely standing hairs on upper side of dentes upto mucrones. Now examination of the topo-types of the species proves it to be good member of the genus *Lepidonella*, Yosii (1960) himself also compared the type-species with *L. picta*. Further, the type-species appears very close to *Lepidonella subcarpenteri* (Denis, 1948), n.comb. from Indochina in colour pattern; the lanceolate unguiculi in the latter species is the only character which separates the two species. Nature of unguiculi appears to be group-specific in this genus. The type-species differs from *Lepidonella incerta* (Handschin, 1925), n.comb., *Lepidonella nigrofasciata* (Handschin, 1928), n.comb. by its characteristic mucrones which lack the intermediate tooth (i.t.) and in the nature of body facies which is not strongly lepidocyrtiform.

Interrelationships : *Lepidonella* is related to *Bromocanthus* by virtue of certain common characters which are not found in any other genus under Paronellinae. The arrangement of ocelli appears to be a common primitive character retained by both the genera and thus hints at their probable common ancestry. Moreover, the structure of ungues and unguiculi in the two genera are also similar. *Lepidonella*, however, is distinctly different from *Bromacanthus*, as mentioned earlier, in the nature of its mucrones which are always with more than two teeth and apically located on dentes. Further, the absence of distinct dental spiny appendages and femoral organ also clearly make *Lepidonella* distinct from *Bromacanthus*. It is related to *Paronella* and its allied genera in the nature of scales clothing body (typical scales) and achaetotic body. It is, however, phylogenetically quite distinct from them in the absence of E.O.S. and in other fundamental features. *Lepidonella* differs from *Microparonella* in the nature of mucrones and dental spines, in the structure of ungues and unguiculi and in the presence of full complement of ocelli. Further, the species of *Microparonella* as a result of some sort of cavernicolous or euedaphic adaptation do not have dark pigmentation on body. The contrary, the species of *Lipidonella* are usually dark pigmented.

Distribution : The genus is chiefly distributed in the Oriental South East Asian Islands and in the islands of the Australian Region. Its presence in Ceylon, Indochina and India (Bombay) [*L. ceylonica* (Yosii) 1966 and *L. subcarpenteri* (Denis) 1948] indicates its possible wide distribution in the Oriental and Australian Regions.

Species included : *Lepidonella tokiokai* Yosii, 1960. *Lepidonella picta* (Schäffer) 1898. New Combination. *Lepidonella incerta* (Handschin) 1925. New Combination. *Lepidonella nigrofasciata* (Handschin) 1928. New Combination. *Lepidonella papuanus* (Womersley) 1937. New Combination. *Lepidonella ceylonica* (Yosii) 1966. New Combination. *Lepidonella annulicornis* (Oudemans). New Combination. *Lepidonella subcarpentari* (Denis) 1948. New Combination. *Lepidonella oudemansi* (Yosii) 1983. New Combination.

***Bromacanthus* Schött, 1925**

Bromacanthus Schött, 1925. *Sarawak Mus. Jour.*, **3** : 107-127

Pseudoparonella s. str. Handschin, 1925. *Treubia*, **6** : 225-270 (in press).

Handschinella Yosii, 1959b. *Contr. Biol. Lab., Kyoto Univ.*, **10** : 1-65.

Redefinition : Body often conspicuously lepidocyriform; usually devoid of dark pigmented patches; antennae shorter or sub-equal to body; trochanteral organ consists of large number of smaller spines; each of hind femora with c. 3 rows of blunt, specialised, ciliated setae (“femoral organ”, Yosii, 1959b); ventral tube anteriorly on anterior face with 5 macrochaetae on either side of the ventral groove, arranged in 2 distinct rows, a characteristic feature of the genus; dentes with an inner row of well developed striated spines, due to such striations the spines often look serrated on surface, outer row poorly developed (more setiform than spiniform); mucro bidentate, sub-apically located on dentes tip of dentes projects beyond mucrone in the form of a spoon-shaped process (“loffelartig” of Börner, 1906 in *P. setigera*) of mucronal end of the sub-genus *Pseudoparonella*; 2 large ciliated dental spiny appendages present dorsally near base of each mucrone, 1 located apically and the other sub-apically; macrochaetae absent on vertex and on area dorsalis of head.

Body clothed with larger, round, elongate and oval scales, scales always with round apices (typical scales); flexed macrochaetae on body absent (achaetoic body).

Type-species *Bromacanthus handschini* Schött, 1925, by monotypy.

DESCRIPTION OF THE TYPE-SPECIES***Bromacanthus handschini* Schött, 1925**

(Figs. 1–3; 7, 8)

1925. *Bromacanthus handschini*, Schött, *Sarawak Mus. Jour.*, **3** : 107-127.

Material : 2 slide-preparations of Schött : Slide No. 878, labelled as “*Bromacanthus handschini* n. sp. Borneo, H.S.” Slide No. 879, labelled as “*Bromacanthus handcini* n. sp. Borneo, H.S.”—From Swedish Museum Natural History, Stockholm, Sweden, 15 exs. in 1 vial labelled as “Biak : Mangrowawa, 30-31-V.1959, Gressitt. Coll. Rotton Leaves” from the Bernice P. Bishop Museum, Honolulu, Hawaii.

Colouration : Ground colour pale yellow; darker pigment if present localised along tergal margins, Ants. I, II, III mostly non-pigmented, IV occasionally with dark bluish pigment; appendages with faint blue pigment, ventral tube and furca without pigment (Fig. 2, A).

Clothing : Body achaetoic, clothed heavily with scales nearly spherical in shapes and secondarily may be of other configurations, but always with rounded apices. (Fig. 1, A-D). 2 + 2 lasiotrichia

on Abds. II and IV, 3 + 3 on Abd. III; bases of lasiotrichia with certain specialised, small club-shaped scales, Abd. IV with certain non-flexed macrochaetae; Ants. III and IV in addition to the usual ciliated setae, with certain erect smooth setae, microchaetae on Ant. IV arranged in distinct whorls which make the segment appear annulated; appendages clothed with scales and setae, manubrium and dentes dorsally clothed with elongate, claviform scales and ventrally with spines and setae; chaetotaxy of head and body as in Figs. 7 and D.

Head : Somewhat oval in outline when viewed dorsally; without frontal spines; ocelli 8 + 8, G and H reduced, arrangement of ocelli characteristic, ocellus B displaced occupying a more or less central position in each ocellar field (Fig. 2, B); prelabral setae 4, ciliated, labral setae, 5, 5, 4, anterior margin of labrum with 4 tubercles (Fig. 4, C); antennae shorter or sub-equal to the length of body; relative length index of Ants. I : II : III : IV = 10 : 14 : 9 : 21, Ant. IV apically without distinct sense knob, but with some apparently smooth setae.

Thorax : Th. II convex, little overarched anteriorly; relative length index of Ths. II : III = 37 : 15; ungues and unguiculi of fore and middle legs more elongate than the hind legs (Fig.), hind ungues more curved than fore and middle ones; ungues with paired inner basal teeth moderately developed, followed by two conspicuous unpaired distal teeth; unguiculi of all legs appear truncate or sub-lanceolate type, inner truncated angles not much prominent; tenent hair long, well developed, clavate (1, E, F); tibiotarsal lobes not conspicuous; trochanteral organ with many (c. 65) very short

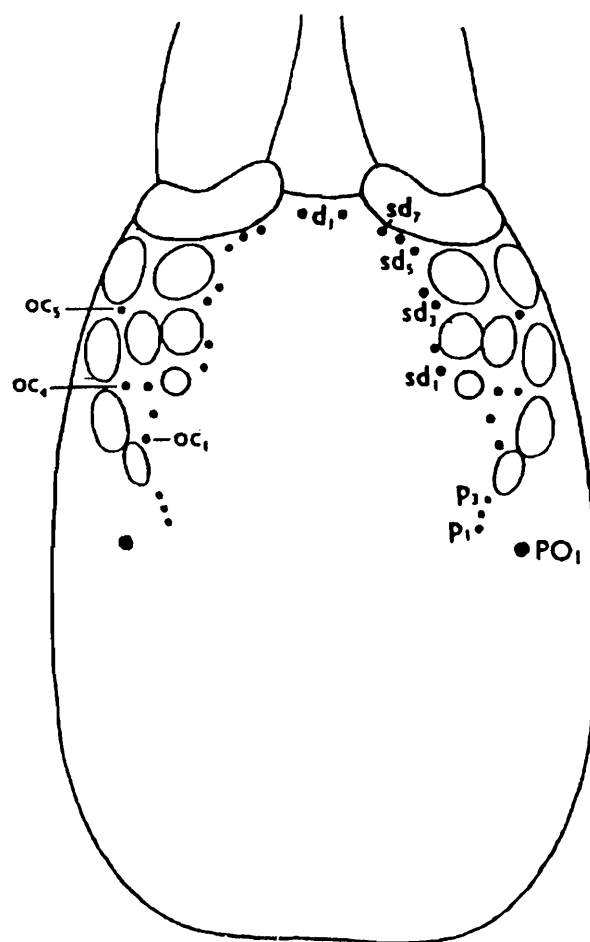


Fig. 7. : *Bromacanthus handschini* Schött. Cephalic chaetotaxy.

spines, 2 apical spines being longer than the rest (Fig. 1, G), femoral organ well developed consisting of c. 20 peculiar club-shaped minutely ciliated spiny setae, arranged in 3 indistinct rows, each such seta with a depression on inner surface, guarded on outer side with 3 longer and 1 smaller setae and on inner margin with a few simple setae (Fig. 1, H).

Abdomen : Relative length index of Abds. I : II : III : IV : V : VI = 11 : 4 : 7 : 10 : 86 : 7 : 5; ventral tube moderately long, anterior face of ventral tube anteriorly with 5 + 5 macrochaetae, inserted in a characteristic manner (Fig. 1, 1), general surface of anterior and posterior faces clothed with scales and simple microchaetae; rami of retinaculum each with 4 teeth, corpus with a median seta; furcula shorter than body, scarcely tapers distally; dentes longer than manubrium, relative length index of manubrium : mucrodens = 21 : 24; each dentes armed with an inner row of spines, each such spine with some longitudinal striations on the surface which give it an appearance of serrations, outer margin of dentes without spines (Fig. 2, D, E); dentes anteriorly projected beyond mucro in the form of a spoon-shaped process; mucro not clearly demarcated from dentes, bidentate, teeth being curved apically in many examples (2, F, G).

Length : (excluding appendages) : upto 2 mm.

Type-specimens : Schött (1925) based the description of his new genus and species on 3 exs., which came from Borneo. He did not select any type of the type-species. Two slides available from the Swedish Museum Natural History, Stockholm, Sweden, indicate the locality of the

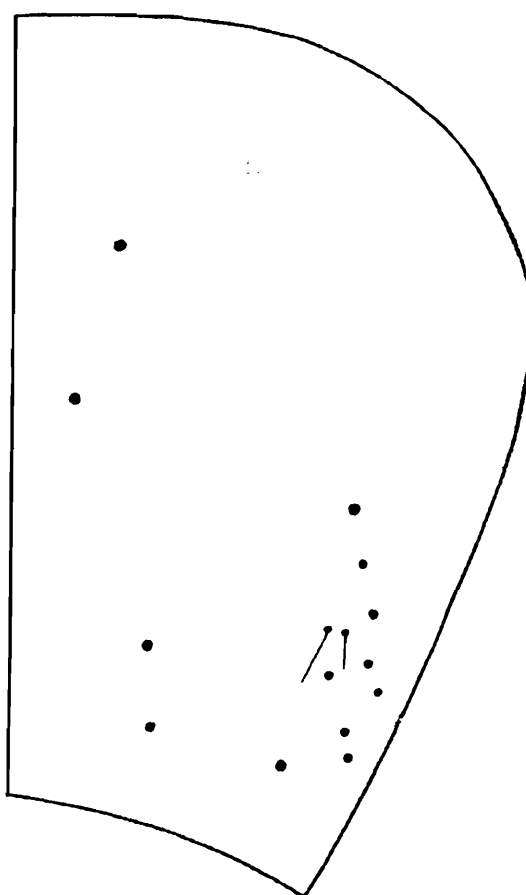


Fig. 8. : *Bromacanthus handschini* Schött. Chaetotaxy of Abd. IV.

specimens as that of the locality mentioned by Schött (1925) in the text. Thus these slides should be regarded as the syntypes of *Bromacanthus handschini*. Unfortunately, no entire specimen is mounted on any of the 2 slides and the investigator takes opportunity to label the Slide No. 878 as the lectotype which represents the femoral organ, a most characteristic feature of the genus.

Type-locality : Mount Dulit, North Sarawak, Borneo.

Comparisons The genus is known by two more species viz., *Bromacanthus setigera* (Börner, 1906), n. comb. and *Bromacanthus orientalis* (Handschin, 1930), n. comb. *Bromacanthus handschini* Schött although appears identical with *B. setigera*, further investigations are needed to establish their actual relationship. *B. orientalis* always have dark pigmented hind trochanter (as mentioned by Handschin, 1930) unlike the other two species. Studies on chaetotaxy of Abd. IV, as done by Snider (1961) in *Lepidocyrtus*, may perhaps reveal the actual relationship of these species.

Interrelationships Phylogenetically, *Bromacanthus* has close affinity to *Lepidonella* Yosii (1960b) in the presence of 8 + 8 ocelli which are arranged in a circular pattern with ocellus B located almost centrally in each ocellar field, in the general body facies and in the nature of unguis and unguiculi. However, it is distinct from *Lepidonella* in the nature of mucrones which is always bidentate and sub-apically located, in the presence of 2 distinct dental spiny appendages and specialised femoral organ. Furthermore, nature of dental spines, chaetotaxy of the anterior face of ventral tube and head also distinctly separate it out from *Lepidonella*. *Bromacanthus* is also distinct from *Microparonella* Carpenter and *Trichorypha* Schött in the characters, as mentioned above.

Bromacanthus appears to have a distinct relationship with the genera under Lepidocyrtini. This is indicated by the general body facies, nature of scales clothing body (typical scales), achaetotic body ("lepidosis", Yosii, 1961) and in the arrangement of ocelli.

Distribution : The members of the genus are so far known to be chiefly distributed in the Oriental South East Asian Islands including Malayan Archipelago. Handschin (1926) recorded a member of this genus viz., *Bromacanthus setigera*, n. comb. (Börner, 1906) from Philippines and not from New Caledonia as Salmon (1954b) mentioned. Its present record from Biak (an oceanic island in the Australian Region) stands, therefore, as the first record of this genus from this Region.

Species included : *Bromacanthus handschini* Schött, 1925; *Bromacanthus setigera* (Börner) 1906. New Combination; *Bromacanthus orientalis* (Handschin) 1930. New Combination; *Bromacanthus elongatus* Yosii, 1981, *Bromacanthus flavidulus* Yosii, 1981; *Bromacanthus palawanicus* Yosii, 1983; *Bromacanthus halmaherae* Yosii, 1983; *Bromacanthus seramensis* Yosii, 1989.

SUMMARY

The concepts of *Lepidonella* Yosii, 1960 and *Bromacanthus* Schött, 1925 are precised in this investigation on the basis of examination of type-specimens and other representative material of the related species.

Lepidonella Yosii, 1960 is a valid genus and the *Paronella*—like species of Oriental South East Asian Islands (predominantly now known under *Pseudoparonella*) are to be placed in this genus. *Lepidonella* is distinct from *Microparonella* Carpenter, 1916 (Mitra, 2001a, in press).

Bromacanthus Schött, 1925 is a specialised genus having a very conspicuous femoral organ, occurring both in the Oriental South East Asian Islands and islands in the Australian Region. On examination of the type-specimens, it is now proved that femoral organ of *Handschinella* Yosii, 1959 is identical to the characteristic structures of hind femora, described by Börner (1906), Schött (1925) and Handschin (1930). It is, therefore, conclusively proved that *Handschinella* Yosii, 1959 is a synonym of *Bromacanthus* Schött, 1925.

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I am also grateful to the authorities of the Natural History Museum, Basel, Switzerland for permitting me to resurrect and study the type-specimens of the species, described by Prof. Handschim.

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

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**FIRST REPORT ON THE OCCURENCE OF
MACRACANTHORHYNCHUS HIRUDINACEUS (PALLAS, 1781) AND
POLYMORPHUS MAGNUS SKRJABIN, 1913 (ACANTHOCEPHALA)
IN WILD PIG AND GARGANEY TEAL IN INDIA**

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INTRODUCTION

The acanthocephalan parasites recorded herein were collected from the intestine of wild pig (*Sus scrofa cristatus*) at Raimona, Dist. Goalpara, Assam and from the intestine of Garganey Teal (*Anas querquedula*) at Allahabad, U.P. The occurrence of *M. hirudinaceus* in domestic pig (*Sus scrofa domestica*) has been reported from Bengal and Western Uttar Pradesh by Maplestone (1930) and Ahluwalia (1962) respectively. The occurrence of these parasites in wild pig of India has been reported for the first time from Assam, India.

Fotedar and Dhar (1973) reported some late juveniles of *P. magnus* in *Rana cyanophlyctis* from Kashmir but no adult forms of the worm have so far been reported from India. Few adults of *P. magnus* were found in the intestine of Garganey Teal (*Anas querquedula*) at Allahabad, U.P. Garganey Teal is a Palaearctic breeding species wintering in Europe, South America, and southern Asia. Both the species have been redescribed here.

MATERIALS AND METHODS

Some of the specimens of *M. hirudinaceus* were dissected for studying the internal organs owing to their large size and thick cuticle. The proboscis and hooks were studied in higher concentration of glycerine. The specimens of *P. magnus* were studied in whole mounts after staining them in haematoxyline and borax carmine. All measurements are in millimeters unless otherwise stated.

SYSTEMATIC ACCOUNT

Class ARCHIACANTHOCEPHALA Meyer, 1931

Order GIGANTORHYNCHIDA Southwell et Macfie, 1925

Family OLIGACANTHORHYNCHIDAE Southwell et Macfie, 1925

Sub-family MACRACANTHORHYNCHINAE Yamaguti, 1963

Genus *Macracanthorhynchus* Travassos, 1917

Macracanthorhynchus hirudinaceus (Pallas, 1781)

(Plate-1. Figs. 1-3)

Ref. *Macracanthorhynchus hirudinaceus* (Pallas, 1781), Ahluwalia, S. S. (1959), from pig in U.P. Ind. J. Vet. Sci. Anim. Husband. **29**(2/3) 100-107.

Macracanthorhynchus hirudinaceus (Pallas, 1781), Maplestone, P. A. (1930), from pig in W. Bengal, Rec. Ind. Mus. **32**(2) : 77-105.

Three male and three female specimens were collected from wild pig. The specimens have been deposited in the National Collection of Zoological Survey of India under Reg. No. W 8319/1.

Description : Male : Large, anterior half broad, pseudometamerism present, 40-75 long and 3.5 wide. Proboscis orbicular, 0.625 long and 0.875 wide, hooks in 6 spiral rows with 6 hooks in each row, last hooks of each row smaller than the rests, point, the part of hook outside the cuticle 0.15-0.25 long. Neck 1.325 long. Proboscis sheath short. Lemnisci two, very long, coiled, 21.5 long and 1.5 wide, posteriorly broad with few giant nuclei. Testes oval, pre-equatorial, contiguous. Cement gland 8, ellipsoidal, in pairs. Bursa 3.00 long.

Female : Larger than male, 225.00-1100.00 long and 8.7-10.00 wide, ventrally curved, anterior half broad, pseudometamerism present, posterior half very thin. Proboscis orbicular, 0.875 long and 1.125 wide, hooks in 6 spiral rows of 6 hooks in each, point of hook 0.15-0.25 long. Eggs 0.08-0.09 long.

Host : *Sus scrofa cristatus* (Wild pig).

Location : Intestine.

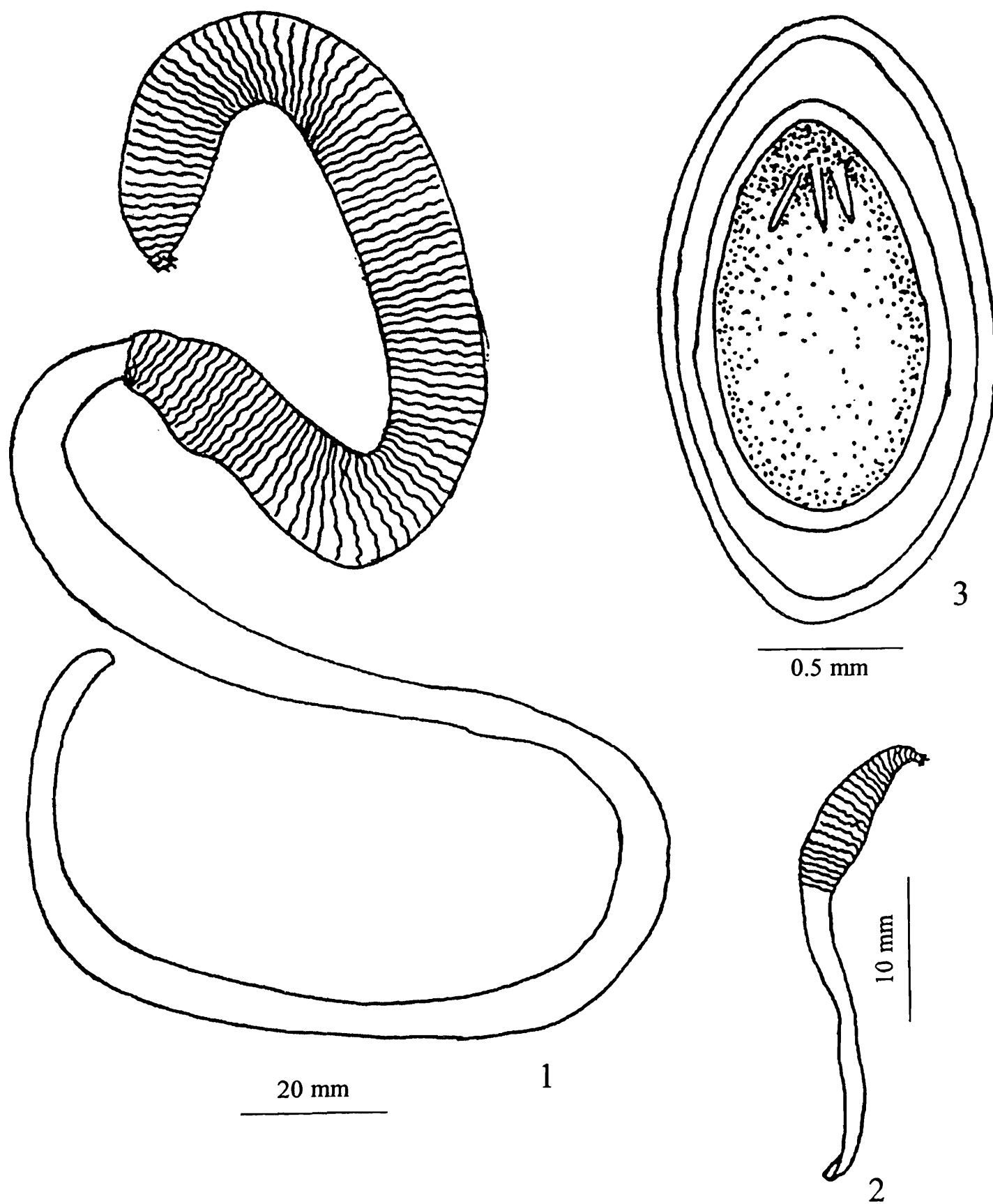
Locality : Raimona, Dist. Goalpara, Assam.

Collector : Dr. B. K. Tikadar, Z. S. I.

Discussion : Pallas (1781) described *Taenia hirudinacea* from pig. Muller (1776) established the genus *Echinorhynchus* for the species and named as *E. hirudinacea* (Pallas, 1781). Hamann (1892) named it *Gigantorhynchus gigas* (Bloch, 1782). Later, Travassos (1917) redescribed it as *M. hirudinaceus*.

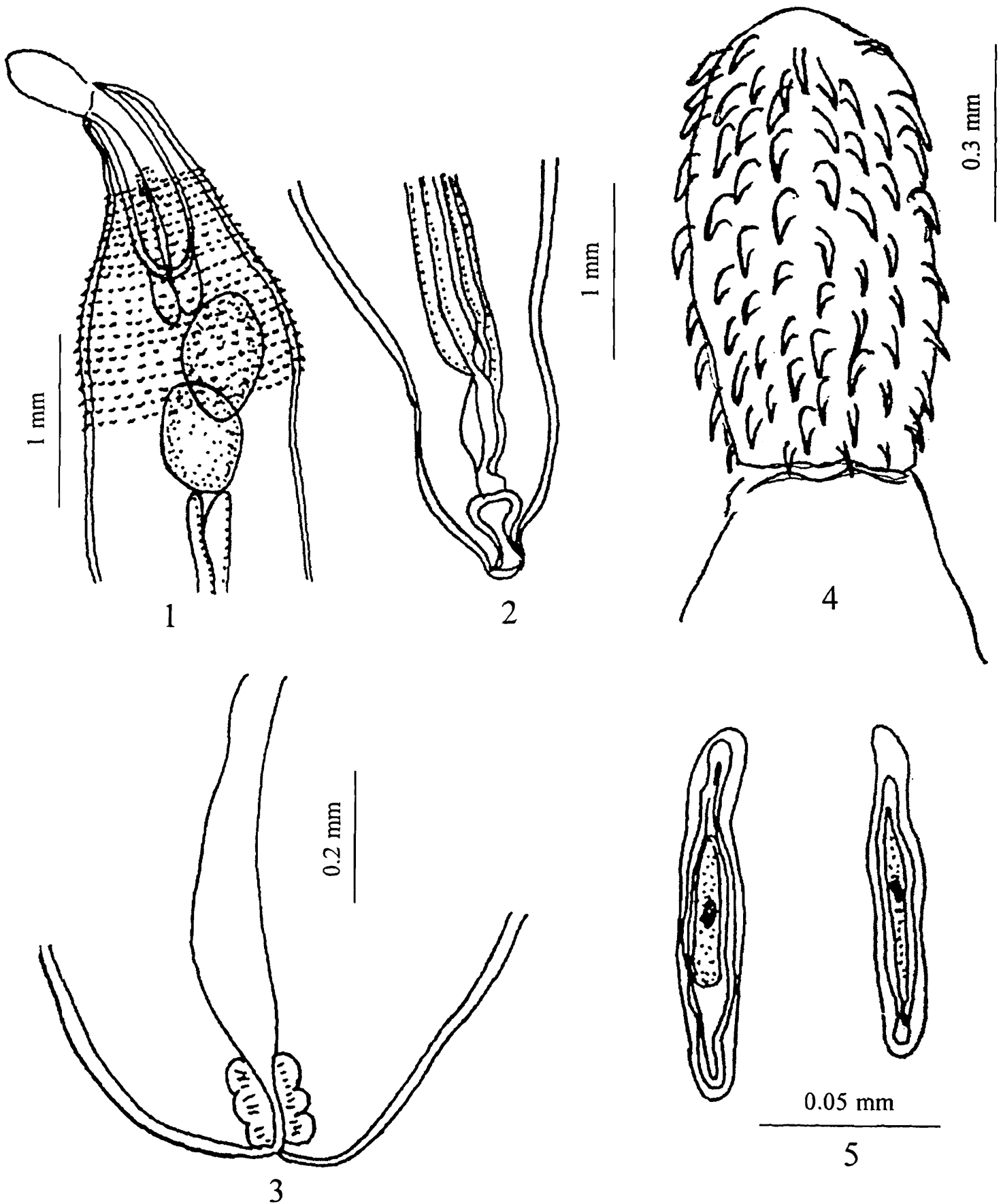
The present form differs from *M. ingens* (Linstow, 1879) Meyer, 1933 and *M. catulina* Kostlew, 1927 in having the size of points of largest hooks less than 0.30 long. *M. hirudinaceus* from *Sus scrofa cristatus* has been reported here for the first time from India. Maplestone (1930) and Ahluwalia (1959, 1962) redescribed the species from *Sus scrofa domestica* from West Bengal and Western U.P. respectively. The species has been redescribed here with a new host record from India.

PLATE-1



Figs. 1-3. : *Macracanthorhynchus hirudinaceus* (Pallas, 1781)

PLATE-2



Figs. 1-5. : *Polymorphus magnus* Skrjabin, 1913

1-anterior half; 2-posterior end of male; 3-posterior end of female; 4-proboscis; 5-eggs.

Class PALAEACANTHOCEPHALA Meyer, 1931

Order POLYMORPHIDA Petrotschenko, 1958

Family POLYMORPHIDAE Meyer, 1931

Genus *Polymorphus* Luhe, 1911

Polymorphus magnus Skrjabin, 1913

(Pate-2; Figs. 1-5)

Ref. *Polymorphus magnus* Skrjabin, 1913 : Fotedar D. N. and Dhar R. L. 1973, juvenile species in *Rana cyanophlyctis* in Kashmir. J. Sci. University of Kashmir, Vol. 1 (1-2).

Three male and three female specimens were collected from Garganey Teal in U.P. They are deposited in the National Zoological Collection of Zoological Survey of India. Under Reg. No. W8320/1.

Description : Male : Body small, fusiform, broad anteriorly, constricted at the testicular region, 5.875 long and 1.125 wide. Proboscis ovate, 0.55 long and 0.32 wide, proboscis hooks in 14-16 rows with 8-9 hooks in each row, anterior 4 hooks of each row large with prominent roots, size of hooks 0.415-0.585 long and 0.016-0.0249 wide. Neck conical, 0.7 long and 0.425 wide. Proboscis sheath double walled, 1.25 long and 0.375 wide, ganglion near centre. Lemnisci longer than proboscis sheath, leaf-like, equal, 1.625 long and 0.2 wide. Body spines in 18-20 rows with 28-30 in each row, size of spines 0.249 long, spines extend from below the neck to the area of body constriction. Testes two, oval, contiguous, T₁-2.25 long and 0.425 wide, T₂-2.125 long and 0.425 wide. Cement gland 4, 2.125 long. Bursa 0.624 long.

Female : Body longer than male, 8.125-8.3 long and 1.70-1.75 wide. Spines 20-26 rows with 30-40 spines in each row. Proboscis ovate, 0.55 long and 0.32 wide. Neck 1.125 long and 0.575 wide. Proboscis sheath 1.5 long and 0.25 wide. Uterus long. Genital pore terminal. Eggs elliptical with polar prolongations of the middle shell, 0.058-0.107 long and 0.016 wide.

Host : *Anas querquedula* (Garganey Teal).

Location : Intestine.

Locality : Allahabad, U.P.

Discussion : Luhe (1911) erected the genus *Polymorphus* with the type species *P. minutus* (Goez, 1782). Ralliet (1919) synonymised *Echinorhynchus boschadis* Schrank, 1788 with *Polymorphus*. Yamaguti (1963) described *Polymorphus boschadis* (Schrank, 1788) as the type species of the genus *Polymorphus*. This appears to be erroneous. Both *E. minutus* and *E. boschadis* have been synonymised with *Polymorphus* by Luhe (1911) and Ralliet (1919) respectively. As a rule, *E. minutus* (Goez, 1782) claims its priority over *E. boschadis*. Therefore, *P. minutus* is prior to *P. boschadis*. Thus, *P. minutus* as the type species of *Polymorphus* is justified.

P. minutus resembles *P. magnus* except in length of the body, size of proboscis, size of hooks etc. The present form closely resembles *P. magnus* with respect to body length, length of proboscis, number of hooks, size of hooks etc. Variation in egg size and body spines between the two is carefully observed.

Hence, the species is reported here as *P. magnus* with a new host record from India. Juvenile of *P. magnus* has also been reported in *Rana cyanophlyctis* by Fotedar et al (1973) from Kashmir.

SUMMARY

Six specimens comprising male and female were collected by Dr. B. K. Tikadar, Z.S.I. from wild boar (*Sus scrofa cristatus*) at Raimona of Goalpara, Assam. The species, *M. hirudinaceus* has been redescribed here with a new host record from India.

Six specimens comprising male and female were collected from Garganey Teal during survey tour of Z.S.I. to U.P. Garganey Teal is a Palaearctic breeding species wintering in Europe, South America and Southern Asia. In India it is found in winter. The species, *P. magnus* has been redescribed here with a new host record from India.

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LIFE CYCLE OF *AMBLYSEIUS ALSTONIAE* GUPTA, AT ROOM TEMPERATURE FEEDING UPON *EOTETRANYCHUS HICORIAE* MCGREGOR ON GUAVA (*PSIDIUM GUAJAVA*)

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INTRODUCTION

The Phytoseiid mite *Amblyseius alstoniae* has the proven ability as bio-controlling agent on important mite pests of agricultural crops. Since the time this species was described from West Bengal (Gupta, 1975), it has been recorded from several other states of India (Gupta 1986, 1987) to feed upon a number of pest species (Gupta, 1985, Gupta & Gupta, 1992). In view of this importance, works on diverse aspects of this mite like feeding potentiality (Dhooria, 1981), food preference (Jose *et al.*, 1989), effects of temperature on development (Kumari & Sadana, 1990), mating behavior (Kumari & Sadana, 1990), seasonal fluctuation (Kumari & Sadana, 1995), predator prey interaction (Kumari & Sadana, 1995a) and effect on pesticides (Rai *et al.*, 1995, 1999) have been done. Since life cycle of this species at room temperature has not been worked out so far and as this species was abundantly available in Sundarban Biosphere Reserve both in mangrove and agri-horticultural crops feeding effectively upon pest mites, it was thought desirable to work out the biology of the species at room temperature and the present paper reports the duration of different developmental stages along with fecundity, longevity and sex ratio.

MATERIAL & METHODS

For mass culture of the prey mite *Eotetranychus hicoriae* on guava which was used as food of the predatory mite, *Amblyseius alstoniae*, the technique followed by Lal (1977) was adopted while the technique used for the study of life cycle of predatory mite was according to Overmeer (1985). The room temperature and relative humidity (RH), which were maintained during the period of study were 30°-32°C and 85-95%, respectively. The data collected was statistically analysed.

RESULTS AND DISCUSSION

1. *Mating* : The mating took place immediately after the emergence of the adult. The male approached to the female vibrating its palps and first pair of legs and reached the posterior end

of the female. Then it crawled beneath her and raised its posterior end so as to oppose the venter of the female. The unintending female, if any, moved away while the intending female remained still at the same spot allowing mating which continued for about an hour or so. A female once mated did not allow other males to mate with it though males mated with several females.

2. *Incubation* : The eggs were elliptical (70-100 microns in length), slightly opaque and laid singly in a scattered manner on the under surface of the leaf. The minimum incubation period was 2.0 days and maximum was 3.0 days with the mean of 2.30 ± 0.14 days. The percentage of hatching was 81.34. The incubation periods as were reported for other Phytoseiid mites from India were 1.92 days in *A. tetranychivorus* (Jagadish & Nageschandra, 1979), 44 hours 42 minutes for *A. longispinosus* (Mallik and ChannaBasavanna, 1983), 50.38 ± 5.01 hours for *A. ovalis* (Borah & Rai, 1989) feeding on castor pollen, 50.04 ± 0.91 hours in *Amblyseius concordis* (Jagadish, et al., 1990), 32.52 hours for *Amblyseius delhiensis* (Nageshchandra et al., 1998). Hence, the incubation period as observed in the present case was within the reported duration for this stage.

3. *Larva Stage* : The minimum larval period was 2 days and the mean was 2.00 ± 0.00 days. They were sluggish having three pairs of legs and mostly did not feed on prey mites. The larva passed through a brief inactive period (quiescent stage) before moulting to the next stage. In case of other species, the duration of this stage was 17.2 hours in case of *A. channabasavannai* (Daniel, 1981), 1.06 days for *A. tetranychivorus* (Jagadish & Nageschandra, 1982), 12 hours 25 min for *A. longispinosus* (Mallik and ChannaBasavanna, 1983), 1.00 ± 0.00 days for *A. finlandicus* (Sharma & Sadana 1985), 21.02 ± 3.08 hours for *A. ovalis* feeding on castor pollen (Borah & Rai, 1989), 17.68 ± 1.90 hours in *A. concordis* (Jagadish et al., 1990) and 27.2 hours in *A. delhiensis* (Nageshchandra et al., 1998). Considering all these, the larval period in the present case appears to be slightly longer than what was reported by earlier workers for other Phytoseiid mite species.

4. *Protonymph Stage* : The mean duration of protonymphal stage was 2.30 ± 0.15 days. It was more active than the larva and had four pairs of legs. Its body coloration was creamish and was found to capture the larvae and nymphs of *E. hicoriae* for feeding. It passed through a quiescent stage before moulting to the deutonymph. The duration of this stage in case of other phytoseiid species was 22.2 hours in *A. channabasavannai* (Daniel, 1981), 1.06 days in *A. tetranychivorus* (Jagadish & Nageschandra, 1982), 20 hours 53 minutes for *A. longispinosus* (Mallik and ChannaBasavanna, 1983), 1.2 ± 0.40 days at 30°C in *A. finlandicus* (Sharma & Sadana 1985), 27.15 ± 2.96 hours feeding on castor pollen in *A. ovalis* (Borah & Rai, 1989), 24.49 ± 2.51 hours in *A. concordis* (Jagadish, et al., 1990), and 46.93 hours feeding on castor pollen for *A. delhiensis* (Nageshchandra et al., 1998). Therefore, protonymphal period as observed in the present case is longer than those reported by the earlier workers.

5. *Deutonymph Stage* : The mean duration of deutonymphal stage was 3.25 ± 0.45 days. It was found to be very active and fed on all the stages of the prey mite. The duration of this stage in case of other phytoseiid species was 23.8 hours in *A. channabasavannai* (Daniel, 1981), 0.92 days in *A. tetranychivorus* (Jagadish & Nageshchandra, 1982). 21 hours 51 minutes in *A. longispinosus*

(Mallik & ChannaBasavana, 1983), 2.4 ± 0.48 days in *A. finlandicus* (Sharma & Sadana 1985), 28.99 ± 5.63 hours feeding on castor pollen in *A. ovalis* (Borah & Rai, 1989), 29.80 ± 2.01 hours in *A. concordis* (Jagadish *et al.*, 1990) and 53.87 hours in *A. delhiensis* (Nageshchandra *et al.*, 1998). However, the duration of 3.25 ± 0.45 days as recorded in this study is much longer as compared to observations made by other workers.

6. *Egg to Adult Period* : The mean egg to adult period was 9.50 ± 0.39 days. It was also observed that the percentage of mortality was 22. In case of other Phytoseiid species this period (egg-adult) was 140 ± 7.51 hours in *A. tetranychivorus* (Puttaswamy, 1978), 85.10 hours in *A. channabasavannai* (Daniel, 1981), 5.8 ± 0.40 days at 30°C in *A. finlandicus* (Sharma & Sadana, 1985), 127.10 hours in *A. ovalis* feeding on castor pollen (Borah & Rai, 1989), 15.8 ± 2.00 days in *A. longispinosus* (Nangia *et al.*, 1990), 66.80 ± 1.14 hours at $35 \pm 1^{\circ}\text{C}$ and 55.3% RH and longest 120.48 hrs at $20 \pm 1^{\circ}\text{C}$ and $60 \pm 3\%$ RH in *A. concordis* (Jagadish *et al.*, 1995, 1999) and 4.83 ± 0.22 days at 30°C in *A. coccosocius* (Saha *et al.*, 1998). Therefore the total life cycle in the present case which was 9.50 ± 0.39 days is relatively longer than those observed by other workers excepting *A. longispinosus* which took longer period (Nangia *et al.*, 1990).

7. *Pre-oviposition period* : The mean pre-oviposition period was 3.72 ± 0.15 days. However, this period is near to the duration observed where it was reported to be 4.50 ± 1.93 days in *A. channabasavannai* (Daniel, 1981), 3.63 days in case of *A. tetranychivorus* (Jagadish & Nageschandra, 1982) and longer than other cases like 1.8 ± 0.40 days at 30°C in *A. finlandicus* (Sharma & Sadana 1985), 1.48 ± 0.02 days in *Phytoseiulus persimilis* (Krishnamoorthy, 1989), 2.43 hours in *A. delhiensis* (Nageshchandra *et al.*, 1998) and 0.3 ± 0.08 days at 30°C in *A. coccosocius* (Saha *et al.*, 1998).

8. *Oviposition Period* : The mean oviposition period was found to be very brief (4.75 ± 0.15 days). Excepting Nageshchandra *et al.*, (1998) who reported this period to be 2.46 days in *A. delhiensis* while in all other cases the oviposition period was much longer for example 15.7 ± 1.71 days in *A. channabasavannai* (Daniel, 1981) 15.8 ± 1.32 days in *A. finlandicus* (Sharma & Sadana 1985), 14.01 ± 2.05 days in *A. ovalis* (Borah & Rai, 1989).

9. *Postoviposition Period* : The mean Postoviposition period in the present study was 8.0 ± 0.25 days which appeared to be much longer as compared to the duration observed by other workers, viz., 5.12 days in *A. tetranychivorus* (Jagadish & Nageschandra, 1982), 1.2 ± 0.40 days in *A. finlandicus* (Sharma & Sadana 1985) and 0.63 days feeding on castor pollen in *A. delhiensis* (Nageshchandra *et al.*, 1998) but came closer to 10.00 ± 1.76 days in *Phytoseiulus persimilis* (Krishnamoorthy, 1989).

10. *Adult Longevity* : The average adult longevity in female was found to be 17.25 ± 0.39 days which came closer to observations made by other workers like 18.6 ± 1.49 days in female of *A. finlandicus* (Sharma & Sadana, 1985), 16.21 ± 2.03 days in *A. ovalis* (Borah & Rai, 1989), but was much shorter as compared to 31.88 ± 3.63 days in *Phytoseiulus persimilis* (Krishnamoorthy, 1989).

11. *Fecundity* : The average fecundity was rather poor which was 11.87 ± 0.67 eggs while in other Phytoseiid species this was reasonably higher as 27.3 in *A. channabasavannai* (Daniel, 1981), 26.8 eggs in *A. tetranychivorus* (Jagadish & Nageschandra, 1982), 15.6 ± 1.20 eggs in *A. finlandicus* (Sharma & Sadana 1985), 39.2 ± 0.49 eggs in *A. ovalis* (Borah & Rai, 1989) and 17.40 in *Phytoseiulus persimilis* feeding on *Tetranychus urticae* (Krishnamoorthy, 1989).

12. *Sex Ratio* : The Male : Female ratio was found to be 1 : 1.25 but for other species it was reported to be 1 : 3.30 in *A. finlandicus* (Sharma & Sadana, 1985) and 1 : 4.87 in *Phytoseiulus persimilis* (Krishnamoorthy, 1989). So, the sex ratio was relatively less female biased as compared to observations made by the other workers.

Table-1. Life cycle of *Amblyseius alstoniae* Gupta on Guava (*Psidium guajava*) under laboratory condition at room temperature.

Stage	Range	Average	Mean $\pm$ S.E.
Egg	2–3 days	2.3 days	2.3 ± 0.14 days
Larva	2 days	2 days	2.0 ± 00 days
Protonymph	2–3 days	2.3 days	2.3 ± 0.15 days
Deutonymph	3–4 days	3.25 days	3.25 ± 0.45 days
Egg to Adult	9–10 days	9.5 days	9.5 ± 0.39 days
Pre-oviposition	3–4 days	3.72 days	3.72 ± 0.15 days
Oviposition	4–5 days	4.75 days	4.75 ± 0.15 days
Post-Oviposition	7–9 days	8.0 days	8.0 ± 0.25 days
Adult Longevity	16–18 days	17.25 days	17.25 ± 0.39 days
Fecundity	10–15	11.87 eggs	11.87 ± 0.67 eggs
% of Hatching :-	81–82%	81.34%	$81.34 \pm 0.54\%$
% of Mortality :- 22%			
Sex Ratio :- Male : Female = 1 : 1.25			

SUMMARY

The present paper reports the duration of different developmental stages of *Amblyseius alstoniae* Gupta along with fecundity, longevity and sex ratio. The life cycle (egg to adult) took 9.50 ± 0.39 days. The fecundity, longevity and Male : Female sex ratio were 11.87 ± 0.67 eggs, 17.25 ± 0.39 days and 1 : 1.25, respectively.

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LIMNOLOGICAL STUDIES OF A FRESHWATER FISH TANK BIBINAGAR, HYDERABAD (PART II)-ROTIFERA

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INTRODUCTION

Seasonal variations in Freshwater rotifers population have been studied by many workers (George, 1966; Nayar, 1970; Pennak, 1949, 1955; Green 1972 and Patil, 1976). However studies of ecology of Indian rotifers is still inadequate. Hence to enhance our knowledge in this field the present investigation was undertaken (January, 1985 to December, 1985) on a freshwater tank at Bibinagar.

MATERIALS AND METHODS

Description of Bibinagar tank is given somewhere else in part I of this study Patil and Panda (1997). Plankton samples were collected with the help of Nylon satin Plankton net (200 mesh/cm). In all 40 litres of water was filtered through the net from different sampling stations for quantitative study. For qualitative analysis samples were collected by towing a net through the surface of water. The plankton concentrate was preserved in 4% formalin. The quantitative enumeration of rotifers were made with the help of "Sedgwick Rafter cell" under 100^x magnification.

RESULTS AND DISCUSSION

During the one year study, 18 species of rotifers were recorded (Table 1). The occurrence of all the species of rotifers was irregular and two major peaks were observed in the month of January and December. George (1966) attributed summer periodicity for rotifers in Delhi water. In the present study, the rotifers showed two pulses, one in January and the other in December. Probably the summer periodicity cannot be attributed to the total number of rotifers as stated by Nayar (1970), Patil (1976). Pennak (1949, 1955) also could not observe any seasonal periodicity.

It is well known that the rotifers are cosmopolitan and this view is supported by many workers like Amren (1964), Green (1967) and Patil (1976). Green (1972) has pointed out that cosmopolitanism is observed common in a number of rotifers but there are many differences in the species list of tropical and temperate or cold temperate region plankton fauna. In all 18 species of Rotifers were recorded with a majority of cosmopolitan species. Some of the species appeared

Table 1. Showing list of Rotifers species.

1. <i>Philodina</i> sp.	10. <i>B. calyciflorus</i> Pallas
2. <i>Polyarthra vulgaris</i> Carlin	11. <i>B. caudatus</i> Borrois & Daday
3. <i>Filinia longiseta</i> Ehrenberg	12. <i>B. rubens</i> Rubans
4. <i>Keratella cochlearis</i> Gosse	13. <i>B. forficula</i> Ehrenberg
5. <i>K. valga</i> Ehrenberg	14. <i>B. quadridentatus</i> Hermann
6. <i>Asplanchna intermedia</i> Hudson	15. <i>B. falcatus</i> Zacharias
7. <i>Anuraeopsis fissa</i> Gose	16. <i>Lecane (M) bulla</i> Gosse
8. <i>Trichocerca cylindrica</i> Imhoff	17. <i>Epiphanes macrourus</i> Borrois & Dady
9. <i>Brachionus angularis</i> Gosse	18. <i>Euchlanis dilatata</i> Gosse

Table 2. Average annual range of various physico-chemical parameters.

Transparency cm.	..	..	30 — 90
Temp. of water °C	..	..	19 — 28
Temp. of air °C	..	..	27 — 43
pH	..	..	8.2 — 9.7
CO ₂ mg/L.	..	..	0 — 35
CO ₃ mg/L.	..	..	34 — 80
HCO ₃ mg/L.	..	..	170 — 370
D.O. mg/L.	..	..	5.1 — 6.9
Total hardness mg/L.	..	..	190 — 220
Ca mg/L.	..	..	65 — 120
Mg mg/L.	..	..	40 — 50
Chloride mg/L.	..	..	64 — 130
Total PO ₄ mg/L.	..	..	0.32 — 0.40
Nitrate-Nitrogen mg/L.	..	..	0.58 — 0.65
Sulphate mg/L.	..	..	8 — 10
Sp. conductivity ug ohm/Cm.	..	..	486 — 600

only in summer. Green (1972) in his study of latitudinal variation of planktonic rotifera indicates that *Brachionus* is important in tropic than in temperate and northern area. The present study corroborate the view of Green. Lair (1980) noticed that Genera *Brachnionus* and *Keratella* were very sensitive to increase in temperature on the contrary this does not seems to be so in the present investigation in this region.

Table 3. Percentage composition of zooplankton.

	Jan, 85	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec, 85	Average Annual % Composition of zooplankton
Rotifera	48.98	10.39	36.12	29.65	33.47	39.86	36.73	34.70	22.91	39.84	6.70	48.07	32.30
Cladocera	29.78	62.31	33.13	42.15	29.29	33.78	36.73	36.87	24.30	33.83	66.49	37.08	38.81
Copepoda	18.29	19.95	18.07	10.75	27.19	20.27	15.92	24.94	45.83	26.31	20.72	8.24	21.37
Copepodid	0	3.12	12.65	8.72	4.18	2.70	4.08	2.60	0	0	5.87	12.09	3.75
Nauplii	2.97	4.16	0	8.72	5.86	3.38	6.53	0.86	6.94	0	0	5.49	3.74

In the present investigation species composition and abundance of Rotifers population in Bibinagar tank has been given. Campbell (1941) has pointed out that D.O., CO₂ and pH seems to be closely related to the abundance of the Rotifer in freshwater. Davis (1955) has shown that pH to be an important factor, while Yousuf and Quadri (1981) have pointed out that temperature is the main factor for the appearance and abundance of Rotifers in freshwater. Balkhi *et al.* (1984) stated that temperature and also D.O. have their influence on the abundance of specific composition of the Rotifera in Anchor lake. In the present study well marked relationship could not be established. Since the peaks of rotifers varies and no specific pattern was observed throughout the one year study.

The rotifer population in the tank was less than cladoceran population Patil & Panda (in press), the reason might be due to forage activities of these large crustaceans, the rotifer population depleted in samples in the presence of predator. This is supported by an excellent work of Pennington (1941) details rapid replacement of rotifers by *Daphnia* in tube culture of micro-algae showing that in the presence of cladocera (large crustaceans) the rotifers population was reduced. Michael (1964) attributed that loricate rotifers showed their maximum intensity in the summer months with a peak in April or May, when the temperature and alkalinity of the water were high. This was also observed by Gray (1953) and Byars (1960). In the present study loricate forms were found without any prominent peak and their occurrence was irregular. The dominance of zooplankton organisms over phytoplankton were observed. Similar relationship has been noticed by Jayangouder (1980) in Ajwa reservoir. This can be explained on the basis of Harvey *et al.* (1935) hypothesis that the grazing effect of herbivore zooplankton is sufficient to limit the phytoplankton population in time and quantity.

Ruttner (1980) concluded that in warm climate *Filinta longiseta* may occur in epilimnion and also stated that in warm monomictic lake there is no room for *Filinia terminalis* but *F. longiseta* may be present. In the present study only *Filinia longiseta* was observed in the routine collection in this tropical reservoir and *Keratella valga* as this species appears to be indicative of mesotrophic environment (Leentvaar, 1980). Pajler (1977) states that this species is distributed in the northern regions may be related to low temperature but Leentvaar (1980) concluded that the distribution of this species is also controlled by water quality. The present investigation corroborate the view of Leentvaar (1981). As per saprobic system *B. calyciflorus*, *B. urceolaris* are indicators of polluted water. Green (1972) and Chengalath *et al.* (1974) have shown the common occurrence of genus *Brachionus* and the absence of or near absence of the boreal genus *Notholca* to be characteristic of many tropical waters. The same holds good in the present study.

As such rotifer group is quite rich in Indian Sub-continent. The present studies on the ecology of Rotifers, indicate certain lacunae, therefore for further study there is ample scope for detailed work on the ecology of Rotifers from other region of India.

SUMMARY

Seasonal variation in Rotifera population was studied for a period of one year. In all 18 species of rotifers were recorded, but their distribution in the population was not very much prominent whereas, their occurrence was also very much irregular. The major peaks were observed in the month of January and December. *Brachnionus falcatus* and *B. quadridentatus* were absent in the samples of summer months in both the years. The population of rotifera was less than cladocera.

ACKNOWLEDGEMENTS

I am thankful to Dr. J.R.B. Alfred, Director, Zoological Survey of India, Kolkata for allowing to undertake this work and to Officer-in-Charge, Freshwater Biological Station, Zoological Survey of India, Hyderabad and Officer-in-Charge, Western Regional Station, Zoological Survey of India, Pune for facilities.

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WOLF SPIDERS OF BANGLADESH : GENUS *PARDOSA* C. L. KOCH (ARANEAE : LYCOSIDAE)

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INTRODUCTION

Wolf spiders play an important role in the suppression of pest insects in the fields and gardens. In Bangladesh, very few works are available on this arthropods (Chowdhury and Pal, 1984; Biswas, *et al.*, 1993; Okuma, *et al.*, 1993; Biswas, 1995; Biswas and Raychaudhuri, 1998a, '98b; Begum and Biswas, 1997) although a great number of works are carried out on different lycosids (Pocock, 1900; Gravely, 1924; Dyal, 1935; Tikader, 1970, Tikader and Biswas, 1981; Tikader and Malhotra, 1976, '80; Biswas and Biswas, 1992; Saha, *et al.*, 1994a, Tikader and Mukherjee, 1971; Patel and Reddy, 1993) in the Indian Sub-continent. Elsewhere, Tanaka (1985, '93a, '93b, '98), Fox (1935), Yaginuma (1986), Kornestedt (1981, '86, '87, '88, '93), Kaston (1948), Chen and Zhang (1991), Zhao (1993) and Yin, *et al.*, (1997a, '97b) made valuable contribution on this spiders from various parts of the world.

The present paper deals with the genus *Pardosa* C. L. Koch represented by 10 (ten) species from Bangladesh. Of these, one species namely—*P. royi* is recognised as new to science and from the others, 7 (seven) species are recorded for the first time from Bangladesh. The new species is described and illustrated.

The identity of the species were confirmed from the Zoological Survey of India, Calcutta. The types are at present in the collection of the Department of Zoology, Government P. C. College, Bagerhat, Bangladesh and will be deposited to the Museum of the Department of Zoology, University of Dhaka, Bangladesh, in due course of time.

Abbreviation used : A.D.I. = Agricultural Diploma Institute; BARI = Bangladesh Agricultural Research Institute; BRRI = Bangladesh Rice Research Institute; BAU = Bangladesh Agricultural University; RU = Rajshahi University.

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SYSTEMATICS

Genus *Pardosa* C. L. KOch, 18481848. *Pardosa* C. L. Koch, *die Arachniden*, 14 : 100.

Diagnosis : Cephalic region raised and almost entirely occupied by the 2 posterior rows of eyes. Chelicerae much smaller than most of the lycosids. Eyes in 3 rows, anterior row of eyes smaller, eyes of posterior row larger. Legs relatively long and thin and with long spines. Metatarsus IV usually as long as to longer than patella and tibia taken together. Tibia I with 3 pairs of ventral spines. Median septum or guide of epigynum almost weakly developed at the anterior end. Median apophysis placed more centrally.

Type species : *Pardosa striatipes* Koch.

Distribution : ASIA; AMERICA and EUROPE.

Key to the species

1. Outer margin of chelicerae atleast with 3 teeth, 1 of which placed distantly; sternum wide anteriorly; leg formula 4321, epigyne as in fig. 60 *sumatrana*
- Outer margin of chelicerae atleast with 2 closely placed teeth; leg formula never as above ..2
2. Outer margin of chelicerae with one tooth only 3
- Outer margin of chelicerae always with 2 teeth 4
3. Labium basally broad and flat; sternum broad anteriorly; ocular quad posteriorly much wide; epigyne as in fig. 18 *heterophthalmus*
- Labium basally bluntly pointed; sternum broad medially; ocular quad posteriorly not so wide; epigyne as in fig. 48 *shyamae*
4. Cephalothorax with deeply distinct cervical furrows 5
- Cephalothorax without any such furrows 6
5. Abdomen elongate, posteriorly pointed bluntly; sternum posteriorly never broad; maxillae and labium basally not narrowed; posterolateral spinnerets evidently long; cheliceral teeth large, not distinctly separated *royi* n. sp.
- Abdomen oval; sternum broad posteriorly; maxillae and labium basally narrowed; posterolateral spinnerets small; cheliceral teeth large, distinctly separated *annandalei*
6. Abdomen broad, posteriorly narrower and bluntly pointed; cephalothorax centrally with a whitish pineapple-shaped area *birmanica*
- Abdomen posteriorly never as above; cephalothorax never with whitish area 7
7. Sternum globose; abdomen centrally with an elongate oval free area; ocular quad rectangular; leg formula 4132 *songosa*
- Sternum heart-shaped; abdomen never with any such area 8

8. Sternum posteriorly broad; labium broad basally; leg formula 4123; epigyne tongue-like *minutus*
 — Sternum anteriorly broad; labium broad medially; leg formula 4213 9
9. Ocular quad entirely blackish; cephalothorax broad at middle; sternum posteriorly abruptly narrowed; abdomen decorated as in fig. 19 *ladakhensis*
 — Ocular quad longitudinally free from colouration; cephalothorax broad at base; sternum posteriorly narrowed; abdomen decorated as in fig. 32 *pusiola*

1. *Pardosa annandalei* (gravely)

(Figs. 1–6)

1924. *Lycosa annandalei* Gravely, *Rec. Indian Mus.*, 26 : 606.

Material examined : 2♀, Pirojpur, 19.VII.1991 Coll V Biswas; 1♀, Chittagong, 25.VIII.1992, Coll : V. Biswas; 2♀, Chandpur, Comilla, 07.VII.1992, Coll : V. Biswas; 1♀, BRRI, Joydevpur, Dhaka, 19.IX.1992, Coll : V. Biswas; 2♀, ADI, Faridpur, 12.V.1990 Coll : V. Biswas; 2♀, Shikerpur, Jhenidah, 18.VIII.1990 and 28.IX.1992, Coll : V. Biswas; 1♀, Batiaghata, Khulna, 12.VI.1991 and Chalna, Khulna, 9.VIII.1992, Coll : V. Biswas; 2♀, Mymensingh, 25.VI.1991, Coll : V Biswas.

Distribution : BANGLADESH : Chittagong, Comilla, Dhaka, Faridpur, Jhenidah, Khulna, Mymensingh, Pirojpur; MYANMAR; INDIA (Tikader and Malhotra, 1980).

2. *Pardosa birmanica* Simon

(Figs. 7–13)

1884. *Pardosa birmanica* Simon, *Ann. Mus. civ. stor. nat. Genova*, 20 : 333.

Material examined : 2♀, Barisal, 8.V.1990, Coll : V. Biswas; 20, 10, BARI, Jessore, 15.IX.1990, Coll : V. Biswas; 1♀, Jhenidah, 19.IX.1991, Coll : V. Biswas; 1♀, ADI, Faridpur, 18.XI.1991, Coll : V. Biswas; 1♀, 1♂, Mymensingh, 19.IV.1992, Coll : V. Biswas.

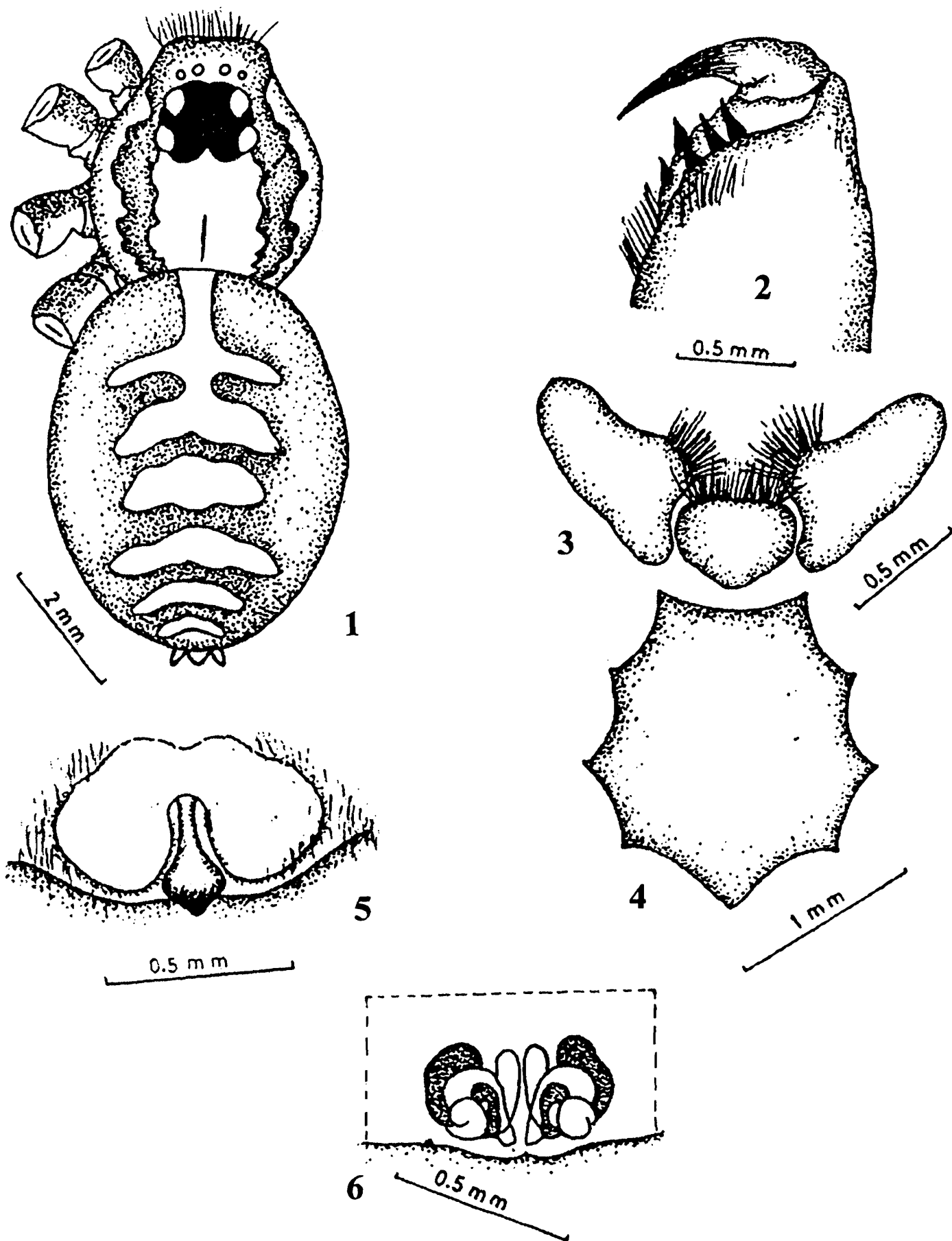
Distribution : BANGLADESH : Barisal, Faridpur, Jhenidah, Jessore, Mymensingh; MYANMAR; INDIA; PAKISTAN (Tikader and Malhotra, 1980).

3. *Pardosa heterophthalmus* (Simon)

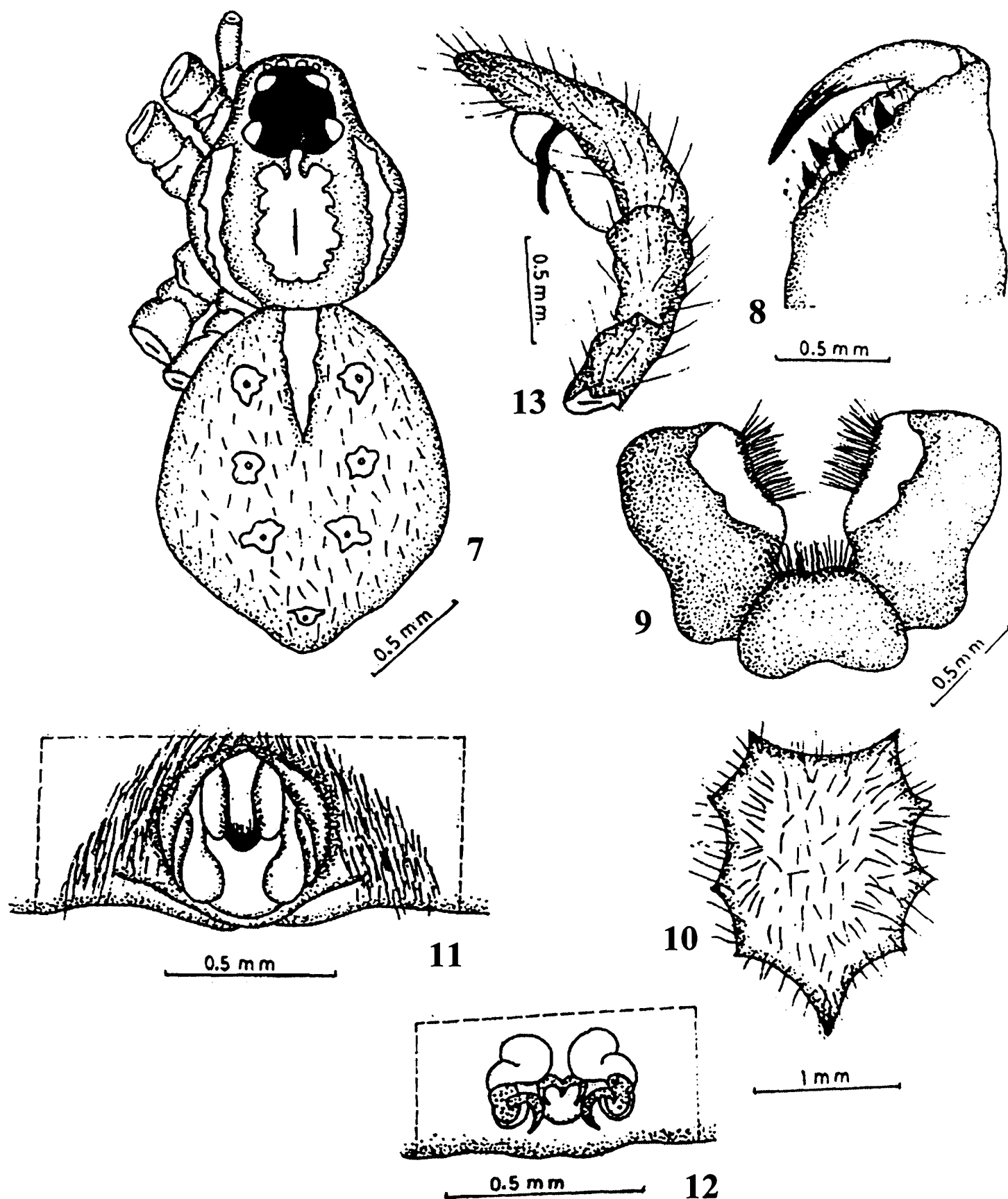
(Figs. 14–18)

1898. *Acroniops heterophthalmus* Simon, *Hist. nat. des. Araignes*, 2 : 362.

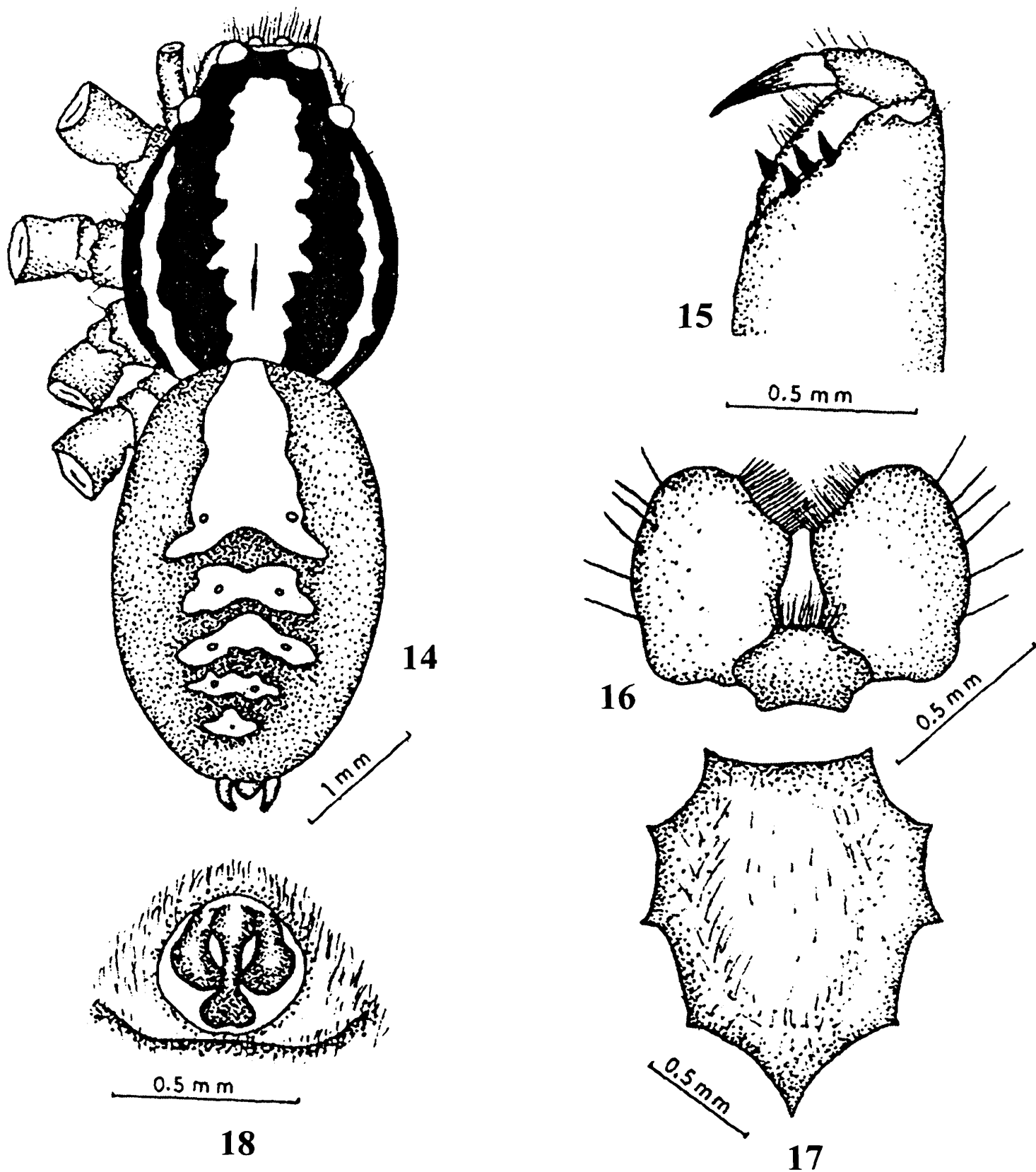
Material examined : 1♀, Dasani, Bagerhat, 19.III.1992, Coll : V Biswas; 2♀, Potia Chittagong, 12.III.1991, Coll : V. Biswas; 2♀, Comilla, 19.V.1991, Coll : V Biswas; 1♀, BARI, Joydevpur, Dhaka, 18.VIII.1992, Coll : V Biswas; 2♀, ADI, Faridpur, 3.IX.1992, Coll V Biswas;



Figs. 1-6 : *Pardosa annandalei* (gravely) : 1. Whole body (dorsal view); 2. Chelicerae; 3. Maxillae and Labium; 4. Sternum; 5. Epigynum and 6. Internal genitalia.



Figs. 7-13 : *Pardosa birmanica* Simon : 7. Whole body (dorsal view); 8. Chelicerae; 9. Maxillae and Labium; 10. Sternum; 11. Epigynum; 12. Internal genitalia and 13. Male palp.



Figs. 14-18 : *Pardosa heterophthalmus* (Simon) : 14. Whole body (dorsal view); 15. Chelicerae; 16. Maxillae and Labium; 17. Sternum and 18. Epigynum.

2♀, Bagharpara, Jessore, 19.VIII.1991, Coll V Biswas; 2♀, Khalishpur, Khulna, 18.V.1991, Coll V. Biswas; 2♀, BAU, Mymensingh, 18.V.1992, Coll : V Biswas; 1♀, Harinarayanpur, Kustia, 11.IX.91 2♀, Digha, Rajshahi, 4.III.1992, Coll : V Biswas; 2♀, Rangpur, 15.III.1992, Coll : V. Biswas; 2♀, Nazirpur, Pirojpur, 11.V.1992, Coll V Biswas.

Distribution : BANGLADESH : Bagerhat, Chittagong, Comilla, Dhaka, Faridpur, Jessore, Khulna, Kustia, Mymensingh, Pirojpur, Rajshahi, Rangpur; INDIA; JAVA (Tikader and Malhotra, 1980).

4. *Pardosa ladakhensis* Tikader

(Figs. 19–25)

1976. *Pardosa ladakhensis* Tikader, *J. Bombay nat. Hist. Soc.*, **74**(1) : 144.

Material examined : 1♂, Bagerhat, 19.V.1992, Coll : V Biswas; 2♀, 1♂, Chalna, Khulna, 18.VII.1990, Coll : V Biswas; 2♀, Jhenidah, 22.IX.1992, Coll : V Biswas.

Distribution : BANGLADESH : Bagerhat, Jhenidah, Khuna; INDIA (Tikader and Malhotra, 1980).

5. *Pardosa minutus* Tikader & Malhotra

(Figs. 26–31)

1976. *Pardosa minutus* Tikader & Malhotra, *Proc. Indian Acad. Sci.*, **83**(3) : 126-128.

Material examined : 1♀, Barisal, 9.XII.1991, Coll : V Biswas; 2♀, ADI, Faridpur, 11.IX.1991, Coll : V Biswas; 2♀, Chalna, Khulna, 9.X.1990, Coll V Biswas; 2♀, Pabna, 11.V.1992, Coll V Biswas; 3♀, Digha, Rajshahi, 5.III.1992, Coll V Biswas.

Distribution BANGLADESH : Barisal, Faridpur, Khulna, Pabna, Rajshahi; INDIA (Tikader and Malhotra, 1980).

6. *Pardosa pusiola* (Thorell)

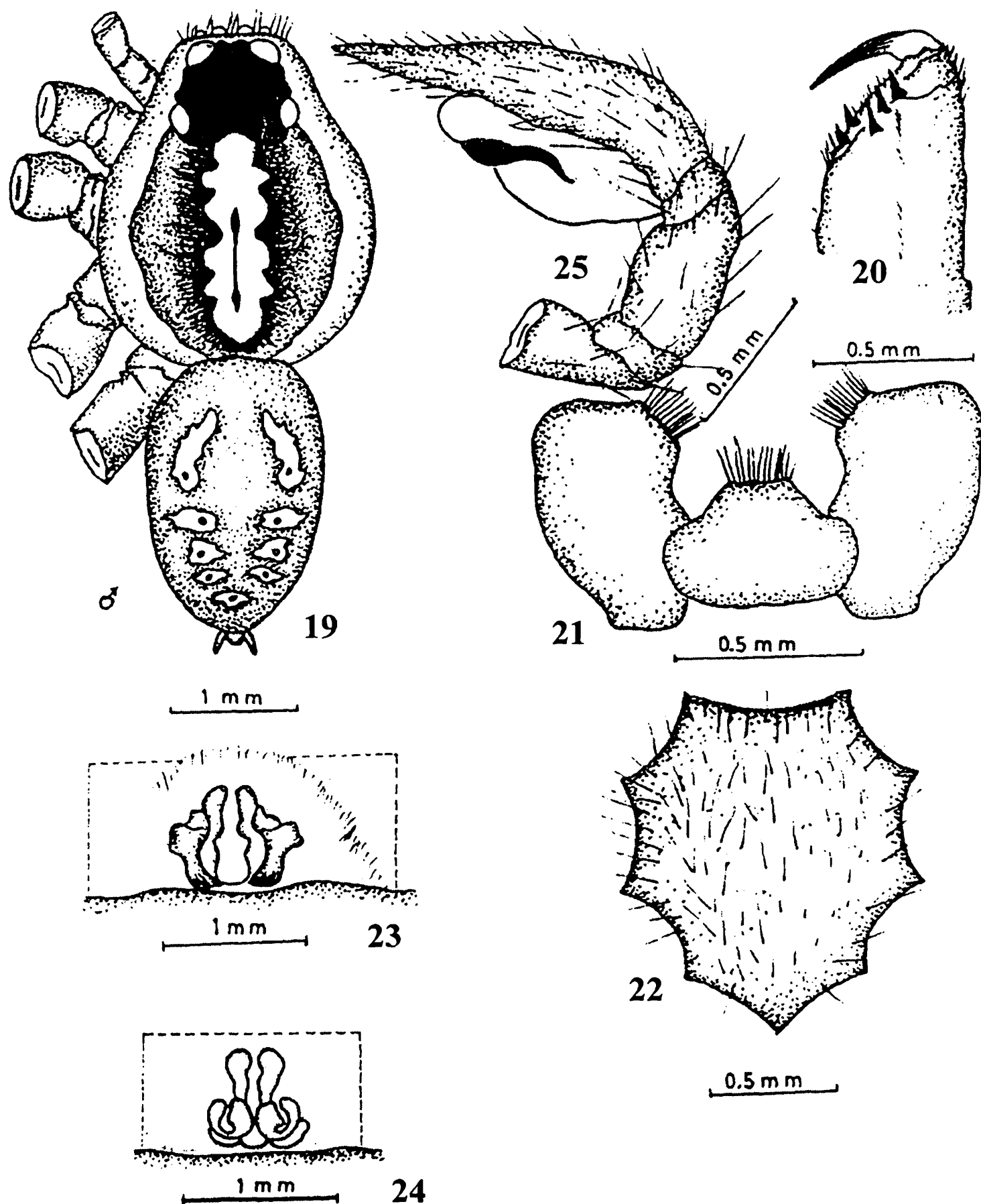
(Figs. 32–37)

1891. *Lycosa pusiola* Thorell, *Sr. Ak. Handl.*, **24**(2) : 65.

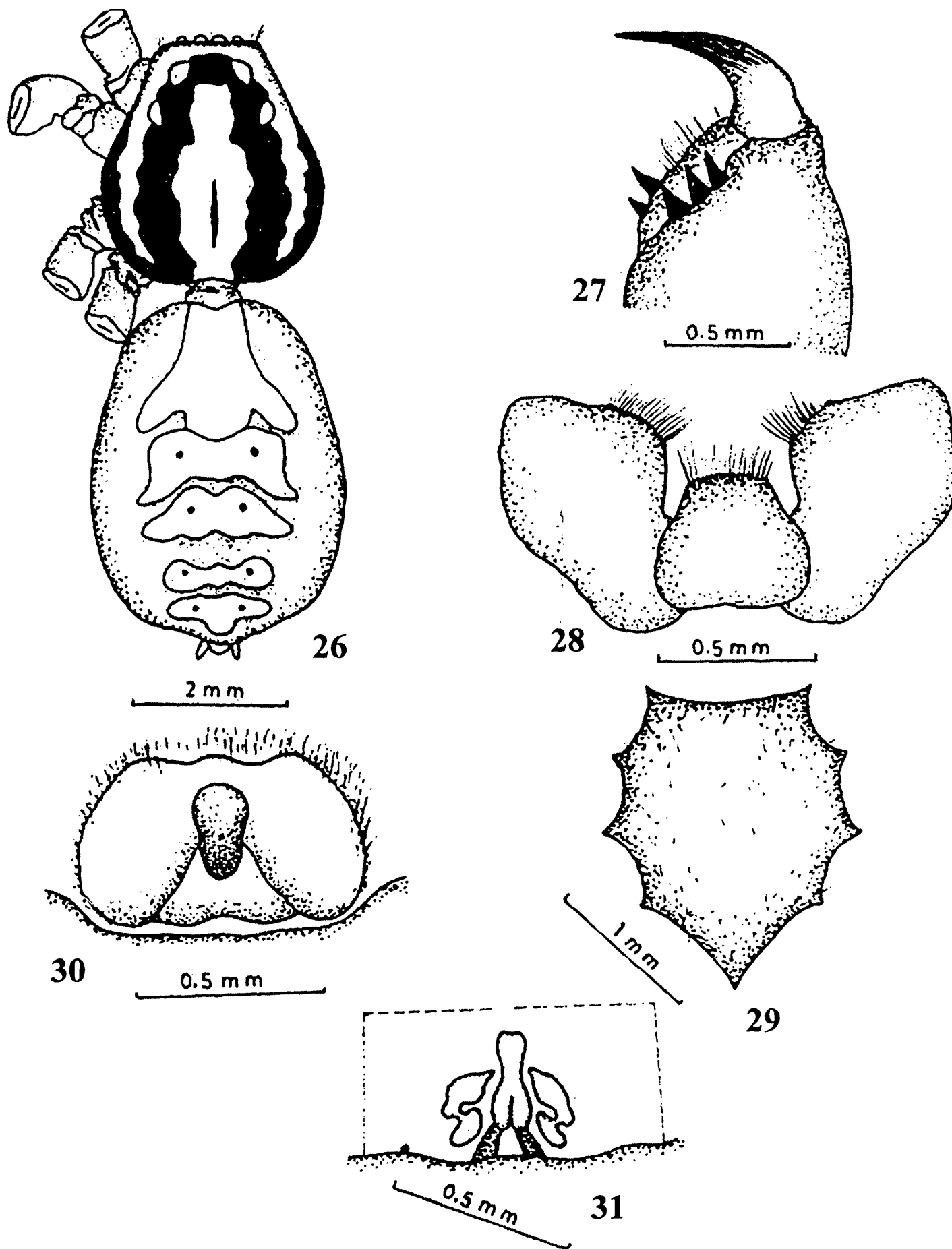
1905. *Pardosa pusiola* : Simon, *Arack. de Java. Mt. Mus. Humburg*, **22** : 51-73.

Material examined : 1♀, Bogra, 18.V.1992, Coll : V Biswas; 2♀, Munsiganj, 11.IX.1990, Coll V. Biswas; 1♀, Narayanganj, 12.VI.92, Coll : V Biswas; 2♀, Potuakhali, 3.X.1992, Coll V Biswas.

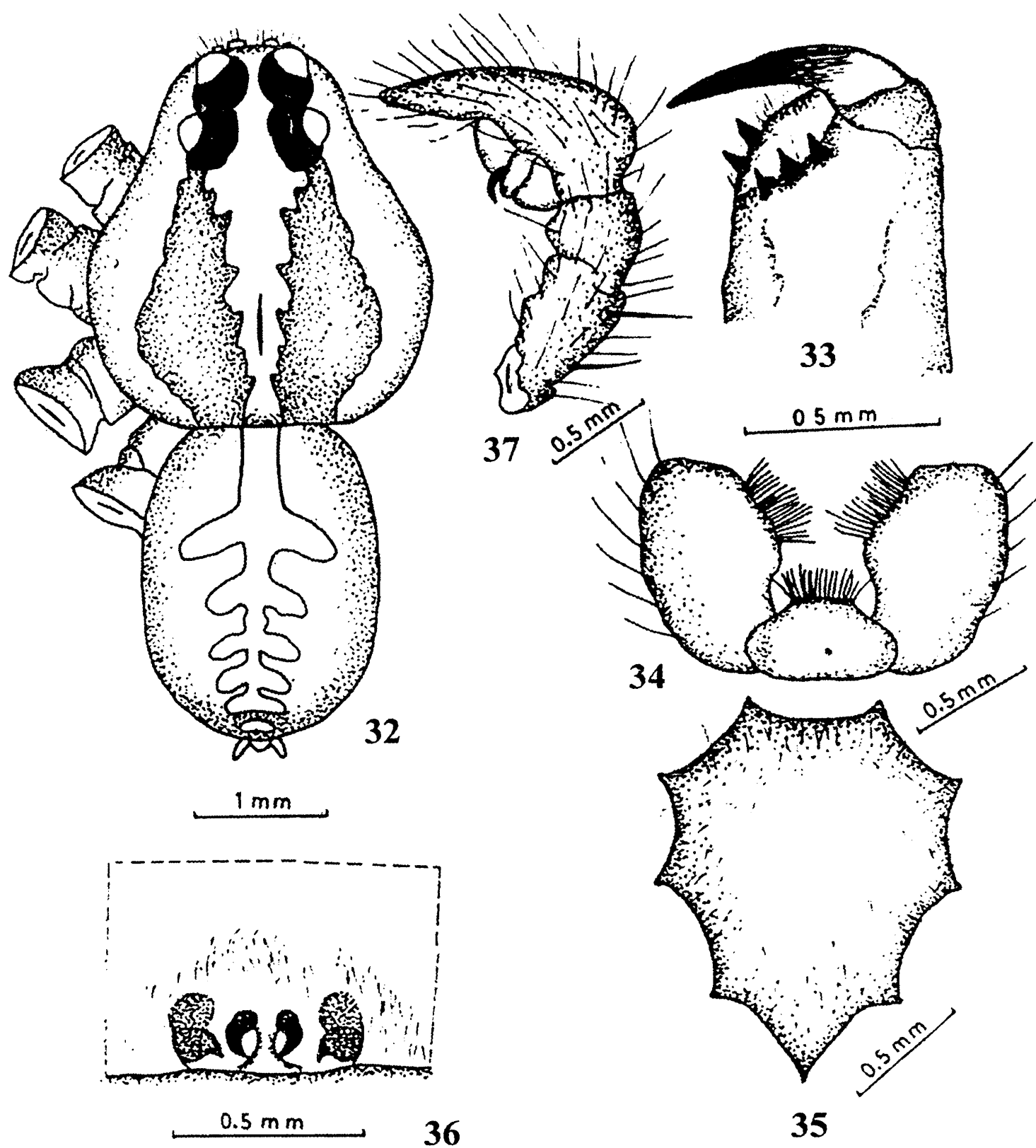
Distribution : BANGLADESH : Bogra, Munshiganj, Narayanganj, Potuakhali; BORNEO; INDIA; INDONESIA; JAVA; SUMATRA (Tikader and Malhotra, 1980).



Figs. 19-25 : *Pardosa ladakhensis* Tikader : 19. Whole body (dorsal view); 20. Chelicerae; 21. Maxillae and Labium; 22. Sternum; 23. Epigynum; 24. Internal genitalia and 25. Male palp.



Figs. 26-31 : *Pardosa minutus* Tikader & Malhotra : 26. Whole body (dorsal view); 27. Chelicerae; 28. Maxillae and Labium; 29. Sternum; 30. Epigynum and 31. Internal genitalia.



Figs. 32-37 : *Pardosa pusiola* (Thorell) : 32. Whole body (dorsal view); 33. Chelicerae; 34. Maxillae and Labium; 35. Sternum; 36. Epigynum and 37. Male palp.

7. *Pardosa royi* n. sp.

(Figs. 38–43)

General : Female : Cephalothorax brownish; legs brown with black spots; abdomen brownish with white spots. Total body length (Holotype) 6.30 mm. Carapace length 3.00 mm; carapace width 2.50 mm; abdominal length 3.30 mm; abdominal width 2.60 mm.

Cephalothorax : Broad, longer than wide, wider at base, narrowing anteriorly, clothed with marginal band of pubescence. Anterior row of eyes straight, similar, shorter than 2nd row; eyes of 2nd and 3rd rows similar; 3rd row of eyes distantly placed; ocular area raised, narrowing anteriorly, somewhat rectangular; base of 2nd and 3rd row of eyes connected. Cephalic region raised, 2 black cervical furrows extend from the centre of thorax upto the anterolateral margins. Chelicerae brown, strong, longer than wide, inner margin with 3 and outer margin with 2 closely placed teeth (Fig. 39). Maxillae brown, longer than wide, anteriorly broad and scopulate (Fig. 40). Labium brown, broad, longer than wide, basally constricted, vase-shaped, anteriorly scopulate (Fig. 40). Sternum pale brown, elongate, nearly oval, broad below the middle, pointed posteriorly, anteriorly flat, clothed with few spines and hairs (Fig. 41). Legs long, slender, clothed with hairs and spines; leg formula 4231 and measurements (in mm) as in Table 1.

Table-1 : Length of legs of female (♀) holotype of *Pardosa royi* n. sp.

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	1.3/1.3	0.6/0.6	1.6/1.6	1.9/1.9	1.4/1.3	6.9/6.8
II	1.8/1.8	0.8/0.8	1.8/1.8	2.0/2.0	1.4/1.4	7.8/7.8
III	1.6/1.6	0.7/0.7	1.7/1.7	1.8/1.8	1.2/1.2	7.0/7.0
IV	1.9/1.9	0.9/0.9	2.0/2.0	2.1/2.1	1.6/1.6	8.5/8.5

Abdomen : Longer than wide, posteriorly wide and bluntly pointed, covered with hairs and spines; ventrally pale, with few brownish markings; anterolateral spinnerets elongate; epigyne and internal genitalia as in figs. 42 and 43.

Male : Unknown.

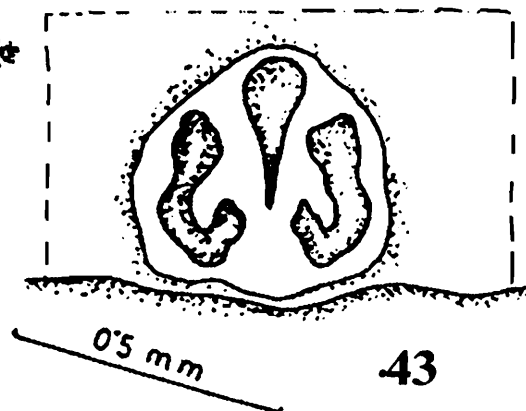
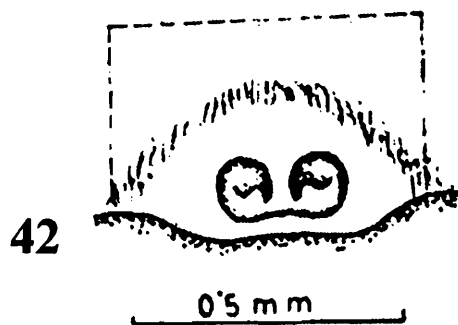
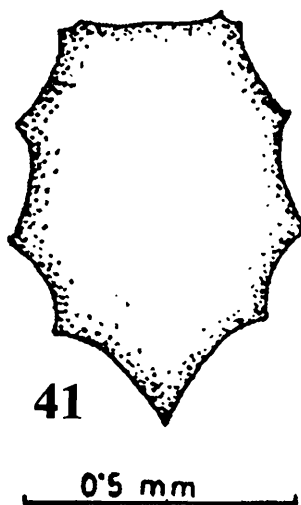
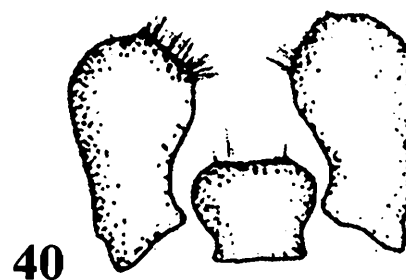
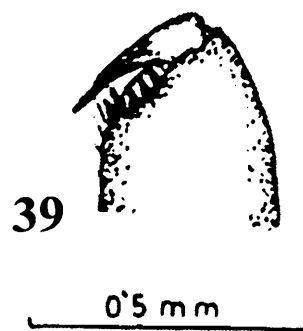
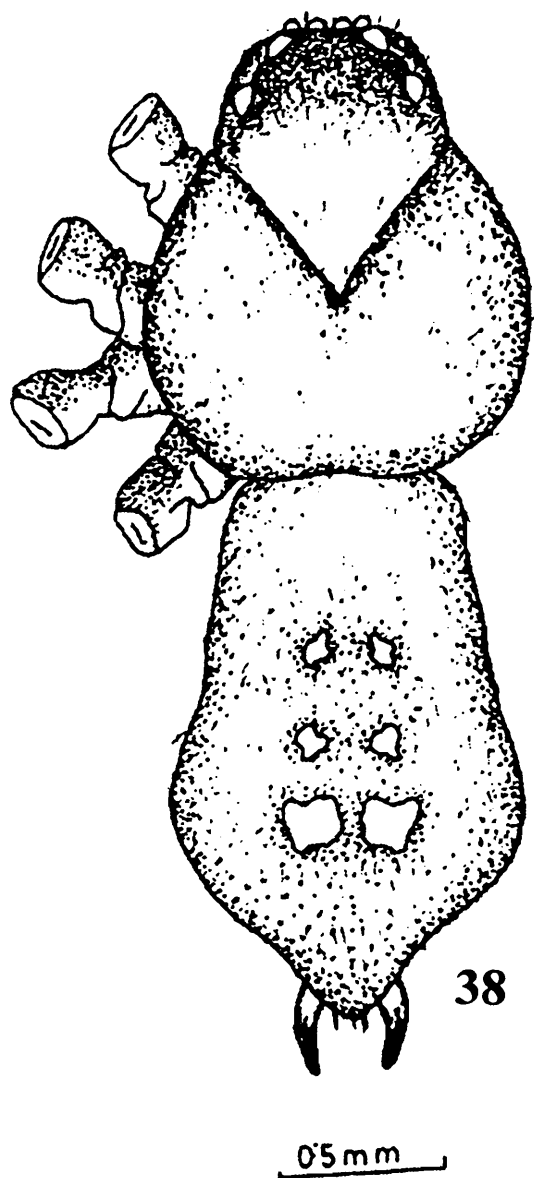
Holotype : Female in spirit.

Paratypes : 2♀, Bagerhat, 18.XI.1992, Coll : V Biswas.

Etymology : The species is named after the famous scientist Acharya Profulla Chandra Roy.

Distribution : BANGLADESH : Bagerhat and Pirojpur, date 25.VIII.1992 and 18.XI.1992, Coll : V. Biswas.

Diagnosis : The epigynum of the present species does not relate to any of the Indian congeners (Tikader and Malhotra, 1980) and the other species known from elsewhere (Tongiorgi, 1966a, b;



Figs. 38-43 : *Pardosa royi* n. sp. : 38. Whole body (dorsal view); 39. Chelicerae; 40. Maxillae and Labium; 41. Sternum; 42. Epigynum and 43. Internal genitalia.

Kronestedt 1981, '86, '88, '93; Tanaka, 1985, '93a, b, '98; Chen and Zhang, 1991; Zhao, 1993; Koh, 1989; Yaginuma, 1986; Kaston 1948; Dondale and Redner, 1990; Shinkai and Takano, 1984; Yin, *et. al.*, 1997a, b).

Therefore, the species is described as new to science.

8. *Pardosa shyamae* (Tikader)

(Figs. 44–49)

1970. *Lycosa shyamae* Tikader, *Rec. zool. Surv. India*, 64(4) : 67.

1976. *Pardosa shyamae* : Tikader & Malhotra, *Proc. Indian Acad. Sci.*, 83(3) : 123.

Material examined : 1♂, Bagerhat, 9.IX.1992, Coll : V Biswas; 2♀, BRRI, Joydevpur, Dhaka, 3.V.1992, Coll : V Biswas; 2♀, Jhenidah, 12.III.1991, Coll : V Biswas; 2♀, Khulna, 18.V.1990, Coll : V. Biswas; 1♂, Shirajganj, Pabna, 10.X.1992, Coll : V Biswas; 3♀, Digha, Rajshahi, 3.III.1992, Coll : V. Biswas; 1♂, Srimongal, Sylhet, 12.X.1992, Coll : V. Biswas.

Distribution : BANGLADESH : Bagerhat, Dhaka, Jhenidah, Khulna, Pabna, Rajshahi, Sylhet; INDIA (Tikader and Malhotra, 1980).

9. *Pardosa songosa* Tikader & Malhotra

(Figs. 50–55)

1976. *Pardosa songosa* Tikader & Malhotra, *Proc. Indian Acad. Sci.*, 83(3) : 128.

Material examined : 2♀, Kochua, Bagerhat, 8.V.1990, Coll : V Biswas; 1♂, Barisal, 12.X.1991, Coll : V Biswas; 2♀, Dhaka, 4.III.1993, Coll : V Biswas; 2♀, Faridpur, 5.VIII.1992, Coll : V. Biswas; 1♂, Mymenshingh, 12.IX.1992, Coll : V Biswas; 1♂, Noakhali, 2.III.1992, Coll : V. Biswas; 2♀, Digha, Rajshahi, 3.III.92, Coll : V Biswas.

Distribution : BANGLADESH : Bagerhat, Barisal, Dhaka, Faridpur, Mymenshingh, Noakhali, Rajshahi; INDIA (Tikader and Malhotra, 1980).

10. *Pardosa sumatrana* (Thorell)

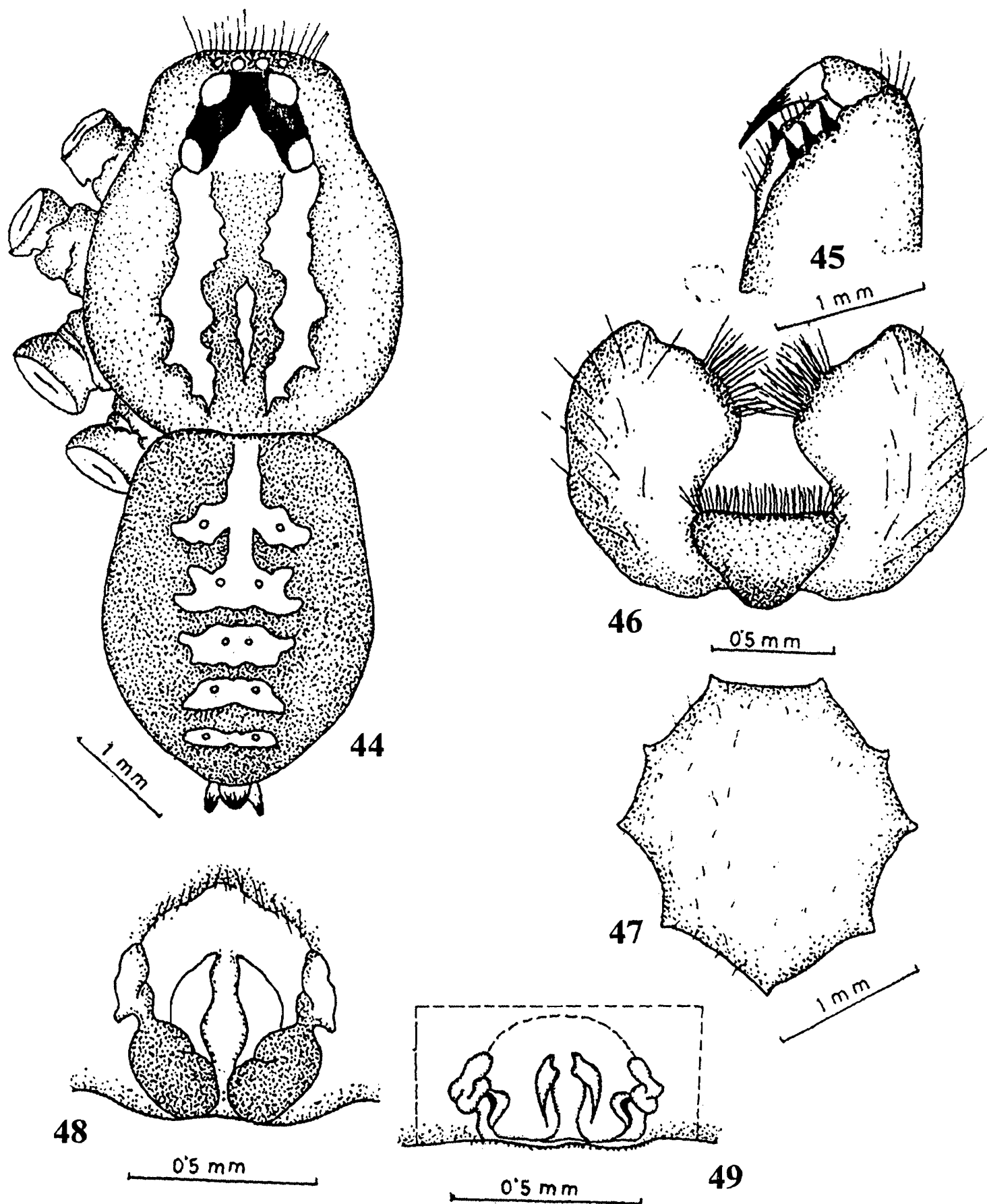
(Figs. 56–62)

1890. *Lycosa sumatrana* Thorell, *Ann. Mus. Stor. nat. Genova*, 30 : 139.

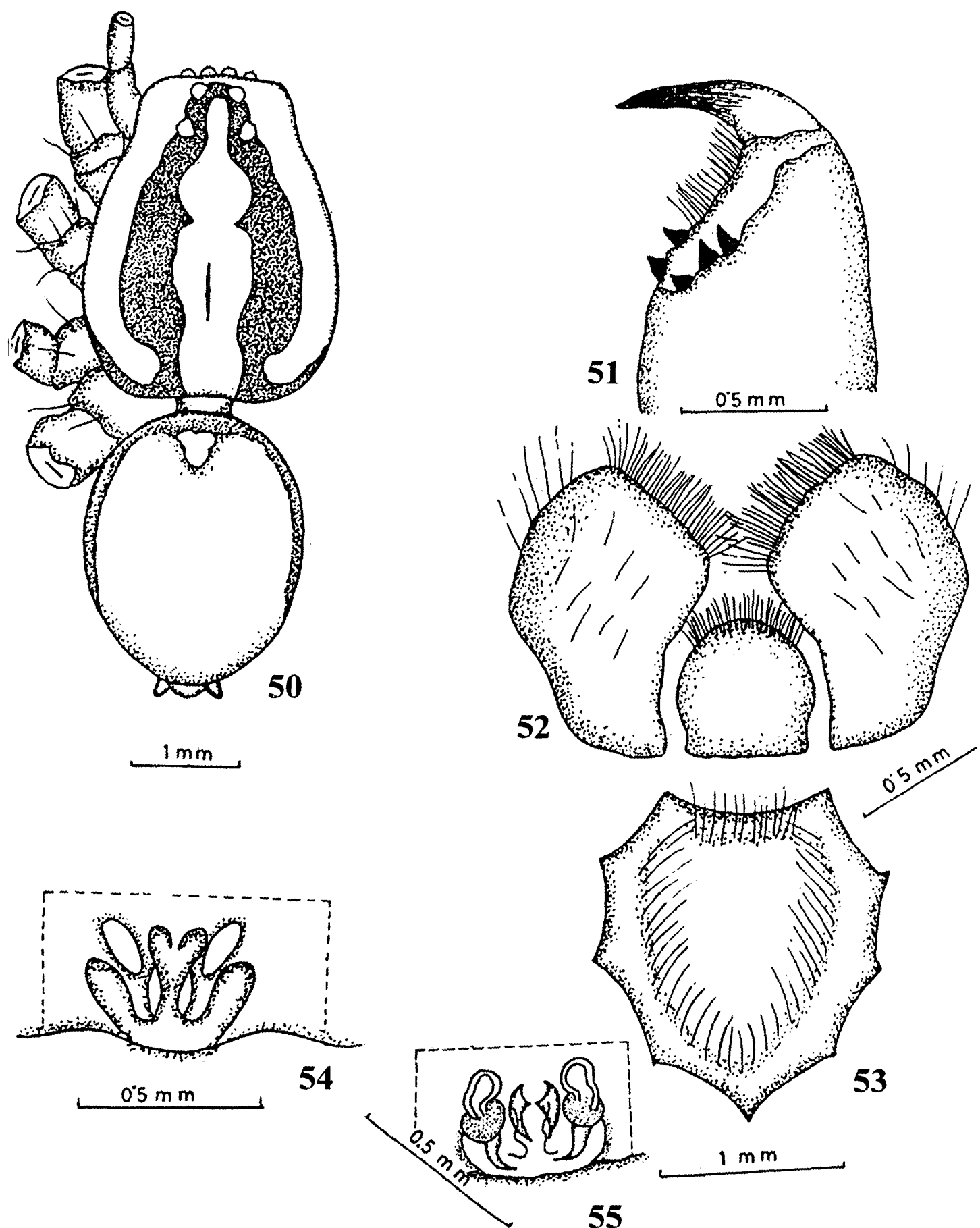
1980. *Pardosa sumatrana* : Tikader & Malhotra, *Fauna of India, Spiders*, 1(2) : 353.

Material examined : 2♀, Chittagong, 12.IX.1990, Coll : V. Biswas; 2♀, R. U. campus, 3.III.1992, Coll : V. Biswas; 2♀, Japhlong, Sylhet, 10.I.1993, Coll : V. Biswas; 2♀, Shikerpur, Jhenidah, 8.V.1992, Coll : V Biswas; 1♂, Kustia, 5.VI.1992, Coll : V Biswas; 1♂, 3♀, Mymenshingh, 5.III.1991, Coll : V Biswas.

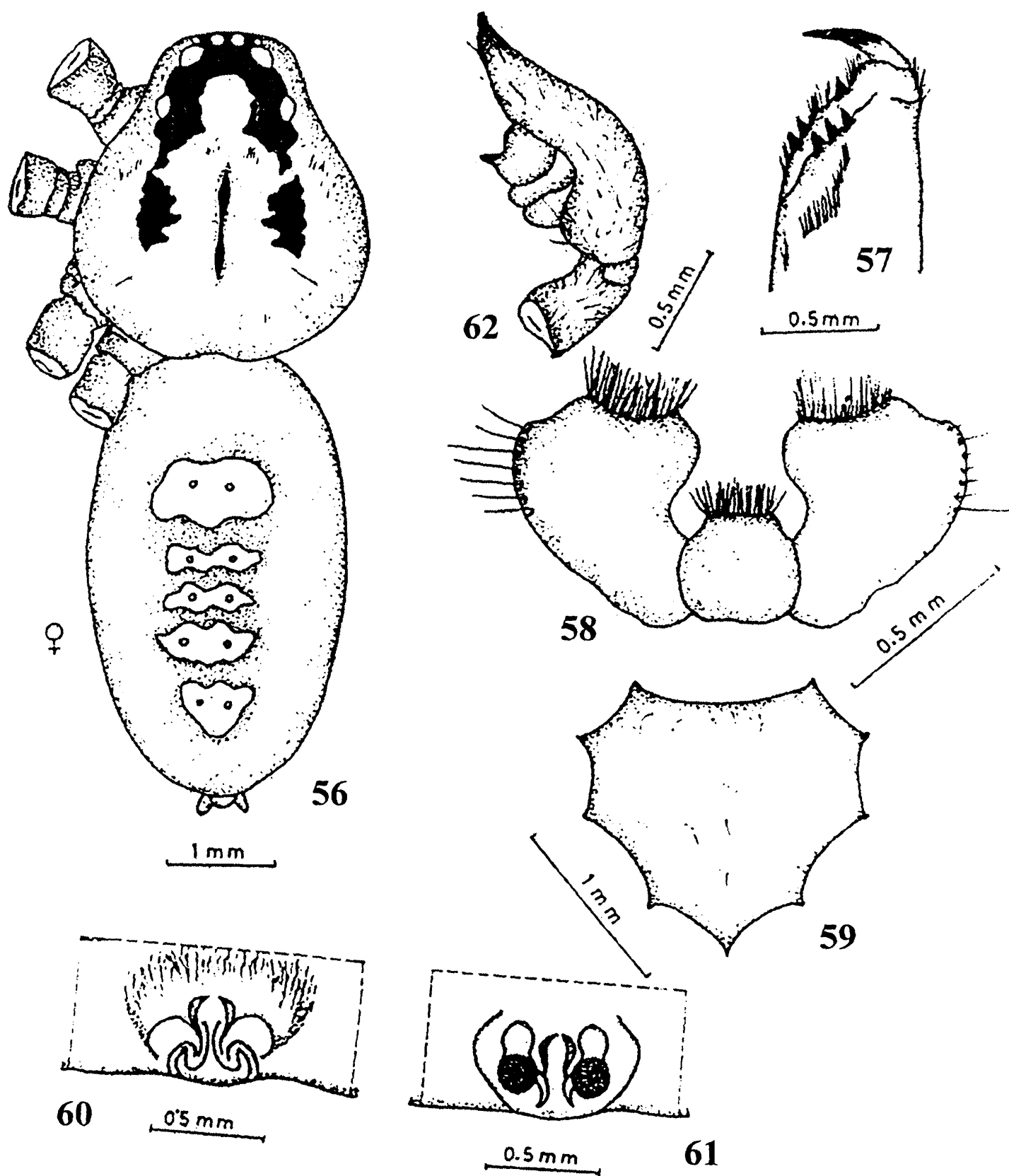
Distribution : BANGLADESH : Chittagong, Jhenidah, Kustia, MyemnsHINGH, Rajshahi, Sylhet; INDIA; SRILANKA; SUMATRA (Tikader and Malhotra, 1980).



Figs. 44-49 : *Pardosa shyamae* (Tikader) : 44. Whole body (dorsal view); 45. Chelicerae; 46. Maxillae and Labium; 47. Sternum; 48. Epigynum and 49. Internal genitalia.



Figs. 50-55 : *Pardosa songosa* Tikader & Malhotra : 50. Whole body (dorsal view); 51. Chelicerae; 52. Maxillae and Labium; 53. Sternum; 54. Epigynum and 55. Internal genitalia.



Figs. 56-62 : *Pardosa sumatrana* (Thorell) : 56. Whole body (dorsal view); 57. Chelicerae; 58. Maxillae and Labium; 59. Sternum; 60. Epigynum; 61. Internal genitalia and 62. Male palp.

SUMMARY

The wolf spiders of the genus *Pardosa* C. L. Koch, Bangladesh, is represented by 10 (ten) species namely-*P. annandalei* (Gravely), *P. birmanica* Simon, *P. heterophthalmus* (Simon), *P. ladakhensis* Tikader, *P. minutus* Tikader & Malhotra, *P. pusiola* (Thorell), *P. shyamae* Tikader, *P. songosa* Tikader & Malhotra, *P. sumatrana* (Thorell) and *P. royi* n. sp.

The study of the spiders of this area was started in 1984, has revealed the existence of the above species for a particular area of Bangladesh. Identity of the species were later confirmed by the Zoological Survey of India, Kolkata.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. S. C. Majumder, Scientist-SD, Sunderban Field Research Station, Zoological Survey of India, Canning, West Bengal, for confirming the identity of the species and the Head, Department of Zoology, University of Calcutta, for providing laboratory facilities.

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NOTES ON SOME DERMAPTERA (INSECTA) FROM NORTH CACHAR HILLS DISTRICT, ASSAM

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This paper is based upon a collection of Dermaptera from the area of Assam, North Cachar Hills District falling under the Kopili Hydro Electric Project run by North Eastern Electric Power Corporation Limited, a Govt. of India Enterprise. The purpose of the study is to assess the impact on the faunal resources of the area due to the said project.

Altogether, seven species belonging to six genera are reported of which two species, namely *Aborolabis pervicina* (Burr) and *Eparchus insignis* (Haan) were recorded earlier from the area (Srivastava and Lahiri, 1983). Four species namely, *Euborellia annulipes* (Lucas), *Nala lividipes* (Dufour), *Labidura riparia* (Pallas), *Circolabia curvicauda* (Motschulsky) have worldwide distribution and *Eparchus insignis* (Haan) is widely distributed in the Oriental Region. Besides, *Aborolabis emarginata* Srivastava, is at present, known only from NE India whereas *A. pervicina* (Burr) is distributed all along the Himalayas in India, Bhutan and Nepal. The occurrence of all species from the area is quite natural.

SYSTEMATIC ACCOUNT

ANISLABOIDEA

ANISOLABIDIDAE

ANISOLABIDINAE

Aborolabis pervicina (Burr)

(Figs. 1-4)

1913. *Anisolabis pervicina* Burr, *Rec. Indian Mus.* 8(2) : 137 (Male, Female; India, Assam and Arunachal Pradesh).
1915. *Paralabis pervicina*; Burr, *J. R. micr. Soc.*, 1915 : 540, pl. 12, fig. 3.
1969. *Aborolabis pervicina*; Srivastava, *Entomologists Rec. J. Var.*, 81 : 246, fig. 1.
1983. Srivastava and Lahiri, *Rec. zool. Surv. India*, 81 : 282.
1987. *Aborolabis nigriceps* Brindle, *Courierforsch. Inst. Senckenberg*, 93 : 337 (Male, Female; Nepal).
1993. *Aborolabis pervicina*; Srivastava, *Rec. zool. Surv. India*, 90(1-4) (1992) : 31, figs. 22-26.

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Material examined : India, Assam, North Cachar Hills, Garampani, 1 Male, 2 Females, 13.iii.1970 (S. K. Talukdar coll.).

Diagnostic characters : *Male* : General colour shining reddish to blackish brown.

Head triangular; eyes shorter than post-ocular area. Pronotum quadrate, gently widened posteriorly. Abdomen punctate, sides of segments 6th to 9th acute angled posteriorly, carinate and striate. Penultimate sternite broadly rounded, punctulated, posterior margin truncate. Ultimate tergite and forceps and genitalia as seen in figs. 3-4.

Female : Sides of abdominal segments ecarinate and convex; forceps simple and straight.

Measurements : *Male* : Length body 8.0-16.0 mm, forceps 2.0-3.0 mm; *Female* : Length : body 7.0-18.0 mm, forceps 2.0-3.5 mm.

Distribution : NE India and Himachal Pradesh.

Aborolabis emarginata Srivastava

(Figs. 5-8)

1976. *Aborolabis emarginata* Srivastava, *J. zool. Soc. India*, **26** : (1 & 2) (1974) : 134, figs. 1 C-E (Male, Female; India : Arunachal Pradesh.

1993. *Aborolabis emarginata*, *Rec. zool. Surv. India*, **90**(1-4). (1992) : 24, figs. 1-3.

Material examined : India, Assam, North Cachar Hills, Umrangso, 2 Males, 3 Females, 1996, ex under stones on the edge of reservoir (G. K. Srivastava coll.).

Diagnostic characters : *Male* : General colour blackish brown. Antennae with three basal and one or two pre-apical segments yellowish.

Head about as long as broad; pronotum slightly expanded posteriorly Apterous; sides of abdominal segments 6th to 9th acute angled, carina present on 7th and 8th only. Penultimate sternite with posterior margin broadly emarginate. Ultimate tergite and forceps and genitalia as seen in figs. 7-8.

Female : Sides of abdominal segments rounded, ecarinate and forceps simple and straight.

Measurements : *Male* : Length body 11.5-11.7 mm, forceps 1.8-2.9 mm; *Female* : Length : body 9.5-12.9 mm, forceps 1.8-2.0 mm.

Distribution : NE India (Arunachal Pradesh, Meghalaya and Assam).

Euborellia annulipes (Lucas)

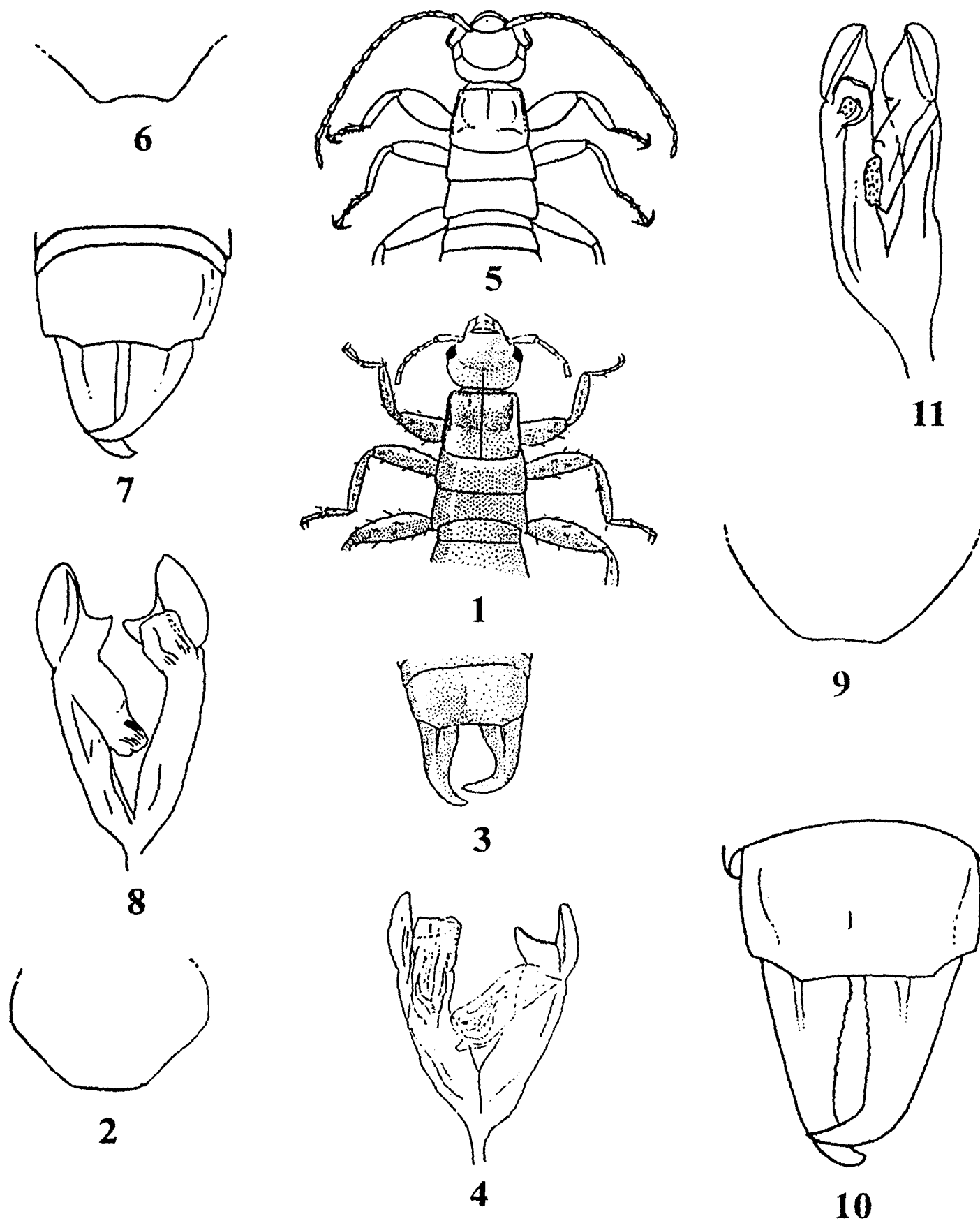
(Figs. 9-11)

1847. *Forficesila annulipes*, *Annl. Soc. Ent. Fr.*, (2) **5** : 84 Female; France-Jardine des Plantes, Paris (Introduced).

1853. *Forficula (Labidura) annulipes*; Fischer, *Orthoropera Europ. Leipzig*, **69**, pl. 6, figs. 6a-c.

1864. *Forficelisa annulipes*; Dohra, *Stettin. ent. Ztg.*, **25** : 290.

1910. *Anisolabis annulipes*; Burr, *Fauna British India, Dermaptera* : 84, pl. 6, fig. 24.



Figs. 1-11. *Aborolabis pervicina* (Burr), Male, 1. Anterior portion of body; 2. Posterior portion of Penultimate sternite; 3. Ultimate tergite and forceps; 4. Genitalia; *Aborolabis emarginata* Srivastava, Male, 5. Anterior portion of body; 6. Posterior half of penultimate sternite; 7. Ultimate tergite and forceps; 8. Genitalia; *Euborellia annulipes* (Lucas), Male; 9. Posterior half of penultimate sternite; 10. Ultimate tergite and forceps; 11. Genitalia.

1914. *Euborellia annulipes*; Burr, *J. R. micr. Soc.*, **1915** : 527, 528 and 545.
 1959. *Anisolabis (Euborellia) annulipes*; Bey-Bienko, *Ent. Obozr.*, **38**(3) : 607.
 1988. *Euborellia annulipes*; Srivastava, *Fauna of Orissa State*, State Fauna Series, **1**(2) : 157, figs. 19-21.

Material examined India North Cachar Hills, Umrangso, near the reservoir, 1 Males, 4 Females, 9 nymphs, ex under stones, 1996 (G. K. Srivastava coll.).

Diagnostic characters : General colour blackish brown to dark brown; antennae with basal and one or two ante-apical segments and sides of pronotum yellow and legs yellow and femora banded with black.

Male abdominal segments 6th to 9th on sides acute angled posteriorly, striate and carinate; penultimate sternite with hind margin briefly rounded; parameres about as broad as long, flat, external apical angle rounded; distal lobes with pads of chitinous teeth.

Measurements Male Length : body 9.5-10.5 mm, forceps 1.9-1.2 mm; Female : body 11.5-13.6 mm, forceps 2.6-3.1 mm.

Distribution : Worldwide.

LABIDURIDAE

NALINAE

Nala lividipes (Dufour)

(Figs. 12-13)

1820. *Forficula pallipes* Dufour, *Ann. Gener. des Phys. Bruxelles*, **4** : 316, pls. 116, fig. 7, 7a and 7b (Male, Female; Lower Catalonia, Spain).
 1828. *Forficula lividipes* Dufour, *Ann. Sci. Nat.*, **13** : 340 (New name proposed).
 1900. *Labidura lividipes*; Bormans and Krauss, *Das Tierreich*, **11** : 36.
 1910. *Paralabidura lividipes*; Burr, *Trans. R. ent. Soc. Lond.*, **1910** : 184.
 1910. *Nala lividipes*; Burr, *Genera Insect.*, **122** : 36.
 1976. *Nala lividipes*; Srivastava, *Rec. zool. Surv. India, Occ. Pap.*, **2** : 41.

Material examined : India, Assam, North Cachar Hills, Umrangso, 1 Male, 1996, ex under stones (G. K. Srivastava coll.).

Diagnostic characters : General colour dull blackish brown to black with varying intensity on various body parts and leg joints dirty yellow.

Elytra and wings well developed, former rough and carinate along the costal margin. Male forceps with a branches stout, incurved; genitalia with parameres narrowed apically, distal lobes with distinct virga. Ultimate tergite and forceps and genitalia of male as seen in Figs. 12-13.

Measurements : Male : Length : body 6.1-8.7 mm, forceps 1.5-2.6 mm; Female : Length : Body 6.0-9.0 mm, forceps 1.15-1.6 mm.

Distribution : Worldwide.

LABIDURINAE

Labidura riparia (Pallas)

(Figs. 14-15)

1773. *Forficula riparia* Pallas, *Reise Russ. Reichs.*, 2 : 727 (Sex ?; Shores of Irtysh River, Western Siberia).
 1863. *Labidura riparia*; Dohrn, *Stettin. ent. Ztg.*, 24 : 313.
 1954. *Diplatys himalayana* Baijal and Singh, *Agra Univ. J. Res. (Sci.)*, 3(2) : 455 (3 nymphs, not Male; India : U.P., Nainital dist.).
 1954. *Spongiphora nainitalensis* Baijal and Singh, *Agra Univ. J. Res. (Sci.)*, 3(2) : 456 (Male; India : U.P., Nainital dist.).
 1954. *Erotesis jeolikotensis* Baijal and Singh, *Agra Univ. J. Res. (Sci.)*, 3(2) : 458 (Female; India : U.P., Nainital dist.).
 1954. *Elaunon nainitalensis* Baijal and Singh, *Agra Univ. J. Res. (Sci.)*, 3(2) : 460 (Male; India : U.P., Nainital dist.).
 1986. *Labidura riparia*; Srivastava, *Rec. zool. Surv. India, Occ. Pap.*, 89 : 4.

Material examined : India : Assam, North Cachar Hills, Umlong, 1 Male, 29.vii.1999; Umrang Reservoir, 1 Male, 3 Females, 1.viii.1998 (S. J. S. Hattar coll.).

Diagnostic characters : General colour varies between yellowish brown and dark blackish brown; antennae, legs and wings yellowish brown.

Antennae with 25-36 segments; eyes distinct but shorter than postocular area. Abdomen, in males, gradually enlarging posteriorly; ultimate tergite with posterior margin in middle straight or sometimes with a pair of sharp spines; parameres longer than broad with a short epimrite at apex, internally. Ultimate tergite and forceps and genitalia of males as seen figs. 14-15.

Measurements : Male : Length : body 14.0-24.0 mm, forceps 4.1-10.0 mm; Female : Length : body 12.0-19.10 mm, forceps 3.0-5.0 mm.

Distribution : Worldwide.

FORFICULOIDEA

SPONGIPHORIDAE

LABIINAE

Circolabia curvicauda (Motschulsky)

(Figs. 16-17)

1863. *Forficesila curvicauda* Motschulsky, *Bull. Soc. Imp. Moscou.*, 36 : 2, pl. 2, fig. 1 (Male, Female; Nura Illia Mountains, Ceylon).
 1864. *Labia curvicauda*; Dohrn, *Stettin. ent. Ztg.*, 25 : 428.
 1867. *Platyslabia guineensis* Dohrn, *Stettin. ent. Ztg.*, 26 : 348 (Male; Principle Island).
 1867. *Labia dimitata* Dohrn, *Sttetin. ent. Zeit.*, 26 : 348 (Male; Luzon).

1903. *Labia flavicollis* Bormans in Burr, *Ann. Mag. nat. Hist.*, (7) **11** : 235 (Male; Samoa).
 1904. *Platylabia camerunensis* Borg. *Ark Zool.*, **1** : 570, pl. 1 26, fig. 4 (M) : Cameroon).
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 1976. *Labia curvicauda*; Srivastava, *Rec. zool. Surv. India, Occ. pap.*, **2** : 32.
 1989. *Parabella curvicauda*; Steinmann, *Das Tierreich*, **106** : 497, figs. 920-922.
 1995. *Circolabia curvicauda*; Srivastava, 1995, *Rec. zool. Surv. India*, **95**(1-2) : 102.

Material examined India, Assam, North Cachar Hills, Umrangso, 1 Male, 1996, ex under bark of a log (G. K. Srivastava coll.).

Diagnostic characters : Colour black or brown; head, elytra and wings black; abdomen and forceps reddish brown, often shaded with black in parts; antennae blackish or reddish brown with one or two ante-apical segments pale. Size small, form depressed.

Head convex, hind margin emarginate; eyes small, shorter than postocular length. Elytra and wings well developed, covered with dense microscopic hairs. Penultimate sternite with hind margin rounded. Pygidium transverse, declivent in basal half, hind margin straight. Ultimate tergite and forceps and genitalia as seen in figs. 16-17.

Female : Pygidium narrower and more prominent and forceps simple and straight.

Measurements : *Male* : Length body 5.6-6.8 mm, forceps 0.5-1.1 mm; *Female* Length : body 5.9-7.2 mm, forceps 0.9-1.5 mm.

Distribution Worldwide.

FORFICULIDAE

OPISTHOCOSMIINAE

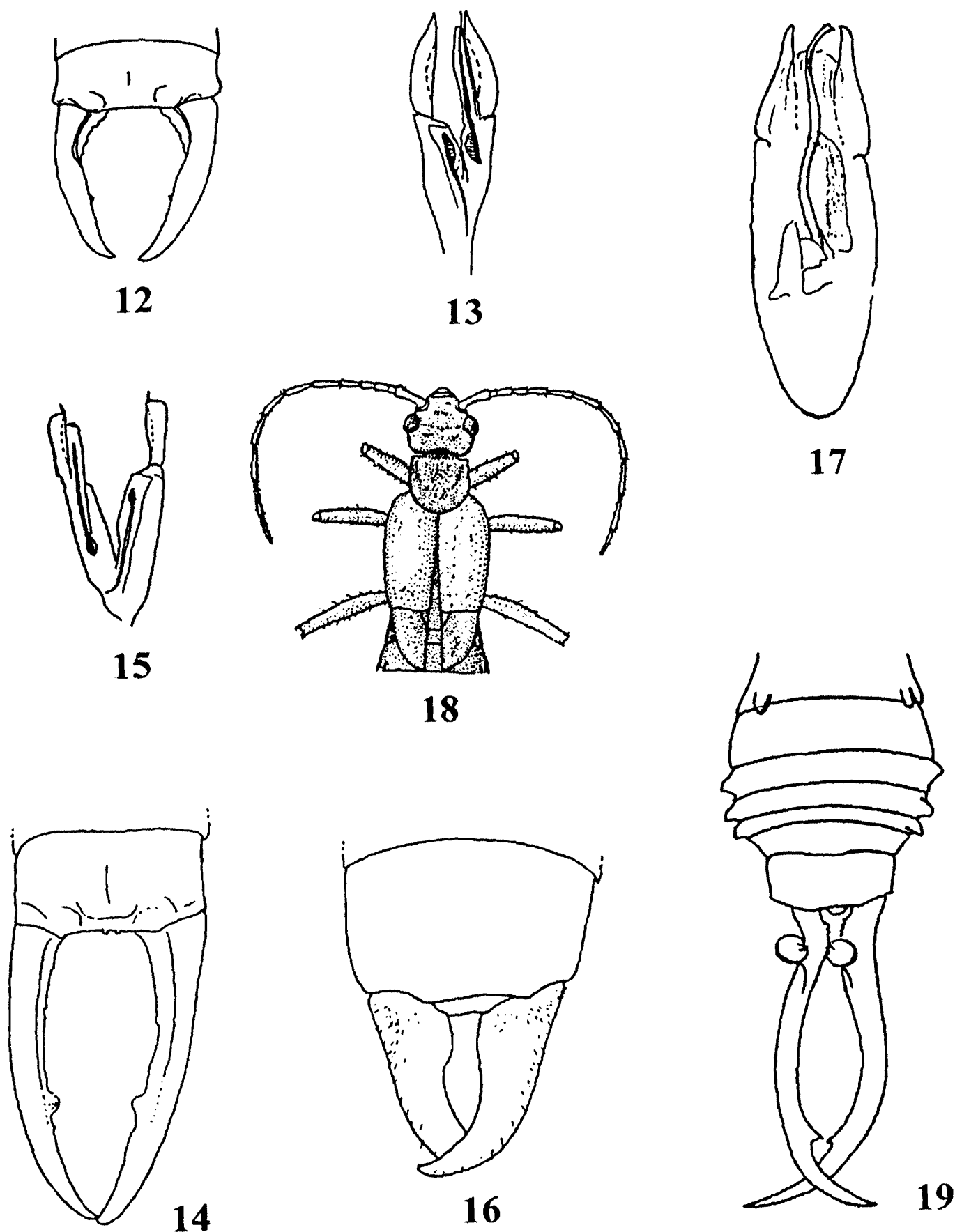
Eparchus insignis (Haan)

(Figs. 18-19)

1842. *Forficula insignis* Haan, *Verh. nat. Gest. nederl. Overz. Bezitt* : 243, fig. 15 not fig. 14 as mentioned in text (Male, Female; Java).
 1865. *Opisthocosmia insignis*; Dohrn, *Stettin. ent. Ztg.*, **26** : 81.
 1907. *Eparchus insignis*; Burr, *Trans. R. ent. Soc. Lond.*, **1907** : 121.
 1954. *Eparchus insignis* (Haan) var. *inermis* Boeseman, *Zool. Verh. Leiden*, **21** : 114.
 1983. *Eparchus insignis*; Srivastava and Lahiri, *Rec. zool. Surv. India*, **81** : 287 (Meghalaya).

Material examined : India, Assam, North Cachar Hills, Garampani, 2 Females, 26.i.1976 (A. K. Ghosh coll.).

Diagnostic characters : General colour dark brownish black, often lighter, sometimes elytra yellowish brown with a yellow spot.



Figs. 12-19. *Nala lividipes* (Dufour), Male, 12. Ultimate tergite and forceps; 13. Genitalia; *Labidura riparia* (Pallas), Male, 14. Ultimate tergite and forceps; 15. Genitalia; *Circolabia curvicauda* (Motschulsky), Male, 16. Ultimate tergite and forceps; 17. Genitalia; *Eparchus insignis* (Haan), Male, 18. Anterior portion of body; 19. Hind portion of body.

Elytra and wings well developed; legs long and slender, hind tarsi with 1st segment distinctly longer than the remaining two segments together. Sides of abdominal segments 6th to 8th, in males, tuberculated. Ultimate tergite and forceps of males as seen in figs. 19.

Measurements Male : Length : body 7.8-10.4 mm, forceps 3.9-5.6 mm; *Female* : Length : body 8.2-10.5 mm, forceps 2.3-3.4 mm.

Distribution : India, Myanmar, Sri Lanka, Indo-China, Java, Celebes and Hainan Isls.

ACKNOWLEDGEMENTS

I am thankful to the Director, Zoological Survey of India, Calcutta, for providing necessary facilities for this study.

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ON A COLLECTION OF DERMAPTERA (INSECTA) FROM AUSTRALIA WITH THE DESCRIPTION OF A NEW SPECIES

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INTRODUCTION

This paper is based upon 32 specimens belonging to six species including one species *Idolopsalis jeekeli* described as new to science. All the species are distributed only in Australia except *Elaunon bipartitus* (Kirby) which is also distributed in the Oriental Region and New Guinea and *Forficula auricularia* L in Europe, Western & North Asia, North America, North Africa, Madagascar, Oceania and New Zealand.

I am thankful to the Director, Zoological Survey of India, Kolkata for providing necessary facilities and to Mr. Ben Brugge, Instituut voor taxonomische Zoölogie (Zoölogisch Museum), Amsterdam for placing this interesting collection at my disposal for study.

ANISOLABOIDEA

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Mongolabis tasmanica (Bormans)

Material examined : Australia, Tasmania : Ben Lemond Natn. Park, 23 km ENE Evandale, St. No. 96, 4 males, 3 Females, 6 nymphs, 23.xi.1980; MT Field Natn Park near National Park 10 km from Maydena, St. No. 105-7, Male, 27.xi.1980; New South Wales, Kosciusko Natn. Park 3 km WSW of Perisher Valley, 20 km W Jindabyne, St. No. 70, 1 Male, 5 Females, 1 nymph, 8.xi.1980; 15 km WSW of Jindabyne, St. No. 72, 1 nymph, 9.xi.1980 (C. & A. Jeekel coll).

Distribution : Australia.

IDOLOPSALINAE

Idolopsalis jeekeli sp. n.

Male : General colour blackish brown; lateral and hind margin of pronotum and along the hind margin of tergites reddish brown. Build medium, pilose.

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Head longer than broad, convex, smooth, sutures obsolete, hind margin emarginate in middle. Eyes not prominent, about half as long as the post-ocular area. Antennae partly damaged (six basal segments on the right and 13 on the left side remaining), basal segment stout, a little shorter than the distance between antennal bases; 2nd short, about as long as broad; 3rd long, slender, one & half times longer than broad; 4th shorter than 3rd stouter, slightly longer than broad; 5th a trifle longer than 4th and about as long as the 3rd but stouter, narrowed basally; 6th onwards gradually increasing in length, each narrowed basally, stout, except a few apical ones thinner. Pronotum quadrate, transverse, smooth, all margins straight, lateral margins gently reflexed, widened posteriorly, postero-lateral angles rounded. Mesonotum transverse, smooth, about half as long as the pronotum, hind margin truncate. Metaonotum strongly transverse, smooth, hind margin broadly emarginate. Legs long, slender, hind tarsi compressed, clad with pubescence on under side, 1st segment slightly longer than the combined length of 2nd and 3rd; 2nd short, broader than long; 3rd slender and claw without an arolium. Abdomen gradually enlarging posteriorly, tergites smooth, convex above, lateral folds on 3rd and 4th tergites obsolete, sides of abdominal segments 6th to 9th acute angled posteriorly with an oblique carina. Penultimate sternite triangular, smooth, hind margin in middle obtuse. Ultimate tergite transverse, disc moderately depressed, obscurely punctate, laterally above with a raised convexity, sloping backwards, narrowed posteriorly, hind margin in middle truncate, laterally oblique and emarginate. Pygidium vertical, not visible from above, narrowed posteriorly, hind margin rounded with a faint depression in middle. Forceps with branches remote, broadened at base, gradually tapering apically, almost straight in basal half, afterwards incurved, right one slightly more strongly incurved, trigonal above in a little less than basal half, afterwards depressed, internal margin faintly serrated. Genitalia (fig. 5) with parameres square, about as long as broad, apices projecting, external apical angle prominent; virga indistinct.

Female Agrees with male in most characters except that ultimate tergite strongly narrowed and forceps simple, contiguous and straight.

<i>Measurements</i> (in mm)	Holotype Male	Paratype Female
Length of body	8.9	7.6
Length of forceps	1.5	1.5

Material examined : Holotype Male (Penultimate sternite mounted on a card and genitalia mounted between two coverslips and pinned with the specimen), Paratype Female, Australia : New South Wales, 20 km NNE of Guyra, St. 57, 30.x.1980 (*C. & A Jeekel* coll.); deposited in the Instituut voor Taxonomische Zoölogie (Zoölogisch Museum), Amsterdam, the Netherlands.

Remarks : With Steinmann's (1989) key to the species of the genus, the described species comes close to *I. whympersi* Burr from Ecuador but differs in having the abdominal tergites smooth;

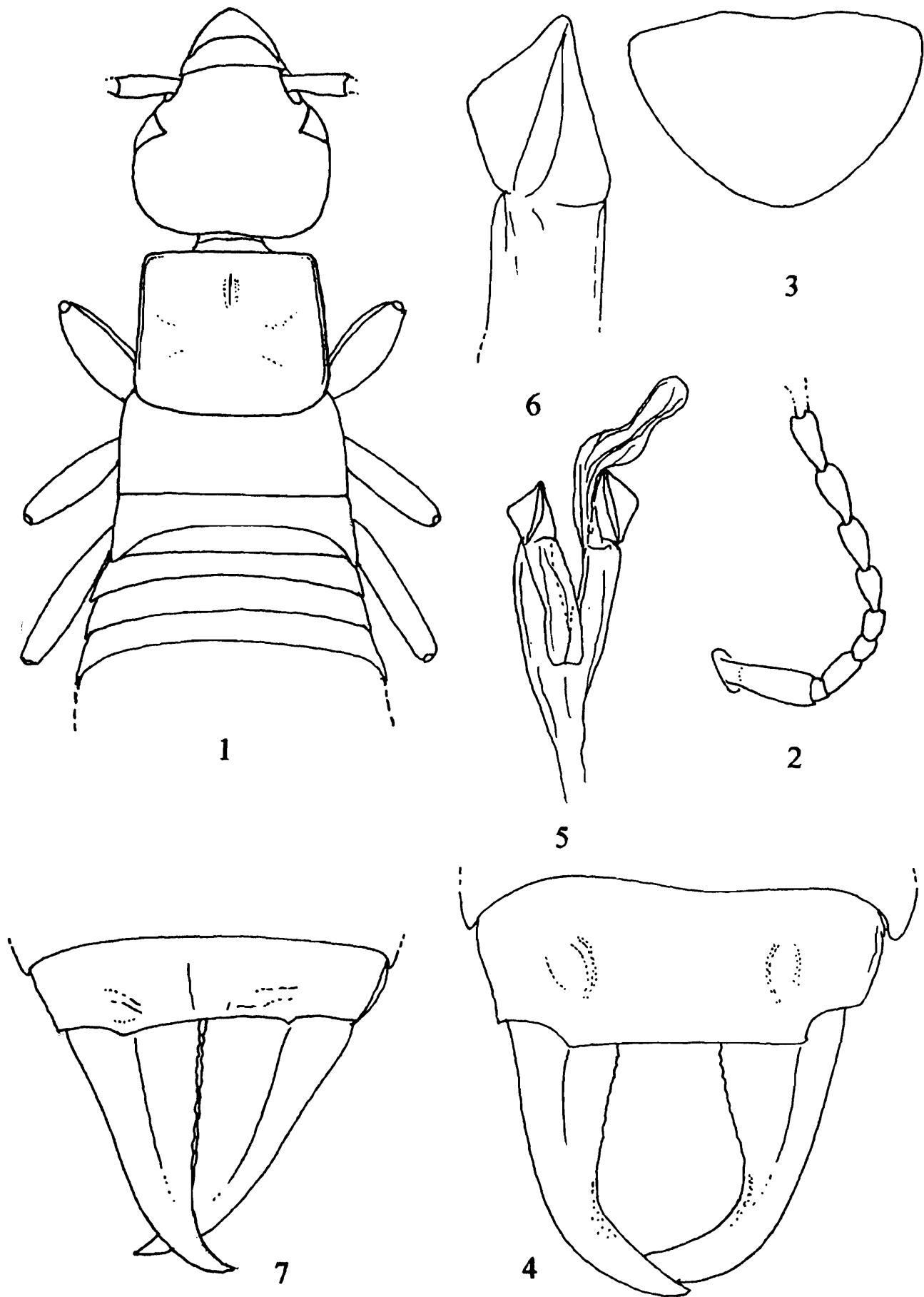


Fig. 1-7 : *Idolopsalis jeekeli* sp.n., Holotype, Male, 1. Anterior portion of body; 2. A few basal antennal segments; 3. Penultimate sternite; 4. Ultimate tergite and forceps; 5. Genitalia; 6. Left Paramere and a portion proparamere, enlarged; Paratype Female, 7. Ultimate tergite and forceps.

in Male, sides of abdominal tergites 6th to 9th with a median carina and genitalia with parameres square and distal lobes without virga.

On the basis of shape of parameres it can be easily separated from all the known species of the genus.

TITANOLABINAE

Titanolabis bormansi Srivastava, 1983

Material examined : Australia : New South Wales, Heaton State, 22 km SE Cessonck, St. 6, 1 Male, genitalia mounted between two coverslips and attached with pin of specimen, 2.xi.1980 (C. & A. Jeekel coll).

Distribution : Australia (New South Wales).

FORFICULOIDEA

FORFICULIDAE

FORFICULINAE

Elaunon bipartitus (Kirby)

Material examined : Australia : Queensland, 5 km S of Redlynch, St. 19, 3 km W. Cairns, 2 Males (macrolabic), 10.x.1980 (C. & A. Jeekel coll).

Distribution : India, Sri Lanka, Vietnam, West Flores, Philippine Isls, Formosa, New Guinea and Australia.

Forficula auricularia (Linnaeus)

Material examined : Australia : New South Wales, Koscinsko Natn Park, Rennex Gap 12 km NW Jinkabyne, St. 71, 3 Males, 1 Female, 8.xi.1980 (C. & A. Jeekel coll).

Distribution : Australia, Europe, North and Western Asia, North Africa, Madagascar, Oceania, Australia, Tasmania and New Zealand.

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EFFECT OF VEHICULAR LEAD POLLUTION ON BIODIVERSITY WITH SPECIAL REFERENCE TO ANTS

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INTRODUCTION

Soil inhabiting ants along with other soil microarthropods constitute the major biotic components of soil ecosystem. This ant community play a major role for smooth functioning of this ecosystem which in turn controls the behaviour of the soil itself. Social insects, like ants (Hymenoptera : Formicidae), have exhibited a great ecological success due to their better adaptability in the soil in comparison to other microarthropods (Holldobler and Wilson, 1990). However, soil arthropods in genera undergo qualitative and quantitative changes in a polluted environment have been demonstrated earlier (Przybylski 1979, 1981, Chattopadhyay and Hazra 2000). It has also been observed that ants are well tolerant to environmental pollution, heavy metals in particular (Petal, 1981; Stary and Kubiznakova, 1987; Krzysztofiak, 1991, Migula *et al.* 1993). On the other hand it has been observed anthropogenic disturbances in habitat result in the lowering of species diversity and species richness in ants (Mackay *et al.* 1991; Gadagkar *et al.* 1993). Pollutants therefore are expected to cast its effects on the species diversity of the microarthropods, including ants, as has already been observed in other groups of organisms (Biswas *et al.* 1998).

Kolkata, the largest metropolis in India, probably has the largest traffic density, the exhaust of which contain a large amount of lead, which is used as antiknock compound in the fuel. Thus, the road side soils are expected to have a high lead load. Since no account is available on the effect of lead pollution on the species diversity of soil ants, the present study was undertaken to—

(a) find out the quantum of lead deposited in the road side soils of Kolkata with its seasonal variations; (b) establish the seasonal variations in species diversity of ants; (c) establish relationship between the lead load and variations in species diversity of ants, through seasons; (d) study the richness of species, equitability in distribution of species and similarity pattern of species diversity between different localities.

STUDY SITES

Four major arterial roads were selected as study sites, one each at North, South, East and Central Kolkata; henceforth referred to as NC, SC, EC and CC respectively.

Soil at NC, along Tala Park Avenue, was coarse and sandy loam in nature admixed with various city refuses, and had little vegetation except some herbs during monsoon. At SC, adjacent to Southern Avenue, the soil was sandy clay loam with rich vegetation of herbs, shrubs and trees. At EC along Eastern Bypass the soil was loam, enriched with vegetation of mainly herbs and shrubs. At CC along Red Road the soil was clay loam in texture having herbs, mainly grasses as vegetal cover interspaced with old trees. The site experienced frequent water logging during monsoon.

MATERIALS AND METHODS

Soils were collected at monthly intervals for 24 months from three horizontal plots—A, B and C away from the roads respectively. Each plot measured about five metres by two metres.

Ten soil samples were collected, at random, from each plot, following standard procedure (Holldobler & Wilson 1990), from 0–5 cm depth of the soil.

Ants were collected from soil samples by hand picking and through light extraction funnel as recommended (Holldobler and Wilson 1990).

Identification of ant fauna was established along with their numerical strength.

Soil samples were analysed for estimation of lead content (in ppm) following atomic absorption spectrophotometry, conducted by Geological Survey of India, Kolkata.

Index of dominance was calculated as $n_i \times 100/N$ where n_i = Number of individuals in i th species and N = Total number of individuals in all the species.

Species diversity index was calculated following Trammer, 1969. Species richness index was found following Margalef, 1951. Evenness or equitability index was established following Pielou, 1975. Modified Sorenson's index of similarity was obtained following Spellerberg, 1991.

The results thus obtained were subjected to various statistical analysis following standard methods including test of significance in the differences of the species diversity indices; correlation between lead concentration and species diversity indices and species richness indices alongwith scattered diagram and trend line for prediction.

RESULTS AND DISCUSSION

A. Concentration of Lead

Concentration of lead (ppm) in the soil was found to vary at different sites and plots. (Table 1). At EC, CC and SC the concentration was found to be maximum at plot A, adjacent to road, and minimum at Plot C farthest from road, whereas at NC the trend was reverse.

On an average each site also exhibited large variations in the concentration of lead in soil (Table 2). At EC the lead concentration (mean) was found to be minimum (121.30 ± 20.14) while

Table 1. Concentration of Lead(ppm) in mean $\pm$ SD at different plots of different sites.

SITES/ PLOTS	EC			CC			NC			SC		
Months▼	A	B	C	A	B	C	A	B	C	A	B	C
AUG '96	115 $\pm$ 17.53	160 $\pm$ 10.09	125 $\pm$ 7.47	320 $\pm$ 9.69	300 $\pm$ 7.48	280 $\pm$ 11.99	325 $\pm$ 18.87	212 $\pm$ 6.10	180 $\pm$ 6.57	170 $\pm$ 12.00	120 $\pm$ 14.63	75 $\pm$ 6.77
SEP	155 $\pm$ 13.85	95 $\pm$ 6.19	140 $\pm$ 6.00	360 $\pm$ 7.00	300 $\pm$ 9.13	185 $\pm$ 9.87	173 $\pm$ 9.13	319 $\pm$ 4.65	410 $\pm$ 9.11	220 $\pm$ 16.22	300 $\pm$ 9.64	100 $\pm$ 7.31
OCT	150 $\pm$ 8.48	100 $\pm$ 4.63	70 $\pm$ 4.79	340 $\pm$ 6.45	400 $\pm$ 10.53	260 $\pm$ 8.76	227 $\pm$ 6.03	373 $\pm$ 5.66	395 $\pm$ 13.12	180 $\pm$ 11.08	200 $\pm$ 13.55	80 $\pm$ 8.74
NOV	180 $\pm$ 8.48	160 $\pm$ 4.63	100 $\pm$ 4.79	320 $\pm$ 6.07	280 $\pm$ 10.14	160 $\pm$ 5.78	428 $\pm$ 8.14	279 $\pm$ 5.06	255 $\pm$ 6.24	260 $\pm$ 11.23	140 $\pm$ 6.81	130 $\pm$ 7.65
DEC	210 $\pm$ 8.48	140 $\pm$ 4.63	160 $\pm$ 4.79	280 $\pm$ 4.94	200 $\pm$ 7.76	200 $\pm$ 8.81	357 $\pm$ 6.62	344 $\pm$ 4.71	200 $\pm$ 5.60	320 $\pm$ 10.13	180 $\pm$ 9.68	120 $\pm$ 7.97
JAN '97	170 $\pm$ 4.79	140 $\pm$ 3.77	60 $\pm$ 4.79	300 $\pm$ 9.15	400 $\pm$ 9.57	180 $\pm$ 5.12	340 $\pm$ 7.08	300 $\pm$ 4.96	220 $\pm$ 13.56	200 $\pm$ 10.32	120 $\pm$ 10.47	100 $\pm$ 7.00
FEB	100 $\pm$ 4.79	90 $\pm$ 4.79	130 $\pm$ 4.79	360 $\pm$ 6.16	450 $\pm$ 5.69	300 $\pm$ 6.08	290 $\pm$ 6.46	368 $\pm$ 5.02	310 $\pm$ 9.42	160 $\pm$ 7.71	140 $\pm$ 7.17	100 $\pm$ 8.47
MAR	125 $\pm$ 4.79	70 $\pm$ 4.79	105 $\pm$ 4.79	375 $\pm$ 6.07	590 $\pm$ 7.50	160 $\pm$ 5.14	220 $\pm$ 6.03	291 $\pm$ 5.10	270 $\pm$ 4.84	200 $\pm$ 10.26	160 $\pm$ 8.21	90 $\pm$ 7.47
APR	115 $\pm$ 4.79	135 $\pm$ 4.79	80 $\pm$ 4.79	300 $\pm$ 7.06	340 $\pm$ 6.08	200 $\pm$ 6.39	250 $\pm$ 5.49	183 $\pm$ 5.16	298 $\pm$ 6.60	230 $\pm$ 9.81	130 $\pm$ 8.82	100 $\pm$ 10.46
MAY	100 $\pm$ 10.3	140 $\pm$ 10.3	130 $\pm$ 5.12	305 $\pm$ 8.11	360 $\pm$ 5.90	320 $\pm$ 6.40	178 $\pm$ 5.49	268 $\pm$ 5.14	364 $\pm$ 6.71	260 $\pm$ 10.57	200 $\pm$ 9.37	80 $\pm$ 9.12
JUN	125 $\pm$ 4.98	150 $\pm$ 4.62	140 $\pm$ 4.77	240 $\pm$ 6.24	200 $\pm$ 5.88	185 $\pm$ 6.28	290 $\pm$ 5.27	287 $\pm$ 5.65	372 $\pm$ 6.05	200 $\pm$ 12.87	100 $\pm$ 8.15	120 $\pm$ 8.51
JUL	115 $\pm$ 14.98	90 $\pm$ 7.54	160 $\pm$ 4.77	280 $\pm$ 6.88	220 $\pm$ 6.62	160 $\pm$ 5.78	201 $\pm$ 5.29	319 $\pm$ 7.11	394 $\pm$ 9.55	176 $\pm$ 10.05	120 $\pm$ 9.05	100 $\pm$ 8.48
AUG	100 $\pm$ 5.53	140 $\pm$ 4.77	60 $\pm$ 5.38	340 $\pm$ 8.67	300 $\pm$ 6.72	400 $\pm$ 5.95	198 $\pm$ 6.05	378 $\pm$ 5.88	438 $\pm$ 6.66	170 $\pm$ 10.46	140 $\pm$ 7.83	100 $\pm$ 12.29
SEP	125 $\pm$ 5.78	135 $\pm$ 6.07	190 $\pm$ 4.79	400 $\pm$ 5.73	255 $\pm$ 8.01	120 $\pm$ 5.76	348 $\pm$ 6.77	471 $\pm$ 7.68	284 $\pm$ 6.20	145 $\pm$ 9.67	110 $\pm$ 10.69	85 $\pm$ 6.51
OCT	160 $\pm$ 5.23	80 $\pm$ 9.39	140 $\pm$ 7.17	350 $\pm$ 6.42	280 $\pm$ 5.88	170 $\pm$ 6.26	166 $\pm$ 6.34	315 $\pm$ 5.58	343 $\pm$ 6.21	160 $\pm$ 5.25	120 $\pm$ 9.05	90 $\pm$ 8.75
NOV	190 $\pm$ 10.24	125 $\pm$ 7.03	90 $\pm$ 5.42	330 $\pm$ 5.90	240 $\pm$ 11.83	200 $\pm$ 11.32	220 $\pm$ 6.05	301 $\pm$ 5.29	280 $\pm$ 5.62	240 $\pm$ 7.00	100 $\pm$ 10.24	80 $\pm$ 9.41
DEC	205 $\pm$ 6.75	90 $\pm$ 6.34	115 $\pm$ 7.25	260 $\pm$ 5.73	220 $\pm$ 6.46	155 $\pm$ 6.10	260 $\pm$ 6.29	140 $\pm$ 4.88	355 $\pm$ 6.78	330 $\pm$ 12.26	140 $\pm$ 8.65	120 $\pm$ 10.50
JAN '98	60 $\pm$ 6.2	65 $\pm$ 6.62	180 $\pm$ 5.74	250 $\pm$ 7.54	230 $\pm$ 7.13	160 $\pm$ 6.75	285 $\pm$ 5.81	305 $\pm$ 6.52	455 $\pm$ 7.13	170 $\pm$ 11.80	140 $\pm$ 10.64	100 $\pm$ 8.94
FEB	100 $\pm$ 6.31	100 $\pm$ 6.62	140 $\pm$ 7.39	245 $\pm$ 5.46	170 $\pm$ 8.69	200 $\pm$ 7.27	280 $\pm$ 6.29	180 $\pm$ 7.20	200 $\pm$ 5.51	150 $\pm$ 7.56	140 $\pm$ 7.24	80 $\pm$ 7.60
MAR	115 $\pm$ 7.56	50 $\pm$ 5.12	90 $\pm$ 5.08	270 $\pm$ 6.75	225 $\pm$ 5.64	215 $\pm$ 5.95	285 $\pm$ 10.19	305 $\pm$ 7.40	455 $\pm$ 6.56	135 $\pm$ 7.68	80 $\pm$ 8.85	75 $\pm$ 6.98
APR	100 $\pm$ 8.60	65 $\pm$ 5.91	115 $\pm$ 7.22	280 $\pm$ 7.61	230 $\pm$ 7.27	200 $\pm$ 7.20	330 $\pm$ 8.92	300 $\pm$ 6.18	300 $\pm$ 5.20	140 $\pm$ 9.35	90 $\pm$ 9.18	110 $\pm$ 7.33
MAY	125 $\pm$ 6.31	80 $\pm$ 5.46	144 $\pm$ 6.62	260 $\pm$ 6.78	200 $\pm$ 7.39	140 $\pm$ 8.70	360 $\pm$ 5.80	260 $\pm$ 5.81	240 $\pm$ 5.73	200 $\pm$ 9.81	130 $\pm$ 8.28	100 $\pm$ 11.50
JUN	115 $\pm$ 6.81	160 $\pm$ 6.60	105 $\pm$ 6.16	200 $\pm$ 7.03	190 $\pm$ 7.27	265 $\pm$ 6.48	530 $\pm$ 6.29	185 $\pm$ 5.85	495 $\pm$ 10.35	205 $\pm$ 12.16	100 $\pm$ 11.06	135 $\pm$ 7.13
JUL	125 $\pm$ 6.06	80 $\pm$ 6.56	150 $\pm$ 7.21	300 $\pm$ 8.01	240 $\pm$ 7.72	200 $\pm$ 7.27	340 $\pm$ 5.12	200 $\pm$ 5.00	220 $\pm$ 5.20	260 $\pm$ 9.55	120 $\pm$ 9.16	120 $\pm$ 6.35
$\bar{X}$	132.50 $\pm$ 36.60	110 $\pm$ 34.00	121 $\pm$ 34.62	302.71 $\pm$ 47.65	284.16 $\pm$ 96.40	208.96 $\pm$ 63.61	286.71 $\pm$ 84.50	286.79 $\pm$ 74.16	322.25 $\pm$ 89.39	203.37 $\pm$ 52.03	138.33 $\pm$ 45.06	99.58 $\pm$ 17.19

Table 2. Concentration of Lead (ppm) in mean $\pm$ SD at different sites (Average).

Site ► Month ▼	EC	CC	SC	NC
AUG '96	133.33 $\pm$ 22.96	300.00 $\pm$ 19.09	121.66 $\pm$ 40.50	239.00 $\pm$ 63.36
SEP	130.00 $\pm$ 27.18	281.67 $\pm$ 73.13	206.67 $\pm$ 83.02	300.67 $\pm$ 97.94
OCT	106.67 $\pm$ 33.58	333.33 $\pm$ 58.01	153.33 $\pm$ 53.69	331.67 $\pm$ 75.09
NOV	146.67 $\pm$ 34.56	253.33 $\pm$ 68.41	176.67 $\pm$ 59.71	320.67 $\pm$ 76.81
DEC	170.00 $\pm$ 30.10	226.67 $\pm$ 38.42	206.67 $\pm$ 84.31	300.33 $\pm$ 71.37
JAN '97	123.33 $\pm$ 46.82	293.33 $\pm$ 90.31	140.00 $\pm$ 44.21	286.67 $\pm$ 50.74
FEB	106.67 $\pm$ 17.66	370.00 $\pm$ 61.93	133.33 $\pm$ 26.13	322.67 $\pm$ 33.85
MAR	100.00 $\pm$ 23.33	375.00 $\pm$ 175.66	150.00 $\pm$ 46.29	260.33 $\pm$ 30.26
APR	110.00 $\pm$ 23.23	280.00 $\pm$ 59.24	153.33 $\pm$ 56.42	243.67 $\pm$ 47.51
MAY	123.33 $\pm$ 19.19	328.33 $\pm$ 24.21	180.00 $\pm$ 75.46	270.00 $\pm$ 76.17
JUN	138.33 $\pm$ 11.34	208.33 $\pm$ 24.01	140.00 $\pm$ 44.36	316.33 $\pm$ 39.79
JUL	121.67 $\pm$ 29.56	220.00 $\pm$ 49.41	132.00 $\pm$ 33.46	304.67 $\pm$ 79.80
AUG	100.00 $\pm$ 33.08	346.67 $\pm$ 41.72	136.67 $\pm$ 30.49	338.00 $\pm$ 102.17
SEP	150.00 $\pm$ 29.11	258.33 $\pm$ 114.52	113.33 $\pm$ 26.25	367.67 $\pm$ 77.90
OCT	126.67 $\pm$ 34.80	266.67 $\pm$ 74.34	123.33 $\pm$ 29.74	274.67 $\pm$ 77.92
NOV	135.00 $\pm$ 42.16	256.67 $\pm$ 55.29	140.00 $\pm$ 71.74	267.00 $\pm$ 34.79
DEC	136.67 $\pm$ 49.85	211.67 $\pm$ 43.70	196.67 $\pm$ 95.22	251.00 $\pm$ 88.18
JAN '98	101.67 $\pm$ 55.79	213.33 $\pm$ 39.24	136.67 $\pm$ 30.54	348.33 $\pm$ 76.14
FEB	113.33 $\pm$ 20.04	205.00 $\pm$ 31.66	123.33 $\pm$ 31.80	220.00 $\pm$ 43.67
MAR	85.00 $\pm$ 27.44	236.67 $\pm$ 24.69	96.67 $\pm$ 28.30	348.33 $\pm$ 76.31
APR	93.33 $\pm$ 22.19	236.67 $\pm$ 33.81	113.33 $\pm$ 22.30	310.00 $\pm$ 15.76
MAY	115.00 $\pm$ 26.22	200.00 $\pm$ 49.58	143.33 $\pm$ 43.06	286.67 $\pm$ 52.81
JUN	126.67 $\pm$ 24.80	218.33 $\pm$ 33.96	146.67 $\pm$ 44.86	403.33 $\pm$ 155.24
JUL	118.33 $\pm$ 29.71	246.67 $\pm$ 41.81	166.67 $\pm$ 66.53	253.33 $\pm$ 62.03
$\bar{X}$	121.30 $\pm$ 20.14	265.28 $\pm$ 32.35	147.10 $\pm$ 28.42	298.57 $\pm$ 43.79

at NC it was maximum (298.57 $\pm$ 43.79). SC had a mean concentration of 147.10 $\pm$ 28.42 ppm which was slightly higher than EC while at CC mean lead concentration was found to be little less than NC.

Lead concentration was therefore in an increasing order at EC, SC, CC and NC. Though lead load in the soil was related to the intensity of vehicular movement, vegetation also probably played a role in controlling the soil lead concentration (Bhalsberg-Phalsson, 1989; Migula and Binkowska, 1993). At EC the vehicular movement was more intense in comparison to NC, but rich vegetation at EC might have resulted in uptaking large lead load from the soil and a poor vegetation at NC might have resulted into maximum soil lead concentration.

The seasonal variations of lead concentration did not follow any particular trend and were found to be highly irregular.

B. Faunal composition and dominance

Altogether 28 species of ants were recorded during this study of which 20, 17, 13 and 17 species were found to occur at EC, CC, NC and SC respectively (Table 3). *Solenopsis geminata* was the most dominant species and widely distributed in all the sites. The abundance of various species varied from site to site, which is reflected in their indices of dominance. (Table 3). It therefore appeared that a rich vegetation and a lowest mean concentration of lead (121.30 ppm) at EC had probably influenced the diversity of species in a positive manner, whereas highest mean lead concentration (298.57 ppm) and scanty floral presence might have had a negative effect on the variation of species at NC. From the index of dominance it is also clear that at NC beside *S. geminata* (30.39) three other species *Pheidole roberti* (18.74), *Tetramorium walshi* (12.76) and *Meranoplus bicolor* (11.34) played dominant role in building up the soil ant community, whereas at EC, CC and SC only one or two species played a major role. This may be attributed to less interspecific competition and better adaptability to the environment.

C. Species richness index

From Table 4 it is evident that species richness indices were quite variable at all the sites and no definite pattern in seasonal variations could be observed. The maximum value was found to be 3.33 and lowest being zero.

However, from the mean values it is clear that species richness index was maximum at plot C of EC, CC and SC whereas the order is opposite at NC. A comparison of mean lead concentration (Table 2) with that of species richness index revealed that they had an inverse relationship, which suggests that concentration of lead might have had a negative effect on the species richness of ants.

On an average it is observed (Table 5) that species richness ranged from 0 to 4.35 at EC, 0.45 to 3.57 at CC, 1.05 to 2.97 at NC and 0.58 to 3.33 at SC in different months; however the fluctuations did not have any definite pattern.

It is also found that at EC the species richness was maximum (5.65) followed by CC (4.94), SC (4.91) and minimum at NC (3.74). *Solenopsis geminata* was observed to be the only species

Table 3. Distribution of ant species at different sites under study. ['+' Present; figures indicate the index of Dominance].

Species	EC	CC	NC	SC
<i>Solenopsis geminata</i>	+ 42.71	+ 41.65	+ 30.39	+ 40.95
<i>Camponotus compressus</i>	+ 3.13	+ 1.85	+ 1.29	+ 0.72
<i>Technomyrmex albipes</i>	+ 6.56	+ 3.35	+ 4.81	+ 5.72
<i>Amblyopone rothneyi</i>	+ 0.04			
<i>Syscia sp.</i>	+ 0.09			
<i>Pheidole roberti</i>	+ 14.35	+ 18.49	+ 18.74	+ 9.82
<i>Meranoplus bicolor</i>	+ 2.07	+ 15.89	+ 11.34	+ 4.05
<i>Tapinoma melanocephalum</i>	+ 5.90	+ 1.96	+ 3.76	+ 2.99
<i>Cardiocondyla nuda</i>	+ 1.19	+ 0.06	+ 0.31	+ 0.72
<i>Crematogaster rothneyi</i>	+ 0.97	+ 0.64		+ 2.27
<i>Paratrechina longicornis</i>	+ 8.81	+ 5.26	+ 5.80	+ 5.60
<i>Anochetus graeffei</i>	+ 0.09		+ 0.31	
<i>Dorylus orientalis</i>	+ 2.06			
<i>Pachycondyla rufipes</i>	+ 0.06			
<i>Plagiolepis jerdoni</i>	+ 4.76	+ 3.12	+ 3.70	+ 6.66
<i>Tetramorium walshi</i>	+ 2.82	+ 1.68	+ 12.76	+ 2.61
<i>Diacamma vagans</i>	+ 0.09			
<i>Messor barbarus</i>	+ 1.01			
<i>Polyrhachis tubericeps</i>	+ 1.06			
<i>Carebara lignata</i>	+ 1.67	+ 3.24	+ 1.36	+ 1.33
<i>Hypoponera truncata</i>		+ 0.35		
<i>Monomorium floricola</i>		+ 1.79	+ 5.43	+ 14.82
<i>Tetraponera allaborans</i>		+ 0.06		+ 0.78
<i>Oligomyrmex asinus</i>		+ 0.06		
<i>Lophomyrmex quadrispinosus</i>		+ 0.58		
<i>Pheidologeton diversus</i>				+ 0.28
<i>Tetraponera rufonigra</i>				+ 0.17
<i>Recurvidris recurvispinosa</i>				+ 0.50

Table 4. Species Richness Index of Formicidae (Hymenoptera) at different plots.

Site/Plot ►	East Calcutta			Central Calcutta			North Calcutta			South Calcutta		
Month ▼	A	B	C	A	B	C	A	B	C	A	B	C
Aug-96	0	2.22	3.33	1.28	1.26	1.33	0	0.62	0.81	0.66	0	0
Sep	1.44	1.11	0	0.90	0	0	0.59	0	0	0	0	3.33
Oct	1.54	1.05	0.69	0	0	0.9	0	0.83	0	1.4	0.93	0
Nov	0.64	1.19	2.22	0.67	1.00	0.85	0	0	0	0	0	0
Dec	1.15	0	0	0	0	0	0	0	0	0	0	1.05
Jan-97	0	0	0	0	0	0	1.30	0.85	0.57	0	0	0
Feb	2.30	1.12	1.19	0	0.96	0	1.88	0	0	0	0	0
Mar	0.60	0	0.62	0	0	1.11	0	1.87	0	1.21	0.71	0.78
Apr	0.67	0.87	0.72	0	0.93	0.87	0.9	1.30	0.80	0	0.69	0.96
May	0	0	2.08	1.47	0.76	0	0	1.44	0	1.91	1.11	0.62
Jun	0	0.61	0.63	0.72	1.18	1.68	0.62	0	1.54	0	0.66	1.10
Jul	0.75	0.93	0	0	0	0	0	0	0	1.42	0	1.74
Aug	0.63	0	1.10	0.65	0	0	2.01	0	0	0.65	0	0.8
Sep	0	1.26	0.87	0.85	0.90	0	1.60	0	0	0	2.06	1.43
Oct	2	0	1.86	0.56	0	0.59	0.68	0	0	0.71	0	0.90
Nov	0	0	0	0	0	2.85	0	1.60	0.70	0	1.08	0.77
Dec	1.85	0	0.93	0.77	0	0.83	0	1.23	0.56	0	0.67	0
Jan-98	0.56	0.54	0	0	2.10	1.12	0	0.72	0	1.19	1.76	0
Feb	0	0	0	1.00	0	0	1.27	0	0.65	0.73	1.11	0
Mar	0	0.71	0	0	0	0	0	1.11	0	0.7	0	0
Apr	1.25	1.43	1.85	0	0	0	1.54	0	0.69	1.54	0	1.16
May	1.20	0	0	1.91	2.27	1.96	0	0.68	0.78	1.26	0.68	2.20
Jun	0.57	0	0.63	2.08	0.61	0	0	0	0.77	0	1.03	3.33
Jul	1.35	0.74	0	0	0.65	0.70	1.51	0.69	0.81	1.88	1.47	1.11
$\bar{X}$	0.77	0.57	0.78	0.54	0.53	0.62	0.58	0.54	0.36	0.64	0.58	0.89

occurring in Jan '97, at EC, which has resulted in reducing the index to zero. It is therefore clear that richness of species in a given environment is dynamic in character, having fluctuation with given time and space and which is dependent on various ecological factors. So far as the present study is concerned the presence of excess amount of lead in the soil might have exerted an effect on the richness of species. It is evident from Figures 1 and 2 that species richness had negative relationship with lead at CC, NC and SC and the relationship was faintly positive at EC. However none of these relationships is found to be significant.

Table 5. Species Richness Index in the community of Formicidae (Hymenoptera) at different seasons and at different sites (average).

Months ▸ Sites ▼	Aug-96	Sep	Oct	Nov	Dec	Jan-97	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan-98	Feb	Mar	Apr	May	Jun	Jul	TOTAL
East Calcutta	4.35	1.76	1.70	2.03	2.27	0	2.58	1.98	2.17	1.13	0.92	1.66	2.46	2.17	3.39	0.49	2.27	1.83	0.99	1.58	2.65	0.93	1.83	2.16	5.65
Central Calcutta	2.11	2.09	2.16	2.86	1.11	0.45	1.32	1.38	1.95	2.31	2.38	0.66	1.91	1.85	1.93	2.60	2.91	2.20	1.87	1.13	1.89	3.57	2.76	2.19	4.94
North Calcutta	1.66	1.16	2.10	1.12	1.05	2.97	2.66	2.26	1.65	1.82	2.05	1.17	1.76	1.82	1.64	2.12	1.48	1.42	2.04	1.99	2.22	2.21	1.82	2.75	3.74
South Calcutta	1.34	3.33	3.04	1.05	0.61	0.47	1.01	3.07	2.00	2.86	1.90	2.87	1.66	2.69	1.86	1.50	0.58	3.09	0.99	1.53	2.67	2.55	2.33	3.24	4.91

Table 6. Seasonal variation in Evenness Index in the community of Formicidae (Hymenoptera) at different sites (cumulative).

Months ▸ Sites ▼	Aug-96	Sep	Oct	Nov	Dec	Jan-97	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan-98	Feb	Mar	Apr	May	Jun	Jul	$\bar{X}$
East Calcutta	0.96	0.47	0.94	0.78	0.37	0	0.61	0.94	0.66	0.38	0.67	0.83	0.58	0.41	0.75	0.69	0.70	0.89	0.66	0.82	0.93	0.28	0.88	0.98	0.67
Central Calcutta	0.65	0.96	0.93	0.92	0.83	0.93	0.95	0.69	0.81	0.88	0.85	0.42	0.73	0.61	0.76	0.56	0.85	0.71	0.83	0.55	1.00	0.87	0.70	0.95	0.79
North Calcutta	0.77	0.78	0.81	0.88	0.92	0.89	0.98	0.78	0.89	0.70	0.66	0.78	0.96	0.90	0.94	0.88	0.62	0.71	0.91	0.86	0.87	0.96	0.97	0.98	0.85
South Calcutta	0.48	0.95	0.91	0.99	0.45	0.49	0.51	0.96	0.70	0.75	0.78	0.90	0.85	0.82	0.78	0.81	0.64	0.71	0.20	0.81	0.70	0.67	0.41	0.92	0.72

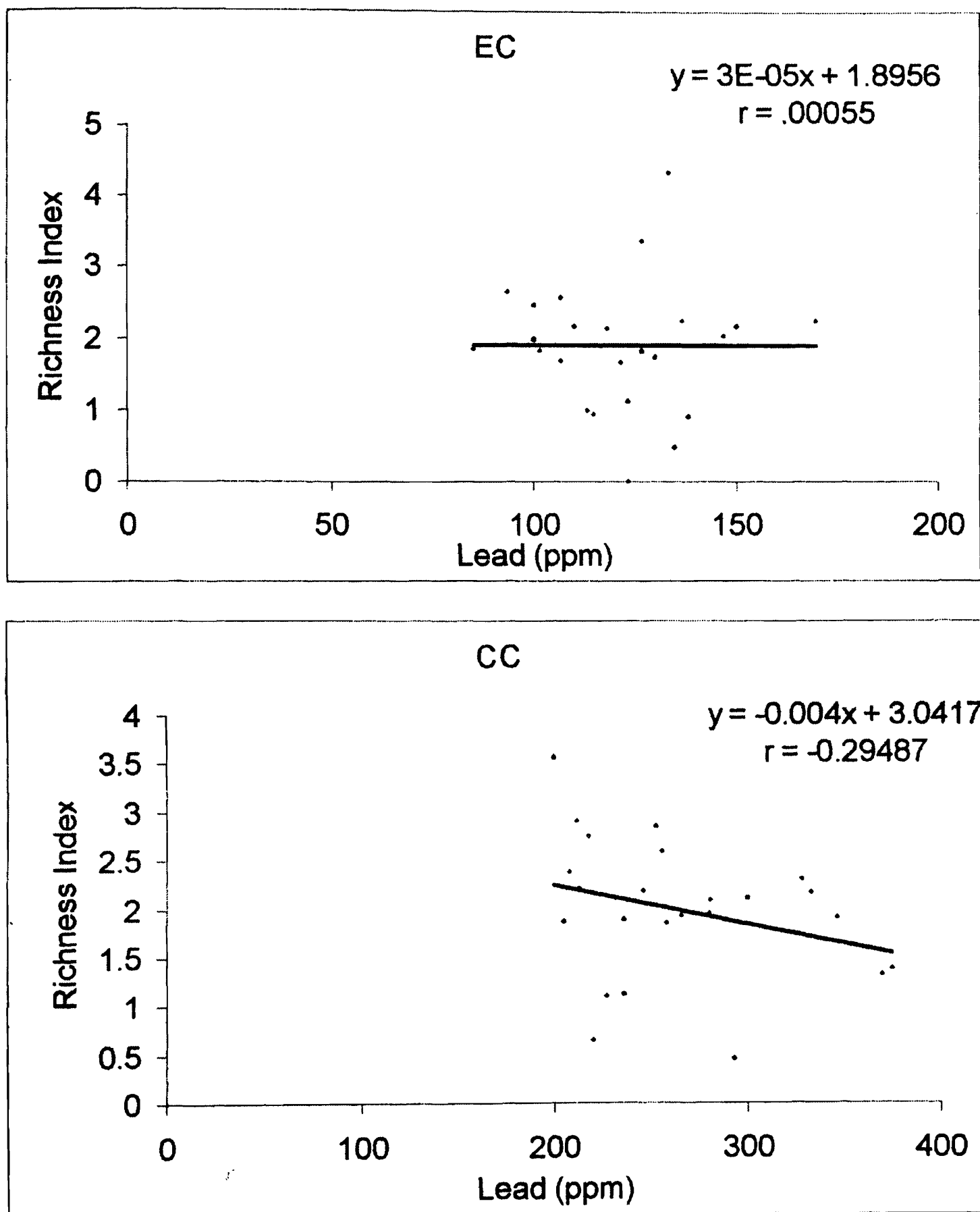


Fig. 1. Showing correlation coefficient (r), regression equation and trend line of species richness index on Lead (ppm) at EC and CC.

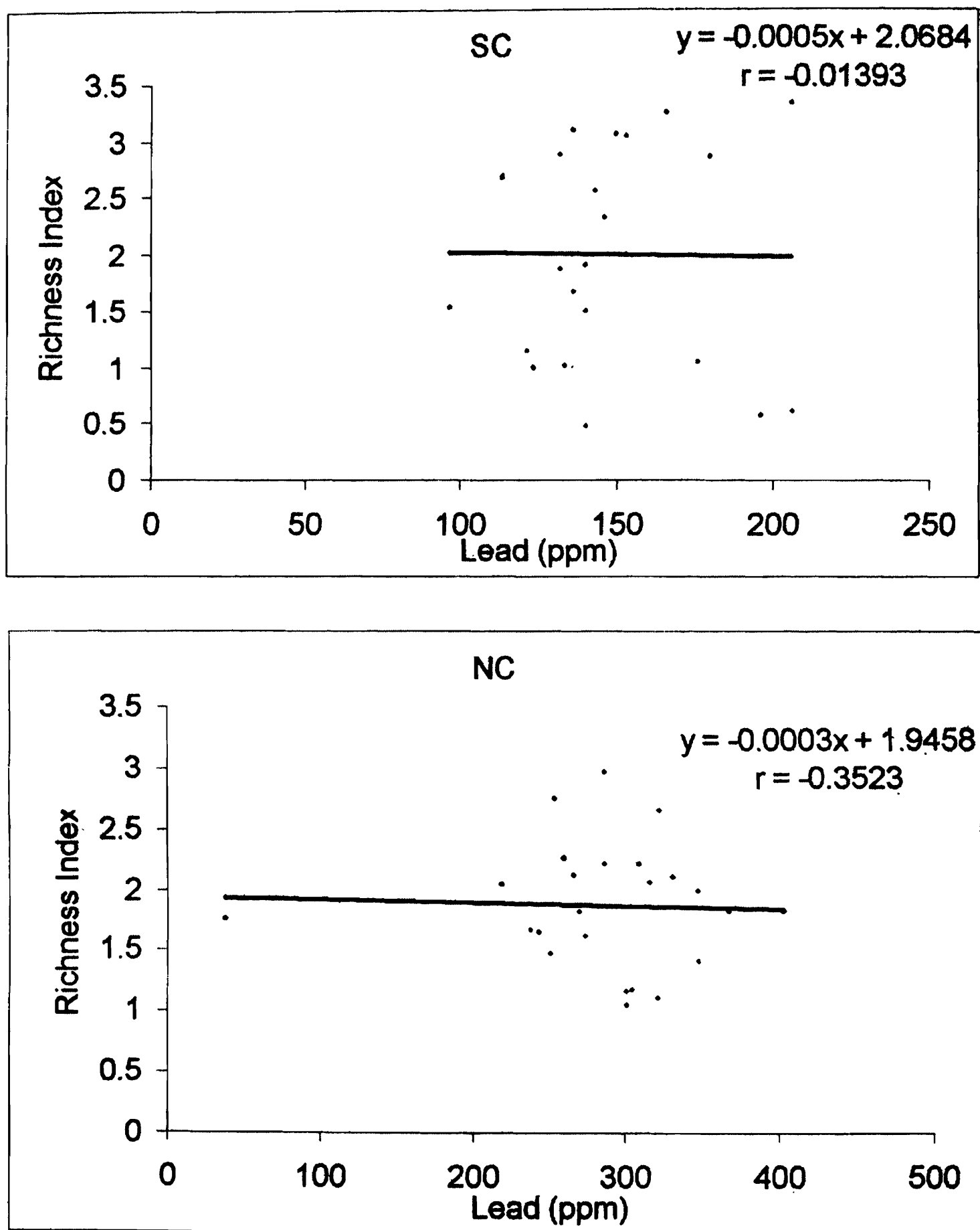


Fig. 2. Showing correlation coefficient (r), regression equation and trend line of species richness index on Lead (ppm) at NC and SC.

D. Index of Evenness

From Table 6 it is observed that evenness in the distribution of species varied greatly from site to site and also in different seasons. The maximum evenness was observed to be 0.98 and minimum of 0.28 at EC while these at CC, NC and SC were 1.00 and 0.42; 0.98 and 0.62; and 0.99 and 0.20 respectively. Higher evenness values on October and July at all the sites suggested that monsoon and post monsoon seasons as best suited for even distribution of species. However, in other months no definite pattern in the evenness could be observed.

It is thus clear that at NC the range of evenness was much better in comparison to other sites with a mean value of 0.85; which suggests that at NC species holding capacity reached a near stability, so far as ant community was concerned, in comparison to other sites. Whereas at EC the range of evenness was maximum, resulting in a lowest mean value of 0.67 suggesting the availability of a better scope of distribution of species.

This factor in all probability was also related to the floral component of the ecosystem. At NC the vegetation was comparatively poor along with a large lead load; the species available, got adapted to such an adverse situation with a better distribution throughout the year. Whereas at EC less lead load and better availability of vegetation and their large fluctuations had its effect on the evenness of species distribution.

E. Index of similarity

As far as abundance of different species was concerned it is found (Table 7) that maximum similarity (79%) existed in between NC and CC while the minimum (64%) was in between NC and EC. Both NC and CC had large concentration of lead, the vegetal composition also did not vary largely, hence these two sites exhibited maximum similarity in the abundance of different species. Whereas EC had lowest lead load and a rich vegetation in comparison to NC which probably resulted into a poor index of similarity.

F. Species diversity index

Plot wise seasonal variations and species diversity indices at each site are given in Table 8. At all the plots in some months monospecific population was found, reducing the diversity to zero, whereas in some months the diversity index was found to be below two decimal levels. Beside this, the index values ranged from 0.16 to 1.44. The maximum values at EC, CC, NC and SC in the plots A, B and C were found to be 1.32, 0.99, 1.05; 1.00, 1.25, 1.44; 1.33, 1.02, 0.95 and 1.25, 1.04, 1.39 respectively. Only at CC the diversity values were found to be maximum in the month of May in all the plots. In all other sites the diversity index did not exhibit any particular pattern of seasonal fluctuation. From Table 2 it is evident that concentration of lead was minimum in May '98, which might be responsible for an increase in diversity at that time at CC.

Table 7. Index of similarity in the population of Formicidae (Hymenoptera) in between different sites.

SITES	N.C.	E.C.	S.C.
C.C.	0.79	0.67	0.75
N.C.		0.64	0.70
E.C.			0.71

Table 8. Seasonal variation in the species diversity indices of Formicidae (Hymenoptera) at different plots.

Site/Plot►	East Calcutta			Central Calcutta			North Calcutta			South Calcutta		
Month ▼	A	B	C	A	B	C	A	B	C	A	B	C
Aug-96	0	0.9	1.05	0.46	0.66	0.72	0	0.62	0.47	0.23	0	0
Sep	0.7	0.39	0	0.62	0	0	0.64	0	0	0	0	0.7
Oct	0.95	0.69	0.57	0	0	0.67	0	0.41	0	0.88	0.64	0
Nov	0.69	0.82	0.99	0.68	0.67	0.58	0	0	0	0	0	0
Dec	0.36	0	0	0	0	0	0	0	0	0	0	0.68
Jan-97	0	0	0	0	0	0.6	0.87	0.69	0.66	0	0	0
Feb	1.32	0.55	0.68	0	0.68	0	1.33	0	0	0	0	0
Mar	0.69	0	0.47	0	0	0.57	0	1.02	0	0.99	0.69	0.68
Apr	0.65	0.66	0.66	0	0.6	0.68	0.99	0.64	0.64	0.47	0.47	0.66
May	0	0	0.64	1	0.63	0	0	0.68	0	0.36	0.66	0.58
Jun	0	0.26	0.28	0.16	0.53	0.72	0.2	0	0.95	0	0.14	0.86
Jul	0.49	0.45	0.64	0	0	0	0	0	0	0.87	0	0.8
Aug	0.2	0	0.68	0.22	0	0	1.24	0	0	0.36	0	0.23
Sep	0	0.7	0.52	0.24	0.43	0	0.67	0	0	0	1.04	0.97
Oct	0.8	0	0.89	0.48	0	0.32	0.58	0	0	0.28	0	0.62
Nov	0	0	0	0	0	1.32	0	0.87	0.68	0	0.57	0.68
Dec	0.72	0	0.28	0.2	0	1.09	0	0.85	0.45	0	0.14	0
Jan-98	0.68	0.67	0	0	0.95	1.09	0	0.28	0	0.6	0.8	0
Feb	0	0	0	0.33	0	0	0.86	0	0.69	0.2	0.7	0
Mar	0	0.17	0	0	0	0	0	0.57	0	0.26	0	0
Apr	1.09	0.83	1.05	0	0	0	0.85	0	0.62	0.75	0	0.72
May	0.63	0	0	0.47	1.25	1.44	0	0.64	0.66	0.62	0.68	1.39
Jun	0.55	0	0.68	0.87	0.68	0	0	0	0.65	0	0.82	1.05
Jul	1.09	0.69	0	0	0.64	0.68	0.93	0.69	0.47	1.25	1.06	0.68
$\bar{X}$	0.48	0.33	0.42	0.24	0.32	0.44	0.38	0.33	0.29	0.34	0.35	0.47

Table 9. Species diversity indices of Formicidae (Hymenoptera) in different months at different sites (Average).

Months > Sites ▼	Aug-96	Sep	Oct	Nov	Dec	Jan-97	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan-98	Feb	Mar	Apr	May	Jun	Jul	Total
East Calcutta	1.72	0.76	1.30	1.25	0.59	0	1.10	1.52	1.07	0.42	0.74	1.16	1.04	0.73	1.47	0.62	1.13	1.58	0.73	1.14	1.66	0.31	1.41	1.58	2.04
Central Calcutta	1.04	1.34	1.29	1.64	0.57	0.64	1.04	0.76	1.11	1.41	1.52	0.29	1.01	0.85	1.22	1.07	1.52	1.27	1.15	0.60	1.11	1.81	1.37	1.53	1.86
North Calcutta	1.24	0.86	1.13	0.97	1.01	1.74	1.75	1.26	1.24	0.97	1.06	1.09	1.34	1.26	1.31	1.41	0.86	0.98	1.46	1.20	1.40	1.55	1.34	1.76	2.06
South Calcutta	0.53	1.05	1.63	0.68	0.31	0.34	0.56	1.87	1.12	1.34	1.26	1.61	1.08	1.46	1.09	1.12	0.70	1.39	0.22	1.12	1.13	1.20	0.74	1.79	2.01

On an average two different patterns of species diversity were obtained. At EC and NC, plots A, B and C had a more or less decending pattern of species diversity, the values being 0.48, 0.33, 0.42 and 0.38, 0.33, 0.29 respectively; while the pattern was reverse at CC and SC (0.24, 0.32, 0.44 and 0.34, 0.35, 0.47).

The decending order of lead load in soil (Table 1) in plots A, B and C at all the sites might have spelt a negative effect on species diversity at CC and SC. At NC where the lead pollution gradually increased from plots A to C might have also exerted a negative effect on the species diversity. However, at EC, though the lead load was much lower in comparison to other sites, it was found to have a positive effect on the species diversity.

At each site on an average it was found that (Table 9) species diversity was maximum in the months of July, August and November, i.e., during monsoon and post monsoon period at EC, CC and NC. However, a summer maxima was observed in March at SC. Thus the normal well established trend of proliferation of soil arthropods during monsoon were still maintained at EC, CC and NC, whereas at SC the best suited environment was probably utilized best. It was also found that, on total, the species diversity was maximum at NC (2.06) followed by EC, SC and CC.

The differences in the species diversity indices at different sites were subjected to 't' tests (Table 10), which showed that the differences in the species diversity indices between NC and EC as well as between NC and SC were quite significant and statistically no difference existed in the species diversity between EC and SC; CC and SC; CC and EC.

Table 10. Comparative 't' values of species diversity indices of Formicidae (Hymenoptera) in between different sites.

SITES	N.C.	E.C.	S.C.
C.C.	1.44	0.75	0.58
N.C.		*2.00	*1.80
E.C.			0.15

*Significant at 5% level.

The results thus obtained when subjected to correlation and regression, it was observed in most of the plots of all the sites that the species diversity indices had negative relationships with concentration of lead. (Figs. 3–6). While these negative relationships were significant at plots CC (C), and NC (B,C); in other plots such relationships were not significant. Only plots EC (B) and SC (C) exhibited positive relationships of species diversity index with lead though those were much below the level of significance.

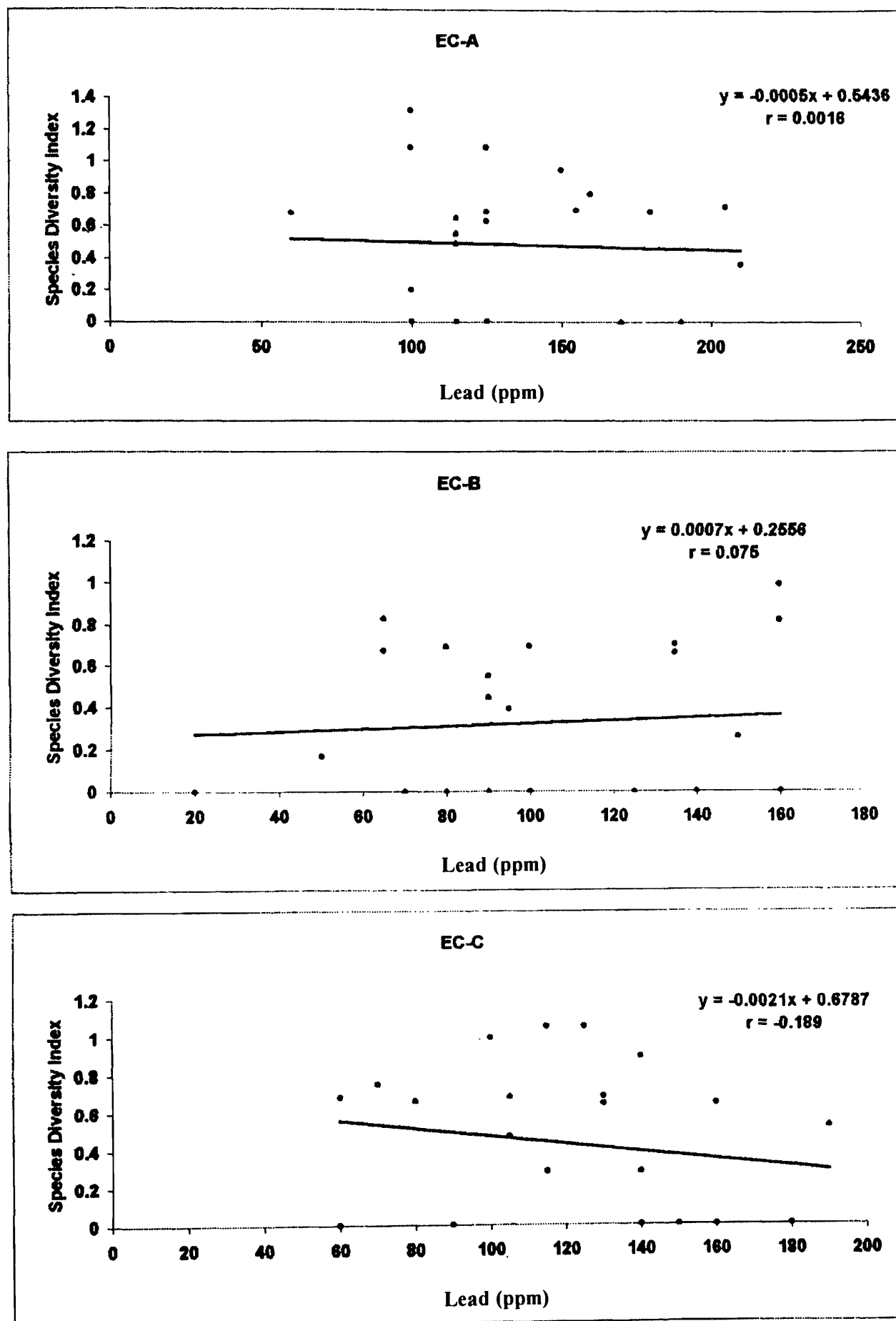


Fig. 3. Showing correlation coefficient (r), regression equation and trend line of species diversity index on Lead (ppm) at different plots of EC.

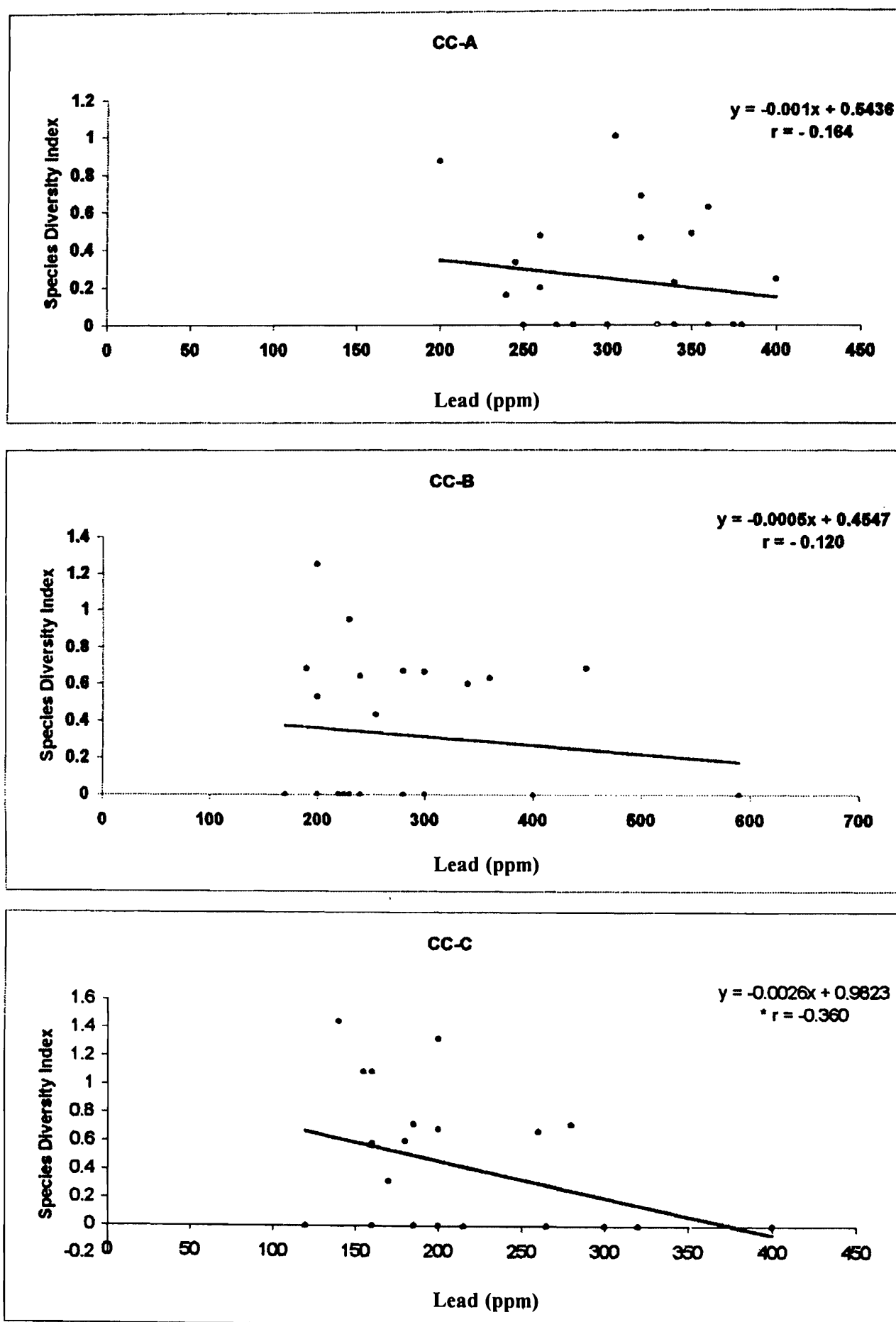


Fig. 4. Showing correlation coefficient (r), regression equation and trend line of species diversity index on Lead (ppm) at different plots of CC (*P < 0.10).

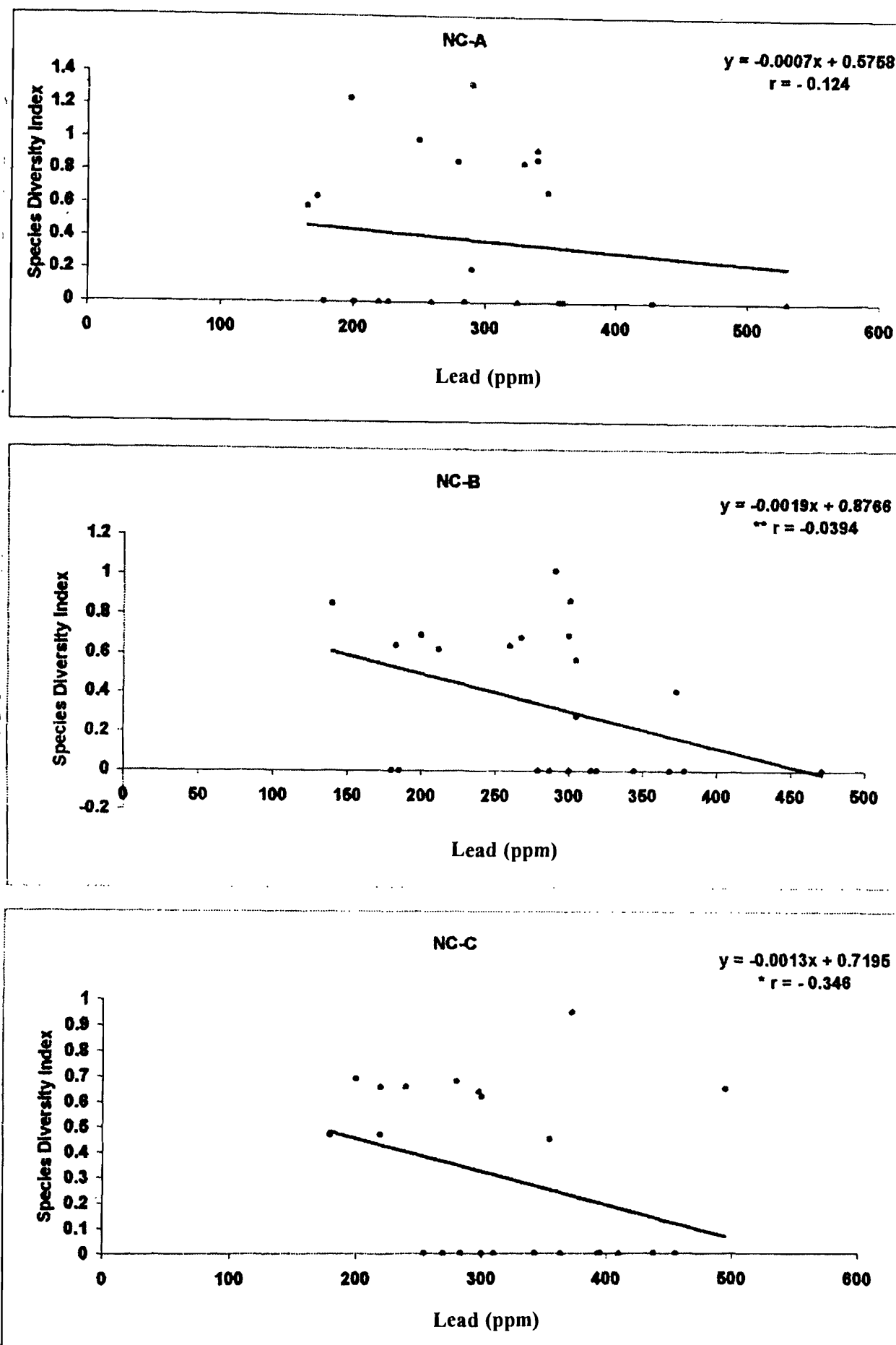


Fig. 5. Showing correlation coefficient (r), regression equation and trend line of species diversity index of Lead (ppm) at various plots of NC (* $P < 0.10$, ** $P < 0.05$).

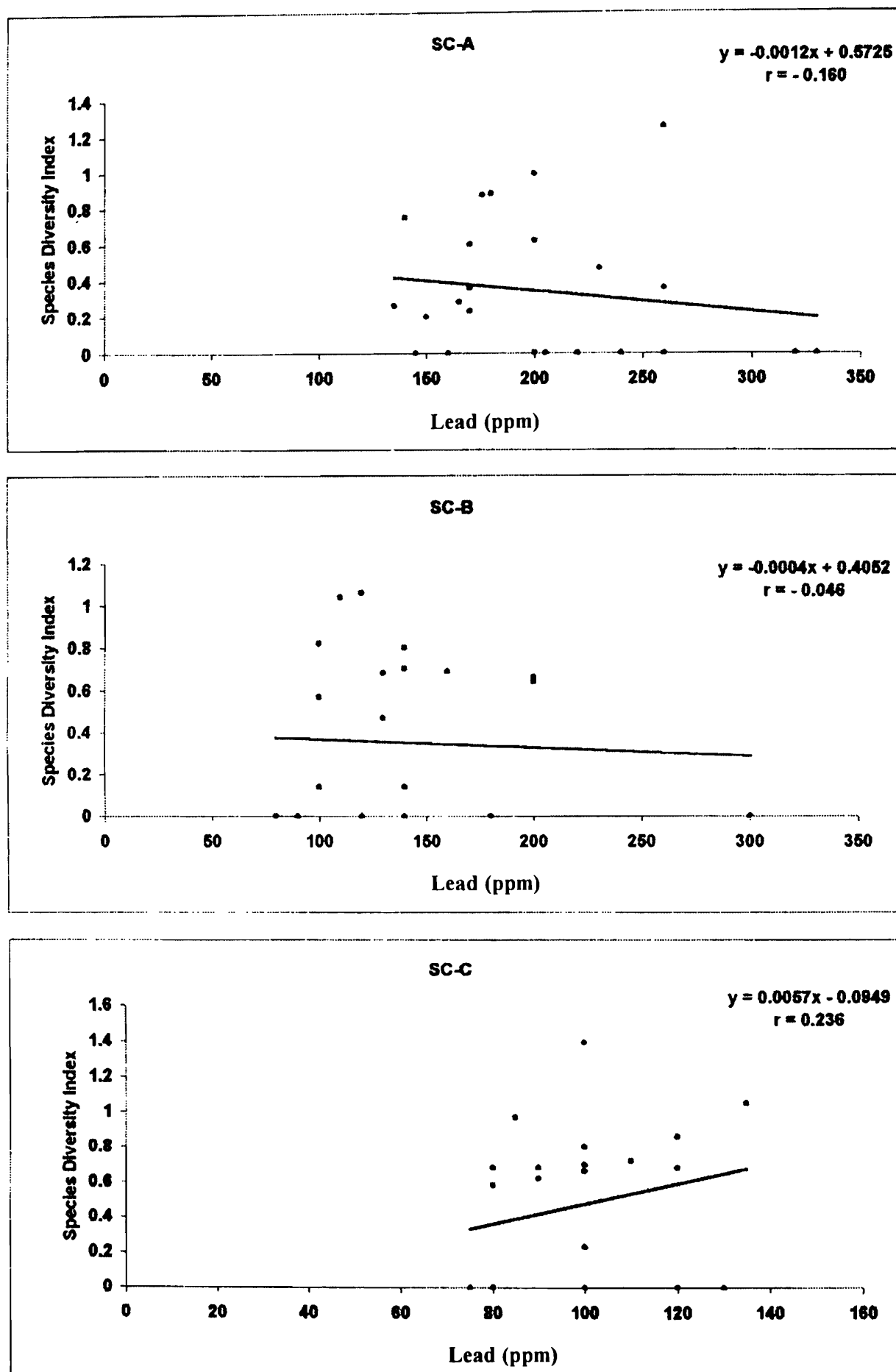


Fig. 6. Showing correlation coefficient (r), regression equation and trend line of species diversity index of Lead (ppm) at different plots of SC.

On cumulative basis the relationships of species diversity index with lead at EC, CC and NC were found to be negative (Figs. 7–8); of which the relationships were significant at EC and NC; while at CC the relationship did not show any significance. At SC however the relationship was positive but not significant.

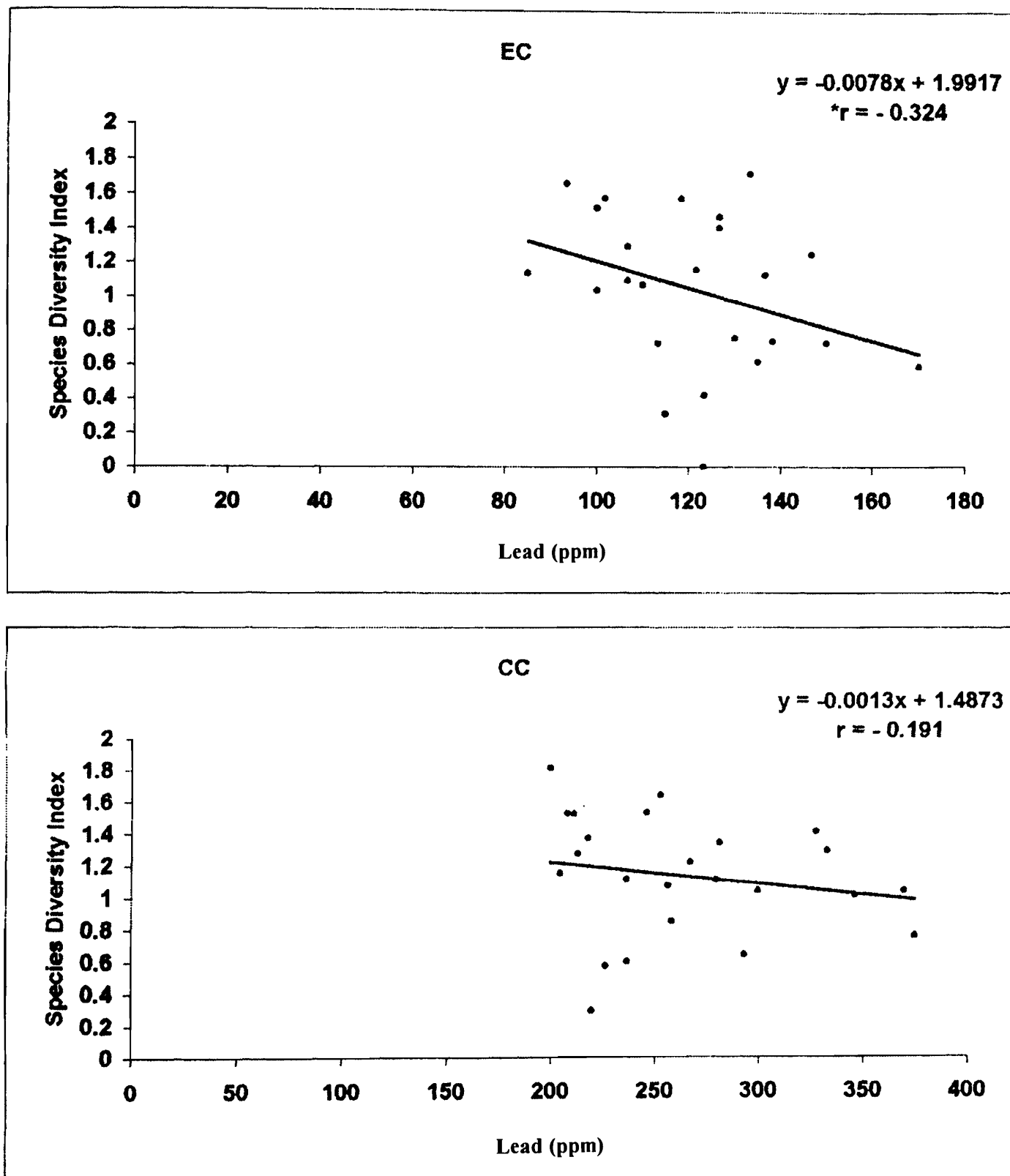


Fig. 7. Showing correlation coefficient (r), regression equation and trend line of species diversity index on Lead (ppm) at sites EC and CC (average) (* $P < 0.10$).

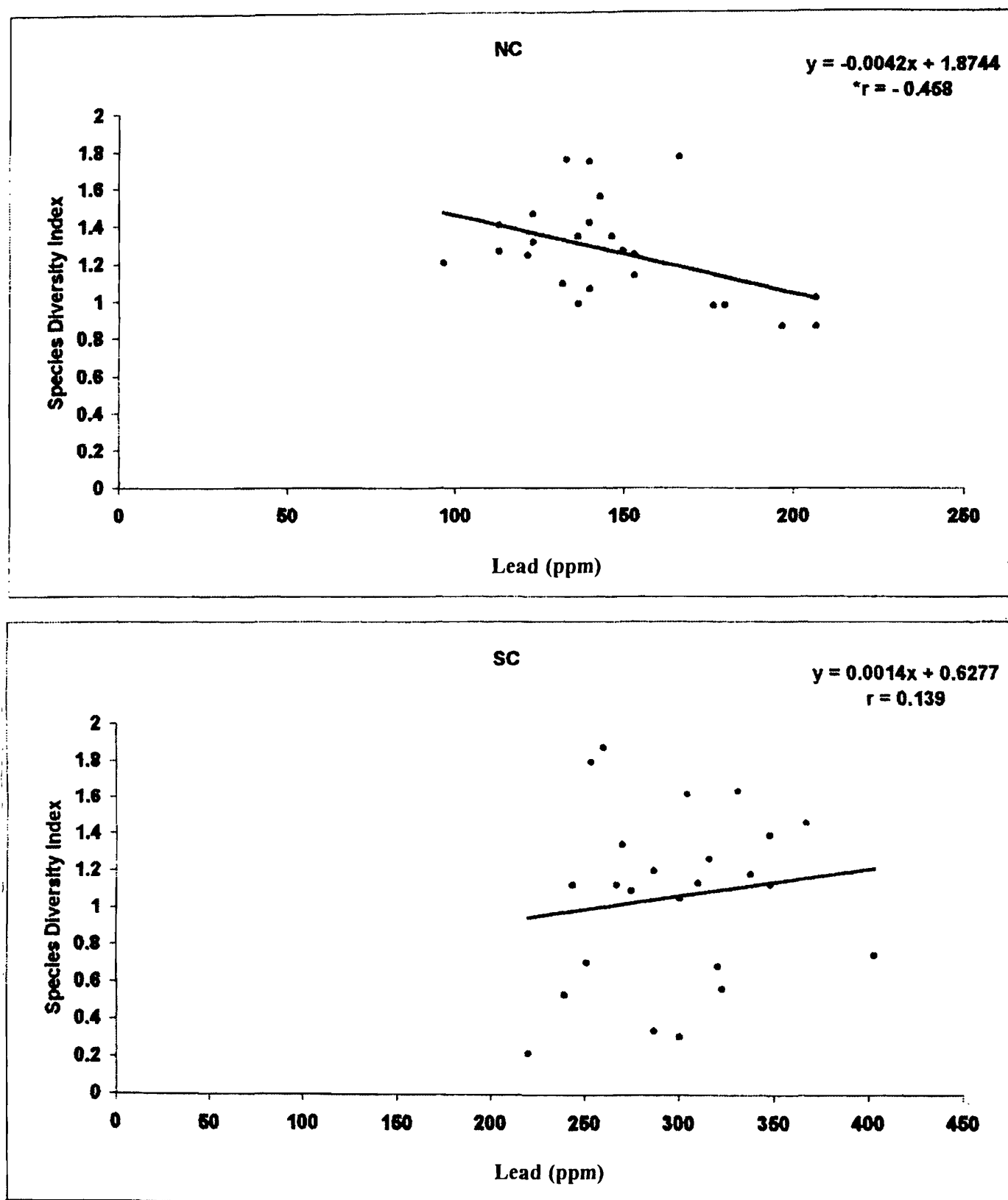


Fig. 8. Showing correlation coefficient (r), regression equation and trend line of species diversity index on Lead (ppm) at sites NC and SC (average) (* $P < 0.05$).

It thus appeared that species diversity of ants in the road side soil was extremely variable from site to site and which was largely dependent on the physico-chemical parameters of the soil. Lead played a significant role by demonstrating a negative effect on species diversity. However, vegetation being capable of absorbing lead from the soil seemed to control soil lead concentration and thereby

influencing the species diversity. The species having maximum tolerance level augmented its population in a positive manner and occupied highest position according to the index of dominance. Large variations existed in the abundance of species at different sites and highest similarity was established in between the sites having similarity in their vegetal components and physico-chemical nature of the soil. Large variations occurred in the richness of species but no significant relationship could be established for such variations on account of lead.

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ON A COLLECTION OF BUTTERFLIES (LEPIDOPTERA) AT THE DESERT REGIONAL STATION, ZOOLOGICAL SURVEY OF INDIA, JODHPUR

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INTRODUCTION

The pattern of faunal distribution depends mainly on climate, vegetation and physiography of the ecosystem. Each species has a unique distributional pattern, which is the result of its ecological and evolutionary history. North-western part of India covering the two states of Rajasthan and Gujarat, besides the Union Territory of Dadra & Nagar Haveli falling under the jurisdiction of the Desert Regional Station (DRS) presents an interesting field of study on the lepidopteran fauna distributed over certain types of diverse ecosystems varying from the arid region in the east upto the salty marsh land of Runn of Kutchch in the west and over and above the Aravallis. The analysis of literature reveals that our present knowledge on distribution of Lepidoptera is insignificant in this region on the ground of utterly inadequate survey. This can be further concluded that comparatively well-known lepidopteran groups have surprisingly failed to draw the proper attention of the taxonomists. Nevertheless, present study on lepidopteran material deposited in the DRS, ZSI, Jodhpur will certainly enrich our knowledge on the Lepidoptera fauna from different districts of Rajasthan, Gujarat and Dadra & Nagar Haveli.

Earlier Nurse (1899), Macpherson (1927), Mosse (1929), Aldrich (1946), Talbot (1947, 1978), Pruthi and Bhatia (1952), Mathur and Champakavalli (1961), Shull (1963, 1964), Kushwaha *et al.* (1963), Shull and Nadkerny (1967), Gupta and Thakur (1986, 1990) and Varshney and Gupta (1996) have made valuable contribution on the taxonomy of Lepidoptera from Rajasthan and Gujarat. The present paper reports thirty-nine species of butterfly representing twenty-five genera grouped under seven families.

MATERIAL AND METHODS

The material studied in this paper were made available from two sources. Besides the collection made by the scientists of DRS, Jodhpur during the last four decades, specimens collected by the authors during the last two years have also been included in the present study. The details of

identified specimens reported by Gupta and Thakur (1986, 1990) from Rajasthan and Gujarat are also incorporated. Maximum number of specimens were collected by insect net while a few ones were hand-picked or collected by light-trapping method. All the specimens are registered and deposited in the collection of DRS.

SYSTEMATIC ACCOUNT

i. Family : PIERIDAE

1. *Colotis etrida* (Boisduval)

Material examined : INDIA RAJASTHAN : Jodhpur : Akaraj ji ka talab (8 Km. SW), 1 ex., 13.xi.1963, Moti Lal, Reg. No. 1559; Patodi House, 1 ex., 8.xi.1966, N.K. Parida, Reg. No. I 2451; Sangaria (14 Km. SW), 1 ex., 29.x.1963, Moti Lal, Reg. No. 1489; Lombardia talab (23 Km. SW), 2 exs., 23.xi.1963, K.C. Kansal, Reg. No. A/117; Chandelav village tank (40 Km. from Jodhpur), 2 exs., 18.xi.1965, V.C. Agarwal, Reg. No. I 2273.

2. *Colotis danae* (Fabricius)

Material examined : INDIA : RAJASTHAN : Jodhpur : Balsamand Garden, 2 exs., 5.ix.1962, K.C. Kansal, Reg. No. A/116, A/120. GUJARAT : Bharuch : Rajpipla, 1 ex., 31.i.1975, T.G. Vazirani, Reg. No. 3176/3.

3. *Colotis calais amata* (Fabricius)

Material examined : INDIA : RAJASTHAN : Pali : Dujana, 1 ex., 12.viii.2000, S.I. Kazmi, Reg. No. R/377.

4. *Colotis vestalis* (Butler)

Material examined : INDIA : RAJASTHAN : Jodhpur : Paota, 5 exs., 18.viii.1961, Ramreet Singh, Reg. No. 1/824.

5. *Ixias marianne* (Cramer)

Material examined : INDIA : RAJASTHAN : Alwar : Sariska : Pancho ki pole, 3 exs., 11.x.1973, Y.P. Sinha, Reg. No. 1479/3.

6. *Delias eucharis* (Drury)

Material examined : INDIA : GUJARAT : Vadodara : Rajmahal, 2 exs., 10.ix.1976, 1 ex., 10.ix.1976, Y.P. Sinha, Reg. No. 5268/3 & 5271/3. Bharuch : 1 ex., 14.ix.1976, Y.P. Sinha, Reg. No. 5458/3. DADRA & NAGAR HAVELI : Dadra : 1 ex., 7.ix.1976, Y.P. Sinha, Reg. No. 5827/3.

7. *Eurema laeta* (Boisduval)

Material examined : INDIA : RAJASTHAN : Pali : Hemawas, 2 exs., T.G. Vazirani, Reg. No. 3814/3. Jaipur : Kabir Marg, 3 exs., 8.x.1973, Y.P. Sinha, Reg. No. 1402/3. Jodhpur : 11 Km. from town, 1 ex., 10.ix.1964, R.N. Bhargava, Reg. No. 3050; Patodi House, 2 exs., 25.x.1966, 2 exs., 30.x.1966, 1 ex., 14.xii.1966, 1 ex., 19.xii.1966, N.K. Parida, Reg. No. I 2139; I 2410, I 2499 & 2505; Mandore, 1 ex., 15.v.1965, V.C. Agarwal, Reg. No. I 2046; Public Garden, 1 ex., 17.viii.1962, 2 exs., 7.i.1963, Moti Lal, Reg. No. 3/423 & Nil; Balsamanad Garden, 1 ex., 5.ix.1962, R.C. Sharma, Reg. No. 3/218; Sangaria : Kuri village, 2 exs., 29.x.1963, Moti Lal, Reg. No. 1489; 1 ex., 27.x.1963, K.C. Kansal, Reg. No. I 772; Chandelav village tank (40 Km. from Jodhpur), 3 exs., 18.xi.1965, V.C. Agarwal, Reg. No. I 2273. Dungarpur : Surpuro ki nadi (4 Km. NW), 3 exs., 26.iii.1964, R.N. Bhargava, Reg. No. I 1424. Alwar : Sariska : Pancho ki pole, 2 exs., 11.x.1973, Y.P. Sinha, Reg. No. 1479/3; Siliscrh, 1 ex., 10.x.1973, Y.P. Sinha, Reg. No. 1437/3. Udaipur : Ahar river, 1 ex., 19.iii.1964, V.C. Agarwal, Reg. No. I 1351. Sirohi : Abu (2 Km. N of Abu Railway Station), 1 ex., 6.3.1964, V.C. Agarwal, Reg. No. I 1216; Abu Bus Station, 1 ex., 7.iii.1964, V.C. Agarwal, Reg. No. I 1234. GUJARAT : Palanpur : Doasa 1 ex., 14.xi.1964, V.C. Agarwal, Reg. No. GI 337. Patan : Anwar tank (10 Km. from Patan), 2 exs., 30.x.1964, R.N. Bhargava, Reg. No. GI 283. Himmatnagar : 3 Km. S of Himmatnagar, 4 exs., 4.xi.1964, 1 ex., 6.xi.1964, R.N. Bhargava, Reg. No. GI 337 & GI 336; 5 Km. S of Himmatnagar, 2 exs., 5.xi.1964, Reg. No. GI 351. Dangs : Ahwa, 1 ex., 5.ii.1975, T.G. Vazirani, Reg. No. 3197/3.

8. *Eurema hecabe hecabe* (Linnaeus)

Material examined : INDIA : RAJASTHAN : Ganganagar : Central State Farm, Suratgarh, 1 ex., 6.ix.2000, S.I. Kazmi, Reg. No. R/45.

9. *Eurema hecabe simulata* (Linnaeus)

Material examined : INDIA : RAJASTHAN : Alwar : Sariska : Pancho ki pole, 3 exs., 11.x.1973, Y. P. Sinha, Reg. No. 1479/3. Jodhpur : Patodi House, 1 ex., 25.x.1966, 1 ex., 26.x.1966, N.K. Parida, Reg. No. I 2439 & 2440; 1ex., 12.ii.1964, V.C. Agarwal, Reg. No. 1952; Public Garden, 1 ex., 14.viii.1962, 1 ex., 17.viii.1962, Moti Lal, Reg. No. 3/421 & 3/423; Lombardia talab (23 Km. SW of Jodhpur), 2 exs., 23.xi.1963, K.C. Kansal, Reg. No. 1625; Agolai, 1 ex., 26.viii.1964, V.C. Agarwal, Reg. No. I 1690. Sirohi : 2 Km. from Abu Railway Station, 1 ex., 6.iii.1964, V.C. Agarwal, Reg. No. I 1216. Dungarpur : Surpuro ki nadi, 1 ex., 26.iii.1964, R.N. Bhargava, Reg. No. I 1424. GUJARAT : Palanpur : Mansarover tank, 3 exs., 11.x.1964, V.C. Agarwal, Reg. No. GI 19; 4 Km. from Palanpur near nallah, 1 ex., 12.x.1964, V.C. Agarwal, Reg. No. GI 44. Bharuch : 1ex., 16.ix.1976, Y.P. Sinha, Reg. No. 5458/3. Patan : Anwar tank (10 Km. from Patan), 2 exs., 30.x.1964, R.N. Bhargava, Reg. No. GI 283. Bhuj : Jakhawara tank (3 Km. from Bhuj), 1 ex., 15.x.1964, V.C. Agarwal, Reg. No. GI 94. DADRA & NAGAR HAVELI : Silvasa : 1 Km. SE, 1 ex., 28.iii.1964, R.N. Bhargava, Reg. No. I 1435.

10. *Cepora nerissa* (Fabricius)

Material examined : INDIA : RAJASTHAN : Alwar : Sariska : Pancho ki pole, 1 ex., 11.x.1973, Y.P. Sinha, Reg. No. 1479/3. GUJARAT : Dangs : Ahwa, 1 ex., 15.ii.1975, T.G. Vazirani, Reg. No. 3177/3. Bharuch : Rajpipla, 1 ex., T.G. Vazirani, Reg. No. 3176/3.

11. *Anaphaeis aurota aurota* (Fabricius)

Material examined : INDIA : RAJASTHAN : Jodhpur : Lardi, 1 ex., 26.ix.2000, M. Faisal, Reg. No. R/46; Manaklao, 2 exs., 24.iii.2001, S.I. Kazmi, Reg. No. R/107, R/108; Lombardia talab (23 Km. SW), 4 exs., 23.xi.1963, K.C. Kansal, Reg. No. 1625; Patodi House, 1 ex., 14.xii.1966, 1 ex., 16.xii.1966, 1 ex., 30.ix.1966, Coll. N.K. Parida, Reg. No. I 2499, I 2502 & I 2408; Salawas village, 1 ex., dt. Nil, Moti Lal, Reg. No. Nil; Kishangarh, 1 ex., dt. Nil, A. Charan, Reg. No. A/676. Alwar : Bundi, 1 ex., 10.x.1973, Y.P. Sinha, Reg. No. 1437/3. Udaipur : Ahar River (2 km. NW of Railway Station), 1 ex., 19.iii.1964, V.C. Agarwal, Reg. No. I 1351. Dungarpur : Surpuro ki nadi, 4 exs., 26.iii.1964, R.N. Bhargava, Reg. No. I 1424.

12. *Catopsilia crocale crocale* (Cramer)

Material examined : INDIA : RAJASTHAN : Jodhpur 1 ex, 10. iv.1964, R.N. Bhargava, Reg. No. 3050; Patodi House, 5 exs., 17.viii.1963, R.S. Pillai, Reg. No. 3/1116; 3 ex., 19.ix.1966, 6 exs., 21.ix.1966, 3 exs., 24.ix.1966, 1 ex., 26.ix.1966, 4 exs., 27.ix.1966, 1 ex., 30.ix.1966, 1 ex., 3.x.1966, 1 ex., 4.x.1966, 1 ex., 17.x.1966, 1 ex., 24.x. 1966, 1 ex., 25.x.1966, 1 ex., 16.xii.1966, N.K. Parida, Reg. No. I 2385, I 2392, I 2400, I 2404, I 2407, I 2406, I 2408, I 2410, I 2411, I 2430, I 2439 & I 2502, 1 ex., 31.x.1964, V.C. Agarwal, Reg. No. I 1708; Paota line, 1 ex., 17.viii.1963, R.S. Pillai, Reg. No. 3/1116; Paota, 1 ex., 28.vii.1961, 1 ex., 29.vii.1961, Ramreet Singh, Reg. No. I/820 & I/781, 1 ex., 31.viii.1963, R.S. Pillai, Reg. No. 2131; Mandor Garden, 1 ex., 9.ix.1964, V.C. Agarwal, Reg. No. 1749; 1 ex., 8.xi.1963, Moti Lal, 1 ex., 9.ix.1964, 1 ex., 31.x.1964, Reg. No. 1925, I 1749 & I 1708; Manaklao, 1 ex., 24.iii.2001, S.I. Kazmi, Reg. No. R/47; Salawas (SW of Jodhpur), 3 exs., 21.xii.1962, Moti Lal, Reg. No. 3/401, Beriganga (14 Km. from Jodhpur), 3 exs., 21.ix.1963, Moti Lal, Reg. No. 1353; Public Garden, 1 ex., 14.viii.1962, 1 ex., 17.viii.1962, 1 ex., 20.vii.1963, Moti Lal, Reg. No. 3/421; Luni River, (40 Km. SW of Jodhpur), 9.vii.1963, K.C. Kansal, Reg. No. 3/981. Udaipur : Ahar River (2 km. NW of Railway Station), 1 ex., 19.iii.1964, V.C. Agarwal, Reg. No. I 1351. GUJARAT : 3 exs., dt. Nil, Y.P. Sinha, Reg. No. Nil. Palanpur : Dantiwara, 1 ex., 13.x.1964, V.C. Agarwal, Reg. No. Nil; Mansarovar tank (2 Km. of Palanpur), 1 ex., 11.x.1964, V.C. Agarwal, Reg. No. GI 19. Bharuch : 1 ex., 16.ix.1976, Y.P. Sinha, Reg. No. 5458/3. Bhuj : Kukarma tank (11 Km. E of Bhuj), 1 ex., 25.x.1964, V.C. Agarwal, Reg. No. GI 240. DADRA & NAGAR HAVELI : Dadra : Dadra, 2 exs., 7.x.1976, Y.P. Sinha, Reg. No. Nil.

13. *Catopsilia pyranthe* (Linnaeus)

Material examined : INDIA : RAJASTHAN : Pali : Hemawas, 1 ex., 12.xi.1975, T.G. Vazirani, Reg. No. 3814/3. GUJARAT : Patan : Anwar talab (10 Km. SW of Patan), 1 ex., 30.x.1964, R.N. Bhargava, Reg. No. GI 283. Palanpur : Narsarover tank, 1 ex., 11.x.1964, V.C. Agarwal, Reg. No. GI 19; 5 Km. from Doasa, 1 ex., 15.x.1964, V.C. Agarwal, Reg. No. GI 94. Himmatnagar : 3 Km. from town, 1 ex., 10.xi.1964, R.N. Bhargava, Reg. No. GI 19.

14. *Catopsilia florella* (Fabricius)

Material examined : INDIA : RAJASTHAN : Jodhpur : Patodi House, 1 ex., 21.ix.1966, N.K. Parida, Reg. No. I 2392.

15. *Catopsilia pomona* (Fabricius)

Material examined : INDIA RAJASTHAN : Jodhpur Public Garden, 1 ex., 14.viii.1962, 1 ex., 20.ix.1963, Moti Lal, Reg. No. 3/421 & 1349.

ii. Family : NYMPHALIDAE

16. *Hypolimnias bolina* (Linnaeus)

Material examined : INDIA : GUJARAT : Dangs : Ahwa : 3 exs., 28.ix.1976, Y.P. Sinha, Reg. No. 5704/3. DADRA & NAGAR HAVELI : Dadra, 1 ex., 7.x.1976, Y.P. Sinha, Reg. No. 5832.

17. *Hypolimnias misippus* (Linnaeus)

Material examined : INDIA : RAJASTHAN : Jodhpur : Public Garden, 1 ex., 20.i.1963, Moti Lal, Reg. No. A/133; Mandore Garden, 1 ex., 8.xi.1963, 1 ex., dt. Nil, V.C. Agarwal, Reg. No. A/134 & A/282.

18. *Acraea violae* (Fabricius)

Material examined : INDIA : GUJARAT : Panchmahal : Godhra, 1 ex., 25.i.1975, T.G. Vazirani, Reg. No.3174/3. RAJASTHAN : Banswara : Phod (4 Km. from Banswara), 1 ex., 25.3.1964, R.N. Bhargava, Reg. No. I 1407.

19. *Cynthia cardui* (Linnaeus)

Material examined : INDIA : RAJASTHAN : Jodhpur : Phallodi, 1 ex., 25.iii.2001, G.S. Arora, Reg. No. R/106. DADRA & NAGAR HAVELI : Dadra : 1 ex., 7.ix.1976, Y.P. Sinha, Reg. No. 5827/3.

20. *Neptis hylas astola* Moore

Material examined : INDIA : GUJARAT : Dangs : Ahwa, 1 ex., 8.ii.1975, T.G. Vazirani, Reg. No. 3184/3, Saputara, 2 exs., 11.ii.1975, T.G. Vazirani, Reg. No. 3184/3.

21. *Atella phalantha* (Drury)

Material examined : INDIA : GUJARAT : Dangs : Ahwa, 1 ex., 8.ii.1975, T.G. Vazirani, Reg. No. 3183/3. RAJASTHAN : Jodhpur : Mandore Garden, 1 ex., 22.vii.1966, P.D. Gupta, Reg. No. I 2367.

22. *Symphaedra nais* (Forster)

Material examined : INDIA : GUJARAT : Dangs : Ahwa, 1 ex., 8.ii.1975, T.G. Vazirani, Reg. No. 3183/3.

23. *Precis almana* (Linnaeus)

Material examined : INDIA : GUJARAT : Palanpur : Umardasi Power Station, 1 ex., 10.x.1964, V.C. Agarwal, Reg. No. GI 3. DADRA & NAGAR HAVELI : Dadra : 6 exs., 7.ix.1976, Y.P. Sinha, Reg. No. 5827/3; 1 ex., 7.x.1976, Y.P. Sinha, Reg. No. 5834/3.

24. *Precis lemonias* (Linnaeus)

Material examined : INDIA : RAJASTHAN : Jodhpur : Patodi House, 1 ex., 12.ii.1964, V.C. Agarwal, Reg. No. A/191, 1 ex., 30.ix.1966, 4 exs., 3.x.1966, 1 ex., 26.x.1966, N.K. Parida, Reg. No. I 2408, I 2410 & I 2440; Public Garden, 5 exs., 16.viii.1962, 2 exs., 17.viii.1962, 1 ex., 20.ix.1963, Moti Lal, Reg. No. A/186, A/188 & A/189. GUJARAT : Dangs : Ahwa, 2 exs., 5.ii.1975, T.G. Vazirani, Reg. No. 3177/3; Malegaon, 1 ex., 11.ii.1975, T.G. Vazirani, Reg. No. 3176/3. DADRA & NAGAR HAVELI : Dadra : 1 ex., 9.ix.1976, Y.P. Sinha, Reg. No. 5827/3.

25. *Precis orithyia* (Linnaeus)

Material examined : INDIA : GUJARAT : Dangs : Ahwa, 1 ex., 8.ii.1975, T.G. Vazirani, Reg. No. 3185/3. Palanpur : Dantiwara (1 Km. West), 1 ex., 13.x.1964, V.C. Agarwal, Reg. No. 3379. RAJASTHAN : Jodhpur : Patodi House, 1 ex., 31.viii.1964, V.C. Agarwal, Reg. No. I 178, 3 exs., 17.viii.1963, R.S. Pillai, Reg. No. A/92, 6816; Public Garden, 1 ex., 20.ix.1963, 1 ex., 17.viii.1962, Moti Lal, Reg. No. A/193 & 3/423; Sangaria, Kuri village (14 Km. SW of Jodhpur), 1 ex., 29.x.1965, Moti Lal, Reg. No. A/194.

26. *Precis hierta* (Fabricius)

Material examined : INDIA : RAJASTHAN : Jodhpur : Public Garden, 2 exs., 20.ix.1963, Moti Lal, Reg. No. A/182, A/195; Patodi House, 1 ex., 3.viii.1963, R.S. Pillai, Reg. No. A/122,

1 ex., 12.ii.1964, V.C. Agarwal, Reg. No., 1952, 1 ex., 30.ix.1966, N.K. Parida, Reg. No., I 2408; Mandore Garden, 1 ex., 9.ix.1964, V.C. Agarwal, Reg. No. I 1749; Balsamand Garden, 1 ex., 5.ix.1962, R.C. Sharma, Reg. No. A/120; Sangaria : Kuri village (14 km. SW of Jodhpur), 1 ex., 29.x.1963, Moti Lal, Reg. No. A/184; Beriganga, 1 ex., 21.ix. 1963, Moti Lal, Reg. No. A/131.

iii. Family : PAPILIONIDAE

27. *Pachliopta aristolochiae* (Fabricius)

Material examined : INDIA : GUJARAT : 3 exs., dt. Nil, V.P. Sinha, Reg. No. Nil. Himmatnagar : (3 Km N), 1 ex., 6.xi.1964, R.N. Bhargava, Reg. No. GI 3660. RAJASTHAN : Jodhpur : Patodi House, 1 ex., 3.x.1966, N. K. Parida, Reg. No. I 2410; Sardarsamand, 1 ex., 26.xi.1963, Moti Lal, Reg. No. 1610; Bhopalgarh, 1 ex., 19.ix.2000, S.I. Kazmi, Reg. No. R/1.

28. *Papilio polytes romulus* Cramer

Material examined : INDIA : RAJASTHAN : Pali : 1 ex., 12.xi.1975, T. G. Vazirani, Reg. No. 3814/3. Jodhpur : Patodi House, 1 ex., 27.ix.1966, N.K. Parida, Reg. No. I 2407; 1 ex., 30.ix.1966, N.K. Parida, Reg. No. I 2408. Jhunjhunu : Police Line, 1 ex., 6.xi. 1962, DRS/ZSI Survey Party, Reg. No. 5835/3. GUJARAT : Bharuch : Rajpipla, 1 ex., 31.i.1975, T.G. Vazirani, Reg. No. 3176/3.

29. *Papilio demoleus* Linnaeus

Material examined : INDIA : RAJASTHAN : Jodhpur : Patodi House, 1 ex., 29.xii.1962, Ramreet Singh, Reg. No. A/412; 1 ex., 19.x.1966, N.K. Parida, Reg. No. I 2435; 1 ex., 4.x.1966, N.K. Parida, Reg. No. I 2411; Mandore Garden, 1 ex., 8.xi.1963, Moti Lal, Reg. No. I 525; Paota, 28.viii.1961, Ramreet Singh, Reg. No. A/109, Public Garden, 1 ex., 14.viii.1962, Moti Lal, Reg. No. A/109; 1 ex., No details, Reg. No. A/398. Pali : Dujana, 1 ex., 12.viii.2000, M. Faisal, Reg. No. R/376. GUJARAT : Dangs : Ahwa, 1 ex., 5.ii.1975, T.G. Vazirani, Reg. No. 3177/3.

30. *Pathysa nomius* (Esper)

Material examined : INDIA : RAJASTHAN : Jodhpur : Mandore Garden, 3 exs., 22.vii.1966, P.D. Gupta, Reg. No. I 2367.

iv. Family : DANAIDAE

31. *Danais chrysippus chrysippus* (Linnaeus)

Material examined : INDIA : RAJASTHAN : Jodhpur : 1 ex., 10.ix.1964, R.N. Bhargava, Reg. No. A/271; Sardarsamand, 1 ex., 26.iv.1963, 4 exs., 26.ix.1963, 12 exs., 26.xi.1963, 7 exs., 4.xii.1962, Moti Lal, Reg. No. A/387, A/115, A/127 & A/108; Filter House, 7 exs., 4.v.1963, Moti

Lal, Reg. No. A/108; Mandore Garden, 2 exs., 8.xi.1963, 1 ex., 11.ix.1963, 4 exs., 3.xii.1963, Moti Lal, Reg. No. A/126, A/131 & A/125, 1ex., 15.iv.1964, V.C. Agarwal, Reg.No., A/258, 2 exs., 24.iii.2001, S.I. Kazmi, Reg. No. R/104, R/105; Public Garden, 2 exs., 14.viii.1962, 1 ex., 16.viii.1962, 1 ex., 17.viii.1962, 3 exs., 20.ix.1963, Moti Lal, Reg. No. A/108 & A/128; Luni River (3 Km. SW of Jodhpur), 2 exs., 12.xi.1962, 2 exs., 12.xii.1962, Moti Lal, Reg. No. A/108; Paota, 1 ex., 8.i.1963, K.C. Kansal, Reg. No. A/108, 1ex., 31.viii.1963, R.S. Pilli, Reg. No. A/132, 1 ex., 29.viii.1964, B. Ram, Reg. No. A/257; 1 ex., 8.iv.1965, R.N. Bhargava, Reg. No. A/284; Patodi House, 1 ex., 24.iv.1964, 2 exs., 25.iv.1964, V.C. Agarwal, Reg. No. A/283, A/264 & A/265, 1 ex., 26.i.1966, 2 exs., 24.ix.1966, 1 ex., 30.ix.1966, 1 ex., 17.x.1966, 1 ex., 19.x.1966, N.K. Parida, Reg. No. A/270, A/266, A/269, A/265, A/285 & A/268; Beriganga, 4 exs., 21.ix.1963, Moti Lal, Reg. No. A/124; Lombar River (25 Km. SW of Jodhpur), 3 exs., 23.xi.1963, K.C. Kansal, Reg. No. A/129; Kuri village (20 Km. from Jodhpur), 7 exs., 25.iv.1964, V.C. Agarwal, Reg. No. I 1495 A/259, A/260, A/261, A/262, A/277 & A/280; Sangaria, Kuri village, 2 exs., 29.x.1963, Moti Lal, Reg. No. A/130; Ummaidnagar, 1 ex., 24.iii.1963, B. Ram, Reg. No. A/108; Agolai, 1 ex., 14.i.1964, V.C. Agarwal, Reg. No. A/275; 1 ex., 18.ix.1964, R.N. Bhargava, Reg. No. A/279. Pali : Hemawas, 1 ex., 12.xi.1975, T.G. Vazirani, Reg. No. 3814/3. Jhunjhunu : Police Lines, 1 ex., 6.xi.1962, around Rest House, 3 exs., 6.xi.1960, 5 exs., 6.xi.1962, DRS/ZSI Survey Party, Reg. No. A/108. Barmer : Naraina tank, Sarcha ki Dhani, 1 ex., 16.xii.1965, P.D. Gupta, Reg. No. A/263. Bhilwara : 1 km. SE, 3 exs., 28.iii.1964, R.N. Bhargava, Reg. No. A/276, A/278 & A/281. Dungarpur Surpuro ki nadi, 1 ex., 26.iii.1964, R.N. Bhargava, Reg. No. A/267. Ganganagar : Central State Farm, Suratgarh, 1 ex., 6.ix.2000, S.I. Kazmi, Reg. No. R/44. GUJARAT : Palanpur : 4 km. West, 2 exs., 12.x.1964 V.C. Agarwal, Reg. No. A/287 & A/288; Dantiwara, 2 exs., 13.x.1964, R.N. Bhargava, Reg. No. A/289 & A/291. Himmatnagar : 3 Km. N, 11 exs., 6.xi.1964, R.N. Bhargava, Reg. No. GI 366, A/290, A/388, A/389, A/374, A/375, A/376, A/370, A/371 & A/373. Patan : 10 Km. from town, 3 exs., 3.x.1964, R.N. Bhargava, Reg. No. A/372 A/368 & A/369. Bhuj : Near Khari River, 1 ex., 22.x.1964, V.C. Agarwal, Reg. No. A/390; Kukarma Tank, 1 ex., 25.x.1964, V.C. Agarwal, Reg. No. A/286; Amisar Tank, 1 ex., 19.x.1964, V.C. Agarwal, Reg. No. A/393. Bharuch : Rajpipla, 1 ex., 31.i.1975, T.G. Vazirani, Reg. No. 3176/3.

32. *Danais genutia* (Cramer)

Material examined : INDIA : RAJASTHAN : Jodhpur : Balsammamand Garden, 1 ex., 5.ix.1962, K.C. Kansal, Reg. No. A/110.

33. *Tirumala limniaca leopardus* Butler

Material examined : INDIA : RAJASTHAN : Jodhpur : Patodi House, 1 ex., 17.viii.1963, R.S. Pillai, Reg. No. A/178. Sirohi : Abu bus stand (4 Km. East) S.E. Aravali range, 1 ex., 7.iii.1964, V.C. Agarwal, Reg. No. I 1234. GUJARAT : 1 ex., Y.P. Sinha, details not available.

34. *Euploea core core* (Cramer)

Material examined : INDIA : RAJASTHAN : Jodhpur : Mandore Garden, 5 exs., 8.xi.1963, Moti Lal, Reg. No. A/179, 1ex., 22.vii.1966, P.D. Gupta, Reg. No. I 2367. Pali : Dujana, 1 ex., 12.viii.2000, S.I. Kazmi, Reg. No. R/110. GUJARAT Dangs : Ahwa, 6 exs., 28.ix.1976, Y.P. Sinha, Reg. No. 5704/3; 2 exs., Y.P. Sinha, no details. DADRA & NAGAR HAVELI : Dadra : 2 exs., 7.ix.1976, Y.P. Sinha, Reg. No. 5827/3. Silvassa : 3 exs., 7.x.1976, Y.P. Sinha, Reg. No. 5827/3 & 5835/3.

v. Family : HESPERIIDAE

35. *Peliopidas mathias* Fabricius

Material examined : INDIA : RAJASTHAN : Barmer : Chotan, 1 ex., 14.viii.2000, S.I. Kazmi, Reg. No. R/375.

36. *Telicota augias* (Linnaeus)

Material examined : INDIA : GUJARAT : Dangs : Ahwa, 2 exs., 5.ii.1975, T.G. Vazirani, Reg. No. 3177/3.

vi. Family : SATYRIDAE

37. *Melanitis leda* (Drury)

Material examined : INDIA : RAJASTHAN : Pali : Dujana, 1 ex., 12.viii.2000, M. Faisal, Reg. No. R/109.

vii. Family : LYCAENIDAE

38. *Euchrysops cnejus* (Fabricius)

Material examined : INDIA : RAJASTHAN : Jodhpur : Patodi House, 8 exs., 20.ix.1966, 2 exs, 21.ix.1966, 6 exs., 23.ix.1966, 1 ex., 26.ix.1966, 1 ex., 30.ix.1966, 2 exs., 4.x.1966, 1 ex., 13.x.1966, 1 ex., 17.x.1966, 1 ex., 26.xi.1966, 3 exs., 14.xii.1966, N.K. Parida, Reg. No. I 2389, I 2392, I 240, I 2404, I 2408, I 2411, I 2410, I 2430, I 2480 & I 2499; Kakani village, 1 ex., 29.x.1963, K.C. Kansal, Reg. No. I 772; Muclia village, 1 ex., 8.xi.1966, R.N. Bhargava, Reg. No. I 2427; Sangaria : Kuri village (4 Km SW of Jodhpur), 1 ex., 29.x.1963, Moti Lal, Reg. No. 1489. Pali : Dujana, 1 ex., 12.viii.2000, M. Faisal, Reg. No. R/32.

39. *Tarucus extricatus* Butler

Material examined : INDIA : RAJASTHAN : Jodhpur : Bhopalgarh, 1 ex., 19.ix.2000, S.I. Kazmi, Reg. No. R/5.

DISCUSSION

In the DRS collection it has been found that thirty-nine lepidopteran species are distributed under twenty-five genera and seven families (Fig. 1). The family Pieridae is represented by highest number (15) of species, followed by Nymphalidae (11 spp.). However, both the families have same generic strength (7). In other words, both the families occupy twenty-eight percent of the total generic strength and the least one (4%) are occupied by Satyridae (Fig. 2). The families Danaidae and Papilionidae share the same generic strength (12%), followed by Hesperidae and Lycaenidae occupying eight percent each.

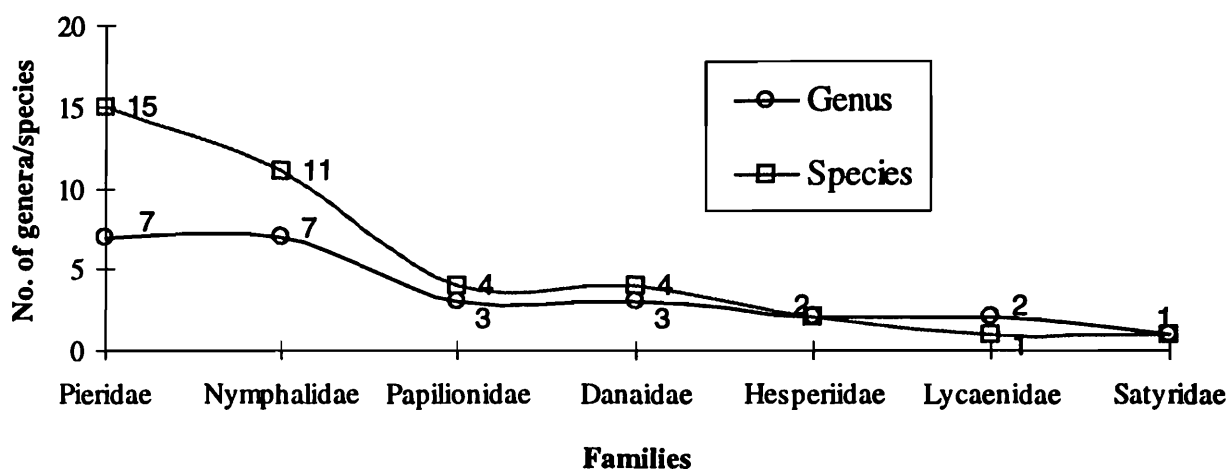


Fig. 1. : Number of genera/species distributed under each family.

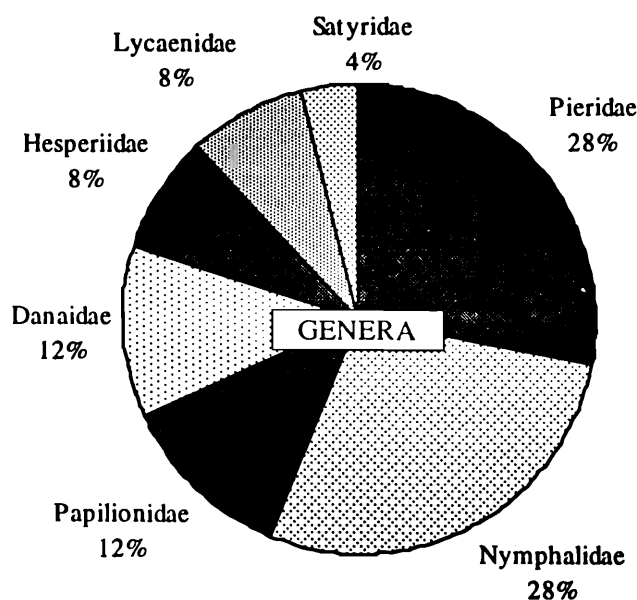


Fig. 2. : Percentage of genera under each family in DRS collection.

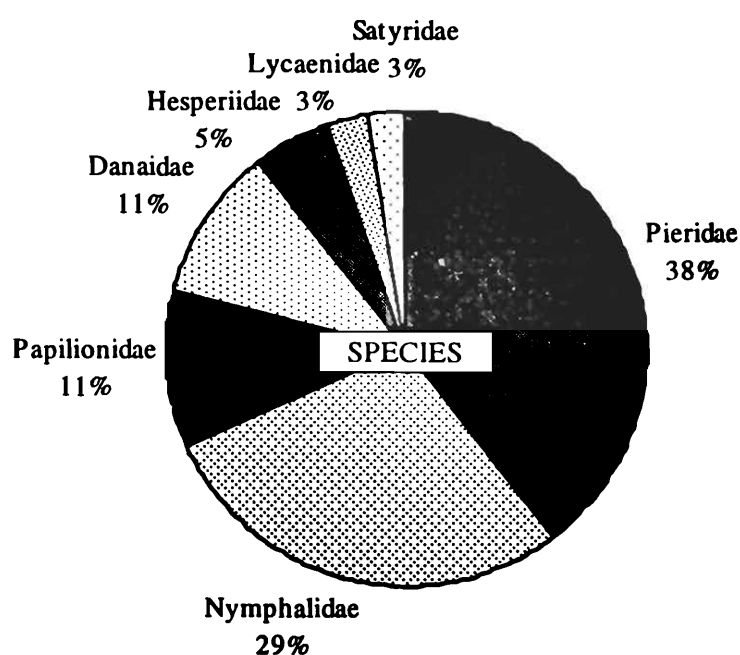


Fig. 3. : Percentage of species under each family in DRS collection.

Figure 3 concludes that Pieridae and Nymphalidae are represented by thirty-eight and twenty-nine percent of the total species strength respectively. The family Danaidae and Papilionidae

represents eleven percent each (*i.e.*, 4 species) of the total fauna. The position occupying the least number (1) of species is shared jointly by families Satyridae and Lycaenidae. Figs. 4–6 provide the district wise information on taxa collected from different districts of the study area. It is evident that out of the thirty-two districts of Rajasthan, only twelve districts are represented in our collection while the districts like Ajmer, Baran, Bharatpur, Bikaner, Bundi, Chittorgarh, Churu, Dholpur, Dausa, Hanumangarh, Jaisalmer, Jalore, Jhalawar, Karauli, Kota, Nagaur, Rajsamand, Sawai Madhopur, Sikar and Tonk are yet to be surveyed (Fig. 4). The district Jodhpur alone recorded the highest number of genera (16) and species (25). Though the district Pali has the same familial strength (5) as that of Jodhpur but the number of the genera (8) and the species (9) is lesser. Except these two districts, all other districts remain poorly surveyed.

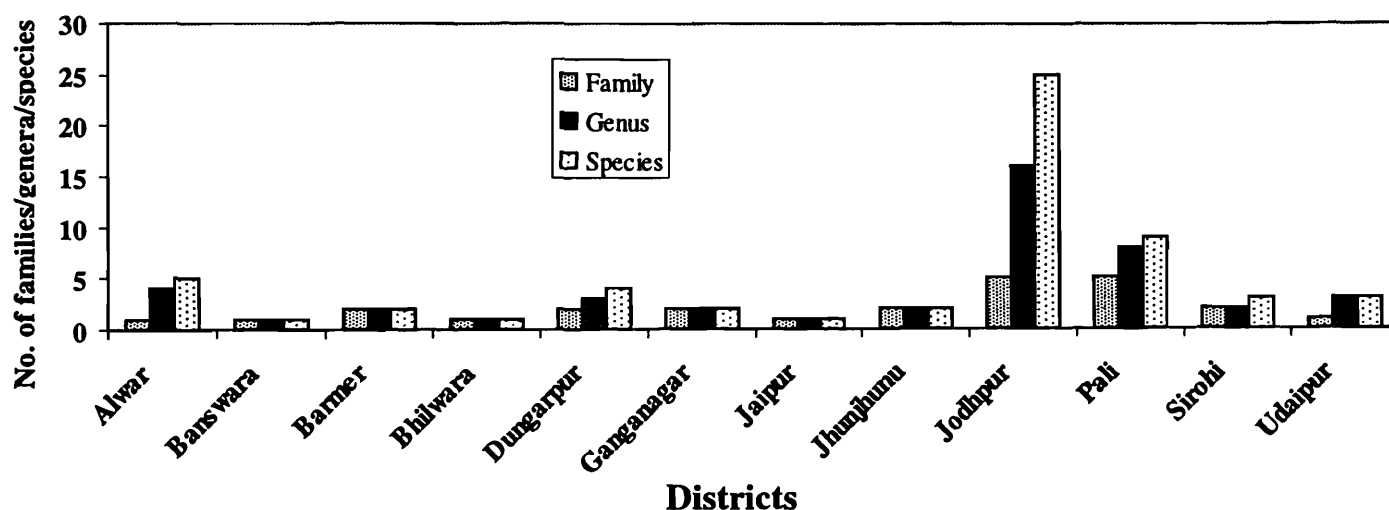


Fig. 4 : Number of families/genera/species recorded in different districts of Rajasthan.

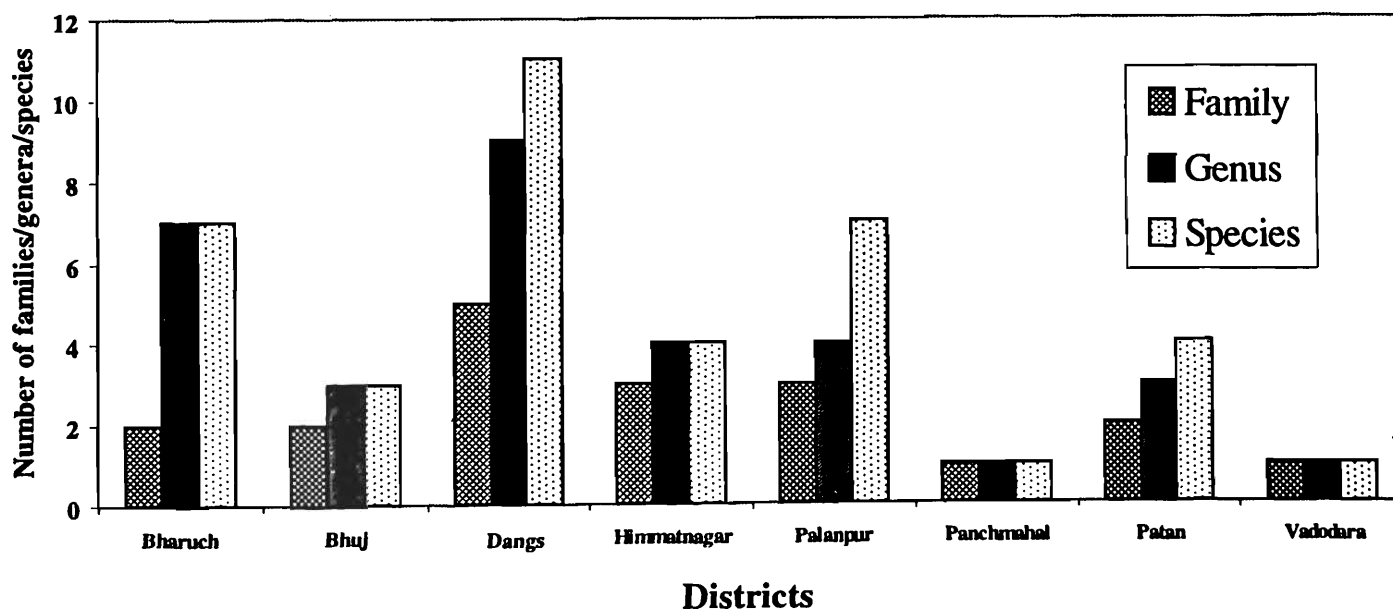


Fig. 5. : Number of families/genera/species recorded in different districts of Gujarat.

The information presented in fig. 5 points to the fact that the lepidopteran fauna of only eight districts of Gujarat are explored by the scientists of this station while there is a dearth of collection

from other seventeen districts. In our collection, Dangs district is well represented by eleven species. In Palanpur, seven species are distributed under four genera and three families while in Bharuch the same number of species are spread over seven genera and two families.

In the Union Territory of Dadra and Nagar Haveli only eight species belonging to seven genera under three families are known from Dadra and Silvassa (Fig. 6).

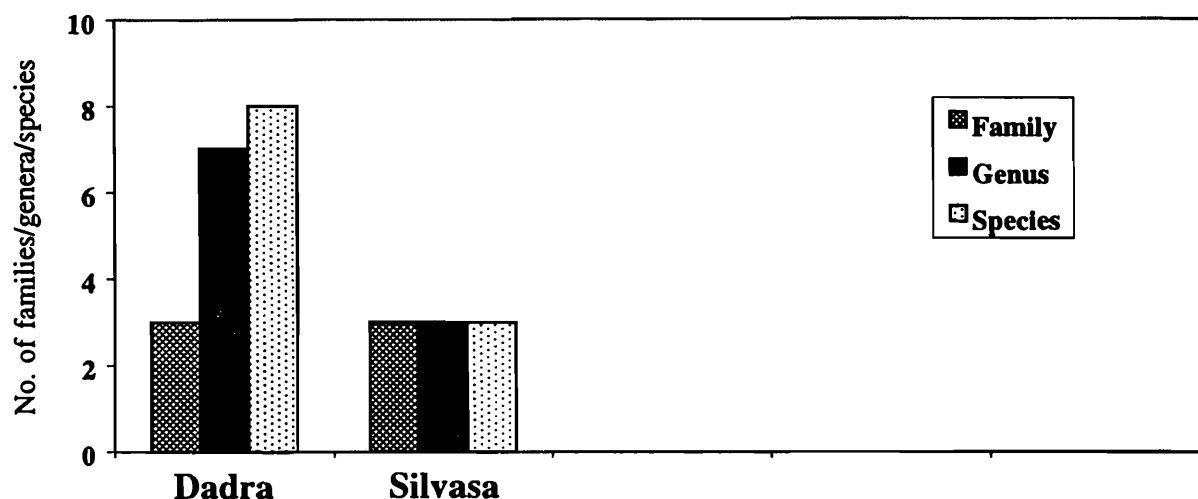


Fig. 6. : Number of families/genera/species recorded in different districts of Dadra and Nagar Haveli.

In our collection, three genera, viz., *Colotis*, *Catopsilia* and *Precis* are represented by four species each (Table 1). The genus *Eurema* holds the second highest position in having three species. There are three genera viz., *Papilio*, *Hypolimnias* and *Danais* which are represented by two species each, while the remaining eighteen genera (*Ixias*, *Delias*, *Cepora*, *Anaphaeis*, *Acraea*, *Cynthia*, *Neptis*, *Atella*, *Symphaedra*, *Pachliopta*, *Pathysa*, *Tirumala*, *Euploea*, *Peliopidas*, *Telicota*, *Melanitis*, *Euchrysops* and *Tarucus*) are represented by a single species each. It has been noted that the genus *Eurema* is most widely distributed genus occurring in fifteen districts, followed by *Danais* (12 districts), *Catopsilia* (10 districts) and *Precis* and *Euploea* (5 districts each).

Collection data shows that thirty-three species of Lepidoptera were found to be associated with seventy-five plant species (Table 2). Out of these, *Catopsilia pyranthe* and *C. florella* were collected from maximum number of plant hosts (8 species).

Two sub-species (*hecabe*, *simulata*) of *Eurema hecabe* were collected from seven plants. Eleven species apparently did not show any host-specificity (Table 2).

Varshney and Gupta (1996) correctly pointed out that no comprehensive studies on the lepidopteran fauna of Rajasthan, Gujarat and Dadra & Nagar Haveli have so far been made that really have any idea of the possible number of taxa inhabiting the area to give a comprehensive zoogeographic treatment. Hence, in absence of any adequate/ sufficient data on the lepidopteran fauna from the neighbouring states it is too early to establish the existence of dominant group of taxa. Although, the present study provides a complete list of the lepidopteran fauna in our collection but definitely it is the need of the moment to chalk out the strategies to collect more information

Table 1. : Occurrence of Lepidoptera taxa from Rajasthan, Gujarat and Dadra & Nagar Haveli represented in DRS collection.

TAXA					STATES & UNION TERRITORY																						
					RAJASTHAN												GUJARAT						DADRA & N. HAVELI				
Family	Genus	Species	Sub-species	Author	Jodhpur	Pali	Alwar	Jaipur	Dungarpur	Udaipur	Sirohi	Barmer	Bhilwara	Ganganagar	Banswara	Jhunjhunu	Bharuch	Himmatnagar	Bhuj	Vadodara	Patan	Palanpur	Dangs	Panchmahal	Dadar	Silvasa	
Pieridae	<i>Colotis</i>	<i>etridae</i>		(Boisduval)	+																						
	<i>Colotis</i>	<i>danae</i>		(Fabricius)	+												+										
	<i>Colotis</i>	<i>calais</i>	<i>amata</i>	(Fabricius)		+																					
	<i>Colotis</i>	<i>vestalis</i>		(Butler)	+																						
	<i>Ixias</i>	<i>marianne</i>		(Cramer)			+																				
	<i>Delias</i>	<i>eucharis</i>		(Drury)													+			+					+		
	<i>Eurema</i>	<i>laeta</i>		(Boisduval)	+	+	+	+	+	+	+							+				+	+	+			
	<i>Eurema</i>	<i>hecabe</i>	<i>hecabe</i>	(Linnaeus)											+												
	<i>Eurema</i>	<i>hecabe</i>	<i>simulata</i>	(Linnaeus)	+		+		+		+							+		+		+	+			+	
	<i>Cepora</i>	<i>nerissa</i>		(Fabricius)			+																	+			
	<i>Anaphaeis</i>	<i>aurota</i>	<i>aurota</i>	(Fabricius)	+		+		+	+								+									
	<i>Catopsilia</i>	<i>crocale</i>	<i>crocale</i>	(Cramer)	+						+							+		+			+			+	+
	<i>Catopsilia</i>	<i>pyranthe</i>		(Linnaeus)		+													+			+	+				
	<i>Catopsilia</i>	<i>flbrella</i>		(Fabricius)	+																						
	<i>Catopsilia</i>	<i>pomona</i>		(Fabricius)	+																						
Nymphalidae	<i>Hypolimnas</i>	<i>bolina</i>		(Linnaeus)																				+		+	+
	<i>Hypolimnas</i>	<i>misippus</i>		(Linnaeus)	+																						
	<i>Acraea</i>	<i>violae</i>		(Fabricius)											+										+		
	<i>Cynthia</i>	<i>cardui</i>		(Linnaeus)	+																				+		
	<i>Neptis</i>	<i>hylas</i>	<i>astola</i>	Moore																				+			

Table 1. : Cont'd.

TAXA					STATES & UNION TERRITORY																						
					RAJASTHAN												GUJARAT						DADRA & N. HAVELI				
Family	Genus	Species	Sub-species	Author	Jodhpur	Pali	Alwar	Jaipur	Dungarpur	Udaipur	Sirohi	Barmer	Bhilwara	Ganganagar	Banswara	Jhunjhunu	Bharuch	Himmatnagar	Bhuj	Vadodara	Patan	Palanpur	Dangs	Panchmahal	Dadar	Silvasa	
	<i>Atella</i>	<i>phalantha</i>		(Drury)	+																			+			
	<i>Symphaedra</i>	<i>nais</i>		(Forster)																				+			
	<i>Precis</i>	<i>almana</i>		(Linnaeus)																			+			+	
	<i>Precis</i>	<i>lemonias</i>		(Linnaeus)	+																			+		+	
	<i>Precis</i>	<i>orithya</i>		(Linnaeus)	+																			+	+		
	<i>Precis</i>	<i>hierta</i>		(Fabricius)	+																						
Papilionidae	<i>Pachliopta</i>	<i>aristolochiae</i>		(Fabricius)	+														+								
	<i>Papilio</i>	<i>polytes</i>	<i>romulus</i>	Cramer	+	+											+	+									
	<i>Papilio</i>	<i>demoleus</i>		Linnaeus	+	+																		+			
	<i>Pathysa</i>	<i>nomius</i>		(Esper)	+																						
Danaiidae	<i>Danais</i>	<i>chrysippus</i>	<i>chrysippus</i>	(Linnaeus)	+	+			+			+	+	+		+	+	+	+		+	+					
	<i>Danais</i>	<i>genutia</i>		(Cramer)	+																						
	<i>Tirumala</i>	<i>limniaca</i>	<i>leopardus</i>	Butler	+						+																
	<i>Euploea</i>	<i>core</i>	<i>core</i>	(Cramer)	+	+																		+		+	+
Hesperiidae	<i>Peliopidas</i>	<i>mathias</i>		Fabricius								+												+			
	<i>Telicota</i>	<i>augias</i>		(Linnaeus)																							
Satyridae	<i>Melanitis</i>	<i>leda</i>		(Drury)		+																					
Lycaenidae	<i>Euchrysops</i>	<i>cnejus</i>		(Fabricius)	+	+																					
	<i>Tarucus</i>	<i>extricatus</i>		Butler	+																						

on their distribution. The in-depth knowledge of the faunal richness, host-specificity, zoogeographical affinities and distribution of these Lepidoptera would certainly enrich our knowledge.

Table 2. : Lepidoptera fauna collected from different host plants.

Name of the species	Host plants
<i>Colotis etridae</i> (Boisduval)	<i>Cadaba indica</i>
<i>C. danae</i> (Fabricius)	<i>Cadaba indica</i> , <i>C. divaricata</i> , <i>Maerua arenaria</i> , <i>Capparis sepiaria</i> .
<i>C. calais amata</i> (Fabricius)	<i>Salvadora persica</i> , <i>S. oleoides</i> , <i>Azima tetracantha</i>
<i>C. vestalis</i> (Butler)	<i>Salvadora persica</i>
<i>Ixias mariane</i> (Cramer)	<i>Capparis sepiaria</i> , <i>C. divaricata</i> , <i>C. aphylla</i> , <i>C. grandis</i> .
<i>Delias eucharis</i> (Drury)	<i>Loranthus elasticus</i> , <i>L. scurrula</i> , <i>L. longiflorus</i> , <i>Xeromphis uliginosa</i>
<i>Eurema laeta</i> (Boisduval)	Host data not available
<i>E. hecabe hecabe</i> (Linnaeus)	<i>Cassia tora</i> , <i>C. fistula</i> , <i>Albizia</i> sp. <i>Wagatea spicata</i> , <i>Sesbania aculeata</i> , <i>Butea monosperma</i> , <i>Schleichera oleosa</i>
<i>E. hecabe simulata</i> (Linnaeus)	-Do-
<i>Cepora nerissa</i> (Fabricius)	<i>Capparis aphylla</i> , <i>C. heyneana</i>
<i>Catopsilia crocale crocale</i> (Cramer)	<i>Cassia fistula</i> , <i>C. tora</i> , <i>Butea monosperma</i> , <i>Brassica oleracea</i>
<i>C. pomona</i> (Fabricius)	-Do-
<i>C. pyranthe</i> (Linnaeus)	<i>Cassia tora</i> , <i>C. auriculata</i> , <i>Litsea chinensis</i> , <i>L. monopetala</i> , <i>L. glutinosa</i> , <i>Mallotus philippensis</i> , <i>Phoebe lanceolata</i> , <i>Triadica sebifera</i>
<i>C. florella</i> (Fabricius)	-Do-
<i>Hypolimnas bolina</i> (Linnaeus)	<i>Fleurya interrupta</i> , <i>Elatostemma cuneatum</i> , <i>Portulaca oleracea</i>
<i>Hypolimnas misippus</i> (Linnaeus)	<i>Portulaca oleracea</i> , <i>Abutilon</i> sp., <i>Hibiscus</i> sp.
<i>Acraea violae</i> (Fabricius)	Host data not available
<i>Cynthia cardui</i> (Linnaeus)	<i>Zornia diphylla</i> , <i>Blumea</i> sp.
<i>Neptis hylas astola</i> Moore	Moore <i>Cylista</i> sp., <i>Mucuna</i> sp., <i>Flemingia</i> sp., <i>Canavalia ensiformis</i>
<i>Atella phalantha</i> (Drury)	<i>Flacourtia ramontchi</i> , <i>E. montana</i> , <i>Smilax</i> sp., <i>Salix</i> sp.
<i>Symphaedra nais</i> (Forster)	<i>Sorea robusta</i> , <i>Diospyros melanoxylon</i> .

Table 2. : Cont'd.

Name of the species	Host plants
<i>Precis almana</i> (Linnaeus)	<i>Asteracantha longifolia</i> , <i>Hygrophila</i> sp., <i>Barleria</i> sp.
<i>P. lemonias</i> (Linnaeus)	<i>Asteracantha longifolia</i> , <i>Nelsonia campestris</i>
<i>P. orithyia</i> (Linnaeus)	<i>Justicia procumbens</i> , <i>J. micrantha</i> , <i>Ipomaea batatas</i>
<i>P. hierta</i> (Fabricius)	<i>Asteracantha longifolia</i> , <i>Barleria</i> sp.
<i>Pachliopta aristolochiae</i> (Fabricius)	<i>Aristolochia indica</i> , <i>Ziziphus mauritiana</i>
<i>Papilio polytes romulus</i> Cramer	<i>Citrus medica</i> , <i>Glycosmis pentaphylla</i> , <i>Zanthoxylum rhetsa</i>
<i>P. demoleus</i> Linnaeus	<i>Citrus</i> sp., <i>Glycosmis pentaphylla</i> , <i>Zanthoxylum rhetsa</i>
<i>Pathysa nomius</i> (Esper)	<i>Polyalthia longifolia</i> , <i>Saccopetalum tomentosum</i>
<i>Danais genutia</i> (Cramer)	<i>Calotropis</i> sp.
<i>D. chrysippus chrysippus</i> (Linnaeus)	<i>Calotropis procera</i> , <i>C. gigantea</i> , <i>Holarrhena antidysenterica</i>
<i>Tirumala limniaca leopardus</i> Butler	<i>Calotropis</i> sp., <i>Dregea volibilis</i>
<i>Euploea core core</i> (Cramer)	<i>Ficus bengalensis</i> , <i>F. indica</i> , <i>F. glomerata</i> , <i>F. religiosa</i> , <i>Nerium odorum</i> , <i>Cryptolepis elegans</i>
<i>Peliopidas mathias</i> Fabricius	Host data not available
<i>Telicota augias</i> (Linnaeus)	Host data not available
<i>Melanitis leda</i> (Drury)	Host data not available
<i>Euchrysops cnejus</i> (Fabricius)	<i>Butea monosperma</i> , <i>Acacia ougenia dalbergioides</i> , <i>Cylista scariosa</i> .
<i>Tarucus extricatus</i> Butler	<i>Zizyphus</i> sp.

ACKNOWLEDGEMENTS

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ICHTHYO-FAUNA OF KONDAKARLA LAKE, ANDHRA PRADESH

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INTRODUCTION

A perusal of the lacustrine-Ichthyo fauna of Andhra Pradesh shows that some significant endeavors have earlier been made by Burman (1993) on the fish fauna of the state Chacko *et al* (1952) Dutt & Murty (1971, 1976) Murty (1977) on Kolleru/Collair lake, Rao and Reddy (1984) on Hussain sagar lake. The available unpublished work on fish fauna of Kondakarla lake is that of Sankara Rao (1992) who recorded 25 species.

MATERIAL AND METHODS

Kondakarla lake is located at about 50 km south-west of Visakhapatnam in Andhra Pradesh between latitudes 17°35'30" and 17°36'02" and longitudes 82°01'0" and covers an area of 6.5 sq. kms. The water body is surrounded by agricultural fields and about 4 km away from the Bay of Bengal. Since this is the major wetland in Visakhapatnam district, the author has collected its fish fauna while studying the limnological aspects of the ecosystem. The 299 fish specimens collected and examined by the author yielded 17 species belonging to 14 genera spread over 11 families in 5 orders. The material was deposited in the National Zoological Collections of Freshwater Biological Station, Zoological Survey of India, Hyderabad. The Registration numbers (FBS/ZSI), first reference, classification (Menon, 1993), material examined and distribution are given under systematic account. Standard Length (SL) of the specimens are given in millimeters.

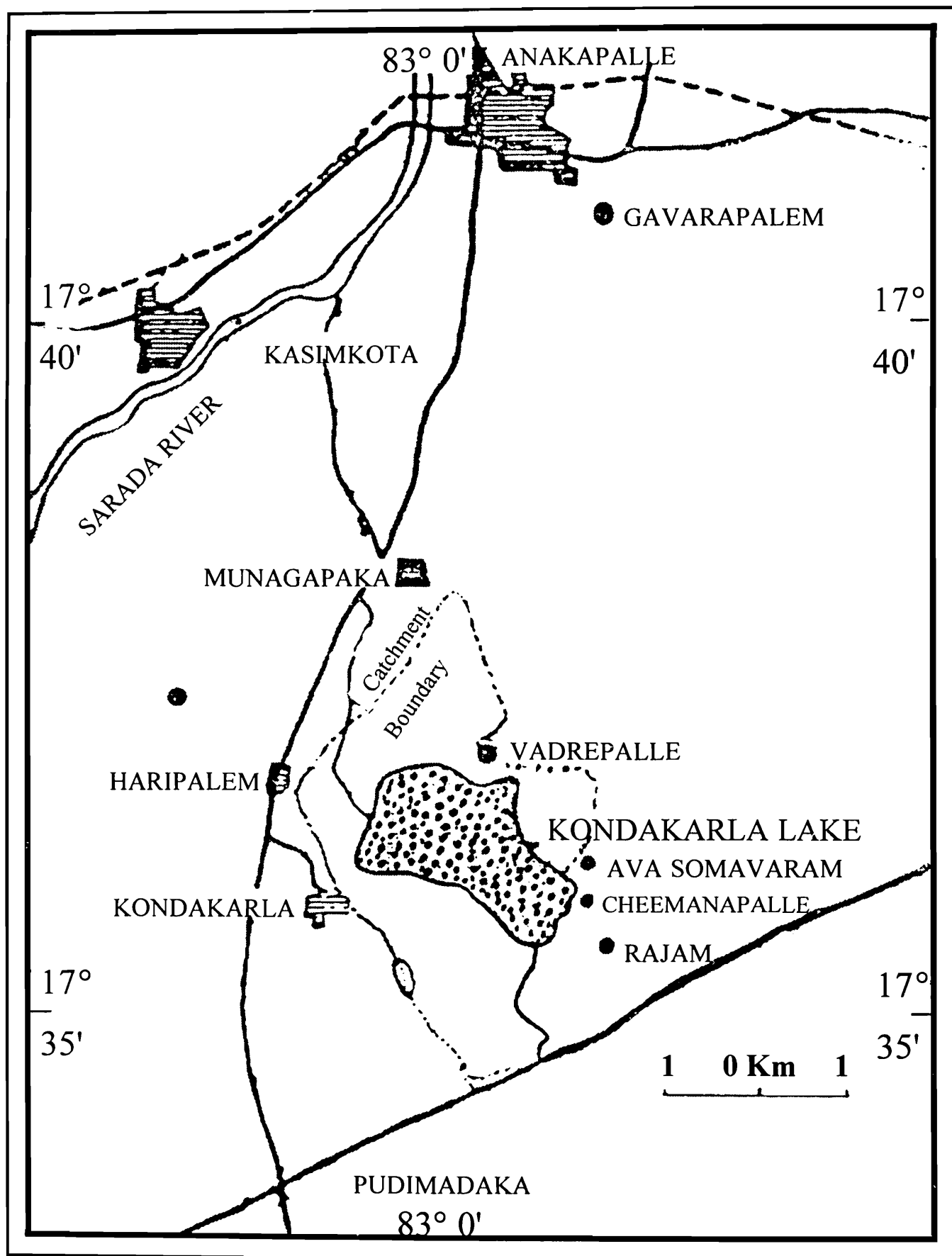
SYSTEMATIC ACCOUNT

Order OSTEOGLOSSIFORMES

Family NOTOPTERIDAE

Notopterus notopterus (Pallas)

1769. *Gymnotus notopterus* Pallas, *Special Zool.*, 7 : 40, pl. 6 fig. 2 (type locality : ponds and rivers of Bengal).
1878. *Notopterus kapirat* Lacepede : Day, *Fishes of India* : 653, pl. 159, fig. 4; Day, 1889, *Fauna Br. India, Fishes*, 1 : 406.
1936. *Notopterus osmani* Rahimullah and Das, *Bull. Soc. Port. Nat.*, 12(18) : 136, pl. 23 (type-locality : rivers of Hyderabad, Deccan).
1976. *Notopterus notopterus* : Misra, *Fauna of India, Pisces* (2nd ed.), 2 : 278, fig. 77 and Pl. 7, fig. 3.



MANDAL HEAD QUARTERS

LAKE

VILLAGES

Material examined : 1006, 1040, 1046, 1095 & 1102; 26.viii.1997, 28.xii.1997, 12.v.1997, 11.v.1997; SL : 150-232 mm; 11 exs.

Distribution : India, Nepal, Pakistan, Bangladesh, Burma, Malaya and Indonesia.

Order CYPRINIFORMES

Family CYPRINIDAE

Subfamily CULTRINAE

***Salmostoma bacaila* (Hamilton)**

1822. *Cyprinus bacaila* Ham. *Fish Ganges*, pp. 265, 384, pl. 8, fig. 76 (type locality : Gangetic provinces).

1878. *Chela bacaila* Day, *Fishes of India* : 603, Pl. 152, fig. 5; Day, 1889, *Fauna Br. India*, Fishes, 1 : 367; Shaw and Shebbeare, 1937, *J. Asiat. Soc. Beng.*, 3 : 19, fig. 11.

1968. *Salmostoma bacaila* : Banarescu, *Revue roum. Biol. (Zool)*, 13(1) : 4, fig. 1.

Material examined : 1058, 1078, 1079, 1089, 1097; 25.viii.1997, 11.v.1997, 24.viii.1997; SL : 66-126 mm; 10 exs.

Distribution : Northern India (Ganga-Brahmaputra drainages) to Mahanadi drainages (Orissa).

Subfamily RASBORINAE

***Rasbora daniconius* (Hamilton)**

1822. *Cyprinus daniconius* (Ham.). *Fish Ganges*, pp. 327, pl. 15, fig. 89. (type locality : rivers of southern Bengal).

1878. *Rasbora daniconius* : Day, *Fishes of India* : 584, pl. 146, figs. 2, 3; Day, 1889, *Fauna Br. India*, Fishes, 1 : 336; Brittan, 1954, *Monogr. Inst. Sci. Techn. Manila*, (3) : 135.

Material examined : 1059, 1061, 1069, 1100; 25.viii.1997, 26.viii.1997, 13.v.1997, 24.viii.1997; SL : 33-60 mm; 32 exs.

Distribution : Throughout India, Sri Lanka, Pakistan, Nepal, Bangladesh, Burma and Thailand.

Subfamily CYPRININAE

***Puntius* sp. Hamilton**

1822. *Puntius* Ham. *Fish Ganges*, pp. 310, 388.

Material examined : 1070, 1081; 13.v.1997, 11.v.1997; SL : 23-70 mm; 2 exs.

Distribution : Widely distributed in South Asia.

***Puntius sophore* (Hamilton)**

1822. *Cyprinus sophore* Ham., *Fish Ganges* pp. 310, 389, pl. 19, fig. 86 (type locality : ponds and rivers in the Gangetic provinces).
1878. *Barbus chrysopterus* (McClelland) Day, *Fishes of India* : 579, pl. 143, fig. 6; Day, 1889, *Fauna Br. India*, Fishes, 1 : 329; Mirza, 1971, *Biologia*, 17(1) : 49.
1878. ? *Barbus sophore* Day, *Fishes of India* : 566, pl. 143, fig. 4; Day, 1889, *Fauna Br. India*, Fishes, 1 : 309; Murthy, 1977, *Proc. Indian Acad. Sci.*, 85(B)(3) : 126.
1878. *Barbus stigma* (Valenciennes) Day, *Fishes of India* : 579, pl. 141, fig. 5; Day, 1889, *Fauna Br. India*, Fishes, 1 : 329; Chaudhuri, 1916, *Mem. Indian Mus.*, 5 : 436.
1924. *Barbus annandalei* Fowler, *Proc. Acad. Nat. Sci. Philad.*, 76 d : 87, fig. 6 (type-locality : Sutlej river at Ludhiana); Chaudhuri, 1916, *Mem. Indian Mus.*, 5 : 436.
1924. *Barbus carletoni* Fowler, *Proc. Acad. Nat. Sci. Philad.*, 76 : 89, fig. 7 (type-locality : Dehra Dun, Uttar Pradesh).
1970. ? *Puntius carletoni* Tilak, *Sci. & Cult.*, 36 (11) : 613, fig. 1.

Material examined : 1057, 1062, 1072, 1075, 1088, 1093, 1098, 1099; 25.viii.1997, 26.viii.1997, 12.v.1997, 11.v.1997, 24.viii.1997; SL : 46-72 mm; 88 exs.

Distribution : Throughout India, Pakistan, Bangladesh, Burma, China.

***Puntius ticto* (Hamilton)**

1822. *Cyprinus ticto* Ham. *Fish Canges*, pp. 314, 398; pl. 8, fig. 87. (type-locality : Southern east part of Bengal). *Cyprinus ticto* Hamilton-Buchanan, 1822, *fishes of Ganges* : 314, 398, pl. 8, fig. 87 (type-locality : South-eastern parts of Bengal); Murthy, 1977, *Proc. Indian Acad. Sci.*, 85B(3) : 130.
1865. *Puntius punctatus* Day, *Proc. zool. Soc. Lond.*, 302 (type-locality : Cohin); Hora, Misra and Malik, 1939, *Rec. Indian Mus.*, 41(3) : 263.
1871. *Barbus (Puntius) stoliczkanus* Day, *J. Asiat. Soc. Beng.*, 40(2) : 328 (type-locality : Moulmein, Eastern Burma); Hora, Misra and Malik, 1939, *Rec. Indian Mus.*, 41(3) : 263.
1878. *Barbus ticto* Day, *Fishes of India* : 576, pl. 144, fig. 7, 1889, *Fauna Br. India*, Fishes, 1 : 325; Hora and Misra, 1938, *J. Bombay nat. Hist. Soc.*, 40(1) : 28, fig.
1878. *Barbus punctatus* Day, *Fishes of India* : 577, pl. 144, fig. 5; 1889, *Fauna Br. India*, Fishes, 1 : 326.
1878. *Barbus stoliczkanus* Day, *Fishes of India* : 577, pl. 144, fig. 5; Day, 1889, *Fauna Br. India*, Fishes, 1 : 326; Silas, 1952, *Proc. nat. Inst. Sci. India*, 18(5) : 431.

Material examined : 1067, 13.v.1997; SL : P 22-24 mm; 3 exs.

Distribution : India : except Kerala and South Tamil Nadu; Nepal; Pakistan; Bangladesh.

Order SILURIFORMES

Family BAGRIDAE

Mystus bleekeri (Day)

1846. *Bagrus keletius* (nec Valenciennes) Bleeker *Nat. Gen. Arch. Ned. India* 3(2) : 135 (type-locality : Bengal).
1877. *Macrones bleekeri* Day, *Fishes of India* : 451, pl. 101, fig. 1 (Replacement name for *Bagrus keletius* Bleeker, 1846); Day, 1889, *Fauna Br. India, Fishes*, 1 : 162.
1910. *Mystus bleekeri* var. *Burmanicus* Jenkins, *Rec. Indian Mus.*, 5(2) : 138 (type-locality : Bhamo, Burma).
1976. *Mystus (Mystus) bleekeri* Misra, *Fauna of India, Pisces* (2nd ed.), 3 : 85, fig. 17.
1977. *Mystus bleekeri* Jayaram, *Rec. zool. Surv. India Occ. Paper No. 8* : 29, Fig. 21B.

Material examined : 1049, 1051, 1060, 1076, 1083, 1085; 12.v.1997, 30.xii.1997, 31.xii.1997, 11.v.1997; SL : 36-112 mm; 75 exs.

Distribution : Northern India, Southern limit up to Mahanadi river, Pakistan, Nepal, Bangladesh and Burma.

Mystus vittatus (Bloch)

1797. *Silurus vittatus* Bloch, *Ichth. Hist. Nat.*, 11 : 40, pl. 371, fig. 2 (type-locality : Tranquebar, S. India).
1877. *Macrones vittatus* Day, *Fishes of India* : 448, pl. 98, fig. 3, and pl. 99, fig. 4; Day, 1889, *Fauna Br. India, Fishes*, 1 : 157.
1976. *Mystus (Mystus) vittatus vittatus* Misra, *Fauna of India, Pisces* (2nd ed.) 3 : 105, fig. 20.

Material examined : 1084; 11.v.1997; SL : 75-78 mm; 16 exs.

Distribution : Throughout India, Pakistan, Bangladesh, Sri Lanka, Burma and Thailand.

Family CLARIIDAE

Clarius batrachus (Linnaeus)

1758. *Silurus batrachus* Linnaeus, *Syst. Nat.* 1st ed., 10 : 305 (type-locality : Assam and Africa).
1877. *Clarius magur* (Hamilton-Buchanan) Day, *Fishes of India* : 485, pl. 112, figs. 5, 5a; Day, 1889, *Fauna Br. India, Fishes*, 1 : 115, figs. 48, 49; Misra, 1976, *Fauna of India, Pisces* (2/e), 3 : 125, fig. 23.
1877. *Clarias jagur* (Hamilton-Buchanan) Day, *Fishes of India* : 484.
1877. *Clarius assamensis* Day, *Fishes of India* : 485 (type-locality : Goalpara and as high as Suddya, Assam); Day, 1889, *Fauna Br. India, Fishes*, 1 : 117; Hora, 1936, *Rec. Indian Mus.*, 38(3) : 350.

Material examined : 1041, 1045, 1053, 1054; 13.v.1997, 29.xii.1997, 30.xii.1997, 24.viii.1997; SL : 121-230 mm; 8 exs.

Distribution : India, Pakistan, Nepal, Bangladesh, Indonesia, Singapore, Borneo and the Philippines.

Family HETEROPNEUSTIDAE

***Heteropneustes fossilis* (Bloch)**

1798. *Silurus fossilis* Bloch, *Ichth. Hist. Nat. Poiss.* 11 : 36, 370, fig. 2 (type-locality : Bengal).

1877. *Saccobranchus fossilis* Day, *Fishes of India* : 486, pl. 114, fig. 1 : Day, 1889, *Fauna Br. India, Fishes*, 1 : 125, fig. 53.

1976. *Heteropneustes fossilis* Misra, *Fauna of India, Pisces* (2/e), 3 : 135, fig. 24.

Material examined : 1032, 1044, 1055, 1103; 25.viii.1997, 19.xii.1997, 24.viii.1997, 12.v.1997; SL : 136-275 mm; 4 exs.

Distribution : India, Sri Lanka, Nepal, Bangladesh, Burma, Thailand and Laos.

Order CHANNIFORMES

Family CHANNIDAE

***Channa punctatus* (Bloch)**

1793. *Ophiocephalus punctatus* Bloch, *Natur. Aus. Fische*. 7 : 139, pl. 358 (type-locality : Coramandel coast).

Material examined : 1033, 1034, 1035, 1038, 1042, 1056, 1073, 1074, 1092; 25.viii.1997, 24.viii.1997, 26.viii.1997, 13.v.1997, 11.v.1997, 12.v.1997; SL 87-135 mm; 18 exs.

Distribution : India, Afghanistan, Pakistan, Nepal, Sri Lanka, Bangladesh, Burma and Yunan (China).

Order PERCIFORMES

Sub-order PERCODEI

Family CENTROPOMIDAE

***Chanda nama* (Hamilton)**

1822. *Chanda nama* Ham. *Fish Ganges*, pp. 109, 371, pl. 39, fig. 37 (type-locality : N. E. Bengal).

1875. *Ambassis nama* Ham. *Fishes of India* : 50, pl. 14, fig. 5; Day, 1889 *Fauna of Br. India*, 1876 *Fishes*, 1 : 484, fig. 149.

Material examined : 1104; 13.v.1997; SL : 27 mm; 1 ex.

Distribution : Throughout India, Pakistan, Bangladesh, Nepal and Burma.

***Pseudambasis ranga* (Hamilton)**

1822. *Chanda ranga* Ham., *Fish Ganges*, pp. 113, 371, pl. 6, fig. 38 (type-locality : Gangetic provinces).
1875. *Ambassis ranga* Day (*partim*) *Fishes of India* : 51, pl. 14, fig. 6; Day (*partim*), 1889, *Fauna Br. India*, *Fishes*, 1 : 485.

Material examined : 1066, 1073, 1082, 1096, 1101; 26.viii.1997, 13.v.1997, 11.v.1997, 24.viii.1997; SL : 20-66 mm; 14 exs.

Distribution : India, Ceylon, Pakistan, Bangladesh, Nepal, Burma, Malaya, Malay Archipelago, Thailand and Philippines.

Family CICHLIDAE

***Oreochromis mossambica* (Peters)**

1852. *Chromis (Tilapia) mossambica* Peters, *Montab. Akad. Wiss.*, Berlin, pp. 681 (type-locality : Mozambique).
1852. *Chromis (Tilapia) mossambicus* Peters, *Montab. Akad. Wiss.*, Berlin : 681, (type-locality : Mozambique).
1952. *Tilapia mossambica* Jones and Sarojini, *J. Bombay nat. Hist. Soc.*, 50(3) : 606.
1983. *Oreochromis mossambica* Trewavas, 1983, *Tilapiine Fishes* : 292, fig. 100.

Material examined : 1080; 11.v.1997; SL : 21-23 mm; 4 exs.

Distribution : Introduced in India, Pakistan, Sri Lanka etc.

Suborder GOBIOIDAE

Family GOBIIDAE

***Glossogobius giuris* (Hamilton)**

1794. *Gobius giuris* Ham. *Fish Ganges*, pp. 51, 366, pl. 33, fig. 15 (type-locality : Gangetic provinces).
Pethiyagoda 1991, *Freshwater Fish.*, Sri Lanka, p. 245.
1822. *Gobius giuris* Hamilton-Buchanan, *Fishes of Ganges* : 51, pl. 33, fig. 15 (type-locality : Gangetic provinces); Day, 1876, *Fishes of India* : 294, pl. 67, fig. 1; Day, 1889, *Fauna Br. India*, *Fishes*, 2 : 266.
1876. *Gobius gutum* (*nec* Hamilton-Buchanan) Day, *Fishes of India* : 294; Day, 1889, *Fauna Br. India*, *Fishes*, 2 : 265.
1941. *Glossogobius giuris* Koumans, *Mem. Indian Mus.*, 13(3) : 256.

Material examined : 1048, 1068, 1090; 12.v.1997, 13.v.1997, 11.v.1997; SL : 34-96 mm; 6 exs.

Distribution : India, East Coast of Africa, Ceylon, Pakistan, Bangladesh, Andamans, Malay Peninsula, Thailand, China, Japan, Philippines, Australia, Indo-Australian Archipelago and South Pacific Islands.

Family ANABANTIDAE

Anabas testudineus Bloch

1795. *Anthias testudineus* Bloch, *Nat. Aus. Fish.*, 7 : 121, pl. 322 (type-locality : ? Java).
1877. *Anabas scandens* (Daldoff) Day (*partim*) *Fishes of India*, 370, pl. 78, fig. 3 : Day (*partim*), 1889, *Fauna of Br. India, Fishes*, 2 : 367, fig. 120.
1964. *Anabas testudineus riveri* Das, 1964, *Ichthyologica*, 3(1/2) : 93 (type-locality : Rapti river at Basti, Uttar Pradesh).
1964. *Anabas testudineus lacustri* Das *Ichthyologica*, 3(1/2) : 93 (type-locality : Balarampur, Uttar Pradesh).
1964. *Anabas testudineus ricei* Das, *Ichthyologica*, 3(1/2) : 93 (type-locality : Balarampur, Uttar Pradesh).
1968. *Anabas testudineus* Thakur and Das, *Bull. Cent. Inland Fish. Res. Inst.*, (40) 1-47 (Biological data).

Material examined : 1047, 1050, 1071, 1077, 1080, 1086; 12.v.1997, 11.v.1997; SL : 70-106 mm; 23 exs.

Distribution : India, Pakistan, Bangladesh, Sri Lanka, Nepal, Burma, Thailand, Cambodia, Srtutu China, Indo-China, Malay-Archipelago.

Suborder MASTACEMBELOIDEI

Family MASTACEMBELIDAE

Macrognathus punctatus Hamilton

1822. *Macrognathus punctatus* Ham. *Fish Ganges*, pp. 30, 364, pl. 22, Fig. 7 (type-locality : Bengal)
1876. *Mastacembelus pancalus* Day, *Fishes of India* : 340, pl. 72, Fig. 4; Day, 1889, *Fauna Br. India, Fishes*, 2 : 333, Sufi, 1956, *Bull. Raffles Mus.*, (27) : 120, pl. 22, Fig. 20.

Material examined : 1039, 1094; 26.viii.1997, 24.viii.1997; SL : 119-125 mm; 2 exs.

Distribution : India, Pakistan, Bangladesh.

SUMMARY

Studies on the Ichthyo-fauna of Kondakarla lake in Visakhapatnam district of Andhra Pradesh were made covering three seasons during 1996 and 1997. 17 species belonging to 14 genera spread over 11 families in five orders have been identified from 299 examples collected from the water body.

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OCCURRENCE OF *SPONGILLA LACUSTRIS* AND *EUNAPIUS CARTERI* (DEMOSPONGIAE : SPONGILLIDAE) FROM TRIPURA, INDIA

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INTRODUCTION

In order to make an update account of the freshwater sponge fauna of Tripura, India a number of faunistic surveys were undertaken during 1992-93 to cover different areas of the state. During the course of these surveys only two species of freshwater sponges were collected from three localities. There is no such earlier record from those areas. Hence these are the first records of the species from the state of Tripura.

SYSTEMATIC ACCOUNT

Phylum	PORIFERA
Class	DEMOSPONGIAE
Subclass	CERACTINOMORPHA
Order	HAPLOSCLERIDA
Family	SPONGILLIDAE Gray, 1867

Spongilla lacustris (Linnaeus, 1758)

(Text figs. 1-3)

1758. *Spongia lacustris* Linnaeus, *Systema Naturae*. 10th ed., 1 *Animalia* : 1348.
1842. *Spongilla lacustris*, Johnston, *History of the British Zoophytes*, 2nd ed., London : 110.
1968. *Spongilla lacustris*, Penney and Racek, *Bull. U.S. natn. Mus.*, No. 272 : 9 (Synonymy).
1982. *Spongilla lacustris*, Soota and Pattanayak, *Rec. zool. Surv. India*, 80 : 224.
1991. *Spongilla lacustris*, Soota, *Rec. zool. Surv. India, Occ. paper* No. 138 : 27.

Material : 3 exs., Panitila, Pecharthal, North Tripura, 23.iv.1992, P 3428/1, Coll. B. P. Halder and Party.

Description : *Shape*. Sponge 2 mm thick encrusting on aquatic weed, cylindrical, 32 mm long and 8 mm in diameter.

Colour : Grey white in spirit.

Oscules : Small and inconspicuous.

Texture and surface : Texture soft, compressible and fragile, surface hispid.

Ectosome and subectosome : Ectosome microscopically very hispid with longer amphioxeas protruding through surface.

Choanosome : Choanosomal skeletal architecture well developed, consisting of polyspicular longitudinal fibers, coated together in thick sheaths of spongin and of a varying number of secondary transverse fibers.

Megascleres : Smooth, slight to moderately curved amphioxea; length 0.212–(0.278)–0.335 mm, width 0.009–(0.011)–0.012 mm.

Microscleres : Slightly curved amphioxea with small spines equally distributed throughout the spicule, abundance in choanosome; length 0.063–(0.072)–0.083 mm, width 0.003–(0.0032)–0.0036 mm.

Gemmoscleres : Like that of microscleres but stouter, slightly to strongly curved amphioxea, curved spines throughout the spicules, length 0.070–(0.075)–0.084 mm, width 0.003–(0.0034)–0.004 mm.

Gemmules : Abundant, scattered throughout the body, large, spherical; pneumatic layer well developed with gemmoscleres embedded in an irregular manner, foramen simple, diameter of gemmule 0.66–(0.69)–0.70 mm.

Distribution In India : Assam, Bihar, Himachal Pradesh, Jammu and Kashmir, Karnataka, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura and West Bengal. Elsewhere : Widely distributed in the Northern hemisphere with its greatest expansion in cold-temperate regions.

Remarks : This species is widely distributed in India but this is the first record of occurrence from the state of Tripura.

***Eunapius carteri* (Bowerbank, 1863)**

(Text figs. 4 & 5)

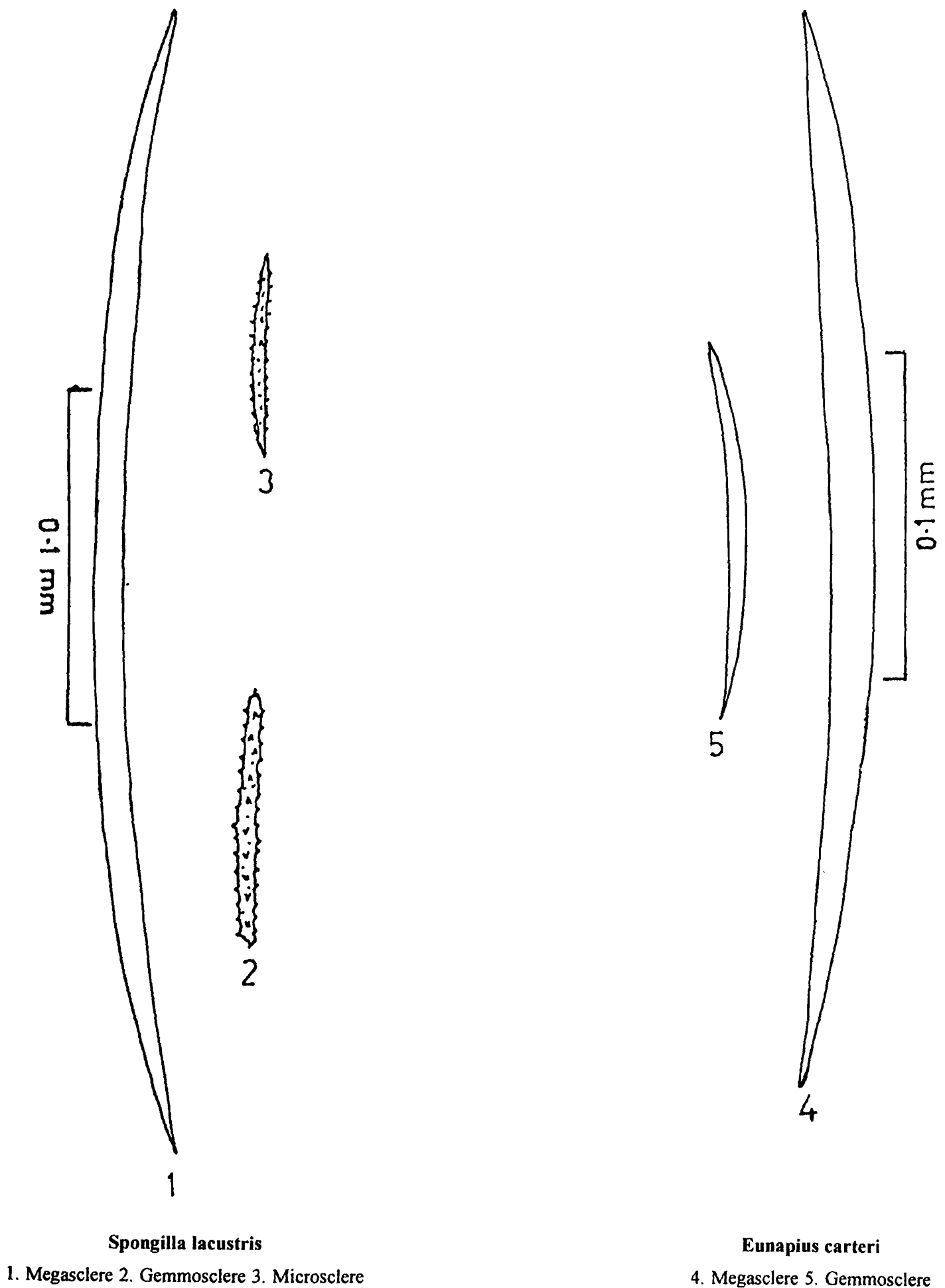
1863. *Spongilla carteri* Bowerbank, *Proc. zool. Soc. London*, 1863 : 469.

1867. *Eunapius carteri*, Gray, *Proc. zool. Soc. London* 1867 : 552.

1968. *Eunapius carteri*, Penney and Racek, *Bull. U.S. natn. Mus.* No. 272 : 23.

1991. *Eunapius carteri*. Soota, *Rec. zool. Surv. India Occ. paper* No. 138 : 34.

Material : One ex., Nayapara, Dharmanagar, North Tripura, 14.iv.1992, P 3429/1, Coll. B.P. Haldar and Party; one ex., Champanagar, Taliamura, West Tripura, 27.iv.1992, P 3430/1, Coll. B.P. Haldar and Party.



Description : Shape : Lobate, spherical bulbous, forming irregular masses of varying dimension, 10-15 mm highest length.

Colour : Grey in spirit.

Oscules : Large, conspicuous but not raised above the surface.

Texture and surface : Texture moderately soft and fragile. Surface hispid.

Ectosome : Microscopically hispid.

Choanosome : Choanosomal skeleton well developed, consisting of definite vertical spicule fibers, interconnected by irregular transverse fibers and held together by spongin.

Megascleres : Smooth, stout, fusiform and slightly curved amphioxea; length 0.306–(0.336)–0.359 mm, width 0.010–(0.012)–0.015 mm.

Microscleres : Absent.

Gemoscleres : Like that of megascleres but smaller, more curved and sharply pointed; length 0.146–(0.173)–0.226 mm, width 0.006–(0.0077)–0.008 mm.

Gemmules : Less in number, scattered singly throughout the skeletal meshes, comparatively large, spherical; pneumatic layer very thick, gemmoscleres embedded in the layer; foramen tubular; diameter range 0.573–(0.626)–0.666 mm.

Distribution : Cosmopolitan.

Remarks : This species is widely distributed in India but this is the first record of occurrence from the state of Tripura.

SUMMARY

The paper deals with two species of freshwater sponges *Spongilla lacustris* (Linnaeus, 1758) and *Eunapius carteri* (Bowerbank, 1863), which are the first report of freshwater sponges and new records of the species from the state of Tripura, India.

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ON FORMICIDAE (INSECTA : HYMENOPTERA) OF NONGKHYLLEM WILD LIFE SANCTUARY, RI-BHOI DISTRICT, MEGHALAYA

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INTRODUCTION

Ants form a single large family—the Formicidae. They are found in all terrestrial habitats. Majority of them are omnivorous and play a major role as predators and scavengers. Besides animal food they also utilize plant seeds, nectar and honey dew secreted by the plant sucking insects. Ants are social insects and they live in groups. Nests may vary from simple to complex structures made on ground, leaves, under bark on tree trunk or rotten wood. Some species even form symbiotic associations.

Nongkhyllem Wild Life Sanctuary established on the 15th of March 1981 is aimed at protecting, propagating and developing the wild life. Located at the Ri-Bhoi district of Meghalaya, it covers an area of 29 sq. km. and forms a portion of the Nongkhyllem Reserve Forest. It is approachable from Umling and Nongpoh. The sanctuary engulfs hills and low lands and is drained by rivers and streams like Umran, Umring, Umpurthih and Umtru. The vegetation is of a mixed type.

Mathew and Tiwari (2000), reported 163 species of ants under 52 genera from Meghalaya which included 40 species recorded from the Nongkhyllem Reserve Forest. The present report, based on the observations made and collections deposited at the Eastern Regional Station, Zoological Survey of India, Shillong, reveals 52 species under 24 genera. Species listed with asterik marks are new records for the sanctuary.

SYSTEMATIC ACCOUNT

Phylum ARTHROPODA

Class INSECTA

Order HYMENOPTERA

Family FORMICIDAE

1. Subfamily AENICTINAE

1. *Aenictus binghami* Forel

1901. *Aenictus binghami* Forel, *J. Bombay nat. Hist. Soc.*, 13 : 465.

Material examined : 9 ex. (Regd. No. A1/5857, 5858, 5859), Nongpoh, 19.x.1982.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : Myanmar.

2. *Aenictus fergusonii* Forel*

1901. *Aenictus fergusonii* Forel, *J. Bombay nat. Hist. Soc.*, **13** : 473.

Material examined : 4 ex. (Regd. No. A1/621, 6122), Raitwang, 10.ii.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Sikkim, Southern and Western India.

2. Subfamily CERAPACHYINAE

3. *Cerapachys aitkenii* Forel

1900. *Cerapachys aitkenii* Forel, *J. Bombay nat. Hist. Soc.*, **13** : 332.

Material examined : 9 ex. Umtasor, 25.iv.84.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Karnataka, Western India.

4. *Cerapachys sulcinodis* Emery

1889. *Cerapachys sulcinodis* Emery, *Ann. Mus. Civ. Stor. Nat. Genova*, **27** : 493.

Material examined : 7 ex. (Regd. No. A1/6006, 6007, 6019, 6020, 6021, 6023, 6035), Umtasor, 31.iii.84.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Sikkim, Myanmar, Malay Peninsula.

3. Subfamily PONERINAE

5. *Diacamma rugosum* (Le Guillou)*

1842. *Ponera rugosa* Le Guillou, *Annals de la Societe Entomologique de France*, **10** : 318.

For various synonyms see Bolton, 1995 : 170.

Material examined : 1 ex. (Regd. No. A1/5049), Nongpoh, 28.i.82.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : India : Karnataka, Maharashtra, Orissa, West Bengal; Myanmar, Sri Lanka.

6. *Diacamma scalpratum* (F. Smith)

1858. *Ponera scalprata* F. Smith, *Cat. Hym. Brit. Mus.*, **6** : 84.

For various synonyms see Bolton, 1995 : 170.

Material examined : 10 ex. (Regd. No. A1/5829, 5833, 5834, 5835, 5844, 10121, 11204, 11205), Umtasor, 19.v.82, 24.ix.82.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : India : Sikkim, Myanmar.

7. *Gnamptogenys bicolor* (Emery)

1889. *Ectatomma (Stictoponera) bicolor* Emery, *Ann. Mus. Civ. Stor. Nat. Genova*, **27** : 493.

For various synonyms see Bolton, 1995 : 208.

Material examined : 9 ex. (Regd. No. A1/5795, 5796, 5810, 5821, 5822, 5849), La-ilad, 23.i.82; Umtasor, 19.v.82 and 24.ix.82.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : Myanmar, China, Malay Peninsula.

8. *Leptogenys diminuta* F. Smith.

1857. *Ponera diminuta* F. Smith, *J. Proc. Linn. Soc., Zool. London*, **2** : 69.

Material examined : 3 ex. (Regd. No. A1/6032, 6049, 6052), Umtasor, 31.iii.84.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Throughout India, except the drier parts of Punjab and Central India.

9. *Leptogenys jeanettei* Mathew & Tiwari

2000. *Leptogenys jeanettei* Mathew & Tiwari, *Zool. Surv. India, State Fauna Series 4, Fauna of Meghalaya, Part-7* : 281.

Material examined : 2 ex. (Regd. No. A1/10011, 10012), La-ilad, 12.iii.87.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Not known.

10. *Leptogenys kitteli* (Mayr)

1870. *Lobopelta kitteli* Mayr, *Verh. zool.-bot. Ges. Wien*, **20** : 966.

For various synonyms see Bolton, 1995 : 232.

Material examined : 5 ex. (Regd. No. A1/5847, 5848, 6034, 6042), Umtasor, 19.v.82, 31.iii.84; Nongpoh, 19.x.82 and 28.x.83.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : India : West Bengal, along the foot hills of Himalayas from Simla to Sikkim, Myanmar.

11. *Odontoponera transversa* (F. Smith)

1857. *Ponera transversa* F. Smith, *J. Proc. Linn. Soc., Zool. London*, **2** : 68.

For various synonyms see Bolton, 1995 : 298.

Material examined : 6 ex. (Regd. No. A1/5827, 5830, 5843, 6038, 6047, 11206), Umtasor, 24.ix.82, 31.iii.84; Nongpoh, 19.x.82; La-ilad, 22.iv.88.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : The whole of India.

12. *Pachycondyla amblyops* (Emery)

1887. *Ponera amblyops* Emery, *Ann. Mus. Civ. Stor. Nat. Genova*, **25** : 434.

For various synonyms see Bolton 1995 : 302.

Material examined : 2 ex. (Regd. No. A1/12925), Umtasor, 19.v.82.

Distribution Within N. E. India : Assam, Meghalaya. *Elsewhere* : India : Sikkim, Myanmar, Malay, Peninsula.

13. *Pachycondyla astuta* F. Smith

1858. *Pachycondyla astuta* F. Smith, *Cat. Hym. Brit. Mus.*, **6** : 107.

For various synonyms see Bolton, 1995 : 303.

Material examined : 2 ex. (Regd. No. A1/5866, 5920), Umtasor, 19.v.82.

Distribution Within N. E. India : Assam, Meghalaya. *Elsewhere* : Myanmar, China, Malaya.

14. *Pachycondyla leeuwenhoekii* (Forel)*

1886. *Ponera leeuwenhoekii* Forel, *J. As. Soc. Beng.*, **55** : 244.

For various synonyms see Bolton, 1995 : 306.

Material examined : 1 ex. (Regd. No. A1/10013), La-ilad, 12.iii.87.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : West Bengal; Myanmar.

15. *Pachycondyla luteipes* (Mayr)*

1862. *Ponera luteipes* Mayr. *Verh. zool.-bot. Ges. Wien*, **12** : 722.

For various synonyms see Bolton, 1995 : 307.

Material examined : 9 ex. (Regd. No. A1/5865, 5868, 5915, 6015), Umtasor, 24.ix.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Throughout India : Myanmar, Sri Lanka, Malaya.

16. *Pachycondyla rufipes* (Jerdon)

1851. *Ponera rufipes* Jerdon, *Madr. J. Lit. S.*, **17** : 119.

For various synonyms see Bolton, 1995 : 309.

Material examined : 3 ex. (Regd. No. A1/5826, 5845, 12926), Umtasor, 19.v.82, 24.ix.82; Nongpoh, 19.x.82.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : India : West Bengal, Southern and Western India, Myanmar, Sri Lanka.

4. Subfamily PSEUDOMYRMECINAE

17. *Tetraponera aitkenii* (Forel)

1902. *Sima aitkenii* Forel, *Rev. Suisse Zool*, **10** : 245.

For various synonyms see Bolton, 1995 : 417.

Material examined : 2 ex. (Regd. No. A1/5871, 5906), Umtasor, 19.v.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Karnataka.

18. *Tetraponera allaborans* (Walker)

1859. *Pseudomyrma allaborans* Walker, *Ann. Mus. Nat. Hist*, **3**(4) : 375.

For various synonyms see Bolton, 1995 : 417.

Material examined : 18 ex. (Regd. No. A1/5904, 5905, 5910, 5919, 5925-29, 6064, 6067, 10122), Umtasor, 19.v.82, 24.ix.82; Nongpoh, 28.i.82; La-ilad, 27.v.87.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : West Bengal; China, Formosa, Java, Myanmar, Philippines, Singapore, Sri Lanka, Sumatra.

19. *Tetraponera rufonigra* (Jerdon)*

1851. *Eciton rufonigra* Jerdon, *Madr. J. Lit. Sc.*, **12** : 111.

For various synonyms see Bolton, 1995 : 419.

Material examined : 3 ex. (Regd. No. A1/5846, 6063), Nongpoh, 19.x.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Through out India; Cambodia, China, Java, Myanmar, Singapore, Sri Lanka, Sumatra.

5. Subfamily MYRMICINAE

20. *Cataulacus taprobanae* F. Smith

1853. *Cataulacus taprobanae* F. Smith, *Trans. Ent. Soc. London*, **2** : 225.

Material examined : 6 ex. (Regd. No. A1/5097, 5838, 5839, 5840, 5842, 10125), Nongpoh, 23.i.82, 19.v.82, 24.x.82; La-ilad, 27.v.87.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : India : Kerala, Maharashtra, Sikkim, West Bengal, Western India; Myanmar, Sri Lanka, Sumatra.

21. *Crematogaster rogenhoferi* Mayr

1879. *Crematogaster rogenhoferi* Mayr, *Verh. zool.-bot. Ges. Wien*, **28** : 683.

Material examined : 55 ex. (Regd. No. A1/9877, 10120), Nongpoh, 6.xii.86; La-ilad, 27.v.87.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* India : Kerala, Maharashtra, Sikkim, West Bengal, Western India, Sri Lanka, Sumatra.

22. *Crematogaster rothneyi* Mayr*

1879. *Crematogaster rothneyi* Mayr, *Verh. zool.-bot. Ges. Wien*, **28** : 685.

Material examined : 1 ex. (Regd. No. A1/6043), Nongpoh, 28.x.83.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Maharashtra, Sikkim, West Bengal.

23. *Lophomyrmex bedoti* Emery*

1893. *Lophomyrmex bedoti* Emery, *Rev. Suisse. Zool.*, **1** : 192.

Material examined : 19 ex. (Regd. No. A1/5070, 5806, 5818, 5841, 5855, 6018, 6044), Nongpoh, 11.iv.78, 19.x.82; Umtasor, 24.ix.82, 31.iii.84; La-ilad, 23.i.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Myanmar, Sumatra.

24. *Lophomyrmex birmanus* Emery

1893. *Lophomyrmex birmanus* Emery, *Rev. Suisse. Zool.*, **1** : 192.

Material examined : 4 ex. (Regd. No. A1/5916, Umtasor, 19.v.82).

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Myanmar.

25. *Lophomyrmex quadrispinosus* (Jerdon)

1851. *Oecodoma quadrispinosus* Jerdon, *Madr. J. Lit. Sc.*, **17** : 3.

For various synonyms see Bolton, 1995 : 248.

Material examined : 9 ex. (Regd. No. A1/5062, 5828, 6008, 6039), Nongpoh, 28.i.82; Umtasor, 24.ix.82, 25.iv.84, 31.iii.84.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Karnataka, Kerala, Orissa, Sikkim, Uttar Pradesh, West Bengal.

26. *Meranoplus bicolor* (Guerin-Meneville)*

1844. *Cryptocerus bicolor* Guérin-Meneville, *Cuv. Iconogr. Regn. Anim. Ins.*, **3** : 425.

For various synonyms see Bolton, 1995 : 250.

Material examined : 2 ex. (Regd. No. A1/10119), La-ilad, 27.v.87.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Throughout India; Malaya, Myanmar.

27. *Meranoplus laeviventris* Emery

1889. *Meranoplus laeviventris* Emery, *Ann. Mus. Civ. Stor. Nat. Genova*, **27** : 506.

Material examined : 4 ex. (Regd. No. A1/5869), Umtasor, 19.v.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Myanmar.

28. *Monomorium longi* Forel*

1902. *Monomorium longi* Forel, *Rev. Suisse. Zool.*, **10** : 211.

Material examined : 1 ex. (Regd. No. A1/6050), Umtasor, 31.iii.84.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : Not known.

29. *Recurvidris recurvispinosa* (Forel)

1890. *Trigonogaster recurvispinosa* Forel, *Ann. Soc. Ent. Belg.*, **34** : 110.

For various synonyms see Bolton, 1995 : 377.

Material examined : 4 ex. (Regd. No. A1/5811, 5814, 5826, 6053), Umtasor, 24.ix.82, 31.iii.84.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Maharashtra; China.

30. *Rhoptromyrmex wroughtonii* Forel

1902. *Acidomyrmex wroughtonii* Forel, *Rev. Suisse. Zool.*, **10** : 231.

Material examined : 37 ex. (Regd. No. A1/5861, 5863, 6133, 6137, 9900), Nongpoh, 28.i.82, 1.x.82, 6.xii.86; Umtasor, 19.v.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Karnataka; China, Indochina, Malaya, Philippines, Taiwan, Thailand.

31. *Tetramorium barryi* Mathew

1981. *Tetramorium barryi* Mathew, *Oriental Ins.*, **14**(4) : 424-427.

Material examined : 2 ex. (Regd. No. A1/6037, 6048), Umtasor, 31.iii.84.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Not known.

32. *Tetramorium bicarinatum* (Nylander)

1846. *Myrmica bicarinata* Nylander, *Acta. Soc. Scient. fenn.*, **2** : 1041-1062.

For various synonyms see Bolton, 1995 : 405.

Material examined : 4 ex. (Regd. No. A1/5786, 5803, 5819, 5824), Umtasor, 24.ix.82.

Distribution : Within N. E. India : Arunachal Pradesh, Assam, Meghalaya. *Elsewhere* : India : Andaman Islands, Karnataka; China, Bhutan, Myanmar, Pakistan, Sri Lanka, Malaysia, Sumatra, Taiwan, Philippines, Britain, Australia, Brazil, Peru, U.S.A., Holland, Colombia.

6. Subfamily DOLICHODERINAE

33. *Dolichoderus affinis* Emery

1889. *Dolichoderus affinis* Emery, *Ann. Mus. Civ. Stor. Nat. Genova*, **27** : 508.

Material examined : 4 ex. (Regd. No. A1/5065), Nongpoh, 28.i.82.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : Myanmar, Siam.

34. *Dolichoderus feae* Emery

1889. *Dolichoderus feae* Emery *Ann. Mus. Civ. Stor. Nat. Genova*, **27** : 509.

Material examined : 3 ex. (Regd. No. A1/5063), Nongpoh, 28.i.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Myanmar.

35. *Dolichoderus sundari* Mathew & Tiwari

2000. *Dolichoderus sundari* Mathew & Tiwari, *Zool. Surv. India, State Funa Series 4, Fauna of Meghalaya, Part-7* : 341.

Material examined : 10 ex. (Regd. No. A1/13028, 13029), Nongkhylllem Reserve Forest, 28.i.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Not known.

36. *Liometopum lindgreeni* Forel

1902. *Liometopum lindgreeni* Forel, *Ann. Soc. Ent. Belg.*, **46** : 293.

Material examined : 2 ex. (Regd. No. A1/6054), Umtasor, 31.iii.84.

Distribution Within N. E. India : Assam, Meghalaya. *Elsewhere* : Myanmar.

7. Subfamily FORMICINAE

37. *Camponotus camelinus* (F. Smith)

1857. *Formica camelinus* F. Smith. *J. Proc. Linn. Soc. Zool. London*, **2** : 57.

For various synonyms see Bolton, 1995 : 90.

Material examined : 4 ex. (Regd. No. A1/5860, 5862, 5872, 6017), Nongpoh, 19.x.82, 28.x.83; Umtasor, 24.ix.82; La-ilad, 23.i.82.

Distribution . Within N. E. India : Meghalaya. *Elsewhere* : India : Sikkim, Myanmar, Singapore, Sumatra.

38. *Camponotus selene* (Emery)

1889. *Polyrhachis selene* Emery, *Ann. Mus. Civ. Stor. Nat. Genova*, **27** : 516.

For various synonyms see Bolton, 1995 : 123.

Material examined : 14 ex. (Regd. No. A1/5836, 5837, 5853, 5856, 9898). Umtasor, 24.ix.82, 19.v.82; Nongpoh, 6.xii.86.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Throughout India.

39. *Camponotus wasmanni* Emery

1893. *Camponotus wasmanni* Emery, *Rev. Suisse. Zool.*, 1 : 224.

Material examined : 2 ex. (Regd. No. A1/5922), Umtasor, 19.v.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Throughout India.

40. *Echinopla* sp.

Material examined : 2 ex. (Regd. No., A1/12927), Umtasor, 19.v.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Nicobar Island, Australia, Borneo, Java, Indonesia, Malaysia, New Guinea, Philippines, Singapore, Sulawesi, Sumatra.

41. *Lepisiota capensis* Forel

1862. *Acantholepis capensis* Myar, *Verh. zool.-bot. Ges. Wien.*, 12 : 699.

Material examined : 5 ex. (Regd. No. A1/6024, 6040, 6041), Nongpoh, 28.x.83; Umtasor, 31.iii.84.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Sikkim; Myanmar, Singapore, Sumatra.

42. *Oecophylla smaragdina* (Fabricius)

1775. *Formica Smaragdina* Fabricius, *Syst. Ent.*, : 828.

For various synonymies see Bolton, 1995 : 298.

Material examined : 74 ex. (Regd. No. A1/5785, 5815, 5852, 6005, 6036, 9899, 10006, 10007), Umtasor, 24.ix.82, 31.iii.84; La-ilad, 23.i.82, 12.v.87; Nongpoh, 19.x.82, 23.xii.78.

Distribution : Within N. E. India : Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura. *Elsewhere* : Throughout India; China, Myanmar, Sri Lanka, New Britain.

43. *Paratrechina longicornis* (Latreille)

1802. *Formica longicornis* Latreille, *Nat. Hist. Fourmis*, : 113.

For various synonyms see Bolton, 1995 : 314.

Material examined : 3 ex. (Regd. No. A1/12928), Umtasor, 19.v.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Throughout India.

44. *Polyrhachis armata* (Le Guillou)

1842. *Formica armata* Le Guillou, *Ann. Soc. Ent. Fr.*, **10** : 313.

For various synonyms see Bolton, 1995 : 343.

Material examined : 11 ex. (Regd. No. A1/5791, 5801, 5807-09, 5817, 6012-14, 6075), Umtasor, 19.v.82, 24.ix.82; Nongpoh, 28.x.83, 25.iv.80.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : Borneo, Java, Myanmar, Philippines.

45. *Polyrhachis dives* F. Smith*

1857. *Polyrhachis dives* F. Smith, *J. Proc. Linn. Soc. Zool. London*, **2** : 64.

Material examined : 17 ex. (Regd. No. A1/5794, 5804, 5832, 5837, 6072, 6389, 6409), La-ilad, 23.i.82; Umtasor, 19.v.82, 19.i.83; Nongpoh, 28.i.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Borneo, China, Formosa, Java, Indo-China, Japan, Malaya Peninsula, New Guinea, Sumatra, Philippines.

46. *Polyrhachis furcata* F. Smith

1858. *Polyrhachis furcata* F. Smith, *Cat. Hym. Brit. Mus.*, **6** : 64.

Material examined : 7 ex. (Regd. No. A1/5792, 5805, 5816, 10116), La-ilad, 23.i.82, 27.v.87; Umtasor, 24.ix.82.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : Borneo, Myanmar.

47. *Polyrhachis hector* F. Smith

1857. *Polyrhachis hector* F. Smith, *J. Proc. Linn. Soc., Zool. London*, **2** : 62.

Material examined : 7 ex. (Regd. No. A1/5787, 5788, 5799, 5823, 5850, 10118), Umtasor, 24.ix.82; La-ilad, 23.i.82, 27.v.87; Nongpoh, 19.x.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : Myanmar, Sumatra.

48. *Polyrhachis illaudata* Walker*

1859. *Polyrhachis illaudata* Walker, *Ann. Mus. Nat. Hist.*, **4** : 373.

Material examined : 2 ex. (Regd. No. A1/5939, 11203), Nongpoh, 19.x.82; La-ilad, 22.iv.88.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Karnataka, Kerala, Sikkim, West Bengal; Borneo, china, Java, Myanmar, Philippines, Sri Lanka, Sumatra.

49. *Polyrhachis laevissima* F. Smith

1858. *Polyrhaechis laevissima* F. Smith, *Cat. Hym. Brit. Mus.*, 6 : 64.

Material examined : 5 ex. (Regd. No. A1/5790, 5800, 5812, 5825), Umtasor, 24.ix.82, 19.v.82.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : India : Orissa, West Bengal; Borneo, Java, Myanmar, Siam, Singapore.

50. *Polyrhachis rastellata* (Latreille)

1802. *Formica rastellata* Latreille, *Hist. Nat. Fourm.* 130.

For various synonyms see Bolton, 1995 : 355.

Material examined : 11 ex. (Regd. No. 5789, 5798, 5802, 5854, 5867, 5938, 6051, 6395), Umtasor, 19.v.82, 24.ix.82, 19.i.83, 31.iii.84; Nongpoh, 19.i.82.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Karnataka, Maharashtra; Borneo, Myanmar, Siam, Sumatra.

51. *Polyrhachis striata* (Mayr)

1862. *Polyrhachis striatus* Mayr, *Verh. zool.-bot. Ges. Wien*, 12 : 686.

For various synonyms see Bolton, 1995 : 357.

Material examined : 2 ex. (Regd. No. A1/5793, 5940), Umtasor, 24.ix.82; Nongpoh, 19.x.82.

Distribution : Within N. E. India : Assam, Meghalaya. *Elsewhere* : India : Sikkim; Borneo, China, Indo-China, Java, Sumatra, Myanmar.

52. *Polyrhachis tibialis* F. Smith*

1858. *Polyrhachis tibialis* F. Smith, *Cat. Hym. Brit. Mus.*, 6 : 63.

Material examined : 2 ex. (Regd. No. 10117), La-ilad, 27.v.87.

Distribution : Within N. E. India : Meghalaya. *Elsewhere* : India : Karnataka, West Bengal; Myanmar.

SUMMARY

A total of 52 species under 24 genera and 7 subfamilies are reported. Indo-Australian genus *Echinopla* is reported for the first time from Peninsular India.

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CRUSTACEAN ZOOPLANKTON OF DAMODAR RIVER

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INTRODUCTION

Studies on lotic zooplankton are in many ways less advanced than those on the standing waters. The relatively poor state of knowledge on lotic zooplankton is partly due to economic reasons. The aquaculture industry has been on the whole less interested in the zooplankton of rivers and streams than those of lakes and reservoirs and so fewer scientists have worked on the former. The special features of the lotic habitats are that the changes in environment are often more rapid and less predictable and are influenced by factors such as flood and desiccation which frequently play a major role. Further, studies of stream plankton need much more effort than those in lentic habitat. Many wetland biologists consider zooplankton to be transients of the river biota, washed from lakes, ponds and backwaters. However, sufficient examples are available in literature indicating that the zooplankton of a river form an integral part of the lotic community and contribute significantly to the biological productivity of this ecosystem (Hutchinson, 1967; Hynes, 1970).

Extensive surveys of river zooplankton have been made in temperate regions, however, in tropical part of world such as in India, it is scanty and scrappy. In view of filling up the gap in the knowledge on this potamofauna, to begin with, Damodar river was taken up for study. The present study on the potamozooplankton of river Damodar includes Cladocera, Conchostraca, Ostracoda and Copepoda.

KEY WORDS : Crustacea, Potamozooplankton, Damodar river, Biomonitoring.

MATERIAL AND METHODS

Zooplankton samples were collected using the method of Venkataraman (1992) from a total of eight stations, four sites viz. Jarindi, Telumuchu, Jamadoba and Domgarh pumping station, Sindri from Bihar state and four sites viz. Dishergarh, Burnpur, DTPS Site and Rondia from West Bengal (Fig.1).

Description of the study area : I. Bihar State

Station 1. Jarindi : Water is clear and slow moving, with less than one foot depth. Aquatic macrophytes and algal mats are seen growing where the water flow is very minimum. Human activities such as buffalow bathing and brick making are observed.

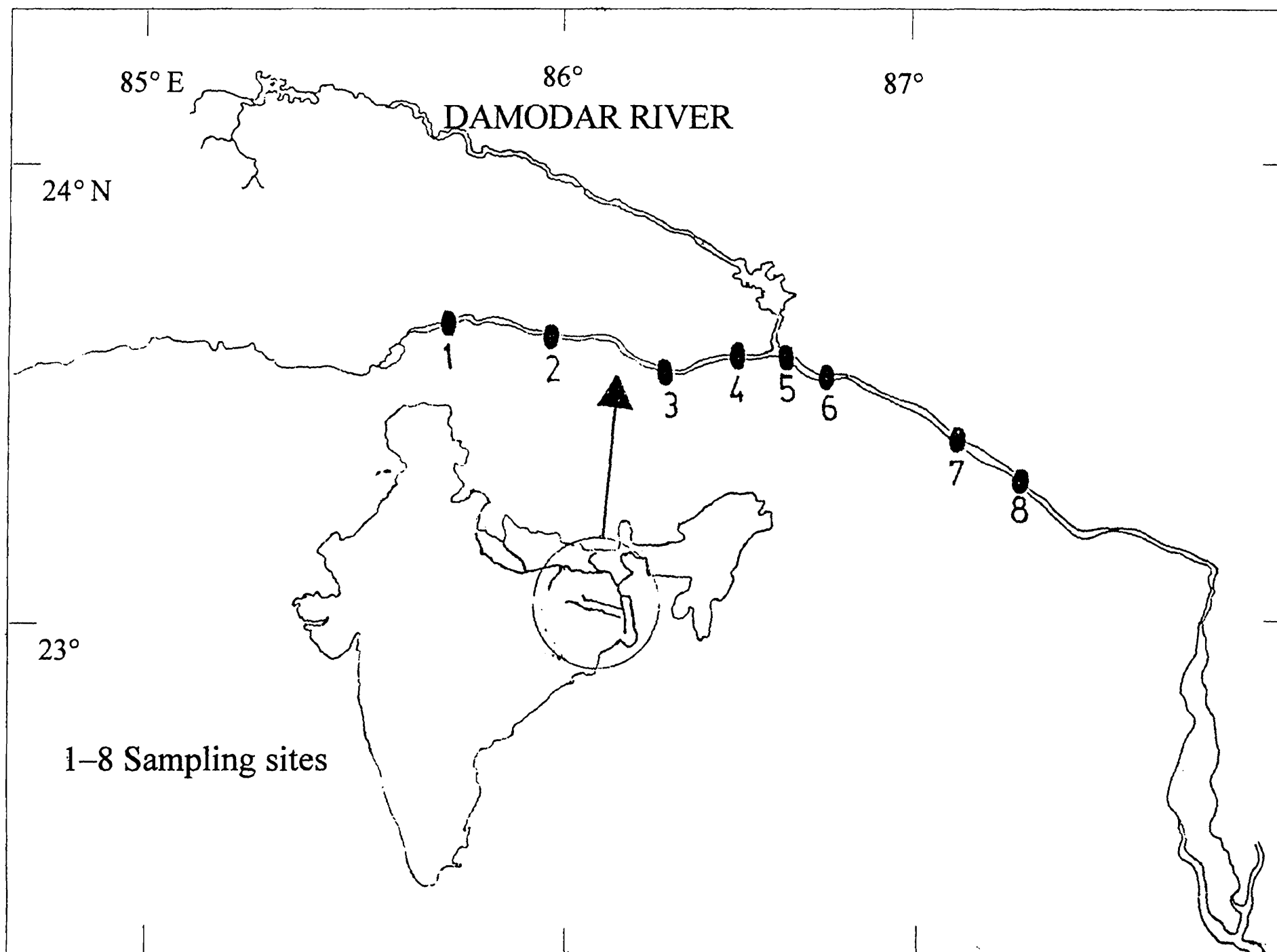


Fig. 1. Map showing the different stations where the collections are made. (1. Jarindi; 2. Telemuchu; 3. Jamadoba; 4. Sindri; 5. Disergarh; 6. Burnpur; 7. DTPS site; 8. Rondia).

Station 2. Telumuchu : Water is fast flowing and highly turbid with fly ash from a thermal power station nearby. The depth is two feet. Macrophytes such as *Hydrilla* sp. and *Lemna* sp. are present. Kathra and Dugdha coal washeries are present in this area.

Station 3. Jamadoba : Water is fast flowing and turbid with fly ash. The substratum is rocky. Bhowara and Jamadoba coke plants are present in this area.

Station 4. Domgarh pumping station, Sindri : Water is clean with sandy substratum. Aquatic macrophytes are seen growing but are clogged with grease and oil. Human activities such as buffalow bathing, brick making and fishing are observed. F.C.I. Sindri Plant, pathardih and Bhojudin coal washeries are present in this area.

II. West Bengal State

Station 5. Dishergarh : Main stream is fast flowing with clean water and sandy substratum. Activities such as buffalow and human bathing are noticed. *Vallisneria* sp. are seen growing on the banks where the water flow is very less.

Station 6. Burnpur : Substratum is sandy and the main stream is fast flowing with more than 1-2 m depth and eroding and depositing type. Macrophytes such as *Hydrilla* sp. and *Vallisneria* sp. are observed. Water is clean with algal mats on the shallow regions of the bank.

Station 7. DTSP site : Water is black in colour with fly ash and substratum is rocky and deep upto 3m. Industrial waste from Bengal paper mill and D.T.P.S. are discharged in to the river in this area.

Station 8. Rondia : Water is clean with sandy bottom and fast flowing. Macrophytes such as *Hydrilla* sp., *Najas* and *Vallisneria* sp. are observed on the banks of the river.

DESCRIPTION OF SPECIES COLLECTED

1. *Diaphanosoma excisum* Sars, 1885

1885. *Diaphanosoma excisum* Sars, *Norske. Vidensk Selsk. Forhandl. Christiania.*, **8** : 1-46.

1993. *Diaphanosoma paucispinosum* Brehm, *Arch. Hydrobiol. Suppl.* **11** : 631-771.

Material examined : Females from Jamadoba of Bihar, Dishergarh of Westbengal State.

Female : Size 1.05 mm. Head large and rounded anteriorly. Eye small. Posteroventral corner broadly rounded with 5-9 marginal denticles followed by a series of fine setules. Claw serrated on the distal convex surface; concave surface with three long basal spines.

Distribution : India—Andaman and Nicobar Islands, Rajasthan, Tamil Nadu and Tripura states. Elsewhere—common in tropical regions.

Remarks : Very common. Occurs in all types of habitat except in marshes.

2. *Diaphanosoma sarsi* Richard, 1895

1895. *Diaphanosoma sarsi* Richard, *Ann. Mus. Civico. Stor. Nat. Genova.*, **14** : 565-578.

1898. *Diaphanosoma singalense* Daday, *Terms.Fuzetek.*, **21** : 1-123.

Material examined : Females from Dishergarh, West Bengal State

Female : Body size 1.25 mm. Eye large, fills the head almost completely. Long setae on margin of ventral fold. Posteroventral corner with 17-23 spines. Postabdomen with characteristic setae on the lateral side.

Distribution India-Bihar, Rajasthan, Meghalaya, Tamil Nadu and Tripura.

Remarks : Occur mostly among aquatic macrophytes.

3. *Pseudosida bidentata* Herrick, 1884

1884. *Pseudosida bidentata* Herrick, *Goel and Nat. Hist. Survey Minnesota, Ann. Rep.*, **12** : 1-191

1953. *Pseudosida szalayi* Brehm, *Ost. Zool. Zeit.*, **4** : 241-345.

Material examined : Females from Rondia, West Bengal State.

Female : Body size 1.20 mm. Body elongated oval; head short; eye relatively small and situated near to the anteroventral corner. Antennules unsegmented, long and attached to the posteroventral part of the head. Antenna not extending beyond the posterior margin of valves. Ventral margin with a series of long setae followed by a series of spinules on the posteroventral corner. Postabdomen with 10 groups of lateral spines. Claw long with 3 basal spines.

Distribution India-Andaman and Nicobar Islands, Rajasthan, Tripura and Tamil Nadu. Elsewhere- South East Asia, South Africa and South America.

Remarks Mostly occur among aquatic macrophytes.

4. *Latonopsis australis* Sars, 1888

1888. *Latonopsis australis* Sars, *Forth. Vidensk. Selsk. Christiania*, **8** : 1-46.

1892. *Latonopsis occidentalis* Birge, *Trans. Wis. Acad. Sci. Arts and Letts.*, **4** : 77-109.

Material examined : Females from Dishegarh, Burnpur, and DTPS site of West Bengal State.

Female : Body size, 1.70 mm. Head large with antennule on the ventral side. Eye large, situated very near to anterior margin of the head; ocellus conspicuous; setae on antenna : 4-7/0-1-4. Ventral margin ornamented with rows of long hairs at the anterior side, medium hairs at the middle and three long setae at the posteroventral corner. Postabdomen broad with two spines at the base of the claws, anal denticles 10-12.

Distribution India Rajasthan, Tripura and Tamil Nadu.

Remarks : Mostly occur among aquatic macrophytes.

5. *Scapholeberis kingi* Sars, 1903

1903. *Scapholeberis kingi* Sars, *Arch. Math. Nat.*, **25** : 1-44.

1853. *Daphnia mucronata* King, *Proc. R.Soc. van. Diemens land*, **2** : 243-263.

Material examined : Females from Domgarh pumping station, Sindri of Bihar State.

Female : Body size 0.59 mm. Body rounded dorsally. Head small and slightly depressed, rostrum rounded and projecting ventrally. Eye large, ocellus small, situated closer to the rostrum than to the eye. Valves with lines and reticulations; posterior ventral margin has a long denticle. Postabdomen broad, dorsal margin with five or six denticles. Claw curved dorsally with spinules along the concave surface.

Distribution : India : Andaman and Nicobar Islands, Kashmir, Rajasthan, Meghalaya, Assam and Tamil Nadu. Elsewhere : Africa, North and South America, South East Asia and China.

Remarks : Occurs in the surface of the water body.

6. *Simocephalus vetulus* (O. F. Muller, 1776)

1776. *Daphnia ventula* O.F. Muller, *Havniae*, 1-282.

1898. *Simocephalus ventuloides* Sars, *Zool. Mus. Imp. Acad. Sc.* 3.

Material examined : Females from Burnpur and Rondia of West Bengal State.

Female : Body size 2.2 mm. Shape broadly oval or rhomboid. Dorsal margin moderately to strongly arched; posterior part of dorsal margin with distinct denticles. Head small with large eye and elongated ocellus. Postabdomen with 10 anal spines and a long, curved and denticulated claw.

Distribution : India : Punjab, Kashmir, Karnataka, Bihar and Tripura.

Remarks : Mostly occur among aquatic macrophytes.

7. *Ceriodaphnia cornuta* Sars, 1885

1885. *Ceriodaphnia cornuta* Sars, *Norske. Vidensk. Selsk. Forhandl. Chirstiania*, **8** : 1-46.

1894. *Ceriodaphnia rigaudi* Richard, *Revue. Biol. Nord. France*, **6** : 360-378.

Material examined : Females from Jarindi, Jamadoba of Bihar State and from Dishergarh of West Bengal State.

Female : Body size 0.39 mm. Head depressed and separated from the carapace by a dorsal depression. Antennules short and broad, with a long seta and a group of sensory setae on the apex. Eye large, ocellus absent. Postabdomen with four or five curved denticles. Claw long, gently curved with a series of setules along the concave surface.

Distribution : India : Andaman and Nicobar Islands, Rajasthan, Meghalaya, Tamil Nadu and Tripura states. Elsewhere : South East Asia, China and other tropical regions.

Remarks : Very common. Occurs in all types of habitat, especially shallow ponds. Both horned and hornless individuals are found together with *D. excisum* and *M. micrura*.

8. *Moina micrura* Kurz, 1874

1874. *Moina micrura* Kurz, Sitzber. K. Acad. Wiss. Wein. Math. Nat., **69** : 40-46.

1892. *Moina dubia* Guerne et Richard, Mem. Soc. Zool. France., **5** : 526-538.

Material examined : Females from Jarindi, Jamadoba, Domgarh pumping station in Sindri of Bihar State and Dishergarh of West Bengal State.

Female : Body size 0.73 mm. Head large, rounded with a deep cervical depression posteriorly. Eye large, ocellus absent. Antennules long and movable with a group of sensory setae on apex. Postabdomen with 6-8 ciliated lateral spines. Claw long, slightly curved dorsally, with pecten at base.

Distribution : India : Bihar, Rajasthan, Tamil Nadu, Tripura and Andaman and Nicobar Islands. Elsewhere : Africa, USSR, South East Asia and Europe.

Remarks : Very common. This is the most widely distributed species of the genus *Moina*.

9. *Bosmina longirostris* (O. F. Muller, 1776)

1776. *Lynceus longirostris* O. F. Muller, *Havniae* : 1-273.

1862. *Bosmina longirostris* Sars, *Forhandl. Vidensk. Christiania.*, 144-167.

Material examined : Females from Dishergarh of West Bengal State.

Female : Body size 0.59 mm. Shape oval. Posterodorsal corner distinctly angular, posteroventral corner with spines. Eye large. Antennules curved. Postabdomen quadrate. Claw with spinules.

Distribution : India : Kashmir and Meghalaya. Elsewhere : Cosmopolitan.

Remarks : Occur in running water and limnetic regions of the wetland.

10. *Bosmina deitersi* Richard, 1895

1895. *Bosminopsis deitersi* Richard, *Bull. Soc. Zool. DeFrance.*, **20** : 96-98.

1984. *Bosminopsis deendrai* Rana, *J. Bombay nat. Hist. Soc.*, **81** : 668-699.

Material examined : Females from Dishergarh of West Bengal State.

Female : Body size 0.38 mm. Body oval. Head rounded, rostrum long with two lateral branches. Eye large. Valves with polygonal reticulation, dorsal margin with cervical depression, ventral margin with a long and pointed marginal spine on the posteroventral corner. Postabdomen with 4-6 groups of short spinules. Claw serrated with a large basal spine.

Distribution : India : Delhi and Rajasthan. Elsewhere : South East Asia, Africa, North and South America.

Remarks : Not common. Occurs in open waters and rivers.

11. *Macrothrix spinosa* King, 1853

1853. *Macrothrix spinosa* King, *Pap. Proc. R. Soc. Van Diemens Land*, **2** : 243-263.

1915. *Macrothrix spinosa dentata* Phayfair, *Proc. Linnean Soc. N.S. Wales.*, **34** : 93-151.

Material examined : Females from Jarindi, Jamadoba, Domgarh pumping station in Sindri of Bihar State and Dishergarh, DTPS site, Rondia of West Bengal State.

Female : Body size 0.41 mm. Body rounded oval; dorsal margin serrated. Head rounded, ventral margin slightly concave with slightly pointed anteroventral corner. Antennules short, with a long seta near its base. Eye large, ocellus small and situated much nearer to the base of antennules than to the eye. Postabdomen broadly rounded. Claw short and serrated on the concave surface.

Distribution : India : Andaman and Nicobar Islands, Manipur, Rajasthan, Tripura and Tamil Nadu. Elsewhere : Cosmopolitan.

Remarks : Very common. Occurs in all types of habitats.

12. *Echinisca triserialis* (Brady, 1886)

1886. *Macrothrix triserialis* Brady, *Intellectual Observer*, **12** : 416-424.

1971. *Echnisca triserialis* Smirno, *USSR Acad. Sci. Zool. Institute Nova. Ser. No. 101. Leningrad*, 539 pp.

Material examined : Females from Telumuchu of Bihar State and Burnpur, Rondia of West Bengal State.

Female : Size 0.56 mm. Body oval, dorsal margin with a slight cervical depression. Eye large, ocellus small and situated nearer to the apex of rostrum than to the eye. Antennules long with a long lateral seta. Antennae short with a longest seta having two or three longer spines in the middle. Postabdomen bilobed with rows of spines increasing in size proximally. Claw short and serrated without basal spine.

Distribution : India : Andaman and Nicobar Islands, Rajasthan and Tamil nadu. Elsewhere : Cosmotropical.

Remarks : Very common. Occurs in all the marshes of West Bengal.

13. *Ilyocryptus spinifer* Herrick, 1882

1882. *Ilyocryptus spinifer* Herrick, *10th Annual Rep. Geol. and Nat. Hist. Survey Minn.*, 235-252.

1914. *Ilyocryptus halyi* var *longiremis* Stingelin, *Mem. Soc. Neuchatel. Sci. Nat.*, **5** : 600-638.

Material examined : Females from Domgarh pumping station in Sindri of Bihar State and Dishergarh of West Bengal State.

Female : Body size 0.76 mm. Body oval. Head small. Eye large, ocellus small, situated about halfway between eye and base of antennules. Antennules long with a group of sensory setae on distal end. Valves with a series of long feather-like setae on ventral side. Postabdomen with slight

depression in the middle. Preanal margin with eight marginal denticles, postanal margin with 12 denticles up to anal groove and with five long and stout spines on the lateral surface.

Distribution : India Andaman and Nicobar Islands, Rajasthan, Tamil Nadu, Tripura and Meghalaya. Elsewhere : South East Asia, China, Australia and North and South America.

Remarks : Mostly found at the bottom debris.

14. *Chydorus ventricosus* Daday, 1898

1898. *Chydorus ventricosus* Daday, *Termes. Fuzetek.*, **21** : 1-123.

1966. *Chydorus brehmi* Biswas, *Crustaceana*, **11** : 113-114.

1971. *Chydorus eurynotus brehmi* comb.n.Smirnov. *USSR Acad. Sci. No. 101. Leningrad*, 539 pp.

Material examined : Females from Domgarh pumping station in Sindri of Bihar State and Rondia of West Bengal State.

Female : Body size 0.74 mm. Body oval. Posteroventral corner rounded, with denticle. Valves with hexagonal markings. Rostrum long and pointed. Labrum long, curved anteriorly and slightly pointed. Postabdomen long with distinct preanal corner. Dorsal margin with 9-10 anal denticles. Claw setulated along concave surface with basal spines.

Distribution : India : Gujarat, Andaman and Nicobar Islands, Rajasthan and Tamil Nadu. Elsewhere : South East Asia, Sri Lanka, China and Africa.

Remarks : Mostly found among aquatic macrophytes.

15. *Chydorus reticulatus* Daday, 1898

1898. *Cydorus reticulatus* Daday, *Termes Fuzetek*, **21** : 1-123 (p 27).

Material examined : Females from Domgarh pumping station, Sindri of Bihar, Dishergarh, Burnpur and Rondia of West Bengal.

Female : Body size 0.25mm. Shape spherical with a well marked postero-dorsal corner. Valves reticulated with hexagonal pattern and puntations inside the patterns. Posteroventral corner rounded without denticles. Rostrum curved posteriorly. Antennules about $\frac{1}{2}$ the length of rostrum. Ocellus situated closer to the eye than to the apex of rostrum. Labral plate slightly depressed anteroventrally. Postabdomen with distinct preanal corner and indistinct postanal corner. Dorsal margin with 6-7 anal denticles. Claw setulated along the concave surface and with 2 basal spines.

Remarks : Mostly found among aquatic macrophytes.

16. *Chydorus barroisi* Richard, 1894

1894b. *Pleuroxus barroisi* Richard, *Revue Biol. Nord, France*, **6** : 360-378.

1895. *Chydorus barroisi* Sars, *Vidensk. Selsk. Skrifter I. Math. Naturv. Klasser* : 1-56. (p 25-28).

1982. *Ephemeroporus barroisi* (Richard) Frey, *Hydrobiologia*, **86** : 231-261.

Material examined : Females from Jarindi of Bihar State and Burnpur, Rondia of West Bengal State.

Female : Body size 0.32 mm. Body elliptical in shape with a spine in the posteroventral corner. Carapace ornamented with striation. Labrum with 3-5 denticles. Postabdomen with 7-9 unequal spines and a long basal spine.

Distribution : India : Gujarat, Rajasthan, Tamil Nadu, Tripura and Andaman and Nicobar Islands.

Remarks : Mostly found among aquatic macrophytes.

17. *Chydorus pubescens* Sars, 1901

1901. *Chydorus pubescens* Sars, *Arch. Math. Nat.*, **23** : 1-102.

1955. *Chydorus kallipygos* Harding, *Trans. Linn. Soc. London.*, **1** : 329-354.

Material examined : Females from Jamadoba of Bihar State.

Female : Body size 0.26 mm. Body rounded, dorsal and ventral margin bulge. Valves reticulated with dots within the hexagonal cells. Surface of valves with short hairs. Postabdomen narrow distally with 8-9 pointed denticles. Claw with 2 basal spines.

Distribution : India : Assam. Elsewhere : South East Asia.

Remarks : Mostly found among aquatic vegetation.

18. *Chydorus eurynotus* Sars, 1901

1901. *Chydorus pubescens* Sars, *Archiv for math. Og. Naturv.* XXIII, **3** : 1-102 (p 70).

1974. *Chydorus eurynotus* (Sars, 1901) Smirnov, *Fauna of the USSR, Crustacea* 1(2) : 1-644 (p 376).

Material examined : Females from Burnpur of West Bengal State.

Female : Body size 0.24 mm. Body oval, posterodorsal and posteroventral corners distinct. Valves with faint reticulation. Rostrum slightly curved posteriorly. Ocellus smaller than eye, situated closer to eye, than to apex of rostrum. Postabdomen with 10-12 short denticles. Claw with two basal spines.

Distribution : Elsewhere : South East Asia, Africa and South America.

Remarks : This species is a synonym of *C. pubescens* Sars, 1901 however; Michael and Hann (1979) considered this species as valid. It is found among aquatic macrophytes.

19. *Pseudochydorus globosus* (Baird, 1843)

1843. *Pseudochydorus globosus* Baird, *Ann. Mag. Nat. Hist.*, **68** : 81-95 (p 90).

Material examined : Female from Dishergarh of West Bengal State.

Female : Body size 0.79 mm. Body spherical, posteroventral corner rounded, without denticles. Valves with polygon marking. Rostrum pointed. Antennules not reaching the apex of rostrum.

Ocellus smaller than eye and situated nearer to eye than to the apex of rostrum. Postabdomen with 20 anal spines decreasing in size proximally. Claw with two basal spines.

Distribution : India Tamil Nadu and Meghalaya. Elsewhere : Holartic, Ethiopian, Indomalayan and Australian region.

Remarks Guernsey(1907) recorded this species from Calcutta and after that it is not found again either by Sharma (1978).

20. *Dunhevedia crassa* King, 1853

1853. *Dunhevedia crassa* King, *Pap. Proc.R. Soc. Van Diemens Land*, **2** : 243-263.

1971. *Dunhevedia crassa crassa* Smirnov, *USSR Acad. Sci. Zool. Institute Nova. ser. No.101. Leningrd.* 539 pp (p 320-322).

Material examined : Female from Jamadoba, Domgarh pumping station in Sindri of Bihar state and Dishergarh, Burnpur, DTPS site, Rondia of West Bengal State.

Female : Body size 0.53mm. Body curved dorsally. Posteroventral corner of valves with a bifurcated denticle. Rostrum blunt, labrum rounded with pointed apex. Ocellus small and situated slightly closer to eye than to apex of rostrum. Postabdomen with groups of scattered spinules, claw setulated with one basal spine.

Distribution : India : Gujarat, Rajasthan, Tamil nadu, Tripura and Andaman Nicobar Islands. Elsewhere : South East Asia, Australia and USSR.

Remarks : Not common. Occurs in marshes.

21. *Alona pulchella* King, 1853

1853. *Alona pulchella* King, *Pap. Proc. R. Soc. Van Diemens land.*, **2** : 243-263.

1933. *Alona arenaria* Brehm, *A. Ch. Hydrobiol., Suppl.* **11** : 631-771.

Material examined : Females from Jamadopa, Domgarh pumping station in Sindri of Bihar state and Dishergarh of West Bengal State.

Female Body size 0.52 mm. Shape oval, without spines on the posteroventral corners and reticulations on the carapace. Antennules not reaching apex of rostrum, Labrum with pointed apex. Postabdomen with straight dorsal margin and 7-9 anal denticles present. Claw with a medium sized basal spine.

Distribution : India : Gujarat. Elsewhere : Cosmotropical.

Remarks : Mostly found among aquatic macrophytes.

22. *Alona rectangula* Sars, 1862

1862. *Alona rectangula* Sars, *Forhandl. Vidensk. Selsk. Christiania*, 144-167.

1971. *Alona rectangula rectangula* Smirnov, *USSR Acad. Sci. Zool. Institute Nova. Ser. No. 101. Leningrad.* 539 pp.

Material examined : Females from Jamadoba of Bihar State and Rondia of West Bengal State.

Female : Body size 0.31 mm. Shape rectangular, maximum height slightly before middle. Posterodorsal corner with a slight angle, posteroventral corner rounded without denticle. Valves with striations forming a rectangular pattern. Antennules not reaching the apex of rostrum. Postabdomen with 7-8 groups of anal denticles and claw long basal spine.

Distribution : India : Gujarat, Rajasthan, Meghalaya and Kashmir. Elsewhere South East Asia, Africa and USSR.

Remarks : Mostly found among aquatic macrophytes.

23. *Alona karua* King, 1853

1853. *Alona karua* King, *Pap. Proc. R. Soc. Van Diemens Land* 2 : 243-263.

1971. *Biapertura karua* Smirnov, *USSR Acad. Sci. Zool. Institute Nova ser. No. 101. Leningrad.* 539 pp.

Material examined : Females from Domgarh pumping station, Sindri of Bihar State.

Female : Body size 0.29 mm. Body with distinct lines and polygonal pattern. Posteroventral corner rounded with 2-3 denticles followed by a row of setules. Antennules not reaching apex of rostrum. Ocellus small, situated closer to eye. Postabdomen broadly rounded. Claw with a short basal spine.

Distribution : India : Andaman and Nicobar Islands, Meghalaya, Tamil Nadu and Tripura. Elsewhere : Cosmopolitan.

Remarks : Very common. Occurs in all marshy habitats of West Bengal. Fernando (1974) and Michael and Sharma (1988) included this species under the genus *Biapertura*. However, Frey (1980) did not agree to this and hence, it was not included under the genus *Biapertura*.

24. *Alona guttata* Sars, 1862

1862. *Alona guttata* Sars, *Forhandl. Vidensk. Selsk. Christiania.*, : 250-302 (p 51-52).

Material examined : Females from Domgarh pumping station, Sindri of Bihar State.

Female : Body size 0.32mm. Valves without striation, posteroventral corner rounded. Antennules not reaching apex of rostrum. Ocellus smaller than eye, situated half way between eye and apex of rostrum. Plate of labrum rounded with groups of setae at the posterior region. Postabdomen without denticles. Claw slightly long with a series of stules along the concave margin.

Distribution : India : Himachal Pradesh, West Bengal, Tripura, Tamil Nadu and Andaman Islands. Elsewhere : Cosmopolitan.

Remarks : Mostly found among aquatic macrophytes.

25. *Alona verrucosa* Sars, 1901

1901. *Alona verrucosa* Sars, *Arch. Math. Nat.*, **23** : 1-102.

1988. *Biapertura verrucosa* Michael and Sharma, *Fauna of India, Cladocera*, 262 pp.

Material examined : Female from Dishergarh and DTPS site of West Bengal State.

Female : Body size 0.28 mm. Body elongated oval. Posteroventral and posterodorsal corners rounded. Antennules not reaching apex of rostrum. Ocellus small, situated slightly closer to eye than to apex of rostrum. Postabdomen with 5-6 denticles. Claw with a short basal spine.

Distribution : India : Gujarat, Tamil Nadu, Rajasthan and Tripura. Elsewhere South East Asia, Ethiopian and Neotropical regions.

Remarks : Fernando (1974) and Michael and Sharma (1988) included this species under the genus *Biapertura*. However Frey (1980) did not agree to this and hence, it was not included under the genus *Biapertura*.

26. *Alona davidi* Richard, 1895

1895. *Alona davidi* Richard, *Mem. Soc. Zool. France*, **7** : 237-243.

1971. *Alona davidi davidi* Smirnov, *USSR Acad. Sci. Zool. Institute Nova ser. No. 101. Leningrad*, 539.

Material examined : Females from Rondia of West Bengal State.

Female : Body size 0.35 mm. Maximum height slightly before middle. Posterodorsal and posteroventral corners rounded. Rostrum blunt. Ocellus smaller than eye. Postabdomen with prominent preanal and postanal corners. Claw with short basal spine.

Distribution : India : Rajasthan, Andaman and Nicobar Islands and Tamil Nadu.

Remarks : Common. Occurs only in marshes.

27. *Notoalona globulosa* (Daday, 1898)

1898. *Alona globulosa* Daday, *Termes. Fuzetek.*, **21** : 1-123.

1987. *Notoalona globulosa* Rajapaksa and Fernando, *Hydrobiologia*, **144** : 131-153.

Material examined : Females from Dishergarh of West Bengal State.

Female : Body size 0.36 mm. Valves with striations. Rostrum short and blunt, antennules not reaching the apex. Ocellus smaller than the eye, situated closer to the eye than to the apex of rostrum. Labrum serrated on anteroventral margin. Postabdomen long with 12 to 13 anal denticles, claw long with short basal spine.

Distribution : India : Andaman and Nicobar Islands, Rajasthan and Tamil Nadu. Elsewhere : South East Asia, Neotropical and Nearctic regions.

Remarks : Rare. Occurs in small numbers in marshes.

28. *Leydigia acanthocercoides* (Fischer, 1854)

1854. *Lynceus acanthocercoides* Fischer, *Bull. Soc. Imp. Nat. Mosc.*, **27** : 423-434.

1875. *Leydigia acanthocercoides* Kurz, *Sitzber. K. Acad. Wiss. Wein. Mth. Nat.*, **69** : 40-46.

Material examined : Females from Rondia of West Bengal State.

Female : Body size 0.89 mm. Valves with longitudinal lines. Rostrum blunt, antennules not reaching apex of rostrum. Ocellus smaller than eye, situated closer to the eye than to the apex of rostrum. Labrum rounded with fine setae. Postabdomen with about 18 groups of small denticles, each group consists of 3 or 4 denticles with the distal-most denticle being the longest of each group. Claw with a short basal spine.

Distribution : India : Gujarat, Rajasthan, Andaman and Nicobar Islands and Tamil nadu. Elsewhere : South East Asia, Ethiopian, Neotropical and USSR.

Remarks : Rare. Occurs in reddish-brown ponds of West Bengal.

Order CONCHOSTRACA

Family CYCLESTHERIIDAE

29. *Cyclestheria hislopi* (Baird, 1860)

1860. *Cyclestheria hislopi* (Baird) *Proc. Zool. Soc. London* **28** : 445-446.

1973. *Cyclestheria hislopi* (Baird) *J. Madurai University Suppl. 1. pp.* 63.

Material examined : Many females from Telumuchu of Bihar State and Rondia of West Bengal State.

Female : Shell thin, transparent and nearly rounded. Umbone close to the anterior extremity. Shell with 6-7 growth lines. The ocellus large equal to the size of as eyes. The antennules or the first antennae unsegmented, clubshaped with sensory hairs at their tips. The second antennae biramous with each flagellum 7-jointed and each joint bearing setae. The telson large, armed with 7-8 pairs of strong hooks, the first pair long and serrated on the edge; the second pair near the root armed with about 10 rather stout spines.

Distribution : Common. Occur throughout Indian subcontinent.

Remarks : This is the first record of its occurrence in West Bengal.

Sub-class OSTRACODA

Family CYPRIDIDAE

30. *Stenocypris distincta* (Victor and Fernando, 1979)

1979. *Stenocypris distincta* (Victor and Fernando, 1979) *Rec. Zool. Surv. India* **74**(2) : 196-200.

Material examined : Females from Telumuchu of Bihar State.

Female : Length-3.20 mm. Valves elliptical; valves elongate; anterior and posterior margins rounded; left valve slightly larger than the right; radial band of septa prominent, wider anteriorly and narrow posteriorly; valve margins hairy except dorsally; valve surface with puncta and hairs; ventral margin slightly concave in the middle, dorsum with a low arch sloping posteriorly. Natatory setae of the second antenna well developed, not reaching the tips of the terminal claws and smooth; sensory club three segmented, claws toothed. Second thoracic leg with a long terminal scythelike claw, second segment with a single seta, hairy; dorsal surface and margin having groups of spines and ventral margin hairy. Furcal rami asymmetrical, terminal and subterminal claws of both rami toothed, dorsal setae absent; right ramus curved broader with dorsal margin heavily toothed, terminal seta more than $\frac{1}{2}$ the length of the terminal claw; left ramus straight, dorsal margin with groups of teeth covering $\frac{1}{4}$ the length of the ramus, terminal seta more than two-thirds the length of the terminal claw.

Distribution : Madurai, India.

Remarks : This is the first record of its occurrence in Bihar and West Bengal.

31. *Parastenocypris canaliculata* Hartmann, 1964

1964. *Parastenocypris canaliculata* Hartmann Syst. Beih. 3 : 1-155.

1979. *Parastenocypris canaliculata* Hartmann Rec. Zool. Surv. India 74(2) : 205-206.

Material examined Females from Telemuchu of Bihar State.

Female : Valves with irregular, continuous pore canals along the margins; surface with minute hairs. Asymmetrical furca, bent at the proximal end; right ramus with groups of stronger spines for $\frac{2}{3}$ the the length of the ramus, on the dorsal margin; left ramus is also armed with spines but they are relatively weak. Length 2.08 mm and height 0.91 mm.

Remarks : This is the first record of its occurrence in West Bengal.

Order COPEPODA

Family DIAPTOMIDAE

32. *Rhinediaptomus indicus* Kiefer, 1936

1936. *Rhinediaptomus indicus* Kiefer Zool. Anz. XIII.

2001. *Sinodiaptomus (Rhinediaptomus) indicus* Keifer J. Aqua. Biol. 16(1-12) pp 7.

Material examined Females from Tamadoba of Bihar State and DTPS site of West Bengal State.

Female : Body size 1.45 mm. Metasomal wings asymmetrical; urosome 3-segmented. P₅: Coxal process is short and conical claw bears fine hairs along the inner margin; exopodite 3 not distinct and bears 2 unequally long setae; endopod long, cylindrical, tip sloping inwards with 2 spinules and few hairs.

Distribution : Occur throughout Indian sub continent.

Remarks : This is the first record of its occurrence in West Bengal.

33. *Paradiaptomus greeni* Gurney, 1906

1906. *Diaptomus greeni* Gurney *Proc. Asiat. Soc. Bengal (New series)* 2 : Calcutta.

2000. *Paradiaptomus greeni* Gurney *Fauna of Tripura (part 4)*, pp 261.

Material examined : Females from Dishergarh and Rondia of West Bengal State.

Female : Body size 2.30 mm. Metasomal wings are large and lamellate; genital segment with a bilobed projection on right and a digitiform process on left margin; urosome 2-segmented. Extremities of body pink coloured.

Family CYCLOPOIDAE

34. *Mesocyclops hyalinus* Rehberg, 1880

1880. *Mesocyclops hyalinus* Rehberg, *H. zoologischer Anzeiger*, 3 : 301-303.

2001. *Mesocyclops hyalinus* Rehberg, *J. Aqua. Biol.*, 16(1-12) : 7.

Material examined : Females from Jarindi, Telumuchu, Jamadoba and Domgarh pumping station, Sindri of Bihar State, Burnpur and Rondia of West Bengal State.

Female : Body size 0.9 mm. A₁ reaching slightly beyond the metasome and consisting of 17 segments; last 2 segments together longer than the previous three; last segment with a smooth hyaline membrane without any notches. Inner spine of P₅ apical or subapical in position on the second segment. Inner terminal spine of P₄ endopod distinctly longer than outer terminal spine and shorter than the terminal segment. Inner margin of the caudal ramus bare.

35. *Mesocyclops aspericornis* (Daday, 1906)

1906. *Mesocyclops aspericornis* Daday, *Math. Termeszl ertes.*, 24 : 34-77.

1907. *Cyclops leuckarti*, *Rec. Indian Mus.*, 1 : 21-33.

Material examined : Females from Domgarh pumping Station, Sindri of Bihar State and DTPS site of West Bengal State.

Female : Body size 0.9 to 1.3mm. A₁ reaching slightly beyond the metasome and 17-segmented; last 2 segments together longer than the previous three hyaline plate of the last segment with several indistinct notches or serration), some times with one deep notch as in male. Inner spine of P₅ at middle of second segment and shorter than the terminal seta. Inner margin of caudal ramus bare. A specific diagnostic character of *leuckarti* is the conspicuously ribbed outer margin of the basis of the maxilla.

DISCUSSION

Twenty eight species of Cladocera, one species of Conchostraca, two species of Ostracoda and four species of Copepoda were collected from eight different sampling stations in Damodar river (Table 1). Among Cladocera *M. spinosa* and *D. crassa* and a cyclopoid copepod *M. hylinus* were found to occur in as many as six collection sites. The species such as *Diaphanosoma sarsi*, *Pseudosida bidentata*, *Scapholeberis kingi*, *Bosmina longirostris*, *Bosminopsis deitersi*, *Chysorus pubescens*, *C. eurynotus*, *Pseudochydoras globosus*, *Alona guttata*, *A. davidi*, *Notalona globulosa*, *Leydigia acanthocercoides*, *Stenocypris distincta*, and *Paracentrocypris canaliculata* are available in only one collection spot (Table 1).

The eight sampling stations have been compared by means of the Sorensen index of similarity for Cladocera. This was calculated for each combination of stations according to the following equation (Sorensen, 1948) : $S = 2C/a+bx100$, where 'C' is the number of species common to both associations, 'a' the number of species in one association and 'b' the number of species in the other association. The resultant Sorensen indices for 28 pairs of stations are given in Table 2. The indices are generally high, reflecting the smaller number of similar species involved and their wide distribution, but the two groups of stations are easily discernible. Jamadoba, Damgarh, Burnpur and Rondia have high-interrelated indices. Telemuchu has less indices showing the amount of pollution Load.

Index of biotal dispersity (IBD) of Koch (1957) was used to assess how widely dispersed the cladoceran species are between a number of stations. $IBD = T-S/S(n-1)X100$ where 'T' is the arithmetica sum of species living in each of 'n' compared associations, and 'S' is the total list of species in 'n' compared associations. If each station had a completely different set of species Cladocera, 'S' would equal 'T' and the IBD would be zero. If each station had an identical set of species 'T' would equal n X S and the IBD would be 100.

When the Koch index for all eight stations is calculated the resulting IBD is 17.4, but if separate indices are calculated for the four stations (Jamadoba, Domgarh, Burnpur and Rondia) there is an increase in the IBD (24) and 14 for rest of the stations. The large increase in IBD when the less polluted stations in West Bengal region (stations 5-8) are considered separately, indicates that these stations resemble each other in their fauna of planktonic Cladocera much more closely than they resemble the polluted stations in Bihar State (Stations 1-4). This is in good agreement with the Sorensen indices. The IBD for Cladocera of Bihar part of Damodar is 15 and the IBD for West Bengal part is 20. The validity of describing members of the zooplankton especially Cladocera as an indicator organism has been questioned by a number of authors because of the lack of basic knowledge of the ecological characteristics and requirements of individual species as well as communities (Bartsch and Ingram, 1966). Sladeck (1973) has extensively reviewed the subject and listed the saprobic indication of over five hundred species of rotifers. Nevertheless, many rotifer species are considered to be indicators of the trophic nature of their habitat (Pejler, 1957;

Table 1. Occurrence of Crustacean Zooplankton at eight different stations of Damodar river (1. Jarindi, 2. Telumuchu Bridge, 3. Jamadoba water works, 4. Domgarh Pump Station, 5. Dishergarh, 7. Singaran (DTPS SITE), 8. Rondia.

	1	2	3	4	5	6	7	8
Phylum Arthropoda								
Class Crustacea								
Subclass Branchopoda								
Order Cladocera								
1. Family SIDIDAE								
Genus <i>Diaphanosoma</i>								
1. <i>Diaphanosoma excisum</i> Sars	-	-	+	-	+	-	-	-
2. <i>Diaphanosoma sarsi</i> Richard	-	-	-	-	+	-	-	-
Genus <i>Pseudosida</i>								
3. <i>Pseudosida bidentata</i> Herrick	-	-	-	-	-	-	-	+
Genus <i>Latonopsis</i>								
4. <i>Latonopsis australis</i> Sars	-	-	-	-	+	+	+	-
2. Family DAPHNIIDAE								
Genus <i>Scapholeberis</i>								
5. <i>Scapholeberis kingi</i> Sars	-	-	-	+	-	-	-	-
Genus <i>Simocephalus</i>								
6. <i>Simocephalus vetulus</i> (O.F.M.)	-	-	-	-	-	+	-	+
Genus <i>Ceriodaphnia</i>								
7. <i>Ceriodaphnia cornuta</i> Sars	+	-	+	-	+	-	-	-
3. Family MOINIDAE								
Genus <i>Moina</i>								
8. <i>Moina micrura</i> Kurz	+	-	+	+	+	-	-	-
4. Family BOSMINIDAE								
Genus <i>Bosmina</i>								
9. <i>Bosmina longirostris</i> (O.F.M)	-	-	-	-	+	-	-	-
Genus <i>Bosminopsis</i>								
10. <i>Bosminopsis deitersi</i> (Richard)	-	-	-	-	+	-	-	-
5. Family MACROTHRICIDAE								
Genus <i>Macrothix</i>								
11. <i>Macrothix spinosa</i> king	+	-	+	+	+	-	+	+
Genus <i>Echinisca</i>								
12. <i>Echinisca triserialis</i> (Brady)	-	+	-	-	-	+	-	+
Genus <i>Ilyocryptus</i>								
13. <i>Ilyocryptus spinifer</i> Herrick	-	-	-	+	+	-	-	-

Table 1. Cont'd.

	1	2	3	4	5	6	7	8
6. Family CHYDORIDAE								
Subfamily Chydorinae								
Genus <i>Chydorus</i>								
14. <i>Chydorus ventricosus</i> Daday	-	-	-	+	-	-	-	+
15. <i>Chydorus reticulatus</i> Daday	-	-	-	+	+	+	-	+
16. <i>Chydorus barroisi</i> (Richard)	+	-	-	-	-	+	-	+
17. <i>Chydorus pubescens</i> Sars	-	-	+	-	-	-	-	-
18. <i>Chydorus eurynotus</i> Sars	-	-	-	-	-	+	-	-
Genus <i>Pseudochydorus</i>								
19. <i>Pseudochydorus globosus</i> (Baird)	-	-	-	-	+	-	-	-
Genus <i>Dunhevedia</i>								
20. <i>Dunhevedia crassa</i> King	-	-	+	+	+	+	+	+
Subfamily Aloninae								
Genus <i>Alona</i>								
21. <i>Alona pulchella</i> King	-	-	+	+	+	-	-	-
22. <i>Alona rectangula</i> Sars	-	-	+	-	-	-	-	+
23. <i>Alona karua</i> King	-	-	+	-	+	+	-	+
24. <i>Alona guttata</i> Sars	-	-	-	+	-	-	-	-
25. <i>Alona verrucosa</i> Sars	-	-	-	-	+	-	+	-
26. <i>Alona davidi</i> Richard	-	-	-	-	-	-	-	+
Genus <i>Notalona</i>								
27. <i>Notalona globulosa</i> (Daday)	-	-	-	-	+	-	-	-
Genus <i>Leydigia</i>								
28. <i>Leydigia acanthocercoides</i> (Fischer)	-	-	-	-	-	-	-	+
Order Conchostraca								
Family CYCLESTHERIIDAE								
Genus <i>Cyclestheria</i>								
1. <i>Cyclestheria hislopi</i> (Baird)	-	+	-	-	-	-	-	+
Subclass Ostracoda								
Order Popocopida								
Suborder Podocopa								
Family CYPRIDIDAE								
Subfamily Stenocyprinae								
Genus <i>Stenocypris</i>								
1. <i>Stenocypris distincta</i> Victor & Fernando	-	+	-	-	-	-	-	-
Genus <i>Parastenocypis</i>								
2. <i>Parastenocypis canaliculata</i> Hartmann	-	+	-	-	-	-	-	-

Table 1. Cont'd.

	1	2	3	4	5	6	7	8
Subclass COPEPODA								
Suborder Calanidae								
Family DIAPTOMIDAE								
Genus <i>Rhinediaptomus</i>								
1. <i>Rhinediaptomus indicus</i> Kiefer	–	–	+	–	–	–	+	–
Genus <i>Paradiaptomus</i>								
2. <i>Paradiaptomus greeni</i> Gurney	–	–	–	+	–	–	+	–
Family CYCLOPIDAE								
Genus <i>Mesocyclops</i>								
3. <i>Mesocyclops hyalinus</i> Rehberg	+	+	+	+	–	+		+
4. <i>Mesocyclops aspericornis</i> (Daday)	–	–	–	+	–	–	+	–

Table 2. Sorensen indices for Cladocera from eight stations on Damodar River.

	Jarandhi	Telumuchu	Jamadoba	Domgarh	Burnpur	Disherghar	Singar	Rondia
Jarandhi	–	0	46	31	46	17	25	25
Telumuchu	0	–	20	20	12	22	40	15
Jamadoba	46	20	–	44	40	24	31	38
Domgarh	31	20	44	–	48	24	31	38
Burnpur	46	20	40	48	–	33	40	29
Disherghar	17	22	24	24	33	–	33	60
Singaran	25	40	31	31	40	33	–	25
Rondia	25	15	38	38	29	60	25	–

Arora, 1966; Hodgkinson, 1970). The dominance of certain eurytopic Cladocera found in the present study in the polluted regions of the Damodar river such as *C. cornuta*, *M. micrura*, *M. spinosa* and *C. barroisi* can be used as an indicator of pollution as found in other studies (Campbell, 1939; Gaufin and Tarzwell, 1952; Hynes, 1959).

SUMMARY

In tropical part of world including India, extensive survey of river zooplankton is scanty and scrapy than the temperate. In view of filling up the gap in the knowledge on this potamofauna, to begin with, Damodar river was taken up for study. A total of eight stations, four in Bihar and four

in West Bengal of Damodar river were studied for their crustacean zooplankton. Among the zooplankton collected such as Cladocera, Conchostraca, Ostracoda and Copepoda, Cladocera dominated with 28 species, 18 genera and six families. *Ceriodaphnia cornuta*, *Moina micrara*, *Macrothrix spinosa* and *Chydorus barroisi* were found to occur in most polluted regions of the river. Jamadoba, Domgarh, Burnpur and Rondia have high interrelated Sorensen indices with high IBD (24) when compared to other polluted stations (14).

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ON THE INDIAN SPECIES OF *HALTICOPTERA* SPINOLA (HYMENOPTERA : CHALCIDOIDEA : PTEROMALIDAE)

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INTRODUCTION

Halticoptera Spinola belongs to the subfamily Miscogasterinae of Pteromalidae (Chalcidoidea) and is widely distributed in Europe and the Americas (Boucek, 1988). The members of the genus are parasites of Diptera mining leaves or burrowing in other tissues of herbaceous plants or ferns. In the Indian subcontinent the genus is known by a single species *H. propinqua* (Waterston) from Sri Lanka, India and Pakistan. Here one new species *H. agaliensis* is described under the genus and *H. propinqua* is reported for the first time from Kerala. Key to separate these species is provided. Based upon the study of the holotype of *H. propinqua* and fresh specimens from Kerala, the species is redescribed.

The type specimens of the new species are kept in the collections of Western Ghats Field Research Station, Zoological Survey of India, Calicut.

ABBREVIATIONS USED

F1-First funicular segment; OOL-Ocellocular distance; POL-Postocellar distance; T1, T2-gastral tergites 1 and 2; Smv-Submarginal vein; Mv-Marginal vein; Pmv-Post marginal vein; Stv-Stigmal vein; BMNH-British Museum of Natural History, London; ZSIC-Zoological Survey of India, Calicut.

Key to the Indian species of *Halticoptera*, females

1. Median area of propodeum finely but distinctly reticulate; gaster with posterior margin of T1 deeply incised in the middle (Fig. 3); petiole a little wider than long; forewing with Mv $3.5 \times$ Stv (Fig. 4); POL sub equal to OOL; frenal area of scutellum moderately reticulate; hind femora metallic; fore and mid femora dark brown, length 2.3-2.5 mm. India
..... *H. agaliensis* sp. nov
- Median area of propodeum smooth and shiny; gaster with hind margin of T1 only very slightly incised in the middle (Figs. 6 & 9); petiole a little longer than wide; forewing with

Mv $2.6 \times$ Stv (Figs. 7 & 9); POL $1.4 \times$ OOL; frenal area finely reticulate; all femora honey yellow, not metallic; smaller species; length 1.3-1.6 mm. India, Sri Lanka, Pakistan
 *H. propinqua* (Waterston)

1. *Halticoptera agaliensis* sp. nov.

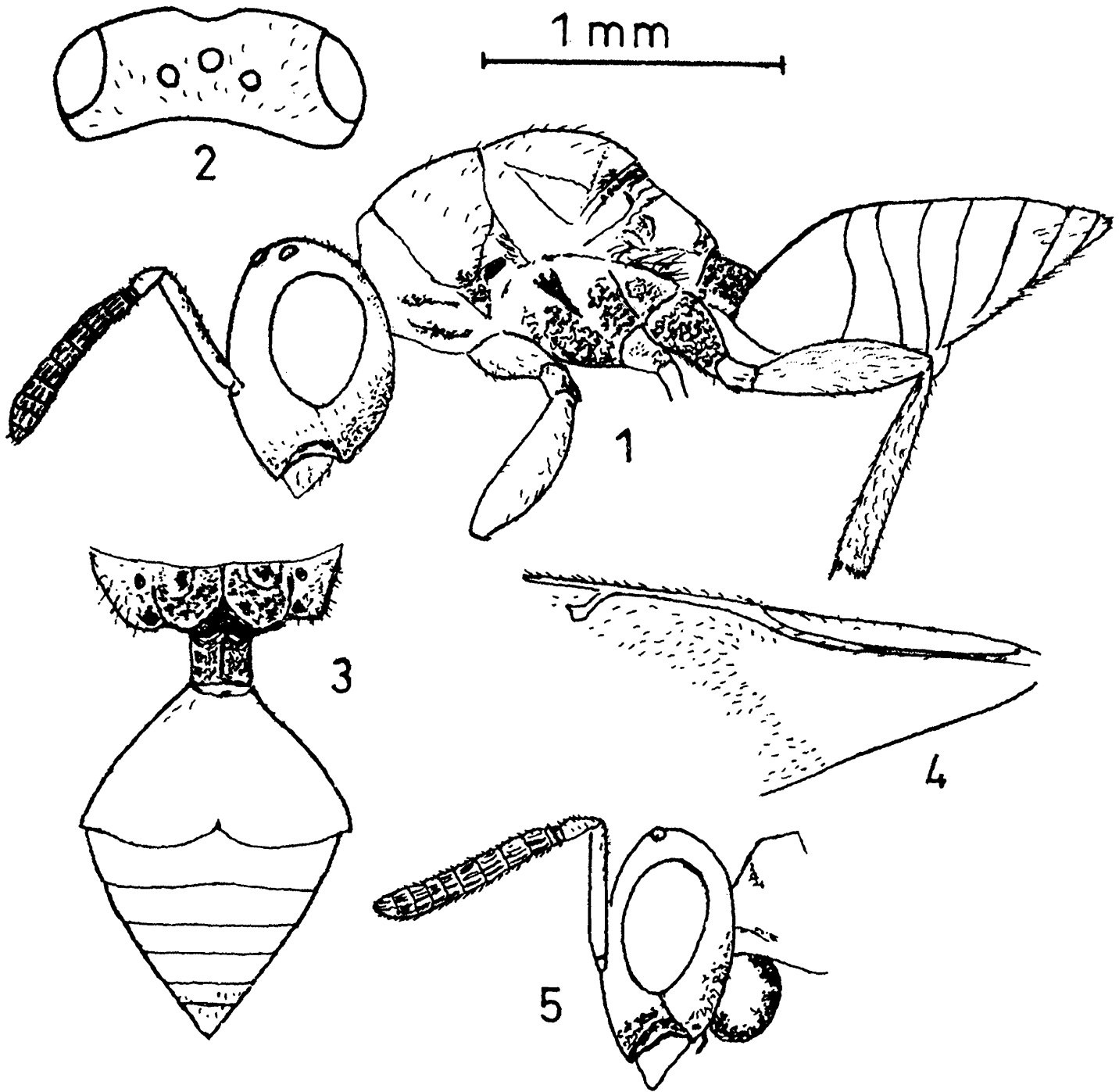
(Figs. 1-5)

Female : Length 2.3-2.5 mm (Holotype 2.5 mm). Body dark metallic blue with more metallic refringence on gaster. Antennae with basal half of scape testaceous, remainder dark brown; coxae concolorous with mesosoma; femora dark brown, metallic blue reflection on hind femora; remainder of legs honey yellow with tips of tarsi brown. Tegulae pale brown; wings hyaline; veins pale brown.

Head : (Figs. 1 & 2) Uniformly and moderately reticulate with sparse white pubescence, reticulation coarser on upper frons and vertex; clypeus finely reticulate, anterior margin deeply incised medially with two sharp teeth. In dorsal view head width $1.9 \times$ length; POL sub equal to OOL; head behind ocelli abruptly sloping so that occiput almost vertical; temple length $0.3 \times$ eye length. In front view head width $1.3 \times$ height; malar space length $0.44 \times$ eye length; malar grooves distinct; eyes separated by $1.6 \times$ their length; eye length $1.4 \times$ width (in profile). Antennae inserted along the line of lower ocular boarder; scape not quite reaching median ocellus, as long as eye; pedicel plus flagellum length $0.8 \times$ width of head; pedicel longer than Fl; anelli transverse, equal; funicular segments quadrate, little widening towards the tip; clava as long as 2.5 preceding segments combined.

Mesosoma : Coarsely reticulate, pronotal collar not margined anteriorly, but with slight indication of a ridge medially due to raised edges of reticulation; posterior smooth strip narrow. Mesoscutum width $2 \times$ length; notauli almost complete, though not clear in the posterior half. Scutellum as long as wide, reticulation on frenal area closer but not finer; axillae wide anteriorly so that anterior margin of scutellum narrow. Propodeum (Fig. 3) with median area finely but distinctly reticulate; median carina sharp and complete; plicae distinct as far forwards as spiracles; callus with long white hairs. Prepectus broad, reticulate punctate. Mesepisternum closely reticulate. Mesepimeron with broad reticulation on lower part, separated by a longitudinal alveolate groove from the smooth upper part. Metapleuron finely reticulate with a deep pit towards the posterior corner. Hind coxae reticulate; hind femora alutaceous. Forewing length $2.3 \times$ width; basal part almost bare; marginal fringe small. Relative lengths of Smv, Mv, Pmv and Stv as 33 : 19.5 : 11.5 and 5.5.

Gaster : (Figs. 1 & 3) Cordiform, length $1.4 \times$ width in dorsal view; petiole finely reticulate with distinct median and lateral ridges, a little wider than long; T1 occupying about half of gaster length, posterior margin deeply incised.



Figs. 1-5. *Halticoptera agaliensis* sp. nov. 1-4, Female. 1, Body in profile; 2, Head in dorsal view; 3, Propodeum and gaster in dorsal view; 4, Forewing; 5, Male Head and antenna in profile.

Male (Fig. 5) Length 2.3 mm. Resembles female but differs in having more metallic refringence on body, antennae uniformly testaceous, legs except coxae testaceous, maxillary palpi and stipites moderately enlarged and shorter gaster.

Holotype Female : India : Kerala; Agali (Palghat district), 12.ii.1987, Coll. P. M. Sureshan. (ZSIC)

Paratypes 1 Male, data same as that of holotype. 1 Female, Kerala : Calicut University campus, 3.ii.1987. Coll. P. M. Sureshan. (ZSIC)

Remarks : This species resembles the British species *H. letitiae* Askew (1972) having finer reticulation on median area of propodeum; gaster with T1 medially incised, metallic femora and in the nature of antenna. But it differs from *letitiae* in having Mv of forewing longer, 3.5x Stv and distinctly longer than Pmv; frenum closely reticulate, not marked by a groove; pronotal collar with a narrow shiny posterior strip and gaster longer than mesosoma (excluding propodeum). In *letitiae* Mv shorter, only 1.6x Stv and only slightly longer than Pmv; frenum almost smooth, marked by a groove; pronotal collar with a broad shiny strip posteriorly and gaster as long as mesosoma (excluding propodeum).

Etymology The species name pertains to the type locality.

2. *Halticoptera propinqua* (Waterston)

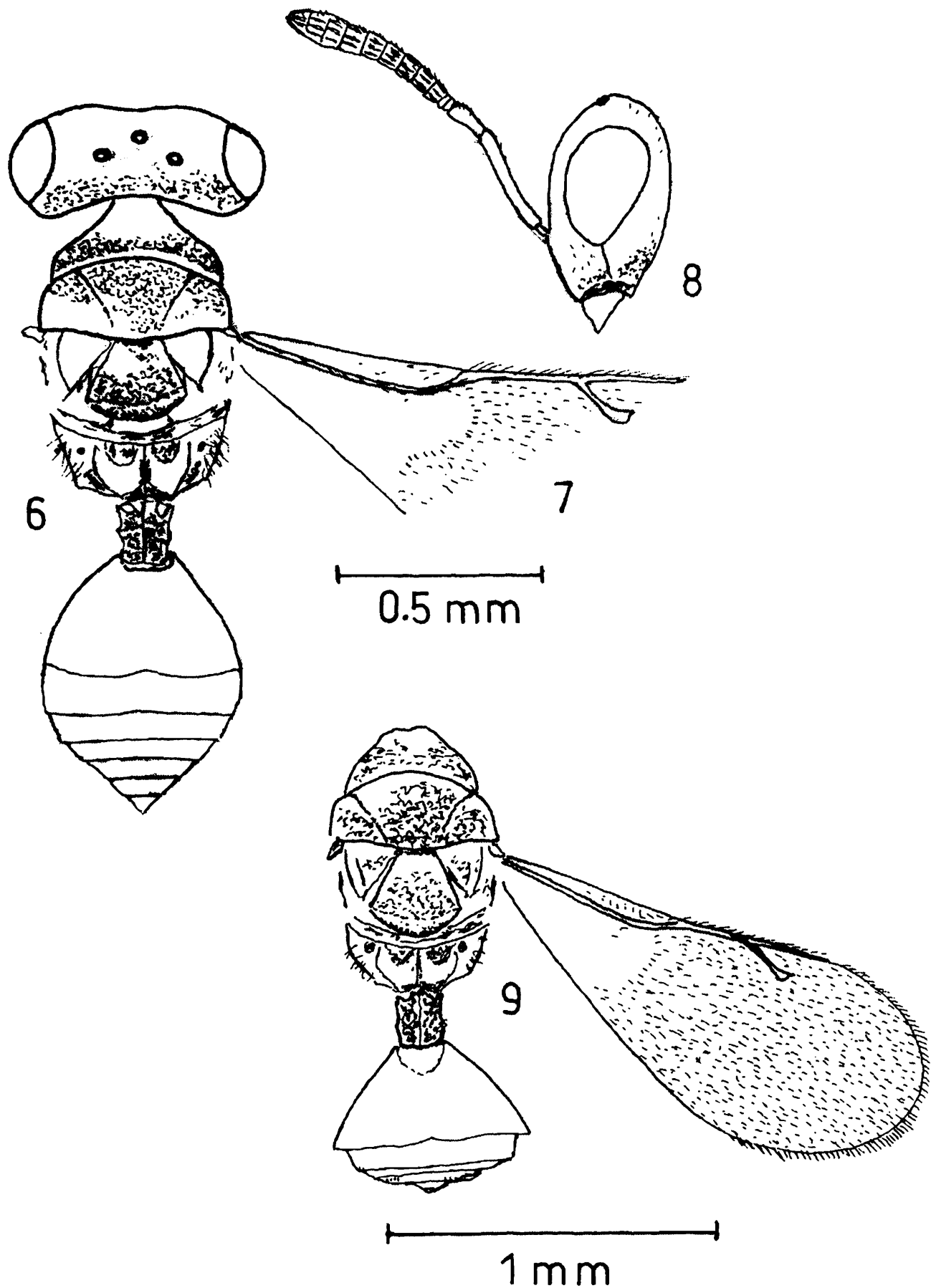
(Figs. 6-9)

Polycystus propinquus Waterston, 1915. 325. Male. Sri Lanka, Paradeniya (BMNH) (Examined). Syn. by Boucek et al. 1979.

The original description of the species by Waterston (1915) was based on a male specimen from Sri Lanka. Boucek et al (1979) reported the species from India (Delhi, Hyderabad). I have examined the holotype of the species in BMNH remounted by Boucek, which is in poor condition without head and antenna. I have also examined fresh specimens from Kerala, based upon which the species is redescribed.

Female Length 1.3 – 1.6 mm. Head, mesosoma and petiole dark metallic bluish green; gaster brown. Antennal scape testaceous, except distal tip and remainder of antenna brown. Coxae concolorous with mesosoma, except middle coxae brown, legs otherwise yellow except tips of tarsi dark brown. Tegulae brown; wings hyaline; veins pale brown.

Head : (Figs. 6&8) About 1.26x as broad as mesosoma (24:19). In dorsal view, width 2.2x length and in front view width 1.3x height; POL 1.4x OOL; temple length 0.3x eye length. Head closely and distinctly reticulate, reticulation coarser on frons and vertex; malar space length little more than half length of eye; eyes separated by 1.4x their length. Antennae (Fig. 8) inserted along lower ocular line; scape slender, slightly curved, reaching little beyond median ocellus, length slightly greater than eye length; pedicel plus flagellum length 0.9x head width; pedicel longer than



Figs. 6-9. *Halticoptera propinqua* (Waterston). 6-8, Female. 6, Body in dorsal view; 7, Forewing; 8, Head and antenna in profile; 9, Body (without head) in dorsal view, Holotype, ♂.

anelli and F1 combined; anelli transverse; F1 shortest; all funicular segments transverse, gradually widening towards the tip; clava almost equal to three preceding segments combined.

Mesosoma : Reticulate, moderately arched in profile, reticulation coarser and broader on mid lobe of mesoscutum. Pronotal collar rounded anteriorly with a smooth strip posteriorly. Mesoscutum width 2x length; notauli complete. Scutellum convex, as long as broad, reticulation finer on frenal area. Dorsellum shiny. Propodeum (Fig. 6&9) shiny with two broad foveae anteriorly on either side of median carina, interior of which is finely reticulate; plicae complete; spiracles very small; callus with few scattered hairs. Propodeum width 1.8x length in dorsal view. Forewing length 2.5x width; basal cell almost bare with one or two hairs on basal hair line; Mv 1.5x Pmv and 2.6x Stv. Relative lengths of Smv, Mv, Pmv and Stv as 22 : 13 : 8.5 and 5.

Gaster (Fig. 6) Ovate, petiole distinctly reticulate, little longer than wide, with distinct median carina. In dorsal view gaster length 1.3x width; T1 occupying little more than half length of gaster; hind margin of T1 and T2 very slightly incised in the middle, almost straight; hypopygium reaching little beyond middle of gaster.

Male : Length 1.6 mm. Resembles female but differs in having more metallic reflection on body, antennae uniformly testaceous with clava little darker and gaster short.

Material examined Holotype, Male of *H. propinqua* (Waterston) (BMNH collection. No. 5874) CEYLON : Paradeniya, 22.vii.1913. Coll.A.Rutherford; 1 Female, INDIA : Kerala, Mananthavady, (Wynad district), 22.ii.1988; 1 Female, Kerala, Manjeswaram (Kasaragod district), 27.ii.1988; 1 Female, Thariyod (Wynad district), 22.ii.1988; 1 Male, Kerala : Kottiyam (Nr. Trivandrum) 23.ii.1989. (Coll.P.M.Sureshan).

Remarks This species closely resembles *H. circulus* (Walker) in general colouration, in having pronotal collar anteriorly rounded; propodeum with median area smooth, narrow forewing and gastral petiole little longer than broad and in males inflated part of maxillary stipites small, but differs in having Mv of forewing 2.6x Stv, basal cell almost bare with one or two hairs on the basal hair line, reticulation on scutellum comparatively finer, little raised and frenal area almost shiny (in *circulus* Mv almost twice as long as Stv, basal cell of forewing with atmost 5–9 hairs, reticulation on scutellum distinctly raised).

SUMMARY

One new species of *Halticoptera* Spinola viz., *H. agaliensis* is described from India. *H. propinqua* (Waterston) is redescribed and reported for the first time from Kerala.

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Short Communication

FIRST REPORT OF A HITHERTO UNKNOWN LARVAL FOOD PLANT OF THE BROWN KING CROW, *EUPLOEA KLUGII* MOORE (LEPIDOPTERA : INSECTA)

The caterpillars of the Brown King Crow butterfly, *Euploea klugii* Moore (synonym : *Euploea crassa* Butler), are known to feed on *Ficus hispida* and *Streblus asper*, members of the plant family Moraceae (Wynter-Blyth, 1957., Kunte, 2000). In the present communication, we are reporting *Ficus tinctoria* (Fam : Moraceae) as a host plant of the Brown King Crow for the first time.

On 17, August 2001, we noticed a caterpillar (Fig. 1) feeding on a *Ficus tinctoria* plant growing by the side of a compound wall in Calicut city, Kerala. The fig plant locally known as 'Ithi' or 'Kal-Ithi' is common throughout the Calicut city, often found growing on compound walls and ill-maintained buildings. The caterpillar appeared similar to that of the Common Indian Crow, *Euploea core* (Cramer). The full grown caterpillar was highly voracious and consumed one full leaf of the plant within 25 minutes. The caterpillar was taken and reared in lab. It pupated 3 days later. The pupa (Fig. 2), unlike that of *E. core*, was larger in size and lustrous green in colour with golden lines on the wing margins, its predominant green colour making it not so easy to be located on the leaf on which it was attached. Eight days after pupation, the butterfly (Fig. 3) emerged from the pupa. It was a male specimen and identified as the Brown King Crow belonging to the subspecies *Euploea klugii kollari* C. & R. Felder.

E. k. kollari occurs mainly during the monsoon. While on the wing, it can easily be mistaken for the Common Indian Crow, *E. core* and the Double-branded Black Crow, *E. sylvester* (Fabricius) to which it resembles. However, *E. k. kollari* can be distinguished by the following combination of characters that the species possesses. Wings black, marked with white marginal and terminal spots; wings broader than in *E. core* and *E. sylvester*; upper surface of the wing, in male, with a short, broad band (band short but not broad in *E. core* and two bands, parallel and longer in *E. sylvester*) and upper surface of the hind wing with a large, pale brownish- yellow area in and above the cell (not found in *E. core* and *E. Sylvester*). Besides these distinguishing characters, in the female of *E. k. kollari*, undersurface of the forewing may or may not have a white streak in interspace 1b, whereas *E. core* possesses a short whitish streak (not minute as in *E. klugii*) and *E. sylvester* has two similar streaks. In addition, females of the Common Indian Crow and the Double-branded Black Crow have a spot in the cell on the undersurface of the forewing, which is lacking in the Brown King Crow.

With its four subspecies namely, *E. k. kollari* C. & R. Felder, *E. k. sinhala* Moore, *E. k. klugii* Moore and *E. k. erichsonni* C. & R. Felder, the Brown King Crow is usually a butterfly of low elevations preferring wet jungle country (Talbot, 1947). Nevertheless, the butterfly can be found, at times at higher elevations while migrating. The species is found in India, Sri Lanka, Bangladesh, Myanmar, Bhutan, Nepal, east to Indo-China and Sumatra (Wynter-Blyth, 1957; Larsen, 1987; Mondal and Maulik, 1997). Within Indian limits, *E. klugii* Moore occurs in southern India (The Malabar coast, the western ghats and the eastern ghats), Orissa, Bengal and North-eastern India (Assam, Meghalaya, Nagaland and Sikkim). The subspecies exhibiting brilliant blue gloss on wings, found in the North-eastern India belong to *E. k. klugii*. Though the species is locally common in Sri Lanka and North-eastern India, it is local and rare in southern India.

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PLATE - I



1



2



3

Fig. 1. The Caterpillar of *E. k. kollari* on *F. tinctoria* leaf.

Fig. 2. The pupa of *E. k. kollari* on *F. tinctoria* leaf.

Fig. 3. The adult male of *E. k. kollari*.